Electric Auto Association

CURRENT EVENTS

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EV MOTORCYCLE CONVERSION

By Gregory Whitney

I have been building electric vehicles since 1982 and finally decided to convert a motorcycle to run on electricity. After finding an old Honda Trail, which had no engine, I bought it for $50 and used an electric prop pitch motor to power it. This motor came off of a 1950-1960 era C-124 Globemaster cargo aircraft. The motor will run on 6 to 36 volts and is very well built. It should be, as the government paid approximately $700 for it at the time of procurement.

A Ron Rissel controller (built by a local EAA member) was setup to deliver 90 amps to the motor, but cruise amps are between 20 and 30. A small Curtis or other similar controller could be substituted.

Delco group 24-size batteries were chosen for the conversion for the following reasons. They were the largest ones that would fit. They were inexpensive (even less expensive if the Wal-Mart house brand Delco's are used). They do not leak because they are semi-sealed with just two small vents on the top. Smaller batteries can certainly be used, but range would probably be lessened.

To begin the conversion, I first stripped the motorcycle down to its component parts. They were cleaned, refurbished, and painted as shown in Figs. 1&2. A battery rack was fabricated from 1/8"x1"x1" angle iron. Footpegs, a kickstand, and a jackshaft mounted in pillow block bearings were attached to it as shown in Fig. 3.

As the Honda has a pressed-steel frame, it was necessary to cut a transverse hold through the frame to house the motor. (This operation should not be necessary on a tube-frame motorcycle.) Once the hole was cut, a 10-gauge motor housing tube was formed and welded in place in the frame.

Continued on page 4

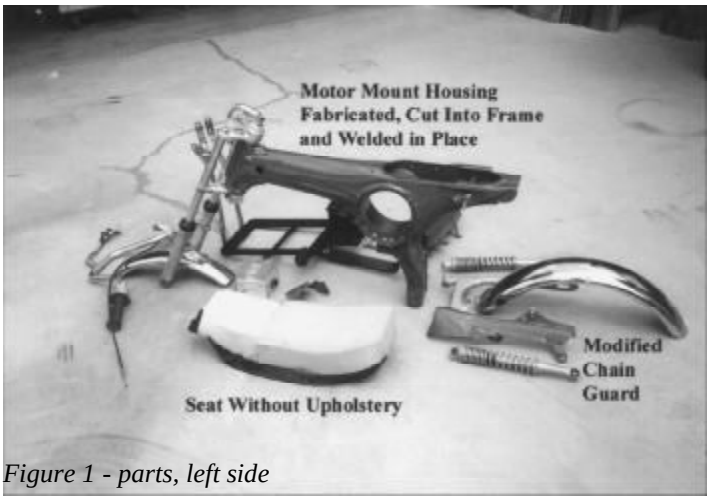

Figure 1 - parts, left side

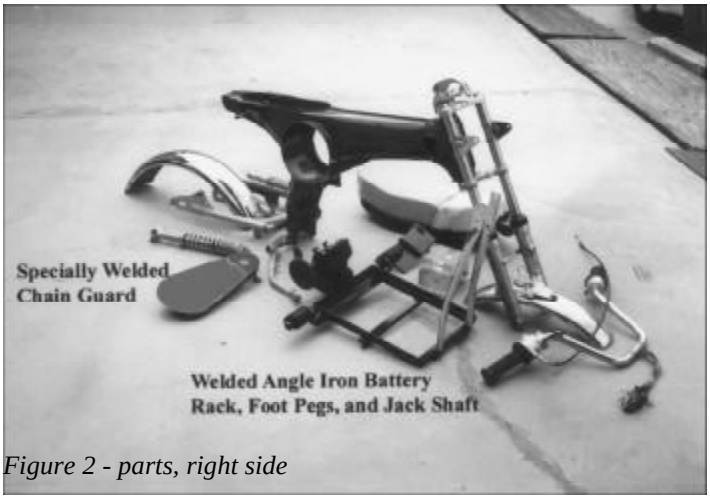

Figure 2 - parts, right side

Final EV mini-bike

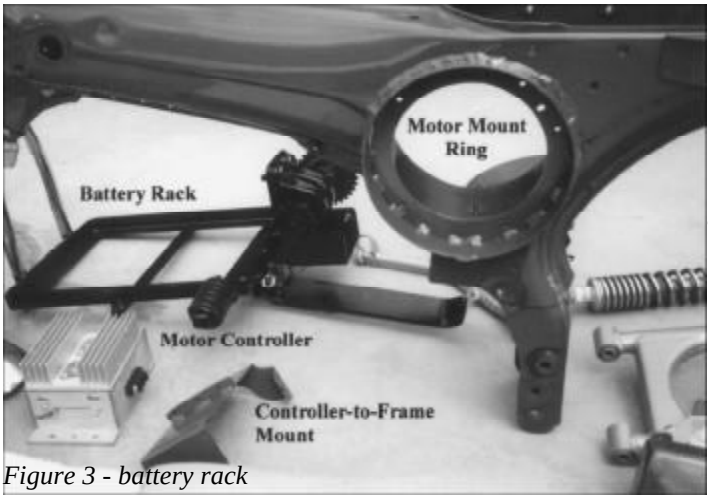

Figure 3 - battery rack

IN THIS ISSUE

Articles:

EVents:

Columns:

COVER STORY

Photos by Gregory Whitney.

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New Higher Pacific Gas & Electric Rates

By Bob Wing

My latest bill for Aug 18, 01 includes the new rates. PG&E and State code requires a time-of-use meter for EVs, but PG&E says not in west Marin County. There used to be an installer here but closed that down when he retired. Now it is 55 minutes each way for a repairmen/installer to get here.

PG&E declared bankruptcy but the hearing judge approved $100 + million bonus for top executives to keep the top staff from leaving, bonus generally equal to their annual salary. Stockholders get nothing, as do many suppliers. My experience with both Pacific Bell and PG&E was that they always had 10 or 12 possible people in line for each promotion and many training courses in preparation. Who wants the staff to stay who pushed for separating power generation from distribution so the California PU Commission would no longer control their rates.

If we only had public power like Sacramento, San Francisco and many other small utilities our rates would be lower because of long-term investment. Water will be the next shortage, 10% of PG&E supplies are hydro. I hope the California Governor sets up state owned power system for price stability. So, Cal Edison may declare bankruptcy next.

My monthly bill including the Ford Ranger EV has been about $80/month. Now:

Baseline usage 322.4 Kwh @ $0.12589
101-130% of Baseline
96.7 Kwh @ $0.14321
131-200% of Baseline
225.7 Kwh @ $0.19445
201-300% of Baseline
96.2 Kwh @ $0.23838

With additional charges and 10% legislative discount this bill is $112. This does not seem too bad as there is only one free charge station at Novato Costco in Marin county and another at Petaluma Discount Outlets in Sonoma county, both about 25 miles each way from home and no place I want to spend 3-4 hours to recharge. Now if there was just an Avcon charger, only EV1 at Larkspur Landing, I could take the ferry boat to San Francisco and spend the time in a very pleasant way. I doubt if we will see high Amp chargers at these free public charge stations with the high price of power to the storeowners.

Electricity is still cheaper than gas for our other car. And the Ranger is much quieter but I have to watch out for bicycles, they do not hear me coming. Sonoma County has bikes lanes on almost all 2-lane secondary roads, none in Marin County with more turns and hilly roads.

Happy charging,
Bob Wing

My EV History Collection now at Stanford University

By Bob Wing

My 30-year collection of hard copy EV History covering the years 1895 to Sept 2001 is now available at the Bing Wing of the Green Library at Stanford University, Palo Alto, California. My intent is to make this collection permanently available to students, faculty, staff and the public. The collections are stored in a separate building on campus. One needs to know the items desired so they can be delivered by messenger to the Bing Wing. These items are only available to the public for use at the library.

My thanks to David Kirsch, Ph.D., author of The Electric Vehicle and the Burden of History, Rutgers University Press, published in 2000. He used my library on several occasions while preparing his Stanford doctoral dissertation. David is now an AT&T Faculty Fellow and Visiting Assistant Professor at the Anderson School at UCLA.

This collection from around the world includes conferences and proceedings, about 30 different EV journals, magazine, newsletters, (some for their entire print history); early antique EVs, autos and trucks; EV components such as chargers, controllers, batteries, battery management systems, history of EV manufacturers and so on. I have kept at home one file drawer of duplicate early history of EVs from 1895 to the 1980s as much of this material was very hard to obtain, and I refer to it frequently.

Thanks to my friends overseas and in the US who contributed over many years. I will continue collecting periodicals and conference proceedings, as these are easy to file. I now have space as 16 library cartons have shipped out.

Special thanks to Alicia Marìa Gamez, Ph.D., Curator for American and British History for coming to Inverness to pick up the last 9 of 16 cartons.

Bob Wing
bwing@svn.net
POB 277, Inverness CA 94937-0277

Call for EAA Board of Directors Elections:

Requirement: Must be a current paid EAA member to run for Board of Directors. Each serves a 3-year term and may be re-elected. Currently 3 Board positions open – to be filled by Incumbents or new Candidates. All Candidates must submit an Application. The three existing Board Members up for renewal are:

- Stan Skokan, current Treasurer
- Anna Cornell
- Kurt Bohan

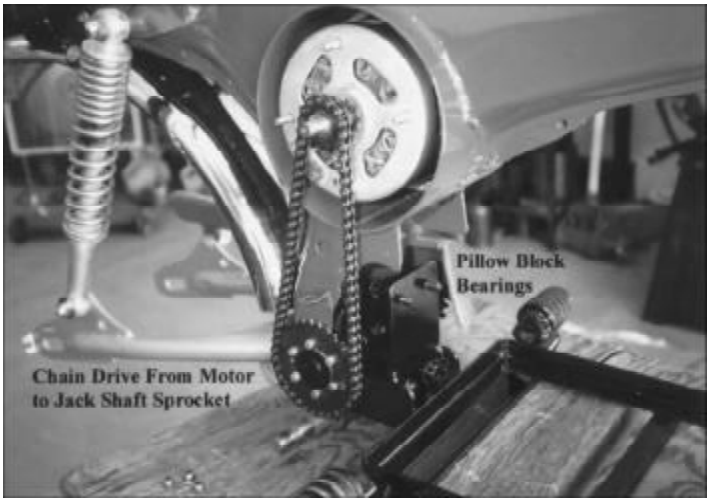
For new candidates, we are looking for enthusiastic supporters of the EV cause to get plugged in and represent EAA Member interests. The Board meetings are held every two months and can be attended by teleconference, so it is not mandatory to physically live in the San Francisco area of California to be on the Board.

Application for Candidate (written):

- Description of qualifications (no long biographies) – for reprint on ballot.
- List of goals, personal focus for EAA – for reprint on ballot.
- Description of availability (phone, fax, email, mail) for Board use only.

Email to: EAA-contact@excite.com
mail to: 2 Smith Ct., Alameda, CA 94502.

Schedule:
Application Deadline – **Nov 7, 2001**
Voting Deadline – **Dec 31, 2001**



from page 1 *Figure 4* *Figure 5*

while still leaving enough room for the front fender and wheel to clear. Figure 4 shows that the jackshaft on the battery-rack serves three purposes. First, it transfers the chain drive down to align with the rear wheel sprocket. Second, it transfers the chain drive from the right side to the left side of the bike. And third, it makes the changing of sprocket ratios a simple task.

Figure 5 also shows the motor controller mount and throttle cable connection, the batteries held in place with a non-conductive wooden hold-down, and the fabricated chain guard. Figure 6 is a top view of what the rider sees as he straddles the bike. Figure 7 is the left side of the completed machine.

With an 18-tooth sprocket on the motor driving a 30-tooth input sprocket on the jackshaft, and an 18-tooth output sprocket on the jackshaft driving a 40-tooth sprocket on the motorcycle's rear wheel, this bike will travel 22-mph @ 24 volts. It will travel 30-mph @ 36 volts. This translates into a cruising range of 25 miles at 22-mph (24v) and 35 miles at 30-mph (36v). These are road-tested values.

The bike is currently limited at 90 amps and draws 20 to 30 amps at cruise on level ground. To arrive at the 36-volt range, I fabricated a temporary battery rack over the rear wheel to carry a third battery. After running the 30-volt speed and range tests, the motor was hot to the touch and had a hot motor smell but no damage. Remember that the motor is mounted in a "can" on the frame and gets very little air circulation. With the addition of a cooling fan to blow air over the motor, 36-volts should be feasible for this type of conversion. On a tube-frame bike where the motor would be exposed to ambient airflow, extra cooling probably would not be needed.

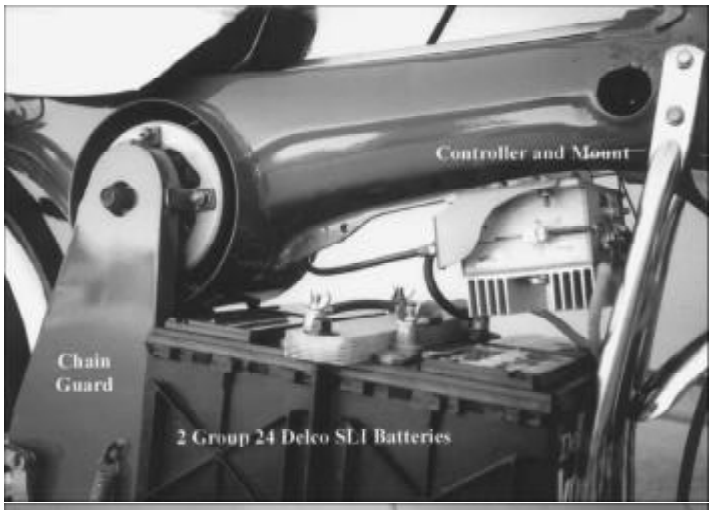
When the bike is running on 24-volts, the rider can drive the 22 miles, then reach into the motor and touch the armature for a prolonged time without discomfort. We have used these motors on sidewalk scooters, motorscooters, go-carts, bicycles, mopeds, motorcycles, winches and hoists – they are fantastic!

SPECS:
Base frame -Honda Trail Bike

Motor - Prop pitch control motor for C-124 Globemaster aircraft

Batteries - 2 or 3 12V deep cycle or SLI
Drive - 18-tooth motor to 30-tooth jackshaft input, 18-tooth jackshaft output to 40-tooth rear wheel

Top speed	22 mph@ 24V	30 mph@ 36V
Amps @ cruise	20-30	Rissel controller current limited @ 90A
Range @ 24V	~25 miles @ 22 mph	
Range @ 36V	~35 miles @ 30 mph	



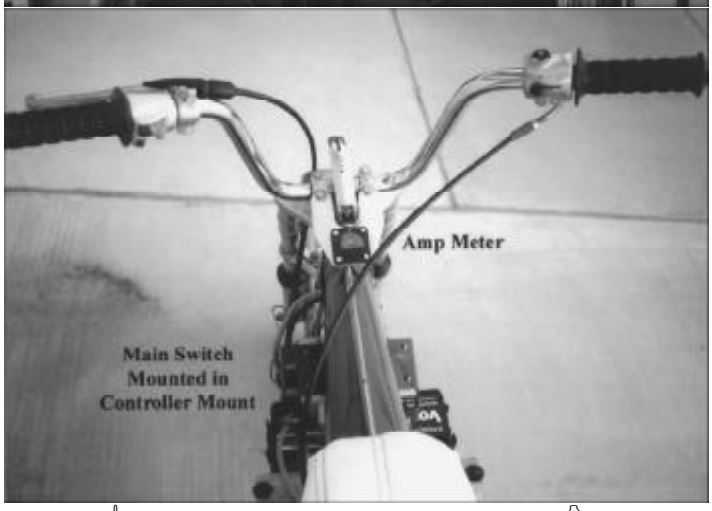


Figure 6 *Figure 7*

Monitor All Batteries at Once

By Gordon Stallings

Introduction

How do you check the condition of your batteries in your electric car? One measure of battery condition is the voltage output under various loads. My Solectria Force has thirteen 12-volt batteries connected in series. Although measuring the voltage of the entire string can tell you if there is a problem, it doesn't isolate the trouble to an individual battery. The Solectria owner's manual recommends load testing the batteries once a year. This test requires a block of time and considerable work. The battery compartments must be opened and each battery's voltage measured.

It would be much more convenient, and safer too, if this test could be done without the effort and hazards involved in accessing the battery chambers. Even better, if the metering were in the passenger compartment, then the driver could evaluate the dynamic performance of each battery under actual driving conditions.

This article describes how to build an instrument that performs this task.

Statement of the Problem

One simple way to monitor the voltage of multiple batteries would be to use a voltmeter and a multiple position switch. Figure 1 is a schematic of such an arrangement with four batteries.

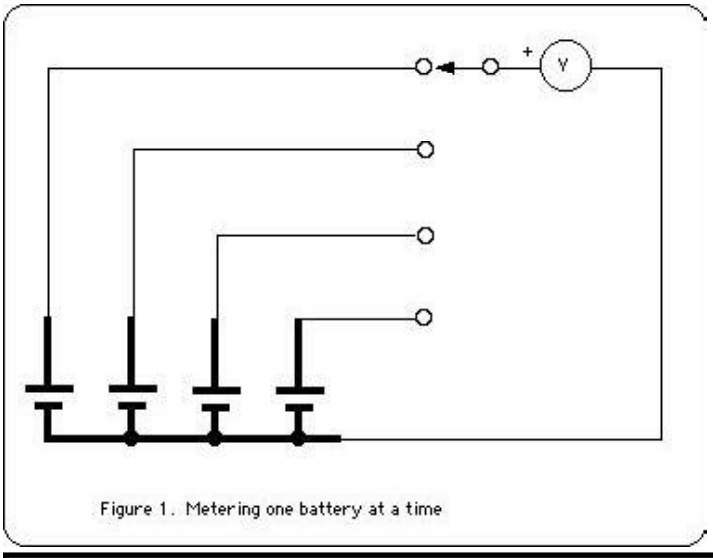


Figure 1. Metering one battery at a time

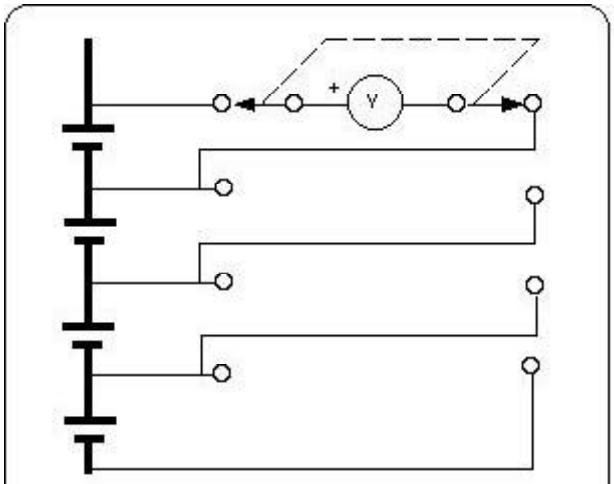


Figure 2. Selecting one battery in a series-connected string.

This arrangement requires the batteries to be separate and to share a common connection. However, most battery systems are series connected.

The diagram in Figure 2 uses one voltmeter and a two-pole multi-position rotary switch to select the battery to monitor. While accomplishing the goal of bringing the metering of batteries out of the battery compartment, this design has some safety problems.

A direct connection to any point in the battery pack is dangerous because of the shock hazard and also because a short-circuit could result in injury or fire.

Revising the design as shown in Figure 3 can reduce the risks.

By placing current limiting resistors right on the battery terminals, only micro-amperes are allowed to flow on the wires of the instrument, even in the case of a short circuit. Note that the meter itself is not a voltmeter but is a micro ammeter with a scale marked in volts.

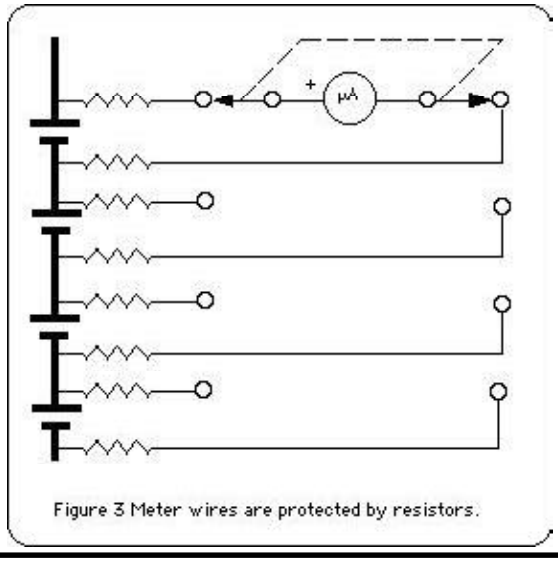


Figure 3 Meter wires are protected by resistors.

Citicar Design

If providing separate meters for each battery eliminates the switch, then the batteries can be compared under identical load conditions. In 1989, I installed just such a meter system in my Sebring-Vanguard Citicar. The dashboard sported eight vertical panel meters, one for each 6-volt battery. I included trimmer potentiometers behind the dash to provide calibration of the meters. Figure 4 is the circuit diagram for one meter.

These meters did an excellent job in the Citicar. It was easy to spot a weak battery and individual cell failures were immediately evident by the 2-volt drop in the meter. I wanted to have similar metering in the Solectria Force.

Designing the System

The dashboard appearance of the Force would suffer if I installed thirteen meters of any sort. But there is room in the instru-

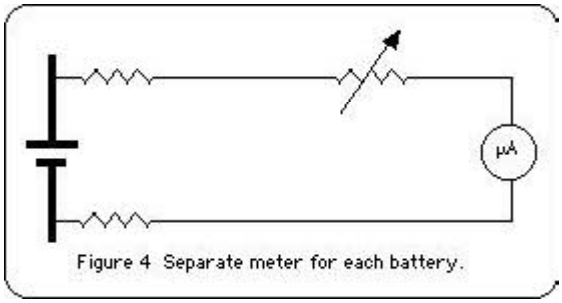


Figure 4 Separate meter for each battery.

ment cluster for one small gauge. I decided to make a display that could show all 13 batteries at once in bar graph format. So the challenge was to design something that could continuously display the voltage of each battery altogether in a compact space on the dashboard. Figure 5 shows what I had in mind for the display presentation.

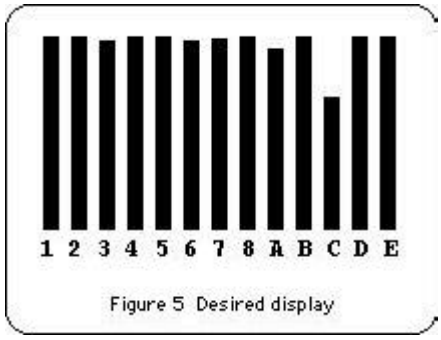


Figure 5 Desired display

The numbering below the bars identifies each battery. The numbers 1 to 8 identify the batteries in the rear set and the letters A through E identify the five batteries under the hood. The height of a bar indicates the terminal voltage of that battery. The display is "live" so that a change in battery voltage results in a corresponding change of bar height. In the example above, battery C has low voltage.

I evaluated several alternatives before settling on a design. My goal was to build a system that is safe, responsive, reliable, accurate, and cheap. As with any design, there were some tradeoffs to be made. The resulting design met most of my goals. I will describe a few of the reasons that I made certain design choices.

The Display

It is difficult to find a display that will fulfill my needs for a bar graph display. I considered using some sort of LED bar graph unit as found on some stereo systems. Eventually, I located a liquid-crystal display of the proper size for the dashboard installation. This display, a Densitron LM4064, is point-addressable, 64 by 100 pixels. Its exterior dimensions are about two inches square and one fourth inch thick.

The display operates using standard 5-volt digital logic, so there must be a conversion from the analog battery voltage to digital values. Fortunately, a huge assortment of digital devices can operate with the display.

The Converter

There are analog-to-digital (A/D) converters available that include switching for monitoring multiple voltages. The switched input scheme is called a multiplexer (mux). So an A/D with mux could replace the voltmeter and switches shown in Figure 1 but only if the batteries are *not* connected in series.

The Isolator

I located a linear optical isolator that serves a key role in the design.

Imagine a small lamp connected to each battery. The brightness of the lamp would depend upon the voltage provided by the battery. If the light from the lamp falls onto a photocell, then the photocell's electrical output would represent the battery voltage. The higher the battery voltage, the brighter the bulb and, as a result, the higher the photocell output. The advantage of this scheme

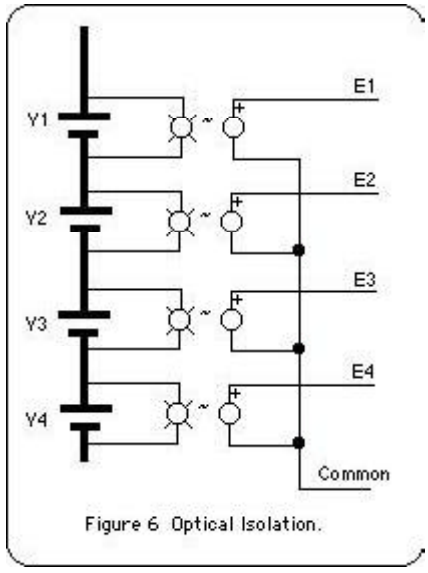


Figure 6 Optical Isolation.

is that the photocells are electrically independent and do not have to be connected in series. In particular, they can be connected with a shared common point, as shown in the Figure 6.

In this diagram, the voltages E1 through E4 are suitable as inputs to an A/D converter, each one respectively representing the voltages V1 through V4 of the batteries.

The PS8602 is an optical isolator that performs the desired function. It delivers analog output for analog input. This makes it possible to get all battery readings referenced to the same electrical common point. By using these isolators, analog-to-digital conversion is much easier and safer as well.

In Figure 7, V is linearly related to the voltage across the battery but it is electrically isolated from the battery.

The variable resistor provides adjustment to make sure that all channels deliver the same V for the same battery voltage. I used two 1k resistors to limit the current into pins 2

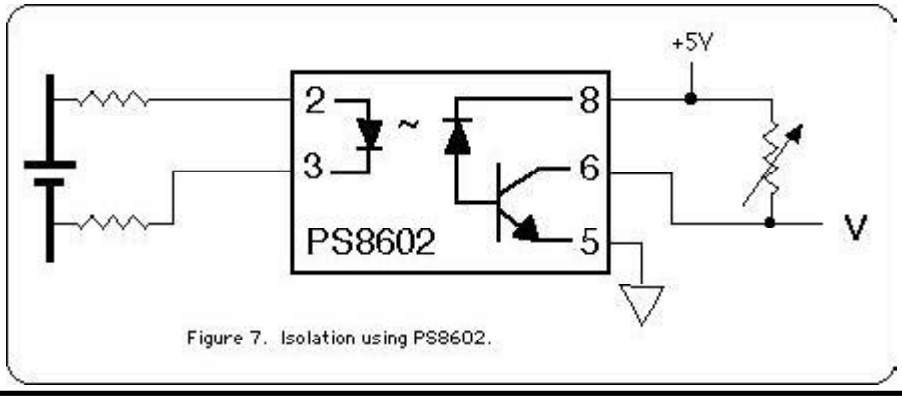


Figure 7. Isolation using PS8602.

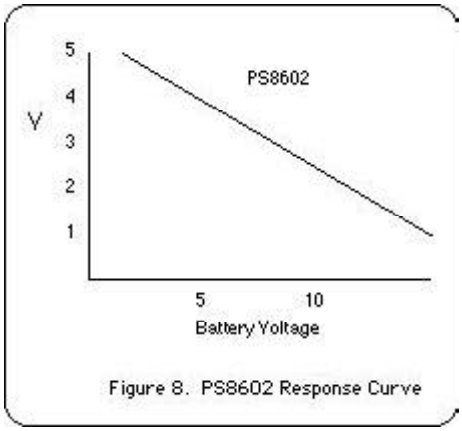


Figure 8. PS8602 Response Curve

and 3. When I adjust the variable resistor to deliver 1 volt at point V when battery voltage is 15-volts, I obtain the curve in Figure 8 as battery voltage varies.

Notice from the graph that output voltage decreases as battery voltage increases. The computer can correct this reverse behavior.

The Computer

The task of operating multiple-channel analog-to-digital (A/D) converters and then arranging dots on the liquid-crystal display in the desired pattern is an obvious job for a computer. I used a Basic Stamp2, which has enough input/output (I/O) lines to control the display and the A/D converters. There are some very nice A/D devices that are designed to work well with small computers like the Stamp.

The Resistors

With 1k resistors at the battery terminals, the current through each resistor is about 6 milli-amperes. However, a worst-case short-circuit between two sensing wires in the rear battery compartment could place 96 volts across 2k ohms. For the resistors to tolerate this condition indefinitely, they would have to dissipate about three watts. I did some tests with 1/4-watt metal-film resistors and found that they tend to blow apart under overload conditions. So in the unlikely event of a short in the sensing wires, a resistor will serve as a fuse.

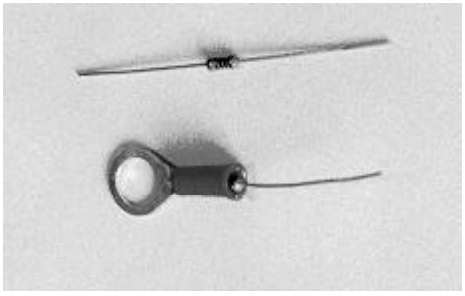


Photo 1 - Resistor in Lug

The resistor fits inside the collar of a ring lug, providing a very convenient way to install the resistors and connect the sense wires. See Photo 1.

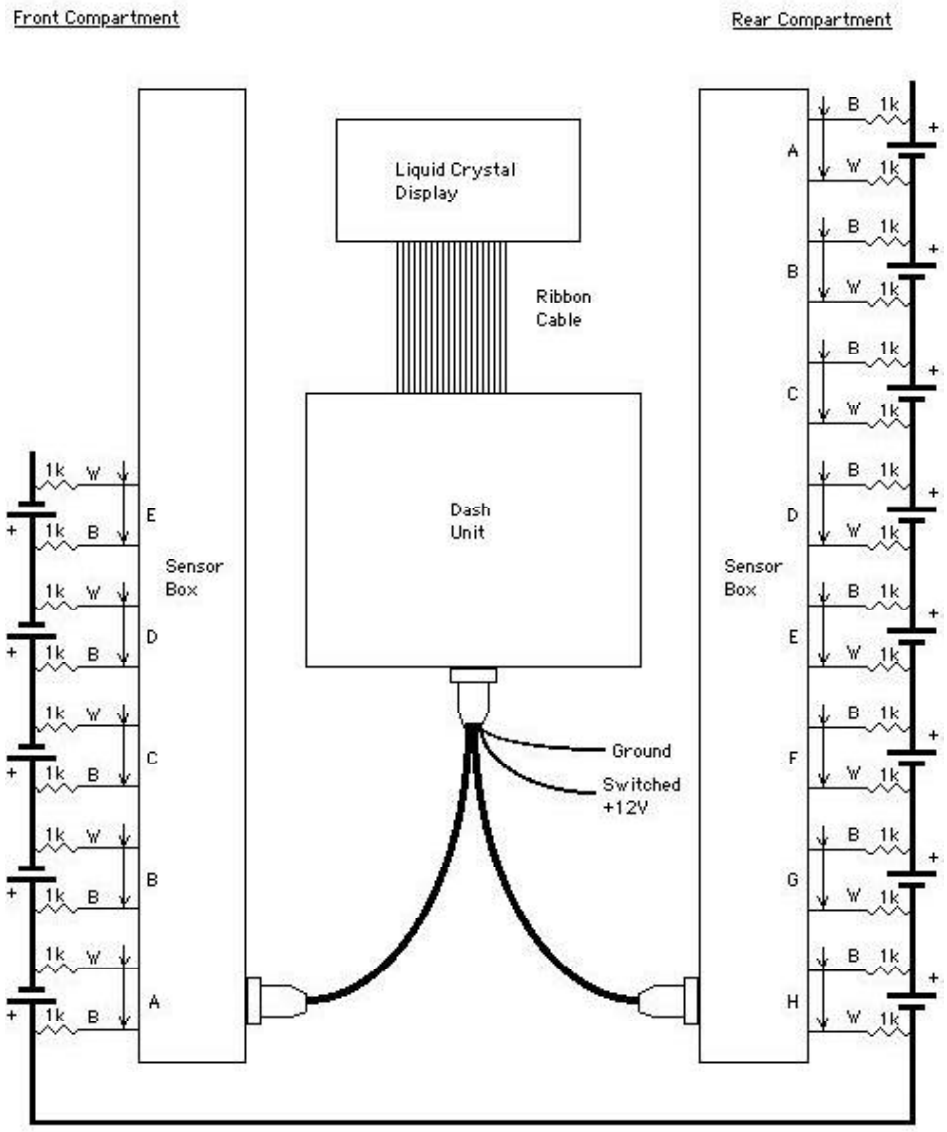
The Design

The A/D unit I chose will handle eight channels of analog. It includes a serial interface for communication with the computer. The batteries in the Force are arranged 5 in front, 8 in back. So the design naturally breaks into two "sensor boxes" near the batteries and a "dash unit" in the dashboard instrument cluster. The Basic Stamp computer is in the dash unit. A small cable interconnects the units. Twisted pair wire is used for the short length of sense wires connecting the resistor lugs to the sensor box. This reduces the influence of stray electrical fields on the analog signals.

See the Cabling Schematic for the final design plan.

Gordon's Battery Monitor

Cabling Schematic



Solder the 1k ohm resistors onto the ring lugs for connection to the batteries.
The black and white wires are twisted pairs.
Sections F, G, and H of the front sensor box are not used.

Schematics

The schematic of the sensor box shows the optoisolators, the A/D mux and a voltage regulator. There are also adjustable resistors for each channel to provide single point calibration. This adjustment compensates for variation between resistors on the battery lugs, differences in isolators, etc. By using a voltage regulator in each sensor box, noise coupling on the power lines is eliminated.

The schematic of the dash unit shows the Basic Stamp2 computer and its cable connections. The Basic Stamp includes a voltage regulator that can accept the regular 12-volt accessory power. This regulator has enough spare capacity to support the power needs of the liquid-crystal display as well. The display includes an LED backlight. I chose to power the backlight whenever the instrument is on. The 150-Ohm, 1-watt resistor powers the backlight.

Implementation

I used Express PCB, a web-based printed circuit board manufacturer to have custom circuit boards made for this project. This greatly simplifies construction for a modest price. The battery box boards fit into a commercial box from Serpac. The end panels on the box mount multi-pin connectors. I put a DB-25 on one end to provide the connections to the twisted pairs that bring the analog signals from the batteries. On the other end, a DB-9 connects the box to the plenum-grade ethernet cable that carries signals between the battery box and the dash unit. This cable also delivers the 12-volt power to the battery boxes, but that power is only provided when the dash unit is plugged in. See the schematics for details on this.

I also used a printed circuit board to mount the Basic Stamp behind the display. The display and computer assembly fit snugly into the instrument cluster behind a handmade mounting bracket. Space is limited in the dashboard, so the only connector on the printed circuit board is the one that accepts the end of the flex cable from the display. Cables for interfacing to the sensor boxes are soldered directly to the printed circuit board and terminate in connectors behind the dash.

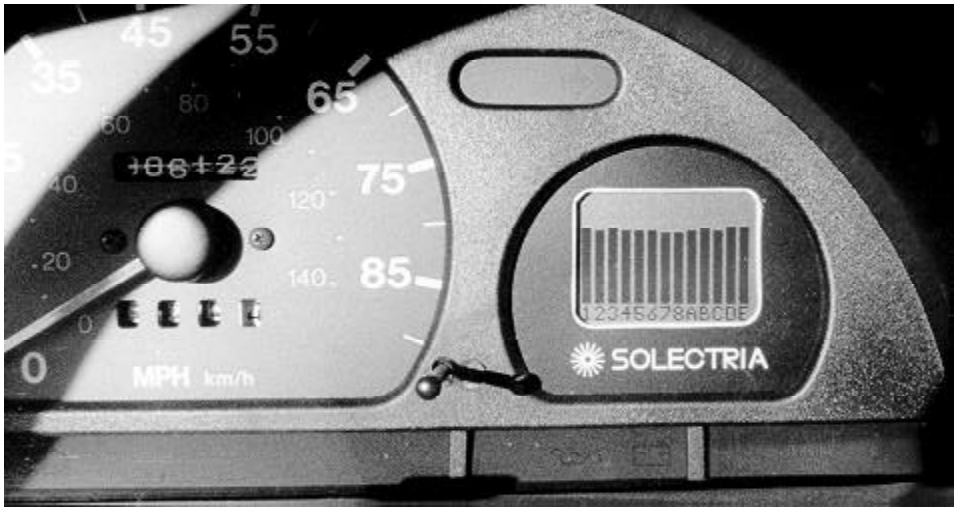


Photo 2 - Display in Dash

The bezel for the display is cut from the original plate that Solectria put into the dash. This gives a very professional look to the installation. See Photo 2.

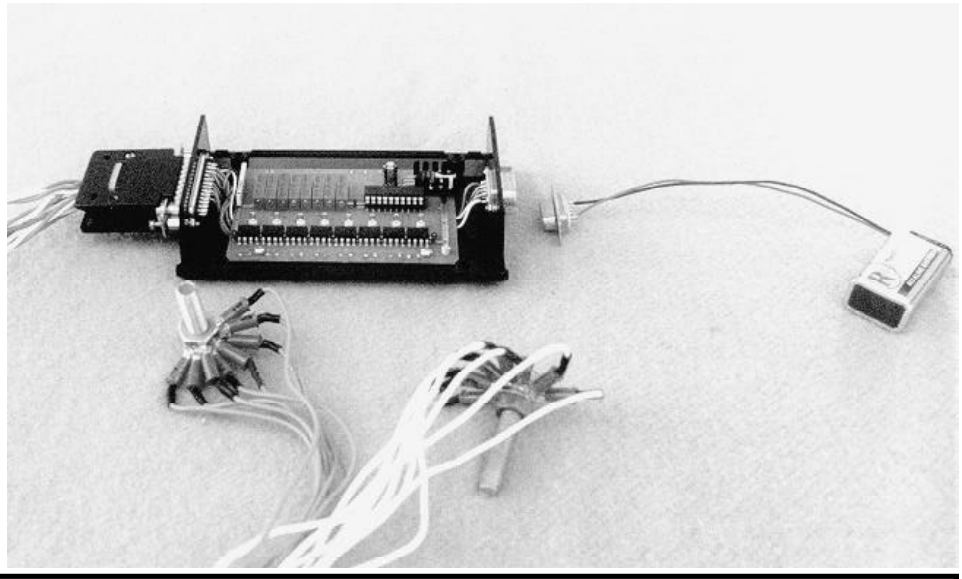
Calibration

Any instrument is only as good as its calibration. So accurate calibration is essential. Each channel of analog signal must be calibrated so that the final display indicates the true voltage of each battery. One way to do this is to connect the cabling and resistor/ring lugs to the sensor box as shown in Photo 3. All positive leads are connected together on one bolt, and all negative leads are connected together on a separate bolt. By applying a known voltage to the two bolts, all of the isolators will be energized under identical conditions. This voltage should be "pure" DC. Any ripple in the power will result in poor calibration.

The 9-volt battery shown in the photo substitutes for the car's 12-volt accessory power during calibration. To calibrate a channel, I connected a voltmeter to the output of an isolator and adjusted the output voltage by means of the 10-turn potentiometer for that channel. I provided test points on each isolator's output to make this measurement easy. I chose to set all channels to deliver 1.50 volts out when 13.5 volts are applied at the ring lugs. This keeps the isolator in its linear region and guarantees that all healthy batteries will show the same reading on the display.

However, this is a single-point calibration and as such, it does not correct for any varia-

Photo 3 - Calibration



tion in the performance of individual isolators. Since the display is only qualitative, I did not bother to deal with this. But it could be done with additional programming.

Programming

The Basic Stamp 2 proved to be an ideal computer for this project. Its BASIC-like language is simple to learn and it can handle bits, nibbles, bytes, and words as needed. I used the BS-2 Starter Kit to connect the Stamp to the A/D converter. Once programming was developed that could communicate with the A/D, then I did the same thing for the liquid-crystal display. The BS-2 has enough program and variable storage for this project and it consumes less power than the fancier Basic Stamp models.

The final program listing for this design fills a little more than two pages of paper. It performs the following tasks when power is applied:

- Erase the display.
- Write the numbers and letters along the bottom.
- Begin Loop
- For each channel,
- Request the value from the A/D mux for that channel;
- Display the bar height corresponding to the A/D value.
- (next channel)
- Repeat the Loop

The program repeats the loop as long as power remains on.

Performance

The bar height represents a voltage range from 5.5 volts to 18.5 volts. This covers the voltages of interest and provides good resolution. One pixel of bar height represents about 0.25 volts. The program loop time is less than one second. This means that changes to battery voltages due to acceleration or regeneration show up on the display very quickly.

The display not only shows the condition of the batteries. It also shows the condition of the battery connections. If a battery's voltage is excessive during regeneration or charging, it may indicate a loose terminal connection.

Evaluation

On a scale of one to ten, here is my evaluation of how well I met my goals.

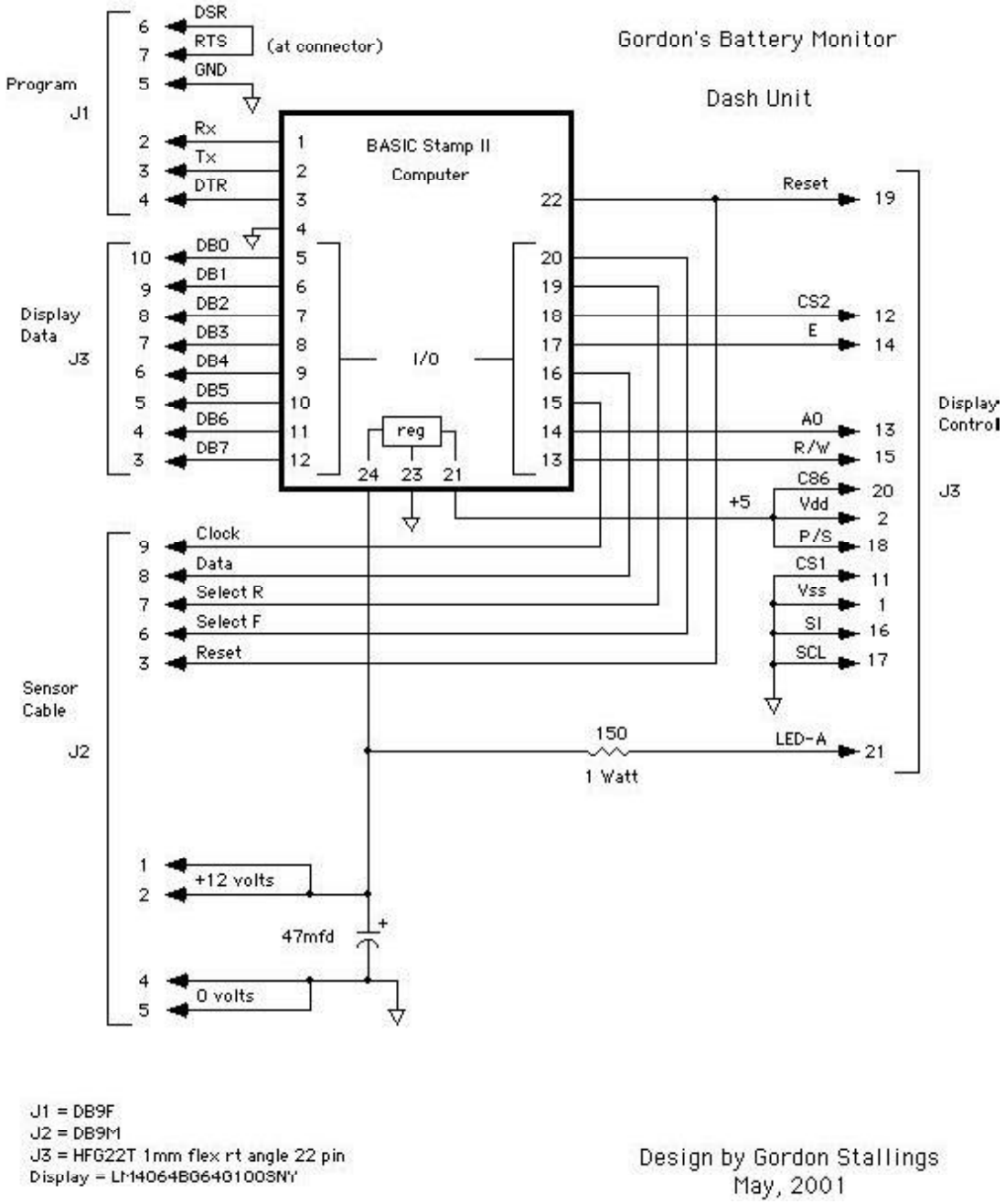
Safe: I would give it a "9". The chances of a fault that would bring the battery power into the passenger compartment are very small. I mounted the sensor boxes in protected areas so that they would not be the first thing to be crushed in an accident. A short-circuit in the sensor wiring might cause a small fire at the battery lug before the resistor burnt out. But the wiring has been kept short and it is protected from any contact with sharp edges that might fray the insulation.

Responsive: 8. The loop time for the computer is slow enough that a sudden change of load on the batteries will show up as a rippling change on the display. But it is not so slow as to be annoying.

Reliable: 8. The instrument is solid-state except for the display. It consumes very little power and operates well over the temperature range that I experience. The weakest link is probably the display. I was unable to obtain the display that I wanted and had to settle for the "commercial" temperature range of 0 to 50 degrees Centigrade. The wide-temperature-range unit is rated for -20 to +70 degrees Centigrade, which is more in line with the automobile environment. Conditions of condensing humidity can also damage the display. I am hoping that the display's location inside the instrument cluster will reduce the risk of humidity short-out.

Accurate: 7. Single-point calibration does not compensate for the differences in "gain" of the different optoisolators. Consequently, the bars do not "track" completely when voltage moves away from the calibration value. This only amounts to about one volt difference when the input voltage drops to six volts. This would be a problem if the vertical scale were marked. Several things could be done to improve the accuracy. One way would be to select matching optoisolators from a larger set. Another approach is to do a two point calibration. This requires some programming to make the computer compensate for differing slopes on different channels. For my purposes, I feel that the accuracy is sufficient. In particular, when driving with a healthy battery pack, all of the channels stay together very well over the voltage ranges that are spanned between heavy regeneration and heavy acceleration.

Cheap: 6. This is a tough one. Including the development kit and the extra things I bought that were not used, my total cash outlay was $670. If my labor were included, it would be much more. I feel that it is very



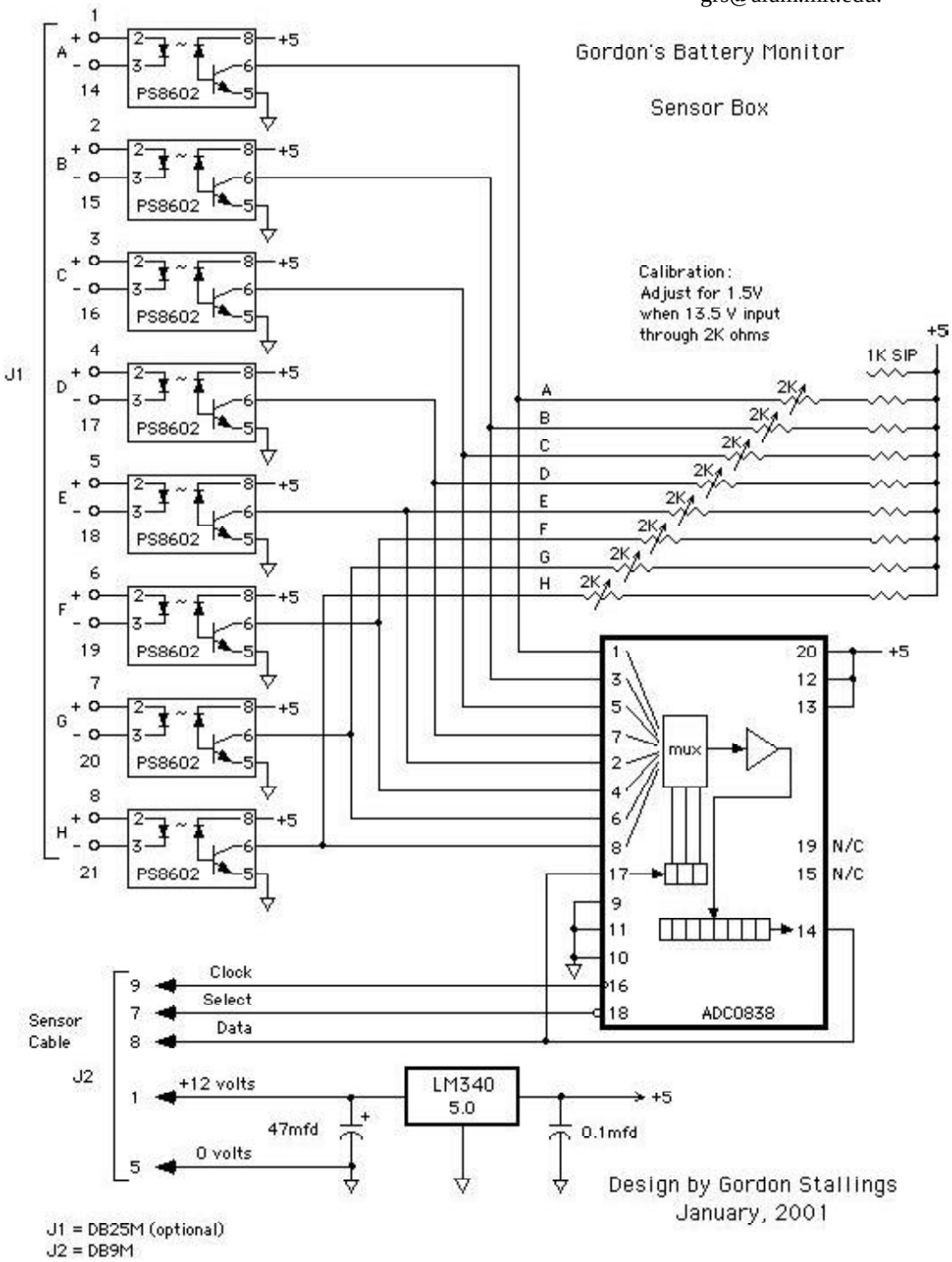
much worth the cost and time involved to have such a cool and useful instrument in the dashboard. There are costly commercial units available which do a similar function but they do not mount in the dash.

Conclusion

It is always a thrill to design and bring to life a combination of hardware and software. Even after exhaustive study of the data sheets of the components, it is almost certain that the first configuration will not work at all. But with perseverance, all the problems and mistakes can be found and corrected simply by changing the program statements or revising the wiring connections. Step-by-step, the project fell into place and even the bezel that covers the mounting of the display worked out perfectly.

The design is easily adapted to different installations. Other than the printed-circuit boards and the software, everything is off-the-shelf. The sensor boxes are quite general and can sense any battery voltage by using appropriate resistors. The sensor boxes are compatible with any computer that can control digital I/O lines. Any sort of display can be used with suitable programming. A point-addressable display can be programmed to show the data in a variety of ways.

For more information about this project, feel free to contact me by email at grs@alum.mit.edu.



CONVERSION WORKSHOP, STEP 7 DESIGNING THE MOTOR MOUNTS

By Michael P. Brown, ©2001

At the end of the last article, we kind of left things hanging. The motor and transmission were bolted to the vehicle by the original transmission mounts, and either wood blocks or a chain in approximately its final position supported the motor.

In this article, we will talk about designing the interface between the electric motor and the existing engine mounts, which are either bolted or welded to the chassis. We call this interface the "motor mount", but the metal and rubber parts that went between the original engine and the chassis are also commonly called motor mounts. To keep it from getting too confusing, I will refer to these original factory parts as "engine mounts".

Getting in Position

In the article on removing the IC components, we took a measurement that located the engine vertically in the engine bay. Now we will use this measurement to locate the electric motor in the vehicle, and design the mount that holds it there.

The transmission mount gives us a point from which to start the motor mount design, as it locates the assembly fore-and-aft and side-to-side, as well as vertically at one end. If the mounting hole on either the transmission or the chassis is slotted, look for marks that indicate where it was in its previous life, and fasten it there.

At this point, I support the other end of the motor with a floor jack. Engine hoists are difficult to work around and, in a lot of cases, are rented by the day. This mount design stage can take some time. Using the jack, raise or lower the motor until you duplicate the measurement you took at the start of the conversion process.

Now the motor can be held in place with wood blocks between it and a crossmember, if there is one in a suitable location. On a front wheel drive car, the motor can be suspended with a chain from a straightedge or board lying across the fenders, if it is strong enough. The purpose of using the wood blocks or chain is to get the floor jack out of the way. This is handy if the car has to be moved for some reason. However you hold the motor in place, be sure to maintain the transmission height at the measurement taken earlier.

Check for damage

Now is the time to take a look at the engine mounts that held the engine in the car. These are usually pieces of hard rubber bonded to metal so that they can be fastened to the chassis and engine. Living as close to the engine as they do, there is a possibility of damage from oil leaks and heat. The rubber will be sticky to the touch and mushy when force is applied if it is oil soaked. If there is heat damage, it will be blistered, hard, and brittle. Make sure that there are no tears in the rubber and no separation where the rubber is bonded to the metal.

Unless they are totally destroyed or collapsed, damaged mounts can still be used at least for the design phase of your motor mount. If the design you develop can use the original style of mounts, but yours are in poor condition, buy new ones when you are ready to start assembly.

Before we go any further, I'd like to add a word of caution. On all motors, there are four sets of two or three bolt heads in a row spaced 90 degrees apart on the motor case. These bolts hold the field coils to the motor case. Under no circumstances are these bolts to be removed and their holes used to hold part of the motor mount. Even loosening the bolts may result in motor damage.

Front engine/rear wheel drive design

Now we are going to focus on the front engine/rear wheel drive car or truck motor mount design. Since most of the passenger cars converted are front wheel drive, this section applies mostly to light trucks. This type of mount is often called a "cradle mount." It consists of a U-shaped steel strap bent to fit around the outside diameter of the motor, and another smaller piece of strap that bolts to the top of the U-strap to clamp it in place. The purpose of this mount is to locate the motor end of the motor/transmission assembly both vertically and side-to-side in the car or truck. The strap should be no less than 3/16 of an inch thick and no less than 1 1/2 inches wide.

Next bolt the original rubber/metal engine mounts to the chassis. The gap between the rubber/metal mount and U-strap around the motor is what you have to fill. This can be done with another pair of straps which will bolt to the rubber/metal mount on one end, and be welded to the U-strap on the other end. The bolt end of each chassis strap may have to be angled to match up to the face of the rubber/metal mount.

Once you have the strap design worked out, it is important to make flat triangular plates to weld across the angle where the motor straps meet the chassis straps. These plates are called gussets, and they will make the mount stronger and prevent bending and twisting.

Mock-ups To Check Fit

I have found it very helpful to use cardboard or foam-core art-board to make a mock-up of the mount. Another place where a mock-up can help is checking for interference between the mount and things like motor terminals or the heads of the motor field bolts I mentioned earlier.

Sometimes offsetting a hole in the strap a little can eliminate a fitting problem. Another trick is to use a steel spacer plate to offset the rubber/metal mount a little forward or backward from its original position on the chassis. Also, be sure that no part of the mount assembly projects into the space where you are planning to put battery racks and boxes later.

When all of these issues have been resolved, measure the parts of the mock-up and make drawings for yourself or the welder who will fabricate the mount. It doesn't hurt to show your welder the mock-up as well.

The cradle mount system is the easiest one to use in front engine/rear wheel drive cars or trucks. It uses existing parts and doesn't require any welding on the chassis. Ninety percent of the rear-wheel drive cars and trucks suitable for conversion will work with the motor mount we have just described. If you have a vehicle that won't work, call or

email me and we'll talk about it.

Torque Control

As I said earlier, the purpose of this mount is to locate the motor vertically and side-to-side in the car or truck. The motor case must also be prevented from rotating around the armature when it is in the nearly locked armature condition that occurs during a standing start. The best fitting cradle mount, tightened as tight as possible, will not stop the motor case from rotating under these conditions. Even if you could fasten the cradle mount directly to the motor, IC engine mounts are not designed for this kind of load and will stretch enough to cause problems.

The solution to this problem is a torque rod. This is a rod or bracket that goes between the chassis and the motor/transmission assembly to prevent rotation. I like to use a torque rod from a 1975-1979 Honda Civic. It looks like a dog bone with a rubber bushing at each end. One of the bushings and its holder unscrew from the rod, leaving a handy threaded hole you can use to fasten a bracket between the rod and the motor or adaptor. The bushing end of the rod then mounts to the chassis and holds the motor in place.

The torque rod can go between the motor and the chassis or between the adaptor and the chassis. It can act in tension or compression, so it can be mounted where it is least in the way. The use of one rubber-bushed end is recommended to isolate the chassis from drive train vibrations.

Front Wheel Drive Design

Now we'll look at the front-engine/front-wheel drive cars, which are the cars most modern conversions are based on. The good news is that the engine/transmission packages are pretty sophisticated, with good locating systems, usually two transmission mounts, and torque control already built in. The bad news is the engine compartments are small, so mount design can get tricky. Also, the cars are of unibody construction, so bolting and welding things to the chassis must be done carefully.

Most of these cars have two transmission mounts and at least one of them bolts directly to the transmission. In some cars the bolts holding one of the mounts go through the engine block and then into the transmission. In this case, the original bolts can be used along with washers or machined spacers to make up the difference between the thickness of the engine block and the adaptor plate. If this needs to be done in your car, do it before the next step.

Lower the motor/transmission assembly into the car and attach the transmission mounts to the chassis. Support the motor with a floor jack or a chain to the straightedge as I described for rear wheel drive cars. Duplicate the transmission height measurement taken earlier.

Now we can design the motor mount. Again, it is best to use as much from the original mount system as possible. Bolt the factory engine mount into position and see if an arrangement of plates and straps will fill the gap. How easily this is accomplished depends a lot on the brand of motor you are using. The popular Advanced DC motors have threaded holes on the brush end of the motor for mount bolts. The older GE and Prestolite motors have no such holes so a clamp similar to the cradle mount described above must be worked into the mount design.

Sometimes there is no way to use any of the original mount in your design. In that case, design the part that attaches to the motor, make your drawings, and have it built. With that in place, design and fabricate the mating parts that have to be welded to the chassis. Bolt everything together where it belongs and tack weld the chassis parts to the car. Then take everything apart and make permanent welds.

Welders and Bushings

If you are doing your own welding, this is easy. If not, you might pick a welder who can come to you for the chassis welding. But you should still have everything else done at the welder's shop, as mobile rates are usually higher. I had one conversion towed to my welder's shop, installed the motor, and had him do the rest of the mount fabrication. The tows there and back to my shop cost a bit, but the results were worth it.

A word about rubber bushings. If you use the factory rubber bushings or mounts in their original position with the loads applied in the same direction, you should be all right. On the VW Rabbit, the engine mount bushing is round, and the hole through it for the bolt to the chassis is off-center. There is an arrow and the word "Up" molded into the rubber. This bushing only works in one orientation.

If I had used the original part in my mount, it would have been turned with the arrow pointing to one side, which would not have worked. Instead, I ended up using a GM rear control arm bushing (Moog #K6178), which was the right length, had the right bolt hole size, and was heavier duty as well. Most of the time, a search through the catalogs at a good parts house will provide you with what you need for a suitable substitution.

On front wheel drive cars, the torque rod issue is usually dealt with by the factory, as too much movement front-to-back would have an adverse effect on the gear shift and throttle linkages. Here's a good rule to follow: if there is a torque rod in the original engine mount system, then you should use it or something like it in your motor mount system. The factory torque rod will probably work in your application with little or no modification.

Mission Accomplished

So there you have an idea of what is involved in designing a motor mount for your conversion. I hope I haven't scared anybody off. If you want to skip the whole mount design part of a conversion, convert an air-cooled VW Bug. The motor can just hang off the transmission without a mount, like the gas engine did. These transmissions had three mounts on the transmission alone, which were capable of supporting the engine as well.

These are some general thoughts about motor mount design. If you have a specific question or problem, feel free to phone or email me and I'll try to help.

In the next issue we will start to talk about battery rack and box design.

Simple EV "Gas Gauge"

By Mark Brueggemann, Albuquerque, NM

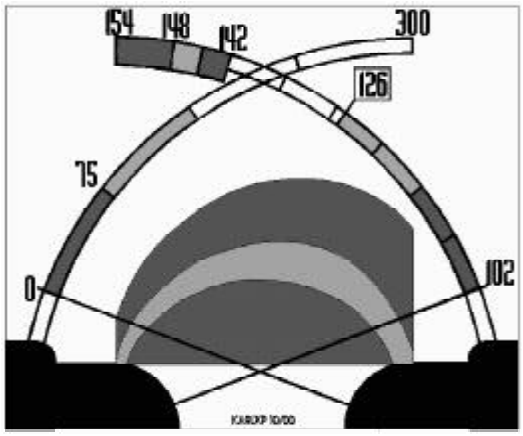
This article details the construction and use of a simple EV battery state of charge meter. The meter answers the need for a quick check of your EV batteries' state of charge while in motion. It is inexpensive to build, simple to install and easy to interpret, just like a gas automobile's fuel gauge. As described here, it cost less than $30 to build.

Operation

This SOC meter has proven to be a very useful addition to my EV. While it doesn't give you an actual amp-hour value of remaining battery capacity, it does tell you your *usable* SOC (State of Charge) at any time while in motion. While driving, all that is required is to glance at the meter and see where the needles cross. If it's in the green you're fine, yellow, you'd better be on your way to a charge, and red, you'd better stop before you reverse a cell. I've been using this meter since July 2000 and now trust it implicitly.

Theory of Operation

There are no new concepts or advanced technologies here. I'm using what may be considered an unconventional analog meter to graphically display my EV's state of charge by comparing voltage to current under load. As a lead-acid battery discharges its internal impedance goes up. Hence, the voltage drop across the pack under load will be less at full charge than when 50% discharged, and much less than when fully discharged. By empirically testing the impedance of the pack in the vehicle, then mathematically extrapolating the points in between, I plotted on the analog meter what the SOC (State Of Charge) was for any point between fully charged and discharged. The same information (current and voltage) is available with standard current and voltmeters most EVs have, but my concept allows the SOC to be determined at a glance, rather than having to interpret the data presented on two separate meters simultaneously.



Static Voltage SOC Scale - Full Size

The inspiration to use a cross-needle meter came from my MFJ-817 SWR meter, an instrument we use in ham radio to measure

This is the cross-needle meter movement as received from MFJ.

the ratio of transmitted power to power reflected back by the antenna. It has two movements with a common face, each needle with about a 90-degree swing. The meter movements themselves are available as a replacement part from MFJ Enterprises (http://www.mfjenterprises.com). I set up one movement to read voltage, the other current. The area where the needles cross in the middle is where I put my computed SOC value graphics. Other data such as power in watts or horsepower could also be put in this area. I chose SOC since getting home is usually the most important to EV'ers! The green, yellow and red shaded areas represent the following states of charge:

GREEN: 100-50%
YELLOW: 50-20%
RED: Less than 20%

These values were derived by empirically testing the pack to determine the 100% SOC voltage drop (so that cables, terminals, contactors and other series components were included), then mathematically calculating the equivalent impedance. The 20% SOC point ("RED" area) wasn't actually measured, its values were chosen as the "EV rule of thumb" discharge limit of 1.75VPC (Volts Per Cell) at 75A draw.

Construction

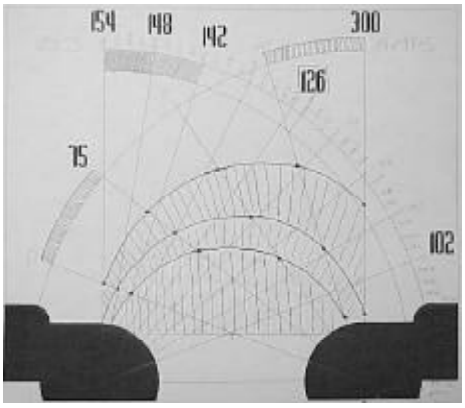
Using the table (below), I used an old version of Corel Draw for OS/2 to create a new meter face for the MFJ SWR bridge meter movement. I printed it on glossy laser printer stock and glued it over the existing meter face using rubber cement. Colored perma-

The MFJ-817 Peak Reading SWR/Wattmeter

Measured/Calculated Battery Pack Impedance Chart
As measured at the input to the controller.

SOC	No Load Voltage	Pack Z	Pack V @X Amps	0A	75A	150A	225A	300A
100%	153.36	.13920 Ohms	:	153.36	142.90	132.50	122.00	111.60
50%	147.60	.16908 Ohms	:	147.60	134.90	122.20	109.60	96.90
0%	141.84	.19920 Ohms	:	141.84	126.90	112.00	97.00	82.10

Bill Cingras's home-built 36Ver



Worksheet for creating SOC graphic.

nent markers are used to fill in the appropriate colored areas. There are two scales built into the meter. The first is the direct SOC reading in the area where the needles cross. The second is a static voltage graphic on the voltmeter scale. The SOC of a battery that has been idle (not charging or discharging) for at least 3 hours or more may be determined by measuring it's open-circuit voltage. This scale can be used to read the pack's open-circuit voltage and get a rough idea of the SOC without even turning the vehicle on. This is subject to temperature of the pack, but gives a useful indication of SOC.

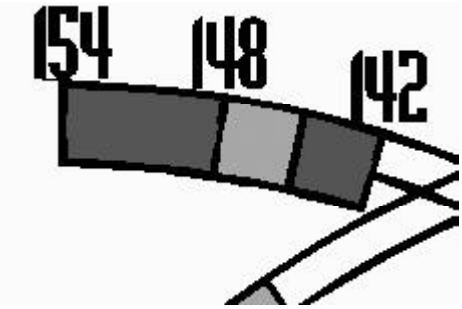
The circuitry used is very straightforward. The current meter uses the negative-most battery interconnect cable as a shunt, with a 1K ohm pot in series to set the current reading against a calibrated value. I would've liked to use a standard shunt, but these particular meter movements have an full-scale sensitivity of 165mV, not the 50mV movement standard shunts require. The voltage side uses an expanded scale voltmeter circuit commonly found in EVs.

Given the size and quantity of parts, I built the circuit "dead bug" style inline with the cable connecting it to the meter. It looks like a bump of tape in the center of the cable, with the pot adjustment screws peeking out from under the tape (I used 10-turn miniature pots). The assembly should be transferred to a more permanent and waterproof enclosure for long-term installation. Voltage calibration was performed on the bench with a high-voltage power supply and digital voltmeter; the current calibration was performed in the vehicle by matching the readings to a separate 50mV meter and a standard shunt. Since very small changes in the actual shunt used will result in erroneous current readings, I thought it would be best to calibrate it in the vehicle under actual use conditions.

That's it! Other than the physical mounting considerations in the vehicle, the "EV Gas Gauge" is ready to use and needs no further user intervention or adjustments.

Comments and Observations

This is no E-Meter. It will not tell you how efficient your EV is, provide you with streaming data or gather statistics on your pack for you. It doesn't cost $300, either. Even though it's not temperature compensated, I found that it really doesn't matter. When it's cold the meter drops more quickly than when it's warm; thus technically it is reflecting the *effective* SOC you have available to you. Just because it's cold out doesn't mean you reduce your amp-hour draws to compensate. In reality you usually use more amp-hours to overcome stiff tires and lubricants, plus the additional load of a heater. Thus, I've learned to really pay attention to the EV gauge when driving with cold batteries since they deplete that much more quickly. A big plus I've found with this setup is that it reports your SOC after mixed driving and charging cycles. I don't have to do a 100% charge to reset the reading, as with an E-Meter. I can mix charging and driving during the day and know where my pack capacity is at any given moment. I consider my concept to be the direct equivalent of an ICE's gas gauge. It is not an absolute quantitative measurement but a close indication of what I've used and how much is left. Just like in a dino-juice car, if you drive hard and fast the needle goes down more quickly than if you drive slow and easy. More than once I've turned around based on what my EV gauge has told me, and likely prevented myself from needing a tow or worse, damaging my battery pack.



Static Voltage SOC Scale

For more information, see author's website: http://www.qsl.net/k5lxp/ev/evgauge/evgauge.html

Part Number: 400-3084A
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Tech: (800) 647-8324 (662) 323-0549
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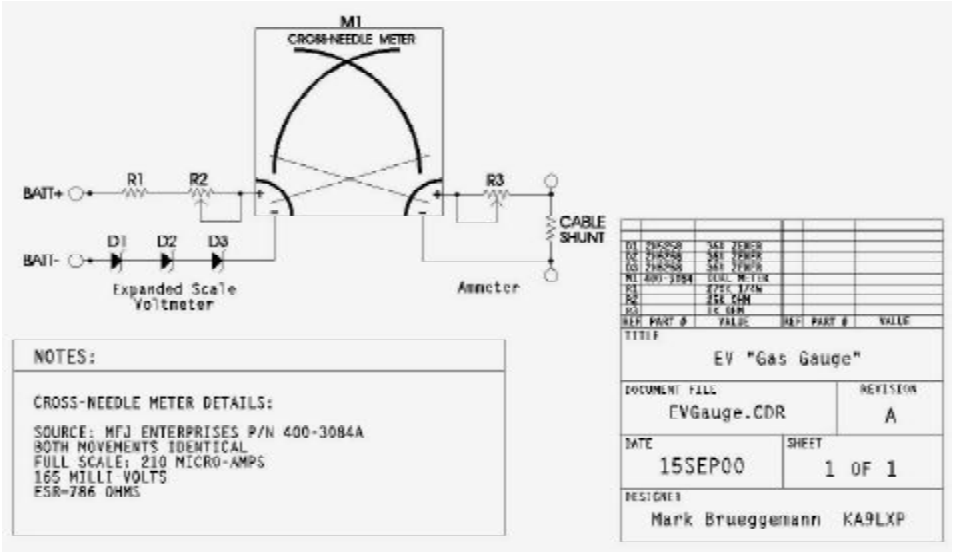


NEDRA SACRAMENTO EVENT

By Rich Brown

Hi all,

I guess it is about time to write something about the Northern California NEDRA Event at Sacramento, on Sept 29. I arrived somewhat late at around 10:30 am. Otmar was already there with his s-t-r-e-t-c-h van, 2/3 of two VW vans that have been joined together to make one very long van. Otmar uses the stretch van to flat tow "CA POP E" his orange Porsche 914.

I parked next to the truck I had rented and set-up my trusty old variac based shop charger. After hooking up the charger cords I started the rented 3600-watt generator and the D'7 was being noisily charged with a paltry 14 amps. I greeted Otmar (Doctor 'Zilla), Bruce (Evangel) Parmenter, Royce Chow, Nathaniel Martin, Brian (Main Fuse) Hall and his gang.

Eventually, after charging for a few minutes, Otmar and I decided to line up for a run. Drag racing is all about lining up, being ready to race and then waiting. It took awhile but we were finally called up to the line.

I was directed into the left lane and Otmar was pointed to the right. I drove around the water pit, but Otmar did a nice showy little burnout. A bit of nice smoke rolled off his tires. I was proud of him. All the gasser dudes were watching us.

It was time for us to stage. We rolled forward...first pre-stage... then the second, staged light. Usually, at this point, I see a green flashing LED on my instrument cluster pounding out the seconds to launch. It tells me that the bypass contactor is armed and ready to slam huge amps into the dual 8" motors mounted just inches away from me. At Woodburn this year, that bypass contactor welded shut and I had an exhilarating and somewhat costly shut down experience. It was recommended by some to launch of the line with my controllers and then engage the by pass so that it doesn't have to switch or carry the big amps. That made sense to me, so I thought I would give it a try. I certainly didn't want to weld another contactor anytime soon!

The yellow lights started counting down on the tree. Otmar and I both waited for the green before mashing the go pedals. The "CA POP E" had a great launch and immediately jumped out ahead of me. The D'7 on controllers alone launched much more tame than usual. I waited for the motors to spin up and then, without looking, I flicked the small red paddle switch on the dash that arms the bypass contactor. Since my right foot was already buried in the floor. The contactor closed immediately...whoa!! It's like a really big turbo that finally kicks in.

It was to little too late though. I didn't close any ground on Otmar. I flew through the traps and let off of the throttle. The D'7 continued to accelerate! I got that sinking feeling and hit the brakes...didn't help...let it pick up some more speed and pulled the circuitbreaker release handle on my dash. Otmar slowed and was waiting for me. I rolled down the window and yelled to him that I needed a tow.

Otmar's light Porsche 914 and 240V of Optimas were more than a match for the D'7. Otmar turned in a fantastic 14.88 in the 1/4 mile! The D'7 did a mediocre 15.5. Otmar broke the record of 16.1 that he had previously set at Woodburn just a month ago.

My wife drove the truck back down the inside return track to where I was parked on the grass. I verified that the new bypass contactor, that I had just installed, had indeed welded on the first use. I removed the bypass cable that ran from the contactor to "motor +" on the Raptor controllers and was able to drive back to the pits. I think I am getting a reputation. Everyone just new I had melted something with smiles grins all around.

I did race Otmar a couple more times on controllers alone, but the D'7 was slow without its "turbo boost". Otmar had a very good day he was able to best his first time and turn a very quick 14.7x.

Congratulations to all who were there and had fun. There are lots of other stories out there. it would be nice to here them.

Rich Brown
San Jose, CA
Dualin'7

Otmar's "CA POP E", Porsche 914 EV

Anaheim makes Electric Cars Available

A new clean-air program in Anaheim, California, is giving low- to moderate-income residents access to city-owned electric vehicles for free as part of a $300,000 state pilot program to cut pollution. Anaheim purchased 10 electric cars and placed them in areas targeted for redevelopment. Following a drivers' license check, any resident living in a complex where the cars are garaged can borrow one and go for a drive. (USA Today, July 25, 2001)

Paice Introduces Hyperdrive Hybrid Technology

Paice Corporation recently introduced a new hybrid drive system that is expected to significantly improve the performance, fuel economy and pollution control of virtually all cars and light trucks. The company said its Hyperdrive system will be the first gasoline-electric hybrid powertrain that will be able to power all types of vehicles in demand by consumers. This drive system can double the fuel economy of most cars, sport-utility vehicles and light trucks, and its pollutant emissions are significantly below all current and proposed regulatory limits.

Paice CEO and Hyperdrive inventor Alex Severinsky also said that Hyperdrive can equal or better the speed, acceleration, grade-climbing and trailer-towing performance of current vehicles and is able to operate in all climates and weather conditions. The company said the Hyperdrive technology can be produced at costs similar to current vehicles because it uses the same technologies and materials. In addition, Hyperdrive runs on gasoline, diesel and other fuels with existing distribution infrastructure.

EFC Reports Successful Testing of Electric Bus

Electric Fuel Corp. (EFC) announced record-breaking results in Phase 2 performance testing of its all-electric transit bus. The prototype bus, powered by EFC's Instant Power zinc-air battery technology, was driven a record 110 miles on a single charge, more than 100 of which was under the Society of Automotive Engineers' demanding Central Business District (CBD) cycle. EFC officials said by reaching 110 miles with a full load, their EV bus exceeded its design goals for this testing phase, set at 95-miles with 50 percent passenger load. "We hope to be able to have our first on-road drives of the Electric Fuel bus in Las Vegas this fall," said Yoel Gilon, EFC's EV program manager. "The actual scheduling will depend upon the various project partners and the FTA."

The vehicle, a standard 40-foot transit bus, has room for 40 seated and 37 standing passengers and weighs about 20 tons. Further Phase 2 testing will focus on the zinc-air batteries' ability to move the bus as well as to power such systems as air conditioning and handicap lifts.

House Energy Package Supports EV Technologies

The U.S. House of Representatives has approved the bill H.R. 4, known as the "Securing America's Future Energy Act of 2001" or "The SAFE ACT," by a vote of 240 to 189.

If enacted into law, H.R. 4 will provide significant federal income tax credits to consumers who purchase battery-powered EVs, fuel cell-powered EVs, hybrid electric cars, trucks and buses, and neighborhood electric vehicles. In addition, the current $100,000 deduction for EV and alternative fuel recharging and refueling property is extended until December 31, 2007.

"One of the real barriers to the commercialization of electric vehicles during early market introduction is the high initial purchase price," said Electric Vehicle Association of America member Curt Magleby. "Providing consumer-based incentives for advanced transportation technologies like battery, electric, hybrid and fuel cell vehicles will help consumers make the choice to purchase these clean and energy efficient options."

EPRI Report Says Plug-In HEVs More Efficient

EPRI, formerly the Electric Power Research Institute, recently released a report which found that a "plug-in" hybrid electric vehicle (HEV) with a 60-mile, all-electric range produces half the amount of harmful air pollutants as an HEV with no all-electric range. The report also found that the plug-in HEVs are four times more fuel-efficient than HEVs with no electric range. However, the study also noted that the cost for plug-in HEVs would be greater than self-charging EVs because of the larger battery packs needed in the plug-in HEVs.

The report concluded that "all hybrid powertrains can operate midsize passenger cars comparably with conventional vehicles, and do so with major reductions in petroleum use and pollution." Additionally, the study found that "efficiency and environmental benefits increase with HEV [all-electric] range."

EPRI also conducted a consumer preference survey as part of the project. The survey found that most consumers would prefer to charge a plug-in HEV on their own premises, rather than at a gasoline station. The survey also found that between 35 and 46 percent of the respondents would buy a self-charging HEV over a conventional vehicle because of the lower cost increment of a self-charging HEV.

Mitsubishi to Conduct 500-mile EV Test Run

Mitsubishi Motors Corporation recently announced that it would attempt to make a two-day, 800-km (500-mile) test run with its electric vehicle (EV) around the island

of Shikoko in real world traffic conditions without recharging.

The test is scheduled to take place on August 25 and will assess the capabilities of the vehicle's electric engine and batteries on public roads. Mitsubishi said it will build upon this experience in designing its future hybrid electric and fuel cell-powered vehicles.

The company said the current prototype is based on its Eclipse, which is built in the U.S. The electric motor, built by Mitsubishi Heavy Industries, Ltd., weighs half as much as earlier models. Japan Storage Battery Company makes the manganese lithium ion battery.

DOE Studies Neighborhood Electric Vehicles

The Department of Energy (DOE) field operations program recently studied 15 automotive fleets that operate neighborhood electric vehicles (NEVs) in the United States. The study was conducted in order to understand how NEVs are being used in fleet applications.

DOE said the 15 fleets included military, commercial, municipal, rental, and transportation organizations. The fleets were identified, contacted by phone or e-mail, and asked 20 questions about their 348 NEVs. Results from these questions showed that NEVs are driven 1.2 million miles per year, which means that about 29,000 gallons of petroleum are saved.

Moltech Batteries Help University of Wisconsin Engineers

Student engineers from the University of Wisconsin-Madison (UW) have used Moltech Power Systems' nickel metal hydride (NiMH) battery technology to achieve top rankings in two national hybrid electric vehicle (HEV) competitions. UW engineering students received top awards in the Tour de Sol and the FutureTruck 2001 competitions by re-engineering two SUVs using NiMH batteries to achieve reduced emissions and improved efficiency.

In the FutureTruck 2001 competition, the UW team was given a full-size sport-utility vehicle to re-engineer for increased efficiency and reduced emissions while maintaining performance and consumer expectations. In placing second overall the UW team received awards for lowest greenhouse gas (GHG) emissions, safety, best appearance, best use of materials and innovations in aluminum.

The UW team also placed first overall in the Tour de Sol, entering a mid-size car powered by a similar Moltech NiMH battery, which provided the vehicle with 33 percent more power than the nickel cadmium (NiCd) battery the team used in the competition the previous year. The increase in power allowed the team to create a more efficient vehicle, utilizing more stored energy for greater acceleration and performance.

Nevada Electric Vehicles Opens New Shop

Nevada Electric Vehicles, Inc. (NEV) recently unveiled its new Las Vegas area showroom, located at 7585 Commercial Way, Suite 1 in Henderson, NV. The grand opening ceremony and opening festivities continued for a week. The company distributes a number of electric vehicle (EV) products, including custom-built golf carts by Western Golf Cars, the eBike electric bicycle, the Lido neighborhood electric vehicle, and products from Duffy Electric Boats.

Owners Mark Reid and Dave Phillips also offer other services to potential customers, including parts and service, custom vehicle accessories and more. The company said it is stressing the convenience of electric vehicles, as well as the potential benefits to the environment. Additionally, customers will be able to take advantage of federal tax credits for their EV purchases.

Xoliox Develops New Battery Technology

Xoliox recently announced that it has developed a new technology that it believes has the potential to be useful in making batteries for electric vehicles. The company said that its metal oxide nanomaterials have demonstrated the ability to charge and discharge power more than 100 times faster than conventional lithium ion batteries.

Xoliox, which specializes in the development of nanomaterials for high-tech applications, said that the ability to charge and discharge power from a battery so quickly would help to make electric vehicles a viable alternative to the internal combustion engine. The company's researchers said that the performance and convenience of this new technology could break down many of the commercialization barriers for electric vehicles. (FINANCIAL TIMES: 8/16)

Hybrid Electric Vehicles Could Sell Above Allotments in 2001

Japanese automakers Honda and Toyota recently reported that sales of their hybrid electric vehicles (HEVs) in 2001 are exceeding the number that they had planned to import. Toyota has sold 8,400 of its Prius HEV, a rate which is considerably higher than the company's allotment of 12,000 for the year. Honda said it has sold nearly 3,000 of its Insight HEV, a rate which is expected to meet the company's allotment of 6,500 for this year. "There have been a lot of horror stories on how we're taking huge losses," said Toyota national advanced technology manager Ed LaRoque. "We're not."

Honda said sales of its Insight HEV increased 137 percent earlier this year when gasoline prices soared above $1.70 per gallon. Although gasoline prices have abated, sales of HEVs are still high. "I think the car makes a philosophical statement," said James Crowley, an owner of an Insight HEV. Crowley noted that the two things he most enjoys about driving his HEV is "the odd stares and the thumbs up signs he receives from other drivers."

Toyota hopes to produce 300,000 HEVs worldwide by 2005. Honda said that it will fit an undetermined number of its Civic vehicles with HEV technology starting next year. In the meantime, Honda and Toyota salespeople in the U.S. are lamenting the limited supply of the automaker's HEVs. Toyota officials said there is an average waiting time of three months for a Prius HEV. (REUTERS: 8/19)

Toyota Introduces Crown Royal HEV Models

Toyota Motor Company recently launched three models of the Crown Royal Saloon equipped with a mild hybrid system that uses

a compact belt-driven motor to help lower emissions. The company said its Toyota Hybrid-System-Mild enables the reduction of emissions such as hydrocarbons and nitrogen oxide from 3.0-liter models to levels at least 50 percent lower than the 2000 standard.

Toyota also said the hybrid electric vehicle (HEV) models are equipped with direct-injection engines, compact motor generators and compact 36-volt batteries, and meet 2010 fuel consumption standards required by the Japanese government. (KYODO: 8/20)

Ford Develops New HEV Powertrain

Ford Motor Company recently announced that it has developed a new drivetrain for use in its future hybrid electric vehicles (HEVs). Ford said that the system, which it developed with the help of Aisin AW, will debut in the 2003 Ford Escape HEV. Featuring a PowerSmart transaxle system, the new drivetrain is expected to provide improved acceleration and overall improved system efficiency. The Escape HEV combines the technology of an electric motor and a fuel-efficient, four-cylinder gasoline engine, to form the world's most fuel-efficient sport-utility vehicle (SUV), and is expected to provide a fuel economy of nearly 40 miles per gallon in city driving conditions. Ford claims that the vehicle can maintain this efficiency while achieving acceleration and performance similar to that of an Escape equipped with a traditional 200 horsepower (hp), V-6 gasoline-fueled engine.

Japan Storage Battery Company, Toyota Develop More Powerful HEV Battery

Japan Storage Battery Company (JSBC) and Toyota Motor Corporation have developed a "powerful" new type of battery to be used in hybrid electric vehicles (HEVs). The new lead acid battery provides a voltage of 36 volts — triple the voltage of conventional lead acid batteries. Toyota said it is using the new battery for its recently released Crown sedan HEV.

JSBC and Toyota said that when the HEV's brakes are applied, the vehicle captures the energy generated by braking and stores it in the new battery in order to provide power to the electric motor. The companies said the new HEV battery is designed to withstand repeated charging and discharging and will last for approximately three years — about six months longer than existing battery technology.

JSBC will manufacture the battery at an initial rate of 500 units per month. The company said it may also sell the battery to European markets. (NIKKEI ENGLISH NEWS: 8/22)

California Town Installs 24-Hour EV Charger

The city of Colfax, CA, once an important part of the Central Pacific railroad, has installed an electric vehicle (EV) charging station that will benefit drivers making the trip over the Sierra Nevada range. The city worked with Electric Vehicle Infrastructure, Inc. to install the single charger in the Colfax Depot, which will be available to EV drivers 24 hours a day. The new Colfax charg-

ing station is able to charge two vehicles at the same time. The company said it takes between four and six hours to fully charge two EVs.

"We wanted to do our part to support the state's program to clean up the air, and we feel it is important to have the infrastructure in place to welcome the electric vehicles that will be sold in the coming years," said Colfax Area Chamber of Commerce president Bill Medlyn. "We don't expect many people to be coming here to get a full charge, but while they top off their vehicles before heading on to the Tahoe or Grass Valley areas, they can enjoy the city shops, the beautiful Colfax Theater or get a bite to eat."

He noted that "several EV clubs from the Bay area come through regularly, but special arrangements had to be made with local businesses to tap into their electricity...[However,] now we can offer a convenient and safe alternative."

Spectrolab Provides Solar Cells for American Solar Challenge Winner

Spectrolab, Inc provided the solar cells used to power the University of Michigan's solar-powered car M-Pulse to its victory at the American Solar Challenge (ASC) last month.

The University of Michigan solar car team found Spectrolab's e-store on the Internet and purchased approximately 3,000 dual-junction gallium arsenide terrestrial solar cells to power their vehicle. Spectrolab said its solar cells generated enough power to charge the M-Pulse's batteries even when the vehicle was traveling at 55 miles per hour (mph). Under normal conditions, the solar cells produced about 1,200 watts of electricity. However, during cloudy conditions, the cells were able to generate as much as 1,600 watts due to the additional solar energy reflected off the clouds.

NESEA to Host Energizing Schools 2001 in PA

The Northeast Sustainable Energy Association (NESEA) recently announced it will host a two-day conference designed to "showcase energy and environmental education opportunities that provide project-based science, social studies and technology learning." The conference, titled "Energizing Schools 2001," will be held October 18 and 19 in Philadelphia, PA.

The event will present "standards-based educational programs and materials that motivate students with project-based activities on current, real-life topics." NESEA noted that high school and college students are invited to attend along with teachers and professors.

The conference will feature three education tracks: teaching the transportation of tomorrow, teaching the energy of tomorrow, and project-based learning for electric vehicles (EVs). NESEA said the EV track will show teachers how to develop their students' math, technology and personal skills while building an electric-drive vehicles.

On October 18, presentations will focus on selling the value of project-based learning to school administrators, ways to select and document EV projects, and methods for mentoring students involved in EV projects. The day will close with a ride and drive event featuring environmentally sound vehicles.

Topics to be covered on October 19 will include battery-powered EVs, hybrid electric vehicles, solar-powered vehicles, fuel cell vehicles, electric go-carts, and EV testing and construction. Contact: NESEA, phone 413-774-6051, fax 413-774-6053, website http://www.nesea.org.

CEV Announces Delivery of Electric Trucks

Canadian Electric Vehicles, Ltd. (CEV) recently announced the delivery of Might-E and Isuzu electric-powered trucks to customers in the U.S. and Canada. The Errington, British Columbia-based Company sells electric vehicles (EVs), converts passenger cars and trucks to run on electricity and sells kits for customers to convert vehicles to electric power.

Late last month, the company delivered 12 electric trucks based on the Isuzu NPR cab and chassis for use in airports in California. The EV trucks have a payload of 6,000 pounds and will be distributed by Portland, OR-based FMI Truck Sales.

In addition, the company said it has delivered its first Might-E truck to Correctional Services Canada. The three-quarter ton truck will be used as a carpenter's van inside the prison grounds. CEV said the Might-E truck is a battery-powered, mid-size truck that has been under development for the past four years. The truck has a payload of 1,000 kilograms (kg) and a towing capacity of 15,000 kg. The company noted that a hybrid electric version of the truck is currently under development.

Honda to Launch Civic HEV in December

Honda Motor Company recently announced it will launch a hybrid electric version of its Civic passenger car in December which will have a fuel efficiency of more than 29 kilometers per liter. The Civic hybrid electric vehicle (HEV) will be Honda's second hybrid model, following the two-seater Insight.

The Civic Hybrid will use as its main power source a gasoline engine which will be assisted by an electric motor when needed. Honda has not yet disclosed the price or number of units to be manufactured. The company did acknowledge that the hybrid Civic will cost more than normal Civic models.

Honda said it has been selling about 90 Insights per month in Japan and hopes the popularity of its conventional Civic model will boost sales of its hybrid version.

EPRI Releases Consumer Interest Study on HEVs

The Electric Power Research Institute (EPRI) recently released a study which found that many consumers think plug-in hybrid electric vehicles (HEVs) offer the best in combined propulsion. Consumer describe plug-in -HEVs as "the best of both worlds with the advantages of both electric and gasoline vehicles — such as savings on fuel and maintenance, use of an existing 120-volt infrastructure, long range and popular features."

The study also found that thirty to 50 percent of surveyed consumers would choose a plug-in HEV or a no-plug HEV mid-size sedan, even if priced 25 percent higher than a $19,000 conventionally-powered vehicle.

EPRI said the study showed that 63 percent of respondents preferred plugging in a vehicle at home to going to the gas station, and 86 percent said they have relatively easy access to a 120-volt outlet — the infrastructure needed for plug-in HEVs.

The institute noted that a plug-in HEV with a 60-mile, all-electric range could potentially be the first advanced vehicle to attain the equivalent of 80 miles per gallon without using a diesel engine, expensive lightweight construction, new infrastructure, or extreme body aerodynamics.

EPRI said the study showed that plug-in and non-plug-in HEVs provide "major fuel economy improvements and significant reductions in smog-forming and greenhouse gas emissions."

Texaco Purchases Energy Conversion Shares

Texaco, Inc. recently announced that it has purchased almost $9 million in stock of Energy Conversion Devices, Inc. (ECD), whose batteries are used to power electric vehicles (EVs). ECD said Texaco's purchase of 448,358 shares maintains the company's 20 percent stake in ECD.

Texaco said that it hoped to maintain a 20 percent stake in the company, and that it was forced to purchase more shares when ECD decided to increase the number of outstanding shares.

Texaco and ECD said that they have created a joint venture to make the batteries used in EVs available on a commercial basis. Texaco said earlier this year, the company committed $150 million to the development and commercialization of EV batteries over the next few years.

EV Rental Cars, ALA to Offer Used AFVs

Environmental Vehicle Rental Cars (EV Rental Cars) and the American Lung Association (ALA) recently joined to offer ALA staff, volunteers and donors discounts on purchases of previously owned alternative fuel vehicles (AFVs) in EV Rental Cars' fleet. Under the agreement, the groups will also offer special reduced rates when traveling at any of EV Rental Cars' locations nationwide.

In addition, EV Rental Cars announced that it has opened two new locations in San Jose and Oakland airports, bringing the total number of EV Rental Cars locations in California to nine.

EV Rental Cars said it is the only environmental vehicle rental company in the U.S. The company offers electric, natural gas, hybrid electric and super ultra-low emission gasoline-powered vehicles for rent through its association with Budget Rent a Car.

The company began renting vehicles in December 1998, with eleven electric cars at Los Angeles Airport, and since then has grown to more than 330 cars at 12 locations.

"Air pollution continues to create health problems for Californians, so driving vehicles that are fueled by cleaner options, like electricity, is crucial," said ALA board chair Bruce Herold. "Renting or purchasing cleaner-fueled vehicles will help all of us breathe easier."

MDE Employee Builds Electric Vehicle

The Maryland Department of the Environment (MDE) recently announced that one of its employees, Russ Summers, has built his own electric vehicle. Summers said that he was inspired by "Detroit's inability to produce an affordable" electric vehicle (EV), and one of his co-workers who drove an electric Ford Escort station wagon.

In July 1997, Summers decided to try and convert a 1985 Ford Mustang into an EV. Although it took him close to four years, Summers proudly announced last month to his co-workers, that he had driven the EV to work.

After removing the internal combustion engine, exhaust system, catalytic converter, starter motor and alternator, Summers had to teach himself the basics of welding to install the conversion items, including nine 87-pound batteries that power the vehicle. Summers said that the total cost of the conversion was about $5,500.

Summers said that the most difficult part of the conversion was to place the batteries in an arrangement, which properly distributed the weight throughout the vehicle. Summers even wrote a software program to help him determine the optimal weight distribution for the batteries.

Although Summers said that his EV is driveable, it still has several bugs to work out. Most notably the four-speed transmission must be reworked and the batteries must be charged between trips, making the vehicle unsuitable for anything more than short commutes.

ZAP Unveils 2002 Model for Electric Scooter

Sebastopol, CA-based ZAP recently unveiled its redesigned 2002 model Zappy electric scooter. The company said the 2002 model includes "across-the-board improvements, from its performance and construction, to its looks."

The new motor is faster and more powerful than the old motor while offering greater overall efficiency. Another improvement is the wider, newer technology drive belt, which should last longer than the old belt. The scooter's braking system has been improved as well.

LA DWP EV Fleet Logs 1,000,000 Miles

The Los Angeles Department of Water and Power (DWP) announced that its 170-electric vehicle (EV) fleet has logged a million miles of zero-emissions service to the company and community. The utility's EV program helped introduce the public to electric vehicles, and helped install in-home chargers, as well as offering incentives to residential customers for off-peak period charging, and partnering with companies and agencies installing public charging facilities. The DWP's charging facilities are fed by solar-power generated electricity, so the energy used to charge the zero-emission EVs is pollution free itself.

Additional benefits of the program include eliminating emissions from over 12,000 pounds of smog-forming pollutants, preventing the release of over 1 million pounds of greenhouse gases, and saving nearly 60,000 gallons of gasoline.

Wide variety of EV's lineup to give demo rides *Ed Thorpe*

The original Volks Porsche by Electro Auto *Scott Cornell*

3-4 year old Honda EVplus' lineup with new RAV4 *Ed Thorpe*

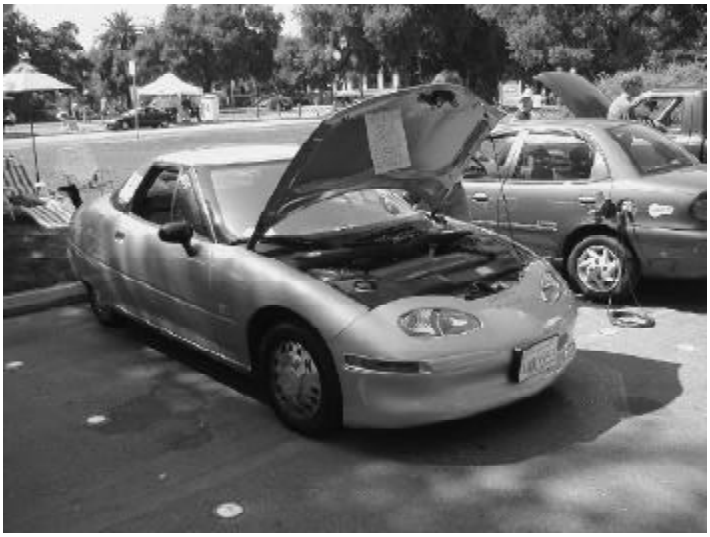
Courious families look at Scott Cornell's 'Gia *Ed Thorpe*

New Ford TH!NK picks up interested passengers *Will Beckett*

EVs are production & conversion cars, and bikes *Will Beckett*

Toyota EV RAV4 *Herb Beck*

Ford TH!NK driver talks with Bruce Parmenter *Herb Beck*



GM EV1 shows its technology *Herb Beck*

Ford EV Ranger *Herb Beck*

Dodge EPIC Minivan *Ed Thorpe*

Will Beckett's Solectria Force *Herb Beck*

Rich Brown's Mazda, back from Woodburn races *Ed Thorpe*

Lee Hemstreet's Hawaiian Racing Turtle *Scott Cornell*

Scott Leavitt's practical EV conversion *Scott Cornell*

David Coale's Bay Area Action MG conversion *Ed Thorpe*

Corben Sparrows coming and going *Herb Beck*

Even EV bikes can pull a load *Herb Beck*

AC Propulsion's T-zero, fastest production EV *Scott Cornell*

Bob Schneeveis' lastest EV creation *Scott Cornell*

EV motorcycle, racer and other forms *Ed Thorpe*

People test out Mike Saari's E-bikes *Herb Beck*

An electric 'Curved Dash Olds' *Scott Cornell*

Ed Thorpe gets his 15 minutes of fame *Scott Cornell*

CANADA

VANCOUVER ELECTRIC VEHICLE ASSOCIATION
Web Site: http://www.veva.bc.ca/
Contact: Haakon MacCullum, 1-604-878-9500, hmaccallum@hotmail.com
Mailings: P.O. Box 3456, 349 W. Georgia St., Vancouver, BC V6B3Y4, Canada
Meetings: 3rd Wednesday/month 7:30 pm
Location: Varies, see Web Site for details.

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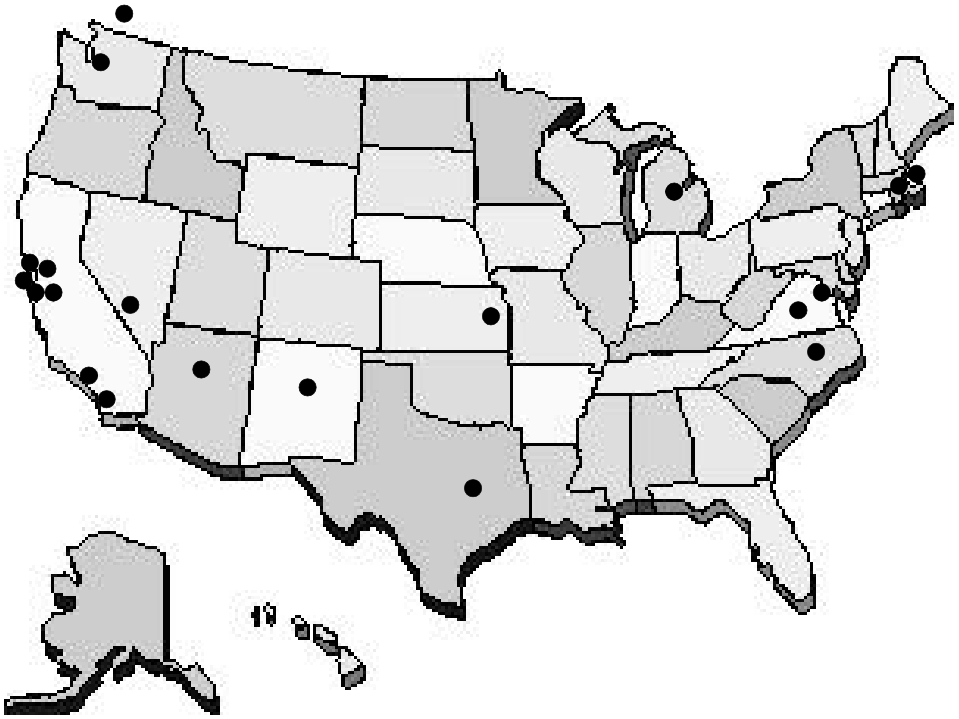
Location: Call for meeting details.



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Location: San Bruno Public Library (downstairs), 701 West Angus St., San Bruno, CA

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Contact: Steven Lough, 1-206-524-1351, slough@halcyon.com
Mailing: 6021 32nd Ave. NE, Seattle, WA. 98115-7230, USA
Meetings: Call for details.

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ELECTRIC VEHICLE ASSOCIATION OF WASHINGTON DC
Web Site: http://www.evadc.org/
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Location: National Institute of Health (NIH), Building 31-C, 6th Floor, Bethesda, MD.
Note: Please call Charlie Garlow 1-202-564-1088 to confirm attendence.

Listing updated, verified and current as of 9/28/01.

For information on how to become affiliated with the EAA, checkout ***http://www.eaaev.org***

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November 5 - 8, 2001

SAMPE, Seattle, Washington, USA
33rd International Society for the Advancement of Material and Process Engineering, Technical Conference
Web Site: http://www.sampe.org/eventsi.html

November 5 - 6, 2001

ALTENERGY 2001, Edmonton, Alberta, Canada
First alternative fuel energy conference sponsored by Canada to focus on the latest science and business applications and solutions of the alternative fuel industry
Contact: AltEnergy 2001
Fax: 1-403-258-0745
Web Site: http://www.altenergy2001.org

November 5 - 6, 2001

CLEAN AIR TECHNOLOGIES 2001, Anaheim, California
SCAQMD sponsored international conference on urban air pollution technologies and solutions.
Contact: Anita Saunders
Phone: 1-323-466-3445
Fax: 1-323-466-8653
E-mail: info@aqmdconferences.org
Web Site: www.aqmdconferences.org

November 5 - 6, 2001

MID-ATLANTIC EV CHALLENGE, Richmond, Virginia, USA
Sponsored by Richmond Technical Center.
Contact: William Baul
Phone: 1-804-780-6237
E-mail: BasketBaul@aol.com
Web Site: http://www.evchallenge.org

November 26 - 28, 2001

CAATS ANNUAL MEETING, San Francisco, California, USA
Annual meeting of the California Alliance for Advanced Transportation Systems.
Contact: Randi Dixon
Phone: 1-916-325-0473
E-mail: Randi_Dixon@caats.org
Web Site: http://www.caats.org

December 8 - 10, 2001

EVAoSD WISH RALLY, San Diego, California, USA
First event by the San Diego EAA, to raise money for the Let's Celebrate Foundation. Chris Jones will drive he's Sparrow EV as far as he can in 3 days, from San Diego to Hollister (the Corbin Motors Sparrow factory) and back.
Web Site: http://www.wishrally.com

December 11 - 14, 2001

ELECTRIC TRANSPORTATION INDUSTRY CONFERENCE: Battery, Hybrid, and Fuel Cell Technologies (NAEVI), Sacramento, California, USA
Sponsored by EVAA, the 4-day conference will focus on the historic battery and hybrid-electric vehicle technologies including fuel cell advancements.
Contact: EVAA
Phone: 1-202-508-5995
Fax: 1-202-508-5924
E-mail: ev@evaa.org
Web Site: http://www.evaa.org

February 20-22, 2002

CLEAN HEAVY-DUTY VEHICLES FOR THE 21ST CENTURY, Tempe, Arizona, USA
Hosted by WestStart and the U.S. Army National Automotive Center, this second annual conference will explore international trends in advanced transportation technologies for heavy-duty vehicles and clean fuels.
Contact: Susan Romeo, WestStart
E-mail: sromeo@calstart.org
Web Site: www.calstart.org

March 4-7, 2002

SAE 2002 WORLD CONGRESS, Detroit, Michigan, USA
Annual SAE meeting reviewing the latest in vehicles and vehicle technologies
Contact: SAE
Web Site: www.sae.org

March 13-15, 2002

GLOBE 2002 DRIVING CORPORATE LEADERSHIP AND GLOBAL ENVIRONMENTAL BUSINESS TO NEW HEIGHTS, Vancouver, British Columbia Canada
Conference on balancing business, energy and environmental agendas that will define the emerging energy strategies in North America
Contact: Globe 2002
Phone: 1-604-775-7300
Fax: 1-604-666-8123
E-Mail: info@globe.apfnet.org
Web Site: www.globe.ca

May 15 - 17, 2002

6TH EUROPEAN CONFERENCE ON MOBILITY MANAGEMENT, Gent, Belgium
Conference on the strategies for sustainable mobility.
Contact: ECOMM 2002
Web Site: www.ecomm.org

June 3 - 5, 2002

2002 FUTURE CAR CONGRESS, Arlington, Virginia, USA
Conference addressing issues involved in the development of automotive technologies aimed at reducing fuel consumption and emissions.
Contact: SAE
Phone: 1-724-772-4006
E-mail: meetings@sae.org
Web Site: www.futurecarcongress.org

June 9 - 14, 2002

14TH WORLD HYDROGEN ENERGY CONFERENCE, Montreal, Quebec, Canada
Conference on hydrogen as an energy source.
Contact: University of Quebec
Phone: 1-819-376-5108
Fax: 1-819-376-5164
E-mail: irhydrog@UQTR.Uquebec.Ca

June 19-21, 2002

11TH INTERNATIONAL TRANSPORT AND AIR POLLUTION SYMPOSIUM, Graz, Austria
Scientific conference assessing air pollution from transportation systems and effects on the environment.
Contact: Peter Sturm, Graz University of Technology
E-mail: sturm@vkmb.tu-graz.ac.at
Web Site: www.fvkma.tu-graz.ac.at

July 21, 2002

FEDFLEET2002, Kansas City, Missouri, USA
Annual workshop of the National Federal Fleet Managers. Forum for fleet professionals at all levels of government as well as private fleets.
Contact: FedFleet 2002

Phone: 202/501-1777
E-mail: vehicle.policy@gsa.gov

October 14 - 18, 2002

9TH CONGRESS ON INTELLIGENT TRANSPORTATION SYSTEMS, Chicago, Illinois, USA
Conference to promote awareness and deploymnet of ITS technologies.
Contact: Robert Willis, ITS America
Phone: 1-202-484-4544
Fax: 1-202-484-3483
E-mail: rwillis@itsa.org

F100 conversion, possible?

By Mitchell Oates
[mitchoates@prodigy.net]

Besides the aerodynamics and weight of your vehicle, which I'm unfamiliar with (I can't even remember what an F100 from that era looks like), it's close to 34 years old. It's only going to get harder to find parts, and any useful aftermarket goodies such as air bag suspension to handle the extra weight of the batteries are going to be nonexistent for that old a truck.

Mike Brown of ElectroAutomotive offers good advice on picking a vehicle. Ideally, you want a vehicle that's around 10 years old and had a large production run so parts are still readily available. Also make certain you can still obtain the shop service manual (Chilton's is useless). The vehicle should be in good shape overall, except for the engine so you don't have to sink a ton of money into it to make it roadworthy. And it should be easily modified to accept it's new EV guts and in particular handle the weight of the batteries, is a vehicle you like, and will do the job you want it to do as an EV.

100 miles per charge is really pushing the envelope with the technology available at the hobbyist level. An EV is a mission intensive vehicle, you need to have a pretty definite idea what you're going to be using it for before being able to decide if you can even build one that will meet your needs.

So far you've only said you want 100 miles range, no concern for acceleration. Hilly terrain will eat power and decrease range. Without battery heaters and insulation, really cold winters will cut your range by 1/2 or more. Electric heat for winter and A/C during the summer will use power and cut into range. A 100 mile battery pack is going to require a high capacity charger with 220 AC input to recharge them in a reasonable amount of time and give them the proper finishing charge rate, besides limiting places available for charging when away from home. Do you want a 100-mile range so you can do 50-mile trips and have plenty of reserve, or are you routinely going to do 100-mile trips that drain the batteries?

Better that you take a cold hard look at what you want an EV to do and decide that you can't build one to suit your needs, than to dive in and spend the time and money to build one and end up with a useless vehicle.

If you don't have them, get a copy of one or all of several Conversion books: Mike Brown's "Convert It", Bob Brant's "Build Your Own Electric Vehicle", Bob Batson's "Selecting A Vehicle for Conversion". Mike Brown also has some excellent videos made when he was giving some of his conversion workshops that have a lot of useful info in them for first timers.

In the final analysis, if after having looked at all the factors involved, the truck will do what you want as an EV, and you really want to keep it and convert it to an EV, who are we to say no? After all, it is YOUR truck. :-)

Recharging by conduction - 120V, 240V, 14-50 and Avcon

Sources for Existing EVs for Sale:

Silicon Valley Chapter EAA
http://home.pacbell.net/beckettw/forsale.htm#owned

Innevations
http://www.innevations.com/used-evs.html

Eco-Motion Electric Cars
http://www.halcyon.com/slough/contributions.html

Arcata Electric Car
http://www.tidepool.com/~ecar/list.html

EV Tradin' Post
http://members.nbci.com/evalbum/geobook.html

EVA/DC
http://www.evadc.org/forsale.html

Triangle EAA
http://www.rtpnet.org/~teaa/forsale.html

Check out these websites and the various EAA Chapter websites for new and used EV vehicles, production and conversions, and EV parts.

Electric Auto Association (EAA) Membership Application Form

Copy and fill out this form, attach a check or money order or use PayPal in US funds only for $39 ($42 Canada) ($45 International) payable to '**Electric Auto Association**'. You can fold this form as indicated and mail it with your payment enclosed. Do not use staples, instead use tape to seal the form before you mail it. Or send an e-version of this form, pay through PayPal using the link on http://www.eaaev.org/eaamembership.html.

New Member: Renewal: Country (if non-USA):_____ Date: _____

Name: _____ *email: _____

Mailing Street Address: _____ Home phone#: _____

Mailing City, State & ZIP: _____ *Work phone #: _____

*Do you own or lease an Electric Vehicle? Production Conversion Bicycle Other:_____ No

I support the _____ EAA Chapter, or please select an EAA Chapter closest to me.

(*optional) All information in this application is for the exclusive use of the EAA and not be sold or given to any other organization.

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Please Identify your primary areas of interest relating to the EAA (check as many as you wish):

Hobby/Builder	Professional (income)	Competition (Rallies, Races, Records)	Owner/Driver
Environmental/Gov. Regs.		Social (Rallies, Shows, Dinners)	New Technology & Research
Promotion & Public Awareness of EVs		Student or General Interest	Electrathon/Bicycle/other

The Electric Auto Association www.eaaev.org

'Providing free Electric Vehicle information to the public since 1967'

The Electric Auto Association (EAA) is a non-profit organization (eaaev.org 501c3) for the promotion of Electric Vehicle use in and by the public. Your membership is Tax Deductible and you will receive the informative EAA publication, "**Current EVents**". All information and statistics in this application are for the exclusive use of the EAA and is not sold or given to any other organization or company. From your membership dues, a percentage goes to the EAA Chapter you support for public Electric Vehicle promotion activities like EVents, Rallies, Shows, and EV rides.

(fold the bottom half under. This will now be the front of the letter. Be sure to seal it with tape)

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eaamembership@email.com

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EAA Merchandise

The **Electric Auto Association** (EAA) is a nonprofit organization for the promotion of public awareness of Electric Vehicle use as a viable transportation option. All minor sales proceeds are used to cover the costs of our nonprofit efforts in this cause. Please show your support with your purchases for better, cleaner, quieter, and lower maintenance transportation.

Product	Description	Comments	Item#	Price
Licence Plate Holder	Black plastic frame, white lettering on visible green.	Allow 6 weeks.	LICPH1	$ 10.00
Licence Plate Holder	For motorcycles. Black or chrome metal.	Allow 6 weeks.	LICPH2	$ 14.00
Embroidered Patch	White, Sew-On.	Allow 3 weeks.	PATCH1	$ 6.50
Embroidered Patch	Green, Sew-On.		PATCH2	$ 6.50
Embrodered Hat	Adjustable fit.		CAP002	$ 15.00
"Electric Vehicle Parking Only" Sign	Metal sign, reflective white background with dark green lettering. Wall or pole mounting.	Like public no-parking sign quality.	PARK01	$ 25.00
EAA Key **Chain**	With LED light and "30 years 1967-1997".		KEY01	$ 2.50
Coffee Mug	Ceramic.		MUG03	$ 5.50
Insulated Car Coffee Mug	Plastic.		MUG02	$ 6.50
Embroidered Polo Shirt	Size: S,M,L,XL,XXL. Color: Forest, Teal, or Navy.	Allow 10 weeks.	SHIRT01	$ 40.00
EAA Jacket	Size: S,M,L,XL,XXL. Color: Blue or Black.	Allow 10 weeks.	JACKE1	$ 59.00
EAA Wind Breaker	Size: S,M,L,XL,XXL. Color: Blue or Black.	Allow 10 weeks.	WBREK1	$ 49.00
EAA Sweat Shirt	Size: S,M,L,XL,XXL. Color: Blue or Black.	Allow 10 weeks.	SWEAT1	$ 39.00
EAA ball-point pen	EAA ball-point pen with EAA.	Sold individually.	PEN01	$ 1.00
Car Window Shade	EAA Car Window Shade.		SS001	$ 8.00
Bumper Sticker #1	EAA Bumper Sticker.	Size: 10.5" x 3.75"	BS800	$ 2.00
Bumper Sticker #2	EAA Bumper Sticker "The Switch is on".	Size: 15" x 3.75"	BS002	$ 2.00
Decal	EAA Decal (The Switch is on).		DECAL	$ 1.00
	— EV Buyers Guides —			
2000	Electrifying Times Preview 2002.		BG2000	$ 5.95
1999	Electrifying Times	Not available.	BG1999	NA
1998	Electrifying Times Preview 2000.		BG1998	$ 5.95
1997	1997 EV Buyers Guide.		BG1997	$ 5.95
1996	1996 EV Buyers Guide.		BG1996	$ 5.95
1995	1995 EV Buyers Guide.		BG1995	$ 5.95
	— Literature —			
Convert-It	EV conversion Book		CONV01	$ 24.95
KTA Catalog	Electric Vehicle Kits & Component Parts		CATAL1	$ 5.00
Window Literature Holder	Light plastic.		WL002	$ 15.00
	— Special —			
AVCON to 14-50 Electrical Adapter Kit	Sheet metal box, 14-50 outlet (2 hots and a ground, no neutral), for 220 VAC chargers only.	Allow 6+ weeks delivery after payment deposited. Some assembly required.	ADAPT1	$200.00
EAA Membership	Fill out Membership for on opposite page	Include form w/ order.	EAAM01	$ 39.00
Shipping	US =10% / CANADA =15%, OTHER = 20% of the sub-total.	*Orders are restricted to the US, Mexico and Canada*	Subtotal Shipping	$_____ $_____
			Handling	$ 2.00
			TOTAL	$_____

To order, include your name, phone number, mailing/shipping address and payment by check or money order. Please specify quantity for each item and size/color for clothing.

Send orders to:

EAA Store, 5820 Herma St., San Jose, CA 95123-3410

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