

**Oregon
Research
Electronics**



Product Manual Addendum

Acceleration Logger - Model AL100-ADC



31677 N. Lake Creek Drive, Tangent, OR 97389 USA
+1-541-928-7869 ORElectronics@comcast.net

Copyright 2018, Oregon Research Electronics

June 8, 2018

Special Notices

TRADEMARKS: In the following, "ORE" and the "ORE Graphic" (in any size and color) are trademarks of Oregon Research Electronics. Various other business names are the property of their respective copyright or trademark holders.

CONTACT: ORE can be reached at: ORElectronics@comcast.net or at engineering@orelectronics.net

Certifications: This product is RoHS (EU's Reduction of Hazardous Substances) compliant. It is built to CE and FCC electromagnetic compatibility standards.

GENERAL WARRANTY: The AL100-ADC is NOT warranted for use in any life-support application nor any application where malfunction could be reasonably expected to cause injury or damage. Specifically, ORE shall not be liable for any of the following:

- Damage to any equipment attached to the AL100-ADC.
- Consequences of decisions based on data gathered using the AL100-ADC.
- Injury incurred configuring, downloading data, or installing the AL100-ADC.
- Operation of any AL100-DC under conditions that exceed the Absolute Maximum Ratings stated in the device specifications.
- Operation with non-standard batteries, reversed batteries or leaking batteries.
- Use of the enclosure exposed to petro-chemicals.
- Damage caused by over-tightening or under-tightening the enclosure lid.

Oregon Research Electronics supplies the AL100-ADC "AS IS", without any warranties, with all faults, at the buyer's and further users' sole risk. The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies Oregon Research Electronics from all claims arising from the handling or use of the goods.

Oregon Research Electronics will replace any AL100-ADC that the user deems unacceptable in performance, provided that it is returned in resalable condition. Oregon Research Electronics will replace the unit or refund the purchase cost at ORE's discretion. Shipping costs may be refunded at ORE's discretion.

Oregon Research Electronics will replace any unit that is defective in manufacture, at no additional cost to the customer.

If these conditions are unacceptable, return the unit in new condition to ORE for a refund.

TABLE OF CONTENTS

PART 1: INTRODUCTION.....	5
PART 2: TERMINAL LOGIN MESSAGE	6
PART 3: THE MENU.....	7
PART 4: THE FILE HEADER	7
PART 5: THE FILE FORMAT	8

PART 1: INTRODUCTION

The "ADC" feature was added to the AL100 to assist in getting the longest operating life from batteries.

The changes have been quite small. Two wires and one part have been added to the circuit board. There are no other physical changes. There have been a few code changes to implement the battery reading. The result is a slight change in the terminal login message, the format of file headers and timestamps and a slight change to the menu.

In all other matters, refer to the AL100 Manual for details.

PART 2: TERMINAL LOGIN MESSAGE

The terminal login message changes, as shown below.

```
*****  
*                                     *  
*           AL100 A-Logger           *  
*           Version: 2.0-ADC         *  
* Oregon Research Electronics        *  
* ORElectronics@comcast.net        *  
*                                     *  
*****  
OK  
>
```

Only the "Version" line changes to add the text "-ADC".

PART 3: THE MENU

One new line appears as follows:

```
J r : Batt volt = 484
```

This is read-only and gives the present reading of the battery by the power monitoring system. The numeric value is somewhat arbitrary and is explained more fully in comments about file format.

PART 4: THE FILE HEADER

The file header is designed, in part, to allow unambiguous recognition of file format by analysis software. There are changes in the first two lines.

```
AL100 Acceleration Logger+ADC  
Version: 2.0  
Sample Rate: 100Hz/10  
Full Scale: +/- 2g  
Factory S/N: 0  
User S/N:  
Label:  
Date/Time: 2000-01-01 00:02:04  
Time stamp: 5 sec with temperature
```

The characters "+ADC" are added to the first line and the version number changes to "2.0" in the second.

Programmers are advised that model number (such as "AL100") and presence of "+ADC" will always be in the first line and "Version", in the style shown, in the second line.

PART 5: THE FILE FORMAT

A new record type is added to the data file. It is a "V" record and occurs about once every 20 seconds

The record appears as

```
V,489,345
```

A complete block of data now might appear as follows

```
AL100 Acceleration Logger+ADC
Version: 2.0
Sample Rate: 100Hz/10
Full Scale: +/- 2g
Factory S/N: 0
User S/N:
Label:
Date/Time: 2000-01-01 00:02:04
Time stamp: 5 sec with temperature
```

```
###, X, Y, Z
1,-49606,-2645,125282
2,-49592,-2348,125600
T,1,22
3,-50023,-2706,125259
4,-50072,-2464,125204
5,-49921,-2364,125868
6,-49289,-2968,127460
7,-48561,-3337,124338
8,-48384,-4085,126704
9,-47079,-2952,124994
10,-48494,-4877,124932
11,-49516,-2984,127374
12,-47779,-3155,125886
13,-48469,-3278,126708
V,489,345
```

The elements of this new V record are as follows:

- Record identifier "V"
- Battery voltage as noted below
- Reference voltage as noted below

The record is a standard CSV format and is terminated, like all records, with a single carriage return.

PART 5A: Battery Voltage

Most of the time, the battery voltage is expressed as a fraction of the internal power supply voltage which is close to 3.3V. The relationship is

$$V_{\text{battery}} = (N_{\text{battery}}/1023) * 3.3V$$

where N_{battery} is the number for battery voltage in the V record.

In the example above, with $N_{\text{battery}} = 489$, we have

$$V_{\text{battery}} = (489/1023) * 3.3V$$

$$V_{\text{battery}} = 0.478 * 3.3V$$

$$V_{\text{battery}} = 1.57V$$

When the battery discharges to some voltage around 1.1V this relationship starts to fail. The failure happens because the power supply can no longer maintain a 3.3V output with such a low input voltage. When this happens, the reference voltage will appear to RISE. This is described in the next section.

PART 5B: Reference Voltage

The microcontroller includes a voltage reference. It is quite stable over time, temperature, and supply voltage. But, its absolute accuracy is quite poor.

When power is provided by a relatively new battery, the reference voltage is given by

$$V_{\text{reference}} = (N_{\text{reference}}/1023) * 3.3V$$

where $N_{\text{reference}}$ is the number for reference voltage in the V record.

In the example above, with $N_{\text{reference}} = 345$, we have

$$V_{\text{reference}} = (345/1023) * 3.3V$$

$$V_{\text{reference}} = 0.337 * 3.3V$$

$$V_{\text{reference}} = 1.11V$$

Compared to the specified reference voltage of 1.10V +/-10%, this particular chip is quite good. The value should be consistent with a power supply voltage down to 1.8V.

PART 5C: Declining Battery Voltage

As the batteries discharge, a sequence of "stages" is passed through.

1. New Battery - when the batteries are above 1.1V or so, the power supply can maintain its full 3.3V output. Since the power supply is the reference for these measurements, the N_{battery} value will drop steadily and the $N_{\text{reference}}$ value will hold steady.

2. Well Discharged Battery - when the battery drops to a voltage where the power supply voltage can no longer be maintained, the power supply voltage will begin to decrease. Since the measurement reference is now decreasing, the $N_{reference}$ value will begin to increase. In this stage, $N_{battery}$ will probably hold fairly steady. In this stage, the absolute values of acceleration measurements may become questionable though periodic motion should continue to be reliable.
3. Dead Battery - eventually, the battery will discharge to the point where the power supply will not operate at all. This will probably occur while the power supply output is still more than the minimum microcontroller operating voltage of 1.8V. If this is the case, the the apparent $N_{reference}$ will continue to increase right up to the point where everything ceases operation.

You can determine what the boundaries between these various stage are using the following procedure.

1. With new batteries, note $N_{reference}$ and determine the actual reference voltage, $V_{reference}$. Also note $N_{battery}$ and $V_{battery}$.
2. At the point where $N_{reference}$ starts to increase, note $N_{battery}$, and determine the battery voltage and the elapsed time from the beginning of operation. This is the duration of reliable operation under the chosen operating conditions.
3. Note the elapsed time from the beginning of measurements at the last recorded sample. This is the duration of reliable, then uncertain operation.

In the future, it is then possible to estimate the available remaining battery life by opening the lid and measuring a battery with a voltmeter. The larger the reading is, compared to the value determined in Step 2, the greater the remaining life. It should be noted that the rate of battery voltage decrease increases as the batteries become more and more discharged.