



Handheld ECM Unit, Version 3

Designed, manufactured and programmed by:

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1 INTRODUCTION

The handheld ECM unit provides the user with a lightweight instrument for measuring the electrical conductivity of ice cores.

This manual covers both revision 2 (r2) ECMs (those having serial numbers beginning with ECM2), and revision 3 (r3) ECMs (those having serial numbers beginning with ECM3).

Features include:

- Automatic power down after 2 minutes inactivity.
- Non-volatile data storage depends on the ECM revision (denoted by r2 or r3):
 - r2: approximately 100 minutes of data storage (corresponds to 140m of ice core at 2cm/sec).
 - r3: approximately 18 hours of data storage (corresponds to 1300m of ice core at 2cm/sec).
- An optical encoder option is available which records position information at the same time as data acquisition - this option reduces data storage capacity by a factor of two. For r2 ECMs, the maximum length data record that can be stored by the encoder option is 14.5m with a resolution of 0.22mm (r2) or 0.015 – 0.056mm (r3). R3 ECMs have no practical limit to the length of a single core (the limit is over 30km).
- Protection of the high-voltage supply by limiting survey time to 200 seconds (r3 ECMs only).
- Each data set is identified by a core identifier which also serves as the file name of the retrieved data file. For r2 ECMs, the identifier can be up to 8 character. For r3 ECMs the identifier can be up to 10 characters. When characters are entered on the keypad, they are limited to uppercase non-accented roman characters, numbers, and some special characters (see table below). When using the supplied PC software, lowercase letter may also be used. At this time, the ECM does not support Unicode characters.
- Electrode voltage can be adjusted, but default setting is 1000 VDC.
- Charges from any 9-12 VAC or VDC power supply.
- Serial interface for connection to IBM-PC computer. Note that a serial-USB converter will be necessary for modern computers. The ECM does not use a direct USB connection because of concerns with interference from the high-voltage supply.
- Power supply is a 6V sealed lead-acid battery with excellent cold-weather performance. This battery is completely safe and certified for transport by aircraft (see certification at the end of this document).
- The maximum ECM current that can be measured by this unit is:
 - r2 ECM: 50 μ A.
 - r3 ECM: 100 μ A (analogue meter limited to 50 μ A)
- The sampling rate for the ECM is as follows:
 - r2: approximately 5Hz
 - r3: 6.25Hz

2 OPERATING INSTRUCTION

2.1 Charging the unit:

The ECM unit contains a 6V Sealed lead-acid battery. Whenever the unit is not in use (including during storage), it is recommended that the battery be connected to a 9-12 VAC or VDC power supply. This will ensure that the battery remains fully charged (float condition).

A universal 155/230VAC 50/60Hz charger is provided with plugs for North America, Europe, UK, and Australia. At the ECM unit, the connector is a 2.5mm circular plug. When using a DC charging supply, remember that the polarity is not important.

Charge indication is different for different modems. For r2 ECMs, a green LED will illuminate below the LCD screen when charging is complete. For r3 ECMs, the reverse is true – the green LED will extinguish when charging is complete.

2.2 Turning the unit on:

The ECM unit is turned on with the main power switch. This switch connects and/or disconnects the battery from the ECM electronics, but not from the charging circuit - the battery charger circuit is always connected to the battery through a resettable thermal fuse.

If the unit has turned itself off, it can be turned on again by toggling the switch to the OFF position and then back to ON.

The battery is protected with thermal fuse. When the unit is turned on, the LCD display will show the unit serial number, battery voltage and temperature followed by the command prompt.

Except when performing data acquisition, the unit will enter standby mode after an inactive period of two minutes.

2.3 Entering commands

Commands to the ECM unit can be entered through the keypad and/or the serial port. From an operational standpoint, the two sources are equivalent and interchangeable (the one exception to this rule concerns early termination of the D command).

2.4 The keyboard

Whenever a key is pressed on the keyboard, the unit produces a high-pitched "beep" to acknowledge the key press.



To enter the characters 0-9, * and #, the key is pressed once (which produces the above-mentioned "beep") and then released. If a key is pushed two or more times in quick succession, the alphabetical characters associated with that key are entered. The keys 2-9 have their letters printed on them (as on a North American telephone keypad). Additional characters are associated with the 1 and 0 keys (punctuation and other letters, respectively) as per the following table:

Key	1 push	2 pushes	3 pushes	4 pushes
1	1	!	-	_ (underscore)
2	2	A	B	C
3	3	D	E	F
4	4	G	H	I
5	5	J	K	L
6	6	M	N	O
7	7	P	R	S
8	8	T	U	V
9	9	W	X	Y
0	0	_ (underscore)	Q	Z
*	*	*	*	*
#	#	#	#	#

2.5 Serial port

The serial port communicates at 19200 baud, no parity, 8 data bits, one stop bit. There is no flow control (hardware or software). To connect to a computer, use a straight-through 9-pin cable (male at one end, female at the other), or a USB-serial converter. A USB interface is not used in order to avoid interference issues with the high-voltage supply. The pinout of the 9-pin connector is as follows:

Pin	Function
5	Ground
2	Transmit
3	Receive



2.6 Basic Commands

There are a number of basic commands that can be entered through the keyboard or serial port. These commands perform the following operations:

- display clock
- set clock
- set line frequency rejection mode (r2 only)
- configure encoder (r3 only)
- clear data storage memory
- retrieve data

- collect ECM data

Under normal circumstances, these commands are issued by the ECM PC software over the serial port link. The ECM PC software makes the use of these commands transparent to the user.

NOTE: Most commands can be aborted by entering a '#' or '!'

Command	Revision	Function
* (asterix)	r2, r3	Enter survey command mode
4	r2, r3	Dump entire contents of FLASH memory to serial port (for debugging only)
A	r2, r3	Print battery voltage and temperature to serial port
C	r2, r3	Print clock to serial port once per second
D	r2, r3	Dump raw data to serial port
E	r3	Configure encoder parameters
F	r2, r3	Dump formatted data in engineering units to serial port (this is normally used to retrieve data)
H	r3	Show power-on greeting
P	r2, r3	Turn instrument off
R	r2, r3	Reset ECM unit (power on takes about 4 seconds)
S	r2, r3	Set time using serial port
CTRL-C	r2, r3	Clear memory

2.7 Special Commands

After entering survey command mode (Basic command *) a new set of commands are available.

Command	Revision	Function
* (asterix)	r2, r3	Return to basic command mode
1	r2	Turn on high voltage (<i>we strongly suggest you never use this command as there is no warning that the high voltage is energized as there is during an ECM survey</i>) WARNING: The electrode voltage is potentially lethal – take extreme caution.
2	r2, r3	Turn off high voltage
4	r2, r3	Set time using keyboard
6	r2, r3	Collect ECM data
C	r2, r3	Clear ECM memory



3 ECM setup

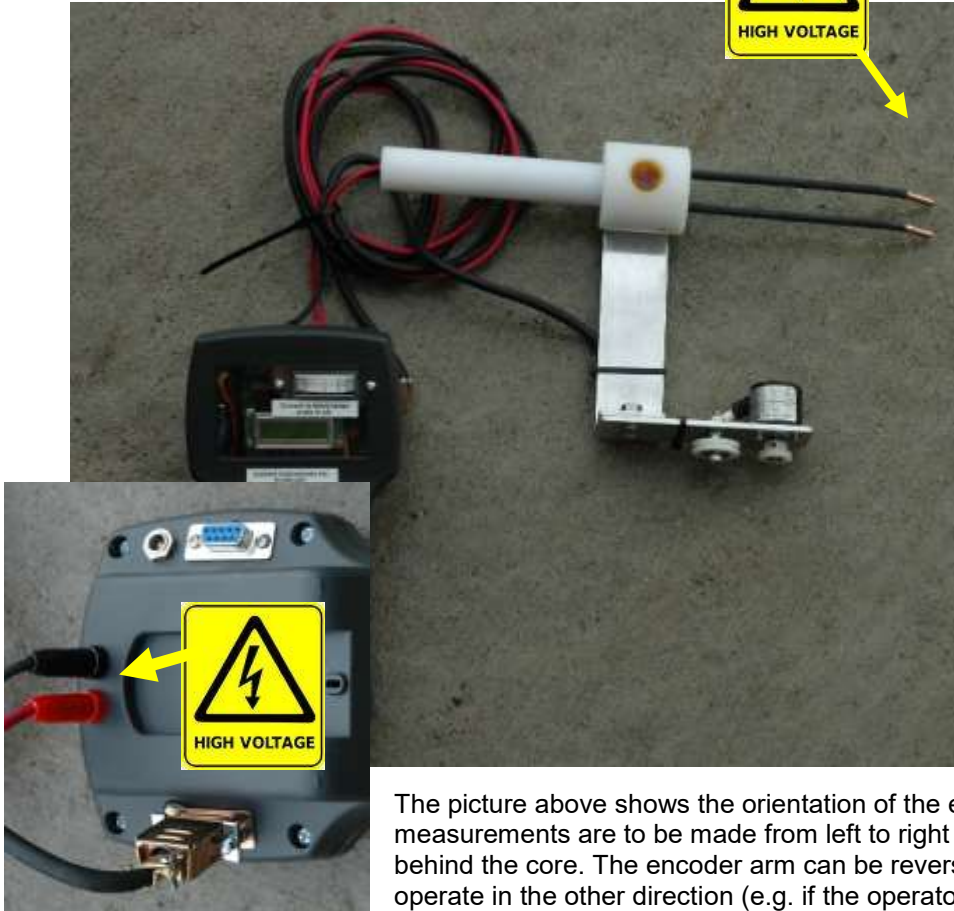
The ECM unit consists of a base unit connected by two rubber high-voltage wires to a handheld electrode assembly. If you have the encoder option, there is an arm attached to the electrode with an encoder.

The encoder plugs into the male 9-pin connector at the back of the ECM unit, and the electrode plugs into the red and black banana plugs. The voltage supplied by the ECM unit is



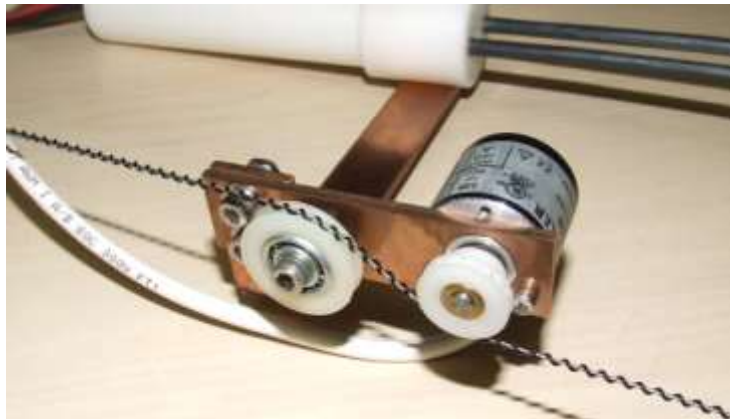
approximately 1000VDC (red = positive, black = negative).

If you have the encoder option, the special wire supplied with the ECM unit should be stretched alongside, and behind, the ice core. Crimp eye terminations are supplied and can be attached to the cable once it is cut to length for your setup. You can use a rubber band or small extension spring to maintain tension. The wire should be threaded over the encoder pulley as shown below.



The picture above shows the orientation of the encoder unit if the measurements are to be made from left to right on the core, with the wire behind the core. The encoder arm can be reversed if you want to operate in the other direction (e.g. if the operator is left-handed).

3.1 Encoder configuration (r3 only)



The r2 ECM counts “forward” pulses regardless of the direction of rotation of the encoder. The r3 ECM is sensitive to the direction of rotation of the encoder. If you find that your installation produces negative position readings, you have two choices:

1. use the basic command “E” via the serial port, to change the encoder polarity, or
2. thread the Syncromesh® cable through the encoder and idle pulleys such that the cable is on the other side of the encoder (and the encoder therefore turns in the opposite direction).

To change the encoder configuration (which is stored in non-volatile memory), connect the ECM to a computer using a terminal emulator (we recommend the open-source program called TeraTerm). This configuration cannot be made through the ECM PC software. Issue the command "E" and confirm. You will now be asked three questions:

- "Enter encoder ppr: " enter the number of pulses-per-revolution for your encoder. This value will depend on the encoder installed in the ECM. Hengstler encoders will have a part number RI32-O/nnnAR, where nnn is the number of pulses-per-revolution. Note that the r3 ECM is able to resolve 4 times this value.
- "Enter encoder polarity (0 or 1): " represents the direction of rotation. R3 ECMs are delivered from the factory with a polarity value of 0.
- "Enter wheel circumference in um: " represents the circumference of the Synchromesh® drive wheel attached to the encoder. For the factory-installed wheel, the value is 57150µm (57.15mm).

After entering these values, the stored values will be echoed back to you. Note that the ECM will automatically multiply the pulses-per-revolution value by 4.

4 Running an ECM survey

The Special command “6” runs an ECM survey. You will be prompted for the name of the core. The name may be up to 8 characters long (10 on a r3 ECM). If you enter a duplicate name (i.e. one for which a survey in the ECM unit already exists, or one that already has a data file on your computer), do not worry – the download program will save all data and will never overwrite data. However, you will get multiple data files with similar file names referring to the core (see section on file names).

1. If you want to abort the survey, press *.
2. If the survey name is not 8 or 10 characters long, press # to finish entering the name and continue with the survey.
3. The ECM will ask you to press the 1 or 3 key to start the survey. R3 ECMs will also permit the use of the red button on the wand (see section 4.1). After you press this key (or press the red button), the high voltage will turn on. There will also be a warning tone and a red LED lamp to indicate that high voltage is present on the electrodes.
4. Data will be collected when ANY button on the keypad is pressed, or the red button is held down. The encoder position will be initialized to zero and the red LED will begin to flash.
 - R3 ECMs will shut off the high voltage automatically after 10 seconds if you do not proceed with this step (i.e. the survey will be aborted).
5. As soon as the key is released, the high voltage will turn off and the survey is finished. Voltages on the electrodes drop to safe levels within a few seconds.
6. R3 ECMs will display the position and speed of the electrodes, and well as the elapsed time for the survey.



4.1 R3 wand

New r3 ECMs are supplied with an updated wand that includes a large red button (which can be used to initiate and sustain a survey – see section 4). The r3 wand also includes a smaller black button which can be used to reset the encoder to zero. Note that the encoder is always zeroed when a survey is started, so this black reset button does not normally need to be used.



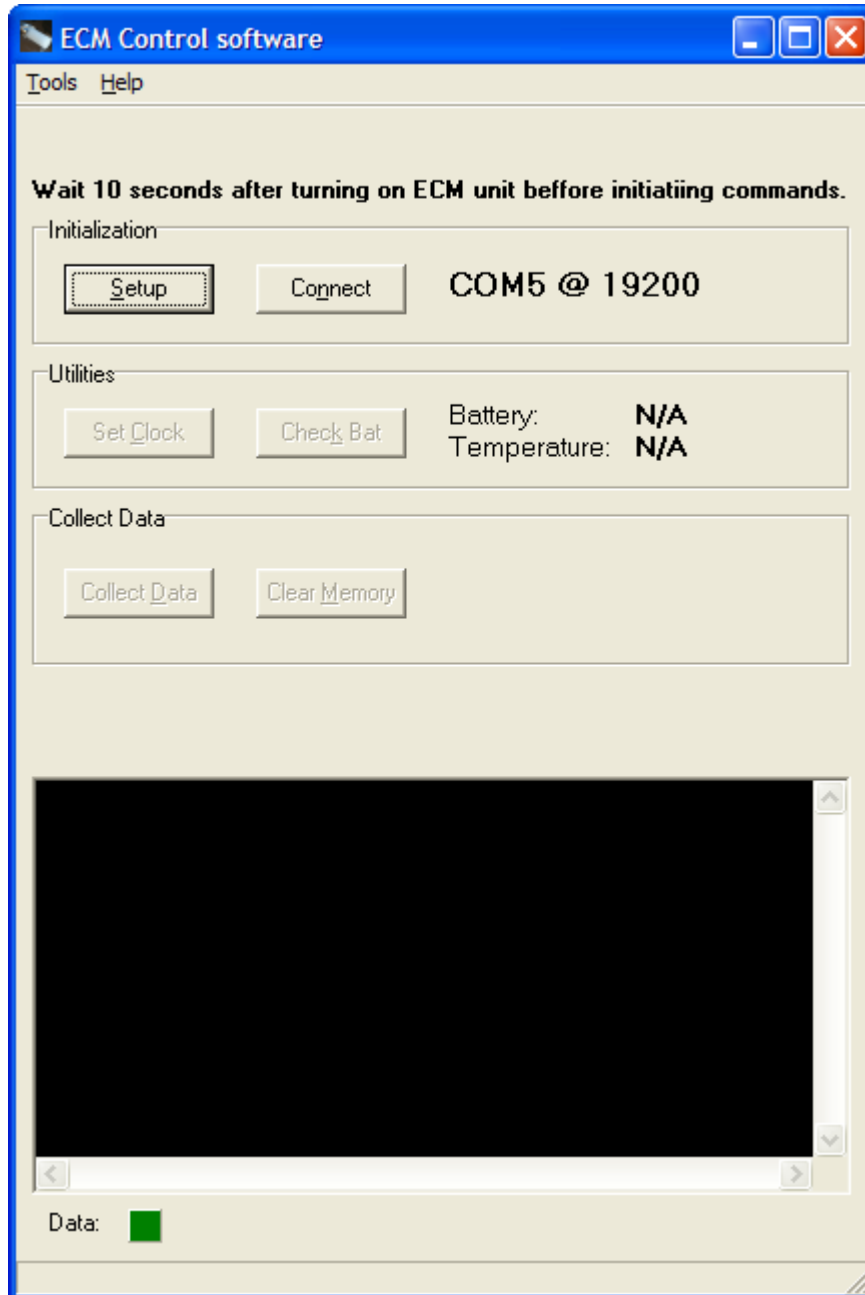
4.2 R3 wand wiring

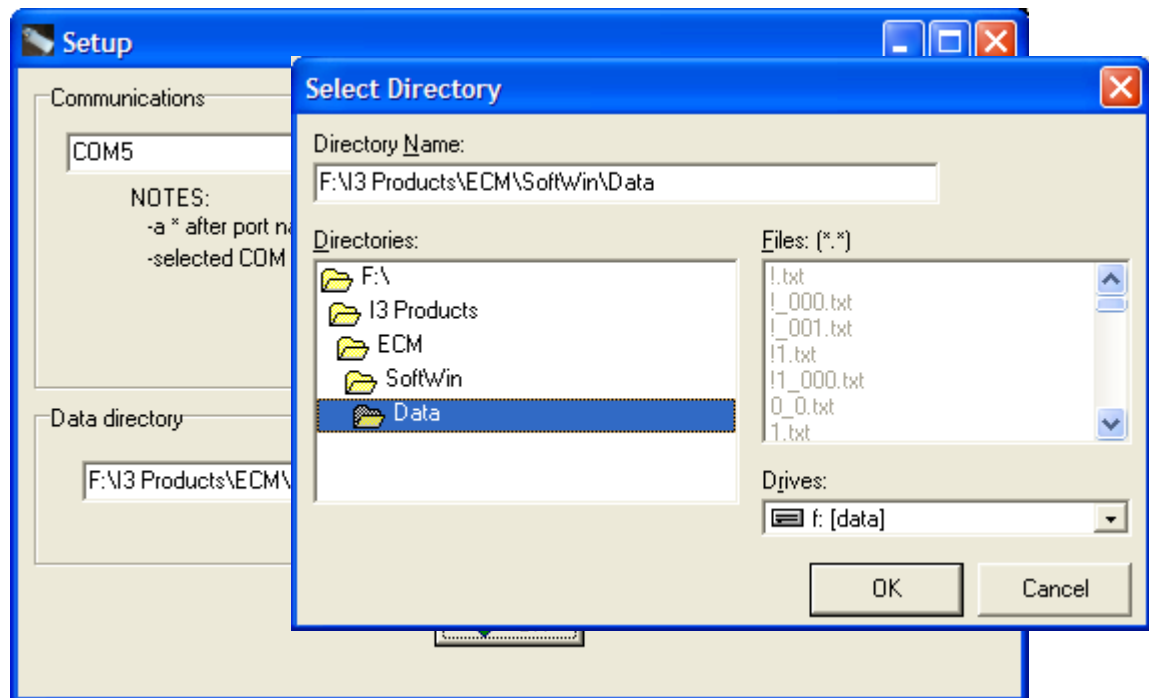
The wiring for the r3 ECM wand is as follows:

Pin	Function
3	Encoder phase B
4	Encoder phase A
5	Ground
6	Normally-open high voltage button, grounded when pressed.
7	+5VDC encoder supply voltage
8	Normally-open encoder zero button, grounded when pressed.
9	Wand LED (no series resistor)

5 The r2 ECM program

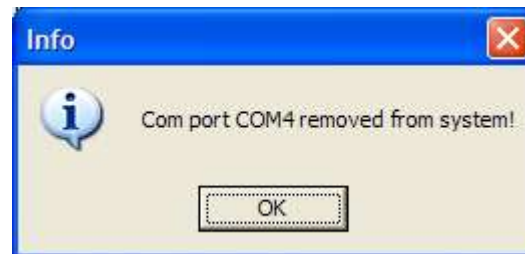
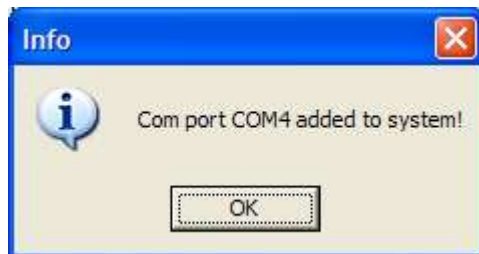
The ECM program is used to download data from the ECM unit. It can also be used to set the clock on the ECM unit and to clear its memory.





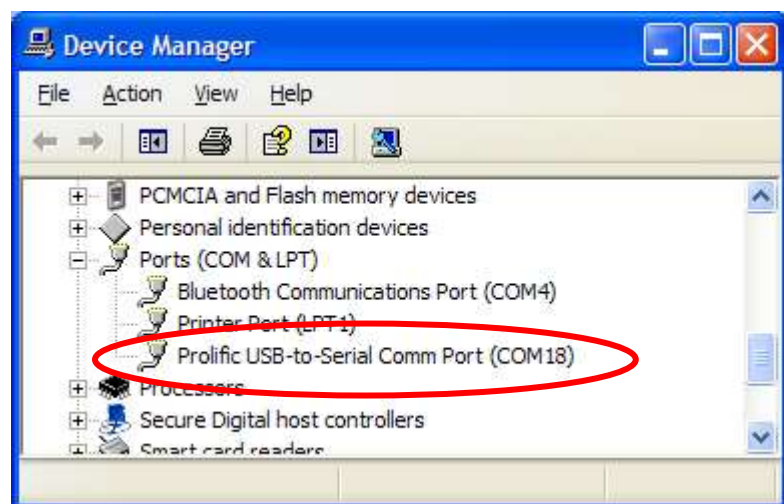
5.1 Setup

The Setup button allows you to change the serial COM port that you are using with the ECM. If you are using a removable USB-serial adapter, the program will give you messages when serial ports are added to or removed from the computer (see below).



You can also use the “Device Manager” to start the computer’s device manager. This will show all the serial ports available on the computer. The USB-serial converter supplied with the ECM shows as “Prolific USB-to-Serial Comm Port” (in this case COM18).

The “Select Directory” button lets you select the directory where you want data to be stored on your computer when it is downloaded



from the ECM unit. The default directory is the program installation directory.

If you enter the name of a new directory in the text window, the directory will be created.

5.2 Operation

Once you have the serial port and data directory selected, you can press the “Connect” button to establish a connection to the ECM unit. The other buttons will then become available.

5.2.1 Set clock

This function, as you might expect, sets the clock on the ECM unit to the clock on the computer.

5.2.2 Check battery

This button will read the battery voltage and temperature off the ECM unit and display them on the screen.

5.2.3 Collect Data

This function collects all the data from the ECM unit and places it into text files on your computer in the data directory you selected. The files are named XXXXXXXX_NNN.txt. XXXXXXXX is the name of the ice core that you entered. NNN is a number from 0-999 which is present if more than one copy of the downloaded data is present, or if there are more than one measurements on the same core. For example, if you have a survey called “ICE09_34” and download data three times without clearing memory, you will get three identical files called ICE09_34.TXT, ICE09_34_000.TXT, ICE09_34_001.TXT. Similarly, if you have several ECM surveys of the same code, and enter the same core name, you will get similarly-named files.

The contents of each text file is as follows:

```
Name.....: T
ECM Serial.....: ECM2-100 (1.3)
Date.....: 09/11/27 13:46:24
Battery (V).....: 6.1 (634)
Temperature (C)..: 22.1 (327)
Output (V).....: 1117.1 (3744813)
0.000, -0.3, 0, 8328437, 0
0.000, 31.4, 0, 13662650, 0
0.000, 46.5, 0, 16178137, 0
0.000, 46.5, 0, 16178432, 0
0.000, -0.3, 0, 8328492, 0
0.036, -0.3, 0, 8328521, 162
0.047, -0.3, 0, 8328216, 213
0.116, -0.3, 0, 8328288, 523
0.117, -0.3, 0, 8328348, 528
```

The heading information is clear (numbers in brackets indicate raw digitizer values). The columns of data represent:

Column	Meaning
1	Position in m
2	Current in micro-Amps
3	Error flag (should be zero)
4	Raw current digitizer value

5	Raw position digitizer value
---	------------------------------

To convert the raw integer format to a current flow in μA , subtract 8388608 (2^{23}) and multiply by 5.972×10^{-6} (the reference voltage for the A/D converter is 2.50 VDC, and the current sense resistor is 49.9k Ω , hence $(2.5 / 8388608) / 49900 \times 10^{+6} \mu\text{A}$ per count).

For the encoder, multiply the raw encoder count by 0.000223242 (or more precisely .05715 m $\text{rev}^{-1} / 256 \text{ pulses rev}^{-1}$) to get metres of travel.

5.2.4 Clear Memory

This function will, after you respond to two warning messages, clear the memory of the ECM unit. To clear the memory, you must answer YES to the first question and NO to the second. There is a confirmation message that memory has been cleared.

6 The r3 ECM software

Documentation not complete.

7 Battery data

7.1 Lifetime

The anticipated lifetime of the Panasonic LC-R061R3P battery contained in the r2 and r3 ECM unit is 3-5 years. The battery can be replaced by the user.

- Remove the 6 Phillips screws holding the back of the ECM unit together, and replace the battery. The red wire connects to the positive lead of the battery, and the black wire connects to the negative (“-”) lead. Take care to avoid stress or damage to the wires and connectors, and ensure that no wires are pinched when reassembling the ECM.

7.2 Transport

The Panasonic LC-R061R3P battery contained in the r2 and r3 ECM unit is certified for transport as general cargo on both ships and by air. No special or dangerous-goods handling is required.

This valve-regulated (sealed) lead-acid (VRLA) battery can withstand electrolyte leakage during the vibration test, the differential atmospheric pressure test and the altitude test in accordance with the special requirements of transportation regulations specified by the following international organizations:

- Air transport: IATA (International Air Transportation Association (IATA) and ICAO (International Commercial Aviation Organization) special provision **A67**.
- Marine transport: IMO (International Maritime Organization) and IMDG (International Maritime Dangerous Goods) special provision **238**.
- Transport by truck and rail (USA): Meet the requirements of DOT **49 CFR 173.159(d)**.