

UBA External Devices Manual

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Changes:

Dec 2013, for UBA Console rev 1.50

ExtVAmp: model 3 added for external amplifier that shares the UBA's ground with the negative input

Dec 2012 for UBA Console rev 1.30

Added:

ExtChargeDevice: similar to ExtLoadDevice

ExtChargeControl: similar to ExtChargeDevice

ExtSensor: general case of ExtThermistorRabcd and ExtTempProbe

Table of Contents

Changes:	1
Introduction:	4
Using a Resistor as an External Load:	5
Method 1 - Manually Connect a Power Resistor:	5
Example for manually calculating capacity:	6
Method 2: Manually Connect a Power Resistor and Specify Its Resistance:	6
Calibration File Modifications:	6
Method 3 - The UBA Controls the Load Resistor:	7
Controlling the Load with Direct Digital Drive:	7
Controlling The Load With Optically Coupled Drive:	7
Controlling The Load with A Relay:	8
Calibration File Modifications For a Switched Resistive Load:	8
Testing With The Battery Connected to The Accessory Port:	9
Combined Channels:	10
Using an Active Load as an External Load:	11
Controlling the Active Load:	11
Calibration File Modifications For an Active Load:	11
Uncontrolled Constant Current Load with no Current Measurement:	12
Uncontrolled Load with Current Measurement:	12
Controlled Constant Current Load with no Current Measurement:	13
Controlled Load with Current Measurement:	13
Resistive Load Described As an Active Load:	13
Using a Non-Linear Load as an External Load:	14
Running UBA Console with an External Load:	15
Step 1 - Verify that UBA Console has read any external devices in the calibration file:	15
Step 2 - Verify that the calibration lines and set-up are correct:	16
Step 3 - Run a Battery Analysis:	16
UBA Load Monitoring:	18
Using a Resistor as a Load Current Sensor:	18
Warning:	19
Using a UBA to Test a Battery Charger:	22
Important Note:	22
Warning:	22
Monitoring Charger Voltage and Current:	22
Considerations for Monitoring Charger Performance:	24
Pulsing Charge Current:	24
Battery Voltage Error Due to Sense Resistor:	24
Running UBA Console to Monitor Charger Voltage and Current:	25
Using an External Charger In a Charge/Discharge Cycle:	26
Vencon High Current Load Module:	28
Appendix A - UBA External Device Reference:	29
External Loads & Chargers:	29
External Load Devices:	29
ExtLoadDevice Syntax:	29
ExtLoadDevice Examples:	31
External Charge Devices:	32
ExtChargeDevice Examples:	33
Analog Input "-4" - Charger Voltage Channel:	33
External Load Control:	34
ExtLoadControl Syntax:	34
ExtLoadControl Examples:	35
ExtChargeControl Syntax:	35
External Battery Voltage Amplifier/Attenuator:	36
Battery Voltage Amplifier/Attenuator Syntax:	36

ExtVAmp Examples.....	37
External Sensor.....	38
External Temperature Sensor – Voltage Output.....	38
External Thermistor Sensor.....	38
External Sensor – The General Case.....	39
Accessory Analog Input.....	41
Appendix B - UBA Accessory Port1 & Port2.....	43
 Accessory Port 1 Pinout:.....	43
 Accessory Port 2 Pinout:.....	44
 Notes:.....	44
Appendix C - UBA Accessory Port1 Optoisolated Output.....	45
 Accessory Port 1 Optoisolated Pinout:.....	45
 Notes:.....	45
Footnotes:.....	46
 Accessory Port 2.....	46
 Future Upgrades.....	46
 ExtLoadDevice Syntax:.....	46
 ExtLoadControl Syntax:.....	46

Introduction

This manual describes the use of external devices with your UBA (both UBA4 and UBA5).

The UBA itself is a very versatile battery analyzer. But to make it even more versatile, we've included two accessory ports that can be used to connect to external instruments. This manual shows you how to use the first accessory port and one bit from the second accessory port.

This manual describes how the UBA can use external loads, chargers, voltage amplifiers, current and temperature sensors. With these devices, you can greatly expand the functionality of the UBA.

The appendixes include the format for describing the external devices in the calibration file and a description of the accessory port.

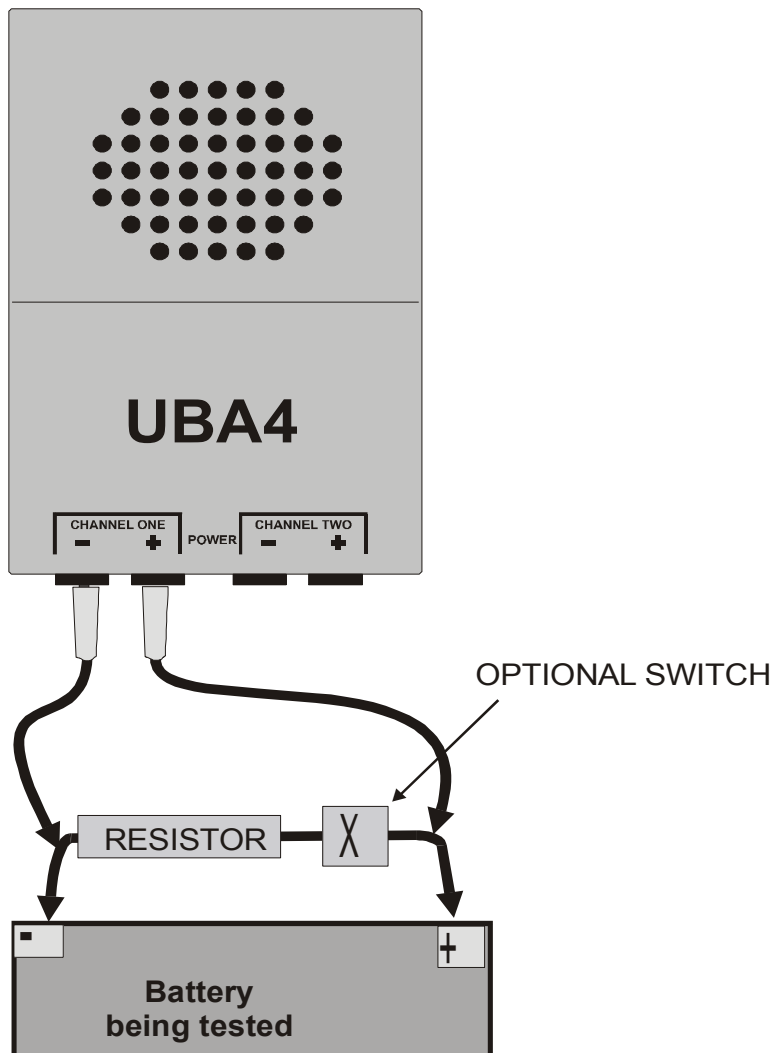
Using a Resistor as an External Load

You may want to use a resistor instead of the UBA's internal load as a load for battery testing. Here are reasons why:

1. You require a load current greater than that which the UBA can supply. For example, you want to discharge a battery at 10A. You could buy two or three UBAs and combine their channels, but a power resistor is generally less expensive.
2. You require a load current less than that which the UBA can supply. For example, you want to discharge a small "button" size battery. You can buy a UBA modified with its load current controllable down to less than a milliamp, but a resistor is less expensive.
3. You want to discharge a primary battery with a resistor to test to the ANSI specification.
4. You want to discharge the battery down to 0V, match the intended load, or monitor the charge or discharge current of a battery in situ.

Method 1 - Manually Connect a Power Resistor

The simplest way to use a resistor as a load is to connect it to the battery and then start a battery analysis. The UBA then acts as a data logger.



Adding a switch makes it easier to connect the load to the battery and start the battery analysis simultaneously. For the battery analysis, use a battery analysis routine (BAR) with a load current of zero and a cut off voltage of zero (or just use the data logger BAR). UBA Console will record the voltage while the battery is being discharged. You can calculate the load current by dividing the battery voltage by the load resistance and you can calculate the battery capacity by integrating the current. You can integrate the current by importing the test results into a spread sheet and creating a column with the load current (in milliamps) where each cell is calculated by dividing the voltage by the load resistance. Create a delta capacity column beside the current column where each cell is the current multiplied by the time between rows (in hours). The sum, shown in the delta capacity column, is the capacity (in mAh).

Example for manually calculating capacity

Time (hours)	Voltage	Current (mA)	delta capacity
T ₀ (start time)			
T ₁	V ₁	$I_1 = V_1/R * 1000\text{mA}$	$C_1 = I_1 * (T_1 - T_0)$
T ₂	V ₂	$I_2 = V_2/R * 1000\text{mA}$	$C_2 = I_2 * (T_2 - T_1)$
....			
T _N	V _N	$I_N = V_N/R * 1000\text{mA}$	$C_N = I_N * (T_N - T_{N-1})$
			Total: $C_1 + C_2 + \dots + C_N$

The problem with using this method for rechargeable batteries is that the battery isn't automatically disconnected when it reaches its cut-off voltage, this may overdischarge and damage it, and UBA Console doesn't give a current during the test nor a capacity afterwards – you have to do this manually. An improvement on this test is to specify the resistance of the load you're using, which brings us to the next method.

Method 2: Manually Connect a Power Resistor and Specify Its Resistance

If UBA Console knows the value of the load resistor, it can not only calculate the load current and display it during the battery analysis, it can also display the capacity discharged in real time and record the final capacity. UBA Console uses the resistor value to calculate the load current and capacity.

Calibration File Modifications

The UBA Console receives the value of the load resistor from the UBA calibration file. The load resistor is specified as an external load device as follows:

```
ExtLoadDevice: name 3 resistance max_pwr
```

Where:

name is a name you give the resistor

'3' is the model number for a resistor

resistance is its resistance in ohms

max_pwr is the maximum power in Watts that the resistor can dissipate (use 0 for no limit).

Example, a 5 Ohm 2W resistor.

```
*ExtLoadDevice: name model resistance limit <- this is a comment line
ExtLoadDevice: Resistor5R 3 5 2
```

For further details, consult the *UBA External Device Reference* in Appendix A.

For this method you have to manually connect and disconnect the load resistor, in the next section we show how to have the UBA do this for you.

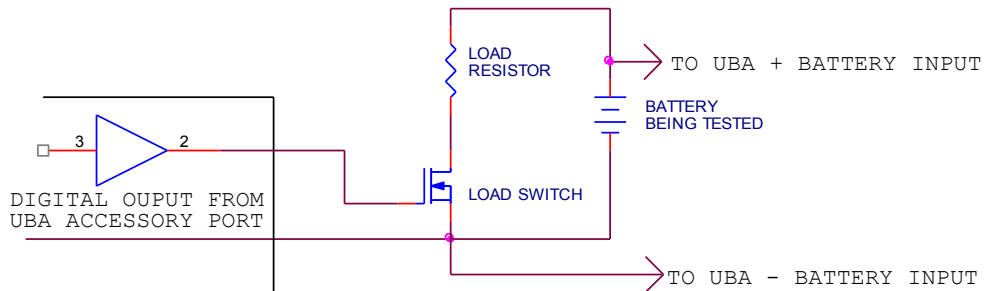
For maximum accuracy we suggest that you have the UBA's battery leads connect across the resistor load and switch if used and then run wires from the resistor to the battery. This way UBA Console will use the voltage across the resistor to calculate the load current and, if you specify the wire resistance from the battery to the load, will display the battery voltage with the voltage drop removed.

Method 3 - The UBA Controls the Load Resistor

With this method, UBA Console connects the resistor load at the beginning of the discharge cycle and disconnects it afterwards. It requires something to connect and disconnect the load, such as the Vencon HCLM (high current load module), the Vencon Relay Module or you can build your own load controller using the output from the accessory port as described below.

Controlling the Load with Direct Digital Drive

This circuit requires only one FET. You can use this circuit if you have access to the accessory port, either on the UBA PCB (available if no other accessory port 1 accessories are used) or via a connector mounted on the back of your UBA (if ordered with your UBA).

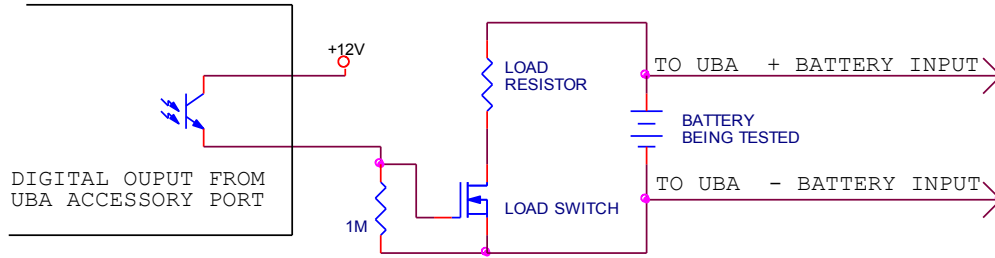


CONTROLLING THE LOAD WITH DIRECT DIGITAL DRIVE

The digital output directly drives a FET. A logic level FET is recommended because the maximum output of the UBA is 5V (no load). A logic 1 on the accessory port output connects the load resistor. Try to use a digital output that has a default (reset) low value (DO1 or DO0 on UBAs with firmware 13 or later) so that, after reset, the load is switched off.

Controlling The Load With Optically Coupled Drive

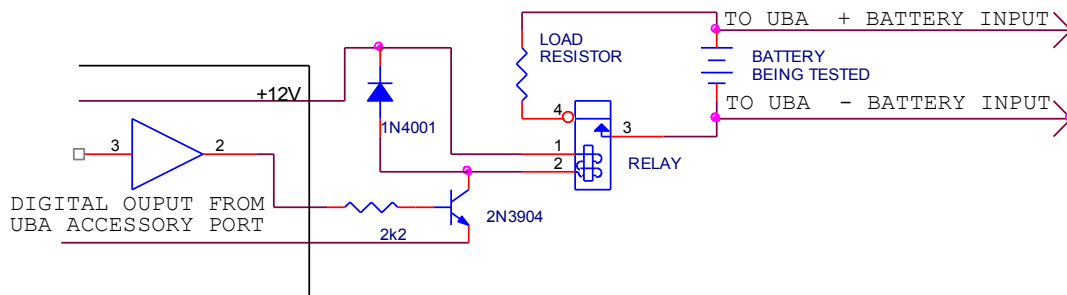
If you have an opto-coupled accessory output (the Vencon DODOTP use this circuit. It requires 8 to 15 Volts (or less if you use a logic level FET). You can use an external power supply, the battery being tested (if its voltage is high enough), or a small 9V battery. Although this circuit is a bit more complicated than the direct-drive circuit, it isolates the switch from the UBA and is best when using high current loads. Try to use a digital output that has a default (reset) low value (DO1 or DO0 on UBAs with firmware 13 or later) so that, after reset, the load is switched off.



CONTROLLING THE LOAD WITH OPTICALLY COUPLED DRIVE

Controlling The Load with A Relay

This circuit uses the digital output to control a relay. Choose a relay to control a high current or because its contacts are isolated from the UBA, to control an external charger.



CONTROLLING THE LOAD WITH A RELAY

Calibration File Modifications For a Switched Resistive Load

The format for a switched resistive load is similar to an unswitched load, with the difference being an additional ExtLoadControl field.

```
ExtLoadDevice: name 3 resistance max_pwr ExtLoadControl
```

Where,

name is a name you give the resistor

'3' is the model number for a resistor

resistance is its resistance in ohms

max_pwr is the maximum power in Watts that the resistor can dissipate (use 0 for no limit)

ExtLoadControl is the name of the device that connects or switches the resistor in and out.

The external load control is specified in a line right after the "ExtLoadDevice" line as follows:

```
ExtLoadControl: name 2 dochan_on dochan_off maxamps
```

Where,

name is a name that you give this control

'2' is the model number for an electronic switch or relay

dochan_on and *dochan_off* are the digital output channels that turn the load on and off

maxamps is the maximum current that this control can support.

The *dochan_on* or *dochan_off* entry is expressed in the form: "...dcb" where each letter represents a output line, i.e.: "a" represents accessory digital output 0, "b" represents digital output 1, "c" the digital output 2 on the 2nd accessory port located on the 2nd accessory port and "d" controls the fan. Setting the

digit to “x” means no change; to “1” means set the line high; and to “0” means set the line low. *dochan_off* can also have a value of “!” which means the opposite of *dochan_on* (which is normally what you want).

Example 1:

A 1 Ohm 100W resistor controlled by a FET driven directly by the accessory digital output line ‘1’ where a high on this line turns the FET on would be specified as follows:

```
*ExtLoadDevice:  name      model  resistance  limit  ExtLoadControl
ExtLoadDevice:  Resistor1R.1  3      2          100    Resistor1RSW

*ExtLoadControl  name      model  dochan  maxamps
ExtLoadControl:  Resistor1RSW 2      1x !    10
```

Notes:

- specifying the ExtLoadControl controlling the ExtLoadDevice (“Resistor1RSW” in the above example) tells UBA Console that this resistor is controlled and there’s no load current if the ExtLoadControl is off;
- the dochan of “1x !” means that setting digital output ‘1’ high turns on the load and setting it low turns off the load;
- an exclamation mark (explained later) is not used after ExtLoadControl because digital output ‘1’ is set low after reset (but adding the exclamation mark won’t hurt).

Example 2:

Our 1 Ohm 100W resistor is now controlled by a FET driven by the accessory digital output line ‘0’ where a high on this line turns the FET on:

```
*ExtLoadDevice:  name      model  resistance  max_amps  ExtLoadControl
ExtLoadDevice:  Resistor1R.2 3      2          10      OptoSwitch

*ExtLoadControl  name      model  dochan  maxamps
ExtLoadControl!: OptoSwitch 2      x1 !    3
```

Notes:

- the dochan of x1 means that setting digital output ‘0’ high turns on the load;
- we’ve added an exclamation mark (!) after ExtLoadControl, to instruct UBA Console to set this control OFF (i.e. digital output ‘0’ low) after initializing the UBA. This is necessary for UBA5 firmware revisions prior to 13 because digital output ‘0’ is set high after reset and will remain that way until the ExtLoadControl! line is read in the calibration file.

For further details, consult *Appendix A*.

Testing With The Battery Connected to The Accessory Port

The UBA supports using the accessory analog input to measure the battery voltage. The external amplifier might be a high impedance amplifier for electrochemical research or a high voltage attenuator (amplifier with negative gain) for testing high voltage batteries.

You can use a resistor load when using an external amplifier for the battery voltage. In that case, the external resistor load is assumed to be connected to the battery, and not the voltage going into the UBA’s battery input.

For example:

```
*ExtVAmp:  name  model aichan  Vin0 Vout0 ... Vin_n Vout_n
ExtVAmp:  10xAmp  2      0      0.0  0.0    0.1  1.0

*ExtLoadDevice:  name  model resistance limit
ExtLoadDevice:  Resistor5R  3      5      2
```

In this example we use an amplifier with a gain of ten and a 5 Ohm resistor. If the battery voltage is 100mV the voltage going into the external analog input will be 1V. UBA Console will calculate 20mA as the current through the 1 Ohm resistor.

Combined Channels

You can use an external resistor with combined channels. You may want to combine channels to increase the charge current, but still use a resistor for the load. In that case, UBA Console uses the voltage that is displayed when calculating the resistor load current. It works if you are using the average of all the combined channels (default) or you are selecting one of the battery inputs as the battery voltage.

If you prefer to use a different voltage for calculating the resistor current, you can use an external load device model 2 to describe the resistor. That model allows you to specify the source from which to sample the voltage used to calculate the load current.

For example, if you combine channels and specify -2 for the analog channel, it will use the battery voltage from the first channel in the combined channel:

```
*ExtLoadDevice:  name  model Ain do Ro limit control  Iin Vin ...
ExtLoadDevice:  Model2Ain-2  4  -2 x 0  0  <none>  10 1
```

For example, if you combine channels and specify -3 for the analog channel, it will use the battery voltage from the displayed voltage:

```
*ExtLoadDevice:  name  model Ain limit control  Iin Vin ...
ExtLoadDevice:  Model2Ain-3  2 -3 0 <none>  0 0 10 1ExtLoadDevice:
```

Using an Active Load as an External Load

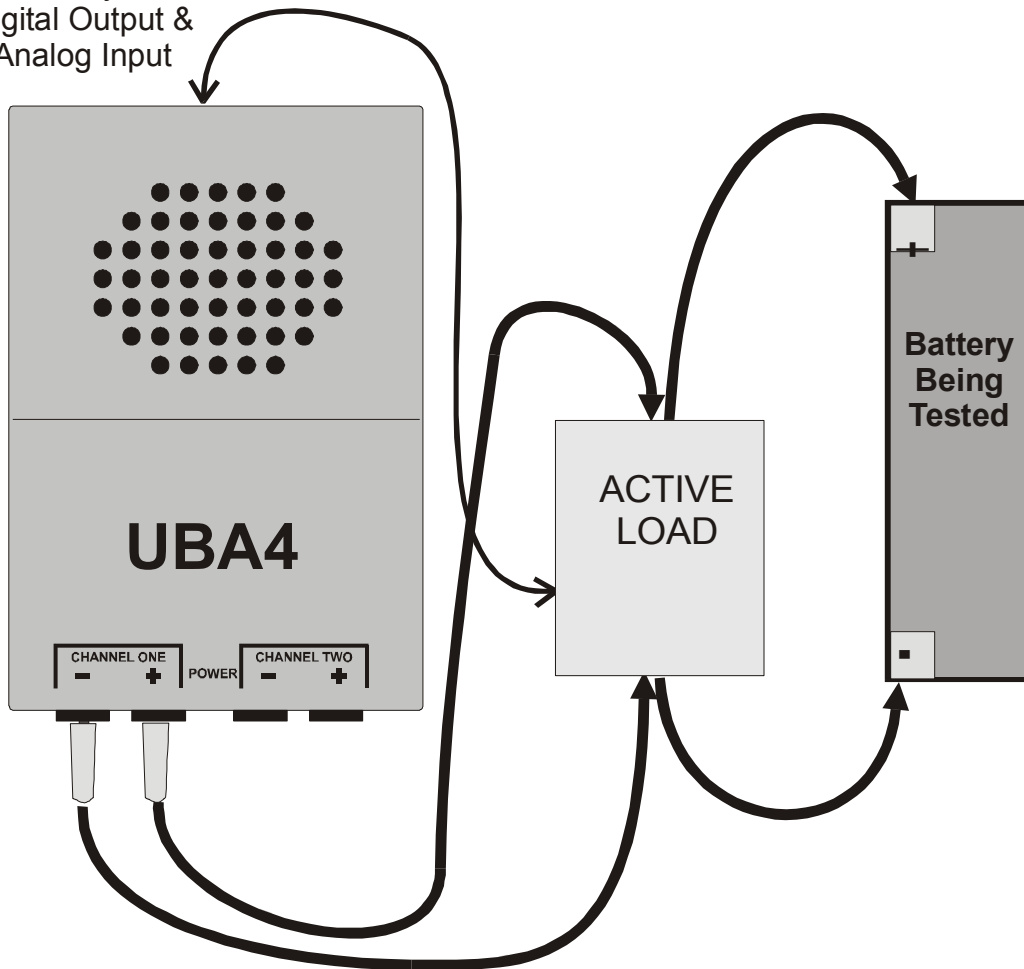
You can program your UBA to control an active load instead.

Your UBA can turn on the active load at the beginning of the discharge cycle, measure the load current (if the active load has an analog output signal), and turn it off at the end of the cycle.

Controlling the Active Load

The UBA uses the digital output on the accessory port to control the active load. If the active load has a voltage output that represents the load current, the UBA can monitor it using the analog input on the accessory port. The following is the way the active load should be set up:

Accessory Port:
Digital Output &
Analog Input



Note, the UBA is connected to the Active Load and not to the battery. This is done for two reasons. First this reduces the ground potential difference between the UBA and the active load which would interfere with the control and measurement of the active load. And second UBA Console assumes that it's measuring the voltage across the load and, if requested by setting the external resistance, can compensate for the voltage drop from the load to the battery.

Calibration File Modifications For an Active Load

The ExtLoadDevice line, in the calibration file, describes if the UBA controls the ExtLoadControl line.

The ExtLoadDevice line specifies the type of load (constant current or constant resistance), the load current or resistance, and whether it's controlled. The ExtLoadControl line specifies how the load is controlled (only on or off are currently supported).

These lines are specified as follows:

ExtLoadDevice: name 4 aichan do Ro limit control Iin0 Vout0 ... Iin_n Vout_n
ExtLoadControl!: name 2 dochan_on dochan_off limit

Where for the ExtLoadDevice:

name is a name you call the device
2 is the model number for a general load
aichan is the analog input channel that this device connects to on the UBA
do is the state digital of the digital lines to optionally enable or select this device.
Ro is the output resistance of the device
limit is the maximum load current
control is the name of the external load control that controls this device
Iin0 Vout0... describe the I-V characteristics of the device.

and for the external load control:

name is a name you call the control
2 is the model number for an electronic switch
dochan_on and *dochan_off* are the digital output channel on and off settings
limit is the maximum current.

For further information see Appendix A.

Depending on the type of load you have, there are a number of possible ways to program it, as shown below.

Uncontrolled Constant Current Load with no Current Measurement

If your active load isn't controlled (i.e., is always on) and does not have a measured current output, you need only to specify the ExtLoadDevice with no analog input.

Example – 10A load.

```
*ExtLoadDevice: name model aichan do Ro limit control Iin0 Vout0  
ExtLoadDevice: CCLoad1 4 -1 x 0 0 <none> 10 0
```

This specifies an ExtLoadDevice called CCLoad1 that doesn't measure a current output signal (the "-1"), isn't controlled by an ExtLoadControl (the "<none>"), has no current limit (the "0"), and is always 10A.

Uncontrolled Load with Current Measurement

If your load isn't controlled, but does have an output voltage representing the load current you need only an ExtLoadDevice line in the calibration file.

Example:

```
*ExtLoadDevice: name model aichan do Ro limit control Iin0 Vout0  
ExtLoadDevice: CCLoad2 4 1 x 0 0 <none> 10 1
```

This specifies an ExtLoadDevice called CCLoad2 with an output voltage signal representing load current. This signal is connected to accessory input 1 and a 10A load current gives an 1V signal (UBA Console assumes 0A gives 0V, thus an effective resistance of 0.1R).

Controlled Constant Current Load with no Current Measurement

If your active load is controlled (i.e., can be turned on and off) but has no voltage output representing current, you need an ExtLoadDevice and ExtLoadControl line in your calibration file.

Example:

```
*ExtLoadDevice: name model aichan do Ro limit control Iin0 Vout0
ExtLoadDevice: CCLoad3 4 -1 x 0 0 CCSwitch3 10 0

*ExtLoadControl name model dochan maxamps
ExtLoadControl: CCSwitch3 2 x1 ! 20
```

This specifies an ExtLoadDevice called CCLoad3 with no current signal output, and no current limit. It draws 10A when turned on. An external load control called CCSwitch3, which turns on the load by putting a digital high on digital accessory output 0 and can control up to 20A, is also specified.

Controlled Load with Current Measurement

You will need an ExtLoadDevice and ExtLoadControl line in your calibration file.

Example

```
*ExtLoadDevice: name model aichan do Ro limit control Iin0 Vout0
ExtLoadDevice: CCLoad4 4 0 x 0 0 CCSwitch4 100 1

*ExtLoadControl name model dochan maxamps
ExtLoadControl!: CCSwitch4 2 1x ! 20
```

This specifies an ExtLoadDevice called CCLoad4 with analog current signal on accessory input 0 that's controlled by CCSwitch4, has no current limit, and has 1V for 100A of current (effective resistance of 10mR).

An ExtLoadControl called CCSwitch4 which turns on the load by putting a digital high on digital accessory output 0 and has a 20A current limit, is also specified.

Resistive Load Described As an Active Load

For a resistive load it's possible to specify a model of 2 (general load instead of 3 for resistor) and specify the I-V characteristic of a resistor. As an example:

```
*ExtLoadDevice: name model aichan do Ro limit control Iin0 Vout0
ExtLoadDevice: RLoad 4 -3 x 0 0 RSwitch 1 2

*ExtLoadControl name model dochan maxamps
ExtLoadControl!: RSwitch 2 x1 ! 20
```

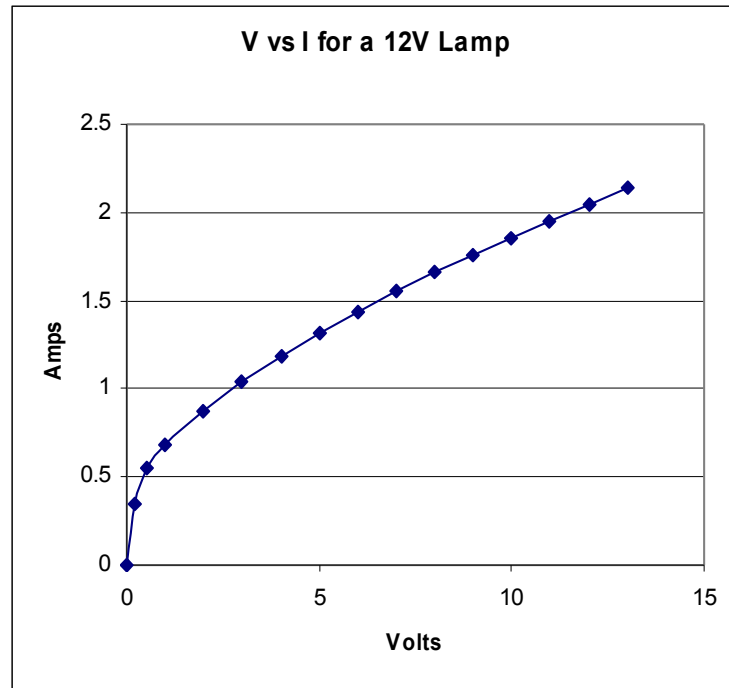
This specifies an ExtLoadDevice called RLoad with analog current signal on the battery input (which is what happens when a resistor is used) that's controlled by RSwitch, has no current limit, and has an output of 2V at a current of 1A (resistance of 2R).

An external load control, RSwitch, turns on the load by putting a digital high on digital accessory output 0 and has a current limit of 20A.

Using a Non-Linear Load as an External Load

What about if you have a non-linear load, for example a light bulb or an electronic device. You can't describe it as a resistor which is linear. You probably thought that you can't describe it as an active load, because it isn't. But you can. Here's how. Say for example you have a light bulb as a load. We measured one at various voltages and got the following table and graph.

V (V)	I (A)
0	0
0.2	0.35
0.5	0.55
1	0.68
2	0.87
3	1.04
4	1.18
5	1.32
6	1.44
7	1.56
8	1.66
9	1.76
10	1.86
11	1.95
12	2.04
13	2.14



From the graph you can see that the V-I curve not straight. But you can describe the light bulb fairly accurate by a series of linear line segments. We do that by coping the data directly from the V-I table above (reversing the V and I numbers) into the I-V description of the external load device. We get the following line:

```
*ExtLoadDevice: name model aichan do Ro limit control Iin0 Vout0
ExtLoadDevice: Lamp 4 -2 x 0 0 <none> 0 0 0.35 0.2
0.55 0.5 0.68 1 0.87 2 1.04 3 1.18 4 1.32 5 1.44 6 1.56 7 1.66 8 1.76 9
1.86 10 1.95 11 2.04 12 2.14 13
```

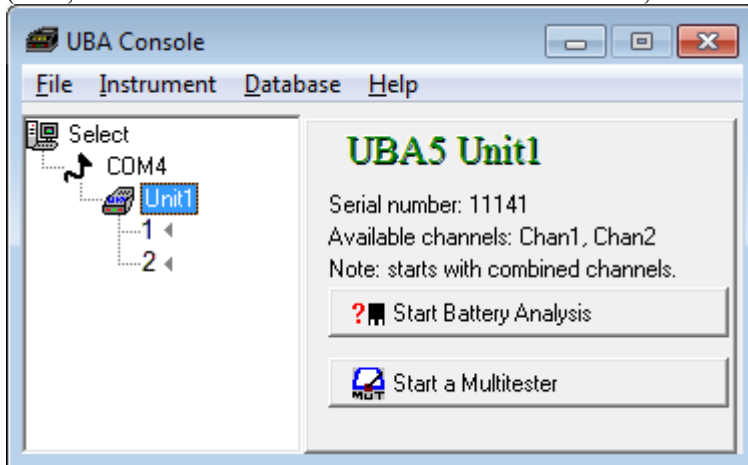
Note, the line in the above example wraps around, but in the calibration it doesn't. Another way to handle a non-linear load is to simply measure the load current. See the section "Using a Resistor as a Load Current Sensor" for an explanation.

Running UBA Console with an External Load

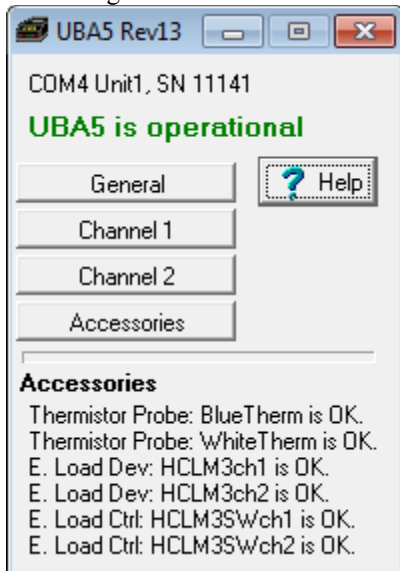
When you start a battery test you have to specify that you are using an external load device and it has to be specified in the BAR. Begin by making sure you've added the correct lines to your calibration file and that everything is set up correctly.

Step 1 - Verify that UBA Console has read any external devices in the calibration file.

In the channel selector, right click on your UBA (Unit1 is this example) and select "Show this UBA". (Note, this is for the version 1.10 and later of UBA Console, for earlier versions view UBA Network)



You will get the UBA window. Click on Accessories and the following window will appear:

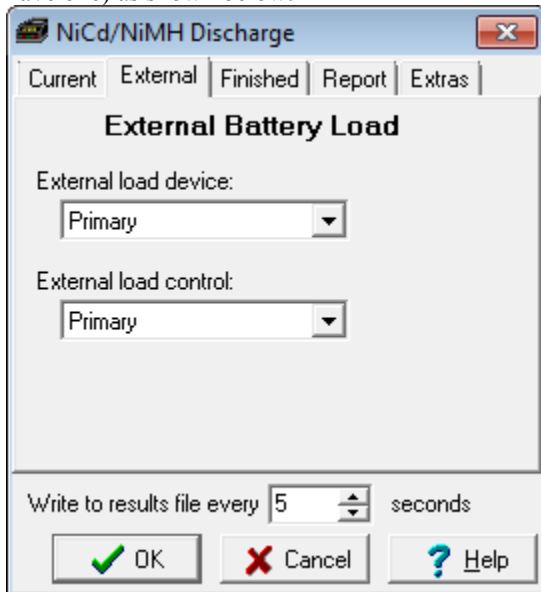


Step 2 - Verify that the calibration lines and set-up are correct.

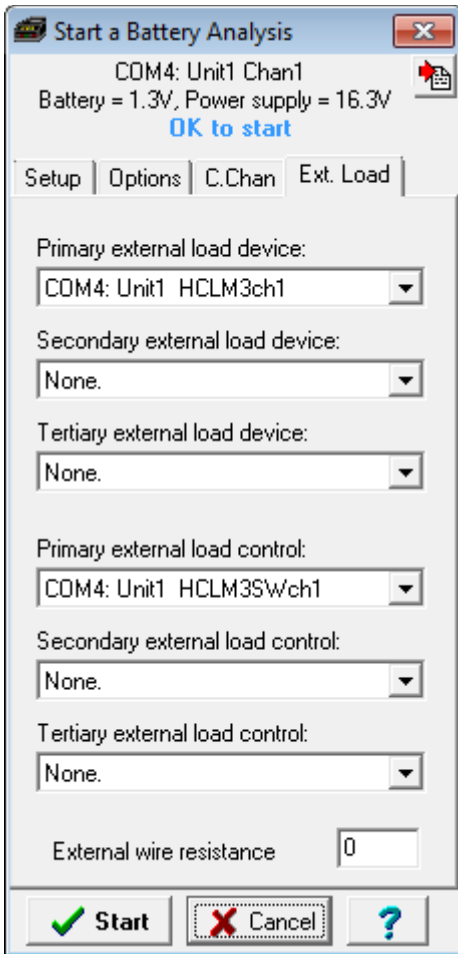
Close these windows and open a Multitester: choose the External Load tab then choose an external load device. If you have a external load control select it and turn it on by clicking on the “On” button. If the battery and load are connected, you should see the measured current displayed (you may have to wait a few seconds).

Step 3 - Run a Battery Analysis

Before you can run a battery analysis, you must make a battery analysis routine (BAR) that uses the external device and control. Open an existing or a new BAR and choose or create the load action that’s to use the external load. Choose Primary for the external load device (and for the external load control if you have one) as shown below.



Save the BAR and start a battery analysis. Click on the External Load tab and choose the external load device to use as the primary load device and similarly for the external load control.



Now start the battery analysis. When the discharge action with an external load specified starts, the load will be connected (if an external load control is used) and the load current calculated and displayed.

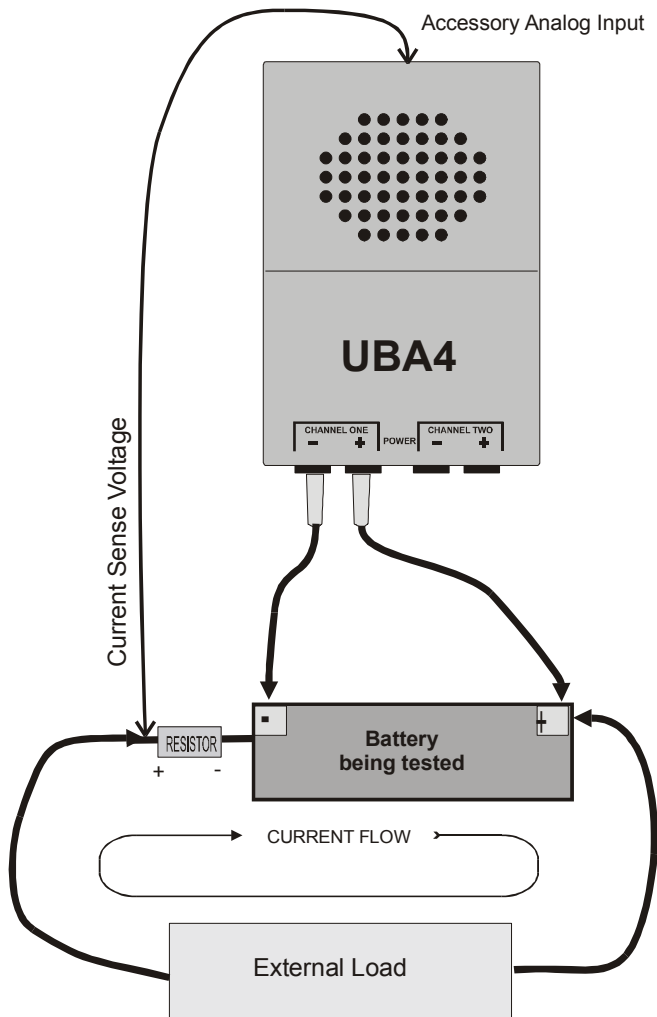
If you have more than one external load device or external load control, call one the primary and the other the secondary. You can control up to three devices and three controls in one battery test.

UBA Load Monitoring

This describes the ways to use an external resistor to sense load current. This is an advanced application and is meant only for esoteric battery testing applications.

Using a Resistor as a Load Current Sensor

When using an external load resistor with your UBA you normally connect the resistor to the load (with or without a control mechanism). But you can also use a resistor to measure load current. Use the following set up:



Notice that the resistor is in series with the battery and an external load. The UBA can measure the voltage across this resistor to calculate the load current.

Connect the current sense voltage to the analog input on the accessory connector and the UBA will use it as the load current. This works only when using an external load, not the UBA's internal load.

Since the UBA is measuring the voltage across the battery (and not the external load) use a value of 0 for the external wire resistance.

Warning

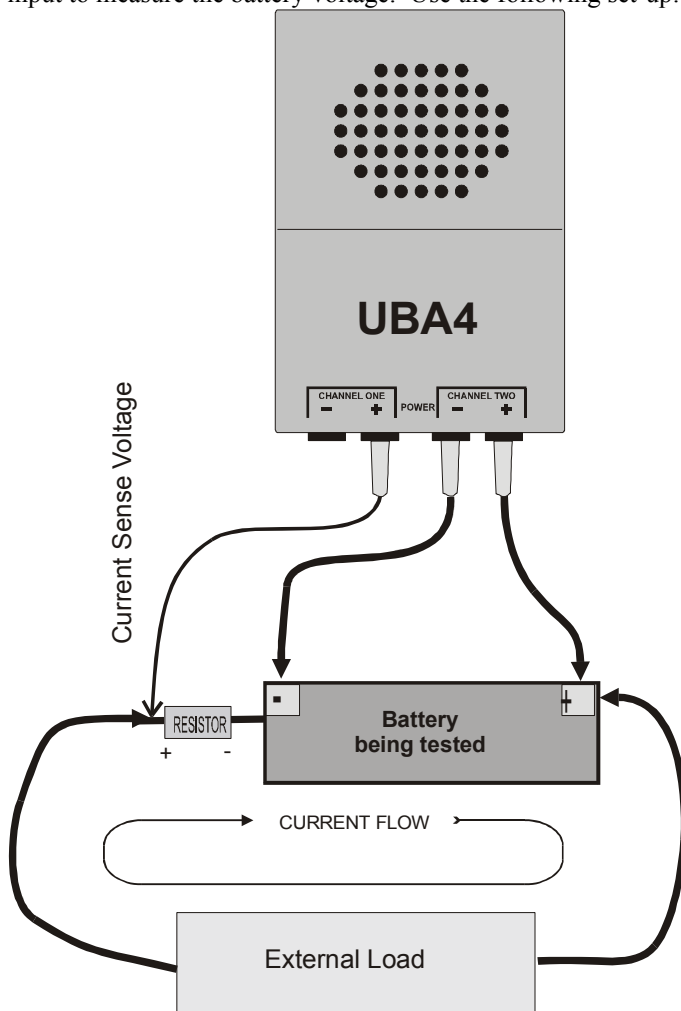
The accessory port is not protected against ESD (electrostatic discharge) nor voltages outside the range from 0 to +5V. The UBA warranty does not cover damage to the accessory port.

If you're using this set-up with a 0.5 Ohm sense resistor, you would add this to your calibration file:

```
*ExtLoadDevice:      name      model aichan do Ro limit control Iin0 Vout0
ExtLoadDevice:  CurrentSense  4      1      x  0  10 <none>  1  0.5
```

Because the resistor is being used to sense the current and not as the load, we have to use a general load (model 2). Doing so enables us to specify that the accessory port monitors the current sense voltage. In this example we've specified an "aichan" of 1, which is accessory port 1 analog input '1'.

If you want to use an current sense resistor, but don't have any accessory connector installed specify a combined channel UBA and use the channel 1 input to measure the current sense voltage and channel 2 input to measure the battery voltage. Use the following set-up:



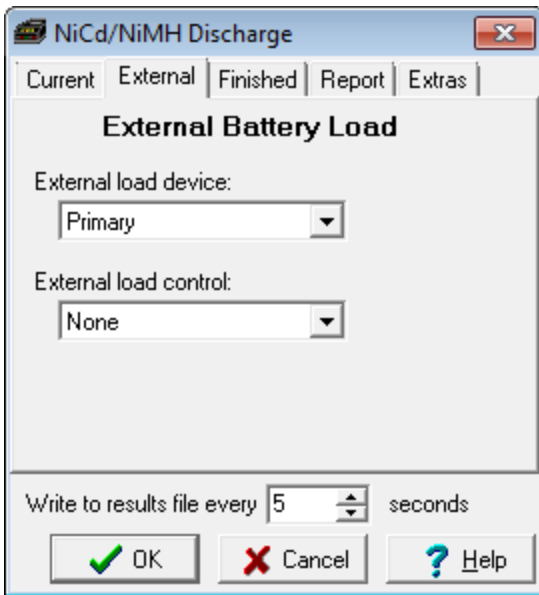
This set up isn't as accurate as connecting the current sense voltage to the accessory input because the low voltage range of the battery input is 0 to 7V, or almost one third less sensitive than the accessory input. But the battery voltage input is more accessible and better protected against over-voltage.

For this set up add to the calibration file:

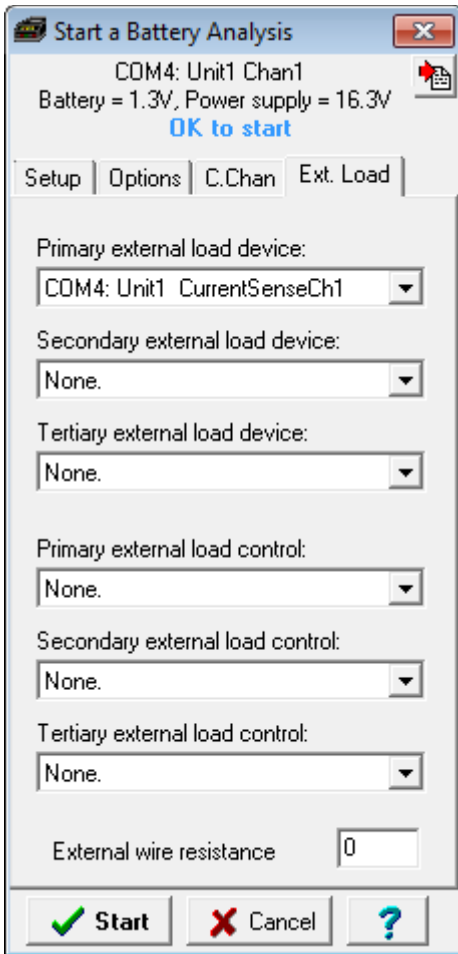
```
*ExtLoadDevice:  name          model aichan do Ro limit control Iin0 Vout0
ExtLoadDevice:  CurrentSenseCh1 4      -2 x 0  10 <none> 1 0.5
```

Here we specify ‘-2’ as the aichan, which means that the resistor voltage is applied to the actual physical battery input (which in a combined channel set-up is the first battery input). Set up the UBA to use combined channels 1 and 2 and specify that channel 2 is to be used for the battery input (so it doesn’t average channel 1 and 2). Now the virtual UBA will be using channel 2 for the battery voltage and channel 1 for the current.

With either of these set ups, the load current will be monitored and recorded with the battery voltage. To use this in a battery test you need to select the current sense resistor for the load current. First make a battery analysis routine (BAR) and specify “Primary” for the external load device, as shown below:



Then when starting a battery analysis, specify this BAR and choose “CurrentSenseCh1” for the primary load device as shown below. The battery analysis will interpret the sense resistor current as the load current.



Using a UBA to Test a Battery Charger

One of the reasons customers purchase a battery analyzer is that their batteries aren't giving the performance they expect. Buying new batteries doesn't solve the problem because users don't know if the problem is caused by defective batteries, incomplete charging, or because batteries are being damaged by either equipment or chargers.

The UBA can be used to monitor battery voltage and current while a battery is being charged and discharged by the customer's equipment. By examining the voltage and current profile one can see if the battery is being properly charged and discharged, i.e., not overcharged and not overdischarged.

Important Note

The circuitry inside the UBA is grounded via the serial line (if using a grounded PC, which is the case for desktop systems) and by the power supply (if using a grounded power supply, which is what we supply with the UBA). The negative battery inputs on the UBA are connected to this ground. Therefore if your equipment is not electrically floating, you have to isolate the UBA or your equipment from ground. You can isolate the UBA with a serial port optoisolator and a linear power supply (both available from us).

Warning:

The accessory port is not protected against ESD (electrostatic discharge) nor voltages outside the range from 0 to +5V. The UBA warranty does not cover damage to the accessory port.

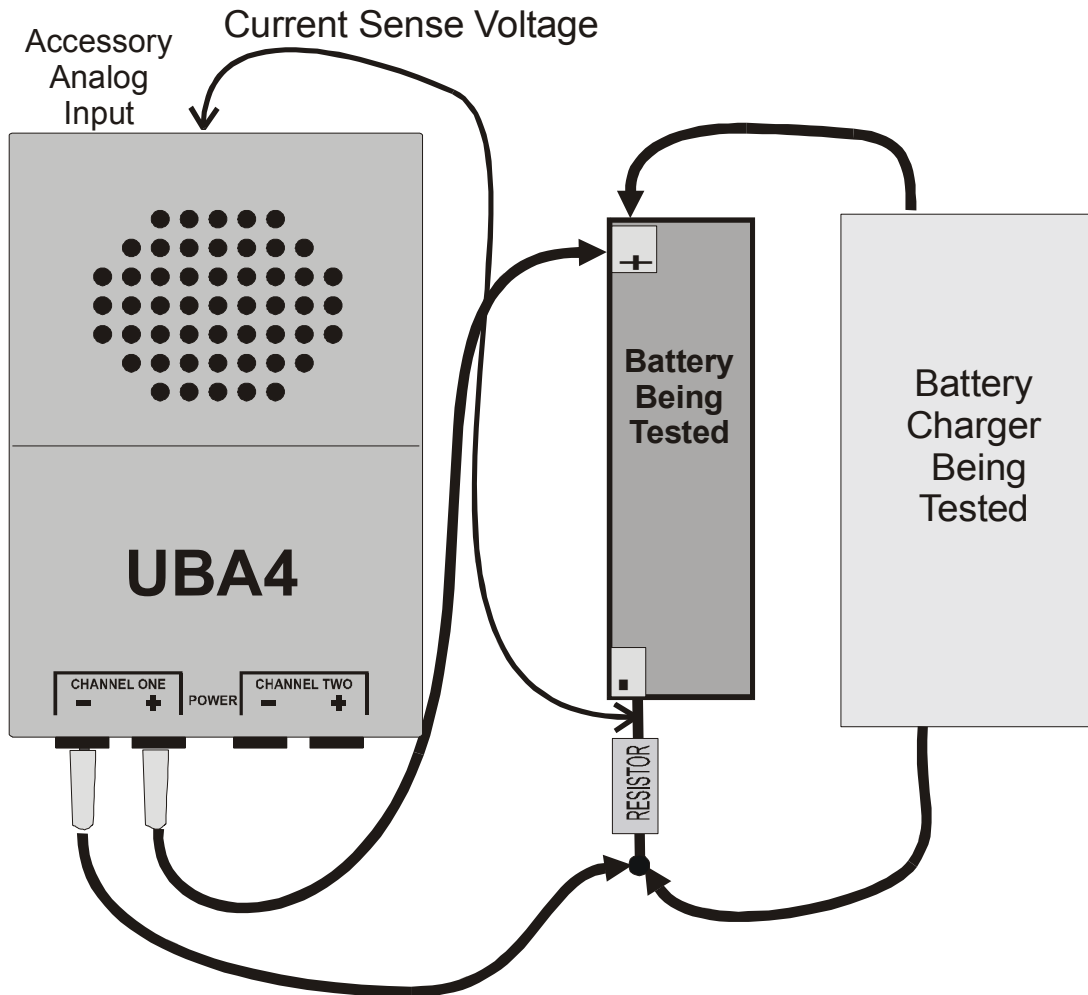
Monitoring Charger Voltage and Current

The UBA can monitor both the battery voltage and charging current (and, optionally, the battery temperature) while a battery is being charged with your equipment. After the charger has finished, you can plot the battery voltage and current, and examine the total charge delivered to the battery. Based on these observations, you can monitor how the charger is working.

In order to measure the charger current, you need to put a small value resistor in series with the battery. The UBA can monitor the voltage on this resistor and convert it into a charge current. In addition, it will integrate the charge current to give you a capacity reading.

You want to choose a current sense resistor with a small enough value that doesn't effect the charging, but not so small that its voltage is difficult to sample accurately. We recommend a resistor less than 1 Ohm, preferably from 0.1 Ohm to 0.5 Ohm. In the Vencon High Current Load Module, we use a 2 milliohm resistor with an amplifier; it has a small voltage drop, dissipates little power, yet uses the full range of the UBA's ADC. The resistor should have a 1% tolerance and should be rated at least twice the expected power it will dissipate (use $P = I \times I \times R$, where P = power in Watts, I = current in Amps and R is resistance in Ohms).

To use the UBA accessory analog input set up your UBA as shown below:

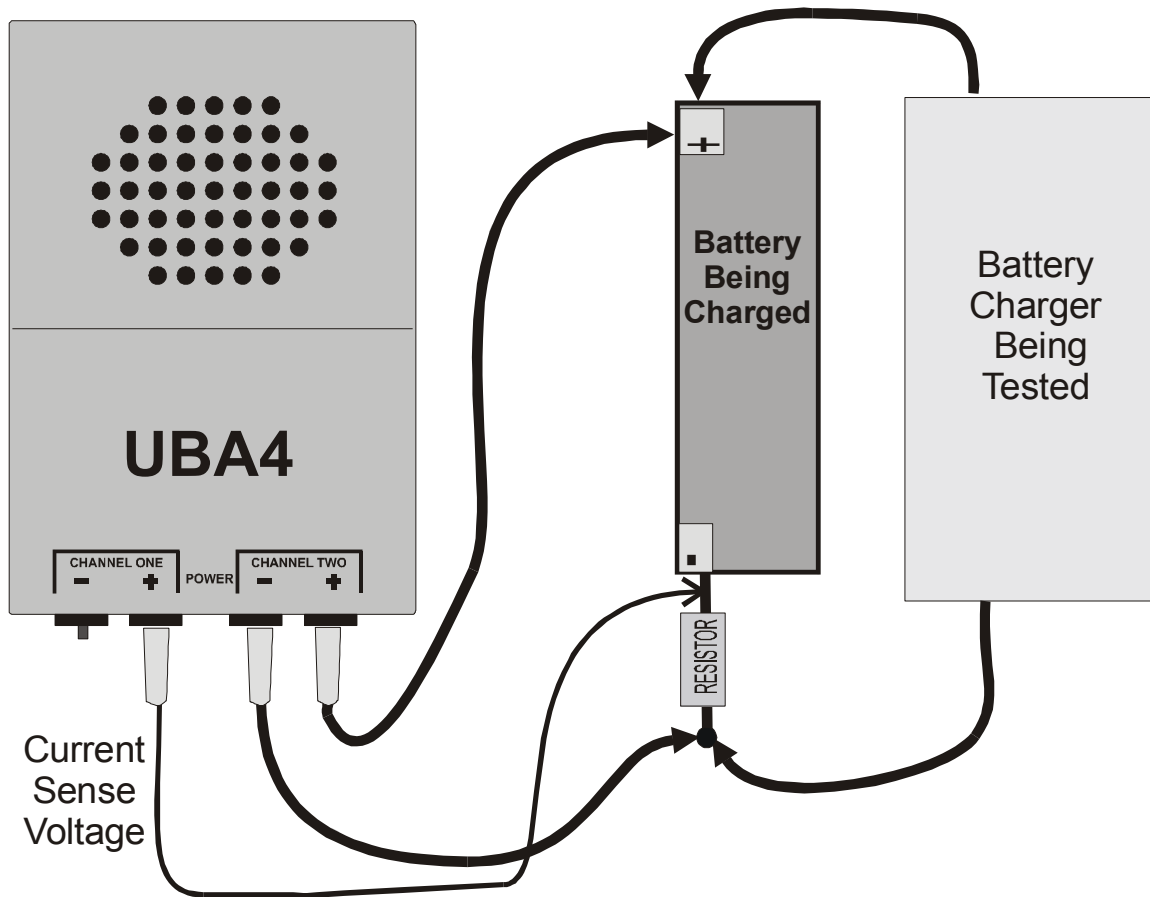


Add these lines to your calibration file:

```
*ExtLoadDevice:      name      model aichan do Ro limit control Iin0 Vout0
ExtLoadDevice: CurrentSense 4      0    x 0 10 <none> 1 0.5
```

The ExtLoadDevice line describes a resistor with a 10A current limit and a 0.5 Ohm resistance, with the voltage on the resistor connected to Analog Input '0' on the accessory port.

Alternatively if you don't have an accessory connector installed, you can use the channel 1 input to measure the current sense voltage and the channel 2 input to measure the battery voltage as follows:



And add these lines to your calibration file:

```
*ExtLoadDevice:      name      model aichan do Ro limit control Iin0 Vout0
ExtLoadDevice:  CurrentSense 4      -2    x 0 10 <none> 1 0.5
```

Here we specify '-2' as the aichan, which means that the resistor voltage is applied to the actual (physical) battery input. UBA Console has to be set-up to use combined channels, specify that channel 2 is to be used for the battery input (so it doesn't average channel 1 and 2). As a result, the virtual UBA will be using channel 2 to get the battery voltage and channel 1 for the current.

Considerations for Monitoring Charger Performance

Pulsing Charge Current

Many chargers (including the UBA) will sometimes pulse the charge current. In that case, you will have to add some filtering to the output of the current sense resistor. A simple RC filter might be enough. If the charge current is pulsed, the battery voltage will have some ripple on it. You can electrically filter this noise or just ignore it because UBA Console does some digital filtering.

Battery Voltage Error Due to Sense Resistor

The current sense resistor will increase the battery voltage that both the UBA and the charger measure. That's the reason it's better to use a sense resistor with as small resistance as possible (but not too small, because it will increase the error in the current measuring circuitry).

A future UBA Console update can account for this extra voltage by subtracting it from the measured voltage reading.

Running UBA Console to Monitor Charger Voltage and Current

Ensure that you've added the appropriate lines to the UBA calibration file; then initialize the UBA. You can check that the ExternalLoadDevice and ExternalLoadControl lines in the calibration file were read by clicking the Accessories button on the UBA window (get this from the tree window in UBA Network by expanding on the COM port and double clicking on the UBA you are using). You should see the ExternalLoadDevice listed, and the ExternalLoadControl, if you specified one.

If you are using channel 1 to measure the charge current, start a virtual UBA (click on the Icon or Instrument|Virtual UBA) and add channel 2.

Test the set-up by starting a Multitester. If you are using channel 1 to measure current, select the "Setup" tab and change the "Get battery voltage from" list to COM1: Unit1 Chan2 (substitute your COM port and Unit number).

Note: the UBA Console does not support an external resistor during charge, but does in discharge mode. As long as you don't specify a load current, there's no problem in treating your set-up as if you're using an external load.

Click on the "External Load" tab. Drop down the "External load control" list and choose which external load control you are using (if you have one). If you are using an external load control, click on the "On" button. The charge current should be displayed in the "External load measured current" line.

Once that you have verified that everything is working in Multitester, you are ready to start a battery test. First, make a BAR (Battery Analysis Routine) that will act as a data logger. Start with a new BAR and add a Discharge Cycle (we have to use a load action because UBA Console doesn't support external devices for charging). Set the cycle up as follows:

1. Discharge Current: 0
2. Write to results file every: 5 (set this to your preference)
3. Click on the External tab.
4. Choose "Primary" for the ExternalLoadDevice.
5. Choose "Primary" for the ExternalLoadControl (if you are using one).

Now save the BAR.

Start a battery analysis and enter:

1. The number of cells
2. The battery capacity
3. The Battery Analysis Routine Filename; enter the BAR we just created
4. A Battery Analysis Filename; enter a filename to store the results.
5. If you are using channel 1 to monitor charge current, select the "Options" page and under "Get battery voltage from" chooseChan2.
6. Choose "External Load" tab. Choose the external load device under "Primary external load device" and if you are using an external load control, choose it under "Primary external load control" and then.
7. Now you can start the battery analysis (and if you haven't already, connect or start the battery charger).
8. Once the analysis has started, right click on the window and choose Grow and check the battery voltage and current.
9. When the charger finishes, stop the battery analysis and then use a spread sheet to examine the voltage and current graphs.

Using an External Charger In a Charge/Discharge Cycle

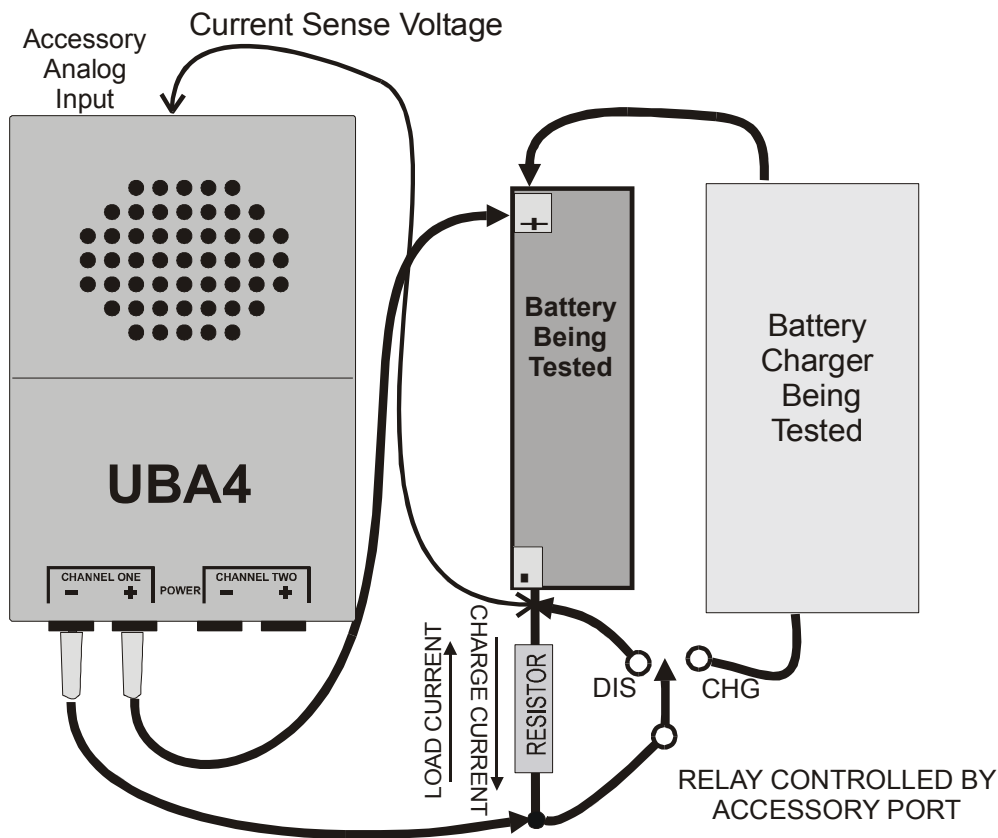
Using the digital output of the UBA accessory port, you can program the UBA to connect and disconnect your charger. The UBA accessory port has two digital outputs. If you have the optoisolated connector installed, the outputs will be optoisolated. Use the ExtLoadControl line in the calibration file to specify which digital lines to control and how to control them. For example, to set digital output 0 high during the discharge action, put these lines in your calibration file:

```
*ExtLoadControl      name          model  dochan  maxamps
ExtLoadControl: TurnChargerOn      2      x1 !    0
```

Note: UBA Console doesn't support external charge controls, but you can use a discharge action with 0 load current. This would be useful if you wanted to test a charger. You could design a BAR with the following actions:

1. Regular discharge cycle with load current specified that will discharge the battery
2. Optional discharge action with 0 current and a time limit that allows the battery to recover from the previous discharge
3. Discharge action that turns on your charger. Give this action a time limit that will allow the charger being tested to complete the charge, i.e., 1 or 2 hours
4. Optional rest discharge
5. Go to step 1 and repeat as many times as you want.

Connect your UBA as shown:



In this set-up, we use a relay to connect the charger to the battery. During charge the relay is in the "CHG" position and, while resting or during discharge, the switch is in the "DIS" position. In addition, when the

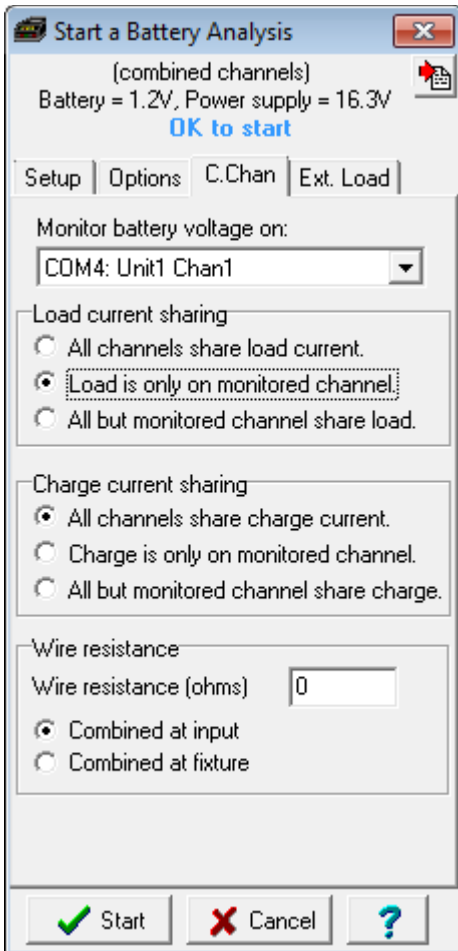
charger is disconnected the current sense resistor is shorted so that the load current doesn't create a negative voltage; it can damage your UBA and reduce the measured battery voltage.

This is the calibration file entry for a 0.5R current sense resistor, a relay on digital output 0 (high is on) and the current sense resistor connected to accessory analog input 0.

```
*ExtLoadDevice:      name      model aichan do Ro limit control Iin0 Vout0
ExtLoadDevice: CurrentSense 4      0      x 0 10 MyRelay 1 0.5
```

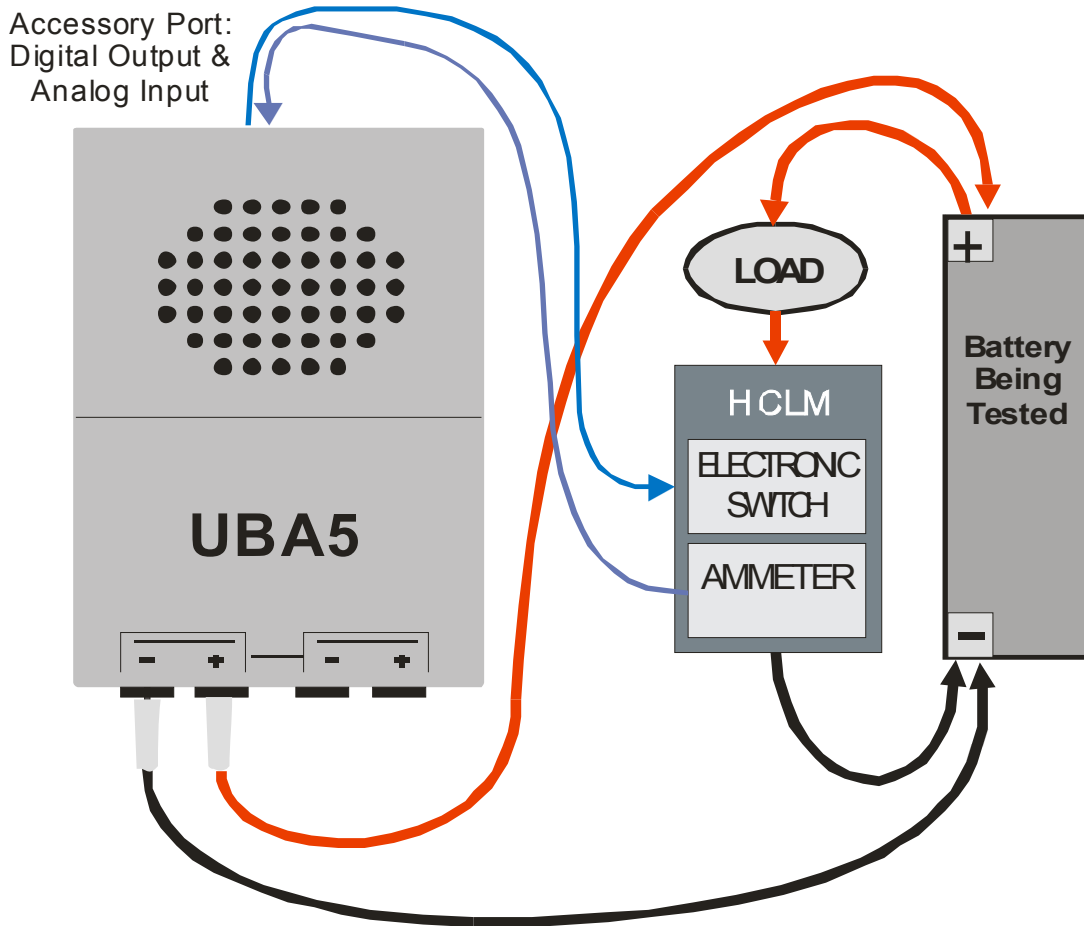
```
*ExtLoadControl name      model dochan maxamps
ExtLoadControl!: MyRelay 2      x1 !      0
```

If you use channel 1 to monitor charger current, the load current will be split between the combined channels. Because channel 1 is connected to the sense resistor (shorted by the relay), no actual current will be drawn from this channel. Therefore the actual load current will be one-half what you requested. When starting a battery analysis, you can specify that "Load is only on monitored channel" so that channel 1 has no load current. This is shown below:



Vencon High Current Load Module

The Vencon High Current Load Module (HCLM) consists of two sections: an electronic switch and an electronic ammeter, which are packaged in the same enclosure; both are capable of handling up to 50A (depends on the model) of current. The HCLM does not come with a load.



UBA Console controls the UBA, which connects the external load to the battery with the HCLM electronic switch and monitors the load current with the HCLM ammeter. The external load can be non-linear because the HCLM ammeter monitors the actual load current. Here is an example of the lines in the calibration file describing the HCLM. (2012: we have a new and improved HCLM which is a bit different)

```
*HCLM SWITCH:
*ExtLoadControl  name          model dochan aichan mode  amps
ExtLoadControl:  SwitchSN      1     x0     0     1    20

*HCLM AMMETER
*ExtLoadDevice:  name model aichan dochan Rout limit control Rgnd Iin0 Vout0 Iin1 Vout1
ExtLoadDevice:  Shunt25A 1 1 1x 1 50 SwitchSN 0.001 0 0 1 .09 10 .9
ExtLoadDevice:  Shunt50A 1 1 0x 1 50 SwitchSN 0.001 0 0 1 .03 10 .3
```

Note that there are two ExtLoadDevice lines; this is because the ammeter has two ranges, 0 to 25A and 0 to 50A. When starting a battery analysis, you choose which range to use.

Appendix A - UBA External Device Reference

External devices are specified by adding lines to the UBA calibration file, one line per device. The lines are added anywhere between the "[Accessories]" line and the "*end of calibration file" line. Use a text editor (Microsoft notepad is fine). You can have as many external device lines in your calibration file as you want. When you start a battery analysis, you specify which one you are using. UBA Console normally won't allow you to choose two external devices that use the same outputs or inputs.

Comment lines in your calibration file start with an asterisk ("*").

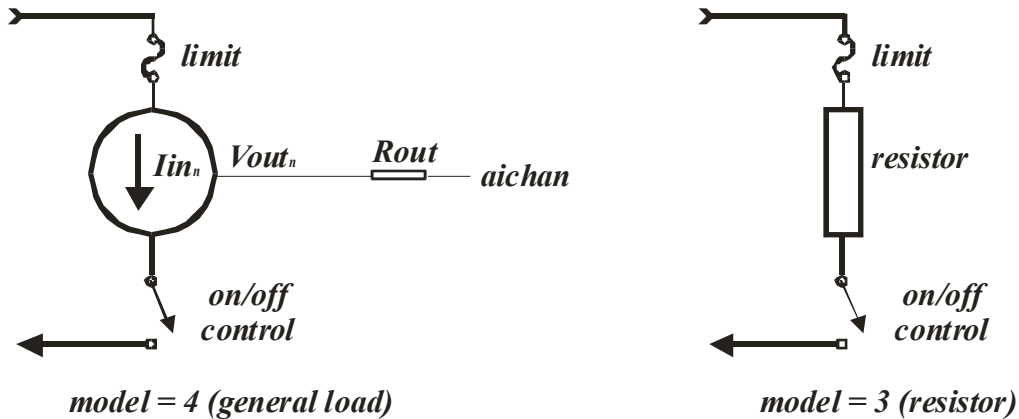
External Loads & Chargers

External load devices and external load controls go together to describe an external load, as do external charge devices and external charge controls describe an external charger. An external load device discharges the battery and an external load control turns the external load device on and off. You can have an external load device that's always connected, i.e., a resistor, which doesn't require an external load control. Some loads, such as a constant current switch, require both an external load device line and an external control device line to be properly described.

An external charge device charges the battery and an external charge control turns the charger on and off.

External Load Devices

An external load device is a load that has either a defined load current relationship (i.e. a resistor or a fixed constant current load) or a voltage output that represents load current. External load devices are described in the UBA's calibration file by the **ExtLoadDevice** line.



Schematic of External Load Device and Control

ExtLoadDevice Syntax:

ExtLoadDevice: name 3 resistance power control (model 3)
ExtLoadDevice: name 4 aichan dochan Rout limit control Iin₀ Vout₀ Iin₁ Vout₁ ... (model 4)

where

- **name** is any name you give this device. The name can contain any characters except spaces.
- **model** is:
 - 1 for the ~~rev1 and rev2 Vencon High Current Load Module (HCLM)~~ (don't use for new design)
 - 2 for a general load (~~also the rev3 HCLM~~) (don't use for new design)
 - 3 for a resistor load
 - 4 is for a standard external load device
- **aichan** (model 4 only) is the analog input channel in which the device's output voltage is measured (in model 3 the battery voltage is used to calculate load current).
 - "0": accessory analog input 0
 - "1": accessory analog input 1
 - "-1": no analog input
 - "-2": the voltage on the battery input (for combined channels this is the first virtual channel) *after* any battery lead voltage compensation is performed (excluding external load wire resistance).
 - "-3": use the battery voltage that is being used (not necessarily the battery input). This is the value that is used for model 3 (a resistor). The battery voltage with voltage drop compensation is used (excluding external load wire resistance).
- **dochan** (model 4 only) is the digital output channel that can be used to select the device. It is expressed in the form: "...*dcb*a" where each letter represents an output line, i.e. "*a*" represents accessory digital output 0 and "*b*" represents digital output 1, "*c*" the digital output 2 on the 2nd accessory port, and "*d*" the fan. Setting the digit to "x" means no change, to "1" means set the line high; and to "0" means set the line low.
- **Rout** (model 4) output resistance of the device. Normally set to 0 ohms.
- **limit** The maximum current that this device can support ('0' = no limit) in Amps, (*note, this parameter is required, but not supported in the current version of software*)
- **power** The power rating of the resistor ('0' = no limit) in Watts. (*note, this parameter is required, but not supported in the current version of software*)
- **control** is the name of the **ExtLoadControl** that controls this device. If there is no **ExtLoadControl** use "<none>" (for model 3 leave blank). If this entry is "<none>" (or blank for a resistor) the software will assume that the load device is always on. (*note, the current version of S/W only tests for <none>*)
- **Iin₀ Vout₀ Iin₁ Vout₁ ...** (model 4 only) is the I (current) vs V (voltage) characteristic of this device. For a given load current, the device's output voltage is specified. Iin₀ would normally be zero, and Vout₀ would be the output voltage of the load device when the current is 0 (i.e. its offset). Iin₁ would be a larger current than Iin₀ and Vout₁ would be the output voltage of the load device at Iin₁. You can have as many of these data points as you want, but they must be monotonic (i.e. Iin_{n+1} > Iin_n). UBA Console uses these values to calculate the load current given the voltage at the specified analog input (**aichan**). If you specify a single point at 0, i.e. "10 0" then a constant current of 10A is assumed. If you specify a single point, not at zero, i.e. "1 10" then it assumes that there is a point at 0, i.e. same as "0 0 1 10".
- **resistance** (model 3 only) is the resistance of the load resistor.

ExtLoadDevice Examples

```
*ExtLoadDevice: name    model aichan do Ro limit control Iin0 Vout0  
ExtLoadDevice: X10IAmp 4      1    x 0  20 MySwitch 10    1
```

This is an external load that has its voltage output connected to accessory1 analog input 1, a limit of 20A, and is controlled by “MySwitch”. It’s a current amplifier that with an effective resistance of 0.1R: at 0A current it gives 0V, and at 10A it gives 1V.

```
*ExtLoadDevice: name model resistance limit ExtLoadControl  
ExtLoadDevice: 10hm   3      1      100
```

This is a 100W 10hm resistor. Because no ExtLoadControl is specified, the software assumes this resistor is always connected. If the resistor was controlled, they you'd use this line:

```
*ExtLoadDevice: name model resistance limit ExtLoadControl  
ExtLoadDevice: 10hm   3      1      100      MySwitch
```

External Charge Devices

An External Charge Device is usually an external charger. The UBA can read a measured charge current signal via either of the analog inputs or on the internal charger voltage A/D input (if you have a customized UBA). Note: unlike the external load device, the current version of UBA Console is unable to sum the measured internal charger current with the measured external charger current, i.e. it can only measure one or the other.

ExtChargeDevice: name 4 aichan dochan Rout limit control Iin₀ Vout₀ Iin₁ Vout₁ ... (model 4)

where

- o **name** is any name you give this control. The name can contain any characters except spaces.
- o **model** is 4 is for a standard external charge device
- o **aichan** (models 1 and 2 only) is the analog input channel in which the device's output voltage is measured (in model 3 this assumes the battery voltage).
 - “0”: accessory analog input 0
 - “1”: accessory analog input 1
 - “-1”: no analog input
 - ~~“-2”: the voltage on the battery input (for combined channels this is the first virtual channel) after any battery lead voltage compensation is performed (excluding external load wire resistance). -- don't use~~
 - ~~“-3”: battery voltage -- don't use~~
 - “-4”: charger voltage channel (used only for custom modified UBAs).
- o **dochan** is the digital output channel that can be used to select the device. It is expressed in the form: “...*dcb*a” where each letter represents a output line, i.e. “*a*” represents accessory digital output 0 and “*b*” represents digital output 1, “*c*” the digital output 2 on the 2nd accessory port, and “*d*” the fan. Setting the digit to “x” means no change, to “1” means set the line high; and to “0” means set the line low.
- o **Rout** output resistance of the device
- o **limit** It's is the maximum current that this device can support (‘0’ = no limit) in Amps. (*note, this parameter is required, but not supported in the current version of software*)
- o **control** is the name of the ExtChargeControl that controls this device. If there is no ExtChargeControl use <none> . In that case the software will assume that the charge device is always on.
- o **Iin₀ Vout₀ Iin₁ Vout₁ ...** is the I (current) vs V (voltage) characteristic of this device. For a given charge current, the device's output voltage is specified. Iin₀ would normally be zero, and Vout₀ would be the output voltage of the charge device when the current is 0 (i.e. its offset). Iin₁ would be a larger current than Iin₀ and Vout₁ would be the output voltage of the load device at Iin₁. You can have as many of these data points as you want, but they must be monotonic (i.e. Iin_{n+1} > Iin_n). UBA Console uses these values to calculate the charge current given the voltage at the specified analog input (**aichan**). If you specify a single point at 0, i.e. “10 0” then a constant current of 10A is assumed. If you specify a single point, not at zero, i.e. “1 10” then it assumes that there is a point at 0, i.e. same as “0 0 1 10”.

ExtChargeDevice Examples:

```
*ExtChargeDevice: name    model aichan do Ro limit control Iin0 Vout0
ExtChargeDevice: ECharger 4      1      x 0  100 <none> 50  1
```

This is an external charger that has its voltage output connected to accessory1 analog input 1, a limit of 100A, and isn't controlled by an ExtChargeControl. A 50A charge current is represented by a 1V input into the UBA.

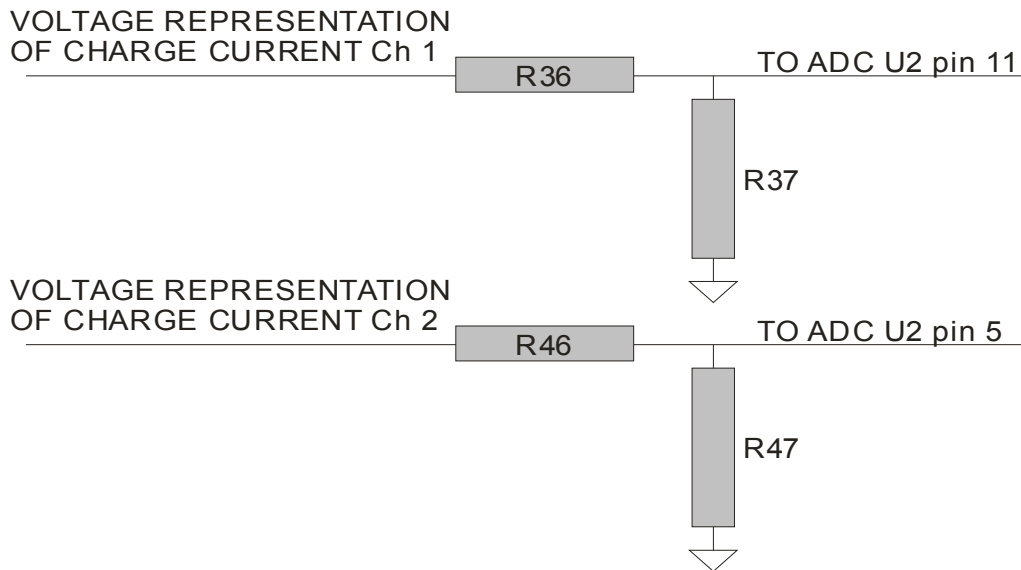
If the charger is controlled by the UBA then add a control, i.e.

```
*ExtChargeDevice: name    model aichan do Ro limit control Iin0 Vout0
ExtChargeDevice: echarger 4      1      x 0  100 ChgSwitch 50  1
```

Analog Input "-4" - Charger Voltage Channel

The easiest way to monitor charge current is by using one of the external analog inputs on the back of your unit. But if they are in use then you can use an analog input that's internal to the UBA circuitry. Normally we would provide this input with a custom UBA. We'll describe this below if you want to do this yourself.

For channel 1, pin 11 on the A/D IC (U2) samples the voltage on the low side of the current sense resistor via a 11:1 divider network made up of series resistor R36 (10K on standard UBA) and ground resistor R37 (1K on standard UBA). The input to the A/D convert is 0 to 2.5V. If you want a 0 to 10V input range then replace R37 with a 2k43 resistor and R36 with a 7k5 resistor, but leave the end of R36 that doesn't connect to R37 floating. This gives a 0.245 attenuation. This is shown below for channel 1 and channel 2.

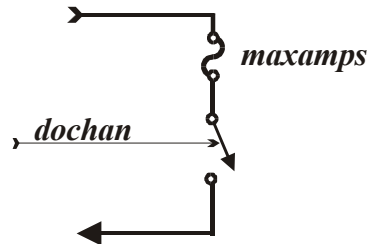


Notes:

- Once modified, your UBA will no longer be able to measure charge current of the built in charger.
- If you connect a voltage into the ADC of less than 0V or greater than 5V you'll probably blow it.
- Don't do this unless you're comfortable modifying circuitry as this invalidates the UBA warranty.
- The voltage input here, similar to the accessory port, is UBA ground referenced, i.e. not isolated.

External Load Control

External Load Control is a device that controls the load, i.e.: connects or disconnects it. It is controlled by the digital outputs on either accessory port.



model = 2 (Electronic Switch)

Diagram Representation of External Load Control

ExtLoadControl Syntax:

ExtLoadControl!: *name 2 dochan-on dochan-off maxamps*

Where:

- **!** is an optional exclamation mark which sets the external load control off when the UBA is initialized
- **name** is any name that you give this control. The name can contain any characters except spaces
- **model** is:
 - 1 for the rev1 & rev2 HCLM (don't use for new design)
 - 2 for an electronic on/off switch or relay
- **dochan-on** is the digital output channel that controls the load. It is expressed in the form: "...*dcb*" where each letter represents a output line, i.e. "*a*" represents accessory digital output 0 and "*b*" represents digital output 1, "*c*" the digital output on the second accessory port, and "*d*" the fan digital output (normally used for the fan). Setting the digit to "x" means no change, to "1" means set the line high; and to "0" means set the line low. For model 1 the complement of **dochan_on** is used to turn the load off.
- **dochan-off** This is similar to **dochan-on**, only it is used to turn the load off. A value of "!" means use the complement of **dochan-on**.
- **maxamps** is the maximum current that this control can support. If the current exceeds this, the control is turned off. A value of 0 means no limit.
(note, this parameter is required, but not supported in the current version of software)

ExtLoadControl Examples

```
*ExtLoadControl name model dochan maxamps  
ExtLoadControl!: MySwitch 2 x0 ! 20
```

This external load control, which is called “MySwitch”, is turned on by a low on digital output 0 and can handle up to 20 Amperes. Note: because it’s turned on by a low from digital output 0, this load will be turned off if the UBA resets. We added an exclamation mark to ExtLoadControl so that this device is turned off (digital output 0 set high) when the UBA is initialized.

```
*ExtLoadControl name model dochan maxamps  
ExtLoadControl: 2ndSwitch 2 1x ! 50
```

This external load control, which is called “2ndSwitch”, is turned on by a high to digital output 1 and can handle up to 50 Amperes. Note: because it’s turned on by a high from digital output 1, this load will be turned off if the UBA resets.

ExtChargeControl Syntax:

ExtChargeControl!: *name 2 dochan-on dochan-off maxamps*

All the parameters are the same as for the ExtLoadControl.

Example:

```
*ExtChargeControl name model dochan maxamps  
ExtChargeControl: ChgSwitch 2 1xx ! 100
```

This uses the digital output on the second accessory port to control a relay during charge.

External Battery Voltage Amplifier/Attenuator

The accessory connector can also be used support a voltage amplifier (or attenuator) that connects to your battery. It can be used as a third electrode amplifier for measuring an electrochemical cell or for differentially measuring a battery voltage.

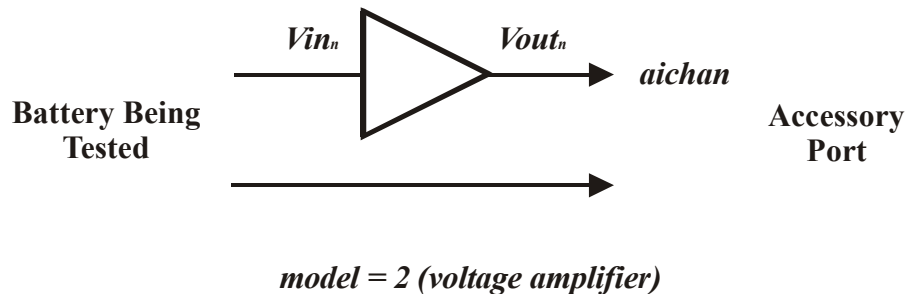


Diagram Representation of External Battery Voltage Amplifier

Battery Voltage Amplifier/Attenuator Syntax:

ExtVAmp : name model=1 aichan dochan Rout Ibias V_{in_0} V_{out_0} ... V_{in_n} V_{out_n}
ExtVAmp : name model=2 aichan V_{in_0} V_{out_0} ... V_{in_n} V_{out_n}

where:

- o **name** is any name you give this amplifier. The name can contain any characters except spaces;
- o **model** is:
 - 1 for the Vencon Extremely Low Current Module
 - 2 for a voltage amplifier with its own floating connection to the battery
 - 3 for a voltage amplifier that uses the UBAs negative input as it's negative input, so that the UBA S/W will account for battery lead voltage drop.
- o **aichan** is the analog input channel:
 - “0” for accessory analog input 0
 - “1” for accessory analog input 1
- o **doch** (model 1 only) is the digital output channel that controls the load.
(this parameter is required, but not supported in the current version of software – set it to 'x')
- o **Rout** (model 1 only) is the output resistance of the amplifier
- o **Ibias** (model 1 only) is the bias current of the amplifier
(note, this parameter is required, but not supported in the current version of software)
- o **V_{in_0} V_{out_0} ... V_{in_n} V_{out_n}** is the DC response of the amplifier expressed as input output points. where V_{in} is the battery voltage and V_{out} is what connects to the UBA analog input.

ExtVAmp Examples

```
*ExtVAmp: name model aichan Vin0 Vout0 ... Vin_n Vout_n
```

```
ExtVAmp: 10xAmp 2 0 0.1 1.0
```

This describes an 10X amplifier that connects to analog input 0. A battery voltage of 100mV is amplified to 1.0V. Since this is a model 2 amplifier, it has its own positive and negative inputs that connect to the battery's terminals in a 4 wire configuration.

If only the positive input to the amplifier connects to the battery it's a 3 wire configuration (better than 2 wire but not as good as 4 wire) and you should use a model 3:

```
*ExtVAmp: name model aichan Vin0 Vout0 ... Vin_n Vout_n
```

```
ExtVAmp: 10xAmp 3 0 0.1 1.0
```

External Sensor

The UBA has two 0 to 2.5V external analog inputs that can be used. You specify in the calibration file the device that's connected to them. UBA Console will then sample those inputs and display their values. The S/W supports three types of lines in the calibration file:

ExtTempProbe: for a temperature probe with a linear output voltage representing temperature.

ExtThermistorRabcd: for a temperature probe that uses a thermistor

ExtSensor: the general case

Make sure you read the next section (Accessory Analog Input) before you write your own lines.

External Temperature Sensor – Voltage Output

The UBA accessory port will accept a voltage representing a temperature.

ExtTempProbe : name aichan V_{20C} V/C Rout

Where:

- o **name** is any name you give this temperature sensor; the name can contain any characters except spaces.
- o **aichan** is the analog input channel:
“0” for accessory analog input 0
“1” for accessory analog input 1
- o **V_{20C}** is the voltage at 20° Celsius.
- o **V/C** is the voltage change per degree Celsius
- o **Rout** is any series resistance from the output of the sensor to the input of the accessory port

Example:

```
*ExtTempProbe: name chan V@20C V/C Rout  
ExtTempProbe: Temp1 0 0.68 0.018 1000  
ExtTempProbe: Temp2 1 0.68 0.018 1000
```

External Thermistor Sensor

The UBA accessory port will accept a resistance representing a temperature, in the following form:

ExtThermistorRabcd : name aichan R_{25c} a b c d

Where:

- o **name** is any name that you give this thermistor; the name can contain any characters except spaces
- o **aichan** is the analog input channel:
“0” for accessory analog input 0
“1” for accessory analog input 1
- o **R_{25c}** is the thermistor resistance at 25° Celsius

- o *a b c d* are the parameters of the thermistor

Example

```
*ExtThermistorRabcd: name      chan R@25C  a      b      c      d
ExtThermistorRabcd: WhiteTherm 0 10000 0.0033 2.5e-4 2.6e-6 6.7e-8
ExtThermistorRabcd: BlueTherm  1 10000 0.0033 2.5e-4 2.6e-6 6.7e-8
```

External Sensor – The General Case

The external temperature probe and the external thermistor are simplified versions of the external sensor described here:

```
ExtSensor: name title units model=1 aichan dochan Rout Xin0 Vout0 Xin1 Vout1 ...
ExtSensor: name title units model=2 aichan dochan Rout Xin0 Vout0 dV/dX
ExtSensor: name title units=°C model=3 aichan dochan R@25C a b c d: factors
ExtSensor: name title units=°F model=4 aichan dochan R@25C a b c d: factors
```

Where:

- o **name** is any name that you give this thermistor; the name can contain any characters except spaces
- o **title** is the title that you want used on the graph (and the title for the column), i.e. “Temperature”
If you want spaces in the title, then use an underscore to represent them, i.e. “Pressure_Sensor”. Don’t add units to the title, the S/W will add the units to the title when the graph is displayed, i.e. “Temp” will display as “Temp (°C)”.
- o **units** is the name of the value that you’re measuring, i.e. °C, °F, psi or even V
Note: for model 2 units should be °C or °F or K.
Note: for model 3 units should be °C
Note: for model 4 units should be °F
- o **model:**
model 1: you specify the transfer function of the sensor by specifying pairs, sensor value-voltage. i.e. if 32°F to 212°F was represented by 0 to 1V you’d use 32 0 212 1
model 2: is used to replace the ExtTempProbe format.
model 3: is used to replace the ExtThermistorRabcd format
model 4: is the same as model 3 but units are in Fahrenheit
- o **aichan** is the analog input channel:
“0” for accessory analog input 0
“1” for accessory analog input 1
- o **dochan** is the digital output that is set to enable the sensor (use xx for no digital signal)
- o **Rout (model 1 & 2 only) is the output resistance of the amplifier**
- o **Xin0, Vout0 (model 2 only)** is a data point giving the output voltage (**Vout0**) for a given sensor input (**Xin0**)
- o **dV/dX (model 2 only)** is the slope of the voltage vs sensor signal line.
- o **R25c (model 3 only)** is the thermistor resistance at 25° Celsius
- o **a b c d (model 3 only)** are the parameters of the thermistor

Examples:

*Pressure sensor with a 0 V output for 0 psi and 1.0 V for 100 psi
*ExtSensor: name units model=1 aichan dochan Rout Xin0 Vout0 Xin1 Vout1
ExtSensor: PressureSensor#1 pressure psi 1 0 xx 0 0 0 100 1

*LM34 Fahrenheit temperature probe (Vout = °F x 10mV)
*Note, a LM34 gives better resolution than a LM35 (Vout = °C x 10mV)
*ExtSensor: name units model=2 aichan dochan Rout Xin0 Vout0 dV/dX
ExtSensor: TempLM34C Temperature °C 2 0 xx 0 20 0.68 0.018

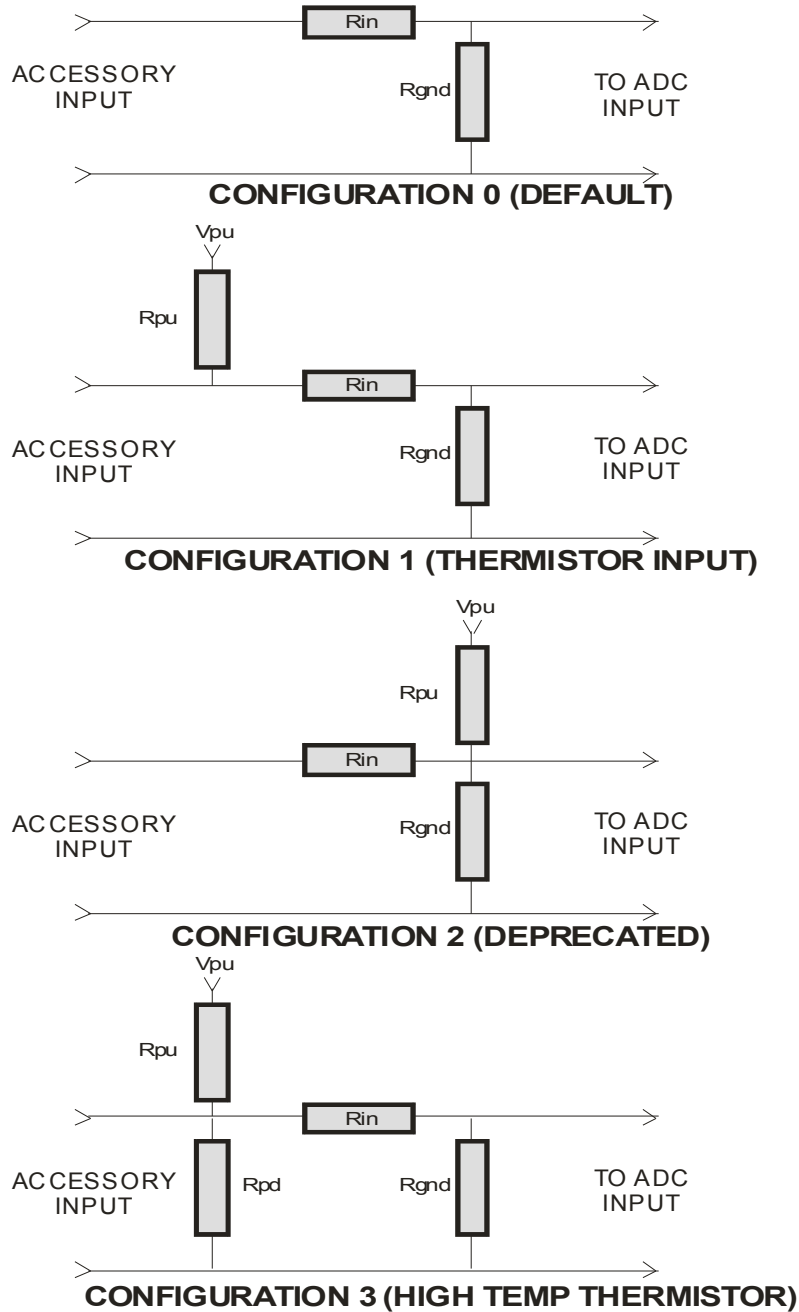
*UBA5 Thermistor (10k at 25°C)
*ExtSensor: name units model=3 aichan dochan R@25C a b c d
ExtSensor: WhiteTherm Temperature °C 3 0 xx 10000 3.35e-3 2.57e-4 2.62e-6 6.4e-8

* Direct Voltage reading of the analog input (used for calibration)
*ExtSensor: name units model=1 aichan dochan Rout Xin0 Vout0 Xin1 Vout1
ExtSensor: Chan0 Voltage V 1 0 xx 0 0 0 1 1
ExtSensor: Chan1 Voltage V 1 1 xx 0 0 0 1 1

Accessory Analog Input

This isn't an external device, but the input network inside the UBA. UBA Console uses it to calculate the transfer function from the accessory input to the ADC (the analog to digital converter inside the UBA) input.

The accessory port has two analog inputs. The AnalogInR lines in your calibration file, which describe how they are wired, are provided by Vencon and shouldn't have to be modified. Your UBA will come in one of three configurations depending on what options you ordered.



AnalogInR : [name] aichan Rin Rgnd [config [Rpu Vpu [Rpd]] [CalFac]]

Where:

- o **name** is an optional name that links this to the accessory that uses it. The name cannot be a number.
- o **aichn** is the analog input channel, 0 or 1
- o **Rin** is the series resistor
- o **Rgnd** is the ground resistor (can't be 0, use -1 if not installed)
- o **config** is the model:
(if blank, default config of 0 and CalFac of 1.0 is assumed)
0 straight attenuation – standard on all UBAs (Rin = 0, Rgnd = 100k)
1 thermistor pull up resistor installed (standard on UBAs with temperature probes)
2 thermistor pull up with Rin located between Rpu and thermistor (supported but obsolete)
3 for extended temperature range thermistor input (used for 200C thermistor option)
- o **Rpu (config 1, 2, & 3)** pull up resistor resistance
- o **Vpu (config 1, 2, & 3)** pull up resistor voltage
- o **Rpd (config 3 only)** is the pull down resistor
- o **CalFac** is a calibration factor (voltage readings are multiplied by this before being used)

name is used when more than one AnalogInR line would be required. For example, if your UBA came with an accessory port then it would have the standard UBA AnalogInR line (see below). When an accessory is used, for example a thermistor probe or a high current load module then UBA Console will first search for a AnalogInR line with a matching name to that of the accessory.

CalFac is only required for fine tuning the response of an accessory. It should vary no more than a couple percent of 1.00 (i.e. 0.980 to 1.02).

Examples:

Standard UBA without thermistor connector (config 0 - all UBAs come with this):

```
*          chan Rin  Rgnd
AnalogInR: 0    0 100000
AnalogInR: 1    0 100000
```

UBA with thermistor connector installed (config 1):

```
*          chan Rin  Rgnd config Rpu  Vpu
AnalogInR: 0 3010 100000 1   26100 5
AnalogInR: 1 3010 100000 1   26100 5
```

UBA with thermistor connector installed (config 0 and config 1): *this is the preferred format*

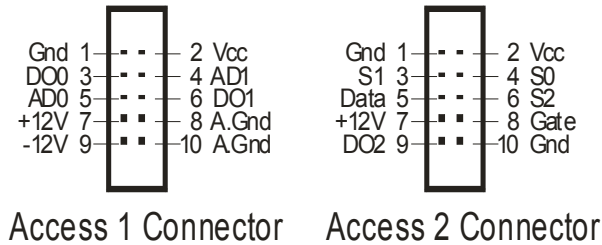
```
*          chan Rin  Rgnd
AnalogInR: 0    0 100000
AnalogInR: 1    0 100000
*
*          name   chan Rin  Rgnd config Rpu  Vpu
AnalogInR: WhiteTherm 0 3010 100000 1   26100 5
AnalogInR: BlueTherm  1 3010 100000 1   26100 5
```

UBA with 200C thermistor connector installed:

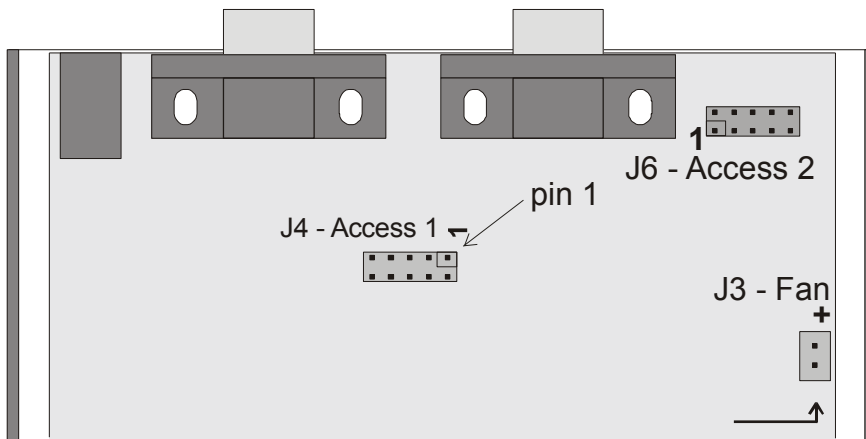
```
*          name   chan Rin  Rgnd config Rpu  Vpu Rpd
AnalogInR: WhiteTherm 0 3010 100000 3   2210 5 2800
AnalogInR: BlueTherm  1 3010 100000 3   2210 5 2800
```

Appendix B - UBA Accessory Port1 & Port2

Accessory Port1 contains power, two digital outputs and two analog inputs. It is located inside the UBA on the PCB. You can connect to this port either by opening your UBA and connecting directly to the Access1 header or by ordering a Vencon accessory port extender that attaches to the back of your UBA. You should avoid connecting directly to the Access 1 connector inside the UBA because it isn't polarized. Also, you have to open the case to access the connector and the wire can interfere with the operation of the fan. In addition to the accessory port extender, we also offer an optoisolated extender that optically isolates the digital outputs.



Note, pin 1 is denoted by an arrow on the back of the UBA or by a “1” on the PCB.



Accessory Port 1 Pinout:

Pin	Name	Description
1	Gnd	Digital Ground
2	Vcc	+5V – connects directly to internal +5V supply. Not current limited.
3	DO0	Digital output “0” (default low, UBA firmware rev 12 and lower: default is high)
4	AI1	Analog input “1”
5	AI0	Analog input “0”
6	DO1	Digital output “1” (default low)
7	+12V	+12V – connects directly to internal +12V supply. Not current limited.
8	A.Gnd	Analog ground.
9	-12V	-12V supply. Very low current, and needs to be enabled inside the UBA.
10	A.Gnd	Analog ground.

Accessory Port 2 Pinout:

Pin	Name	Description
1	Gnd	Digital Ground
2	Vcc	+5V – connects directly to internal +5V supply. Not current limited.
3	S1	not supported
4	S0	not supported
5	Data	not supported
6	S2	not supported
7	+12V	+12V – connects directly to internal +12V supply. Not current limited.
8	Gate	not supported
9	DO2	Digital output “2”
10	Gnd	Digital ground.

Notes:

Grounds:

Both “Digital Ground” and “Analog ground” are connected internally inside the UBA. Use the “Analog ground” for referencing outputs that go to the analog inputs. Keep the current on the “Analog ground” to less than 20mA to limit any ground potential errors inside the UBA.

Power Supplies +5 and +12V:

These outputs are not current limited. The maximum current you can draw depends on the power supply being used. If you are using a 24V power supply, keep the total current below 50mA; for a 15V power supply, keep the total current below 100mA. If you draw too much current, the voltage regulators will overheat and shut down. If you require more current, you can add a heatsink to the voltage regulators (ask us for details).

Power Supply –12V:

The –12V supply isn’t enabled by default. If you require –12V, you have to install a 1k resistor for R84. The current on this line is small, less than 1mA.

Digital outputs:

These are 5V logic family “HC” outputs. They can safely source or sink up to 2mA. Because there is no additional electrical protection beyond what’s provided on the IC on these lines, caution is strongly advised.

Digital Output Default State

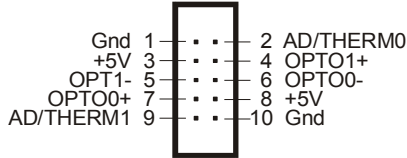
When the UBA is reset (after it’s powered on or when it times out) the digital output lines are set low (UBA firmware revision 12 and earlier: DO0 high, DO1 low). Design your external device so that these states set it OFF, otherwise when the UBA resets your device will turn on. If you add an exclamation mark to the end of “ExtLoadControl”, then when the UBA is initialized by UBA Console your device will be turned OFF.

Analog inputs:

The analog inputs are from 0 to 2.5V (actually 0 to 2.49V) and connect directly to the A/D converter with a 100k 1% load resistor. There is no additional electrical protection beyond what’s provided on the A/D converter IC on these lines, caution is strongly advised. The accessory PCB that can be mounted on the back of the UBA adds some over voltage protection.

Appendix C - UBA Accessory Port1 Optoisolated Output

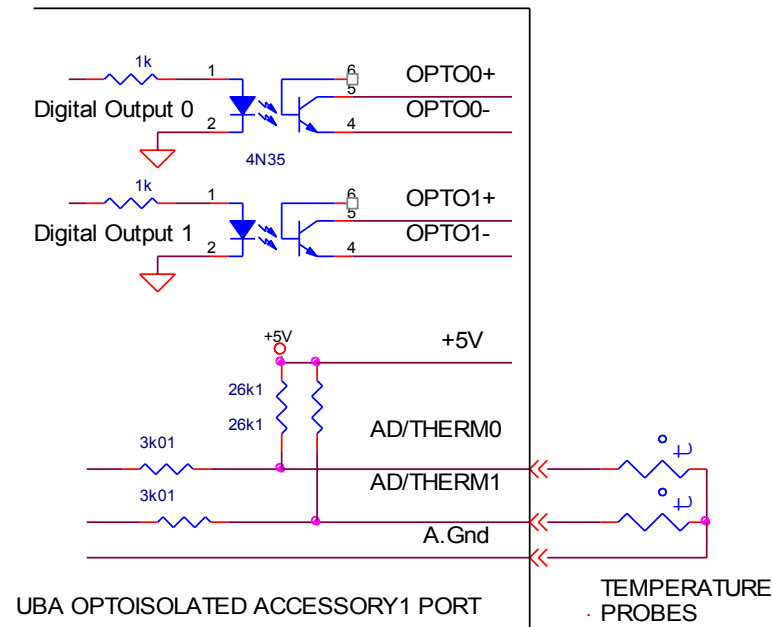
The Accessory Port1 is also accessible with an optoisolated output.



Access1 Optoisolated Connector

Accessory Port 1 Optoisolated Pinout:

Pin	Name	Description
1	A.Gnd	Analog ground.
2	AD/THERM0	Analog input 0 or thermistor input
3	+5V	Connects directly to the +5V internal UBA supply.
4	OPTO1+	+ve isolated output of digital 1
5	OPTO1-	-ve isolated output of digital 1
6	OPTO0-	-ve isolated output of digital 0
7	OPTO0+	+ve isolated output of digital 0
8	+5V	Connects directly to the +5V internal UBA supply.
9	AD/THERM0	Analog input 1 or thermistor input
10	A.Gnd	Analog ground.



Notes:

Analog Grounds:

Analog grounds are connected internally inside the UBA. Keep the current on the “Analog ground” to less than 20mA to limit ground potential errors inside the UBA.

Power Supply:

These 5V outputs are not current limited. Keep the current low so that the current on the analog grounds is less than 20mA.

Optoisolated Output:

There are two optoisolated output: OPTO0 and OPTO1. They can control up to 2mA

They have a maximum forward voltage of 30V and a maximum reverse voltage of 7V.

Note, the outputs of the optoisolator (2N35) connect directly to the output connector with no protection circuitry – don't exceed the forward or reverse voltage otherwise you will damage the isolator.

Digital Output Default State

When the UBA is reset (after it's powered on or when it times out) the digital output lines are set to the off state (for firmware rev12 and earlier: OPTO0 On, OPTI1 Off). Design your external device so that these states set it to OFF; otherwise when the UBA resets your device will turn on. If you add an exclamation mark to the end of "ExtLoadControl", when the UBA is initialized your device will be turned OFF.

Analog inputs:

These inputs have a 26k1 pull up to +5V resistor and then connect to the A/D converter via a 3k01 resistor (see schematic). The voltage range is 0 to 2.5V. There is only a small zener diode for protection on these lines, caution is strongly advised.

Footnotes:

Accessory Port 2

This is a high speed digital output. Only a digital output "2" (pin 9) supported by UBA Console.

Future Upgrades

1. When testing a battery charger, the voltage drop across the sense resistor is added to the battery voltage.
2. When selecting an external load device with an external load control, automatically select the external load control

OLD Models (still supported, but don't use for new design)

ExtLoadDevice Syntax:

ExtLoadDevice: name 1 aichan dochan Rout limit control Rgnd Iin₀ Vout₀ Iin₁ Vout₁ ... (model 1)

ExtLoadDevice: name 2 aichan limit control Iin₀ Vout₀ Iin₁ Vout₁... (model 2)

ExtLoadControl Syntax:

ExtLoadControl!: name 1 dochan_on aichan maxamps (model=1)