Amper, milliAmper
&
microAmper

by

Automation Solutions

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GENERAL SAFETY INSTRUCTIONS

Warnings in this manual appear in either of two ways:

1. *Danger warnings* – The danger warning symbol is an exclamation mark enclosed in a triangle which precedes letters spelling the word “DANGER”. The Danger warning symbol is used to indicate situations, locations and conditions that can cause serious injury or death:

 **DANGER**

2. *Caution Warnings* - The caution warning symbol is an exclamation mark enclosed in a triangle which precedes letters spelling the word “CAUTION”. The Caution warning symbol is used to indicate situations and conditions that can cause operator injury and/or equipment damage:

 **CAUTION**

Other warning symbols may appear along with the Danger and Caution symbol and are used to specify special hazards. These warnings describe particular areas where special care and/or procedures are required in order to prevent serious injury and possible death.

Electrical Warnings – The electrical warning symbol is a lightning bolt mark enclosed in a triangle. The electrical warning symbol is used to indicate high voltage locations and conditions that may cause serious injury or death if proper precautions are not observed:

For the purposes of this manual and product labels, a **Qualified Person** is one who is familiar with the installation, construction, operation and maintenance of the equipment and the hazards involved. This person must:

1. Carefully read and understand the entire manual.

2. Be trained and authorized to safely energize, de-energize, clear faults, ground, lockout and tag circuits and equipment in accordance with established safety practices.

3. Be trained in the proper care and use of protective equipment such as safety shoes, rubber gloves, hard hats, safety glasses, face shields etc. in accordance with established safety practices.

4. Be trained in rendering first aid.

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Manual Revisions

0.78 Oct 2007 Release
0.79 Dec 2007 Calibration explanation, add use of clamp on CT's, load resistor examples corrected. Minor spec changes.
1.00 Dec 2007 ChartLogger re-calibration shown.
2.00 May 2008 Support for hysteresis and pulse counting capability.
2.01 Jun 2008 Cosmetic corrections.

Amper Datalogger Family
Introduction

Automation Solutions Amper, milliAmper and microAmper provide a new, modern way to electronically collect current and voltage data. Each device may be connected to a signal of interest and the device will automatically take readings at a preset rate, saving the data to a standard low cost SD/MMC data card. The data may then be transferred to a PC for further analysis, either with standard PC programs such as Microsoft's Excel or with the provided ChartLogger program, which is capable of manipulating and displaying huge amounts of data. This manual covers operation of three similar models, the Amper, milliAmper and microAmper. The Amper is typically connected in series with a standard 5A current transformer. The milliAmper is typically connected in series in a 4-20mA current loop. The microAmper, along with a resistor, may measure directly applied Voltages or currents and with a non-contact clamp on current probe it may log currents to thousands of Amps. With the exception of the input signal rating the units are identical and only differ by the internal load resistor. They may be referred to below simply as the Amper. Features include:

Easy to operate. There are no switches, knobs or buttons. One blue LED occasionally flashes to indicate successful writes to the card, another red LED flashes if there's an error, such as the data card full. Pulling out the card allows the operator to walk away with logged data in seconds.

Easy to install. There are just two wires to connect, insensitive to polarity. The unit can be connected and running in minutes. The extremely low impedance (0.05 Ohm for 5A CT's and 15 Ohm 0.3 Volt drop for the millAmper) allows it to run in series with many other devices in the current chain.

Easy to configure. All configuration settings are done via simple text files written on the memory card. Use the Amper configuration program (provided) to make any changes, insert the card and the configuration is automatically set and retained; the Amper then automatically deletes the configuration files. The Amper configuration program easily lets the user change settings such as site name, acquisition rate, time and date, CT and scaling factors.

No external power required. The unit typically operates for 5 years with the user replaceable high capacity battery. Since events of interest often occur just before or after power loss being independent of external power is a huge benefit. As well as maintaining the time and date the unit automatically measures its own battery voltage, and will start to write warning messages to the data card typically 3 months before the battery fails.

Accurate data logging. The Amper, designed for 5 Amp CT's, measures current surges up to 30 Amps at full scale A to D resolution to accurately capture events such as motor startups, overloads, heavy load changes, line sags and surges. If the input current is below 6 amps the signal is automatically routed through a separate input signal path so it is still acquired at the full scale A to D resolution. This gives a total resolution exceeding 14 bits. The other models have similar input scaling circuits. True RMS (including dc offset) data acquisition is used, so the data is accurate no matter what shape the signal waveform is. Measurements from any type of VSD, switchboard or non sinusoidal source are all accurately recorded. All data is saved to the card in raw text format, so may be calibrated or offset if required after acquisition without any loss of accuracy.

Fast data logging. The user may set the data acquisition rate, from 20 readings per second to about one per hour; in 50mS increments. Adjustable hysteresis lets the logger accurately catch high speed impulses without creating giant files.

Lots of data logging. The amount of data collected using the Amper may be huge. At the fastest data acquisition rate over 1.7 million readings are taken every day. At this rate in less than an hour files are too big to load into Microsoft Excel. (No problem for the ChartLogger program, included with the Amper) However, the large size and low cost of SD/MMC cards provide deep data storage. Using a 2 GByte card and taking samples twice a second a year's worth of data fits on a single card. Use a sample rate of once a minute and you won't live long enough to see the card full.

Compatible data logging. Every single reading collected by the Amper is stored as a plain ASCII string in a text file, along with the date and time stamp of each reading. Every day a new data file is created. Open any day's file with any text editor such as notepad. View, zoom, scroll, pan, print, see statistics and inspect the data with ChartLogger. (Excel may be used for small files).

Pulse Capability. Change a couple of configuration files on the data card and the Amper is reconfigured to become a powerful pulse logger; useful for utility, traffic, flow and similar measurements. Collect pulse data (up to 10 pulses per second) in buckets of minutes to an hour allowing for easy analysis of totals that are simply impossible to collect with a typical totalizer type counters. Even copy data from the card while running without loosing any pulse counts.

Unattended data logging. Leave the Amper running all the time; if there's a problem swap the card and look at the data. Just pull the Amper data every year or so (unless you need it sooner), replace the battery every 5 years or so; that's it. Forget changing the circular charts, the dried up pens and weekly wind ups.

Specifications:

Operating temperature	-20ºC to 60 ºC non condensing
Storage temperature	-30ºC to 70 ºC non condensing
Size	6.125” x 4.5” x 2.25”
Weight	1.5 lbs; 675 grams.
Power Required	3.6V 19Ah Lithium Battery Tadiran TL-5930S
Battery Life	Depends on acquire rate; typically 3-8 years
Input Signal Range	0 - 6 Amp nominal, 0 – 30 Amp Surge (Amper)
	0 - 100mA (milliAmper)
	0 – 1.5V (microAmper)
Input Signal Load	0.05 Ohm (Amper)
	15 Ohm (milliAmper)
	10.0 KOhm (microAmper)
Input Surge Time Limit	Amper 20 Amps 5 seconds Maximum
	milliAmper 150mA maximum continuous
	microAmper 0.2mA maximum continuous
Accuracy	0.15 % 0ºC to 50ºC
Conversion Resolution	14 Bit
Input Conversion Type	True RMS for any waveform
Fastest Acquire Rate	50mS (20 samples / second)
Fastest Pulse Rate	10 Hertz / 20 edges.
Pulse Counting Bucket Size	1 to 60 minutes.
Data Storage Format	ASCII text files
Data Storage Medium	SD/MMC Flash Memory Cards, up to 2 GByte (FAT or FAT32)
Data Storage Capacity (Analog Mode)	Depends on card size; approximately 60 Million analog samples with a 2 GByte card.
Data Storage Capacity (Pulse Mode)	Greater than 50 years of data using a 2 GByte card.

Operation

Unpacking and Inspection:

DANGER

The Amper datalogger uses a high capacity battery containing Lithium. FAA regulations prohibit transporting this battery via passenger aircraft. If the device has to be shipped via passenger aircraft the battery must be removed before shipment.

NOTE

The date and time maintained by the Amper datalogger will be lost if the battery is removed for more than approximately 10 seconds. Do not remove the battery unless the unit will not be used for extended periods of time or the device needs to be shipped by passenger aircraft.

Open the container and verify the following items are included.

1. Amper Datalogger
2. SD/MMC data card. The ChartLogger and Amper Setup software are on this card.
3. SD/MMC to USB Adapter
4. Manual
5. 2 Pin signal plug
6. Battery (this may already be installed in the Amper)

The microAmper may also be supplied with a resistor kit and BNC adapter.

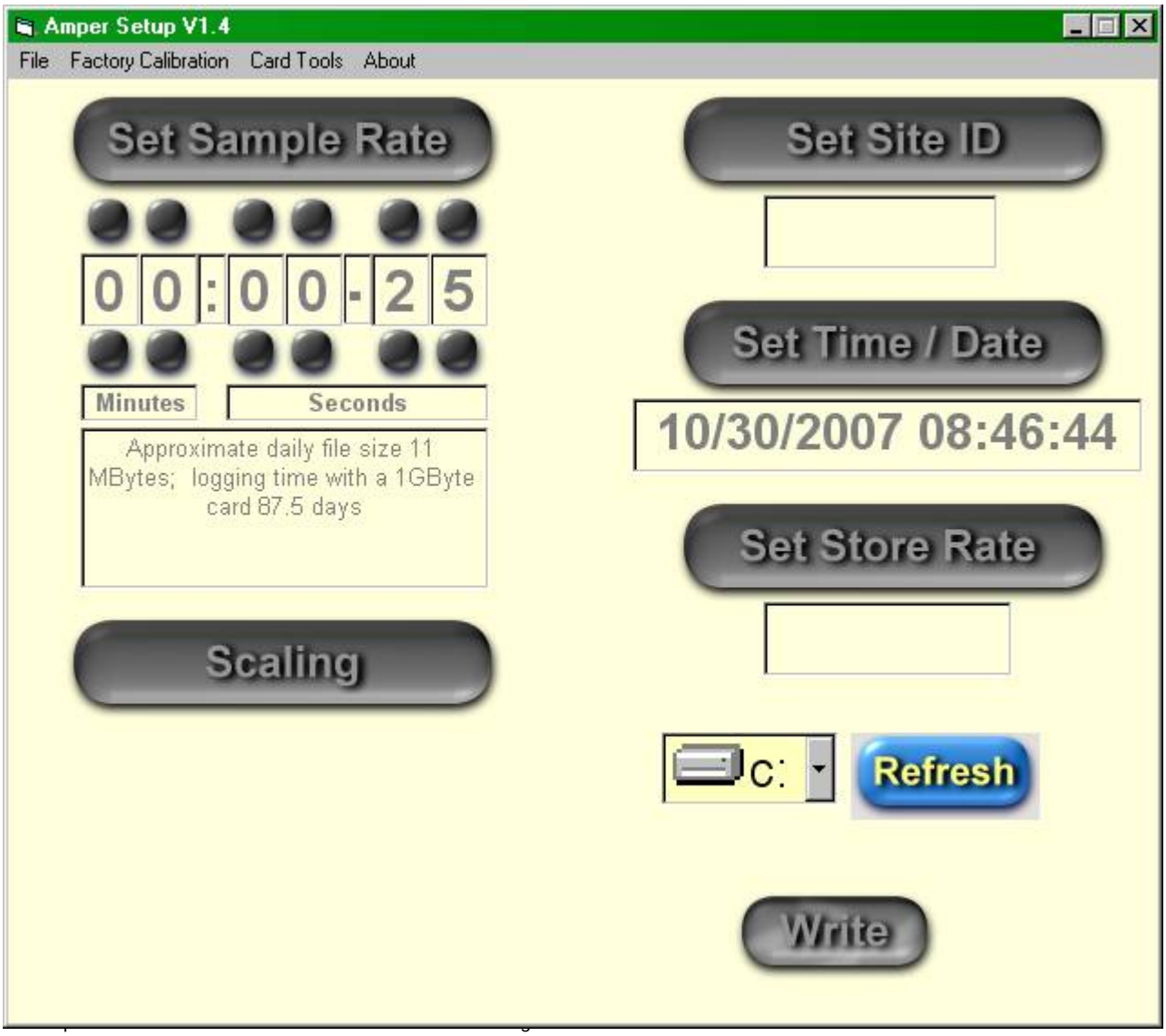
If any are missing please contact the vendor for assistance.

Configuration and Setup

The Amper may need configuring before initial operation, to set suitable parameters such as the site name, sample rate and the local time and date. The AmperSetup program provides a quick and easy way to create these settings and write them to the card, then when the card is inserted into the Amper all settings are automatically updated. Since these configuration files are in a plain text format they may also be created with any plain text editor such as Microsoft Notepad, details on the configuration files are explained further on in the manual. The following chapters explain how to use the Amper Setup program to configure the Amper ready for operation.

Using the Amper Setup Program

The Amper Setup program provides a quick and easy way to generate any configuration files needed. The program itself is provided on the SD card that comes with the Amper. To install the Amper Setup program insert the card in the PC (use the supplied SD/MMC to USB converter if the PC does not have an SD/MMC slot). Navigate to the SD card directory on the PC then double click on “Install Amper Setup”; this will install the setup program. The Setup Program may now be started, and a screen similar to the following will appear:



The large control buttons initially appear grey such as the date and time in the screen above; clicking on them will change color to indicate that they are operational. One or more may be selected to create the required settings.

Set Sample Rate allows changing the sample rate for collected data. The sample rate may be set from 50mS (20 samples a second) to approximately once an hour. An estimate of the data file size will be shown in the box below. Use the up and down buttons to select the required sample rate.

Set Site ID allows changing the ID of the site. This will be used as part of the name for the data files. It may be up to 4 characters long without any special characters. Note that the Set Site ID button must be enabled to allow changes to the scaling with the Scaling button; since the scaling data written to a card needs to know the units ID it is to be associated with. Scaling data from different sites may exist on the same card; these files are not actually read by the Amper.

Set Time Date. This will update the internal clock and calendar in the Amper. The time and data will be taken from the PC's clock, and may be seen in the window below the button.

Set Store Rate. For most applications this is never used. The Amper will only write to the card when it needs to due to its internal data buffers being full. However, if acquiring at a slow rate it may be a long time between card writes; for example if taking a reading every 5 minutes it will be over 3 days before the card is written to. If data is needed before this wait a shorter time may be set here; this will force a write to the card if new data exists within this time frame. It is the longest time between writes (in minutes), so in the above example if the store rate was set to 30 minutes then the most current readings stored on the card would never be more than 30 minutes old.

CT Ratio / Span & Offset. The Amper normally operates with a current transformer (CT). The CT is an isolated pass through device (or hollow transformer) that senses a sample current and provides an isolated output current typically in the range from 0 to 5 Amps RMS. This output current is proportional to the sample current. Typical CT's may be 50:5, 1000:5 etc rating, meaning that they can measure currents up to 50 and 1000 Amps respectively with full scale outputs of 5 Amps. When the CT ratio button is enabled a calibration factor is generated that may be stored on the card. Note that this value is not used or even read by the Amper, but the value is stored on the card so the ChartLogger program may use it. When the ChartLogger imports the data from a site it also automatically reads these parameters if present, so the data displayed in ChartLogger is in scaled units that relate to the site. The CT ratio may be entered here, and is the nominal full scale reading for the current transformer. (The Amper will accurately measure levels up to 5 times higher than this to accommodate overloads). Note that setting the ratio 5:5 effectively scales the input as a 0 to 5 Amp ammeter, and it can be used as such without the use of a CT. If the CT Ratio button is clicked again it displays span and offset values typically used for the milliAmper; although they can be used by the Amper too.

For the milliAmper the nominal full scale value corresponds to 20mA input. The span could be any process variable, for example 10,000 PSI, 120 ft, 100 GPM. Note that most 4-20mA transducers provide 16mA as the full scale 'span' and an offset of 4mA. Since the milliAmper measures from 0 to 20mA the entered span is typically 1.25 * the transducer span, and the offset will be a value subtracted from the result by the ChartLogger program as the data is displayed. For example, if a transducer measuring 0 -1000 generates a 4 to 20mA change, enter a span of 1250 and an offset of 250. This means that an input signal of 0mA will result in -250 being displayed in the ChartLogger, a signal of 4mA would indicate 0, and 20mA would indicate 1000. Generally the only signal sources that would require an offset would be 4-20mA transducers.

To summarize, the nominal full scale range used for display in the ChartLogger program is set by using either the 'CT ratio' or 'Span' button. They both have the same effect, generating the ChartLogger 'span' value. If the 'CT ratio' button is used the ChartLogger 'offset' is set to zero; if an offset is required use the Span / Offset button. Note that the span and offset may be entered or changed later; they are not used by the Amper at all for datalogging but just by the ChartLogger display program.

Write to Card. Once one or more settings have been selected this button will become enabled. It will allow any settings to written to the card. Before clicking on it ensure that the drive letter,

such as D: or E: corresponds to the current card location, and that the card is not write protected. The configuration files will always need to be in the top or root directory of the card.

Connecting the Amper to Electrical Signals

DANGER

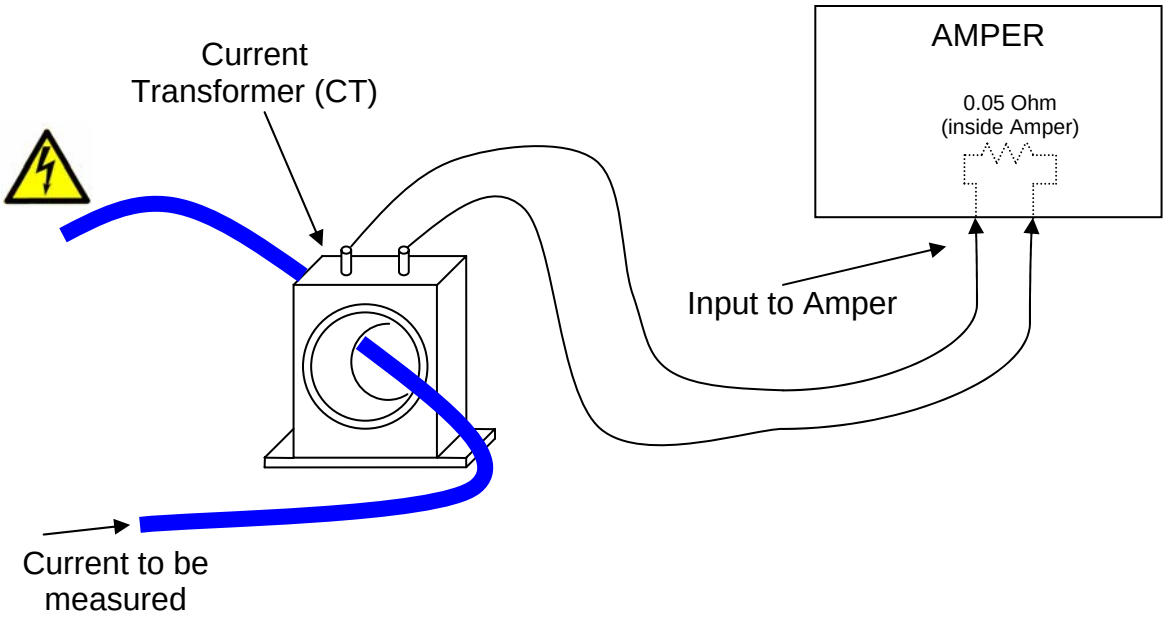
Only qualified persons may make electrical connections to the Amper datalogger. Ensure all local safety codes and procedures are followed.

First ensure any live circuits are disengaged and suitable lockout / tag out procedures are in place.

Amper AC current measurement using a CT with 5 Amp secondary.

There is just a single 2 pin connector on the front of the Amper to connect. The two pins are simply connected in series with the CT secondary. There is no electrical connection between the Amper and the primary current being measured as the CT provides electrical isolation.

Example circuit where current
is to be measured using as CT



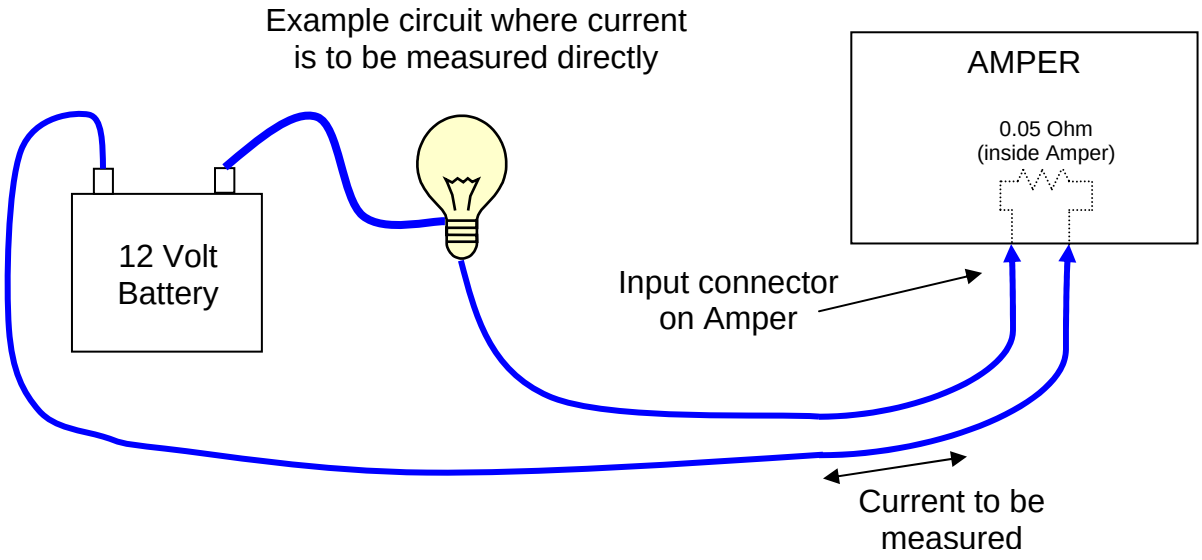
Since the electrical burden is so low the Amper may be connected in series with other current measuring devices such as the Bristol Babcock ampchart without affecting the other devices.

Amper AC and/or DC current measurement without a CT.

DANGER

The Amper is not intended for direct connection to high voltage potentials. The electrical isolation between the 2 pin current sensing input and the grounded case is rated at 40 Volts AC or less. Do not connect the input connection directly to any Voltage exceeding 40 Volts with respect to ground.

First ensure any live circuits are disengaged and suitable lockout / tag out procedures are in place. There is just a single 2 pin connector on the front of the Amper to connect. The two pins are simply connected in series with the current to be measured. Since the electrical burden is very low (approximately 0.25 Volt drop for 5 Amps of current sensed) other devices may be in the circuit without any affect.



The Amper is often used for low Voltage DC current measurements, for example to determine the draw on a solar powered system. Since the Amper measures true RMS current the polarity for connection is irrelevant, as the Amper does not indicate negative currents but rather shows them as true RMS positive currents.

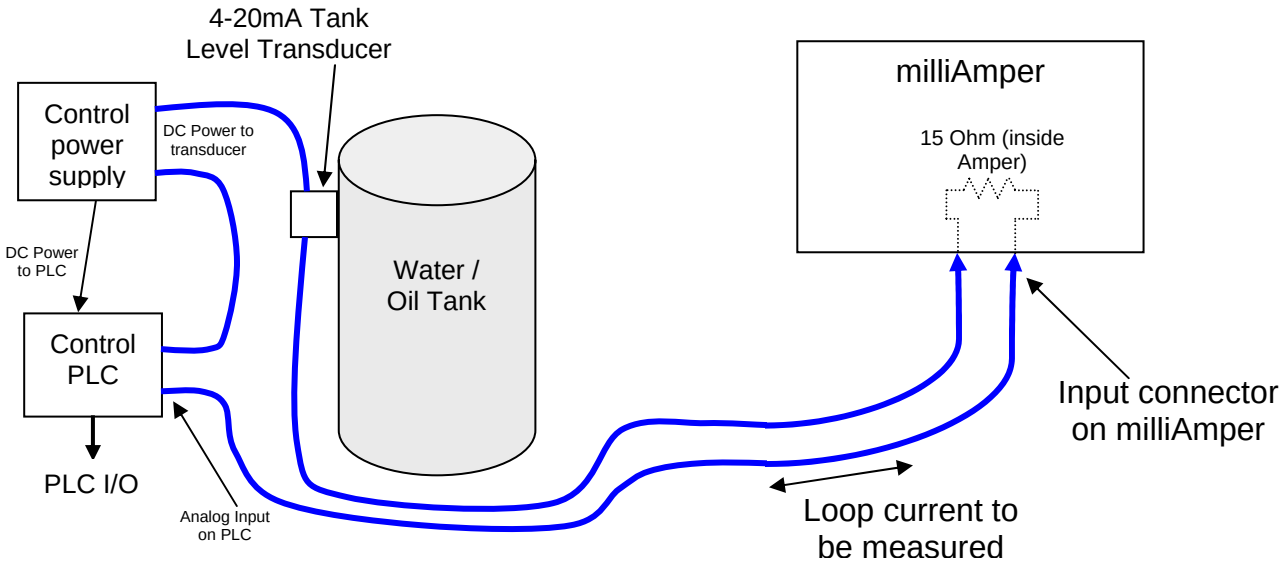
milliAmper AC and/or DC 0-20mA and similar current measurements.

DANGER

The milliAmper is not intended for direct connection to high voltage potentials. The electrical isolation between the 2 pin current sensing input and the grounded case is rated at 40 Volts AC or less. Do not connect the input connection directly to any Voltage exceeding 40 Volts with respect to ground.

First ensure any live circuits are disengaged and suitable lockout / tag out procedures are in place. There is just a single 2 pin connector on the front of the milliAmper to connect. The two pins are simply connected in series with the current to be measured. Since the electrical burden is so low (approximately 0.30 Volt drop for 20mA of current sensed) other devices may be in the current loop without any affect.

Example circuit where 4-20mA current is to be measured



The milliAmper is often used for low Voltage DC milliamp current measurements, for example connected to a suitable transducer it may log the level of a tank or pipeline flow. As the milliAmper measures currents down to zero it also logs events such as power failing to the 4-20mA transducer. The milliAmper measures true RMS current, so the polarity for connection is irrelevant as the milliAmper does not indicate negative currents but rather shows them as true RMS positive currents.

microAmper AC and/or DC Measurements.

The microAmper has a higher impedance load (10.0K Ohms) compared to the Amper and milliAmper. As such it is capable of measuring a nominal Voltage of 0 to 1.5 Volts with a very small current draw. By using an external resistor either in series or parallel with the microAmper much higher full scale Voltages and currents may be accurately measured. For example, by placing a single resistor in series with the microAmper it may easily measure applied AC and/or DC Voltages from 0 to over 50 Volts. By placing a suitable resistor in parallel with the microAmper it may measure currents from micro Amps to many Amps. The microAmper is provided with a selection of resistors to allow logging of common Voltage and current ranges, and is also able to be directly connected to suitable clamp type current probes. The microAmper is therefore the most flexible of the unit three units, but a little more caution is needed before connecting it to signals of interest as suitable resistors may be required to prevent damage to the unit or hazardous conditions.

microAmper Voltage Measurements

DANGER

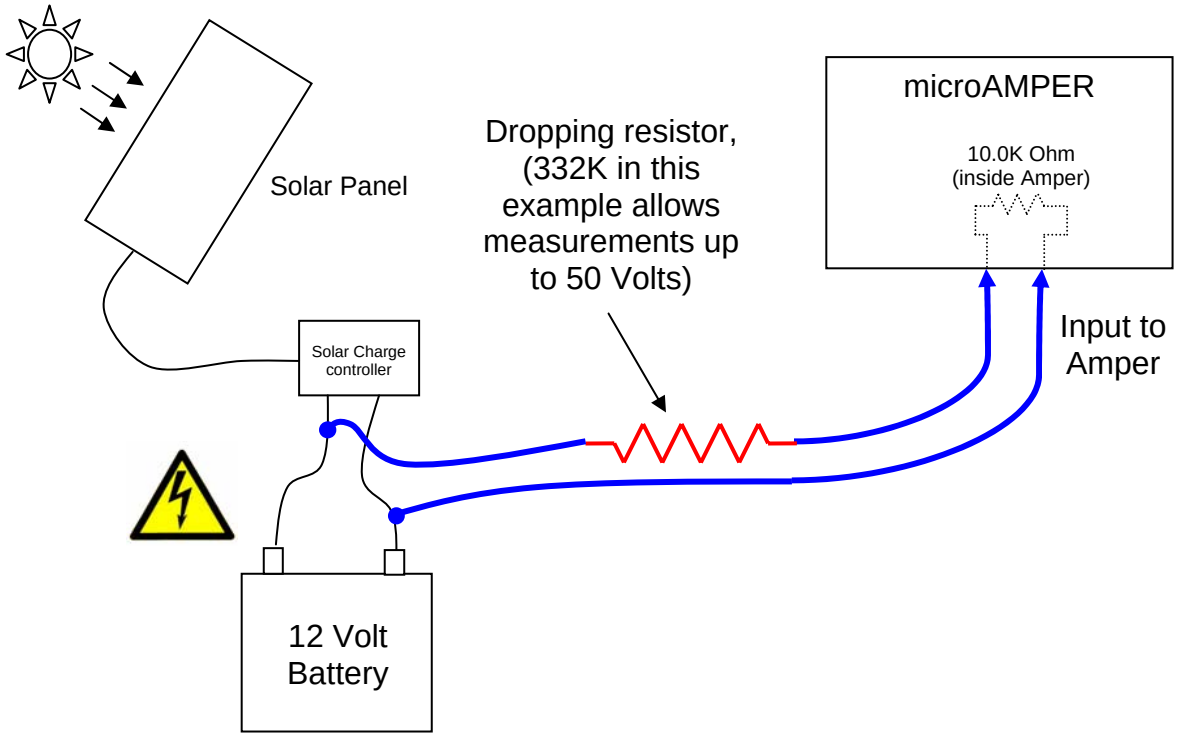
The microAmper is not intended for direct connection to high voltage potentials. The electrical isolation between the 2 pin input and the grounded case is rated at 40 Volts. Do not connect the input connection directly to any Voltage exceeding 40 Volts with respect to ground.

First ensure any live circuits are disengaged and suitable lockout / tag out procedures are in place. There is just a single 2 pin connector on the front of the microAmper, one pin is connected to the low Voltage side of the signal to be measured. The other pin is connected to one side of the user supplied Voltage dropping resistor. The other connection from the user supplied dropping resistor goes to the high Voltage potential side of the signal to be measured.

The microAmper is often used for low Voltage DC Voltage measurements, for example it may log the Voltage level of a battery powered system during charge and discharge cycles. As noted previously, since the microAmper measures true RMS signals the polarity for connection is irrelevant as any negative readings will be shown as true RMS positive values.

Several common Voltage ranges and resistor values are shown as examples below. Note that suggested common values are also listed. Since it is easy to adjust the span to compensate for resistor values commonly available low cost resistors may be used and the microAmper will still produce very accurate readings.

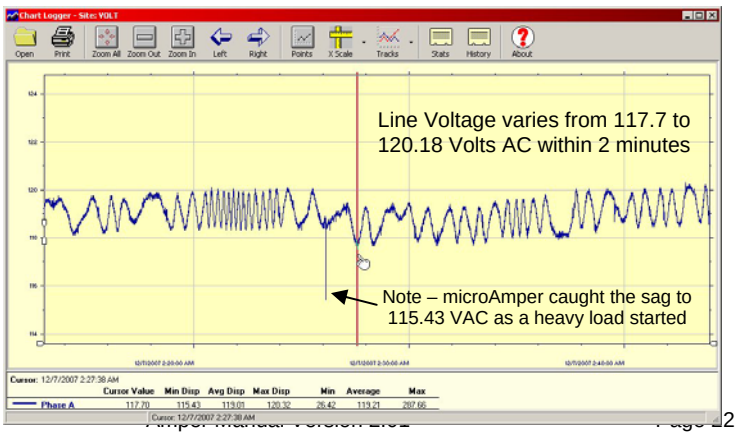
Voltage logging with the microAmper



Nominal calibration Voltage. (AC and/or DC)	Maximum Measured Voltage	Dropping Resistor Required	Closest Common Resistor Value	Scale if using common value resistor
5	25	157K Ohm	158K Ohm	5.04
10	50	323K Ohm	332K Ohm *	10.26
12	60	390K Ohm	392K Ohm	12.06
20	100	657K Ohm	681K Ohm *	20.73
25	125	823K Ohm	1 Meg Ohm	30.3
50	250	1.66Meg Ohm	2 Meg Ohm *	60.3
120	600	3.99Meg Ohm	4.0 Meg Ohm	120.3

* supplied with the microAmper

Commonly available resistors have 1% accuracy; however they will generally remain very stable over their lifetime and temperature changes. Once the microAmper calibration has been adjusted for the required input extremely accurate measurements may be taken over extended time periods. When calibrating it should be noted that many AC Voltage sources such as AC line power continually vary, it is not unusual for line power to vary by more than 1% in less than a minute (see example graph). In the solar panel example shown above if a Voltage that could vary up to 50 Volts were to be logged then a 332K resistor would be placed in series with the



microAmper. Using the Amper Setup program calibration settings could be entered as follows: an offset of zero and a span of 10.26 The microAmper may then be used be used to measure up to 50 V and readings displayed in the ChartLogger program will be accurate to within the resistor tolerance of 1%. Since the ChartLogger allows rescaling after data has been accumulated the scaling could then be adjusted if required.

microAmper 'In Circuit' Current Measurements

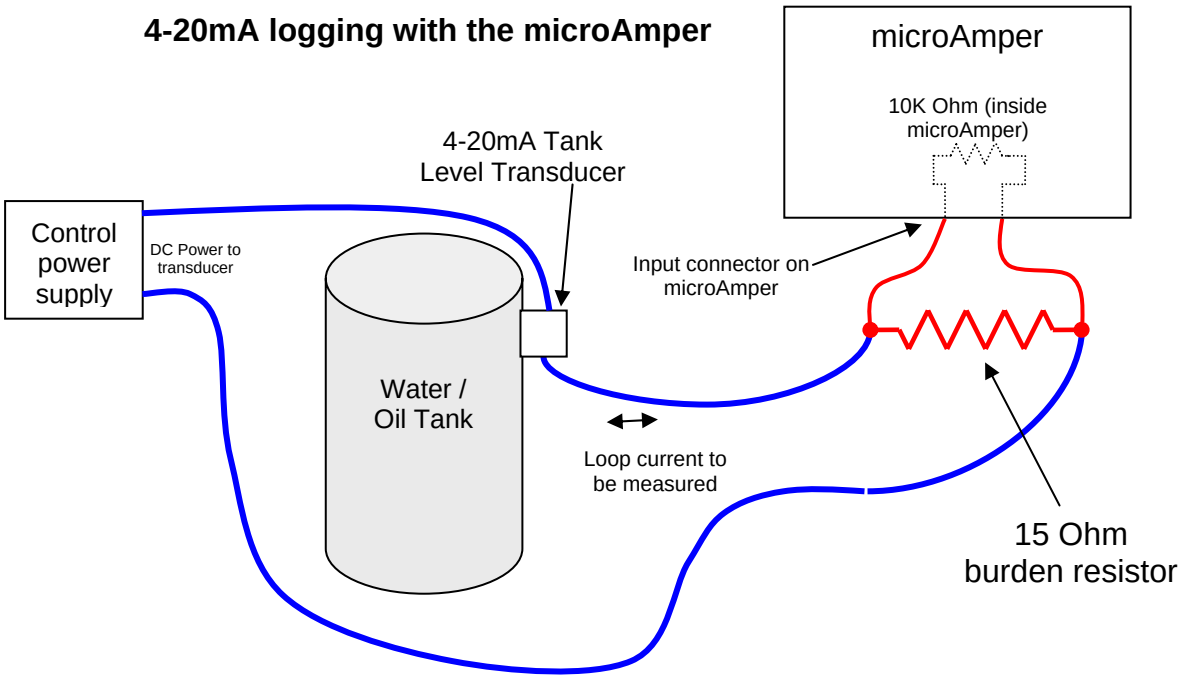
First ensure any live circuits are disengaged and suitable lockout / tag out procedures are in place.

DANGER

The microAmper is not intended for direct connection to high voltage potentials. The electrical isolation between the 2 pin input and the grounded case is rated at 40 Volts. Do not connect the input connection directly to any Voltage exceeding 40 Volts with respect to ground.

There is just a single 2 pin connector on the front of the microAmper, to measure currents with the microAmper a resistor is placed in parallel with the microAmper input terminals. This burden resistor is sized so it will produce an input Voltage to the microAmper below 1.5 Volts, which is the maximum the microAmper can directly measure. When entering scale values the calibration factor is calculated based on a 300mV input signal, so the full scale range is actually 5 times higher than the scale point. As an example a common application would be to measure 4-20mA current loops, In this case a 15 Ohm resistor (provided with the microAmper) would be placed as shown in the diagram providing 300mV to the microAmper input terminals when 20mA is flowing.

4-20mA logging with the microAmper



The calibration values are then chosen based on the 20mA transducer point; note that the microAmper will accurately record currents up to 100mA with this value of burden resistor.

microAmper 'Clamp On' Current Measurements

First ensure any live circuits are disengaged and suitable lockout / tag out procedures are in place.

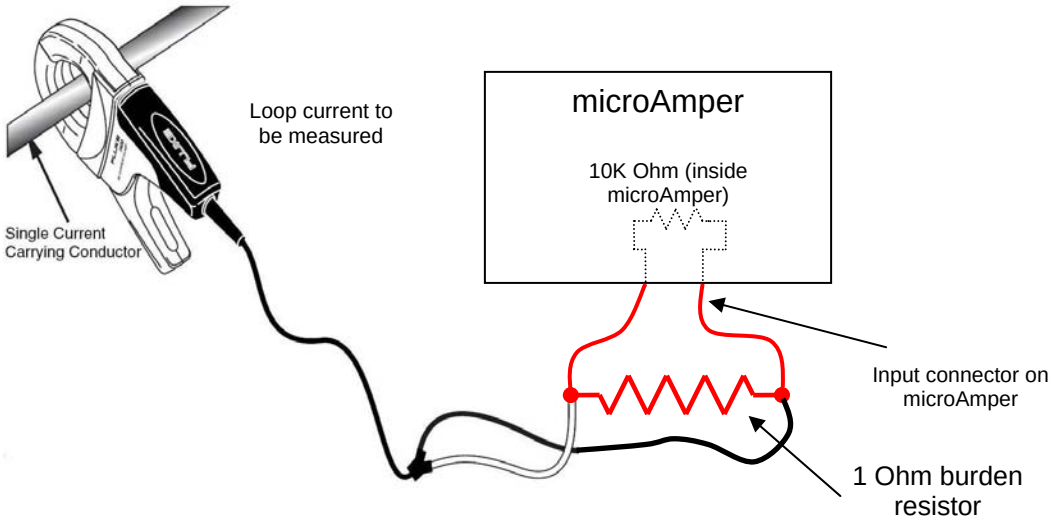
DANGER

The microAmper is not intended for direct connection to high voltage potentials. The electrical isolation between the 2 pin input and the grounded case is rated at 40 Volts. Do not connect the input connection directly to any Voltage exceeding 40 Volts with respect to ground.

The micro Amper may also be used with a 'clamp on' type current probe, which allows measuring current without any direct electrical connection to the signal of interest. There are many brands, types and ranges of these clamps, with different scaling and loads available. Virtually all of them may be used with the microAmper, but depending on the model they may need a suitable burden resistor and the calibration settings may need adjusting. There are two basic types, the first outputs a *current* (typically 1mA per amp sensed) across a burden load resistor (which is often inside a multi-meter set to measure current). This resistor is sized so it will produce an input Voltage to the microAmper below 1.5 Volts, which is the maximum the microAmper can directly measure. A typical burden resistor for this type of probe (example Fluke Model i400 shown which can measure 0 to 400 A rms) would be 1 Ohm resistor (provided with the microAmper) that would result in 400mV at the input to the Amper when 400 Amps were measured. When entering scale values the calibration factor is calculated based on

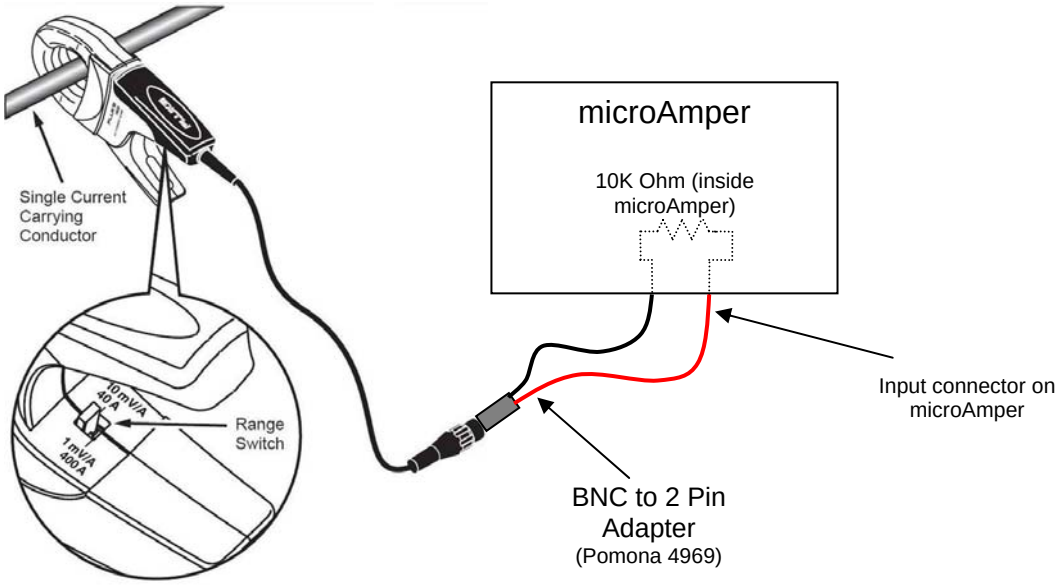
a 300mV input signal, so the span would be adjusted accordingly (and can be rescaled in the ChartLogger program later).

Fluke i400 (1mA per Amp) Clamp Meter with the microAmper



The second type of clamp probe outputs a *voltage* (typically 1 to 100mV per amp sensed depending on the make and model. This kind of clamp is a little more flexible for extended ranges which are often switchable, have increased resolution especially at low currents and typically will not require any load or dropping resistor when operated with the microAmper. The voltage output type probes typically have a BNC connector rather than two banana plugs. A BNC to pigtail adapter is available to connect to the microAmper.

Fluke i400s (millVolt output) Clamp Meter with the microAmper



Generally this type of probe may be directly connected to the microAmper without any resistors; the only caution relates to using the larger capacity Voltage output probes at full load, for

example the Fluke i3000S clamp will output 3.0 Volts rms at a 3000 Amp load which would be outside of the microAmpers 1.5 Volt measurement range. If clamps such as this were to be used a resistor in series with the input signal would allow accurate operation at full range. Again, when entering scale values the calibration factor is calculated based on a 300mV input signal, so the span would be adjusted accordingly (and can set rescaled later in the ChartLogger program).

Starting Data Logging.

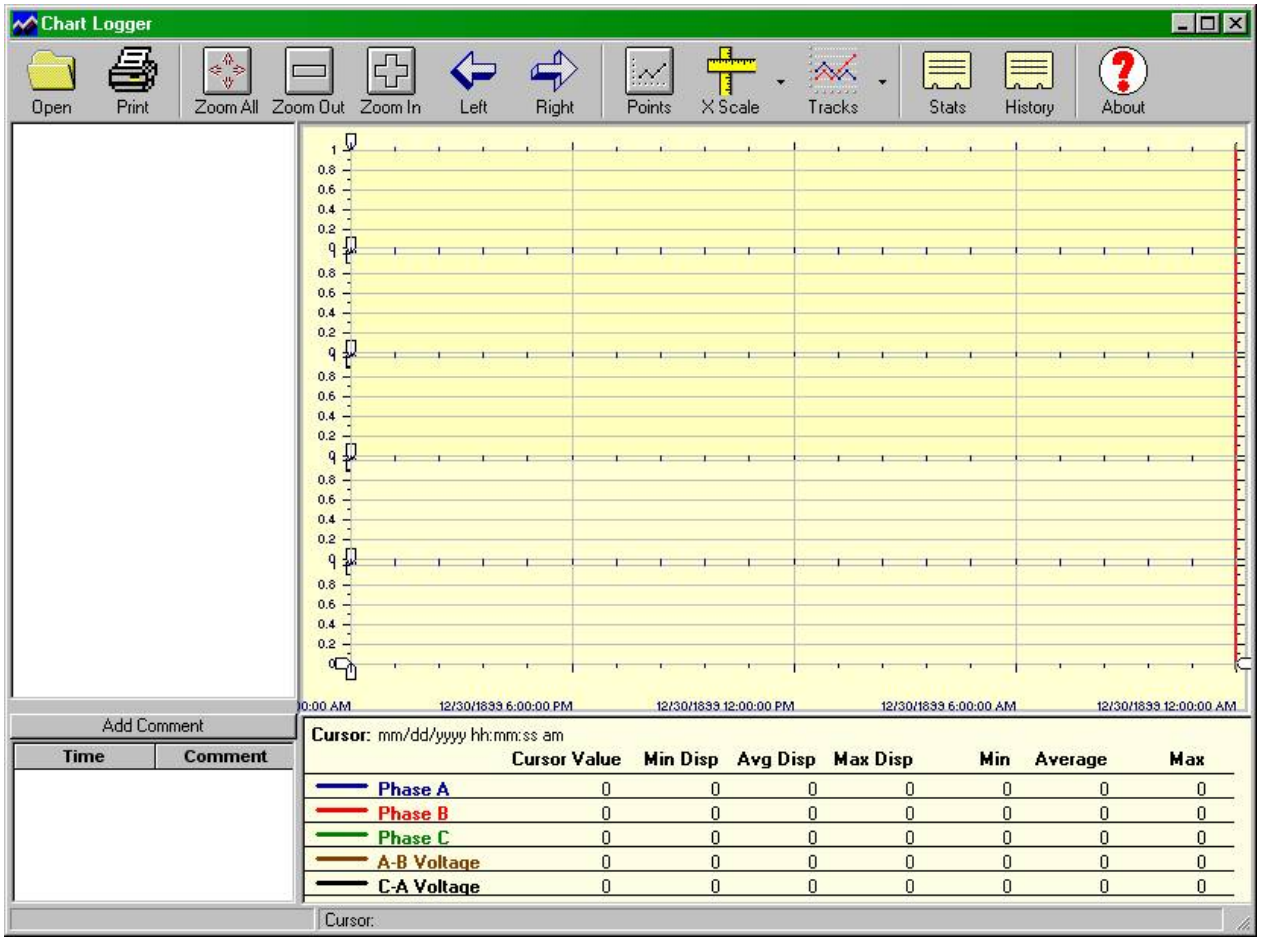
At this point any settings that needed to be changed on the Amper have been written to the SD card and the signal of interest is connected to the 2 pin connector. If the battery is not in the Amper open the battery holder and insert the battery; note that removing the battery for more than a few seconds will loose the current time and date in the Amper and it will need to be reset using the configuration file for the time and date. Ensure that the write protect latch is set to “unlocked” on the SD card then insert it into the Amper. Almost immediately the blue card access LED should rapidly flash; this indicates that the Amper is inspecting and verifying the card. Depending on the card brand, size, contents and directory structure the blue LED may flash for several seconds during this process; then the LED’s should both be off. If configuration files were on the card when it was inserted the Amper will have updated its configuration settings from the files on the card, and will have deleted the configuration files from the card. The logger is now accumulating data and will not access the card until it needs to write data to the card, which may occur within a minute or could take hours, depending on the sample rate and save rate settings. To prevent lost data it is better to not remove the card during a write, so before the Amper writes to the card it will flash the blue LED four times indicating that it is about to write, this acts as a warning to the user before a write occurs. During the actual write the blue LED flashes rapidly, the write time will vary depending on several factors but will typically be a second or two. Any time the blue LED is not flashing it is safe to remove the card by pushing it in slightly then it will eject.

The other LED is red and will flash if there is an error condition. This may be caused by several conditions such as the card being write protected, not fully inserted, the card may be full, or the card having a non standard file format such as 4GByte SD-HC cards which are not supported by the Amper. If the red LED flashes remove the card and inspect it on a PC to try and resolve the problem.

Once sample data has been accumulated on the card remove it and the data may then be inspected using the ChartLogger program running on a PC. If accumulating at the fastest data rate it will be less than a minute between writes to the card, so if no data is to be lost while copying files to the PC another card may be inserted and it will continue collecting the interim data. Since it may be days (or months) between data collections cards can simply be swapped by an operator who brings the sample cards containing data back to a location where it may be easier to copy and inspect the data.

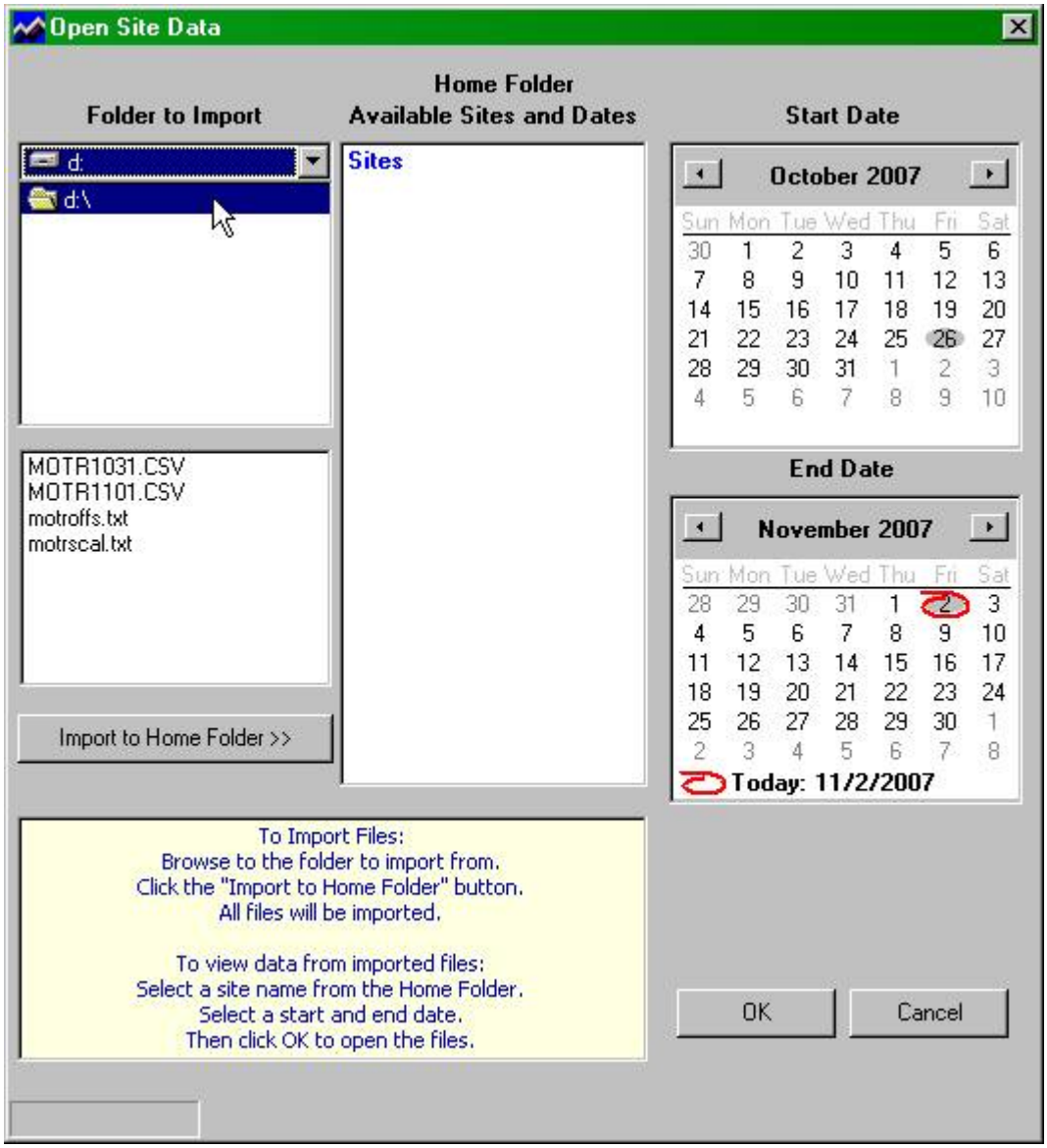
Using the ChartLogger Program

The ChartLogger program provides a quick and easy way to display, manipulate and print data captured with the Amper. The program itself is provided on the SD card that comes with the Amper. To install the ChartLogger program insert the card in the PC (use the supplied SD/MMC to USB converter if the PC does not have an SD/MMC slot). Navigate to the SD card directory on the PC then double click on “Install ChartLogger” icon; follow on screen instructions to complete the installation. The ChartLogger Program may now be started, and a screen similar to the following will appear:

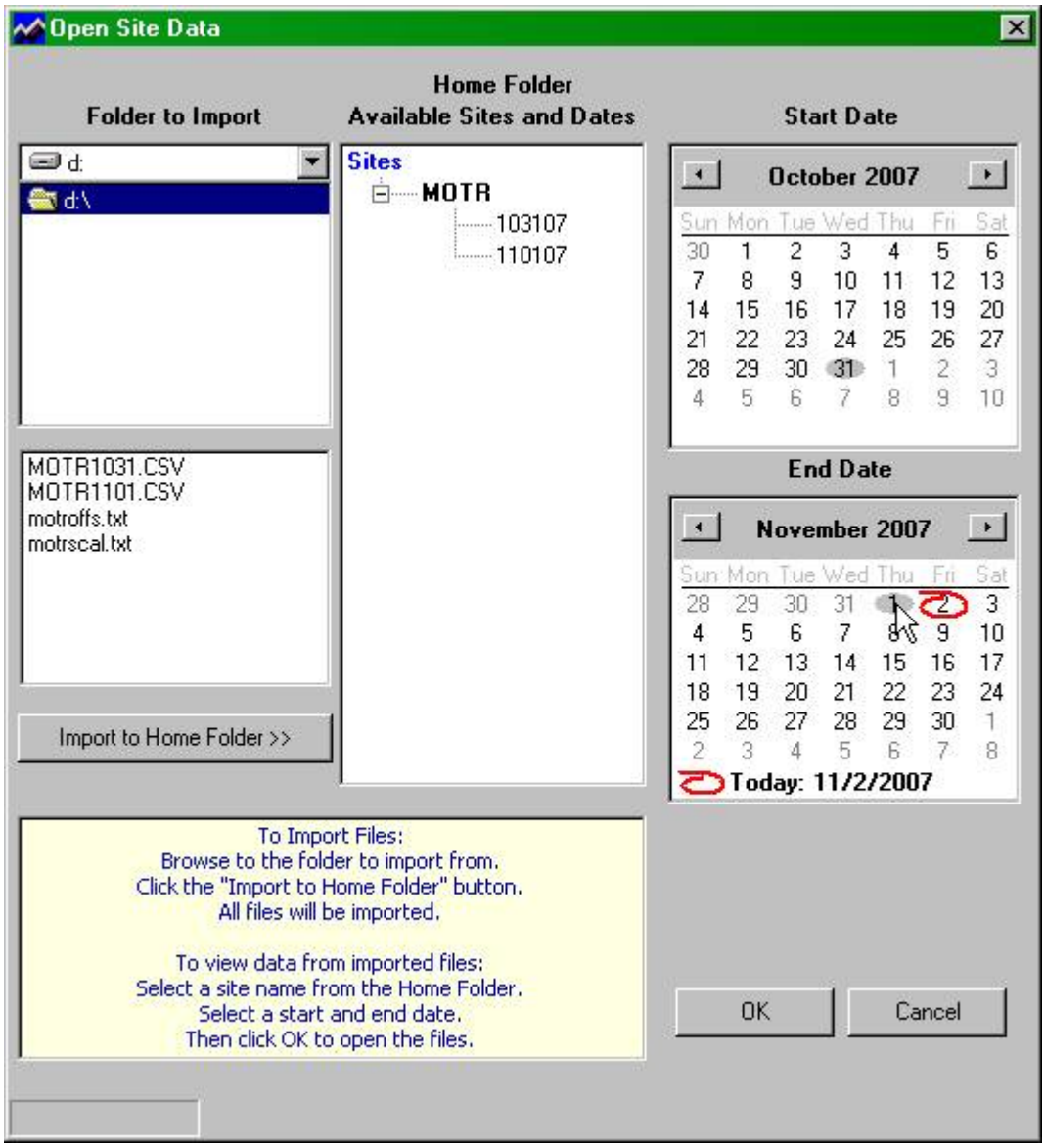


Note that the ChartLogger may also be used with other Automations Solutions products, such as the ASAP/F5 motor controller which can log data from three motor phase currents and two Voltage sources, typically used on submersed oilfield pumps and motors. When first started the ChartLogger displays the above screen with graphs for the ASAP, then when Amper data is loaded the display switches to a single graph.

If the open button is selected a window will appear allowing selection of logfiles, use the menus to navigate to the card location, in this case drive D: The example below shows just two days files from a motor test (note the calibration and offset files are also visible). Click on the ‘Import to Home Folder” button which will copy the files to the PC.


Open Site Data
Folder to Import
Home Folder
Available Sites and Dates
Start Date
d:
d:\
Sites
October 2007
Sun Mon Tue Wed Thu Fri Sat
30 1 2 3 4 5 6
7 8 9 10 11 12 13
14 15 16 17 18 19 20
21 22 23 24 25 26 27
28 29 30 31 1 2 3
4 5 6 7 8 9 10
MOTR1031.CSV
MOTR1101.CSV
motroffs.txt
motrscal.txt
End Date
November 2007
Sun Mon Tue Wed Thu Fri Sat
28 29 30 31 1 2 3
4 5 6 7 8 9 10
11 12 13 14 15 16 17
18 19 20 21 22 23 24
25 26 27 28 29 30 1
2 3 4 5 6 7 8
Today: 11/2/2007
Import to Home Folder >>
To Import Files:
Browse to the folder to import from.
Click the "Import to Home Folder" button.
All files will be imported.
To view data from imported files:
Select a site name from the Home Folder.
Select a start and end date.
Then click OK to open the files.
OK
Cancel

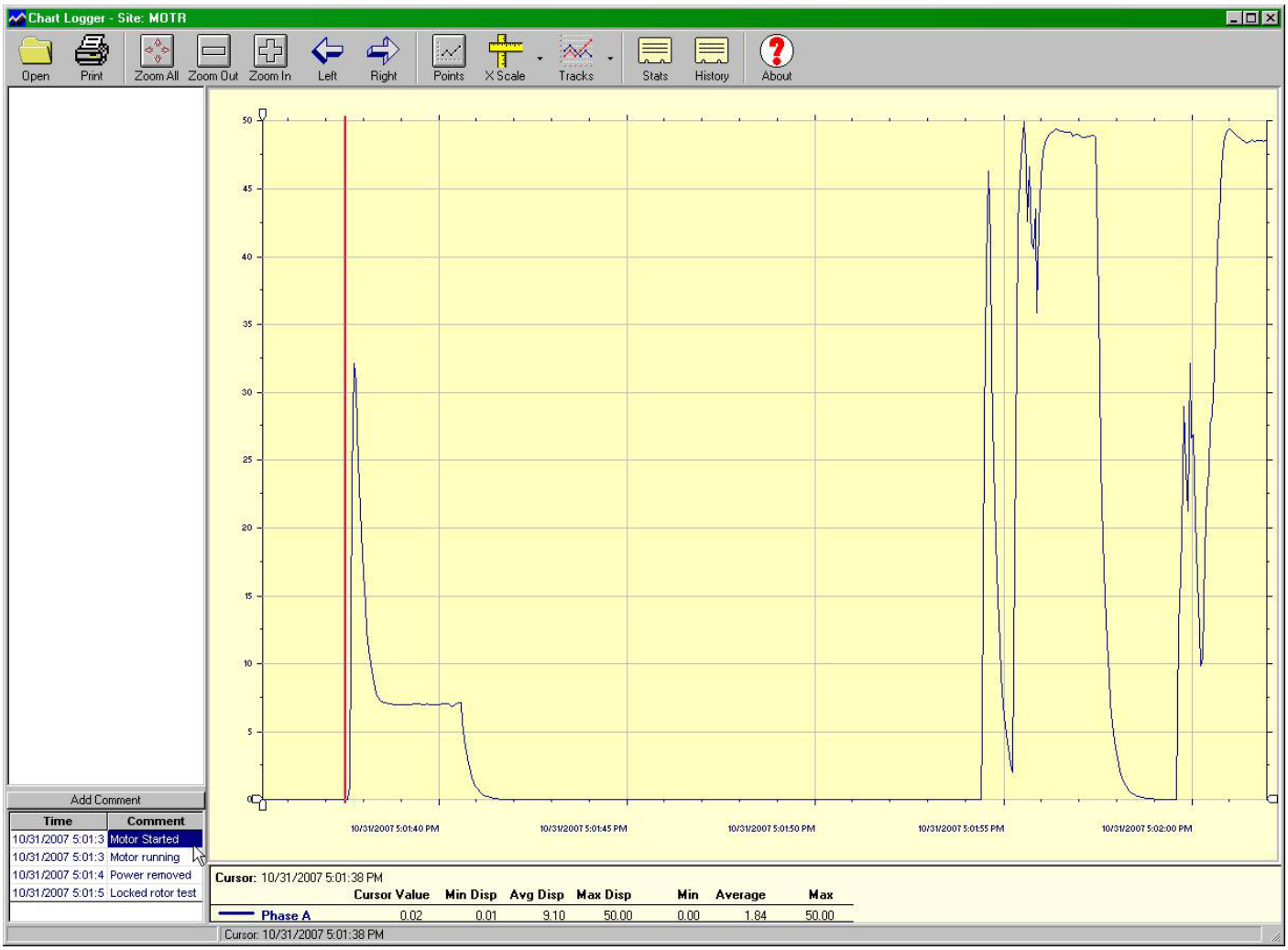
After they have been imported the file window will be similar to below.



ChartLogger imported the data files to its own logfiles directory, and at the same time it changed the filename to include the year. If present it will also import the scale and offset files to a directory called cnffiles. Now to view the graph click on a site name in the home folder, select start and end dates then click OK. The site data window will close and files will be displayed on the graph.

This example shows a few minutes test over two days of a motor and control relay that were generating electrical interference. Click anywhere on the graph to move the cursor, statistics will be displayed at the bottom of the screen. The graph may be zoomed in / out and scrolled using the buttons at the top, also the small arrows at the axis provide detailed zoom and pan control.

Clicking on the History button enables an attached window where points of interest may be noted; once entered they may be clicked and the cursor will jump to that location.



Any notes entered will be stored in the ChartLogger directory and will automatically be recalled if this data is reloaded. The example shows the start up current surge for a motor that normally draws about 7 Amps; in locked rotor condition it draws nearly 50 Amps, the drops in current during the locked rotor test are caused by a failing control relay that supplies power to the motor. The ‘points’ button turns on or off dots that is displayed where every reading taken.

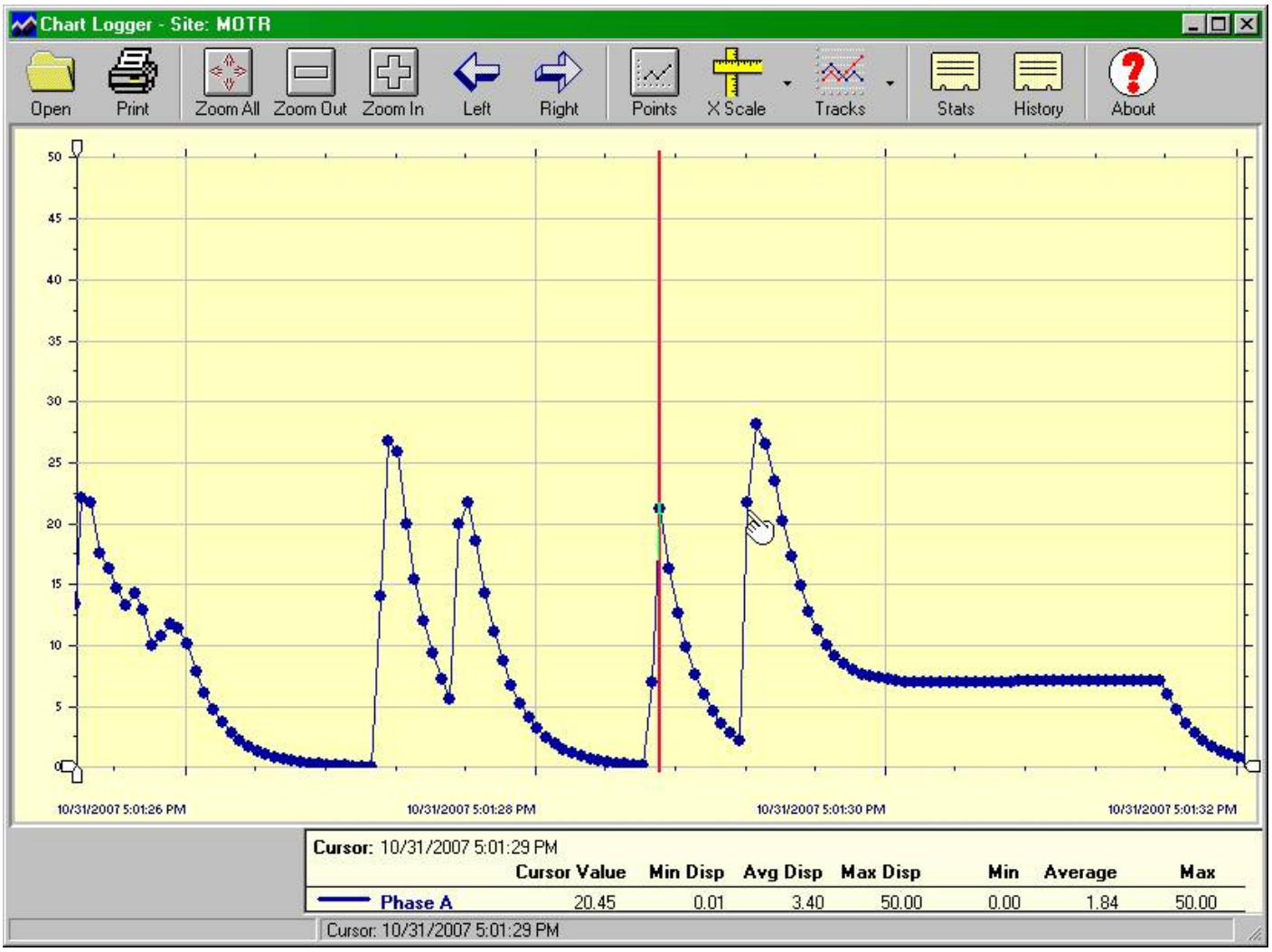
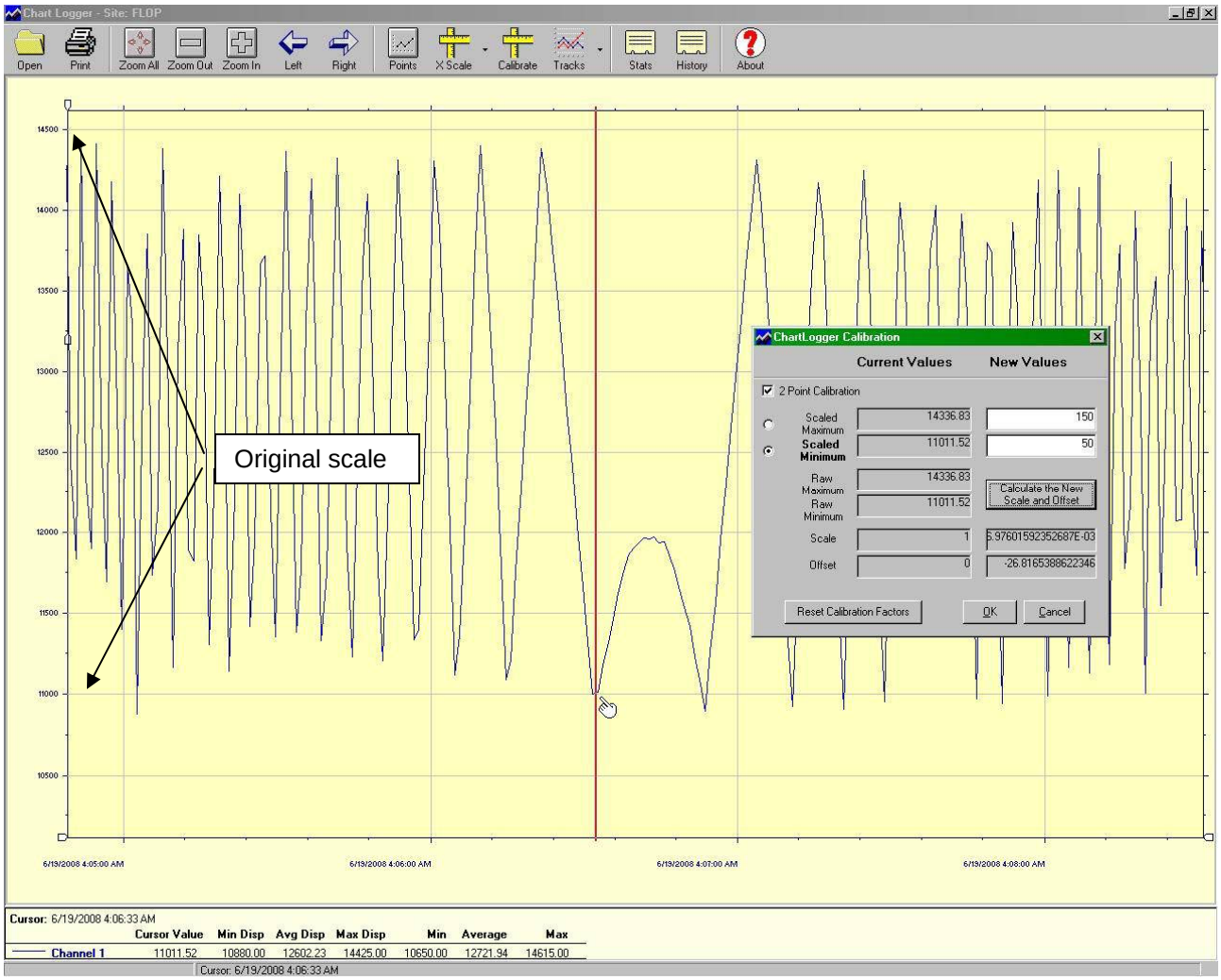


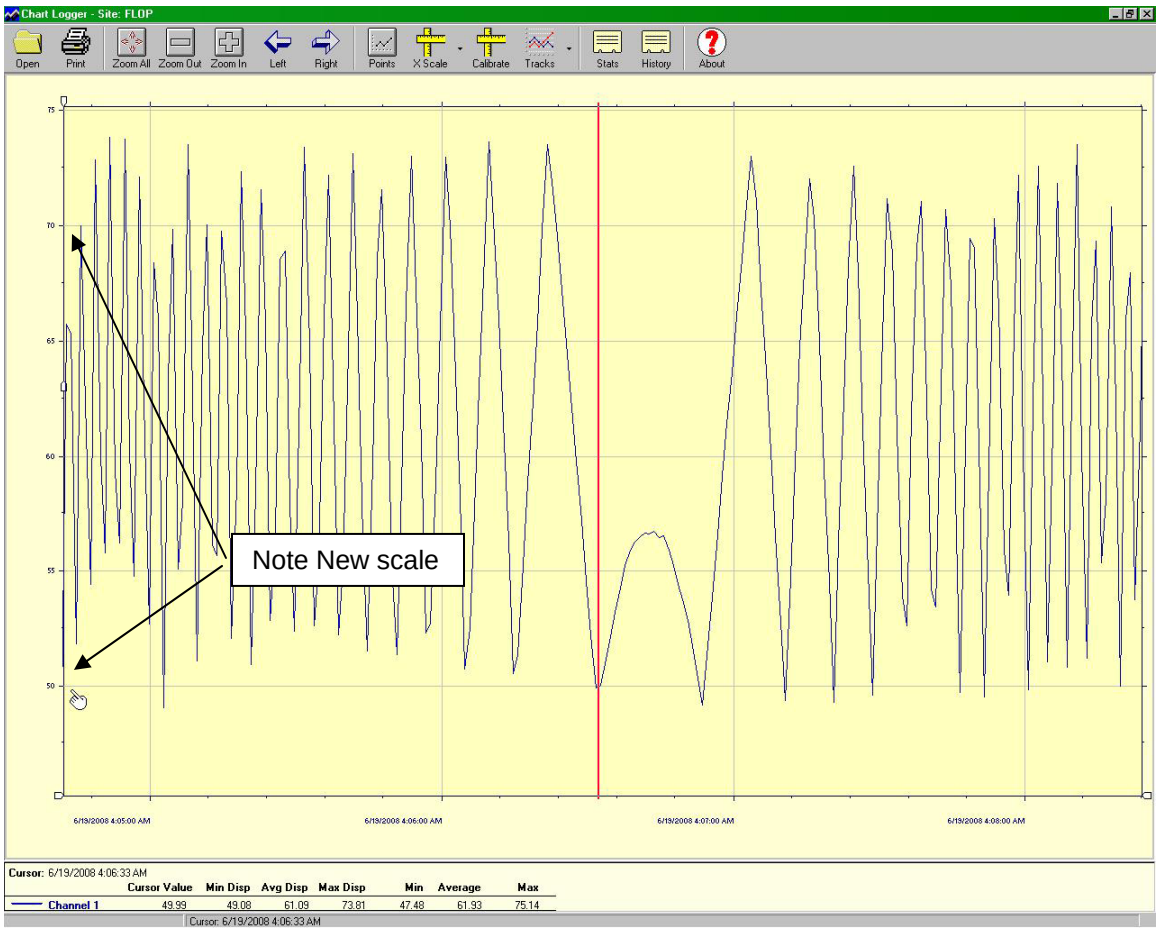
Chart Logger - Site: MOTR
Open
Print
Zoom All
Zoom Out
Zoom In
Left
Right
Points
X Scale
Tracks
Stats
History
About
50
45
40
35
30
25
20
15
10
5
0
10/31/2007 5:01:26 PM
10/31/2007 5:01:28 PM
10/31/2007 5:01:30 PM
10/31/2007 5:01:32 PM
Cursor: 10/31/2007 5:01:29 PM
Cursor Value
Min Disp
Avg Disp
Max Disp
Min
Average
Max
Phase A
20.45
0.01
3.40
50.00
0.00
1.84
50.00
Cursor: 10/31/2007 5:01:29 PM

Scaling and Calibrating With ChartLogger

As explained earlier ChartLogger may use calibration constants that were generated with the Amper Setup program. Often a scaling factor may not be known, for example an analog transducers own span & offset adjustments may have been changed to match a tank level that contained a liquid with unknown density, or a CT ratio may not be marked. It is easy to re scale to match ChartLoggers display with the desired readout. Once the data has been loaded select



'calibrate' from the menu. A dialog will appear that allows single or 2 point calibration, and may be selected by clicking on the '2 point calibration' checkbox. Single point is usually used for data that has no zero 'offset', such as direct connection to a current transformer or an applied Voltage. Dual point calibration is usually used for signals that have an offset, such as a 4-20mA signal where 0 (or any other value) in engineering units may correspond to 4mA. The cursor may now be moved on the graph to find the high calibration point, then enter the desired value in the 'new value' box. If two point calibration is used repeat for the 'low' point. Note that the further apart the high and low points are the more accurate the display will be.



Click on the ‘Calculate New Scale and Offset’ button then click OK. The graph will be reloaded using the new calibration values. The next time this data is loaded it will use the latest calibration coefficients. It should be noted that the data stored on the card and PC always remain in raw units for maximum accuracy, after calibration just the calibration coefficients change.

Pulse Counting Option.

The Amper may easily be configured for ‘pulse counting’ operation. In this mode it will no longer store a continuous stream of analog ‘level’ data points, but instead will count the number of excursions the input signal makes above and below a preset point. The count will actually be double the number of ‘pulses’ seen as it captures edges, which are used by some types of equipment. Rather than keeping one single total count the Amper will put accumulated counts into time ‘buckets’, each of which is then stored on the data card. For example, if the bucket time is set to one hour then each day a data file will be written that contains 24 lines, each line containing the number of counts that occurred during the respective hour. A bucket time of one minute would result in files with 1440 lines per day. These data files can provide very useful data, as pipeline flows, energy usage, traffic patterns and other parameters may easily be analyzed by times as well as by simple totals. The fastest rate that may be correctly sampled is 10 pulses or 20 edges per second.
To enable pulse counting rather than normal analog mode two text files need to be on the card, called bucket.txt and pulse.txt The first, bucket.txt contains the bucket time in seconds; 60 to 3600. Each days results file will have a line appended every bucket time in identical format to the standard ‘analog’ data files, so with a bucket time of 3600 each days file will have 24 lines, one per hour of operation (bucket times start when the card is inserted). The second file needed, called pulse.txt contains a number that is the threshold in raw Amper units for pulse detection, from 1 to 20475. The pulse count increments every time (+ve and -ve) this point is crossed. Typically this value would be approx 50% of the high input Voltage applied but is not critical at all since most pulse, switch, relay or opto devices would cause the applied Voltage to be present or absent. Note that the Amper does not supply the contact or switch closing Voltage source, it must be supplied externally but may be any AC or DC source that the Amper is configured to monitor.
Some suitable pulse.txt values for the millAmper and microAmper are……
milliAmper (4-20mA nominal input). 820 would set the threshold at 4mA, 2048 at 10mA

microAmper with 332K resistor in series (50 Volt full scale input). 1000 = 2.5V threshold, 2000 = 5V threshold, 2400 = 6V threshold, 4800 = 12V threshold.
The applied Voltage may could also be measured by the Amper in normal logging mode then the average reading halved to obtain a suitable threshold.

Since the Amper has an adjustable threshold it may be used for applications that typical pulse counters could not perform. For example, if the microAmper is monitoring AC line Voltage that is nominally 120 VAC the pulse threshold could be set to correspond to say 115VAC. Now it will store in the time stamped buckets a count of every line sag below 115V. The results are written to the data files in exactly the same format as normal data files so can be directly read and displayed with ChartLogger, or of course with excel or any text editor.
When in pulse mode the Amper will write to the data card at the end of every bucket time (even if the count was zero), so whenever the card is removed it will always contain the most up to date information. Pulses often need to be counted for extended time periods such as months but data accumulated in the mean time may be required before then. If the card is removed the data may be copied to a pc and provided the card re-inserted before the present bucket time expires (i.e. when the Amper tries to write to the card again) no data will be lost. The Amper will keep accumulating and retain an accurate count provided the card is re-inserted before the bucket time expires; therefore totals for extended periods may be accumulated and the data may also be collected during this time without loosing any pulse counts.

To change back to regular analog logging rename or delete one or both of the bucket.txt and pulse.txt files on the card, or use a card that does not have these files. The pulse configuration files, bucket.txt, pulse.txt and hyster.txt will not be deleted by the Amper so by looking at the card the user may determine what mode the Amper is in.
The storage time while in pulse mode is effectively infinite since the data files are so small.

Data Reduction - Hysteresis.

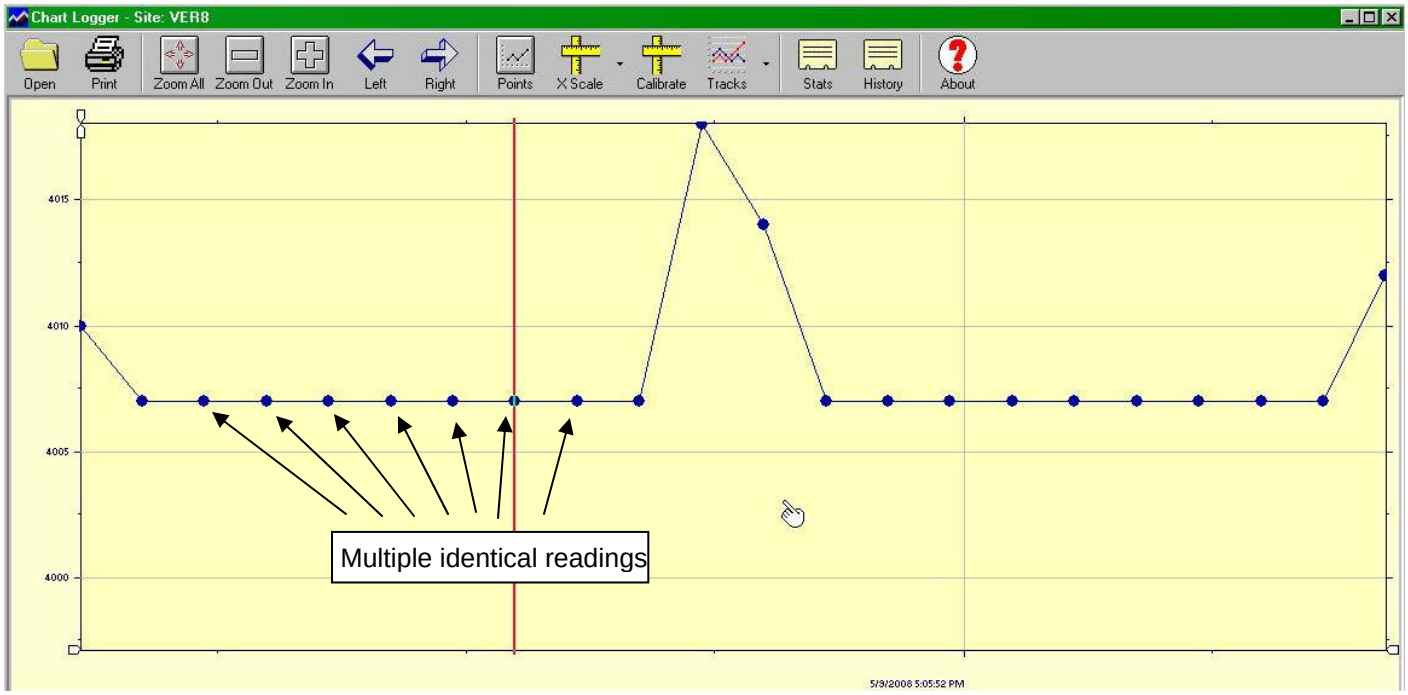
With its fast sampling rate the Amper is capable of accumulating huge amounts of data, which can result in very large files. To help reduce data file sizes a ‘hysteresis’ value may be entered, which can drastically reduce the data file sizes but still allows samples of interest to be captured. If hysteresis is enabled then samples are only stored if they differ by more than the hysteresis value from the previous stored sample. The hysteresis value is entered in raw data units, from 1 to 20475 as a single line in a file called hyster.txt on the data card being used. The Amper will not store the hysteresis value and will only implement hysteresis if the hyster.txt file exists on the card currently being used, so it is obvious if hysteresis is active. If the file does not exist then every point will be logged with its associated time & date stamp. If the hysteresis value is set to 1 then new data points will only be stored if they differ from the previous reading, which effectively provides ‘lossless’ data compression. Note that this can yield a significant file size reduction without losing any data points. If the hysteresis value is set to values higher than 1 then data points within (previous value +/- hysteresis value) will be not be saved. For example, here are some data points taken with no hysteresis…..

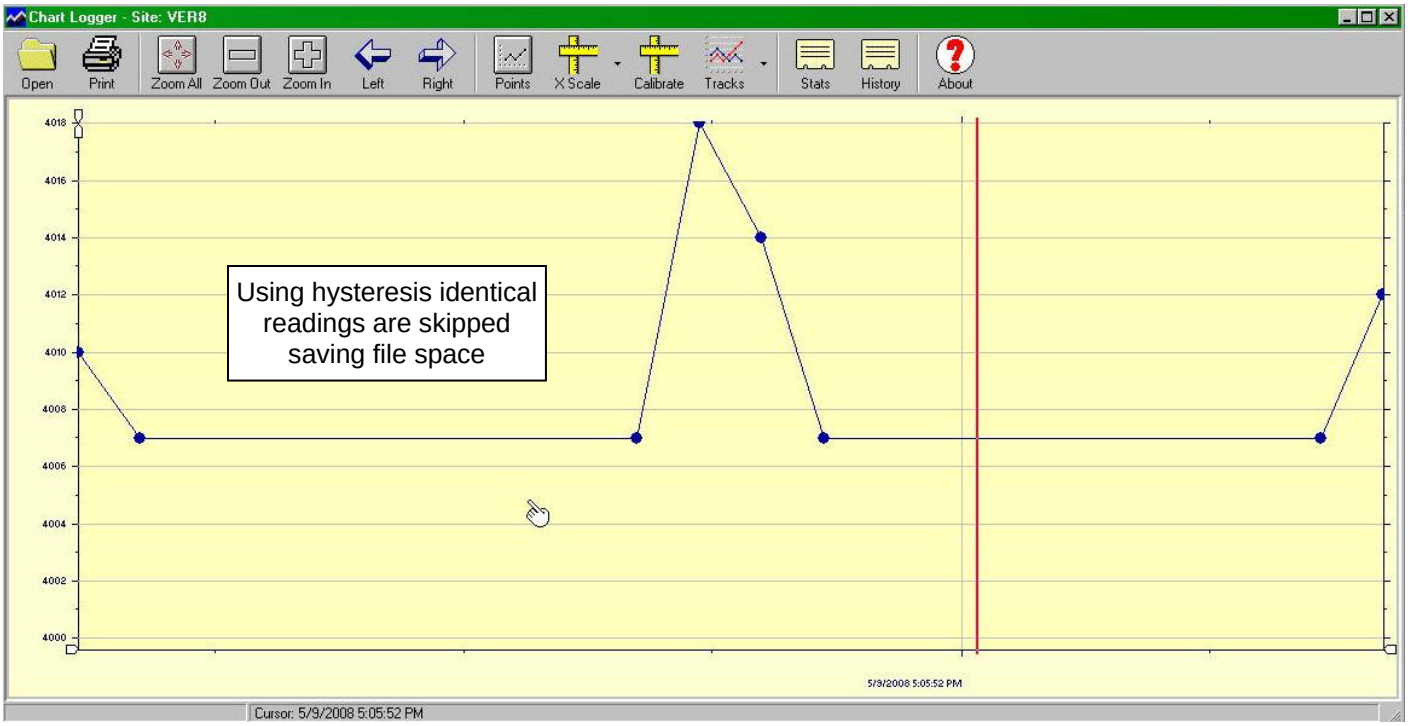
Ver8,05/09/08,17:05:51.29,04010
Ver8,05/09/08,17:05:51.34,04007
Ver8,05/09/08,17:05:51.39,04007
Ver8,05/09/08,17:05:51.44,04007
Ver8,05/09/08,17:05:51.49,04007
Ver8,05/09/08,17:05:51.54,04007
Ver8,05/09/08,17:05:51.59,04007
Ver8,05/09/08,17:05:51.64,04007
Ver8,05/09/08,17:05:51.69,04007
Ver8,05/09/08,17:05:51.74,04007
Ver8,05/09/08,17:05:51.79,04018
Ver8,05/09/08,17:05:51.84,04014
Ver8,05/09/08,17:05:51.89,04007
Ver8,05/09/08,17:05:51.94,04007
Ver8,05/09/08,17:05:51.99,04007
Ver8,05/09/08,17:05:52.04,04007
Ver8,05/09/08,17:05:52.09,04007
Ver8,05/09/08,17:05:52.14,04007
Ver8,05/09/08,17:05:52.19,04007
Ver8,05/09/08,17:05:52.24,04007
Ver8,05/09/08,17:05:52.29,04007
Ver8,05/09/08,17:05:52.34,04012

Here are the same samples taken with an hysteresis value of 2 active…..

Ver8,05/09/08,17:05:51.29,04010
Ver8,05/09/08,17:05:51.34,04007
Ver8,05/09/08,17:05:51.74,04007
Ver8,05/09/08,17:05:51.79,04018
Ver8,05/09/08,17:05:51.84,04014
Ver8,05/09/08,17:05:51.89,04007
Ver8,05/09/08,17:05:52.29,04007
Ver8,05/09/08,17:05:52.34,04012

Note that when a change occurs the Amper also stores the previous ‘identical’ value so that graph charting programs such as ChartLogger will correctly display a straight horizontal line between the points rather than a slope; the horizontal line would have contained identical data points if hysteresis was not enabled.
Hysteresis can allow extended logging for months at a time even at the fastest sample rate of 20 samples a second, since only activity of interest is stored. This is especially useful for capturing fast events that may occur infrequently, such as power surges, lightning flashes, animal or other occasional traffic.





File Formats and Contents.

Configuration Files:

Most users will never need to be aware of the configuration files and contents, since most configurations may be set using the Amper setup program and typically would only be done once; however they are explained here for users who may need the information. If these plain text configuration files exist the Amper will read them when a card is inserted. It will then reconfigure itself to use any new settings found on the card. For some parameters it will save the new configuration settings in non-volatile memory inside the Amper, then delete the configuration files from the card. Configuration settings may be changed at any time, and only ones that need changing need to be updated. For example if the device is moved to a new site the site name may change; or after a new well startup has run for a couple of hours the data acquisition rate may be modified. There following files affect the actual operation of the device, these are named:

time.txt This contains the current date and time in 11/23/07 09:32:56 format to set the Amper to. If it is not in this format it will be ignored. The Amper does not perform automatic daylight saving time adjustments as this varies around the world, but it will compensate for leap years. Once the time is set the Amper will keep track of it automatically; it is typically accurate within a minute or so a year. If the battery is removed for more than ~10 seconds the time will be lost. (The battery can be changed in less than this time).

sample.txt This contains a single number from 1 to 65534 which will be the sample rate, in 50mS increments. So if a sample was required every second the sample.txt would contain the number 20

saverate.txt Usually the Amper writes to the data card when its internal data buffer is full. If acquiring at a slow rate it may be many hours between card writes. Saverate is the time in seconds between writing to the card; this may be set to a suitable value between 60 and 3600 so the user does not have to wait extended times before data is written to the card. The drawback to using faster data writes than required is increased power consumption with resulting reduced battery life, and reduced card life due to more frequent writes. If the file saverate.txt contained 120 then data would be written at least every 2 minutes to the card. Note that the Amper will only write to the card if new data exists that needs to be written.

sitename.txt The data files saved by the Amper have a standard naming convention. The first four characters are the ‘sitename’ which are used to uniquely identify the site. The remaining 4 characters are the day and month. So if a card with a site name of “Well” is left in for a year 365 files will be generated on the card, with the filenames Well0101.txt (January 1st), Well0102.txt etc up to Well1231.txt for December 31st. When ChartLogger imports the data files it automatically renames them to add the year to each filename, so ChartLogger can handle files that span years correctly. If each site has a unique site name then it’s easy to keep track of different sites; even if the same card is used in different units.

pulse.txt This contains the threshold for pulse counting, and is only used when the Amper is in pulse counting mode. The value is from 1 to 20475. See the section on pulse counting for further details.

bucket.txt This contains the bucket size in seconds form 60 to 3600 and is only used when the device is in pulse counting mode. See the section on pulse counting for further details.
hyster.txt This contains the hysteresis value, from 1 to 20475. See the section on hysteresis for further details

Calibration Files:
The following files may also be present on the card, but are not used, deleted or even read by the Amper itself. These files provide a way for the ChartLogger program to import parameters pertinent to a site, such as the CT ratio or milliAmper scale / offset. When the ChartLogger imports the data from a site it also automatically imports these parameters if present, so the data presented to the user in ChartLogger is in scaled units that relate to the site. Note that there is no need for these files to be present on the card as all calibration may be performed inside ChartLogger, which can directly calculate the calibration values needed.

abcdscal.txt where abcd is the site name. See the CT Ratio / Span&Offset section above for how this value is used. If the scale value was saved in the CT mode then the scale is a number (in scientific format) that is simply the CT ratio divided by the factory CT calibration value. The factory CT calibration value is typically 3425, but may be adjusted to compensate for variations in the value of the 0.05 Ohm load resistor. If the scale/ offset were saved using 4-20mA scale (i.e. scale & offset were entered) then the value is the span divided by the factory 20mA cal value (usually 4096).

abcdoffs.txt where abcd is the site name. See the CT Ratio / Span&Offset section above for how this value is used. If the scale value was saved in the CT mode then no offset was used, and this file will not be written. If the scale/ offset were saved using 4-20mA scaling (i.e. scale & offset were entered) then the offset value is simply subtracted from the calibrated value by ChartLogger. Offsets may also be entered for any reading, which has the effect of adding or subtracting a dc offset from the measurement so any offset errors may be removed for use by ChartLogger.

Data Files:
Most users will never need to be aware of the data files and contents, since the ChartLogger is able to import them directly. They are explained here for users who may need the information. New data files are created by the Amper each day. Each file name consists of the site name plus the day and month, such as **abcd0415.csv** where abcd is the sitename and the date of the file is April 15th (0415). Inside the file are a list of date and times and the reading taken. Although the filename does not contain the year every reading inside the file does, so as ChartLogger imports the data it inspects the file then automatically adds the year to the filename as it stores the file on the PC, so the file abcd0314.csv on the card will be imported and renamed on the pc as abcd031407.csv A few lines from a typical file are shown below…..

abcd,04/15/08,22:13:12.75,00515
abcd,04/15/08,22:13:13.00,00557
abcd,04/15/08,22:13:13.25,00561

In this case the site name is abcd. The date and time are shown then the readings. The readings are always shown as a 5 digit number that varies from 0 to 20475, this is the raw value measured by the Amper.

The maximum stored data value, 20475, is not the value typically used for calculating the calibration constant used by ChartLogger. CT's are typically rated with a 5 Amp secondary and various primaries. For user convenience the calibration entry is set so the user can simply enter the primary current corresponding to the '5 Amp' point even though it is not the full scale input range of the Amper (which is designed to measure 5x full scale overloads accurately). The other two units are similar, both have a full scale reading of 20475 which corresponds to 100mA for the milliAmper (which is typically operated up to 20mA), and 1.5 Volts for the microAmper. The actual calibration constant is equal to (users entered span / 4095) for the milliAmper and microAmper; it is equal to (users entered span / 3425) for the Amper.

Miscellaneous Files:

battery.low Once the Amper detects battery capacity is falling it will write this file to the card, once a day at midnight. It will probably be several weeks after the file is first written before the device stops operating, giving the operator time to change the battery.

abcdSOFT.ver This contains the firmware version of the Amper.

Card & Battery Notes.

Cards.

Memory cards have gone through a remarkable change in the last few years; prices have dropped to a fraction of what they used to be and capacities have skyrocketed. This plus recent advances in electronic components have made the Amper possible.

However there are some points to note regarding the cards, as they do have some characteristics that can affect the device operation especially when used at the fastest acquisition rates. The cards have a finite number of times that they may be written, this is often not specified by the manufacturer but is typically 100,000 – 250,000 times. In most applications with sample rates of 5 times a second or less it will take many years for the card to 'wear out' due to frequent writes. However, if the fastest acquire rate of 20 times per second is used the card will be written to nearly 2000 times per day; and in 50 days the card may be worn out and will fail. Therefore the Amper should only be used at the fastest acquire rate with caution, and the user should be aware that the card should be swapped before it gets close to the write limit. (see the section on hysteresis for methods to reduce file activity). Different brands of cards vary in their behavior, but it is conceivable that a card could fail in a mode where files already written could be lost.

Some cards have intelligent controllers inside that attempt to control wear leveling; they try to extend card life by moving data around on the card so all areas get written to the same number of times. This may be beneficial in some circumstances, but while cards are doing this 'leveling' procedure they require extended times (often 30 seconds or longer) to complete, and therefore take much longer than normal to perform a write. While the card is plugged into a PC the user will never be aware of this process and delay, but if the write attempt takes too long in the Amper it may have to give up waiting and flash the error LED, since it cannot store data as fast to the card as it is arriving. If this occurs remove any data found on the card, and re-formatting the card may restore satisfactory results. Note that simply inserting the card into a pc and waiting for a minute or so may also 'rejuvenate' the card, as it will have had enough powered up time to perform its internal wear leveling. These wear leveling routines typically would only cause problems at the fastest acquisition rate with heavily worn cards.

Recently cards have been offered with faster write rates (maybe called Ultra or similar). They offer no benefit at all to the Amper. These cards are optimized for a few occasional writes of very large files as a single fast write; typically for cameras or video devices. The files generated by these devices are very large, but are typically written as a single write very infrequently (few people take 2000 photos every day). The Amper generates multiple writes of small amounts of data perhaps thousands of times a day. Although these cards may support a faster transfer rate for a few large files they typically have reduced capability for repetitive writes. Generally these Ultra cards have reduced lifetimes at high acquisition rates compared to the standard lower cost cards and should be avoided for high acquisition rate applications.

Batteries.

As previously noted the battery life is largely dependant on the data acquisition rate; as the most current is consumed during writes to the cards. If the device is not being used for some time remove the card and the current draw will fall to virtually nothing. If it wont be used for many months the battery can be removed but the clock will need to be reset when it is next used. The Amper does measure the battery Voltage, and when it starts to get low will write a file called "Battery.Low" to the card once a day. This may occur 1-6 months before the battery finally fails (again the time depends on acquisition rate), so it allows time to obtain and replace the battery before it fails.