Addendum to Vectrix VX1 owners manual for bikes modified with “The Laird” firmware

Introduction

The original Vectrix charger software has some deficiencies which caused extreme battery degradation. Due to the Vectrix financial problems and finally its bankruptcy the flawed software was never updated to correct the battery degradation issues. Fortunately the Vectrix owners community responded and one person in particular (alias “The Laird” on the VisForVoltage forum) developed an improved charger software which is now used by many Vectrix owners.

This bike has been modified with this charger software and therefore is in better condition than unmodified Vectrix VX1's. Due to the changed charger software the original Vectrix owner manual is no longer applicable in some areas. This addendum addresses these changes.

For more background on the the software it is advised to read the appendices to this addendum.

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Chapter 1: Important Characteristics

There are some characteristics to using this software which must be understood and it is very important for preserving battery life that the new owner is aware of these and follows the recommendations described in this addendum.

1 Voltage cut-off

Due to the use of an older motor controller software version in conjunction with the modified charger software the bike will allow the driver to continue applying full power (throttle) until the battery voltage drops down to 102 Volts.
At 102 Volts the battery is operating at a dangerously low voltage and cell damage will occur. This is why the driver must always monitor the battery voltage in the left gauge of the instrument cluster (see chapter 2, ITEM 4).

Measures:

When driving immediately reduce the throttle when the voltage reading in the left gauge of the instrument cluster drops below 115 Volts.
When at standstill the voltage reading in the left instrument cluster shows 120 Volts a recharge is required. Stop riding to prevent battery cell damage.

2 Switching on the bike or charging the bike while fans are still running

The modified charger software will always keep the battery cooling fans running after riding or charging for a period of time. This post riding/charging cooling period can vary between bikes and has been adjusted for each bike to accommodate special environmental or other requirements.
The bike with license plate MX DD 35 has a post riding/charging cooling period of 90 minutes.
If during this post riding/charging cooling period (battery fans running) the bike is switched (ignition) on or is connected to AC power three things will happen:

1) The red battery light and the red temperature light will start flashing
2) During riding only: The power bars in the right hand gauge of the instrument cluster will stay fixed and will not indicate the true state of charge
3) After unplugging the bike from power or after switching off the ignition of bike after riding the battery cooling fans will immediately stop running

Measures:

Resetting the bike by switching off the ignition or unplugging the power will restore normal operation for subsequent use.

3 Restriction in the use of chargers

The modified software can only be used in one charger type. This is the “ESD” model. If the charger needs to be replaced please ensure that the replacement charger is also the ESD model. The replacement charger will need to be re-programmed with the modified software. Please refer to Appendix 4 for installation instructions.

4 Software bug

Not related in any way to the modified software, there is a software bug which exists in all Vectrix VX1 bikes. As a result of this software bug the instrument cluster will appear to be frozen and the bike will no longer respond to any input. If this occurs a reset of the bike by disconnecting the battery may be required!

This software bug will be triggered when a bike is switched off and then very shortly after switched on again. The time between switching the bike off and on again must be at least 10 seconds to avoid triggering the software bug.

It is important to be aware of this software bug due to the behaviour as described in Characteristic number 2 above.

5 How to get help

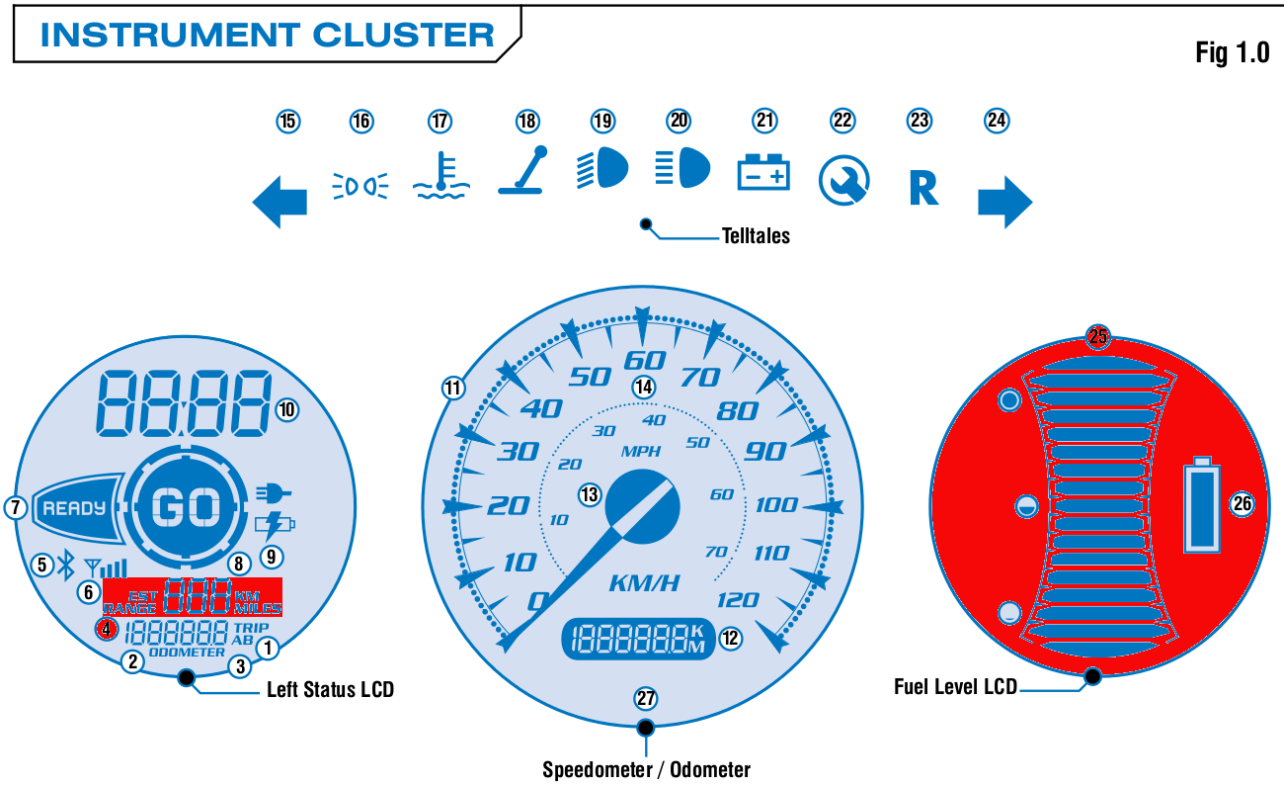
Please visit the VisForVoltage forum and check the community handbook to see if you can find an answer. If you cannot find an answer to your question please create an account, introduce yourself to the forum members and clearly describe your bike and problem symptoms. There are many very knowledgeable bike owners participating in this forum and most problems can be solved.

Link to Vectrix community handbook: http://visforvoltage.org/forum/6737-vectrix-collaborative-handbook

Chapter 2: Changes to Instrument cluster

The behaviour and/or functionality of some of the instrument cluster functions have changed with the use of the modified software. These changes will be described in this chapter.

The instrument cluster is shown in below picture and the changed functions are marked in RED.



ITEM 4

- Function in the old software: ESTIMATED RANGE READING
- Function in the modified software: BATTERY PACK VOLTAGE

The result of this change is that the “EST RANGE” and “KM/MILES” text in the instrument cluster have become obsolete and must be discarded.

In the new function of Battery Pack Voltage this field will always show the actual voltage of the battery pack.
At standstill a fully charged battery will show a voltage above 140 Volt. Depending on how long ago the bike was charged the voltage will vary. Minutes after charging the voltage may be as high as 146 Volt but 4 hours later this could already be reduced to 142 Volts.
The Vectrix battery chemistry is NiMH which has a high self discharge rate. This means that

as soon as the charging is completed that the battery will start to loose its charge. In cold weather situations this self discharge is less evident and higher voltages can be seen. During riding the voltage will start dropping due to the use of energy from the battery and due to the battery internal resistance.
Under load, when the battery must deliver a lot of power to the motor, the voltage will drop mostly due to the internal resistance of the batteries. This is normal, the higher the load is which is put on the batteries the bigger the voltage drop will be (for example due to acceleration or going uphill). It is very important to closely monitor the voltage during riding as it will indicate when the battery pack is reaching dangerously low voltages and will accurately show when the battery is depleted and needs recharging.

Important values to be remembered

At standstill:

Above 140 Volt – Full battery
Between 128 and 135 Volt – Normal use
Below 128 Volt – nearing empty, reduce acceleration and speed
120 Volt – Batteries need recharging, stop riding!

While riding:

Around 130 Volt – Normal use
Between 120 and 126 Volt – nearing empty or high load (acceleration)
Between 115 and 120 Volt – Too high load, reduce acceleration and speed
Below 115 Volt – you are causing battery damage!!

ITEM 25

Function in the old software: BATTERY LEVEL INDICATOR
Function in the modified software: BATTERY LEVEL INDICATOR

Although the function itself has not changed the behaviour has. Previously the battery indicator (fuel gauge) would always show all 17 bars illuminated after charging even if the batteries could not hold a full charge. This means that at some point during the ride the bike would fall below its minimum voltage and stop operating while seemingly still have battery capacity.
In the modified software only the actual charge that has been provided into the batteries is added in bars to the fuel gauge. This means that when the batteries are no longer capable of holding a full charge this will be reflected by having not all bars in the fuel gauge illuminated after charging.

Another change in behaviour is the more pessimistic count of the self discharge effect. This means that the number of bars are reduced based on the time the bike has been left unused after a ride or charge. This will cause the effect that when the bike is used daily the fuel gauge will show a lower capacity (less bars) than what the battery actually holds at that time. Although the accuracy may be off at this point the voltage readout in the left gauge will provide information on the true state of charge.

To know the real capacity of the battery pack (and to reset the fuel gauge accuracy), ride

the bike (very gently!) until it reaches 120 Volt at standstill. After allowing at least the post riding cool period to finish you may recharge the bike. The number of bars showing right after the recharge will indicate the true usable battery capacity.

Important: Due to the high self discharge rate of the Vectrix NIMH battery always make sure that the bike is charged only immediately before riding. If the bike is left unused after charging each of the 102 cells of the battery back will self discharge. Each cell will self discharge at a different rate resulting in cell imbalance. Riding with an imbalanced battery pack will result in cell damage.

Appendix 1: Software characteristics as published on the VisForVoltage forum

Introduction

The below text was copied from the VisForVoltage forum.
A link to the original forum topic is provided below. It advised to read the topic as the responses to the original text have not been pasted into this appendix.

Link: http://visforvoltage.org/forum/11528-ive-cured-my-vectrix-it-no-longer-tells-lies

Text of original post

Hello Folks,

Since the day I bought it, my Vectrix bike has told lies. Sometimes, not a problem, other times, well, BIG problem. Have you ever tried pushing a 'dead' Vectrix? Yes, I know, stupid question. **Of course you've had to push the Bloody thing and usually, because it's been lying again.**

The 'lies' were one of the problems. Besides the battery failures, the lies were probably the next worse thing about the bike. Mine would often suggest that I still had 6 or 8 miles to go, would show perhaps 3 to 5 bars on the 'fuel' gauge and then a hundred yards (metres if you're metric) down the road it would crawl to a virtual halt and I would know that it had been lying again.

As you may know, I have been 'modifying' the vectrix charger behaviour. Initially, after re-arranging the charger in order to prevent 'heat damage' to the battery, I dumped the useless fuel gauge and estimated mileage readout in favour of using the 'left brake/kill switch' combination to allow me to estimate the miles to go. For some ten months that system has worked for me, and perhaps for one or two of you who have been brave enough to try my modified programme.

Just a few weeks ago, I was asked if it might be possible to re-jig the programme to work with the older Motor Controller which, I was told, gives a much more lively performance with it's better acceleration. Well, I never believe everything I am told, so I tried the earlier Motor controller and, yes, it does give a more lively ride and, yes, it does have better acceleration. My interest was captured with a new challenge. It seemed time to 'try again'.

I have learned much whilst working on the programming and felt more able to get the results required. Those results being. An accurate working fuel gauge. A more accurate estimated mileage readout. A charger operation that does not damage the battery. More even control of the battery temperature and one or two more minor improvements.

I have basically succeeded. It has been a long and tedious job, but I now have arranged twenty five changes in the programme in order to achieve the above improvements.

So what is the result of all of this?

Well, the end result (which is all that really matters) is that I have a charger file which, in conjunction with he 1014b Motor Controller, :-

1/ Charges the battery up to over 95% of the actual capacity (up to 30 ampere hour) of the battery without the normally associated heat damage.

2/ Fills up the fuel gauge according to the ampere hours put (charged) into the battery. (this means that 'full' / 17 bars represents 30 ampere hr) If the battery will not accept 30 ampere hrs, say it only accepts 24 ampere hrs, then the fuel gauge will reach only about 13/14 bars. This gives a direct indication of the battery capacity as it is, not as you might wish it to be.

3/ The estimated miles display now reads more accurately with faster updates. Maximum estimated miles is around 68, with a full fuel gauge (17 bars) proportionately less with less bars. On regenerate the display will show a maximum of 75 miles (a default setting) again this is with a full fuel gauge.

4/ The fans run on for ten minutes after switch off, and also if charging is terminated by unplugging. This is a fixed setting.

5/ The fans also run whilst riding and whilst charging.

I have also 'raised' the theoretical 'battery losses' to be more in keeping with the actual self discharge of the battery.

To date, I have not had the bars suddenly disappear with a corresponding loss of battery power. What happens now is that the bars run down and the estimated miles reduce as the battery charge is depleted. Near the end of charge the last bar will 'drop off', the estimated miles will be reading 1 or 0 and there will still be enough charge to run a little further (mile? maybe a bit more). I have not had a power loss and still had bars displayed.

No more lies. No more 'range anxiety'. I now know when it is going to stop, well in advance and fairly accurately.

My own bike which was charging only to around 20 ampere hour a few weeks ago, (I knew that I had a battery problem and this was expected), has just taken a 27 amp hours charge. (I now get well over 30 miles on a charge and this is in hilly country.) My 'damaged' battery is actually improving.

Another bike, which I have installed this programme into, had been standing for some months following an accident, the repair and the owners reluctance to use it for travel to work due to 'range anxiety'. This battery is now showing 23 ampere hour capacity, although when it arrived here two weeks ago, it showed less than 15 ampere hour. It has now been charged five times and is showing a 8 ampere hour improvement.

Just to restate what I am using:
I am using the 1014b Motor controller software with my modified charger programme.
There is no 'left brake /kill switch' facility (for reading the voltage and temperature – that comes only with the later motor controller software).
There are no more 'lies'.
There is no more 'range anxiety'.
There is no more 'pushing a dead Vectrix'.
The actual battery capacity can now be 'seen' on a charge from empty to full. If, at the end of the charge, there are fifteen 'full bars' then the battery capacity is (approximately) fifteen seventeenths of thirty ampere hours i.e. twenty six ampere hour.
There is no excessive temperature rise when charging the battery (not more than 3 degrees C) in fact the temperature sometimes drops whilst charging.
There is no need to 'cool' the battery before charging as the battery no longer gets overheated.

Whether the above is an improvement or not rather depends upon your point of view.

I am looking forward to Xvectrix's point of view on this one and I shall also look forward to your point of view as a Vectrix owner/rider.

One last point. I am willing to share my achievements with you all. I am offering this information and files for your interest only. I am not suggesting that you install these files or use the information in any specific or non specific way. You must accept total responsibility for any use that you put this information and/or files to.

Telling it like it is, as always.

The Laird.

Appendix 2: Background of the original software deficiencies

Introduction

The below text was copied from the VisForVoltage forum.
A link to the original forum topic is provided below. It advised to read the topic as the responses to the original text have not been pasted into this appendix.

Link: http://visforvoltage.org/forum/7912-nimh-battery-problems-and-cures

Text of original post

Notes on the Vectrix Battery – (Use, Improvements and Charging)

The NiMH battery chemistry is a topic which, for most of us, is shrouded in mystery. Myths seem to form a large part of what this chemistry is about and how it should be treated or not treated as the case may be.
The following script lists and explains a number of items which have been fished out of the muddy waters surounding the use and maintenance of NiMH batteries and particularly the battery used in the Vectrix VX1 Maxi-scooter.

First of all, some observations made whilst investigating the Vectrix battery application.

The 'New' Battery as supplied by G.P. Batteries

The battery as supplied by G.P. Batteries of Hong Kong to Vectrix, consists of 102 cells of (nominally) 1.2 volts per cell providing a total voltage, when charged, of about 138 volts (1.35 Volts per cell).
The cells have been selectively matched for capacity, open circuit voltage and internal resistance before being built up into the pair of batteries (front battery of 48 cells and the rear battery of 54 cells)
The batteries were supplied to Vectrix as paired, matched batteries with a long life expectancy.

There will, of course, always be minor variations in the individual cells because, no matter how close the tolerances are in manufacture, there will always be some difference between the specific characteristics of the individual cells. Also, the internal resistance of each cell increases with ageing and cell 'ageing' can itself be increased through miss-use, resulting in some cells of a battery ageing more quickly than others.
If this characteristic of the battery is not catered for in the design of the charge / discharge system, the inevitable result will be battery failures.

The Vectrix Design

Vectrix were in total control of the design of the scooter in terms of the mechanical, electronic and electrical side of things. Unfortunately, there have proved to be some deficiencies in the design of the electronics which have resulted in some problems with the batteries. Some of these problems have now been overcome, some are still to be dealt with. The problems are listed below along with some possible remedial actions.

The main problems experienced by owners of the Vectrix VX1 have been connected with the power source i.e. the battery and it's performance. Basically, complaints have been about poor range (Low mileage), blown fuses, failures of the battery cooling impellers, battery overheating, during riding and whilst on charge, the appearance of the 'red' battery indicator (low battery Voltage) and the BATHOT (battery hot) symbol and occasionally the BUSULT (Battery under safe Voltage) warning.

All of the above has been investigated and the following script contains the findings of that investigation.
Uneven individual cell heating and Battery overheating.

It has been noted that under conditions of high power discharge (hard riding / hill climbing) some of the cells within the battery suffer a greater heating effect than others.
It has also been noted that, on long hill descents, regenerative braking also results in the heating of some cells more than others (and all cells when the battery is near to 'full').
This has the effect that those cells which are hotter suffer from greater internal losses than the cooler cells and this in turn creates an imbalance in the individual cell charges i.e. some cells have more or less ampere hours stored than others.

The 'knock on' effect of the above is that the situation just gets worse and the cells become further imbalanced over time. This imbalance, if allowed to get out of hand, results eventually in low range and/or the appearance of various warning symbols and, at worst, a damaged battery.

The reasons for these heating effects

The basic reason that the cells heat up in use is because each cell has a voltage, a capacity and an internal resistance. The voltage and capacity are both of great value to us but the resistance is the unwanted feature of all batteries.

The resistance of a battery limits the current that can be drawn from the battery. When the voltage at the terminals drops due to the current being drawn, you are seeing the effect of the battery's resistance. The higher this resistance the less current can be drawn for a given voltage drop.

When current is passed through a resistance heat is generated. This heat can be measured or calculated. The heat in watts is equal to IxIxR (the current squared, multiplied by the resistance). In the Vectrix battery the cell resistance is quoted at 'less than 1.2 milli ohms' i.e.0.001 ohms.

If we assume that the actual figure is 1.0 milli ohms then when 100 amperes is drawn from the battery the internal heating effect will be '100 x 100 x 0.001' = 10 watts per cell or 1020watts (1.02 kWatts) for the whole battery. This is a considerable amount of heat and it all has to go somewhere.
Heat effect whilst riding

On a single ride using the 'full' battery capacity (say 24 Amp Hours) at an average speed of 40 MPH, the Vectrix draws (on average) 25 Amps giving a range of just under 40 miles. At 25 amps drawn the heating effect is (IxIxR x 102 cells) 25x25x0.001x102 = 63.75 watts.
A total of just under 63 watt hrs.

On the same ride, but at 50 MPH the Vectrix draws 40 Amps and the range is about 30 miles. At 40 amps drawn the heating effect is 40x40x0.001x102 = 163.2 watts. A total of 97.92 watt hrs.

The heat generated within the battery increase rapidly as the current drawn increases. It also has less time to dissipate as the riding time becomes shorter with increased current drawn.

Heating effects whilst charging

When the battery is charged, current is passed through the cells and the chemical process of discharge is reversed. During charging, the cells again generate heat and this heat is also the result of the internal resistance and the charging current (IxIxR). In addition to the IxIxR heating is the 'extra' heating which occurs in the final stages of charging. This heat is generated due to the

chemical processes 'slowing down' as the battery becomes more full. At this point the cell voltage begins to rise more quickly and heat is generated more quickly. The usual practice is to reduce the charging current to a lower level where these effects are minimised (they cannot be removed altogether) with more of the energy ending up in the cells and less of the energy creating heat.

Heating effects whilst standing

A heating effect which can easily be overlooked is that of 'solar radiation' as in, Sunshine.
In a cooler climate, the problem is minimised and conversely, in a warm/hot climate the problem can become serious. Heat from direct sunshine on the top of the walk through covers will generate a lot of heat which will find it's way into the upper battery cell layers. Heat from a hot roadway will tend to heat the lower battery cell layers.

Heating effects of Regenerative Braking

Regenerative braking is a wonderful way of 'putting fuel back in the tank' free of cost. However, regenerative braking is also just another way of charging the battery and, If heavy regenerative braking is used when the battery is near full (say over 80% full), then the heating effects, (which occur in the later stages of charging), can produce serious overheating. Even short bursts of regenerative braking can result in serious heating and damage.

Dealing with the problems

First of all, the causes of the excess heating should be removed or reduced where possible.

Secondly, where the causes cannot be removed, the resulting heat should be removed or reduced as effectively as possible.

Finally, the results of the remaining heat 'damage' i.e. the resulting 'imbalance' of the cells. must also be dealt with as effectively as possible.

The following lists the causes of the excessive heating and some ways to correct this.

Excessive current demand:-

Reduce the current demand. This could be as simple as advising riders to adopt a more easy riding style and make them aware of the effects (shorter battery life) of 'aggressive' / 'enthusiastic' riding. It is feasible but highly undesirable (and commercially suicidal) to reduce the power available through the scooters software. This could however, be an option where the owner requests it (perhaps on scooters for hire etc).

Regenerative braking:-

Regenerative braking has the sole purpose of 'putting fuel back in the tank' free of cost. It is therefore both practical and desirable to re-arrange the software to restrict the energy generated when braking to a level which the battery can accept without causing damage. The 'new' behaviour could be 'learned' by the rider and should not be a problem. Regenerative braking is NOT a substitute for friction brakes, it is an added extra and should only ever be treated as such.

Charging the battery:-

The charging process, as programmed into the Vectrix, is flawed. The initial part of the charge where the charge current is at 'C.P. (constant power) is correct. It is the later stages that present the problem.

The '3 Amp top-up' which follows the initial charge appears to take no account of the temperature rise which occurs when the battery is in an unbalanced state. There is no reason why the software should not detect an abnormal rise in temperature (as caused by any group unbalanced cells) and, instead of proceeding with the 'top-up', move on to an 'equalising' charge but not at the rate

currently used..

The 'equalising charge' set at slightly under 3 amps is excessive. At 3 amps considerable heat is generated.

Note

Some literature states that 'equalising charges' should not be applied to NiMH batteries and that 'charging at low current is undesirable'. These well meaning statements do not take into account the problems of unbalanced cells as occur in the Vectrix battery. There is no practical reason why the imbalance cannot be corrected as suggested here. In fact there is no other way to correct the imbalance. The Vectrix needs an equalising charge.

In terms of the level of current suggested (0.3 amps). Bench tests have shown that 0.3 amps will correct any imbalance without generating excessive heat. Duracell's literature states that a continuous current of 0.3%C can be used to 'float charge' NiMH cells for use where the cells must be maintained in a fully charged state. The 0.3%C is to balance the cells internal losses and to maintain it in a 'fully charged' condition. This statement shows that low current charging is NOT damaging to the cells.

Solar Heat:-

Where solar heating is a problem it may be feasible to simply park the bike in shade or cover the bike with a heat reflective cover when parked. When riding, the effects of direct sunshine and road radiation will be largely negated by the airflow over and under the bike. What cannot be avoided is the high ambient temperatures, but **remember that the higher temperatures in themselves are NOT necessarily a problem. The problems suffered by the Vectrix batteries are caused by the uneven cell temperatures, within the battery pack. This 'uneven cell temperature' is the major cause of damage and eventual failure of the battery.**

Incidentally:

The NiMH battery specifications (according to Duracell) allow for a 'recommended temperature range' of 0 to 40 Degrees C and a 'permissible temperature range' of -20 to +50 degrees C on discharge and for charging they 'recommend a temperature range' of 10 to 30 degrees C and a 'permissible temperature range of 0 to 45 degrees C. (Needless to say, the nearer the middle of the 'recommended' temperature range the batteries are operated the longer they will last.)

Heat removal:

Heat removal is essential where heat is generated but not wanted. That said, in cooler climates some heat generated within the battery housing could prove beneficial especially in near freezing conditions.

For most places where the Vectrix is operated, heat removal is necessary. Also necessary, but not much considered, is the idea of keeping the temperature of all of the battery's cells as even as is possible. Both of these objectives would be largely achieved if the Vectrix's plenum fans were run whenever the scooter was in use. Therefore it would be desirable for the plenum fans to run whenever:-

a/ the scooter was in use, either being charged or being driven and,

b/ the cell temperatures differed (from each other) by more than a few degrees.

c/ any of the cells were at (say) five degrees above the ambient temperature.

d/ and whenever any combination of a/ plus b/ and/or c/ exists.

All of the above improvements could be programmed into the software.

The Damage limitation – Dealing with the imbalance.

None of the above 'corrections' will prevent the problems of imbalance, they will simply reduce it to one of manageable proportions.
The imbalance can only be corrected by overcharging some cells whilst bringing the remainder up to a fully charged condition.
The overcharging of cells will inevitably reduce their life and the more current during this overcharge the more will be the resulting damage/ageing.

The only practical way to equalise the cells is to pass a low current through the whole battery until the battery voltage stops rising and remains at a steady level for a predetermined time period.

In view of the above it has been found that an equalising current of 0.3 amps is far more effective and far less damaging to the cells than the present 3.0 amps used by Vectrix.

The above suggestions could be incorporated into the charger software. The actual equalising current provided by the charger (via it's software) would have to be increased to account for the current being drawn to run the two plenum fans. Estimated 'equalising' current would probably be 0.3 amps for the battery Plus the current required by the plenum fan power converter (I am assuming that it is taken from the battery rather than directly from the charger)

Without access to the software.

Most of the above would be difficult to achieve and some of it impossible. However, I have already fitted my own Vectrix with an input system for the purposes of providing a 'safer' equalising charge. (It also allows me to resurrect the battery if it ever falls below the voltage necessary to start the charger)

It is also possible to provide the plenum fans with an alternative source of power and therefore have control over them.

The regenerative braking can be dealt with by 'learning' when it is safe to use it and equally, when it is advisable not to use it.

Finally,

If anyone has access to the software writing programmes, I could make good use of a copy. (pirated or otherwise) I do not condone software piracy BUT I bought an electric scooter and I expect to be provided with all possible information whereby I can maintain my property. I now require this software and if a 'pirate' copy is all I can get, then so be it. Please contact me via the forum

Appendix 3: Background of the modified software

Introduction

The below text was copied from the VisForVoltage forum.
A link to the original forum topic is provided below. It advised to read the topic as the responses to the original text have not been pasted into this appendix.

Link: http://visforvoltage.org/forum/10169-modifying-vectrix-charger-programme

Text of original post

Hello folks,

Herewith a commentary on some work I have been doing on the Vectrix Charger Programming.

I have achieved a limited success in the task of re-arranging some of the charger's performance. This has been with the object of reducing the battery 'damage' whilst charging and also, hopefully, to extend the life and therefore the mileage of the battery before replacement becomes necessary.

It is my view that most of the damage to the battery is caused by heat, and that heat is generated / produced by two means. The first is the heat of the charging process and the second cause is the internally generated heat produced by the battery's internal resistance when current is drawn from the battery.

So far, I have concentrated on the charging process. My aim was to reduce the initial charging current, maintain that current to around 80% of 'full' capacity (24 Ah) and then continue the charge with a further reduced current for a sufficient time to complete the charge process. There will be a 'side effect' of this which is a longer charge time, however, I consider that a longer charge time might be worth accepting if a longer battery life results from this. Bear in mind that charge time, including equalisation, can extend to over eight hours with the Vectrix programme/software.

In terms of the initial charge (up to 80%), reducing the current to 6 to 7 amperes only increase the charge time from 2hrs (empty battery) to 3.5 hrs. This is an increase which I am prepared to accept.

The second stage of charging which involves the "tr' cool off periods, lasts for one hour, in the earlier software (Version 2012 and thereabouts) this also involved a low rate charge of 3amps. In the 3001 version, this was reduced to zero charge and still runs for the hour (I believe that Vectrix had noticed that the 'tr' at 3 amps was actually causing further heating of the battery).

The third stage of charging is the C.C. (constant current) stage which runs for a preset time or until a preset voltage is reached or until the battery heats up to a preset maximum temperature.

A final charge stage involves the process of Equalisation. The purpose of which is to bring any cells which have 'fallen behind' in terms of charge (i.e. they are not 'Full' whilst other cells are full) up to a genuine fully charged condition.

The main heat producer during the charge process is the latter part of the initial stage (the part that takes the battery to 80%), this is followed by the Constant Current charge at 3 amps which also produces excess heat. The Equalisation current level is also excessive and contributes yet more heat

to the battery.

Vectrix 'engineers' recognised the problem but failed to deal with it mainly due to their over-qualification for the job which they were doing. A common problem with overqualified engineers is that they are full of theory and short on practice. As anyone who is involved in troubleshooting knows, theoretical knowledge and practice experience can often be very difficult to marry together and in all cases, what happens in practice is far more important that what should happen according to theory.

Vectrix engineers attempted to solve the heating problems by 'cooling' the batteries (the plenum chamber fans). They added periods of 'cooling' to the process (the tr.with no current in later software). They programmed in a temperature limit, beyond which the charge was halted and the fans were kept running, but they completely failed to realise that the best way to deal with the problem was to NOT generate the heat in the first place. They were, of course, far more interested in selling a short recharge time that would appeal to buyers. A VERY BIG MISTAKE.

Where does that leave us? Well, working on an earlier version of the software (I wanted tr. with instruments lit up), I have been able to make a number of alterations to the programme parameters without actually altering the programme routine itself.

I have reduced the initial charge current (C.P.) 6 to 7 amperes (864 watts) and reduced the 'aiming' voltage so that C.P.144 is the voltage limit for the initial charge. At a charge rate of 6 amperes, 80% charge occurs at approximately 144Volts.

I have reduced the 'cool off' current to 1.5 amperes. The 'aiming' voltage is set, within the programme, to equal the C.P. voltage.

I have reduced the Constant Current level to 1.5amperes and increased the maximum time to 4hrs and may yet need to add more time (it was set to around 3.5 previously)

The above changes do increase the charge times, is there really any choice?

Vectrix had set some 'safeguards' in the programme. I have used the word 'safeguard' rather loosely. They had set the maximum battery temperature to 50 degrees Centigrade. By the time that the battery casing, where the temperature is measured, reaches 50 degrees then the internals of the battery are considerably hotter. I don't call that a safe limit.

If the charger 'control' failed then they had a 'safe' limit of 15 amperes and a maximum charge of 32 ah in C.P. mode with a 35 ah absolute limit. What they did not consider was that if the programme 'locks' then even these limits will not help as they will not be applied due to the locked programme.

If the battery temperature exceeded 40 degrees in use (when riding) then the plenum fans where switched 'on'. At 40 degrees C on the battery case, when in use, the damage is already done, as I have already said theory and practice ...?..?..?....?

So much for the Vectrix engineers 'safeguards'

I have incorporated 'safer' limits into the software which I am altering. I have reduced the maximum charger output to 8 amperes. I have arranged for the plenum fans to be always 'on' when the bike is being used. I have set the safe maximum battery temperature (when charging) to 25 degrees C (it is currently 5 degrees outdoors here just now and rarely exceeds 20 degrees) and I have reduced the maximum ampere hours in C.P. mode to 24.

All in all, a number of changes and hopefully for the better.

The above changes are currently being tested and have so far proved to work as intended. It will be a while before the real effects (a longer battery life with fewer imbalance problems) are available.

The above 'work' has taken longer than I expected, but reverse engineering, in order to find out how

a programme works, is not the easiest of subjects and I am still a novice. I have done nothing illegal, all I have done is to make alterations to an existing hex file for my own benefit. I am willing to share my knowledge with you individually so that you too can benefit if you wish. The alterations which I have made can be varied to suit individual requirements (not easy but not too hard either).

This is not a simple process, but I will try to help anyone out there who may be interested in this work. Basically, I have made the alterations directly in the Hex file which is programmed into the bike with the Vectrix Diagnostic Software. The changes to the hex files are written for a specific version and cannot easily be 'fitted' in other versions. Because I have 'downgraded' to an earlier software version, I have lost the estimated mileage readout on the left-hand display and the battery capacity meter (right-hand display) no longer decrements. I have found that the left brake pull that gives the voltage and temperature readout allows me to estimate the remaining battery capacity and I have not been caught out yet.

I am hoping, in due course, to reverse engineer the whole programme. When that is completed, I shall write my own programme to deal with the problems in my own way and will publish the programme as freeware (but that, folks, may take some time)

Dear People at Vectrix,, (I know that you read this column)

Why don't you contact me so that WE can work out YOUR problems together and benefit YOUR business and YOUR customers and perhaps the environment at the same time? I don't even want paying, (although you might like to contribute towards the £150 worth of books I have bought) all I want is a good reliable product. You have nearly achieved that, why not allow me to help you finish the job properly? Contact me through this forum, PLEASE. :-)

And having got that over folks, Merry Christmas and a Happy new year to you all, even to those people at Vectrix.

Keep smiling folks:-)

The Laird..

Appendix 4: Installation of the modified software

Introduction

The below text was copied from the VisForVoltage forum.
A link to the original forum topic is provided below. It advised to read the topic as the responses to the original text have not been pasted into this appendix.

Important: The bike is already loaded with the correct software. This text is only provided in case the ESD charger must be replaced. Always replace the ESD charger with another ESD charger. The Runke charger cannot be used!

Link: http://visforvoltage.org/forum/12321-latest-may-2012-software-instructions

Text of original post

Installing the Adapted Vectrix Software for the ESD.Charger

You will need the following items in order to complete the changes.

1. **Laptop / Computer** capable of running the Vectrix Diagnostic software (Windoze XP works well, others I haven't tried)
2. **CanBus adapter and connecting lead. -**

or:- http://www.gridconnect.com/canadapters.html

3. **Vectrix Diagnostic software** loaded into the computer.

4. **Hex Files named:-**

a/ ESGA6V?? This is the new charger hex file. The question marks replace the temperature limitation in degrees C.

b/ MC1014b This is the 'compatible' Motor Controller file

c/ BCR3001 This is the charger file you are replacing and can be installed to return the scooter to it's present condition if required.

d/ MCR1017 This is the Motor Controller file you will replace and is available for returning the scooter to it's present condition if required.

****

Installing the Diagnostics Software

First task is to load the diagnostic software into your computer.

Connect the USB / CanBus adapter to the computer. When the computer asks for 'driver files' load the Peak disc into the disc drive and click on 'OK'. The computer should report that the drivers

are loaded and the light on the adapter should now be 'ON'.

Make two directories in the root directory of the computer. Name them 'ScooterTemp1' and 'ScooterTemp2'.

Load the files 'Scooterdiag Installer.zip' and the two 'Image' files into the directory 'ScooterTemp1. Unzip the scooterdiagInstaller.zip file. You will get yet another directory with the required files in it.

Load the remaining files into the 'ScooterTemp2' directory. Unzip the 'ScooterDaig.zip' file. You will again get another directory with a single file named 'Scooterdiag.exe'. This file is the latest version of the diagnostic programme, don't play with it, leave it where it is for now.

Go back to the 'ScooterTemp1' directory, go into the 'Scooter diag Installer' directory (the one built by the unzip process), and click on the file named 'Setup' (it is 108Kb in size). Follow the instructions and you will end up with a new directory (in the root directory of the computer) named 'ScooterDiag). This directory contains all of the essential files and a directory named 'Flash'.

******* The 'Flash' Directory contains the files needed by the 'motor controller install process'. DO NOT EVER INTERFERE OR ADD TO THIS DIRECTORY*****.**

Go back to the 'ScooterDiag' directory and rename the file 'ScooterDiag.exe' to ScooterDiagOld.exe'.

Copy the file 'ScooterDiag.exe' from the directory named 'ScooterTemp2' into the 'ScooterDiag' directory. Effectively you have simply replaced the old file with the latest version, Sorry if this all sounds a bit complicated.

Make one more directory in the computer root directory, name it 'ScooterSoft'. Keep all other software i.e. hex files, downloads etc,. in this file (this keeps everything nice and tidy).

One final act is to place a shortcut (the new 'ScooterDiag.exe' file only) onto the desktop, this just makes for easier start up.

If you have the CanBus adapter connected, then click on the desktop shortcut and 'Hey Presto', you will have a Diagnostic screen all set to use and the red light on the diagnostic adapter will blink encouragingly at you to tell you that all is well and working properly.

If the adapter light fails to blink then you may need to change the driver (the usb.dll) file. Those which do work are and .
These files should be located in:- Pcan_usb.sys in the directory, and 'Pcan_usb.dll' should be in the directory.

****

Using the Diagnostics Programme

Start the diagnostic programme, the red light on the can bus will blink if it is recognised and connected to the diagnostic programme.

Close the diagnostic programme.

Connect the computer to the bike using the can bus lead.

Do not have the Bike charger cable connected to a mains supply whilst the computer is connected to the bike even if the mains is switched off. (this applies to a mains powered computer. It is safe to have a battery powered computer connected whilst the bike is connected to the mains power)

Switch the bike on first and then start the diagnostic programme.

The diagnostic programme should show a green bar saying 'can active' at the bottom of the screen.. If not, then start the whole process again even to the point of re-booting the computer if necessary.

You are now able to see the different 'pages' of the diagnostic programme. Do not press anything yet and don't experiment.

Click the firmware upgrade tab.

The fourth module down is Motor controller and it shows the version of software which is current in the Vectrix. Make a note of the detail you will need it if you wish to revert to this software later. Note also the charger version which is on the third module down.

You have successfully installed the Diagnostics software/programmes. Do not play with it. Some of the 'things' that it can do to you/your bike can cause serious trouble. Learn from the mistakes of others.

DO NOT BE TEMPTED TO PLAY WITH OTHER BUTTONS. IT IS POSSIBLE TO REDUCE THE MACHINE TO THE CATEGORY OF 'EXPENSIVE DOORSTOP' WITH THE AID OF THE DIAGNOSTICS PROGRAMME.

Installing the 'new' Modified Software

Connect the computer to the bike using the can bus lead. Do not have the Bike charger cable connected to a mains supply whilst the computer is connected to the bike even if the mains is switched off.

Switch the bike on first and then start the diagnostic programme.

The diagnostic programme should show a green bar saying 'can active' at the bottom of the screen.. If not, then start the whole process again even to the point of re-booting the computer if necessary.

You are now able to see the different 'pages' of the diagnostic programme. Do not press anything yet and don't experiment.

Click the firmware upgrade tab.

The fourth module down is Motor controller and it shows the version of software which is current in the Vectrix. Make a note of the detail you will need it if you wish to revert to this software later. Note also the charger version which is on the third module down.

Load/install the motor controller first. (This is the dangerous procedure).

**********NOTE**********

If the programme asks for a file by name then it is almost certain that you have an incorrect installation of the Diagnostics programme STOP working. Cancel your way out of whatever you are doing and ask for help.

****

This file must go in in one piece, if it fails (I have never had a problem)
DO NOT SWITCH OFF THE BIKE but keep the computer attached to the bike and restart the computer, then re-install the motor controller (the 1014b.hex file).

Loading/installing the Charger file, the esga6V40 is straightforward. It is longer than the BCR3001 file in order that it overwrites any remnants of the earlier file.

Procedure.

Click on the fourth module 'BROWSE' button and locate the file MC1014B.
Click 'open', and you will return to the firmware update page with the file MC1014B ready to

programme into the bike.
Click 'program', at the bottom of the page a green bar will show the progress of the software installation. When it stops and reports 'completed', count to five, then click on the 'clear' button.

Do not be impatient. Touch nothing while the upgrade takes place.

Repeat the above steps for the third module down, this time selecting the new charger hex file- ESGA6V??.hex - The ?? is the cut off temp in degrees C.

Do not mix up the files, only programme the charger with a charger file. Only programme the motor controller with a motor controller file.

If the process halts or stalls at any point in the programming of either file, DO NOT SWITCH THE VECTRIX OFF. Instead, maintain all connections, shut down and restart the computer and or programmes as may be necessary. and repeat the install process, i.e. press the program button again.

Switching the Vectrix off whilst in the process of programming the motor controller module can result in that module requiring a factory re-installation of the boot loader, NOT CHEAP, NOT NICE and maybe NOT POSSIBLE.

If you are in any doubt about anything in the instructions above or if you lack knowledge or experience in this type of activity, THEN DO NOT ATTEMPT THE RE-PROGRAMMING, instead get someone to help and guide you through the process.

On completion of the above, you may find that one or two bike displays appear to behave oddly. Temp and battery indicators may flash alarmingly. Close the diagnostic programme and then switch the bike off and then switch back on,. All should now settle with no unusual behaviour.

Points to note.

Please read these operating instructions for the new software before using the bike and/or charger.

If you normally get 30miles per charge, don't expect more even if the bars tell you otherwise, use the voltage readout instead to tell you when the battery is near discharged.
What you will get is a cooler running battery and a cooler charging battery.

When using these files for the first time.

Following the install, ride the bike until the battery voltage drops to 120 Volts (don't ride to the 'red light' this does not operate until the battery voltage is down to 102 volts – not a good voltage to get down to). This indicates that the battery is nearing empty. Then put the bike on charge. Any remaining bars on the fuel gauge should disappear as the charge begins.

You will have noticed that the plenum fans were running all the time that the bike was powered and for ten minutes after it was turned off. **This is correct**.

The bike will charge at a constant current of 6 amps for up to four hours or until it is around 70%/80% charged.
There will be two short 'tr' periods of 5 minutes each, and then the C.C phase will begin. This will last for up to four hours and be followed by an E.C. period of 1 hour.

(The charger will still provide an occasional 'equalising' charge which will last for 1 hour only and should not cause any temperature rise).

Although this seems long time to charge, the charge is being carried out with little or no temperature rise. The battery will have reached 70%+ within (usually) three and a half hours with little or no heating.
This compares with the Vectrix charge of two and a quarter hours (at around 11amps) to reach the

same level PLUS considerable heating in the process and a 'cool down' period of 1hour. Total time = three and a quarter hours.

The 'fuel gauge' will fill up according to the input AHrs. If the fuel gauge fails to reach 17 bars, then this simply means that the capacity of your battery is lower than 30 Ahr.

In use.

The bike will count down the bars according to you use of 'fuel' and the estimated miles display will indicate the battery voltage. It is normal for the voltage to drop when using power but it should not be allowed to drop under 120 Volts.

The Temperature setting (the ?? degrees C) will stop the charger in the event that the battery exceeds ?? degrees C. It should never be necessary as there are other safeguards (time and voltage) which should always operate first.

I suggest that you run the bike occasionally, until the voltage drops to 120 volts under a light loading. This indicates that the battery is nearing empty. Then put the bike on charge. This to be carried out once per week / once per month or as indicated by any fuel gauge error.

I suggest that, whenever you get down to three bars on the fuel gauge, that you should keep an eye on the voltage gauge, when the volts get down to 126 or less then you are nearing an 'empty tank'.

Do not run the bike 'hard' if it sends the Voltage below 120volts. Do not run the bike to the 'red light'. If the BUSvlt appears you are doing damage to the battery.

For the first charge, you should keep track of the voltage and temperatures. If you have a problem such as a high temperature or the voltage will not rise at the end of charge, it may be indicating that you have a faulty battery, I need to know this and may be able to compensate in the programme for it.

Allow the battery to charge fully occasionally or when you actually need that full charge, otherwise charge only to about 70% to 80%. (this is about an hour after the C.C. stage begins). This prevents higher leakage currents (which occur when the battery is 'full') which will shorten the battery life.

Running down to the 'red light' is not recommended, as the battery voltage is lower with this motor controller software. If the battery is in known good condition there should be no danger or damage, but a battery in poor condition could be damaged further by the excessive discharge level.

If you are in any doubt about anything in the instructions above or if you lack knowledge or experience in this type of activity, THEN DO NOT ATTEMPT THE RE-PROGRAMMING, instead get someone to help and guide you through the process.

Finally, I would like to remind you that my scripts have been a record of my attempts to reduce damage to the battery on my Vectrix scooter. I have told you what I am doing and why I am doing it and how I am doing it. I am not advising you to do anything, instead I am offering you the opportunity to imitate my work if you chose to do so.

Keep smiling folks,

The Laird.