

Tips on Electric Fencing to Protect Honeybee Apiaries from Damage by Predators (Black Bears and Skunks)

Fred Putnam, Jr, Vermont Certified Beekeeper

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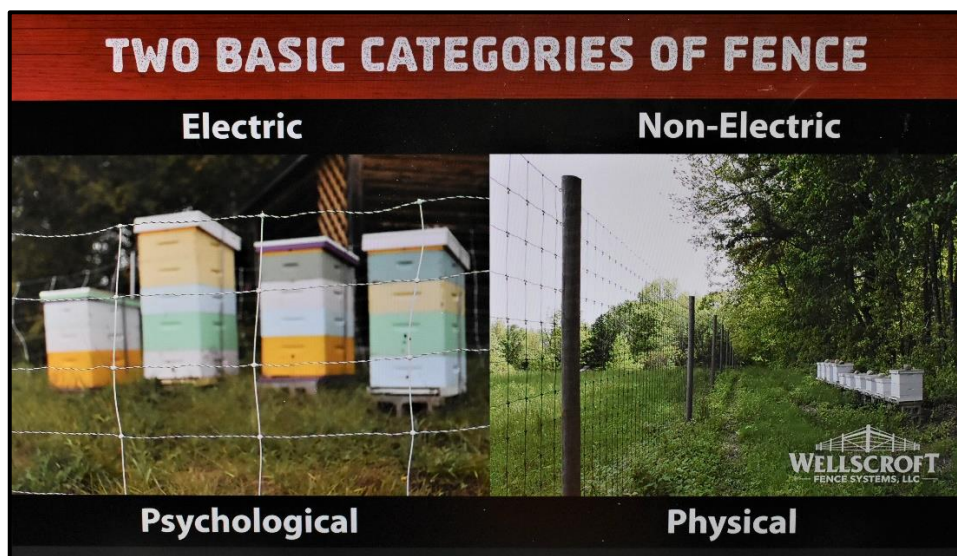
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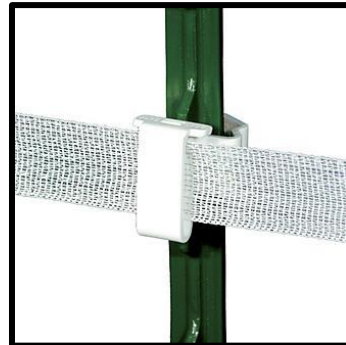
- 1. Step 1 – Install your electric fence first then get bee colonies. Always assume that you will have bears or skunks visiting your apiary.** There are different ways to deter bears and skunks but a good electric fence is the only reliable way. Removing a nuisance bear only works until the next bear shows up and skunks are everywhere.
- 2. Two basic types of fences to consider:**
 - Barrier or physical fences – provide a physical barrier to predators who might want to enter your apiary.
 - Deterrence or psychological fences – by itself the fence is not a physical barrier but has a strong deterrence factor. This includes electric fences and is the focus of this guide.



There are several different types of fencing. Each have different requirements. Some are much more expensive to install than others. All will work on apiaries.

Deterrence fencing can be:

- High tensile smooth wire
- Low tension smooth wire semi-permanent
- Polywire and polytape



- Electric netting



If you are in snow country, the bottom strand(s) on strand fences can be raised before the snow builds up and pins them to the ground shorting out the fence.

Weed control can be a challenge with net fences. Weed control suggestions are included below.

3. Summary of items needed

Required items:

- Fence – smooth metal wire, polywire, polytape, or netting
- Energizer with rated for at least 1.0 output joules or 1.3 stored joules
- Grounding kit with three 3-foot-long galvanized metal grounding rods (no copper or rebar), heavy gauge galvanized wire, and clamps
- Electric fence voltage tester (not the electrician multimeter type)
- Metal clamps for all wire connections (no wire twist connections)
- Gate handles

- Posts
- Insulators appropriate for the type of fence and posts that you've chosen

Optional items:

- **Surge protector** to prevent lightning from burning out your energizer.
- **Fence alert**, a light that flashes when the fence isn't working properly.

4. Common electric fencing mistakes:

- Poor grounding – perform grounding check
- Wildlife not “trained” – fence needs to be baited
- Lack of weed control & sagging lines or net
- Lack of fence monitoring – Get a voltage tester (not a multi-meter) and check line voltage often.



5. Energizers (chargers) – Three kinds:

- Plug-in to run on 110 V household current
- Battery powered (D-cell or lead-acid batteries are common. Must be re-charged periodically.
- Solar – These are actually battery powered but with a solar panel to keep the battery charged.
- Energizer **Joule rating**

A joule is a combination of voltage x amperage x time. **Wellscroft Fence Company recommends an energizer with a rating of at least 1 output joule or 1.3 stored joules for small apiary fences.** Higher ratings can be suitable also, but very high joule ratings (over 40) can be hazardous. There's an explanation of the joules near the end of this guide but a joule rating **does** give an indication of the relative stopping power of a fence energizer. **Do not rely upon mileage rating for an energizer. Determine that the energizer is rated for at least 1.0 output joule.**

- Desired voltage

The electric lines or netting should carry a minimum of 7,000 volts after voltage losses. The deterrent “jolt” from the charger/energizer comes from voltage and amperage. Voltage is a measurement of electrical pressure. Voltage “pushes” amperage down the

fence wire. Amperage is a measurement of electric current or power. Amperage is what you feel when you are shocked. The higher the amperage the more intense is the shock you feel. The higher the voltage the more amperage it can push. Most fence energizers (the real name for a fence charger) with a 1.0 output joule rating will put out 10,000 volts or more in short pulses and can readily “push” that “jolting” amperage.

→ *Best practice: Check your line or net voltage with a fence voltage tester after every apiary visit. Get a voltage tested (not a multi-meter) that reads up to 9,999 volts or higher. They are not expensive.*

→ *Best practice: Check the voltage on your ground rods to make sure the grounds are effective. The process is to do this is described in Appendix 2 at the end of this guide.*

6. Electric fence construction tips to deter predators – this section will focus on wire strand fences. Netting fences are usually not more than four feet high; that may not be high enough to deter a bear that jumps fences.

- Wire fences should have at least five strands and preferably 6. The lowest strand at about 5” (13 cm) above the ground will deter skunks and raccoons and prevent bears from digging under. The second strand should be about 12” above that. The highest strand should be about 5 feet (122 cm) above the ground to deter “jumpers.” Space the other lines equally between the 2nd and top strand. The strands should be tensioned and should not sag. To improve the visibility of the fence.
- The fence should at least 6 feet from any hive to prevent “reaching in.”
- Avoid locating the fence against the edge of a woods line. Leave a 10-20 foot strip between the fence and the edge of nearby woods.
- **The fence should be on 24/7/365.** Bears don’t hibernate as consistently as they once did. See note below on sliding strands up out of the snow during winter and about grounding when there is snow on the ground.
- Keep the lines snug. Hang signs, bait, and wire leads close to a support post to avoid sags in the lines caused by too much weight.
- Do not use guy wires on the outsides of corners. If needed, corner supports should be on the inside of the fence. If a bear trips over a guy wire, the fence may no longer be functional.
- The charger and leads should be on the **inside** of the apiary hot wires or on a sturdy fence line post in a location where the lumbering bear won’t trip over and dislodge them.
- Insulators and wires should be on the **outside** of posts.

- Avoid placing the energizer on the ground where moisture or insects could damage it.



7. Training the predator/baiting

Bait the fence if this is a new fence. Use some bacon strips wrapped over the wire or a can of tuna attached to a hot wire so the bear hits a charged wire, or a charged metal can with its head or nose.

Pictures 1 & 2 - Samples of fence baiting with bacon strips canned tuna. Both need to be replenished periodically. With tuna, be sure to attach the can to a hot wire. Mount it on or next to a post to avoid the weight of the can causing a sag in the fence. Poke small holes into the bottom edge of the can to allow rainwater to drain out. Photos by Colin Kennard, Wellscroft Fence Co.



8. Grounding

- **Use a good grounding kit with galvanized steel ground rods.** An electric fence is an electric circuit that is only completed when an intruding animal (or errant beekeeper!) touches the wires causing electricity to flow into the ground or into a ground wire in an alternating hot/ground wire arrangement (diagram below.) Grounding rods complete the electric circuit from the energizer to the wires through the intruding bear or skunk into the ground or grounded wires and back to the energizer.
- **Prevent electrolysis Do not use copper or plain steel like rebar for grounding rods.** Electrolysis is a process of chemical decomposition by which two different kinds of metal touching each other can corrode one or both metals. This can diminish the charge on the fence lines. Don't combine different types of metals such as steel and aluminum wire.

The high voltage on an electric fence accelerates oxidation and corrosion of steel and copper which can retard current flow in less than a year making the ground ineffective. **Use galvanized steel grounding rods and galvanized steel wire.**



- Find a good spot for grounding rods - Grounding rods can be located away from the apiary if necessary, especially if there's a wet spot nearby. A single grounding rod in a wet spot can be more effective and reliable than several grounding rods in dry or sandy soils.
- Locate in moist soil if possible. **Use 6 feet of grounding rod per joule of energizer output.** In dry soils or during droughts, you may need more grounding to maintain voltage on the lines.
- It's recommended to use insulated grounding wires to connect grounding rods together.
- Grass and weeds will ground out your fence draining away voltage especially after the dew sets at night or after a rain. **Keep the grass and weeds trimmed from the bottom lines or place a narrow strip of geotextile, tarpaper, or mulching plastic down under the wire to control vegetation.**

Improving grounding in dry, sandy, or stony soils, during severe droughts, or when there is snow on the ground.

Good grounding is absolutely essential to maintain an effective potential circuit that will shock

predators such as bears and skunks.

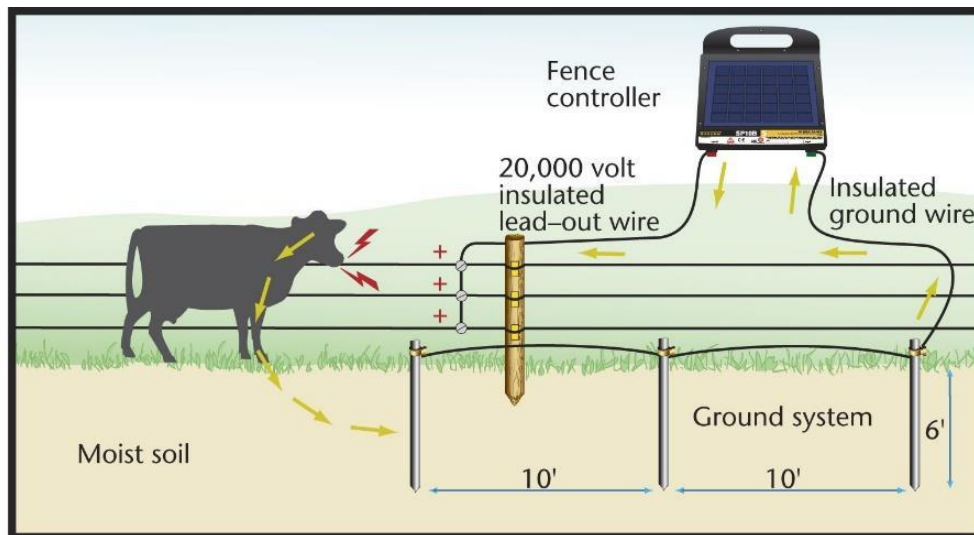
Often, the effectiveness of the grounding rods is reduced in sandy or gravelly soils. During a drought, soils dry out and become less conductive. During the winter, snow on the ground is an electrical insulator. In all these cases, the effective fence voltage drops considerably and can be zero (no “zap” to the bear or skunk.) If the voltage drops below 5,000V, the grounding rods can be supplemented by laying a 2-foot-wide strip of chicken wire, wire cloth, or a series of feedlot panels flat on the ground around the perimeter of the apiary then hook a grounding lead to the chicken wire or the panels. This will be in addition to the hookup to the regular grounding rods. Be sure that each feedlot panel is hooked to a hot wire or that they are all connected together. Be certain to remove the chicken wire or panel once the ground becomes moist again since the growth of grass and weeds can make it difficult to remove them.

Picture 2 – Feedlot panels



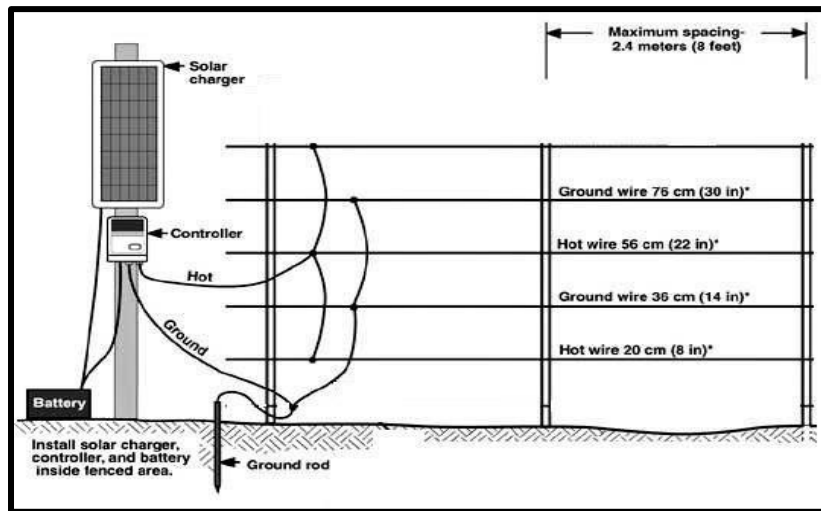
- There are different ways to hook the strands together but if you have good grounding, tie all lines together so all lines are hot as shown in this diagram. (Note the exception below for dry soils, drought, or snow on the ground.)

This grounding image shows three hot strands, but you will use five. Note the three ground rods are 10 feet (3m) apart.



- If there's snow on the ground, change the fence from all wires hot to alternate hot and ground wires. In this picture, lines 1, 3, and 5 are hot and lines 2 and 4 are grounds.

Picture 3 – Creating a built-in ground - Lines 1, 3, and 5 are hot. Lines 2 & 4 are grounded.



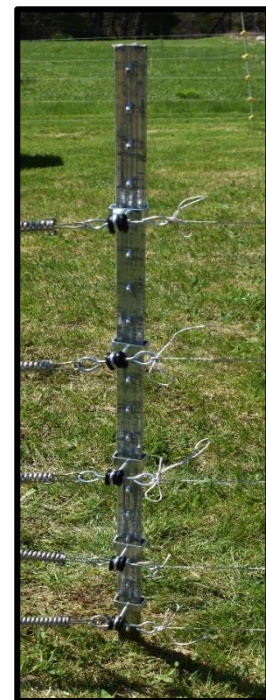
The easiest and simplest to install and maintain is polywire followed by metal strand wire. They are effective and low cost.

9. Posts

Good corner posts are heavy duty steel studded T-posts or pressure treated round posts. **T-posts and T-post insulators are much more durable than u-channel posts and u-channel insulators.**

Pictures below. 4x4s can also be used but they will require two insulators per strand on corners.

Studded T post (yes)



U-channel post (no)



Corner posts need to be rigid to allow you to keep the electric lines or netting snug (somewhat tight – no sags.) Wellscroft Fence Company in Harrisville, NH is the only place locally where you can get galvanized studded T-posts that don't rust. Tractor Supply and similar places carry less expensive painted T-posts. **In either case, try to get posts that are rated at 1.33 lbs. per foot. They are more durable.**

Between the rigid corner posts, you'll need in-line posts to support the wires. These posts can be simple fiberglass or plastic posts that you push in by hand or with a rubber mallet depending upon your soil. Their function is to maintain spacing between the fence lines and to keep the lines from sagging or potentially touching the ground. Think of them as spacers. **Support posts should be no more than 12 to 15 feet apart** or at any high spot that could ground out the bottom wire. An 8-foot spacing between support posts is preferable.

This is a 6-foot-tall steel studded T-post on a corner with a 5-inch offset insulator (holds the wire a max. of 5" (13 cm) away from the steel post) and the top line located at the top of the t-post about 5 feet above the ground. Ideally, there would be 6 strands in this fence.



If you want a more rigid fence, you can use studded T-posts in-line instead of fiberglass or plastic posts



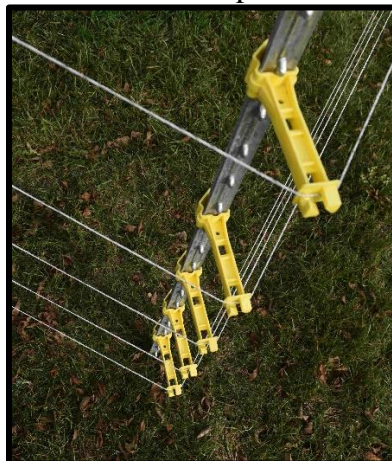
Round or square wooden posts also work but are considerably more work to install. They require “nail-on” insulators.

You can drive T-posts with a simple post driver (Tractor Supply, etc.).

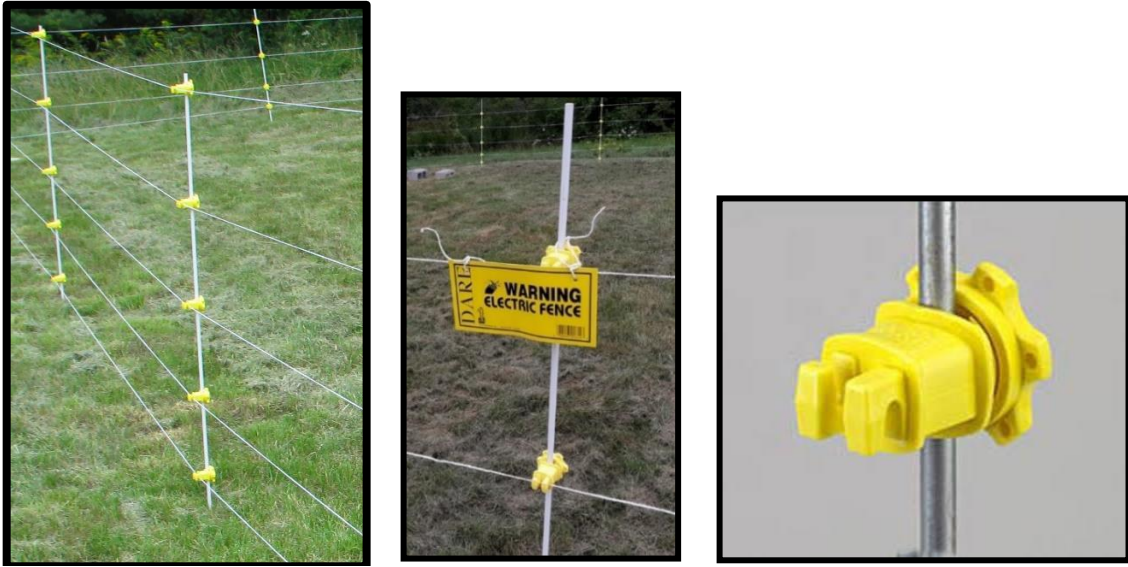


10. Insulators – Insulators keep the charged wires from touching objects that can conduct electricity shorting out the wires causing severe voltage losses. Voltage losses = less or no predator deterrence.

There are different insulators for different kinds of posts and fence materials. This one example.



These are fiberglass in-line posts using a two-piece “screw-tight” round post insulator for polywire.



11. Signing

If others could come in contact with the fence, always attach a warning placard like one of these. Some insurance companies require them.



12. Gates – To allow safe ingress into and egress out of the apiary, the fence system should include a gate. This is one example of a strand wire gate. Simple loops in the ends of the wires into which gate handles can be hooked can be used in place of gate anchors and tensioner springs.



13. Barbed wire – Not electrified and not with electric wires!

No fencing system containing barbed wire should ever be electrified. An owner of such a fence would be considered liable if any animal or person were to be caught up in such a fence (from Univ. of Wisconsin Extension Service.) Minnesota DNR, VT Fish and Wildlife, and Wellscoft Fence Company all recommend that barbed wire should NOT be electrified.

14. Energizer (charger) options and tips

The energizer (charger) is the usually most expensive single item in your fence system. There are two basic kinds of fence energizers: those that plug into a 120-volt household outlet

(alternating current or AC power) and those powered by batteries. Many models of battery powered fence charger have solar panels to recharge the battery. Both battery and AC types are equally as effective against bears. The choice will be determined by how close your apiary is to household power or if this will be a permanent or temporary apiary location. A simple battery powered charger can be used on temporary pollination apiaries.

- If you have household power close to your apiary, you should use an AC powered energizer. If not, use a solar-battery energizer. The Parmak 12V Magnum (not the 6V) or the Intellishock 60 and 120 are both reliable solar energizers. There are other reliable brands and models as well.
- Solar energizers at Vermont latitudes often require battery changes or recharging during the short cloudy or snowy days of December and January when there are many less hours of daylight to charge the battery. You can remove the batteries to recharge them if necessary or have a charged spare on hand.
- Solar chargers must be in a sunny location.
- For the sake of reliability and longevity, get a good quality energizer. Don't try to go cheap on energizers.
- Get an energizer with a one joule output. This is more than sufficient for a maintained fence system.

15. Strapping your hives

And just to be safe, add this second line of defense – strap your hives.

Always strap your hives even if you think you have a good fence. If you forget to turn on the charger, if there is an electrical fault or electrical short, or if a particular bear is very determined, your hives could be exposed to destruction. A strapped hive will not fall apart if a bear tips it over. The destruction of the colony happens when a bear is able to tear the boxes and frames apart. A tipped over but intact colony can usually be saved.

Metal straps are the best since bears cannot tear them as they can with nylon straps. Mann Lake is the only known source for metal straps. They are called banding straps (Item HD- 835):



Appendix 1 - Joule Rating

The joule rating for an energizer is measure of electrical output over a period of time. It is a combination of the voltage and amperage applied over time measured in milliseconds (1/1,000 of a second.)

Voltage and amperage are two measures of electrical current or flow of electrons.

- Voltage is a measure of the *pressure* that allows electrons to flow – the ability of the charge to jump across resistance like a bear’s fur.
- Amperage is a measure of the *volume* of electrons. It is the strength of a current of electricity – that is, how strongly the bear feels the charge.

Voltage x amperage = watts (power.)

A joule is one watt-second, that is, it’s a measure of the number of volts times the number of amps (watts) over a period of time. In a fence energizer context, a joule = volts x milliamps x time (microseconds.) The duration of each pulse is measured in ten thousandths of a second and the amperage is very low at less than about 1/100 of the lethal levels for people.

Thus, a joule rating **does** give an indication of the relative stopping power of a fence energizer.

If you need to compare the joule rating of energizers from different companies: Output joules \approx 70% of stored joules.

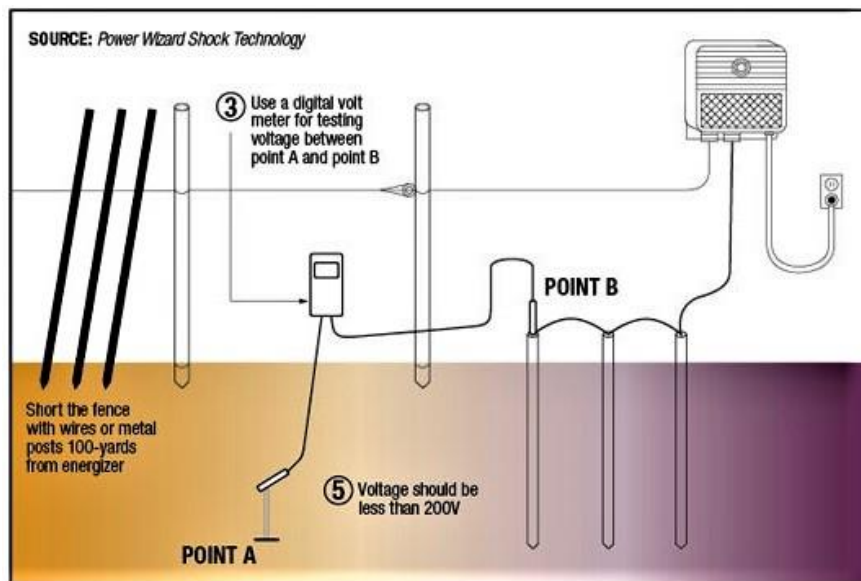
Appendix 2 – Testing the grounding system

Verify that your ground system works

1. Unplug your fence energizer.
2. Place the fence under heavy load by “shorting” the fence as follows: At a location on the fence at least 100 yards from the energizer, lean 3 or 4 steel stakes or unpainted T-posts against the “hot” wire of the fence. Alternatively, some people have found a successful method is to push several pieces of fence wire into the earth and wrap the opposite ends around the hot wire.
3. Plug the fence energizer in and check the fence line voltage with a digital voltmeter. You want to see that the voltage has dropped below 2,000V due to shorting the fence. On some high-powered fence energizers you may not be able to short the fence below 2,000V. However, you can still test them at a higher voltage.
4. Continue to short the fence by leaning steel posts or by making wire connections to ground at 100 yards distance or more from energizer until the fence line voltage drops below 2,000V. (All small apiary fences, place these posts on the line as far from the energizer as possible.)
5. You are now ready to test the energizer ground system. Connect one lead of the digital voltmeter to a 12-inch metal stake driven into the ground 3 feet away from the last fence energizer ground rod. Connect the second lead to the ground rod furthest from the energizer. The voltage reading should ideally be zero or no more than 200V.
6. If the digital voltmeter reading is under 200V, your ground system is adequate, and you will get near maximum performance from your electric fence energizer.
7. If the reading is above 200V, then your ground system needs improvement.

You must:

- Add more ground rods connected in series, ten feet apart and/or
- Move your ground system to moist soil until the ground system voltage is below 200V.



Appendix 3 – Avoiding grounding issues

Avoid grounding issues

Test your electric fence with a digital voltmeter on a routine basis. This is especially important when vegetation is high and touches the fence or when the ground is very dry or very damp.

These are some common grounding issues:

- There is a bad wire connection to the ground wire. Check to make sure the wire is securely fastened and isn't frayed.
- Dry soil conditions requires additional grounding rods.
- The wrong type of rod was used for the grounding, i.e. pipe or rebar. It needs to be galvanized steel at least 4 to 6 feet long.
- The rods weren't long enough. In the case of dry soil, it may require 6 to 8 feet of galvanized steel to reach a moist area of ground.
- The ground conditions changed and due to extreme drought or heavy vegetation, additional rods need to be added.
- The wrong type of wire was used. Using household or industrial cables made for only 400V are not enough to support the system. Make sure you use 10 to 14 gauge insulated lead-out wire rated at 20,000V.