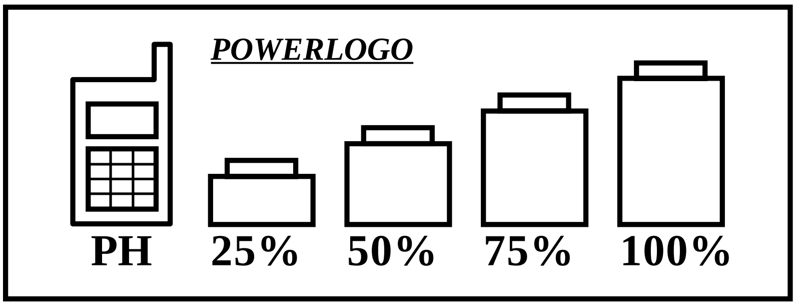
CHIPS GARDEN ™

NiCd / NiMH / Li-Ion Battery Seq. Twin Charge Control IC

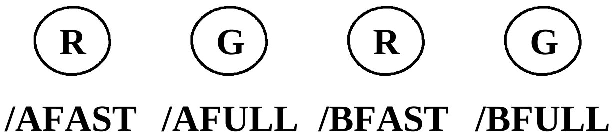
Main Function	General Description
☞ For NiCd / NiMH battery apply constant-current (C.C.) charge technique and provide -ΔV/Δt, Timer, V-Max, terminate-condition detection Apply trickle charge current after battery was full-charged. ☞ For Li-Ion battery apply constant-voltage (C.V.) charge technique to ensure safety and prevent battery from damage. ☞ Provide battery chemistry type input selection, allow system to identify battery type via proper interface circuit. ☞ Support LED/LCD display. ☞ Provide battery power indicator (LCD mode) to illustrate the battery power in percentage. ☞ Support battery discharge function. ☞ 16 Pin SOP Package	**ST-828** has the most simplest and economic way by using the LM339 associate with advance software program to achieve the goal of constant-current and constant-voltagecontrol. Especially suitable for the up-to-date Li-Ion battery charge control and MiMH/NiCd battery are also available. **ST-828** for the phone-set which built-in charge-control function itself, provide a simplest solution to detect the charge status of phone-set. Basically, the phone-set will has higher priority to charge than the battery if both in their own slot. System will monitor the charging status of phone-set and detect the "charge-terminate" situation of phone-set and then transfer the charge process to the battery. **ST-828** support LED/LCD indicators could illustrate the condition during charging (Red-LED for Rapid-Charge, Green-LED for Full-Charged in LED display mode, and 25%, 50%, 75%, 100% for charging power indicator in LCD display mode). **ST-828** is the best cost performance IC to achieve the goal of higher quality and lower the cost of twin charger solution.

<u>**Display Reference**</u>

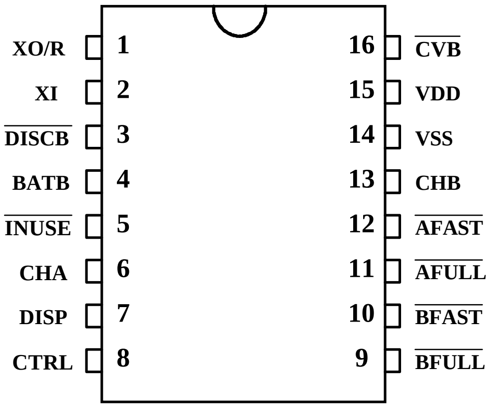
LCD Display



LED Display



Pin out



SOP 16

Pin Descriptions

Pin			Pin Descriptions	Mult Func
1	XO/R	I/O	RC oscillation output terminal.	
2	XI	I	RC oscillation input terminal.	
3	/DISCB	I/O	Battery discharge input/output terminal.	YES
4	BATB	I	Bat. Voltage detection terminal.	
5	/INUSE	I	Phone-set Insert/Remove detection terminal	
6	CHA	O	Phone-set charge control output terminal.	YES
7	DISP	I/O	LED / LCD display selection input terminal.	YES
8	CTRL	O	A/D conversion control output terminal.	
9	/BFULL	I/O	Full charged indicator output terminal-B.	YES
10	/BFAST	I/O	Fast charge indicator output terminal-B.	YES
11	/AFULL	I/O	Fast charge indicator output terminal-A.	YES
12	/AFAST	I/O	Full charged indicator output terminal-A.	YES
13	CHB	O	Battery charge control output terminal.	YES
14	VSS	I	MCU system ground.	
15	VDD	I	MCU power supply input terminal.	
16	/CVB	I/O	Constant-Voltage control output terminal	YES

Note : Descriptions marked with "Mult func" indicate a multi-function on it and is has variant functions were provided in these pins. For the other pin functions and descriptions please refer to detail explanations.

Charge Terminate Conditions:

V_Min : 0.8V/Cell(NiMH) , 2.4V/Cell(Li-Ion)
V-Max : 1.8 V/Cell (NiCd / NiMH)
V-Cut : 4.2 V/Cell (Li-Ion)
4.1 V/Cell (NOKIA 6110....)
-ΔV/Δt : -8mV~ -16mV / Cell

Timer : 6 Hours
Discharge level : 1.0V/Cell (NiMH)
: 3.6V/Cell (Li-Ion)
VDD : 5.0V ±1%
3.3V ±1%

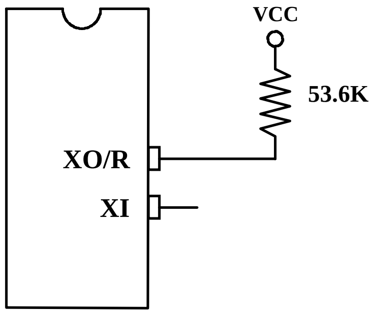
Recommended LCD Specification :

Driving Voltage : 4.5V (@VDD=5V)
2.8V (@VDD=3.3V)
Multiplex Level : Static

Frame Frequency : 64Hz
View Angle : 6 O'clock
View Mode : Positive Reflective

Pin 1 XO/R：RC Oscillation output terminal.

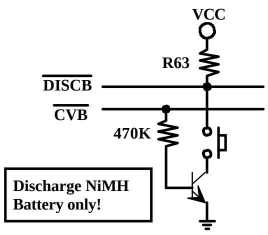
Pin 2 XI：RC Oscillation input terminal.

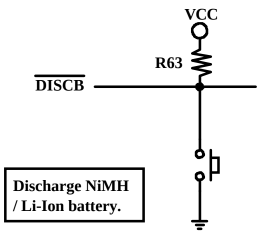


Pin 3 (1) /DISCB：Battery discharge input/output terminal.

Once battery was inserted, signal a LOW condition on this pin will cause system transfer to discharge mode. (Discharge with active-low).

When Pin 3 become low level state (Low-active) with battery in slot. System will enter discharge mode to discharge battery. EDV (End of Discharge Voltage) was 1.0V/Cell for NiMH battery, 3.6V/Cell for Li-Ion Battery.





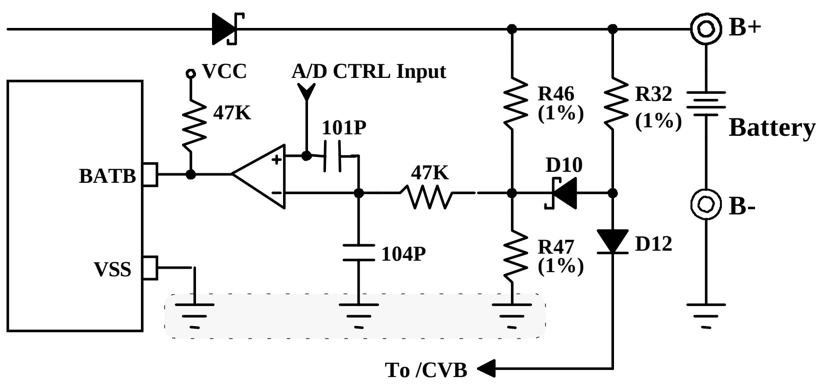
(2) DATA：DS2502/DS2434 EP battery identification chip input terminal.

Once battery was inserted, system will auto to access the identification chips via this pin, also to identify the chemistry type of battery. (eg. MOTOROLA, AEG, ...)

Pin 4 BATB：Battery voltage detection input terminal.

Since the A/D voltage input range from 0~VAref(=VDD), the input voltage can't exceed the range of VDD. Therefore, the actual voltage should be attenuated with a resister network in order to limit it in the range of 0 ~ 5V. The system calculate the voltage of battery base on 2.5 cells. Hence, the formula as following :

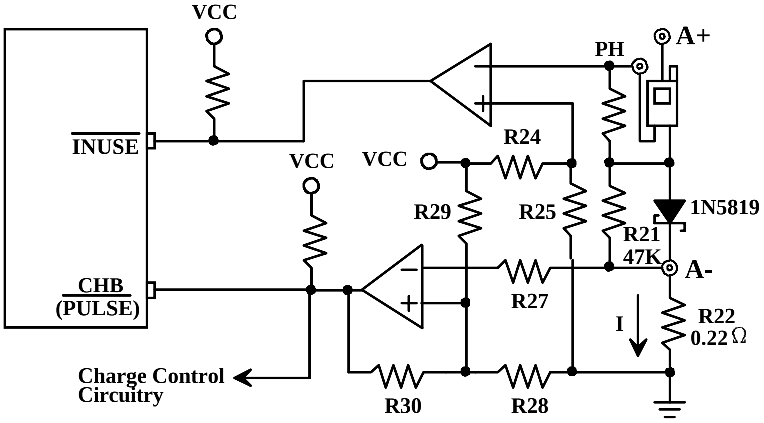
[(Number of Cell*2.0-VCC)/VCC = R46/R47]



R46/R47 (1%) VCC / Battery (NiMH+Li-Ion)		5.0V	3.3V	External control circuit D10,D12,R32 (@VCC=5V)	External NiMH/Li-Ion identify circuit
3 Cells (NiMH)	4.1V (Li-Ion)	3.43K/20K	2.55K/3.3K	X	Yes
	4.2V (Li-Ion)	4K/20K	2.7K/3.3K	X	Yes
4 Cells NiMH Only		12K/20K	4.7K/3.3K	X	X
4 Cells + 8.2V Li-Ion		26.7K/20K		D10, D12, R32=20K	Yes
5 Cells NiMH Only		20K/20K	6.7K/3.3K	X	X
5 Cells (NiMH)	8.2V (Li-Ion)	26.7K/20K		D10, D12, R32=68K	Yes
	8.4V (Li-Ion)	28K/20K		D10, D12, R32=68K	Yes
6 Cells NiMH Only		28K/20K		X	X

Pin 5 (1) /INUSE : Phone-set insert/remove detection terminal.

/INUSE should be in Low-level state while the phone-set was inserted to the slot. A High-level signal on /INUSE pin indicate the phone-set was remove from the slot.



Full-Charged current should be fine tuned, Since the end-of-charge current between different models of phone-set was not all the same. Power consumption between different models of phone-set was not all the same when it nearly full-charged.

Phone-Set Insert/Remove Current Detection Setting (I_{INUSE})

$$I_{INUSE} = (VCC \times \frac{R25}{R24+R25}) \div (R21 + R22)$$

Phone-Set Fast Charge Current Detection Setting (I_{PULSE})

$$I_{PULSE} = (VCC \times \frac{R28}{R28+R29}) \div R22$$

Pin 6 CHA：Phone-Set charge control output terminal

CHA was in High-level state, indicate the charge process to phone-set is in progress. While CHA was in Low-level state, indicate the charge process to phone-set was stopped. When CHA pin was not used, pull-up a 4.7KΩ resistor to VCC was recommended.

Pin 7 (1) DISP : LED/LCD display selection input terminal.

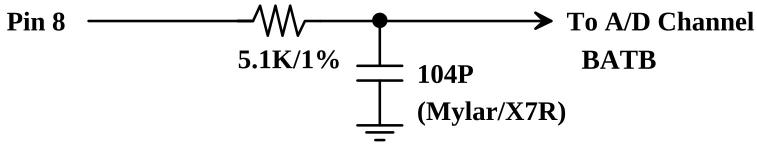
(1) Pull-up a 4.7KΩ resistor to VCC indicate the LED display mode was selected. In thi mode, Pin 9,10, 11, 12 was defined as /BFULL, /BFAST, /AFULL, /AFAST LED indicator output terminal.

(2) When 4.7KΩ resistor was not connected indicate the LCD display mode was selected. In this mode, Pin 9, 10, 11,12 was defined as 25%, 50%, 75%, 100% battery power indicator output.

(2) APHONE : Phone-set charge indicator output terminal.

In LCD display mode, Pin 7 was defined as phone-set charge indicator output. Since the 4.7KΩ was not connected; hence it can be connected to phone-set segment of LCD panel.

Pin 8 CTRL : A/D conversion control output terminal.



Pin 9 (1) /BFULL：Battery full-charged indicator output terminal. (LED mode)
(2) B25%：Battery charge 25% power indicator output terminal. (LCD mode)
(3) OPTION1：MCU option1 selection input terminal.

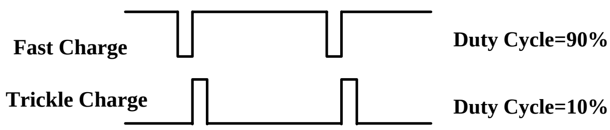
Pin 10 (1) /BFAST：Battery fast charge indicator output terminal. (LED mode)
(2) B50%：Battery charge 50% power indicator output terminal. (LCD mode)
(3) OPTION2：MCU option2 selection input terminal.

Pin 11 (1) /AFULL：Phone-set full-charged indicator output terminal. (LED mode)
(2) B75%：Battery charge 75% power indicator output terminal. (LCD mode)
(3) OPTION3：MCU option3 selection input terminal.

Pin 12 (1) /AFAST：Phone-set fast charge indicator output terminal. (LED mode)
(2) B100%：Battery charge 100% power indicator output terminal. (LCD mode)
(3) OPTION4：MCU option4 selection input terminal.

Pin 13 (1) CHB : Battery charge control output terminal.

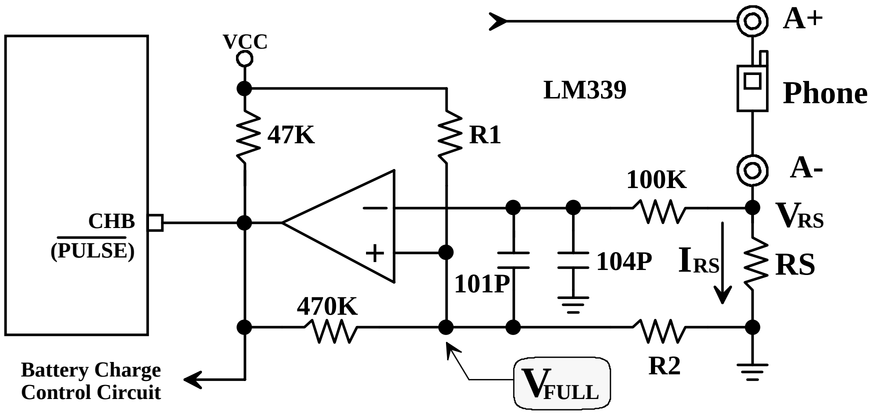
Pin 13 in high-level state indicate battery was in charge-on-duty.



(2) /PULSE : Phone-set charge signal detection terminal.

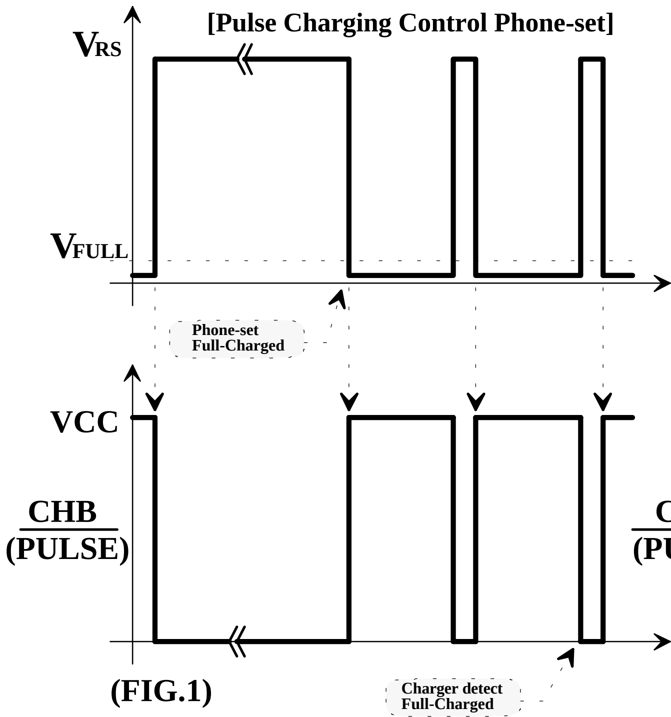
By detecting the charge signal issued from phone-set, the system could identify the charging progress of phone-set and determine when the phone was full-charged, then the system could transfer to another mode in order to charge the battery in the rear-slot.

In the time when the phone-set was charging, system still could identify the charging pattern to look for the intervals to charge battery if phone-set was in charge-off-duty state.

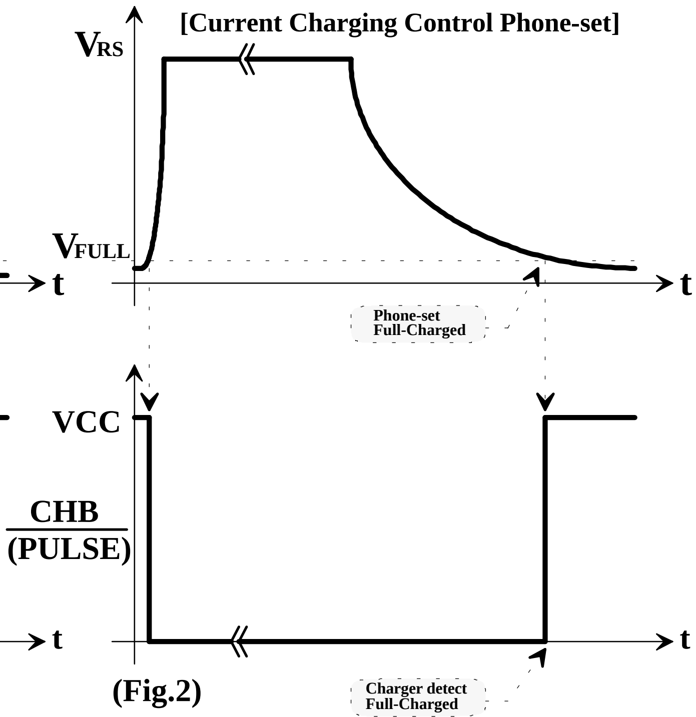


Since the different model of phone-sets draws different current when it reach the full-charged point. Users should adjust the set point (V_{FULL}) in order to detect the status when phone-set was full-charged.

Phone-set Full Charged Current : $I_{RS}=V_{RS}/RS=V_{FULL}/RS=VCC*[R2/(R1+R2)] \div RS$



(FIG.1)



(Fig.2)

(1). /PULSE=Low indicate the phone was in fast-charge stage.

(2). /PULSE=Hi/Low bouncing indicate the phone-set has been or nearly full-charged. System will analysis the charging pattern to determine the phone-set was in full-charged status or not

(3). /PULSE=Hi and /INUSE=H indicate phone-set has been removed from slot.

Caution :

(1) ST-828 only support the phone-set which built-in with charge control function itself if it charge the phone-set without charge control function will damage the phone-set.

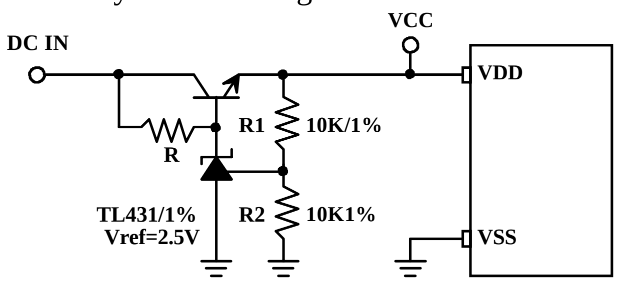
(2) Phone-set charge using pulse control charge technique, the V_{FULL} current set point should be larger than the current draws on phone-set when phone-set was in charge-off- duty.

(3) Phone-set charge using current charge control technique, the VFULL current set point should not br smaller than the current draws on phone-set when it was power-on.

Pin 14 VSS : MCU system ground. (GND)

Pin 15 VDD : MCU power supply input terminal.

1. The reference input plays a major roles in system A/D conversion. And the deviation will cause error of the system voltage set-point . For examples, the discharge voltage will be 5.0V/5Cells while the reference input is 5.0V. And the former (discharge voltage) will become 5.25V/5Cells while the later (reference input) raised to 5.25V (5% up).
2. In order to charge the Li-Ion battery, the system need a strict constant-voltage of 4.25V (Upper Limit). So we got to apply a 5.0V±1% accurate voltage reference. The recommendation as follows:
   (1) Manually screen the 5.0V±1% of LM7805 。
   (2) Use a shut-regulator (eg. TL431) to form a voltage regulator circuit which produce a better accuracy like following :

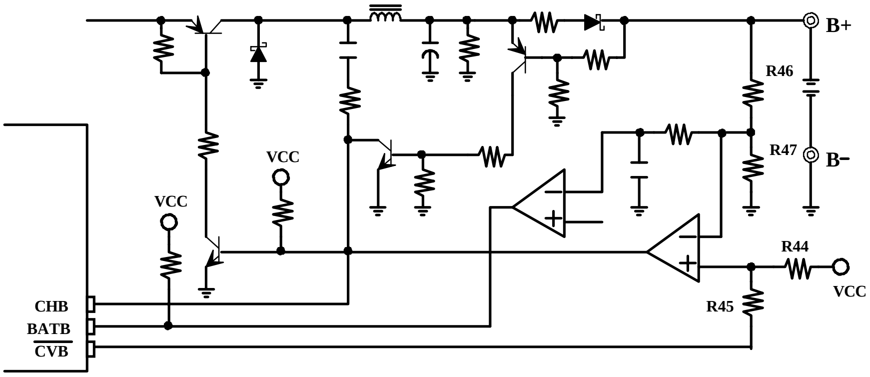


$$V_O = V_{ref} \times (1 + \frac{R1}{R2})$$

Pin 16 (1) /CVB : Constant voltage control output terminal.

/CVB output will be in Hi-Z (High Impedance) state if NiMH/NiCd battery was charging.
/CVB output will be in Low (High Impedance) state if Li-Ion battery was charging.
Detail charging scheme was listed as follows:

CHB	/CVB	Chemistry	Voltage	Recommend /CVB Voltage
Hi-Z	Hi-Z	NiCd/NiMH	2.0V / Cell	6.0V (3 Cells NiXX)
Hi-Z	Low	Li-Ion	4.1V / Cell	4.12V (1 Cell Li-Ion) 8.22V (2 Cells Li-Ion)
			4.2V / Cell	4.22V (1 Cell Li-Ion) 8.42V (2 Cells Li-Ion)
Low	Hi-Z/Low	NiXX/Li-Ion	None	No Output



VR44 = VR45 while constant-voltage mode was activated, hence the formula as follow:

$$V_{B+} \times \left(\frac{R47}{R46+R47}\right) = VCC \times \left(\frac{R45}{R44+R45}\right)$$

$$V_{B+} = VCC \times \left(\frac{R45}{R44+R45}\right) \times \left(\frac{R46+R47}{R47}\right)$$

R44, R45 Recommendation :

While VCC = 3.3V then (R44=2.4K, R45=5.7K

While VCC = 5.0V then (R44=8.87K, R45=21K

(2) TYPE : Battery chemistry type selection input terminal.

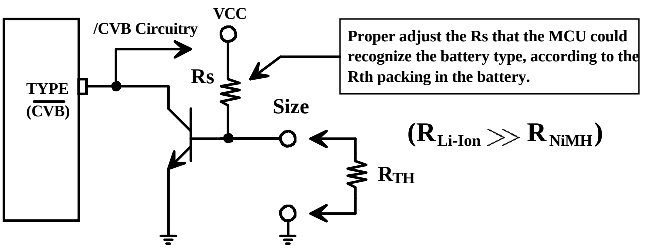
After the battery was inserted, MCU will select the charging mode according to the pin level on TYPE pin. If the pin level was in high-level (VDD) the MCU will recognize as NiMH/NiCd battery while low-level will recognize as Li-Ion battery.

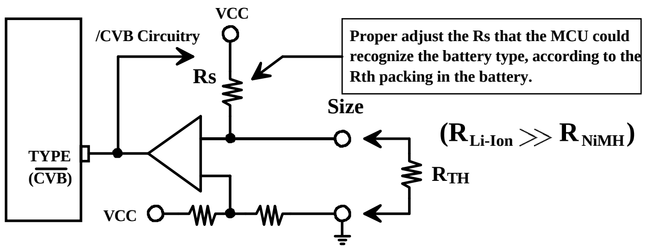
On some specified cellular phone battery like MOTOROLA series, the MCU was able to recognize the battery type recording in the chip of battery via proper interface.

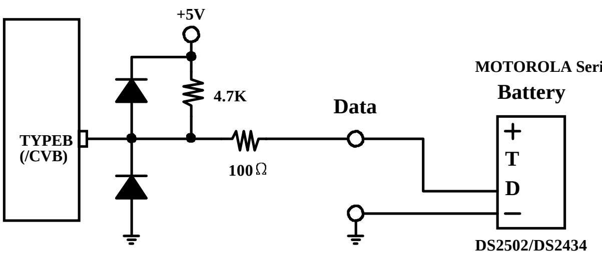
Since the phone-set must has some way to identify the NiMH/Li-Ion battery if both batteries were supported. Something like resistor (eg. NOKIA) or identify chip (eg. MOTOROLA). According to the way, through a proper interface, the battery chemistry type was much easy for MCU to recognize.

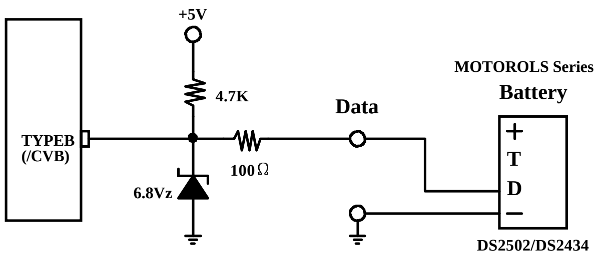
Pin 16 = VDD (NiCd/NiMH Battery) while battery was inserted.

Pin 16 = GND (Li-Ion Battery) while battery was inserted.

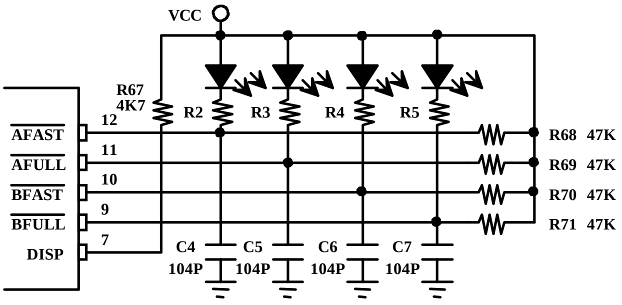




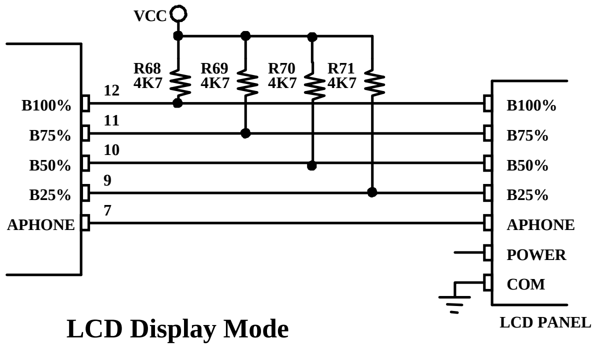




System Function Selection Descriptions:



LED Display Mode



LCD Display Mode

	LED Display Mode (R67 Connected) (OPTION were C4, C5, C6, C7)				LCD Display Mode (R67 Disconnected) (OPTION were R68,R69,R70,R71)			
	C4 (Pin 12)	**C5 (Pin 11)**	**C6 (Pin 10)**	**C7 (Pin 9)**	**R68 (Pin 12)**	**R69 (Pin 11)**	**R70 (Pin 10)**	**R71 (Pin 9)**
Not Connected (Open)	1. General purpose usage. 2. For MOTOROLA series default to NiMH battery.	Indicator flash while battery in stand-by mode.	Battery stand-by indicator output was Pin 9,10 (R/G)	Total-Power Charging Mode.	1. General purpose usage. 2. For MOTOROLA series default to NiMH battery.	Phone-set full-charged indication support. (APHONE Flash)	N/A	Total-Power Charging Mode.
Connected (Closed)	For MOTOROLA series default to Li-Ion battery.	Indicator steady while battery in stand-by mode.	Battery stand-by indicator output was Pin 10 (R)	C.C./C.V. Charging Mode.	For MOTOROLA series default to Li-Ion battery.	Phone-set in slot indication only! (APHONE Steady)	N/A	C.C./C.V. Charging Mode.

ELECTRICAL CHARACTERISTICS

ABSOLUTE MAXIMUM RATING :

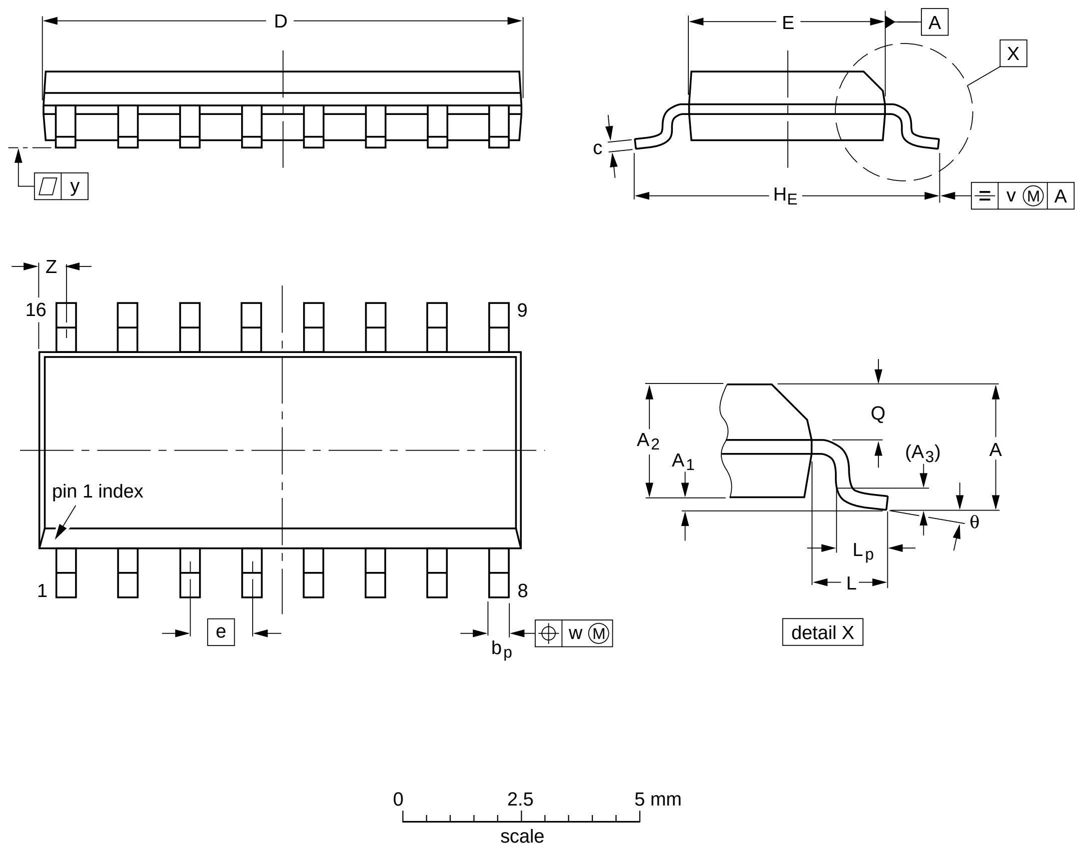
Power Supply Voltage	Vcc = + 2.4 to +5.5V
Input Voltage	Vin = -0.3 to Vcc+0.3V
Output Voltage	Vout = 0V to Vcc
CPU Clock	from 1KHz to 6MHz
Operating Ambient Temperature	Topr = 0℃ to 70℃
Storage Temperature	Tstr = -20℃ to 70℃

DC ELECTRICAL CHARACTERISTICS (25℃, VCC = 5.0V)

Charateristic	Condition	Symbol	Min	Typ	Max	Unit
Power Supply Voltage		V_{DD}	2.4		5.5	V
Output High Voltage Pin 6 ~ 12		V_{OH}	2.4			V
Output Low Voltage Pin 4 ~ 12	I_{OL} = 8 mA	V_{OL}			0.4	V
Output Low Voltage Pin 16	I_{OL} = 25mA				0.5	V
Input High Voltage Pin 4, 6 ~ 13, 16		V_{IH}	3.5		5	V
Input Low Voltage Pin 4, 6 ~ 13, 16		V_{IL}	0		1.4	V
Positive-Going Input Threshold Voltage Pin 3 ~ 5, 13		V_{IH}		2		V
Negative-Going Input Threshold Voltage Pin 3 ~ 5, 13		V_{IL}		0.8		V
I/O Port Hi-Z Leakage Pin 4 ~ 12, 16	Pull-Down/Up Non Actived	I_{IL}			10	uA
Input Pull-Down Current Pin 6 ~ 12	Pull-Down Actived	I_{IL}		100		uA
Pull-Down Resistor Pin 6 ~ 12	(Software Programmable)	Rpudwn		100		KΩ
Pull-Up Resistor Pin 13	Schmidt Trigger Input Open Drain Output	Rpudwn		External		KΩ
Pull-Up Resistor Pin 4, 5	Pull-Up Always	Rpullup		5		KΩ
Pull-Up Resistor Pin 3, 16	(Software Programmable)	Rpullup		100		KΩ
General Current Sink Output Pin 3 ~ 13		I_{OL}		8		mA
High Current Sink Output Pin 16		I_{OL}		25		mA
Power Consumption		I_{CC}		2		mA
Stand-By Current		I_{STB}		5		uA
LVR Trigger Voltage		V_{LVR}		2.2		V

Package outline drawings

SOP16: plastic small outline package; 16 leads; body width 3.9 mm



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A_1	A_2	A_3	b_p	c	D (1)	E (1)	e	H_E	L	L_p	Q	v	w	y	Z (1)	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	10.0 9.8	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8^o 0^o
inches	0.069	0.010 0.004	0.057 0.049	0.01	0.019 0.014	0.0100 0.0075	0.39 0.38	0.16 0.15	0.050	0.244 0.228	0.041	0.039 0.016	0.028 0.020	0.01	0.01	0.004	0.028 0.012	

Note

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.