

## bq2903 Evaluation System

### Features

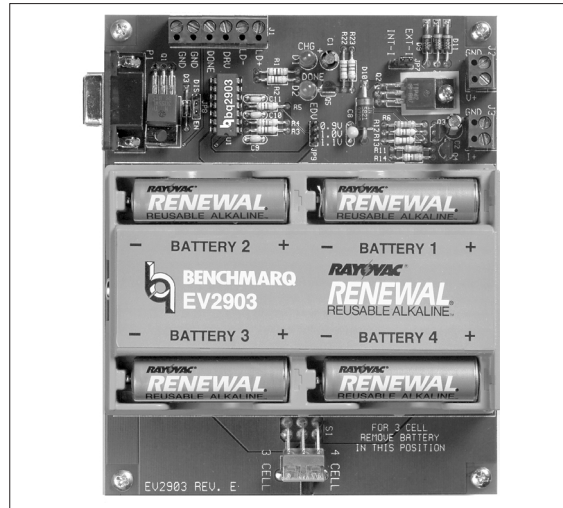
- bq2903 fast charge control evaluation and development system for rechargeable alkaline batteries such as Renewal® from Rayovac®
- Optional on-board 300mA current-limited charge supply
- Fast charge of three or four alkaline cells
- Pulsed charge terminated by minimum current and backed up by a maximum voltage safety termination
- Selectable end-of-discharge voltage
- Charge status indicator LEDs
- Datalog capability for charge and discharge currents through the serial port of a PC

### General Description

The EV2903 Evaluation System provides a development and evaluation environment for the bq2903 Rechargeable Alkaline Charge/Discharge Controller IC. The EV2903 incorporates a bq2903, a bq2014 Gas Gauge IC, an onboard discharge N-FET, and all other hardware needed to charge three or four rechargeable alkaline batteries, such as Renewal from Rayovac.

Fast charge is terminated when the average charge rate falls below approximately 3% of the fast charge rate. For safety, charging is inhibited if the voltage of any cell is greater than 3.0V during charge or if the voltage of any cell is less than 0.4V when not charging (open-circuit voltage).

The user provides batteries and DC power supply. The user configures the EV2903 for the number of cells (three or four), end-of-discharge voltage, and on-board or off-board current regulation.



### Contents

- 1 EV2903 printed circuit board containing:
  - a) bq2903 PDIP IC
  - b) All programming jumpers
  - c) Rayovac housing for three or four Renewal™ batteries
  - d) Two status LEDs
  - e) RS-232 serial port interface
- 1 Documentation kit including data sheets, schematics, and user's manual
- 1 EV2903 User Interface Program diskette
 

This program runs on any PC-compatible computer running Windows 3.x and equipped with a standard RS-232 (COM1, COM2, COM3, or COM4) serial port, and provides the user with a complete menu-driven system to control, monitor, and log data from the EV2903 Evaluation Board. The User Interface Program communicates with the bq2903 over the DQ serial I/O port using the RS-232 interface
- 1 RS-232 Cable

## EV2903

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### EV2903 Switch and Jumper Settings

- S1**      **Cell Selection.** S1 selects three-cell (set to 3) or four-cell (set to 4) configuration.
- JP7**      **Supply Regulation.** Set jumper JP7 to INT-I to use the on-board, voltage-limited current source. Set JP7 to EXT-I to select off-board charging supply.
- JP9**      **EDV.** JP9 selects the end-of-discharge voltage at which the bq2903 disconnects the battery stack from the load. To select 1.0V EDV, leave jumper off to let VSEL floating.
- JP8**      **Internal or External Discharge FET.** JP8 selects the external FET for discharge loads greater than 400mA. Set jumper to EN to enable the external FET, or set it to DIS to disable the external FET.

### EV2903 Connections

- J1**      **DRV.** Auxiliary discharge FET driver output from the bq2903 to connect to gate of a user-selectable, external FET. Source should be connected to GND and drain to LOAD-.
- DONE.** This TTL-compatible output signifies a charge completion by going high. Valid only when DC is applied.
- GND. Charging supply ground.**
- LOAD+.** Connection for the load to the high side of the battery stack.
- LOAD-.** Connection for the load return.
- J2**      Use this connection when using the on-board voltage-limited current source. This connector accepts an unregulated voltage between 9-15V DC at a minimum of 300mA. JP7 should also be in the INT-I position. Do not use J3 in conjunction with J2.
- J3**      Use this connection when bypassing the on-board current source and providing an external charging source. The external supply should be a 300mA current source with a voltage compliance between 8-10V. JP7 should also be in the EXT-I position. J2 should not be used in conjunction with J3.
- P1**      **Serial data bus connection.** This connection is made to the RS-232 cable connecting to the serial port of the PC.

### EV2903 Configuration

The EV2903 Evaluation Board operates with or without the Interface Program. Configure the board first before connecting the batteries and the RS-232 cable.

- Step 1**      Configure all switches and jumpers to their desired settings. The factory default settings are:  
JP7: INT-I  
JP9: EDV = 1V  
JP8: External FET
- Step 2**      If using an off-board discharge load FET, connect the gate to the DRV output on J1, connect the source to GND on J1, and connect the drain to LOAD- on J1.
- Step 3**      Connect the DC power supply to either J2 or J3, depending on the use of external or on-board regulation.
- Step 4**      Connect the RS-232 cable to connector P1 on the EV2903 and to an available serial port on the PC (optional).

### Installing the User Interface Program

The EV2903 board uses a bq2014 Gas Gauge chip on board to monitor the state of charge of the batteries and to provide an easy user interface to this evaluation board. The user communicates with the bq2014 through the User Interface Program, which runs on any IBM PC-compatible computer in the Windows 3.x environment (a 486-33MHz or better is recommended).

Before running the program, you must first install it from the floppy disk to the hard drive. To install the User Interface Program, insert the diskette into the disk drive and choose Run from the File menu in Program Manager. Type "A:\setup" (substituting the appropriate drive letter for "A") and press Enter. The installation program will prompt for the destination directory (select "OK" to accept the default).

### Using the EV2903 Program

To run the program, double-click on the EV2903 icon in the EV2903 program group. All of the status monitors and functions are controlled from the EV2903 Interface screen, Figure 1.

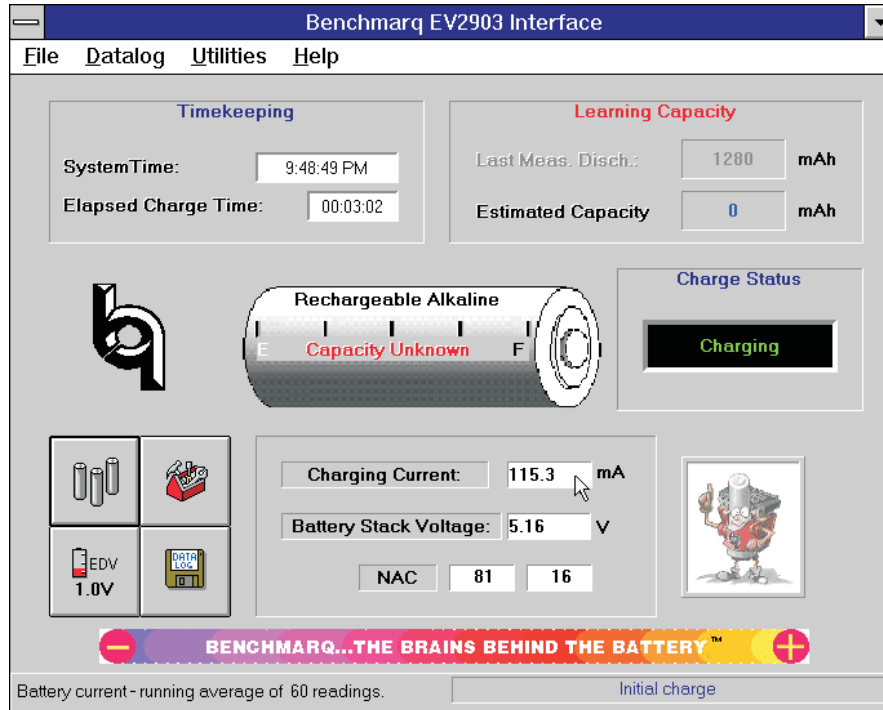


Figure 1. EV2903 Interface Screen

## Selecting a Communications Port Display and Functional Buttons

The EV2903 program displays the port selection dialog box (as shown in Appendix A) the first time that the program is run. You must specify to which communications port (1-4) the EV2903 is connected. Specify the correct port by clicking first on the appropriate selection and then on the “OK” button. After several seconds, the program will display an information box confirming that communications have been established. Please note that the program then saves this information to the hard drive, so the port selection box will not appear again during subsequent use of the program.

### Interface Screen

The Interface screen appears after the program has started and communication has been established with the EV2903 board. If this screen does not appear, please refer to Appendix A (Troubleshooting) for possible solutions.

The Interface screen shows four buttons for display and functional purposes:



Select this button to show either three or four cells in use. This button is for display only to remind the user of configuration.



Select this button to show EDV. This button is for display only to remind user of configuration.



Use this button to calibrate in the battery stack voltage. Select it and then enter the measured stack voltage to calibrate the Battery Stack Voltage display.



Click on this button to start a datalog. Enter the filename where the datalog will be saved and an optional line of text which will be placed on the first line of the datalog.

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## Real-Time Monitoring

The EV2903 Interface screen provides real-time monitoring of the current status of the battery stack. As conditions change, the new values are displayed:

### Current Time:

This displays the current time generated from the PC's real-time clock.

### Elapsed Charge/Discharge Time:

This provides the elapsed time from the moment that a charge/discharge is initiated.

### Last Meas. Disch:

The Last Measured Discharge (LMD) is the last measured discharge capacity of the battery stack. The LMD display will be updated only if a complete battery discharge from full to empty occurs without any partial battery charges. The "Learning Capacity" message will continue to flash until the Last Meas. Disch. display is updated, meaning the EV2903 has learned the batteries' capacity.

### Estimated Capacity:

This is the estimated capacity, or current battery state-of-charge. This value will not be valid until the "Learning Capacity" message is not flashing. This value will decrement during discharge and increment during charge.

### Charge Status:

Charge Status displays the charging/discharging activity occurring with the batteries. These messages will be displayed depending on the status.

Charging	The batteries are taking on a charge.
Discharging	The batteries are discharging to the load.
Full	The batteries are fully charged and have terminated charging.
Empty	The batteries have met the EDV limit and are disconnected from the load.
Idle	The batteries are neither charging nor discharging.

### Charging/Discharging Current:

This is the average charging/discharging battery current. "N/A" will be displayed as the averaging routine is averaging the current. Under the Utilities menu, you can select the number of datapoints included in the average. By selecting a higher number of datapoints, a plot of the data will be smoothed. Benchmark suggests 60 datapoints.

### Battery Stack Voltage:

This is the battery stack voltage as measured by the bq2014 gas gauge and displayed by the EV2903.

While charging, the battery stack voltage may appear to jump around. This action is due to the voltage being sampled at various times, either during the charging pulse or during the idle period. Refer to the bq2903 data sheet for charging activity.

When EDV is met, the Battery Stack Voltage will display "N/A" when the battery stack is disconnected from the load.

### Battery Gas Gauge:

The picture of the battery provides a bar graph depicting the current state of battery capacity. The bar graph shows "Estimated Capacity" as a percentage of "Last-Measured Discharge." The gas gauge will not display capacity until the EV2903 has learned the battery capacity. The EV2903 is still learning the battery capacity as long as the "Learning Capacity" message is blinking.

## Data Logging

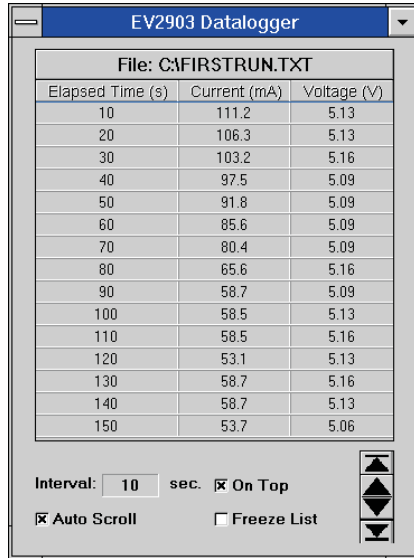
The EV2903 provides for data logging these values:

- Battery Stack Voltage
- Charge/Discharge Current
- Elapsed Time in Seconds

The datalog is activated from the datalog button on the Interface screen or by selecting "Start Log" from the Datalog menu. When selected, a comment screen will appear, allowing one line of text to be included on the first line of the datalog. After the comment screen, a prompt dialog box will appear asking for a file name to which to save the data log. If <Cancel> is selected, the data log screen will still appear, but the data will not be saved. The datalog screen at the bottom will scroll the information as it is taken. Screen options allow for either freezing or auto-scrolling the datalog list. The onscreen datalog list will contain the last 200 datapoints taken, but all the datapoints are saved to the hard drive (if you have entered a file name)

The check boxes allow perusal of the data contained in the list (up to the last 200 datapoints). Auto-scroll enables the list to scroll up every time a new datapoint is added, making the latest datapoints always visible. When not checked, the list does not scroll, but you can manually scroll using the arrow buttons. Freeze list temporarily disables auto-scrolling while viewing datapoints. Clicking the scroll buttons or on any datapoint in the list will automatically freeze the list.

Click on Freeze List to disable and re-enable auto-scrolling. The On Top check box causes the datalog window to remain on top of other windows; when unchecked, other windows may cover up the datalog window. You may minimize the datalog window at any time without disrupting the datalogging process.



The Datalog Settings on the menu bar provides for setting the time interval between each point datalogged. This pull-down menu provides options with a minimum of five-second intervals. Another option allows stopping the datalog when the EV2903 detects that the batteries are idle.

The datalog is saved as a text (.txt) file. If you desire a plot, we suggest importing into a program such as Microsoft Excel.<sup>TM</sup>

## Standard Operation and Helpful Hints

### Learning the Battery Capacity

Upon initialization of the program and/or inserting a different or new set of batteries, preferably start out by charging the batteries to "Full." Then, discharge the batteries until "Empty." Doing this will allow the EV2903 to "learn" the capacity during the first discharge cycle.

### Batteries

For optimal battery performance, replace batteries as a complete set. The EV2903 charges the battery stack in series and not each cell individually. Charging termina-

tion takes place when any cell is fully charged. Discharging terminates when any cell reaches EDV. Please refer to the bq2903 data sheet.

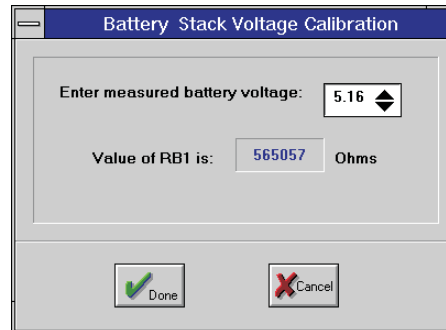
### Battery Stack Voltage (EDV)

When the bq2903 senses EDV, it disconnects the battery stack from the load. At this time, the bq2014 Gas Gauge cannot sense the battery stack voltage, sensing only 0 volts. The battery stack voltage will decrease quickly due to the averaging routine internal to the bq2014. When the EV2903 detects EDV, it will display "N/A" as the Battery Stack Voltage.

### Calibrating Battery Stack Voltage

The Battery Stack Voltage display should be within  $\pm 90\text{mV}$  of the true battery stack voltage. For better accuracy, use the Calibration button. Measure directly across the battery stack and input this value in the Calibration window. Select Done.

For three- and four-cell calibration, measure directly across the "+" terminal of battery 1 to the "-" terminal of battery 3.



### Message Status Bar

The lower right-hand corner of the EV2903 screen will display helpful messages throughout the operation of the EV2903 program. This message bar will indicate the number of complete charge and discharge cycles.

### Utilities Menu

Use this menu to calibrate the battery stack voltage and to set the number of data points which the EV2903 uses to average the current. Benchmarq suggests using 60 data points, which will smooth out graphs showing the current.

Also in the Utilities menu are options for the Register window and Flag window. Use these windows to monitor the status of the bq2014. Please refer to the bq2014 data sheet for information concerning these registers and flags.

## EV2903

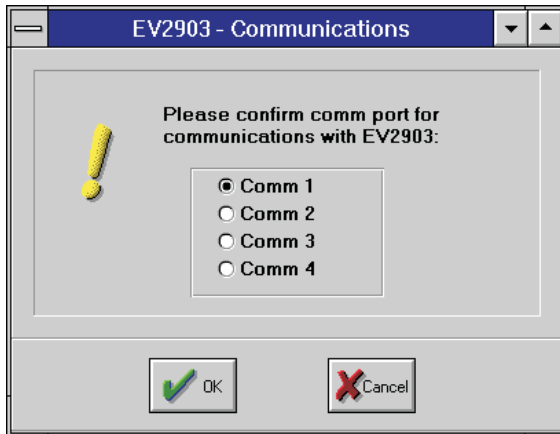
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### Appendix A: Troubleshooting

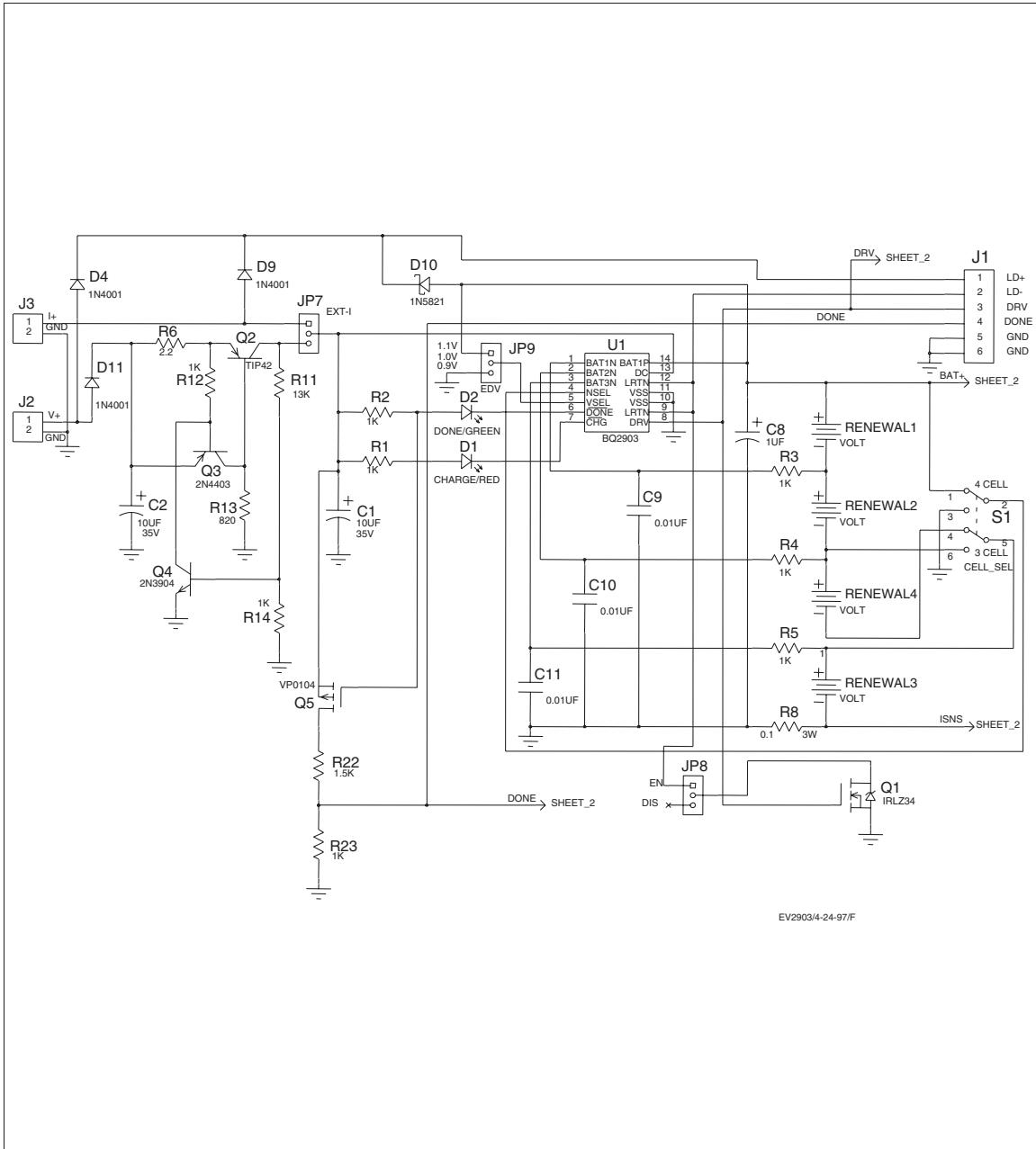
If the EV2903 Interface screen does not appear after starting the program, then communication to the EV2903 Evaluation board has not been established. Please check the following:

### Time-Out Error

On occasion, we have noticed that a communication time-out error will occur. In most cases, clicking "OK" will resume operation.

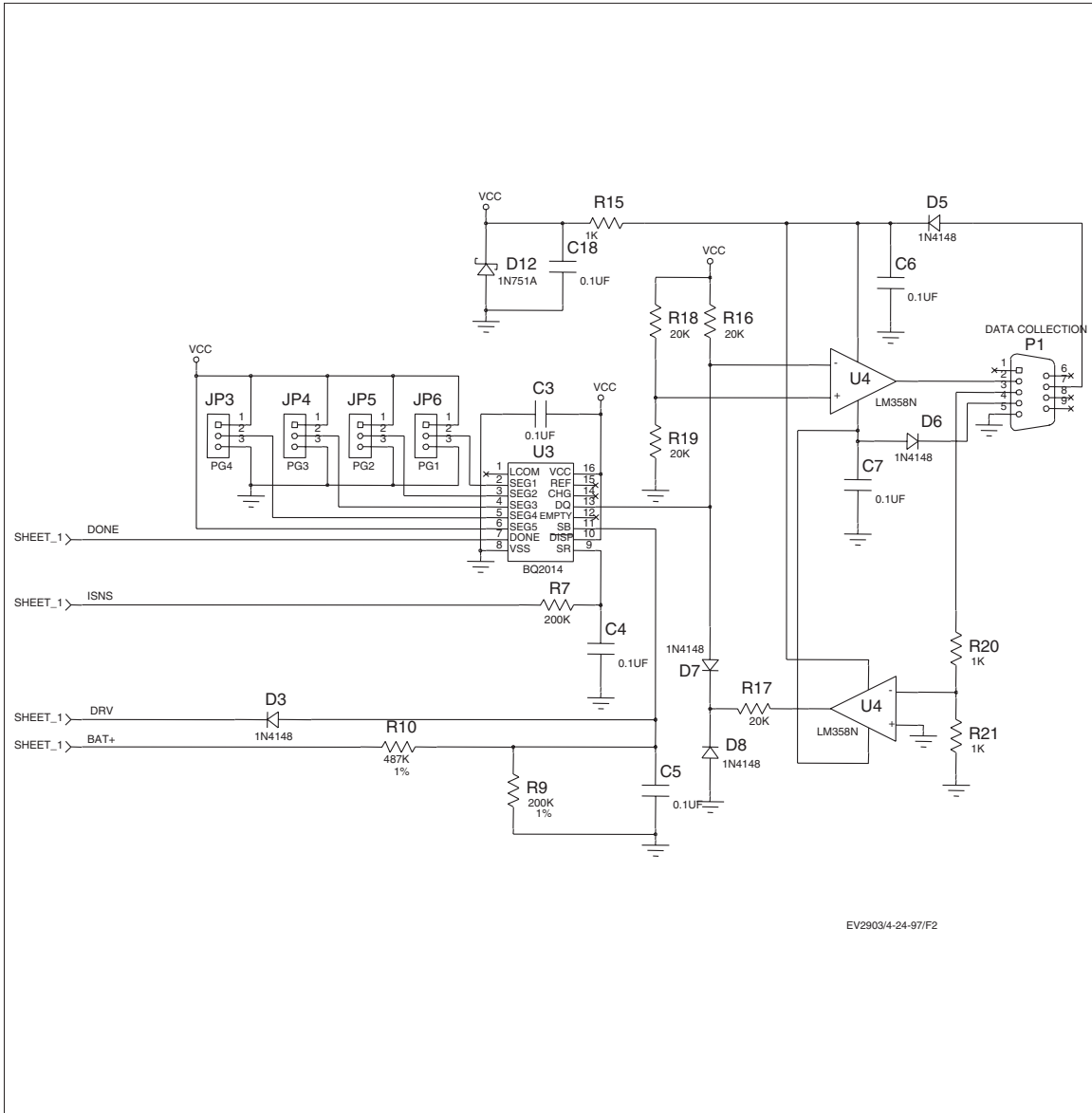


Appendix B: EV2903 Schematic



# EV2903

## Appendix B: EV2903 Schematic Continued





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