Measuring SWR and Things Every CB'er Should Know

PLUS NEW SPECIAL SECTION ON COAX CABLE PROCESSING

from Firestik®; Antenna Co. Technical Support

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SWR TESTING OF MOBILE TRANSMIT ANTENNAS

SWR (standing wave ratio) is a term every CB'er should know. SWR (measured with an SWR meter) shows you how well your coax, antenna mount, ground plane and antenna match the output capability of your CB radio. It is a ratio of maximum voltage or current to minimum voltage or current. Generally speaking, the lower the ratio the better. Defective or inferior components, bad installations and antennas not tuned to the specific location on the vehicle increases the SWR. You should strive to achieve a ratio below 2:1 on all channels.

Before measuring and setting SWR, it is helpful to know some of the things that can cause problems. Spend a few minutes to read this entire pamphlet and you will go into your project with valuable knowledge. It could save you a lot of time, effort and possibly, money.

Unlike receive only antennas (AM/FM radio, TV, scanner), antennas that transmit require tuning. Antenna manufacturers can supply you with an antenna that is pre-tuned to the general frequency of the intended equipment, but they cannot promise you perfect performance "out of the box". The six needed components for a mobile installation are the radio, power feed, coaxial cable, antenna mount, antenna, and ground plane (counterpoise). Even if the manufacturer supplies you with an entire kit (coax, mount & antenna), this, in most cases, leaves you without the counterpoise requirement. There is an exception to this general rule; antenna systems that use the coax cable as a counterpoise. These no-ground-plane kits are generally marketed to owners of fiberglass vehicles. However, for most applications, the mobile antenna will use the vehicle's body as counterpoise. Unless otherwise stated, the following information pertains to installations that DO NOT use coaxial counterpoise antennas.

The vehicle, in mobile installations, is just as important as the antenna and other components. The antenna

is the radiating unit, the vehicle is the reflecting unit. All transmit antennas need a reflective unit. What effect does the vehicle have? Plenty! If you were to install and tune your antenna on a bumper mount then move it to the roof, you would see a change in the SWR. This is due to the change in the antenna's position relative to the vehicle surface. Location is important.

It isn't always feasible, or practical to mount the antenna in the optimum position on any vehicle. Nonetheless, whenever you set aside performance for convenience, you will need to settle for what you can get. Regardless, plan on tuning your antenna. Tuned antennas will give you the best performance you can expect from an antenna mounted in any given location. Most of all, remember that untested installations can cost you big bucks. Operating transmitting radios when the SWR is over 3:1 can damage the radios circuits. Always check your SWR and tune your antenna.

There is a lot to know about transmitting antennas. Even if you have your system installed by a professional, it is helpful for you to know what can effect its performance. The following list was compiled from 20 plus years of technical support files. It represents the areas where most of the performance robbing problems crop up. We highly recommend that you read it. The problems and solutions came from real life situations. Starting with knowledge is always better than learning from disappointment. A step by step SWR measuring and antenna tuning procedure follows this very informative list.

THINGS EVERY CB'ER SHOULD KNOW

1. Every industry has its bottom dwellers. We cannot protect you from them. Consumers who make decisions based strictly on price, or on what someone says instead of what they can do, will often fall prey to the bottom dwellers.
2. Beware of information from "experts" (real or self-proclaimed). There is antenna theory and there is antenna reality. We have yet to see a vehicle that simulates a lab. While theory is a good starting place...experience is the only place to end up. The best book on theory will produce the worst antenna you could own.
3. Some "experts" may "claim" 5/8 wave mobile antennas are not possible because they would need to be 23 feet high. They are wrong! Physical length and ground wave performance are not the same. If you ever hear someone make that claim, ask them how a handheld CB can have a 1/4 wave antenna 8 inches long and 1/4 wave mobile antennas from 12-60 inches long in spite of the fact that a physical 1/4 wave is 108 inches.
4. Never key up or attempt to operate your CB without a working antenna or "dummy load" (non-radiating antenna simulating device) connected to the radios antenna jack, unless you have extra money to buy another radio.
5. All mobile and base transmitting antennas need counter-poise, more commonly called ground plane. The antenna is the reactive unit, the ground plane is the reflective unit. Neither is more important than the other. In mobile installations with standard antenna systems, the vehicle metal (body, frame, etc.) acts as the ground plane. In "no-ground-plane" systems, the coax shield is used for counterpoise.
6. Most, but not all, manufacturers pre-tune their mobile antennas on a test bench. To protect your radio's circuitry and achieve optimum performance, mobile transmitting antennas (CB, cell phone, amateur, etc.) need to be tuned on the vehicle.
7. Before transmitting, you should check your antenna system for shorts or opens. If you have continuity between the center pin of the connector and the outer threaded housing, you may have a short. Don't transmit! If you do not find continuity between the center pin of the coax and the antenna base, you have an open. Fix it. (See "Testing Continuity") Exceptions: Some base loaded antennas use a center tap design and there will be continuity from ground to center conductor. Also, Firestik "No Ground Plane" antenna kits will have coaxial center pin to ground continuity.

8. SWR that pegs the needle on all channels almost always indicates a short in your antenna system. Do not attempt to tune the antenna until the short is fixed. Operating with high SWR will probably damage your CB's internal circuits.
9. Make sure that the antenna you are using is the right antenna for your application. Don't use a TV antenna or an AM/FM antenna for your CB. Do not operate your CB without an antenna or dummy load.
10. Transmitting antennas are sensitive to objects in their "near field of radiation." Tune your antennas in an open area. Never tune inside or next to a building, near or under trees, near or under power lines, and never with a person holding or standing next to the antenna. Try to simulate normal operating conditions.
11. If you mount two or more antennas close to each other, you will alter the transmission patterns of each one. The affect may be either positive or negative. We recommend that a minimum of 12" exist between your CB antenna and other types of antennas.
12. Your radio cannot tell one component from another. As far as the radio is concerned, the coax, stud mount, mounting bracket, antenna and vehicle is ONE unit. Don't be too quick to fault your antenna until you are sure that all of the other components have been given equal consideration.
13. Of all antennas returned to Firestik for warranty service, 75% show no signs of being tuned to the vehicle. All antennas should be checked prior to use. Most will require some adjustment. Less than 3% of all returned antennas have actual performance causing problems. Of those, half of the problems are user or installer created. High SWR and other performance problems are 20 times more likely to be caused by bad coax, bad connections, shorted mounts, poor installation location or faulty test meters.
14. In almost every instance, once you get the same SWR reading on channels 1 and 40, further antenna tuning will not improve the readings. If the SWR is still over 2:1, you have other problems to conquer. Exception: There are rare occasions when the ground plane is so small or large that the system is way out of phase (especially with high-performance antennas). If you have high SWR on all channels and have confirmed that you have no opens or shorts in the feedline, try making a small tuning adjustment in the antenna. There are times when the SWR will drop equally across all channels under unusual ground plane conditions. If you find this to be the case, carefully adjust the antenna.
15. SWR that is high on all channels (over 2:1 but not pegging the needle) after the antenna has been tuned normally indicates a ground plane or coax cable problem.
16. The doors, mirrors, spare tire racks, luggage racks, etc. on many vehicles are insulated from a good ground with nylon or rubber bushings. This also stands true for fiberglass vehicles. Make sure that your antenna mount is grounded, even if it entails running a ground wire to the vehicle chassis. Bad hard ground at the mount generally equates to less than optimum performance. Exception: No ground plane antenna kits do not require a grounded mount.
17. If you are hearing whining noises from your radio while your vehicle is running, it is probably due to "dirty power" being supplied to the radio. Under dash power may be more convenient, but the "cleanest" power will be found by running the radio's power leads straight to the battery.
18. You can never buy coax cable that is too good for your system. Never compromise quality for cost when purchasing coax. Your best bet is to stick with coax that has a stranded center conductor and 90% or higher shielding.
19. Most manufacturers of high performance antennas recommend a specific length of coax cable. If your antenna manufacturer suggests a specific length, give priority to that recommendation.
20. If your ground plane is good, your mount grounded and, your antenna favorably located, coax length rarely becomes an issue. But, if one or more mismatches occur, you may find high SWR. This can often be corrected by using 18 feet lengths of high quality coax.
21. Excess coax between your radio and antenna mount should never be wound into a circular coil of less than 12" in diameter. Doing so can cause system problems. Your best option for handling excess coax is to serpentine the cable into a 12 to 18 inch yarn-like skein. Secure the skein in the

center with a wire tie and tuck it away.

22. Single antenna installations require coax with approximately 50 ohm's of resistance (RG-58/U, RG-58 A/U or RG-8X). Dual antenna installations require the use of 72 ohm cable (RG-59/U or RG-59 A/U).
23. Coaxial cables with foam (polyfoam) center conductor insulation should be your last choice for use on mobile (vehicle) installations. Even though it will work initially, it has limited life and does not stand up to the conditions encountered in the mobile environment. Choose coax with polyvinyl insulation when doing mobile installs.
24. Coax cables should never be cut and spliced together like common electrical wire. Line losses will occur.
25. Coaxial cable with holes in the outer insulation, severe bends, or door, trunk or hood caused pinches will cause performance problems. Treat your coax with care.
26. If you live in an area where rain and/or sleet is common, wipe your antenna down with a rag that has been coated with WD-40, Armor-All, Pledge, light oil, etc. This trick prevents ice build up that can overload and cause your antenna to break. In an emergency use butter, cooking oil or anything else that will repel water.
27. When tuning your antenna(s), make sure that you do so with the vehicle doors, hood and trunk closed. If left open, they can cause inaccurate SWR readings. Try to simulate actual operating conditions.
28. Mobile antennas, for best performance, should have no less than 60% of their overall length above the vehicles roof line. For co-phased antennas to perform optimally, the space between the top 60% of the two antennas needs to be unobstructed.
29. Remember, all transmitting antennas need ground plane (counterpoise). Base antennas, much like "no ground plane" antennas, build it in. Do not use mobile antennas for base station applications unless you know how to build your own ground plane.
30. If you are installing a single antenna on one side or the other of your vehicle, best on-the-road performance will be realized if the antenna is on the passenger side of the vehicle.
31. Co-phased (dual) antenna installations create a radiation pattern that favors communication directly in front and back of the vehicle. This is why co-phase systems are popular with people who do a lot of highway driving. Co-phase antennas must be center or top loaded. Top loaded antennas are the best.
32. Some people believe that co-phased antennas must be separated by a minimum of nine (9) feet. We have successfully used co-phase antenna systems with spacing as little as four (4) feet. Space alters the pattern and not always negatively. Each vehicle will be different.
33. Co-phase antennas can improve performance on vehicles that lack good ground plane characteristics (fiberglass motorhomes, trucks, etc.). Instead of using available metal to reflect the radiated energy, the antennas use each others field.
34. When tuning co-phased antennas (dual), it is best to adjust both antennas an equal amount to maintain equality in their individual resonant frequency.
35. On a co-phase system, if you try to tune each antenna independently using RG-58 type coax and then connect them to the co-phasing harness, you will almost always find that they will appear electrically short as a set. We recommend that you first assemble the entire system. Take all measurements and make all adjustments with both antennas in place.
36. If you are experiencing SWR that is high across the entire band and have eliminated shorts, opens, groundless mounts and coax as potential problems, suspect lack of ground plane. Try adding a spring or quick disconnect to the antenna base. In some cases, the repositioning of the antenna relevant to available ground plane will solve the problem.
37. One of the greatest benefits of the FS series (patented tunable tip) antenna is noted when there is lack of available ground plane. If the tuning screw reaches its "maximum out" position before satisfactory SWR is realized, a common 1/4-20 threaded bolt or screw of a longer length can be used to replace the supplied tuning screw. If the vinyl cap is too short to remain in place, the user

used to replace the supplied tuning screw. If the vinyl cap is too short to remain in place, the user can disregard it or clip a hole in the top for the longer screw to pass through.

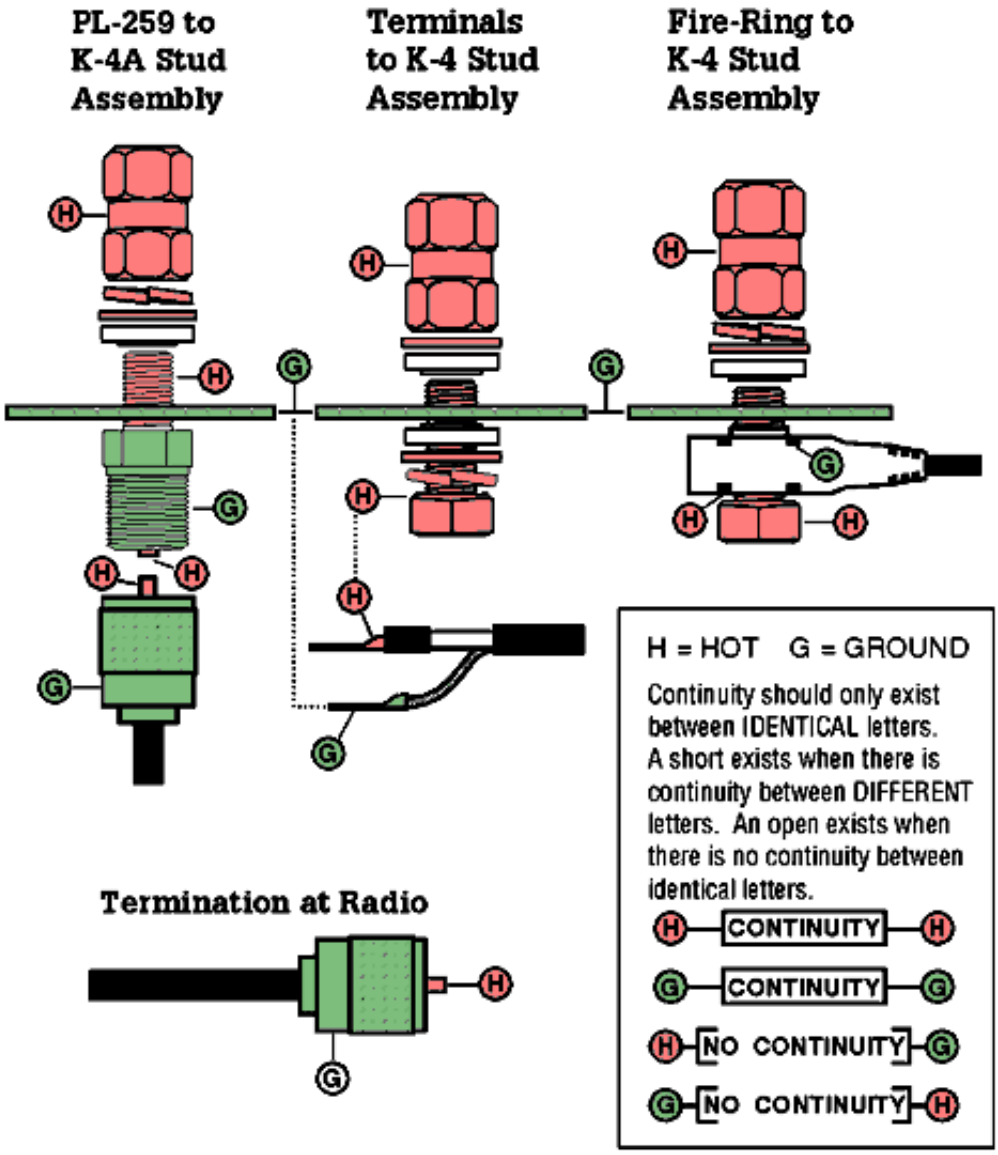
38. In rare instances, like antennas mounted in the middle of a metal van roof, excess ground plane can cause a problem. This usually shows up as high SWR across the band. In these cases, a tunable tip antenna may not be the best choice. The reason being, the antenna is too long and the tunable tip cannot adjust down far enough (see line 40). If you suspect this, an antenna that wire can be removed from will usually fit the bill (i.e. KW or RP series).
39. There may be situations when a tunable tip will bottom out before optimum tuning is achieved. If this happens, try removing the knurled jam nut and finger tighten the tuning screw against the o-ring. If still too long, remove the tuning screw altogether. If total removal causes the antenna to go short, cut the tuning screw in half and re-insert it into the tuning extender and re-test. The following items on the FS Series "tunable tip" antennas, when removed, will have an effect on SWR (in order from least effect to most effect). O-ring, jam nut, tuning screw mass (cutting off length), vinyl cap, tuning screw complete.
40. The vinyl cap on any "tunable tip" Firestik antennas is optional. However, your antenna needs to be tuned as it will be used . . . with or without the tip.
41. Magnetic mounts should be used in temporary situations only. If you leave them in the same spot for a long period, the paint will not age like that of the uncovered areas and/or moisture will be trapped between the mount and vehicle causing rust or discoloration. Periodically lift the magnet and gently clean off the underside of the magnet and the vehicle surface.
42. It is a bad idea to use magnetic mounts and amplifiers together. Magnetic mounts rely on capacitance grounding. This situation can literally cause the paint under the mount to bubble or discolor due to excessive heat build up.
43. On wire-wound antennas that require wire removal for tuning purposes, best overall performance will be achieved by keeping the loose end of the wire pressed down tightly against the wire coil. If you use power amplification on top loaded antennas and do not process the end of the wire load so it can dissipate its heat into other adjacent coils, you can melt the tip of the antenna.
44. Generally speaking, center loaded antennas perform better than base loaded antennas, and top loaded antennas perform better than all. For any given antenna design (base, center or top loaded), the taller the antenna the better. With length comes a wider bandwidth (lower SWR over more channels), more power handling capability and overall performance increases.
45. When ultimate mobile performance is desired, function should be given precedence over mounting location convenience and appearance.
46. Don't confuse SWR with overall performance. You should seek SWR of 2:1 or lower on channel 1 and 40, but keep in mind that best performance may not be found at the lowest SWR readings. For the most part, if you get your SWR below 2:1, on both ends of the band, don't be overly concerned about using meter tricking procedures that bleed off energy.
47. The SWR meters built into CB radios are okay for general readings, but are rarely sensitive and/or accurate enough for fine tuning of antennas. Use them mostly to indicate serious high SWR problems only.
48. Firestik has tested literally hundreds of SWR meters. A large percentage of these have shown to be off by 0.3 to 0.7 when compared to a piece of certified equipment. There is no standard among production meters. However, unless a unit is defective, most will indicate the most serious problems that you might encounter
49. Aside from cost, the type of wire used in or on antennas (copper, silver, aluminum, gold, tinned, etc.) has negligible effect on antenna performance. The antenna must be designed to resonate with the wire type and gauge chosen by the designer. However, larger wire gauges will normally increase the bandwidth and heat dissipation abilities of the antenna.
50. Copper is 55% better than aluminum, 27% better than gold and 578% better than tin insofar as conductivity is concerned. Silver will conduct AC/DC current less than 2.5% more efficiently than copper, but the cost to performance is generally unjustified and any gain, insofar as RF transmission is concerned, is negligible.

is concerned, is negligible.

51. If devices other than an SWR meter are going to be used between the CB radio and antenna, always tune the antenna system first without that device in line. If SWR is high with the other device in line, you will know where the problem is.
52. In "no ground plane" systems, it is best to choose a system that terminates the coaxial ground at the radio end of the cable. These systems are far less reactive to cable routing errors and will almost always outperform systems that are terminated at the antenna base or antenna end of the coax.
53. Cables and antennas from standard & no-ground plane kits are not interchangeable. The "No Ground Plane" antennas from Firestik have a yellow band near the base.
54. Wire wound antennas with a plastic outer coating will greatly reduce audible RF static when compared to metal whip antennas.
55. If you leave your antenna on your vehicle permanently, remove the rubber o-ring that is found on the threaded base of some antennas. Tighten permanent antennas with a wrench. Add a lock washer if you want.
56. If you use mirror mounts and often find yourself in areas with overhead obstructions, tighten the bolts just enough to keep the antenna vertical at highway speeds. If the antenna contacts something overhead, the mount will rotate on the mirror arm and protect your antenna.
57. If you use long antennas and find that they bend too far back at highway speeds, tilt them forward if possible. When under a wind load, they will end up in a relatively vertical position.
58. On antennas that are topped off with a vinyl tip, make sure that you take your SWR measurements with the tip in place. If you tune your antenna with the tip off and then reinstall the tip, your SWR will change.
59. Without advocating the use of power amplifiers or unauthorized channels, take note that the Firestik II tunable tip antennas have a fairly large metal tip that broadens the bandwidth and dissipates a considerable amount of heat.
60. It is illegal to use power amplifiers with CB radios. It is illegal to "tweak" the radios internal circuits to increase output power. The transmitter power of a legal, FCC certified CB radio is 4 watts AM.
61. If having one antenna for CB/AM/FM is appealing, use a CB antenna and a splitter that allows it to be connected to your AM/FM radio. Devices that let you use your AM/FM antenna for CB use will leave you disappointed.
62. On a budget? Buy a cheap radio and a good antenna. Aside from added bells and whistles, all CB's are FCC regulated to transmit no more than 4 watts of power. A good antenna on an inexpensive radio will almost always outperform a bad antenna on an expensive radio.
63. Beware of the wire wound mobile antennas mentioned in ads that claim them to be "full-wave" or "wave and a half". At best, you are being deceived by the misleading association of wire length to actual performance characteristics. Wire length, for all intents and purposes, is irrelevant. With "very" few exceptions, antennas must function as a 1/4 wave or 5/8 wave to be useful on mobile installations. For example, Firestik and Firestik II antennas between 2 foot and 5 foot have a radiation pattern similar to a 5/8 wave reference antenna. However, wire lengths range from 20 feet to 32 feet (0.6 to 0.9 of a full wave length). If wire length was relevant, each antenna would need 22.5 feet of wire.

TESTING CONTINUITY

Checking your CB antenna system for continuity, shorts and opens is a MUST process and should always precede SWR checks and settings. Exception: Cable supplied with 'No Ground Plane' antenna kits will have continuity between the center lead and ground.



* System includes CB radio, coaxial cable, primary mount, stud mount, spring or quick disconnect, antenna, and vehicle or ground plane source.

SETTING THE SWR OF YOUR ANTENNA

SWR (standing wave ratio), is a measurement of how efficiently your antenna system will radiate the power available from your radio. In simple terms, your radio would like to radiate all of its power, but can only do so if the other components cooperate. Bad coax and mounts, or inefficient antennas and ground plane can cause system bottlenecks. The easiest way to understand the concept is to think of it in terms of water flow. That is, if you put a one inch faucet on a two inch pipe, your potential output will be restricted by the one inch outlet. So goes antenna systems. Setting your antennas SWR will reduce the restriction of radiated power.

If all radios only transmitted on one channel, it would be a much easier task to design antennas. As it is, on CB alone, there are 40 channels to contend with. Mobile antennas can only be made to resonate at one specific frequency (channel). The goal of the antenna manufacturers is to build the antenna to resonate at a frequency in the middle of the available band (channel 19 on CB) and make it broad- banded enough to keep the off-frequency related SWR at the two extreme ends of the band below 2.0:1. It should be noted that if you communicate on one or two adjacent channels anywhere within the band, you can tune your

antenna to achieve optimum performance on those channels. Most people, however, prefer to use the entire bandwidth when tuning.

THINGS YOU WILL NEED

1. Knowledge of what not to do .... read previous sections.
2. Properly installed antenna system (mount, coax and antenna) that was made for the type of radio you will be using and has been tested for shorts and opens in continuity. (See "Testing Continuity")
3. Functional radio.
4. SWR meter. (See "SWR Meter Hook-Up")
5. Short piece of coaxial cable (jumper) with PL-259 connectors on both end.

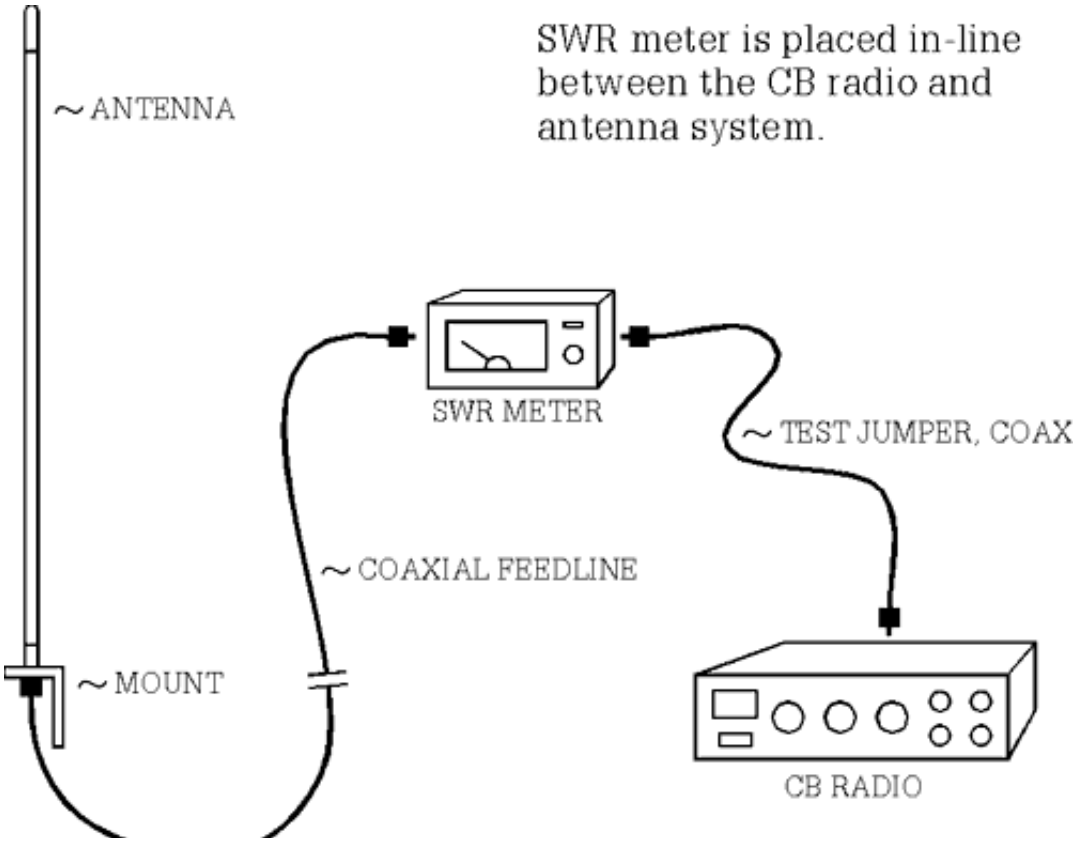
SWR METER HOOK-UP

The SWR of the antenna, without feedline, can be measured by placing the SWR meter in-line at the antenna instead of at the radio. However, the coax can help or hinder performance. In the end, your SWR should be checked at the radio end because all components will be a part of the final operational system being used.

SWR TESTING REMINDERS:

1. Remember to check for continuity, shorts and opens in your coax and mount installation first.
2. Take measurements in an open area with the vehicle's doors and hatches closed.
3. All measurements should be taken with antenna tip on, unless you do not plan to use the tip in normal use.

THE SET UP



If already connected, disconnect the coaxial cable from the radio. Connect the coax cable that normally connects to the back of the radio to the SWR meter connector marked "Antenna" or "Ant". Now, connect one end of the jumper cable to the back of the radio and the other end to the SWR meter connection marked "Transmitter" or "Xmit". Your SWR meter is now in series (in-line) with your radio and antenna.

Since you've already read the previous parts of this pamphlet, you should now have your vehicle in an open area, with all doors closed. Turn your radio on and tune to channel one or the lowest channel on your radio. If your radio has side band operation, make sure you are in AM mode before doing SWR tests.

The following assumes that your SWR meter has a standard set of switches, knobs and meters. That is, there will be at least one switch with the marking Forward (FWD) in one position and Reference (REF or SWR) in the other. There will also be a knob or sliding controller marked "Set" or "Adjust". Most meters come with full instructions. If the common configuration does not match your meter you will need to rely on the meters manual for assistance.

With the radio on the lowest channel (1 on CB) and the SWR meters switch in the Forward (FWD) position, depress the transmit switch (key up) located on the microphone. While holding the unit in this transmit mode, adjust the meter needle to the set position using the Set or Adjust knob on the meter. As soon as the needle is in alignment with the corresponding mark on the meter face, flip the switch to the Reference (REF) position. The meter is now showing your SWR on channel one. Note the value and quickly release the microphone switch. Record this reading on your paper to the nearest 1/10th. i.e. 1.8, 2.3, 2.7, 1.4, etc.

Now, switch your radio to the middle channel (19 on CB). Place the meter switch in the Forward (FWD) position, depress the microphone switch and adjust the meter to place the needle on the Set position of the meter face. Once in the set position, place the meter switch in the Reference (REF) position and note the reading. Release the microphone switch and write this value down to the nearest tenth of a point. Note: If your antenna system is closely matched to the radio you may get little or no movement from the meter needle on this channel. This is normal.

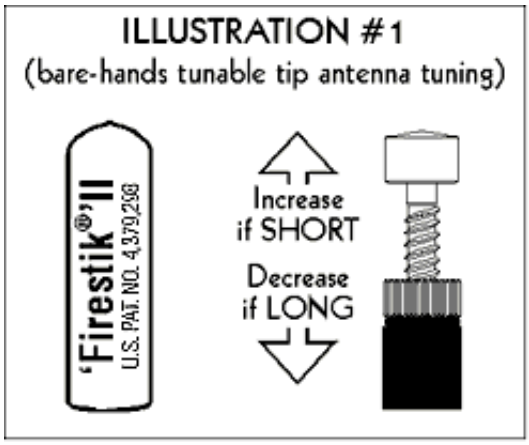
Finally, place your radio on the highest number channel (40 on CB). Place the meter switch in the Forward (FWD) position, depress the microphone switch and adjust the meter to place the needle on the Set position of the meter face. Once in the set position, place the meter switch in the Reference (REF) position and note the reading. Release the microphone switch and write this value down to the nearest tenth of a point.

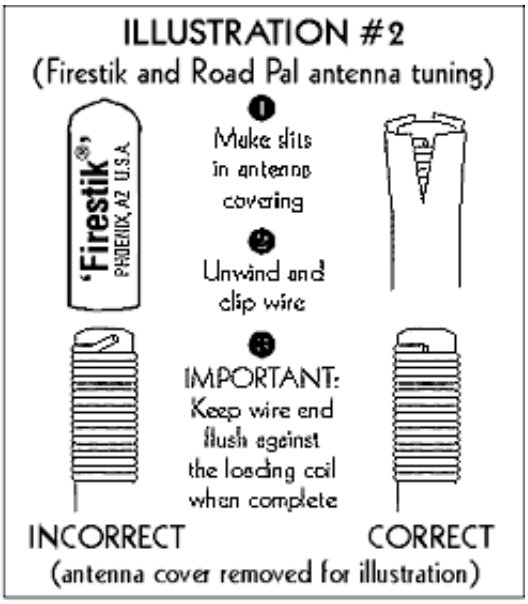
With these three readings, you can determine many things about your system. For instance ...

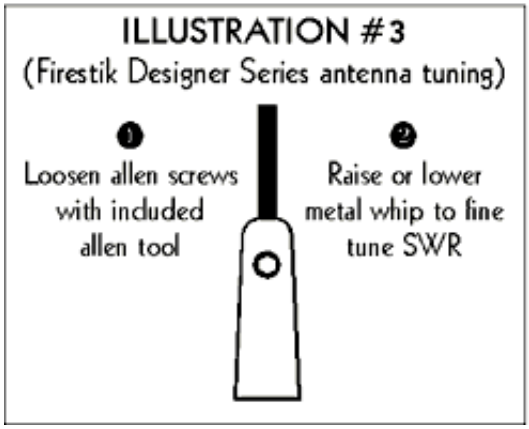
- If SWR on channels 1, 19 & 40 is below 2.0, your radio can be safely operated on any channel without causing damage to the radio's circuitry.
- If SWR on all channels is above 2.0 but not in the "red zone" (normally over 3.0), you may be experiencing coaxial cable reaction (bad quality, wrong length, etc.), insufficient ground plane, or have an ungrounded antenna mount.
- If SWR is in the "red zone" on all channels, you probably have an electrical short in your coax connectors, or your mounting stud was installed incorrectly and is shorted. DO NOT USE YOUR RADIO UNTIL YOU HAVE FOUND THE PROBLEM.
- If SWR on the lowest channel is higher than it is on the highest channel, your antenna system appears to be electrically short. See the following section title "Adjusting Short Antennas".

ADJUSTING LONG ANTENNAS

If the SWR on channel 40 is greater than that on channel 1, your antenna is considered to be "LONG" and reduction of physical height and/or conductor length will correct this situation. Depending upon antenna model, this entails screwing down the tunable tip (Illustration #1: Firestik II, Firefly), or, removing the tip, making short slits in the plastic covering and unwinding and clipping off wire (Illustration #2: Firestik, Road Pal). Firestik Designer Series antennas require loosening the allen screws and lowering the metal whip (Illustration #3).







ADJUSTING SHORT ANTENNAS

If SWR on channel 1 is greater than that on channel 40, your antenna is considered to be "SHORT" and increasing the physical and/or electrical length of the antenna is required to correct this situation. Because we make our antennas extra long, readings which indicate "Short" normally stem from ground plane deficiency (lack of vehicle metal surface for the antenna to reflect its signal rom). This condition is often corrected by adding a spring and/or quick disconnect to increase the physical height. Ground plane deficiencies can also be compensated for by using dual (co-phased) antennas or special no-ground-plane antenna kits.

Lengthening of the Firestik II and Firefly is accomplished by turning the tuning screw further out (Illustration #1). On Firestik and Road Pal models, it requires tip removal, short slits in the plastic covering and, the separation and upward repositioning of three or more wire turns (Illustration #4). Firestik Designer Series antennas require loosening the allen screws and raising the metal whip (Illustration #3).

NOTE: The shorter the antenna, the more sensitive it is to adjustments. For example, removing two wire turns on a 4 foot antenna might move the SWR by 0.3; the same amount removed from a 2 foot antenna may move the SWR by 1.0. Make smaller adjustments on shorter antennas.

DUAL ANTENNAS

Measurements and determination of short or long conditions are the same as the single antenna procedure. However, when tuning co-phased antennas, if you adjust one antenna, it is advisable to adjust the other in equal amounts to keep them in perfect balance.

COAX CABLE PROCESSING with FIRESTIK CONNECTORS

Using ring/spade terminals

Using PRO-259 with cable type insert.

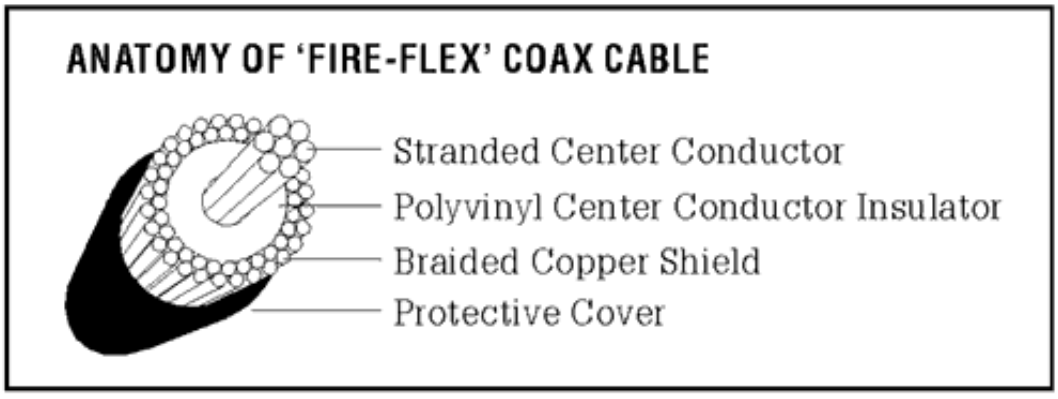
Using Twist-On connector (T6-259 or T7-259)

Using Twist-On connector w/ rubber boot
(BT6-259 or BT7-259)

Using CP-259 to build co-phasing harness

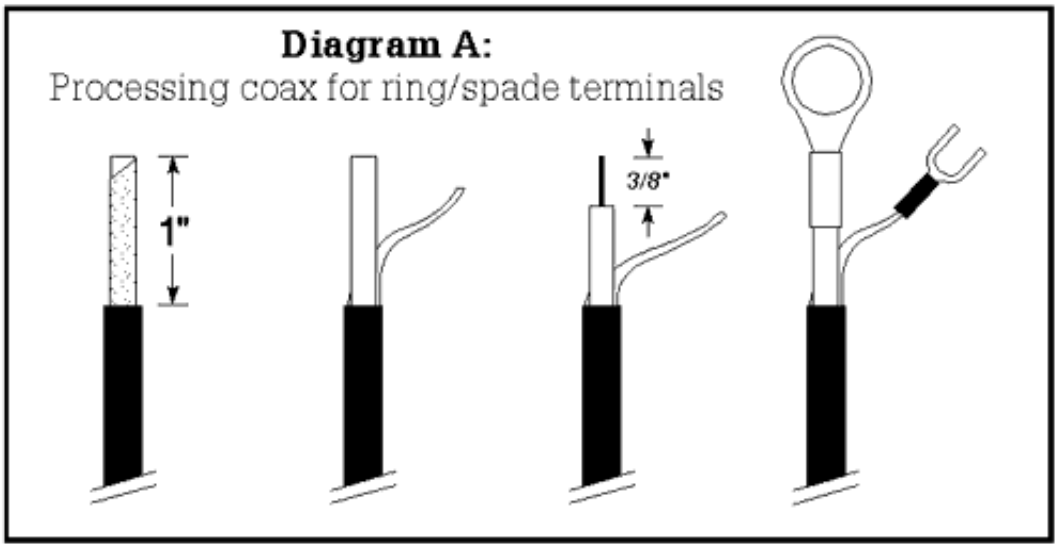
THINGS TO KNOW

- RG-58 refers to any RG-58 type cable such as RG-58-U or RG-58-A/U.
- RG-59 refers to any RG-59 type cable such as RG-59-U or RG-59-A/U.
- The "A" designation after RG-58 or RG-59 indicates a stranded center conductor, wire made up of numerous individual strands versus one solid wire.
- RG-58 type coax is 50 ohm cable and is used for single antenna installations of CB, scanner, 2-meter, and 10-meter Firestik antennas. RG-8 and RG-8X are other common coax types that can be used on single antenna installations.
- RG-59 type coax is 72 ohm cable. It is used for dual (co-phased) CB, 2-meter or 10-meter installations. It is also commonly used for TV antennas and AM/FM receive only antennas. Do not use this coax on single CB antenna installations.
- The length, type and quality of the coaxial feedline can have a major effect on system performance. If in doubt, use 18ft coax that has the "A" designation after the RG type.
- The coax used on Firestik "no-ground-plane" kits must never be altered. It's length and internal features are critical to proper operation.
- The shield on "no-ground-plane" kits is intentionally not used at the mount end of the coax. Leave as is.
- The shield portion of the coax cable is almost always used as the ground.



PROCESSING COAX FOR RING/SPADE TERMINALS

1. Remove 1" (38 mm) of the cable's protective cover (see Diagram A, next page).
2. Use end of nail or other pointed object to unbraid the copper shield. When done, pull to one side and twist into a single wire. Trim off any loose ends.
3. Remove 3/8" (10 mm) of the center conductor insulation and dress by twisting strands into one wire.
4. If soldering equipment is available, tin the ends of both wires.
5. If shrink tubing will be used for additional insulation, slide over wire end(s) at this time.
6. Crimp and/or solder terminal(s) to appropriate wire. In most cases, the larger of the two terminals will go on the center conductor. If both terminals are the same size but one has it's own insulation, this should be used on the center conductor.
7. If shrink tubing was used, slip it over the terminal end and heat until properly fitted.
8. Test your work for opens or shorts (see "Testing Continuity").

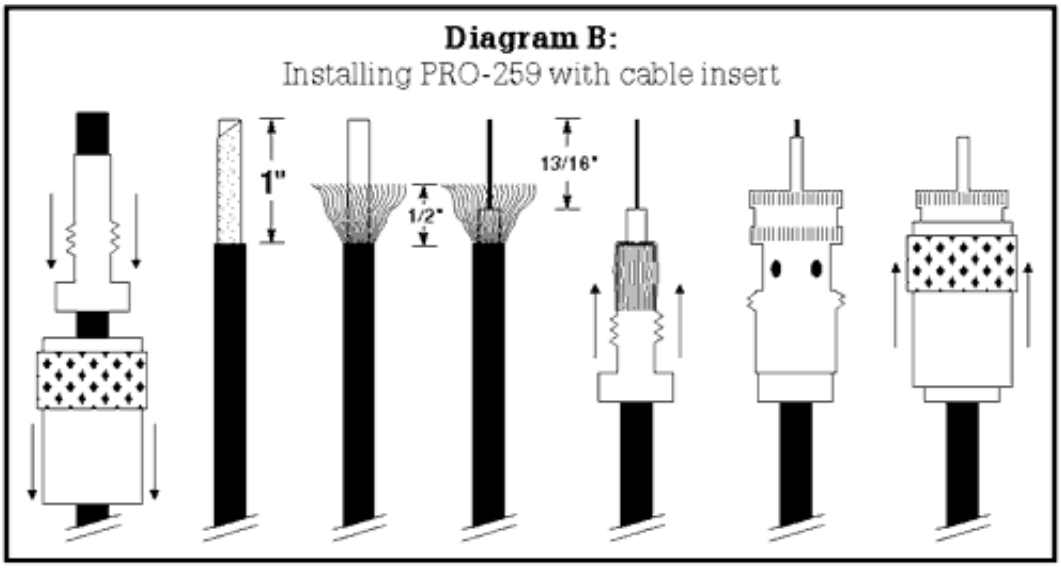


INSTALLING PRO-259 WITH CABLE INSERT

NOTE: Soldering iron and solder required for this connector.

1. Slide appropriate cable adapter over coax, INS-58 for RG58 cable or INS-59 for RG59 or RG8X cable. Make sure wide shoulder is down, threaded portion up (see Diagram B).
2. Remove (unscrew) PRO-259 knurled barrel sleeve from main connector and drop over coax. Make sure that the internal threads are up.
3. Remove 1" (25 mm) of the cables outer cover.
4. Use end of nail or other pointed object to unbraid the copper shield. Trim to approximately 1/2" (12mm) long all the way around.
5. Remove 1/2" (12 mm) of the center conductor insulation and dress by twisting all strands into one wire.
6. Use your soldering iron to tin the end of the center conductor wire.
7. Slide the insert up the cable until the top is even with the trimmed edge of the outer cover. Fold the braided shield over the top of the insert. Make sure the wire does not lay in the treads of the insert. If the braid is a little long, twisting the braid around the insert will keep it out of the threads.
8. Thread the main connector body on to the cable insert until fully seated. Locate shield through one or more holes in main body. Heat body and shield at one or more access holes and fill with solder.

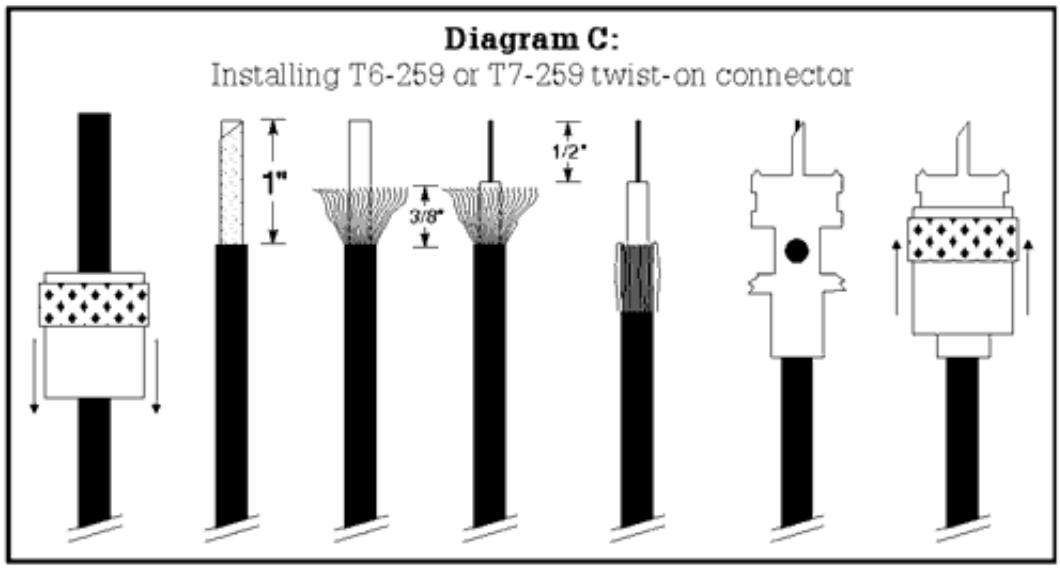
9. Solder center conductor where it protrudes from center pin of main body. Do not over fill or pin will be to fat to fit into mating connector. Trim off any excess wire.
10. Slide the knurled barrel up the cable and re-thread to the main body.
11. Test your work for opens or shorts (see "Testing Continuity").



INSTALLING T6-259 OR T7-259 TWIST-ON CONNECTOR

Note: Soldering iron and solder required for this connector.

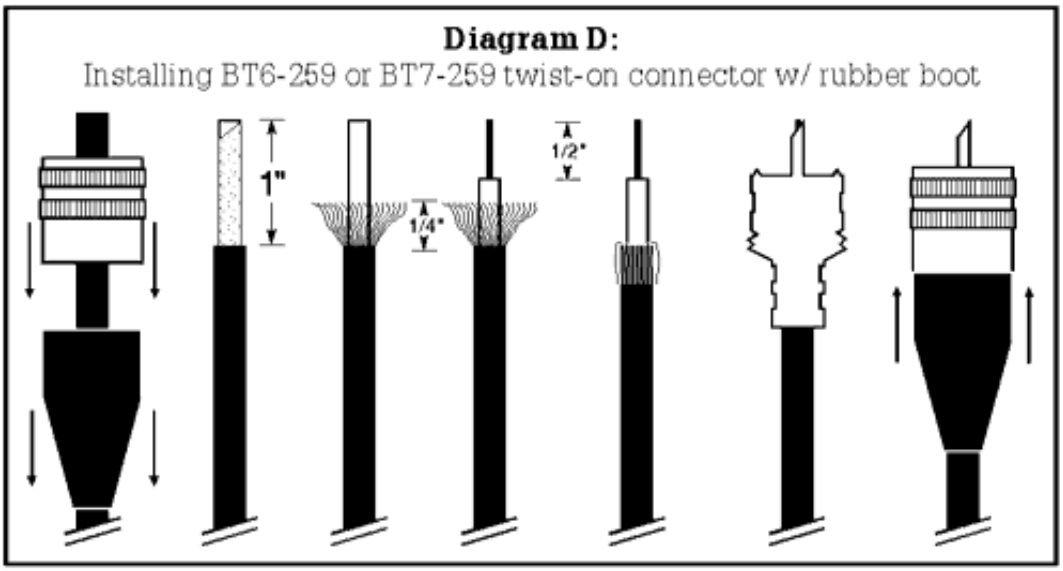
1. Select appropriate connector for cable type, T6 for RG-58 or T7 for RG-59 coax.
2. Remove (unscrew) knurled barrel sleeve from main connector and drop over coax. Make sure that the internal threads are up (see Diagram C).
3. Remove 1" (25 mm) of cables outer cover.
4. Use end of nail or other pointed object to unbraid the copper shield. Trim to approximately 3/8" (10mm) long all the way around.
5. Remove 1/2" (12 mm) of the center conductor insulation and dress by twisting all strands into one wire.
6. Use your soldering iron to tin the end of the center conductor wire.
7. Fold the braided shield down over the top of the outer cover.
8. Thread the main connector body on to the cable until fully seated or the center conductor is at the end of the main body center pin.
9. Solder center conductor where it protrudes from center pin of main body. Do not over fill or pin will be to fat to fit into mating connector. Trim off any excess wire.
10. Slide the knurled barrel up the cable and re-thread to the main body.
11. Test your work for opens or shorts (see "Testing Continuity").



INSTALLING BT6-259 OR BT7-259 TWIST-ON CONNECTOR W/ RUBBER BOOT

Note: Soldering iron and solder required for this connector.

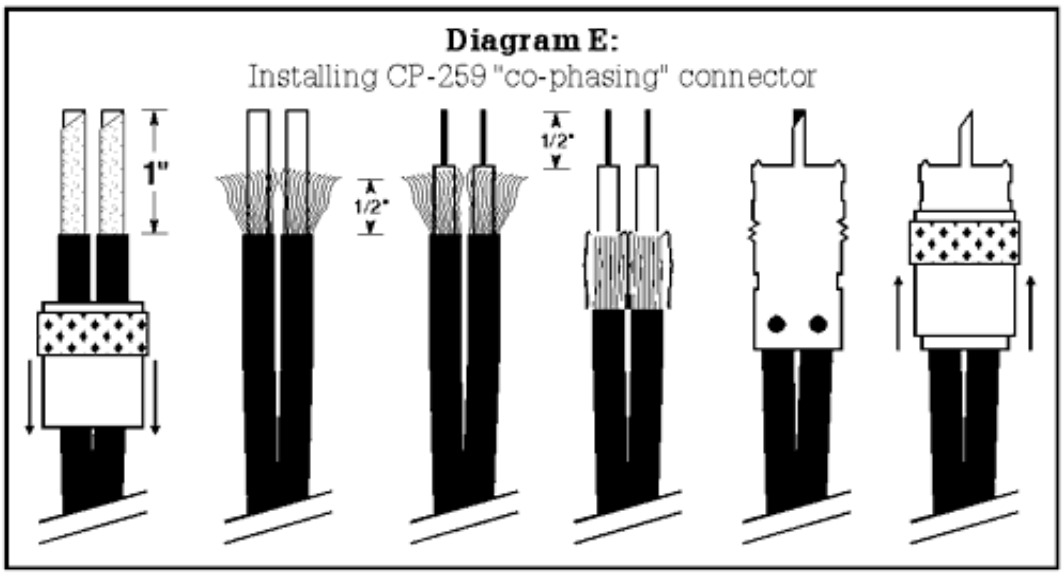
1. Select appropriate connector for cable type, BT6 for RG-58 or BT7 for RG-59 coax.
2. Slide rubber boot over cable with large opening up.
3. Remove (unscrew) knurled barrel sleeve from main connector and drop over coax. Make sure that the internal threads are up (see Diagram D).
4. Remove 1" (25 mm) of cables outer cover.
5. Use end of nail or other pointed object to unbraid the copper shield. Trim to approximately 1/4" (6mm) long all the way around.
6. Remove 1/2" (12 mm) of the center conductor insulation and dress by twisting all strands into one wire.
7. Use your soldering iron to tin the end of the center conductor wire.
8. Fold the braided shield down over the top of the outer cover.
9. Thread the main connector body on to the cable until fully seated or the center conductor is at the end of the main body center pin.
10. Solder center conductor where it protrudes from center pin of main body. Do not over fill or pin will be to fat to fit into mating connector. Trim off any excess wire.
11. Slide the knurled barrel up the cable and re-thread to the main body.
12. Slide rubber boot up cable and snap over the main body (2 clicks)
13. Test your work for opens or shorts (see "Testing Continuity").



INSTALLING CP-259 "CO-PHASING HARNESS" CONNECTOR

Note: Soldering iron and solder required for this connector.

1. Remove (unscrew) knurled barrel sleeve from main connector and drop over both pieces of coax. Make sure that the internal threads are up (see Diagram E).
2. Remove 1" (25 mm) of both cables outer cover.
3. Use end of nail or other pointed object to unbraid the copper shield. Trim to approximately 1/2" (12mm) long all the way around.
4. Remove 1/2" (12 mm) of the center conductor insulation from both cables and dress each by twisting all strands together.
5. Use your soldering iron and lightly tin the ends of both center conductor wires.
6. Fold the braided shield down over the top of the outer cover on both cables.
7. Insert each cable into the connector body making sure the center conductor protrudes from the body center pin.
8. Solder center conductor where it protrudes from center pin of main body. Do not over fill or pin will be to fat to fit into mating connector. Trim off any excess wire.
9. Solder the shield on both cables to the main body using the corresponding access hole.
10. Slide the knurled barrel up the cable and re-thread to the main body.
11. Test your work for opens or shorts (see "Testing Continuity").



NOTE: If you will be using grommets to protect your cable where it passes through the vehicle body, make sure the grommets are on the cable before processing connector(s).

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