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2021Feb Update Re: Release of UBA5 S/W 2.10

This version of S/W has calibration built in. Not only does it check the UBA5's calibration, but it generates a text report and can update the UBA's calibration file.

Note:

At Vencon we have custom software and equipment to do a formal calibration procedure for the UBA4 and UBA5.

You can always send us your UBA4 or UBA5 (henceforth UBA refers to UBA4 & UBA5) for recalibration.

Checking UBA Calibration

Your UBA was calibrated at the factory, using equipment calibrated to NRC and NIST: the calibration is good for two years. After that, you can either return the UBA to us for recalibration or do it yourself. This document describes how to check and recalibrate your UBA. To do so you will need a calibrated voltmeter, ammeter and some batteries or a voltage source and load.

Calibration Specifications

There are no adjustments inside the UBA, it is guaranteed to meet the following specifications at an ambient temperature of 18°C to 25°C. The calibration is fully specified in the UBA calibration file which is in the form SN.cal, where SN is the serial number of the UBA. If your unit no longer meets its specifications you can edit the UBA calibration file to bring it back to spec (described below), or you can return the unit to us for recalibration.

Parameter	Range	Accuracy Specification	
		Percent Full Scale	Absolute Value
Voltage	Low Range (0 to 6V)	+/- 0.5%	+/-35mV
	High Range (6V to 24V)	+/- 0.5%	+/- 130mV
Load Current	(UBA4 0 to 2.5A)	+/- 0.5%	+/-12.5mA
	(UBA5 0 to 3.0A)	+/- 0.5%	+/-15mA
Charge Current (Set)	(0 to 2A)	+2%/-8%	+40/-160mA
Charge Current(measured)	(0 to 2A)	2%	+/- 40mA

Checking Voltage Calibration

Start a Multitester on the channel being checked. Connect a calibrated voltage source of 5 to 6V to the battery input. If you don't have a calibrated voltage source, you can use any voltage source, even a battery, but you will need a calibrated voltmeter to check the voltage. Ensure that the UBA voltage reading (on the screen) is within tolerance. Repeat with a 15V to 24V voltage source for the high range. Ensure that the power supply voltage powering the UBA is at least 1V higher than the battery input voltage.

Checking Load Current

Start a Multitester on the channel being checked. Connect a battery or a power supply from 3 to 5V to the battery input with a calibrated ammeter in series. Request a load current of 100mA. Check that the measured value is within tolerance of the "set to value" (which can be slightly different from the requested value) and the measured value. Repeat for 500mA, 1A and 2.5A (3.0A for the UBA5).

Checking Charge Current

Start a Multitester on the channel being checked. Connect a battery to the battery input terminals with a calibrated ammeter in series. The voltage of the battery is important: if during charge it's higher than 3V below the power supply voltage, you won't be able to fully turn on the charger; if it's more than 8V lower than the power supply voltage, the maximum current will be limited by the UBA power limit. Request a charge current of 500mA. Check that the measured value is within tolerance of the "set to value" (which will probably be different from the requested value). Repeat for 1A and 2A. Note that the charge current is temperature sensitive, wait a few seconds before taking measurements.

Manually Calibrating a UBA4

Your UBA comes calibrated from the factory with all the calibration parameters stored in the calibration file, *SN.cal*, where SN is the serial number of the UBA. It's possible to recalibrate the UBA by changing the parameters in the UBA calibration file. It has to be done manually: in the future, software will be able to assist you.

The resultant calibration will only be as good as the accuracy of the equipment you use.

Manually Calibrating Battery Voltage

In the SN.cal file you will see a channel 1 calibration section (identified by “[ChanCal 0]”). You will find lines similar to these:

```
[ChanCal 0]
BatteryV: 0 0 0 5 1.8
BatteryV: 1 0 0.0011926 20 1.9221
```

The BatteryV line specifies the calibration and is in the following format:

```
BatteryV: range VBAT1 VADC1 VBAT2 VADC2
```

Where **range** is the voltage range: 0 for the low range, 1 for the high range and “**V_{BATi} V_{ADCi}**” is a calibration point where **V_{BATi}** is the voltage at the input of the UBA and **V_{ADCi}** is the voltage that is read by the analog to digital converter (ADC) inside the UBA4. The **BatteryV** line requires at least one “**V_{BATi} V_{ADCi}**” calibration point (the other calibration point is assumed to be “0 0”). In the above example, the low voltage range a battery voltage of 0V, gives an ADC reading of 0V and a battery voltage of 5V gives an ADC voltage reading of 1.8V.

The calibration for Channel 2 is stored in the [ChanCal 1] section.

Calibrating the First Battery Voltage Point

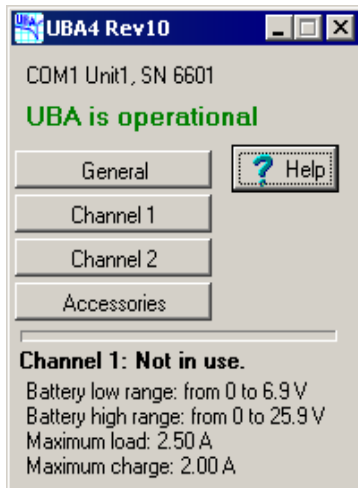
You can calibrate the first calibration point (“**V_{BAT1} V_{ADC1}**”) or set it to “0 0” (either explicitly or by leaving it blank). We recommend that you leave it as originally calibrated, or set it to “0 0”. If you prefer to calibrate it yourself then set it to “0 0”, save the calibration file, and initialize the UBA. Connect a low-voltage source V_{DVM} of about 50mV to 150mV to the battery input and take a reading with the UBA Console S/W (use the Multitester window and call the reading V_{UBA}). You calculate the calibration point from these equations:

$$V_{BAT1} = V_{DVM}$$
$$V_{ADC1} = V_{UBA} \times V_{ADC2} / V_{BAT2}$$

Enter these new values for V_{BAT1} and V_{ADC1} into the calibration file.

Calibrating the Full-Scale Battery Voltage (Second Point)

With the current version of software there no way to set nor know what battery voltage range the UBA is using when measuring a voltage, but you can get the range voltages by clicking on the UBA icon in the Network window, then Channel 1 or 2 and you'll get something such as the following:



If the battery voltage is less than 80% of the low-range full scale voltage, the UBA will be on the low range. Conversely, if the battery voltage is greater than the low-range full-scale voltage, the UBA will be in the high scale.

For calibrating the low range, connect a voltage source close to, but less than, 80% of the low-range full-scale voltage to the battery input and for calibrating the high range connect a voltage source with a voltage of greater than the low-range full-scale. Open a Multitester on the UBA and record the displayed battery voltage reading as V_{UBA} . Measure the actual battery voltage with an accurate and calibrated digital voltmeter. Record the reading as V_{DVM} . The ratio V_{UBA}/V_{DVM} is the accuracy ratio of the UBA. If it's less than 1.0, the UBA is reading low, greater than 1.0 and the UBA is reading high. Use these formulas to get a new voltage pair:

$$V_{BAT1new} = V_{BAT1} \text{ (no change)}$$

$$V_{ADC1new} = V_{UBA} / V_{DVM} \times V_{ADC1}$$

Now enter these new readings into the calibration file, save it and reinitialize the UBA. Ensure that the UBA voltage readings are within spec. If they aren't, repeat the above calibration or contact us.

For increased accuracy, you can specify more than two points for battery calibration. Under normal circumstances this is unnecessary because the circuitry and ADC are linear.

Calibrating Charger Current

The charger calibration parameters are stored in the calibration section (“[ChanCal 0]” for channel 1 and [ChanCal 1]” for channel 2) in the following format:

Charge: DAC_{MIN} DAC_{MAX} DAC₁ I₁ DAC₂ I₂ ... DAC_N I_N

For example, in your calibration file you'll see a line such as (numbers will vary):

Charge: 0 255 0 1.857e-09 5 1.857e-09 ... 100 1.265 ... 255 1.602

Ellipses (...) represent removed DAC-Value pairs.

The first two numbers, the DAC settings “0 255”, mean that the charge current can be set from 0 to 255 on the DAC (digital to analog converter). Don't change it.

The remainder numbers are calibration point pairs in the form of DAC value and a charge current (in Amps). In this example, the calibration pair of “0 1.857e-09” means that for a DAC setting of 0 the charge current is 1.857 picoamps. This really should be 0 amps, but the picoamps value is an artifact of the automatic calibration process used at the factory. The last calibration point “255 1.602” means that at a DAC value of 255 the charge current is 1.602A.

You can change the calibration by changing the calibration points. For example, if you measured 1.20A for the charge current at a DAC value of 100 you would add "100 1.2" to the calibration points. You can add or remove DAC-Value pairs as much as you want, provided that:

1. The first pair has a DAC value of 0
2. The last pair has a DAC value of 255
3. The DAC values are monotonic (i.e., a calibration pair with a DAC value of 101 would come after a calibration pair with a DAC value of 100)
4. The current values are monotonic (i.e., a calibration pair with a current of 1.00A comes after a calibration pair with a current less than 1.00A)

If the above conditions are met, the UBA software will interpolate between DAC-Value pairs to find the optimum DAC value for a requested current.

Note: before modifying your calibration file make sure you have a backup copy.

Getting the Charge DAC-Value pairs

Set your UBA with an ammeter between the UBA and a battery. Start a Multitester on the channel being calibrated. Initially, the charge current will be zero. The ammeter might show a couple of milliamps of current. This is called the quiescent current and is a result of current flowing from the battery into the UBA input voltage attenuator. Record this current. Subtract it from all subsequent current readings to get the actual charge current.

Now request a charge current (for example 50mA). Measure the actual charge current. Wait for the current to stabilize because there will be some temperature drift. Place your mouse cursor over the "Charger set to" text and you will get a hint such as "DAC=20", which shows the DAC value the charger is set to. Record this value and the measured current (remember to subtract the quiescent current) as a DAC-Value pair. Put this DAC-Value pair in the calibration file. Repeat this for as many DAC-Value pairs as you want. The more pairs, the greater the accuracy (because of the non-linearity of the DAC-charge current relationship). If you are especially concerned about accuracy at a certain current, take many readings around that area.

Calibrating Load Current

The load calibration parameters are stored in the calibration section (“[ChanCal 0]” for channel 1 and “[ChanCal 1]” for channel 2) in the following format:

Load: DAC_{MIN} DAC_{MAX} DAC_1 I_1 DAC_2 I_2 ... DAC_N I_N

For example, in your calibration file you'll see a line such as (numbers vary):

Load: 0 255 10 0.0473 110 1.063 255 2.53

The first two numbers are the DAC limits, i.e. “0 255” means that the load current can be set from 0 to 255 on the DAC (digital to analog converter). Don't change them.

The first calibration point is in the form of DAC value and charge current (in Amps). In this example, the calibration pair of “10 0.0473” means that, for a DAC setting of 10, the load current is 47.3 milliamps. The last calibration point “255 2.53” means that at a DAC value of 255, the charge current is 2.53A.

You can change the calibration by changing the calibration points. For example, if you measured 1.20A for the load current at a DAC value of 60 you would add "60 1.2" to the calibration points. You can add or remove DAC-Value pairs as you wish provided that:

1. The first pair has a DAC value of 0
2. The last pair has a DAC value of 255
3. The DAC values are monotonic (i.e., a calibration pair with a DAC value of 101 comes after a calibration pair with a DAC value of 100)
4. The current values are monotonic.

If the above conditions are met, the UBA software will interpolate between DAC-Value pairs to find the optimum DAC value for a requested current.

Note: before modifying your calibration file, make sure you have a back-up copy.

Getting the DAC-Value pairs

Set your UBA up with an ammeter between the UBA and a battery. Start a Multitester Instrument on the channel being calibrated. Initially, the load current will be zero. The ammeter might show a couple of milliamps of current; this is called the quiescent current and is a result of current flowing into the UBA input voltage attenuator. Record this current. Subtract the number from all subsequent current readings to get the actual load current.

Now request a load current (for example 50mA). Measure the actual load current. Place your mouse cursor over the "Load set to" text and you will get a hint like "DAC=10". Record this DAC value and the measured current (remember to subtract the quiescent current) as a DAC-Value pair. This is the DAC-Value pair you will put in the calibration file. Repeat this for as many DAC-Value pairs as you want, but, because the load current to DAC value is linear, you don't require more than three calibration pairs.

The Rest Of the Calibration File

There are other parameters in the calibration file that can be calibrated, but because they affect battery analysis results less we will deal with them later.