ICS1700A Evaluation Board

General Description

The ICS1700A Evaluation Board allows quick evaluation of the ICS1700A Charge Controller for Nickel-Cadmium and Nickel-Metal Hydride Batteries. The evaluation board provides the designer an opportunity to both test the ICS1700A and a fast charge battery charger. The board is self-contained and has provisions for interfacing with an external constant current source to charge a battery.

The board includes resistors that are user-installed to customize operation for the desired charge rate, discharge pulse current, and number of cells in the battery pack. The board has a 5V regulator that provides power to the ICS1700A and the LED display. The board also has a breadboarding area consisting of a matrix of holes for user added components.

Before using the **ICS1700A Evaluation Board**, GPI recommends the user review the ICS1700A data sheet to become familiar with the operation of the controller.

Setting-up the Board for your Application

Refer to the evaluation board schematic diagram. The ICS1700A requires that the battery voltage is normalized to the voltage of one cell, or about 1.2V. To do this, resistors must be installed in the locations marked R6 and R8. The appropriate values can be selected from Table 1. An assortment of resistors is provided with the board.

Table 1

Cells	R6	R8
1	Open	Short
2	2.0k	2.0k
3	1.0k	2.0k
4	1.0k	3.0k
5	3.0k	12k
6	2.0k	10k
7	2.0k	12k
8	1.3k	9.1k

If the evaluation board is used with battery packs containing more than eight cells, the resistors can be determined by counting the number of cells to be charged in series. Then choose either R6 or R8 and solve for the other resistor using:

$$R8 = R6 * (\#\ of\ cells - 1) \quad or \quad R6 = \frac{R8}{(\#\ of\ cells - 1)}$$

The ICS1700A controller has an internal 2.0V reference used to detect the removal of the battery from the charging system. For most batteries, the maximum normalized battery voltage at the VIN pin at full charge is 1.7 to 1.8V. The voltage at VIN is compared to the 2.0V reference voltage when the current source is turned on. If the voltage at VIN is greater than the 2.0V reference, the ICS1700A assumes the battery has been removed and the ICS1700A indicates a fault condition by turning on the BF LED, and shuts down.

When power is applied to the board, the controller will start a charge sequence unless a logic low is applied to the RESET terminal. When RESET is removed by a logic high or open, a charge sequence will begin.

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The board provides several low value resistors that may be used to set the amplitude of the discharge pulse. The resistors can be installed in any or all of the locations labeled R1, R2, or R3. The resistor value is calculated by setting the amplitude of the discharge pulse. The discharge pulse amplitude is typically 2.5 times the charge current based on 1.4V/cell. The resistor locations R1, R2, and R3 are connected in series. The unused locations must have a jumper to complete the circuit. Not using the discharge pulse feature will not affect the performance of the ICS1700A.

The ICS1700A is capable of operating at four different charge rates; 4C (15 minutes), 2C (30 minutes), 1C (60 minutes) and C/2 (120 minutes). The charge rate is selected by SW1 dip switch settings. Table 2 shows the proper settings to use for the desired charge rate.

Power Requirements

The evaluation board uses a regulator to provide +5 volts for the controller. The regulator allows operation from a DC supply of 8 to 32 volts when the supply is connected to the +V terminal. The board may also be operated from an external 5 volt supply by removing the regulator (VR1), wiring a jumper between regulator pins 1 and 3, and by connecting 5 volts directly to the +5V terminal.

Connections To External Circuitry

A normally closed thermal switch or a thermistor should be connected to the TS terminal. If a thermal protection device is not used, the TS terminal must be grounded.

Connect the battery between the +BAT and GND terminals.
Connect the external charging current source and its return between the +CUR and GND terminals.

Two charge signals are provided to control external charging circuitry. CHARGE is high when the charging current is on. The other signal CHARGE is low when the charging current is on.

The charging circuitry should provide a current at an amplitude that is equal to the product of the battery capacity and the desired charge rate. For example, to charge a 1.2 ampere hour battery in 30 minutes, the current required would be 2.4 amps or 2C where ‘C’ is the battery capacity.

It is important to note that the ICS1700A does not control the current flowing into the battery in any way other than turning it on and off. The charging source should be a constant current type.

Table 2: Charge Rate List

Charge Rate	SW1-1 (S0)	SW1-2 (S1)	Topping Charge pulse Rate	Maintenance Charge Pulse Rate	Fast Charge Timer Duration (after reset)
4C (15 min)	ON	ON	one every 40 sec	one every 160 sec	30 min
2C (30 min)	ON	OFF	one every 20 sec	one every 80 sec	60 min
1C (60 min)	OFF	ON	one every 10 sec	one every 40 sec	90 min
C/2 (120 min)	OFF	OFF	one every 5 sec	one every 20 sec	210 min

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Operation

Before applying power to the board, ensure that the board is properly initialized.

- Set SW1-1 and SW1-2 for the correct charge rate.
- Check to make sure the divider resistors R6 and R8 are of the correct value to normalize the battery pack voltage to one cell.
- If applicable, choose resistors R1, R2 and R3 to obtain the required discharge current.
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After applying power to the board:

- Set the external charging current source for the amplitude required by SW1 settings.

Push and hold the reset switch SW2 for at least 700ms. All LEDs should turn off while the switch is depressed. The green CM LED will light and will remain lit until full charge is detected by the ICS1700A. At that moment, the CM LED will start flashing at a 1 Hz rate, indicating that the topping charge stage has begun. The CM LED will flash until a reset is issued either by interrupting the power, removing the batteries or depressing the reset switch SW2.

Battery Polling

Upon power-up or after a reset is issued, any excess charge from filter capacitors at the +BAT and +CUR terminals is removed with a series of discharge pulses. After the discharge pulse series is complete, the voltage at VIN must be greater than 0.5V when a battery is present. If the voltage at VIN is less than 0.5V, the ICS1700A assumes no battery is attached and initiates a polling sequence.

The ICS1700A then applies a 100ms charge pulse. During the pulse, the ICS1700A monitors the VIN pin to determine if the divided down terminal voltage is greater than the internal 2.0V reference. If the battery is present, the voltage is clamped below the 2.0V reference when the current pulse is applied and the fast charge stage begins immediately. If a battery is not present, the voltage at VIN rises above the 2.0V reference and the BF LED lights immediately.

The charge pulses repeat for 10 seconds. If the battery is installed within 10 seconds, the ICS1700A will turn off the BF LED and enter the fast charge stage. If the battery is not installed within 10 seconds, the BF LED remains on and the
ICS1700A shuts down. A reset must be issued to restart the controller after installing the battery.

Battery Fault Detection

The ICS1700A will turn on the BF LED and shut down if the battery is removed or if an open circuit occurs in the current path anytime after fast charge has been initiated. When in the topping charge or maintenance charge stages, a charge pulse may not occur for several seconds. During the period between charge pulses, the voltage at VIN should be greater than 0.5V if a battery is attached. If the voltage at VIN is less than 0.5V, the ICS1700A assumes the battery has been removed, a fault condition is indicated by the BF LED, and the controller shuts down.

Out-of-Temperature Range

The OT LED activates if the battery is either too hot or too cold to fast charge. If a thermistor is used, the ICS1700A employs internal voltage references to determine if a battery is hot or cold. *Note: Remove R9 and replace with a jumper when using a thermistor.* A 10kΩ @ 25°C thermistor with an external pull-up resistor is typically used. See the ICS1700A data sheet for additional information.

If a thermal switch is used, choose a switch that opens at 45°C or lower. If a thermal protection device is not used, the TS terminal must be grounded.

ICS strongly recommends the use of a thermal safety device in the battery pack. One source of thermal switches is Portage Electric Products, Inc., in North Canton, Ohio; (216) 499-2727. A source of thermistors is Semetic USA (Ishizuka Electronics Corp.), Babylon, NY; (516) 587-4086.

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Design Considerations

When designing external current source circuitry for use with the ICS1700A, there are several important considerations to make before starting the design and the PC board layout.

For the 2C and 4C charge rates, consideration has to be given to the use of a pulse-width modulated switch mode current source in order to reduce size and power dissipation. Switch mode current sources can provide the ability to charge battery packs that require voltages higher than the primary supply. For instance, to charge a 24 volt battery from a 12 volt vehicle battery, a switch mode boost converter could be used.

In general, linear chargers are less complex and more cost effective, but less efficient than switch mode chargers. For the 1C and C/2 charge rates, consideration should be given to using a linear charger unless the size and ability to dissipate heat are not available.

It is very important that care be taken to minimize noise coupling and ground bounce. In addition, wires and connectors can add significant resistance and inductance to the charge and discharge circuits.

When designing the printed circuit board, make sure ground and power traces are wide and bypass capacitors are used right at the controller pins. Use separate grounds for the signal, charge, and discharge circuits. Separate ground planes on the component side of the PC board are recommended. Be sure to connect these grounds together at the negative lead of the battery only.

For the discharge circuit, keep the physical separation between power and return (ground) to a minimum to minimize field radiation effects. This precaution is also applicable to the constant current source, particularly if it is a switch mode type. Keep the ICS1700A and the constant current source control circuits outside the power and return loops described above. These precautions prevent high circulating currents and coupled noise from disturbing proper operation.

Galaxy Power, Incorporated wants to help create a successful battery charging solution using the ICS1700A. If you need technical advice or applications information, call the Intelligent Charging Solutions hotline at GPI, (610) 676-0188 x-277.

Ordering Information

ICS1700AEB

Device type:
ICS1700A Evaluation Board

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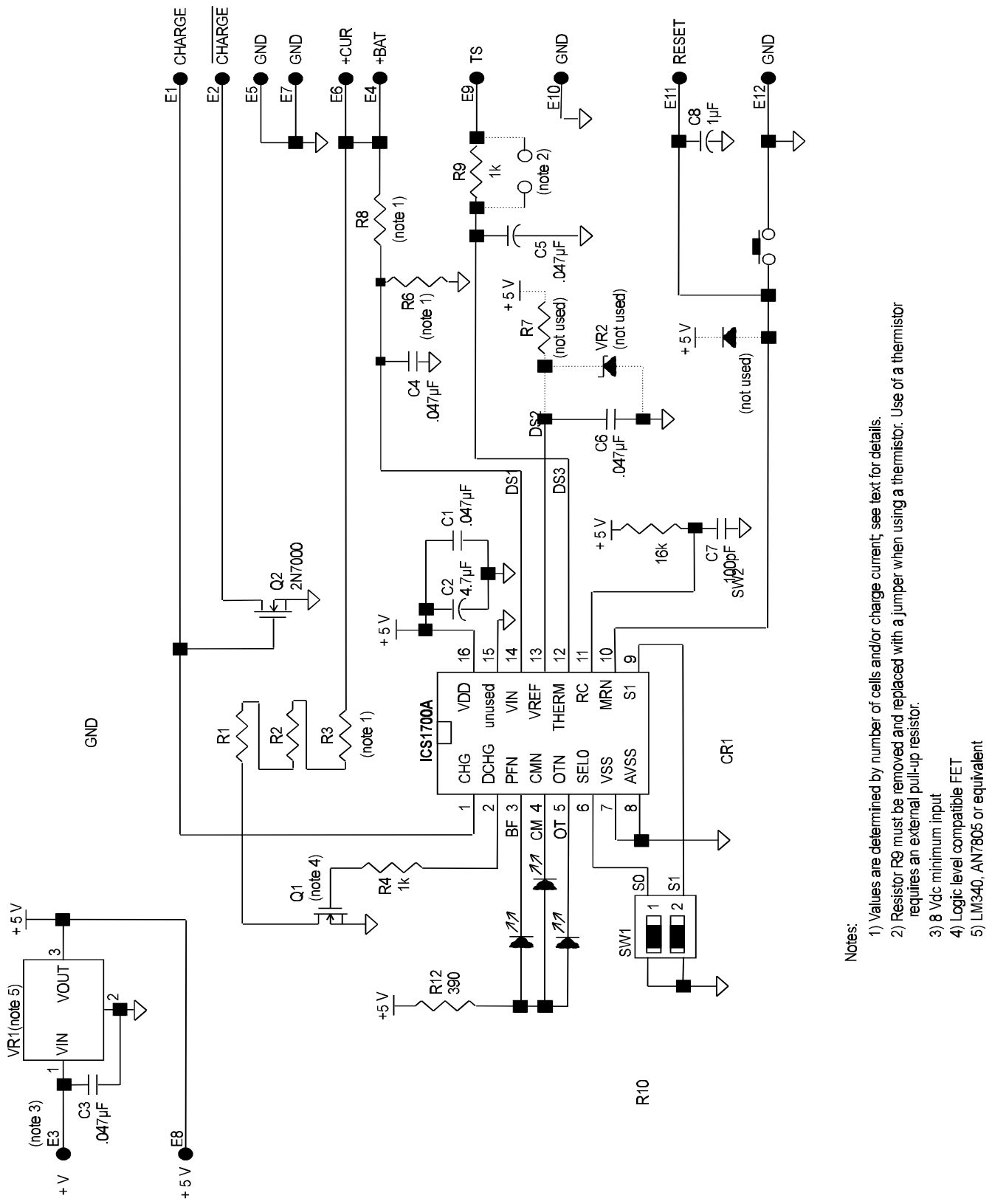

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