TriStar applications guide

Sample configurations for
Data Acquisition and Remote Monitoring of PV systems

## Single TriStar at each site in the field

When you would like to obtain data from the TriStar, any of several devices can be connected to it to transfer the data, as long as they are compatible with MODBUS sent over an RS-232 cable. This data device could be any of the following:

1. Local Serial Connection
2. Landline modem
3. Wireless modem (cellular or satellite network based)
4. Point to point wireless data modem (one master and one slave unit on site)

The TriStar is able to communicate at data rates of up to 9600 bps maximum. It can be set to operate at lower speeds if needed, but devices faster than 9600 bps must be lowered to the TriStar's range in order to communicate with the TriStar properly.

Following are some sample configurations which show how the TriStar can be used in several situations:

**Local Serial Connection**
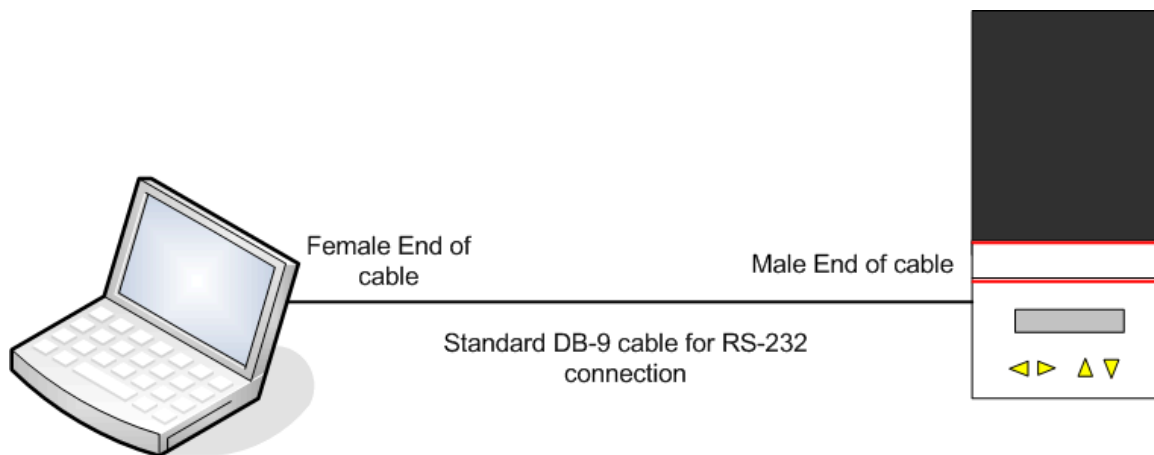
Local Serial Connection – Fig 1.

The TriStar can be connected to a computer through a normal serial port (RS-232 cable). All current operating data can be transferred from the TriStar over this port. See the Appendix for a complete list of the data values that can be received. The Software of choice for the PC can be either the freely distributed TriStarView software located on the Morningstar website, or any other MODBUS capable software. See the Appendix for listings of this type of software.

Landline Modem connection

If the TriStar can be located at a site reachable by a land telephone line, a standard modem is connected to the RS-232 port on the controller. There are some specific setup requirements for a modem to be used in this manner. Please contact Morningstar for more details on the modem types and settings that work most effectively with the TriStar. There are industrial grade modems available that would work well at a TriStar site location. These are more durable, run on DC voltage, and have other features that make them very functional in remote locations. They are also sometimes designed with power consumption as a primary concern, so that they can confidently be used with battery based systems.
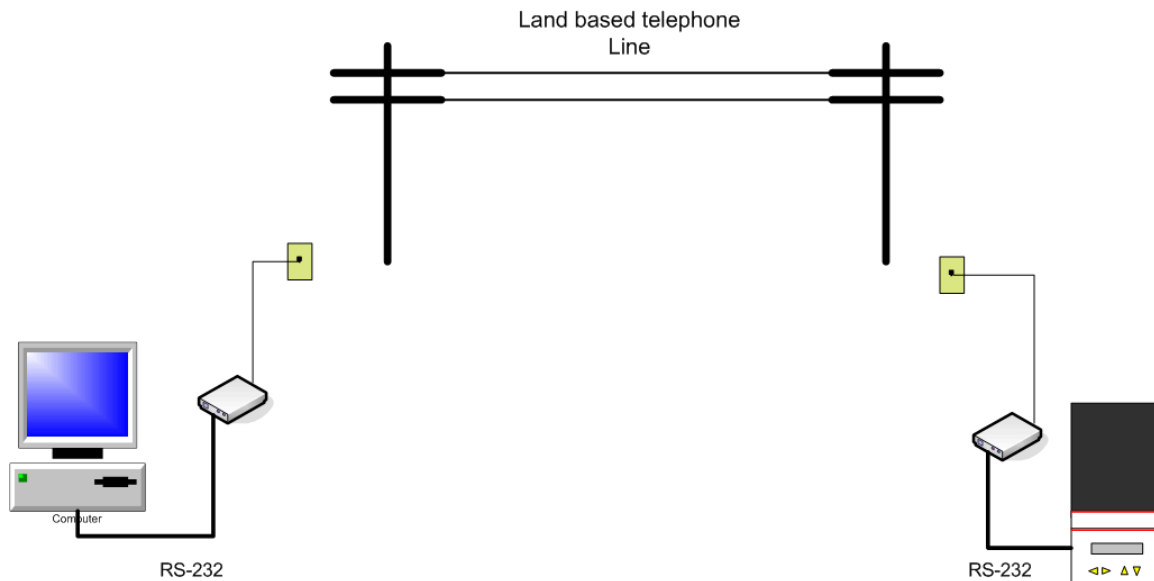

Landline Modem Connection Fig. 2

An example of a company that supplies these modems is:

www.tridentms.com – makers of the Tuff Modem which is an industrial grade modem for critical applications and extreme environments.

Once a modem is located at the TriStar site, it can then be dialed into and a connection established. Once this is done, data can then be transmitted over the land line in the same way in which the TriStar would communicate with a local PC. Whether it is 10 meters or 10 kilometers, the modem makes it seem all the same to the TriStar and the host computer.

Cellular Network
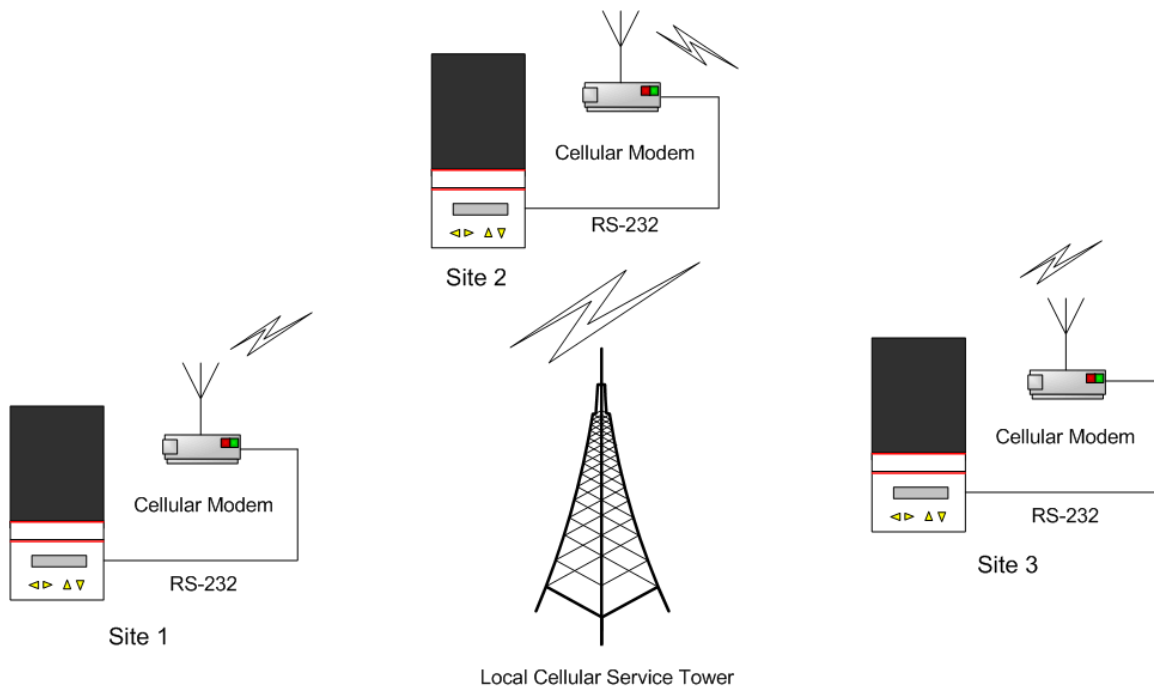

Wireless Cellular Modem Fig. 3

A cellular modem that uses a standard cellular phone network (paid service) is another option for communicating with the TriStar. Most service providers sell a modem version of their cellular phone hardware that will allow you to dial up to a remote site, connect, and transfer data wirelessly. The cellular hardware must have an RS-232 port on it to connect to the TriStar. You can then contact the TriStar the same way you would with a landline modem, except you have the advantage of reaching installations that do not have hardwired phone service.

In extremely remote locations, cellular towers may not yet be available. In this case, there are satellite modems that operate the same way, but utilize satellites in orbit to relay the signal. Depending on the amount of data and the frequency of contact, this can be quite affordable.

Point-to-Point Wireless Transfer

Point-to-Point radios are available that will relay the data connection wirelessly for around 10-30 kilometers, depending on geographical conditions and radio specifications. The difference between these and cellular modems is that there is no external service or antenna required. The radios communicate 1 on 1 with each other directly. There is no

service fee required since you are sending from one unit and receiving with another. Depending on the type of radio, a FCC license may be required, but there are several non-license frequencies available. Consult with a radio specialist for your specific needs. This type of setup can be handy to use when you need to communicate with a TriStar in the general vicinity, but the distance is still prohibitive for the use of a wired connection.
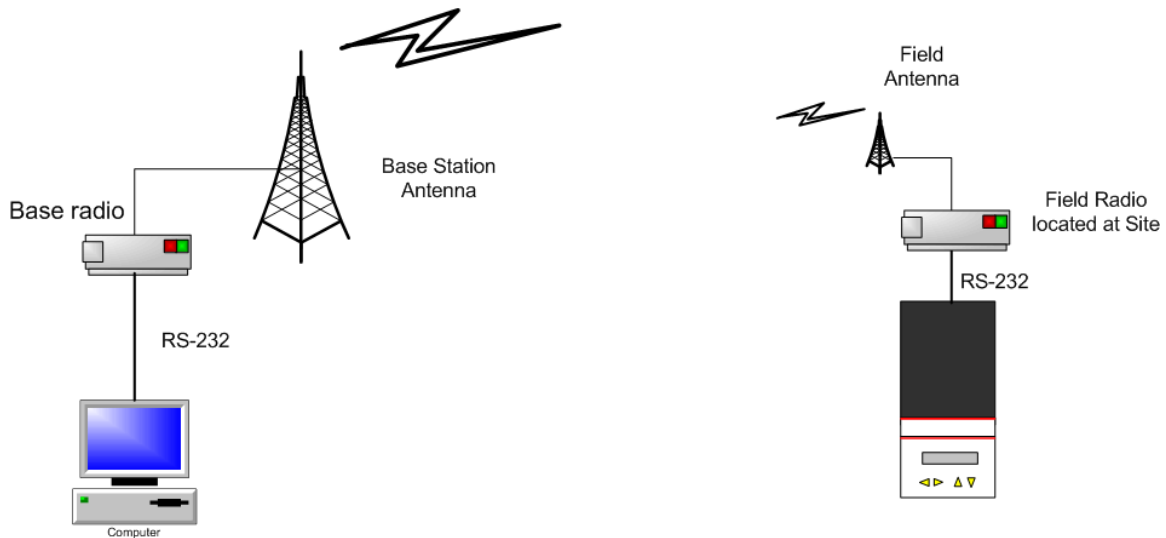
Point to Point Wireless Transfer Diagram – Fig. 4

This is also a preferred approach when you need a dedicated line of communication that is available all the time.

A master modem with a DB-9 serial port is connected to a PC or other device. Another similar modem in slave mode is connected to the TriStar. The connection will then work transparently as if the TriStar was connected directly to the PC port as in the local connection described above. Multiple units can be used in this situation, but in most systems, the base must be switched to communicate with each of them one at a time.

Some examples of wireless modem suppliers.

Data Radio –tested by Morningstar and found to be compatible with the TriStar
http://www.dataradio.com

Kantronics
http://www.kantronics.com/

Teledesign
http://www.teledesignsystems.com/

Multiple TriStars at one site location

The serial RS-232 protocol used on the TriStar is designed to be used with one other device connected to it. RS-232 does not support multiple units as standard. Multiple TriStars cannot network right out of the box, but the TS's operating software was programmed to support networking with the addition of external hardware by the installer. RS-485 is a common networking protocol used in industrial applications. It is readily adaptable to work with RS-232. The RS-232 connection on the TriStar can be connected to an RS-232 to RS-485 adapter.
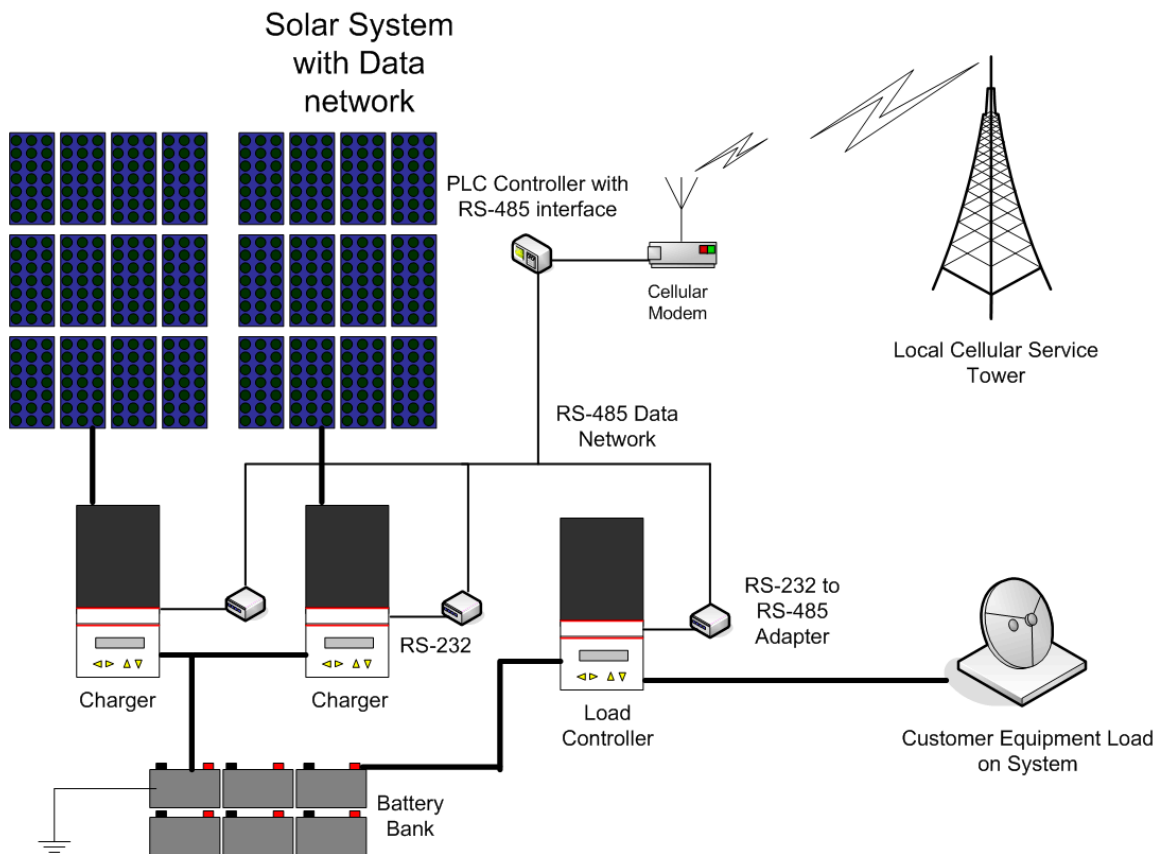
Multi-Unit Data Site – Fig 5.

While RS-232 supports only one device connection at a time, RS-485 supports over 200 different units on the same bus. Each TriStar can be given a unique ID number so that they can all be individually addressed on the same network. The TriStar View software as well as other 3rd party software packages can address multiple ID #'s, but RS-485 or other multidrop networks must be used with the TriStar's to enable this. There must be a master device controller the RS-485 bus. For example, a Programmable Logic Controller (or PLC) is often used for these types of situations. In the example above, 3 TriStars cannot communicate with each other, but they can all be polled by the PLC. Their data is combined and then transmitted.

Data logging

Besides real time transfer of information, data logging is often used to store information about the system for later retrieval. This can be as simple as a counter that runs up energy usage/production, or as advanced as getting regular measurements of 10 different parameters every 15 minutes.

The TriStar internally stores Kilowatt hours, Amp hours (total and resetable), maximum battery voltage and minimum battery voltage.

In additional to these values, the RS-232 port can be tapped to take readings of these figures, as well as the other parameters in order to be stored and accessed at a later time. Analog data measurement can be used on any system by using a series of wires in order "tap" different parts of the system to take readings. The benefit of using the TriStar is that these readings are all being performed by the TriStar, and all that needs to be done is access this data through the RS-232 port and store it. This eliminates the need for a lot of complex measurement hardware like shunts and analog/digital converters. It saves money as well as simplifies the system.

Most commonly, industrial sites use a PLC to connect many pieces of hardware together, communicate with them, and analyze the data. Sometimes PLC's can store the data internally in its own flash memory. The most common interface used by PLC's is the MODBUS protocol over an RS-232 cable. This is what the TriStar was designed to use as well, so it is easily adaptable to this type of environment. Anyone familiar with MODBUS should be able to easily work with the TriStar. The complete TriStar MODBUS specification is available on the Morningstar website. This will have everything you need to know about the TriStar's data and how to get to it easily.

PLC hardware is made by most major control and automation companies. Some of the larger suppliers are:

www.automationdirect.com
www.motorola.com
www.siemens.com
www.modicon.com
www.honeywell.com

Data Acquisition Service

Another approach to data logging and system monitoring would be to use a data acquisition service with the TriStar. All the interfacing, programming and setup are done

by the provider. The service providers collect the data and put it on a secure website to be accessed by the customers at their convenience. This simplifies the collection and logistics of data acquisition. The providers many times use their existing cellular or satellite based networks on their own terms. No dialing up or wireless connection needs to be handled by the customers. They merely use the website as their data storage. The data can even be converted to be viewed in a graphical format, as shown below in a sample picture from the WWmachines website. This makes the information more understandable to someone who does not have a technical background. This "outsourcing" of the data collection can be very cost effective.
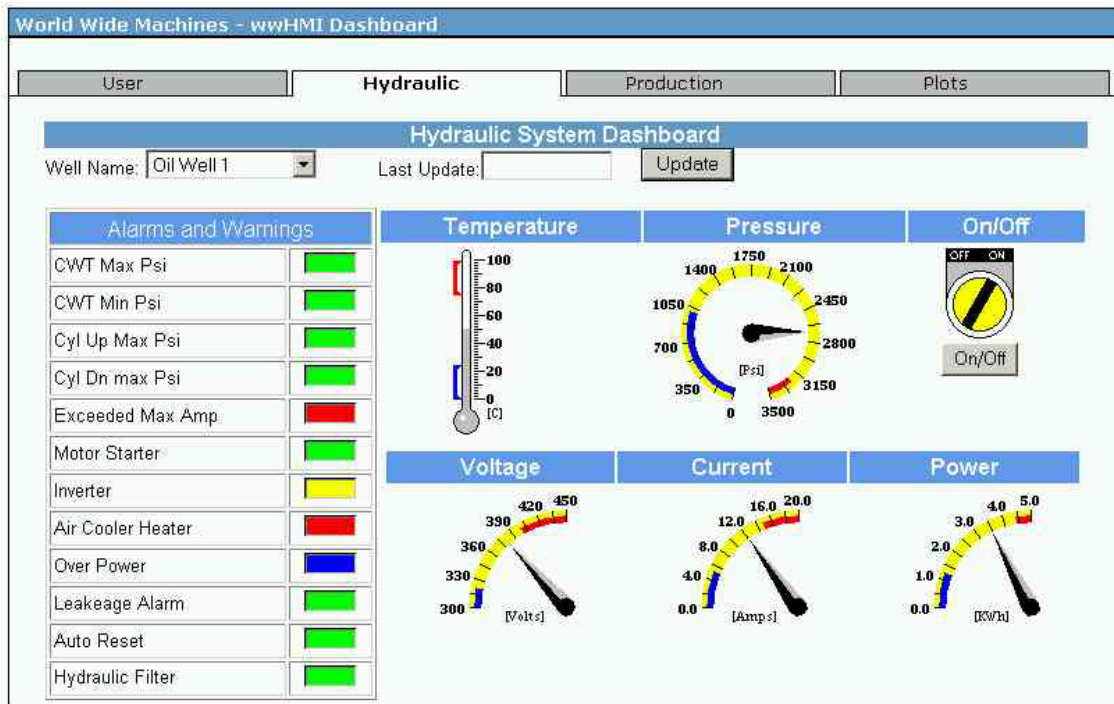
Example Graphical Web Interface – Fig 6.

Once the data is stored and accessible on the internet; it can also be used for many other purposes. The data can be downloaded to a local computer for further analysis. The customers could also work to "link" the data onto their own website so it would integrate seamlessly with their own company website. Contact a data service provider for more information.

Appendix:

Software

Software companies that provide MODBUS software packages for industrial automation and remote control:

National Instruments' Lookout
www.NI.com

Lookout is a sophisticated measurement interface program that can communicate with MODBUS as well as hundred's of other pieces of measurement equipment.

Software Horizons' OI-2000 and Instant HMI for Palm/Pocket PC
http://www.shorizons.com/

OI-2000 is a human-machine interface program. It can convert many of the data values of the TriStar into more easily understood graphical displays such as illuminated indicators, meters, graph's and displays. It gives the data more of a control room atmosphere.

TriStar data fields accessible through MODBUS

The following fields are all individually addressable MODBUS data registers. They can be polled by a MODBUS device to view the current value. For more details on the exact holding registers, please see the Morningstar document "TriStar MODBUS specification" located under the TriStar product section of the Morningstar website.

1. Battery voltage - measured at main terminals

2. Battery Voltage - measured at sense terminals

3. PV Array/Load voltage (depending on mode)

4. Charge Current

5. Load Current

6. Battery voltage measured at main terminals (heavily filtered)

7. TriStar heat sink temperature

8. Battery temperature at remote temperature sensor

9. Regulation Voltage value

10. Resetable Amp-hours

11. Total Amp-hours

12. Hourmeter - # of hours since install

13. Alarm bitfield - each bit corresponds to a different alarm

      1=Remote Temp Sense Open
      2=RTS Shorted
      3=RTS Disconnected
      4=TriStar temp sense disconnected
      5=Heat Sink Temp sensor shorted
      6=TriStar hot
      7=Current Limiting
      8=Current OffSet
      9=Battery Sense wire disconnected
      10=Uncalibrated
      11=RTS miswire
      12=High Voltage Disconnect
      13=High Diversion Duty Cycle - overload warning
      14=miswire external to TriStar
      15=MOSFET locked in open state
      16=Check TS internal power supply
      17=Load Disconnect

14. FAULT bitfield - each bit corresponds to a different fault

      0=external short circuit
      1=overcurrent
      2=MOSFET short
      3=Software error
      4=High Voltage Disconnect
      5=TriStar system overtemperature
      6=setup DIP switch altered
      7=Program setting has been changed

8=Reset
9=miswire
10=Remote temperature sense shorted
11=Remote temperature sense disconnected

15. Dip Switch setting - each bit corresponds to a dip switch to verify hardware setting from a remote site

16. Control mode
    0=charge
    1=load
    2=diversion
    3=lighting

17. Control state

    Charge and Diversion Modes

    0=Start
    1=Night Check
    2=Disconnect
    3=Night
    4=Fault
    5=Bulk
    6=PWM
    7=Float
    8=Equalize

    Load and Lighting Modes

    0=Start
    1=Normal
    2=LVD Warning
    3=LVD
    4=Fault
    5=Disconnect
    6=Normal Off
    7=LVD Override

18. PWM Duty Cycle %