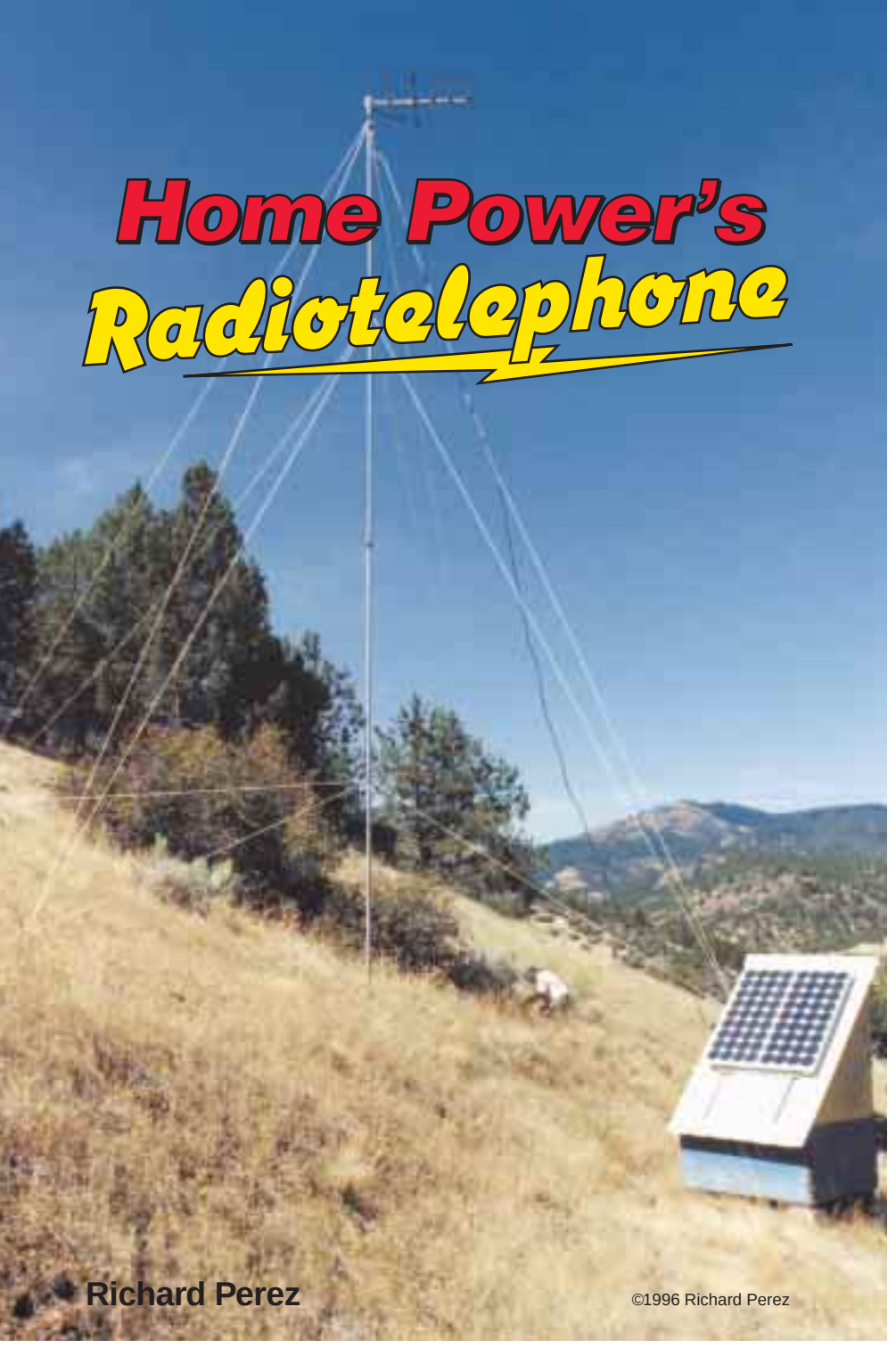
Home Power's Radiotelephone



Richard Perez

When moving to the back country you usually get three things: no grid power, no hardline telephone, and a bad road. Technology allows solving the first two and we're still working on the third. Homesteads beyond the grid are often beyond the phone lines. The expense and right of way problems which make commercial electricity impractical also prohibit running in telephone lines. You can have a telephone without wires—use radio!

Radiotelephone

See the article on page 42 for the basics of radio technologies and operation. Radiotelephones (R/Ts) can provide regular phone service using radio links instead of wires. One end of the radiotelephone system is located where the telephone hardline service is. This end is called the "base." The base radio plugs into the regular telephone hardline(s) and transmits the incoming telephone signal via radio to the other end of the system, called the subscriber or "sub". The sub end of the R/T receives the radio signal from the base. The sub also transmits the outgoing telephone signal from the remote end back to the base unit which in turn places the outgoing signal on the regular telephone lines. Both the base and sub units contain a transmitter and a receiver. Both transmitters operate when the phone is being used (off hook in phone lingo). The system is full duplex, which means you can talk and listen at the same time—just like a regular telephone.

Power consumed by an R/T system is very small. The transmitters vary in output from 2 watts to 25 watts. Receivers operate 24 hours a day and usually consume less than 4 watts each.

The daily energy consumption of the R/T system depends on how much the phone is used. Ours is used about 7 hours daily. Each end of the R/T system (which has a 2 watt transmitter) consumes under 200 Watt-hours daily. If your R/T has higher powered transmitters to span longer distances, then the energy consumption will be higher. For example, an R/T system with 25 watt transmitters and a usage of 7 hours daily will consume about 500 Watt-hours per day at each end. These are relatively small amounts of energy and each end of the R/T system can be powered by one or two standard PV modules.

For battery storage, I tend towards overkill. Communications is an essential service. Our safety and our livelihood depend on good communications. I don't want the R/T to cease operating just because we've had six or seven cloudy days in a row. Most R/T systems can be powered directly by 12 VDC. A radiotelephone with a 2 watt transmitter is best served by a 100 Ampere-hour battery. This gives a week of battery storage even under heavy use. The higher powered 25 watt R/T units will require a larger battery—about 250 Ampere-hours. Sizing the system is just like sizing any other PV system, except oversize the power components by a factor of two or more for reliability.

R/Ts also operate on a variety of frequencies. The two most popular R/T bands are around 150 MHz (VHF) and 460 MHz (UHF). The VHF models are better when there are obstacles (such as mountains and forests) in the radio path, and the UHF models work well when the radio path is unobstructed (line of sight). The VHF band is far more populated. The VHF band is full in many areas and most frequency pairs (two transmitters, remember) are already occupied. If you live very rural, then chances are that VHF frequencies are still available in your area. If not, then try the UHF band and set the system up with line of sight between the base and sub units. In either case, R/Ts use antennas which beam, or focus, their radio output in a single direction. As with any form of radio, bigger and higher antennas are better. Every R/T transmitter must have its frequencies specified and licensed by the Federal Communication Commission.

Left: Custom made Scala antennas are built to match the radiophone's frequency. The antenna on top of the mast is for 2 meter ham use.

Above: The guts of the Carlson Optaphone.

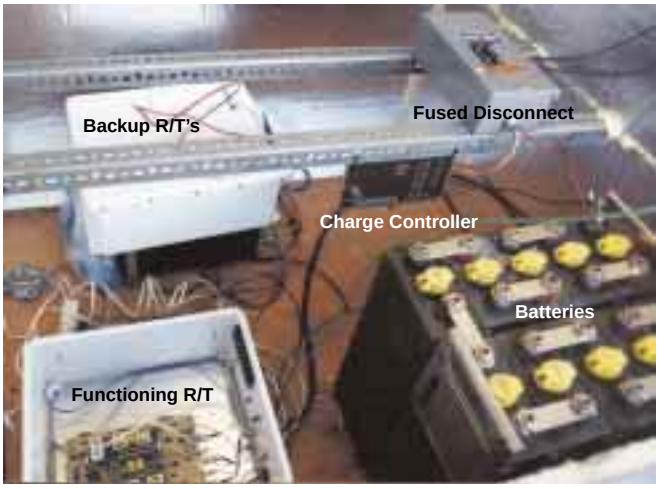
Home Power's R/T

We are currently using Carlson Communication's Optaphone 2000 radiotelephone, a two line system. The base end of the Optaphone is connected to two regular telephone hardlines, each with its own telephone number. This unit replaced a single line Optaphone because everyone at Agate Flat got tired of fighting over the phone. Home Power is a communication business. We needed another line to run FAX and computer modems. Being info nerds, we'd like to run both lines at once.

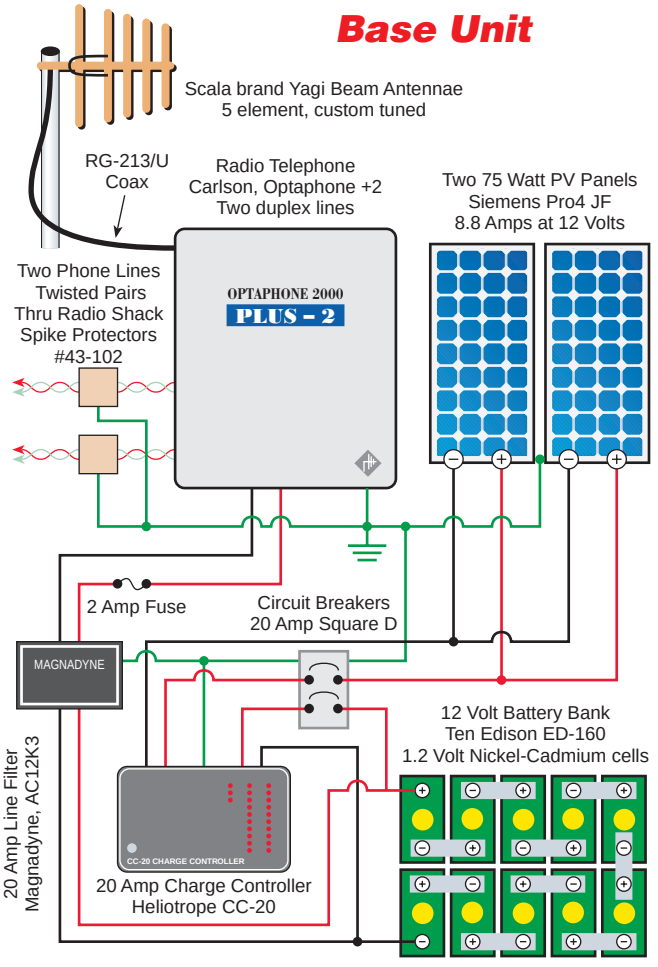
Our R/T system spans six miles (9.6 km). This short distance would be duck soup if there wasn't a mountain located directly in the radio path. It blocks enough of the RF signal to make UHF R/T unusable. We know this because since our first R/T in 1988, we've tried two different UHF radiotelephones. These were very noisy and sometimes didn't work at all even though they were 25 watt transmitters feeding multiple element beam antennas. We moved to the VHF band and everything started working regularly.

The Base

Our near and dear neighbor Stan Krute, allowed us to place the base of our R/T on his property. Stan has been PV-powered for years (two miles off-grid) but his property has access to the hardline telephone system.

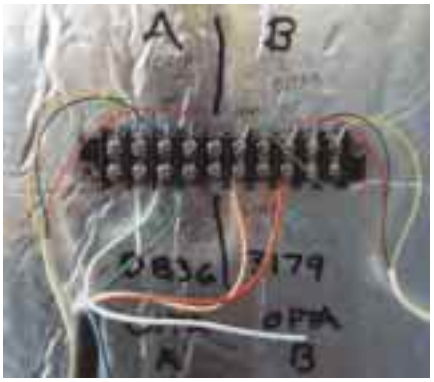


When we installed our first R/T, Stan let us mooch power from his home PV system. We couldn't afford our own PV system at the time. While generous, it was a bad idea. Stan's inverter noise and occasional low voltage caused unreliability in our R/T. If your neighbor is generous enough to allow your base end on their property, don't ask them to also supply the power. Also don't rely on grid/utility power at the base end of the system. Consider the high cost of the R/T system and its low energy requirements, then spend the relatively minor amount of money for an independent power source.



Left:
Inside the R/T shed at the base end.

Right:
Colored spaghetti where the R/T meets the hardline.



Our two phone hardlines run from the Telco phone lines to the side of Stan's house. From there we dug an 800 foot trench up the hill to a high site for the base end of the R/T. We put four pairs of phone wires in the trench, even though we were only using a single pair at the time. Recently we hooked up one of the other pairs for the new two line system. If you are going to trench phone lines, install at least twice as many pairs as you think you will ever need. Wire is cheap compared to the cost of trenching. This way the failure of a pair or the addition of another line will not require too much more work.

The base of our R/T lives in a small (4 feet by 4 feet by 6 feet high) shed high atop a hill behind Stan's house. This shed is superinsulated. The buried phone cables run into the shed and attach to the actual radiotelephone. The roof holds two Siemens PC4JF PV modules. These provide more than enough energy to run the R/T even in the most cloudy weather. The energy is stored in a 160 Ampere-hour, 12 VDC battery of ten series-connected Edison ED-160 nickel-cadmium cells. We use alkaline cells because the shed gets cold during the winter. Both the battery and the PVs

Right:
A Magnadyne filter keeps noise from entering on the power lines.

represent radical oversizing. I want this system to work and recharge rapidly during extended cloudy periods. We use a Heliotrope CC20 PV control to prevent overcharging. We also use a Magnadyne power filter to keep the charge control PWM noise out of the R/T signal.

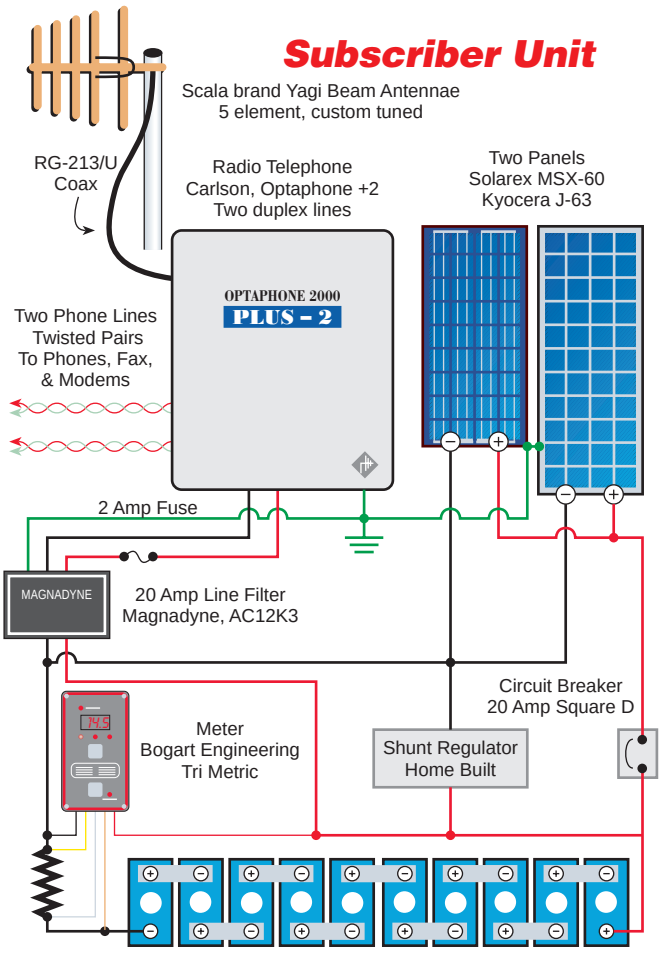
The base unit uses a five element Scala antenna on a 36 foot telescoping steel mast. This antenna both transmits and receives the phone transmission to and from the

The Subscriber End on Agate Flat

Six miles from the base end of the R/T, our sub antenna receives the signal transmitted from the base unit. The signal is passed from another five element Scala beam antenna to the Optaphone, which in turn operates our phone appliances. We have two regular telephones, two cordless (one 49 MHz and one 930 MHz) telephones, a FAX machine, and three computer modems on the system.

The sub end is powered by a Kyocera J63 and a Solarex MSX-60. We made a homebrew shunt controller to keep these modules from overcharging the 100 Ampere-hour, 12 VDC battery of ten Alcad UHP100 nickel-cadmium cells. We also have a TriMetric Amp-hr meter attached. This PV system is totally independent of our main PV/wind system. This prevents electrical noise from effecting the phone and means that if we deplete the house system we'll still have power for communications.

Use the best antennas you can find. We replaced the consumer grade Cushcraft four element beams with commercial grade five element Scala beams. They are custom tuned by the factory for our specific transmitter frequency. The Scala antennas are very well constructed and many times stronger than the old lightweight antennas. They are expensive, but well worth it and a minor cost in the big picture.



month ago. The audio levels are a little low so we'll send it back to Carlson for tweaking. This "try it and tweak it" break-in period is what we've come to expect with our marginal RF path. Those with a line of sight path will find that their R/T system will work well right out of the box.

Obstructed RF paths can use a repeater to beam the radio signals around obstacles or for longer distances. If we can't get our new two line system to deliver the

R/T System Performance

This R/T system has worked well over the years. We have tried Ritron, Telemobile, and Uniden systems before settling with the Optaphone. My only complaint is the slow speed (2400 baud) we have to run the modems. Those with better radio paths will see much better (up to 9600 baud) speed. The FAX and answering machines have no problems with the R/T system. Most folks don't know they are talking to us through a radio link. We installed the two line Optaphone about a

Below: The R/T's independant 12 Volt Nickel Cadmium battery bank

Above: Old Antenna, New Nerd...New Antenna, Old Nerd.

modem speed we need, then we may add a repeater. The drawback of a repeater is that it doubles the system's cost and complexity.

Radiotelephone System Cost

Home Power's complete R/T system cost about $8,000. While this seems like a lot of money, it is inexpensive when compared with our only option, cellular telephone. Considering our heavy phone use, it would cost about $2,000 per month just for the cellular air time. With an R/T system, the phone company bills you just like any other telephone—no by the minute air time charges.

Folks who only need a single telephone line can buy and install an R/T system with PV power at both ends for around $5,000. Home Power's system is designed for heavy-duty use with mega overkill on the power systems.

Radiotelephone System Cost

Quan	*Item*	*Cost*	*%*
1	Optaphone 2000 R/T	$4,520	56.5%
4	PV Modules	$1,600	20.0%
2	Scala Beam Antennas	$520	6.5%
2	Ni-Cd Batteries (Recycled)	$500	6.3%
1	Shed- Base End	$200	2.5%
800	feet of Buried Phone Line	$160	2.0%
2	Telescoping Masts	$130	1.6%
2	Coaxial Cables	$120	1.5%
2	Charge Controllers	$100	1.3%
	Power Wiring & Disconnects	$55	0.7%
	Rigging and Guy Rope	$50	0.6%
2	Phone Line Filters	$39	0.5%
	R/T System Total	$7,994	

Many Thanks

This short article cannot begin to give you an idea of the time and help from others that it required to get us reliable telephones here on Agate Flat. I want to thank Bob-O Schultze of Electron Connection (a pro designer and installer of many R/T systems) for the countless hours he put into making our system work well. Thanks to Stan Krute for allowing us to use his property for the system's base end. Stan hardly complained when we first located our R/T antenna close to his TV antenna and blitzed his TV reception. Thanks to Carlson Communication for working with us on what amounts to a really marginal radio path and a very difficult job.

Access

Author: Richard Perez, PO Box 520, Ashland, OR 97520 • telephone and FAX: 916-475-3179 • Internet email: richard.perez@homepower.org

Optaphone Maker: Carlson Communication Inc., 1180 Evergreen Road, Redway, CA 95560 • 707-923-4000 • FAX 707-923-2655 • Internet email: optaphone@asis.com • Web site: http://www.optaphone.com

Antenna Maker: Scala Electronic Corp., 555 Airport Drive, Medford, OR 97504 • 541-779-6500 • FAX: 541-779-3991 • Internet email: mail@scala.net