DATA SHEET

NE57606

2 to 4 cell redundant Lithium-ion overcharge monitor

Product data

2002 Oct 10

Philips Semiconductors

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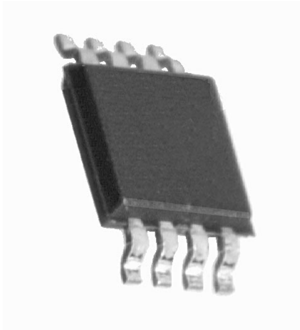
GENERAL DESCRIPTION

The NE57606 is a redundant overcharge detection IC for use within 2-4 cell Li-ion battery packs. It detects the voltage of each Li-ion cell and issues an overcharge signal which then can be used to alert the portable host or be used to turn-off a series charge MOSFET within the battery pack. Its purpose is to act as a back-up protection circuit to a primary Li-ion protection circuits such as the NE57605 and NE57607. The overcharge signal is an open collector output which can be wire-ORed with other safety functions.



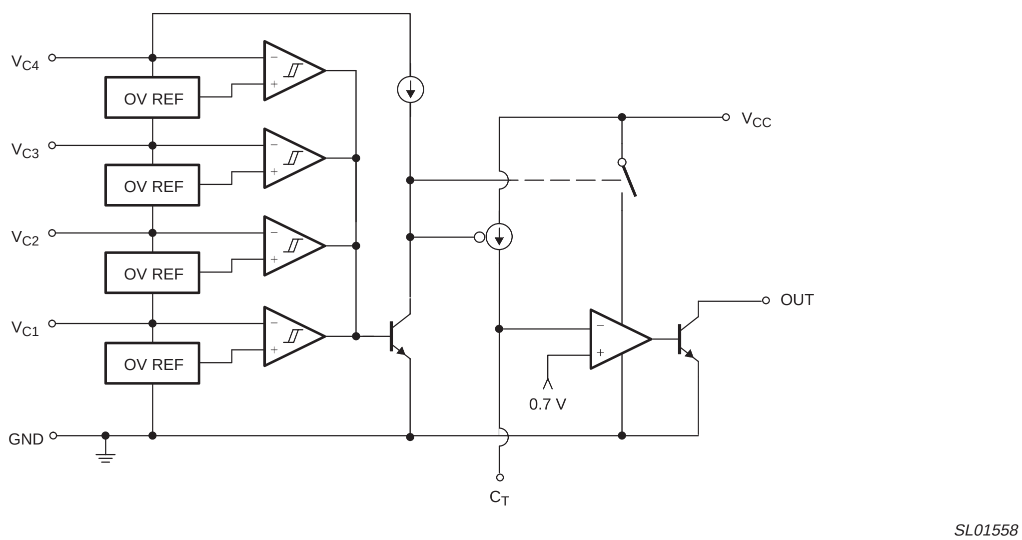
FEATURES

- Consumption current (V_{CEL} = 3.8 V) 3.0 μA typical
- Consumption current (V_{CEL} = 2.3 V) 0.3 μA typical
- Input current between cell pins (V_{CEL} = 3.8 V) ±0.3 μA max
- Overcharge detection voltage = threshold voltage ± 50 mV
- Overcharge detection delay time (CT = 0.22 μF) 1.5 s typical
- Four voltage ranges available

APPLICATIONS

- Li-ion Battery pack protection

SIMPLIFIED DEVICE DIAGRAM



Voltage options

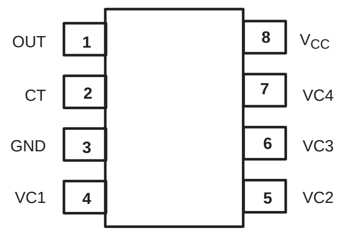
The device has 4 voltage options.

Part Number	Detection voltage	Hysteresis
NE57606Y	4.350 V	250 mV
NE57606C	4.225 V	None
NE57606D	4.130 V	None
NE57606E	4.450 V	100 mV

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	TEMPERATURE RANGE
NE57606YD	SO8	Small outline plastic, surface mount 8-pin	–20 to +80 °C
NE57606CD	SO8	Small outline plastic, surface mount 8-pin	–20 to +80 °C
NE57606DD	SO8	Small outline plastic, surface mount 8-pin	–20 to +80 °C
NE57606ED	SO8	Small outline plastic, surface mount 8-pin	–20 to +80 °C

PIN CONFIGURATION



PIN DESCRIPTION

Pin No	Pin Name	Function
1	OUT	Reset output pin
2	C_T	Delay capacitance pin
3	GND	Ground pin
4	VC1	Cell 1 power supply
5	VC2	Cell 2 power supply
6	VC3	Cell 3 power supply
7	VC4	Cell 4 power supply
8	V_{CC}	Voltage supply to IC

MAXIMUM RATINGS

Symbol	Parameter	Min	Max	Unit
V_{CC}	V_{CC} input voltage	–0.3	+24	V
VC2	V4 input voltage (Note1)	–0.3	+24	V
VC3	V3 input voltage (Note1)	–0.3	+24	V
VC4	V2 input voltage (Note1)	–0.3	+24	V
VC1	V1 input voltage (Note1)	–0.3	+24	V
V_{CT}	CT pin voltage	–0.3	+24	
V_{OUT}	V_{OUT} pin voltage	–0.3	+24	
T_{STG}	Storage Temperature	–40	+125	°C
T_{amb}	Operating temperature	–20	+80	°C
Pd	Power dissipation		300	mW

NOTES:
1. V_{CC} = >V4 = > V3 = > V2 = > V1 = > –0.3
2. A current no greater than 100 µA should be passed through pin Ct.

ELECTRICAL CHARACTERISTICS

T_{amb} = 25°C, V_{CEL} = V4–V3 = V3–V2 = V2–V1 = V1–GND, V_{CC} = 4V_{CEL}, except where noted otherwise

Symbol	Parameter	Conditions	Min	Typ	Max	Units
I1	Consumption current 1	V_{CEL} = 3.8 V		3.0	6.0	μA
I2	Consumption current 2	V_{CEL} = 2.3 V		0.3	0.5	μA
I3	Pin I/O current between cells	V_{CEL} = 3.8 V (V4, V3, V2, V1 side)		±0.0	±0.3	μA
V_S	Overcharge detection voltage	V_{CEL} = L→H, Ta = –20~+70 °C				
		NE57606Y	4.30	4.350	4.40	V
		NE57606C	4.175	4.225	4.174	
		NE57606D	4.080	4.130	4.180	
		NE57606E	4.400	4.450	4.500	
HSY	Hysteresis voltage	V_{CEL} = L→ H →L	0.20	0.25	0.30	V
T_{PLH}	Overcharge detection delay time	C_T = 0.22 μF	1.0	1.5	2.0	S
V_{OL}	Output voltage L	I_L = 100 μA			0.4	V
I_{LEAK}	Output leakage current	V_{CEL} = 3.8 V, V_{OUT} = 24 V			0.1	μA

TECHNICAL DISCUSSION

The NE57606 is typically used in conjunction with a Li-ion protection IC as redundant protection for a 2, 3, or 4-cell lithium-ion battery pack. Lithium-ion cells can present a safety hazard if they become overcharged, therefore careful monitoring of each cell's operating point is necessary. For very safety-sensitive applications, a back-up protection circuit using a device such as the NE57606 is advisable.

The NE57606 monitors each cell within a 2-4 Li-ion cell battery pack. If any cell within the battery pack exceeds the full-charge threshold voltage, the overvoltage fault status output assumes a low state. This output signal should be used to alert other parts of the system that an overcharged state has been reached. This output could also be used to open a MOSFET placed in series with the positive battery terminal to interrupt the charging current from the battery charger.

Redundant Protection of a Lithium-ion Battery Pack

Within a typical Li-ion battery system, there are two or three major circuits responsible for the monitoring and maintenance of the Li-ion cells: the Li-ion battery charger, the Li-ion protection circuit, and sometimes the redundant Li-ion overcharge detector. This type of system is called a triple-redundant protected system. If any one of the protection circuits fail, then there will be two other independent systems to assume the protection function. If the product is designed properly, that is, component de-rating, non-cascading failure modes, ESD, packaging, etc, having two or more simultaneous failures within the protection system is virtually impossible.

During normal operation of the Li-ion system, the battery charger should be the circuit that terminates the charge. The Lithium-ion protection circuit should never be used for routine termination of the charging function. It should be viewed as a back-up protection system in the event of a charger failure. The redundant overcharge detection IC should disconnect the pack from the charger in the event that both other systems have failed.

Setting the trip-point voltages are key to the system's operation. First, the trip point tolerances should not overlap, or the systems will not become active in the proper order over large production. The trip points should be typically set in the following fashion:

1. The battery charger should be set to terminate its charge at a point just below the cell's full charge voltage (–1%)
2. The Li-ion protection circuit is set to open the series charge MOSFET switch at the rated full charge voltage of any of the cell(s). (±1%)
3. The redundant overcharge detector is set to issue an alert and/or disconnect a series charge MOSFET switch when any cell voltage exceeds the rated full charge voltage (+1%)

With trip-points set as described above, the charger will taper its charging current until the charging current falls below a certain current level, after which the charger turns off. Only if the charger does not or cannot terminate the charging, the protection IC will open a series MOSFET switch, thus cutting off any charge current. Lastly, if both the charger and the protection IC were to fail, the NE57606 will open another series MOSFET.

APPLICATION INFORMATION

The NE57606 can be used within 2, 3, or 4-cell battery packs. This can be done by electrically creating a short-circuit across the pins that would have been connected to the ends of the cells. For a 3-cell pack pin VC1 should be connected to ground (pins 3 to 4). All of the combinations are shown in Table 1.

Table 1.

Cells	VC1	VC2	VC3	VC4
4-cell	VC1	VC2	VC3	VC4
3-cell	VC1	VC1	VC2	VC3
2-cell	VC1	VC1	VC1	VC2

The schematics for a 3-cell and a 4-cell monitoring circuit are shown in Figures 1 and 2 respectively.

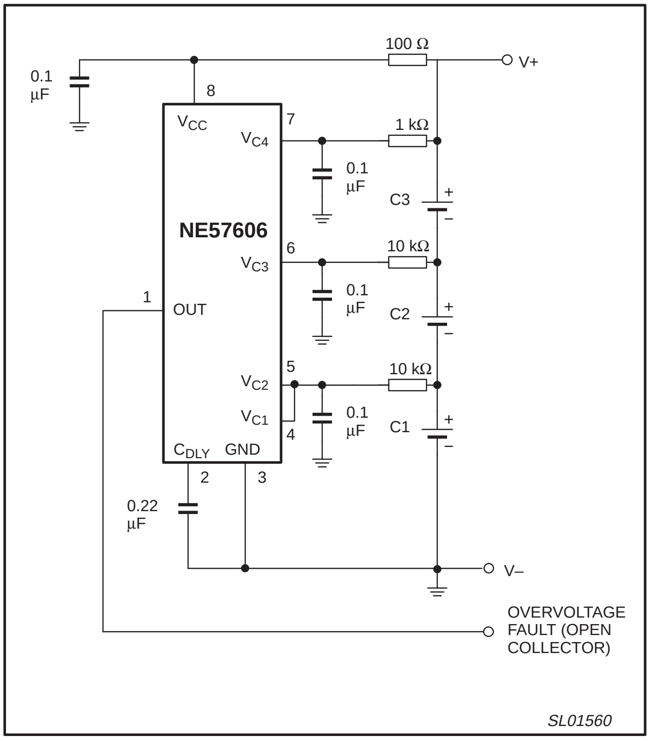


Figure 1. 3-cell monitoring circuit

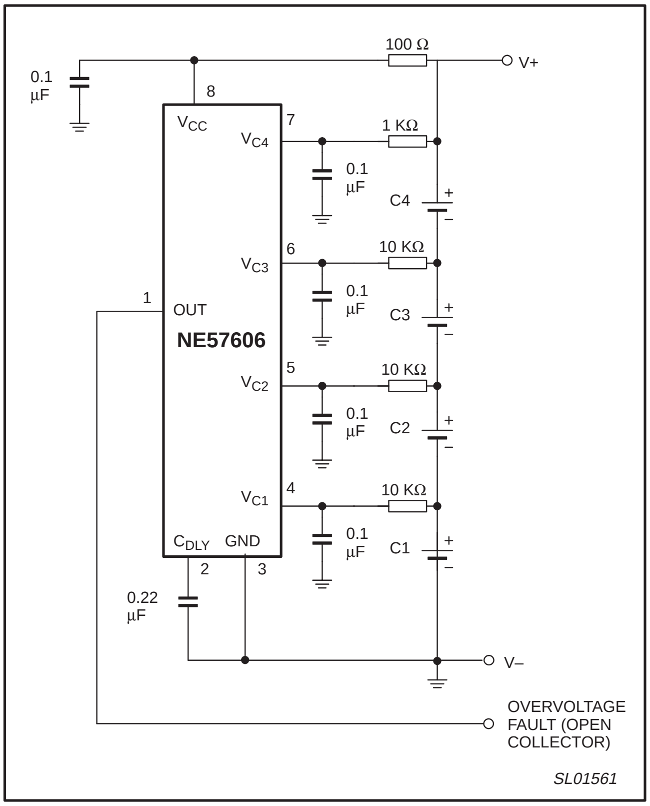


Figure 2. 4-cell monitoring circuit

Using the NE57606 within a Li-ion battery system

A Li-ion and Li-polymer 4-cell battery system using the NE57605 and the NE57606 is shown in Figures 3 and 4.

The circuit in Figure 3 shares the charge MOSFET between the ICs. This is sometimes not acceptable since a failure of the charge MOSFET or its associated drive circuitry can disable protection provided by the second circuit.

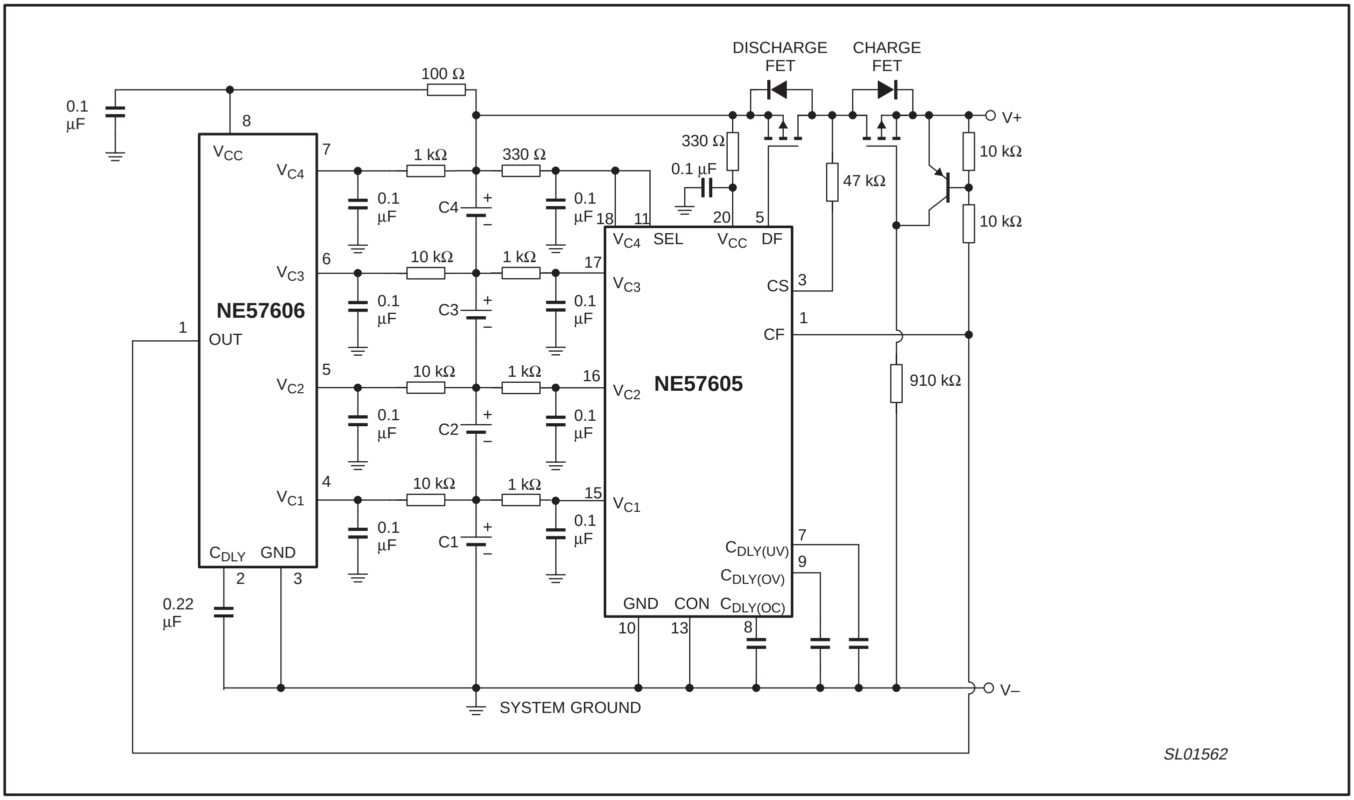


Figure 3. Shared charge MOSFET

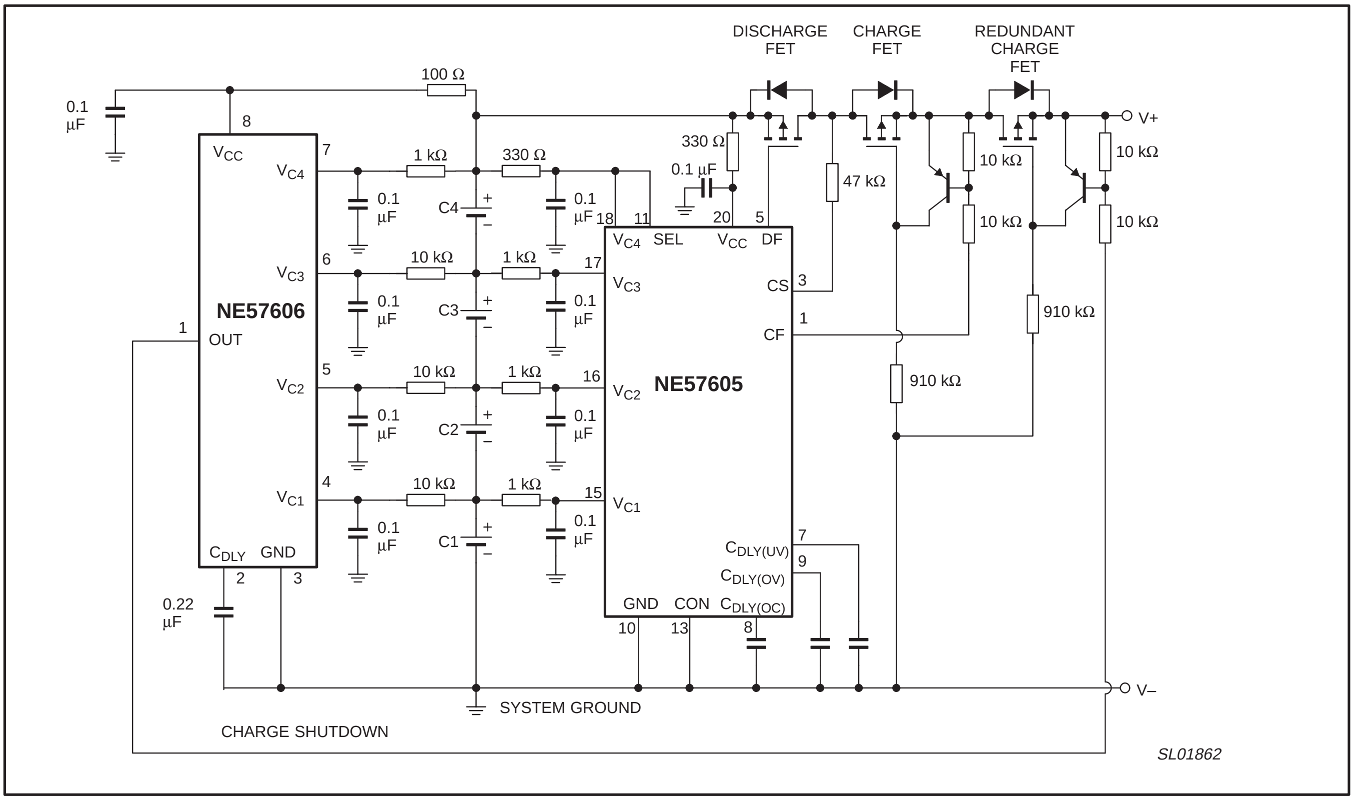
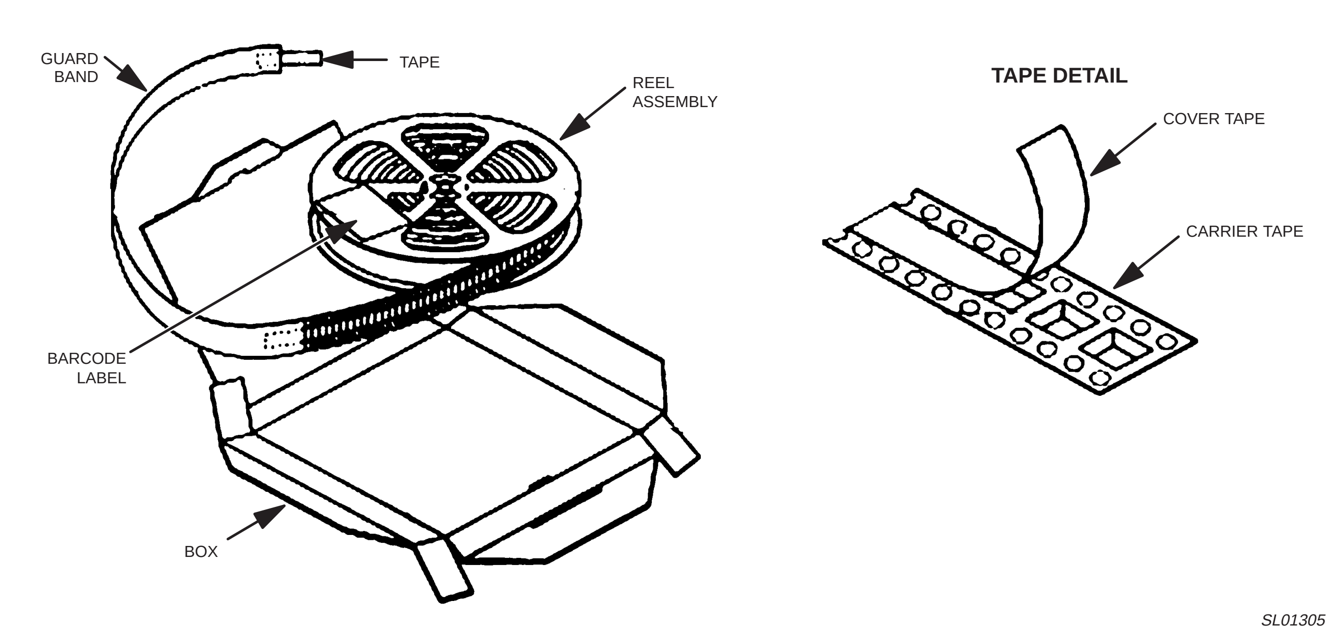


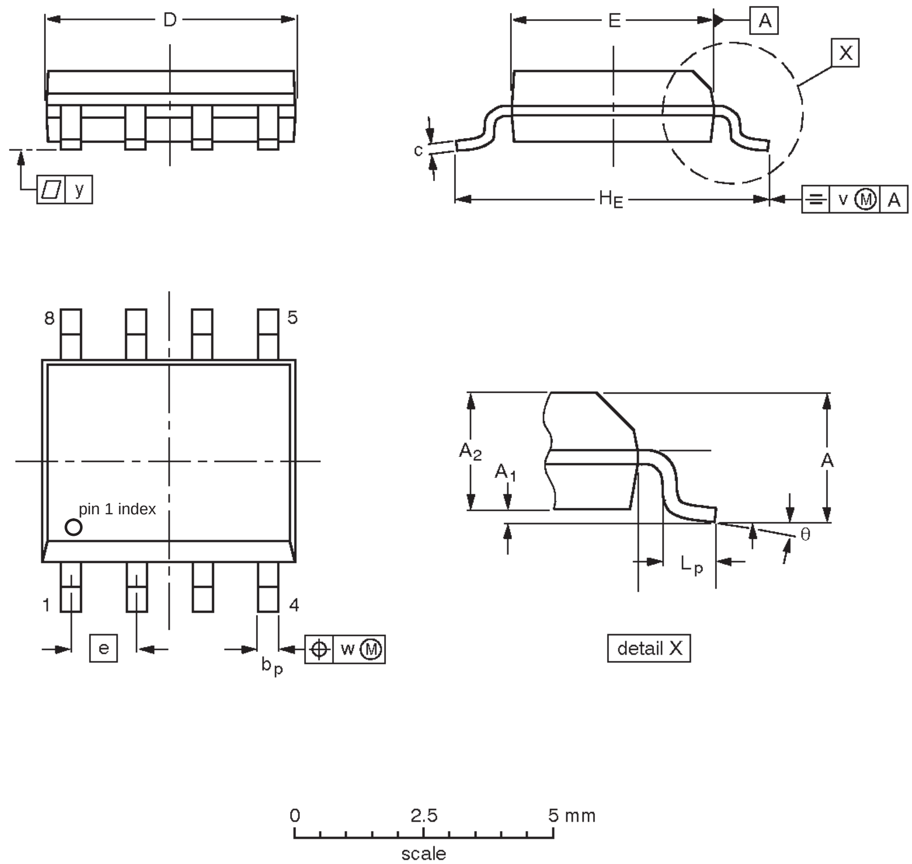
Figure 4. Double-redundantly protected 4-cell Li-ion battery pack (completely redundant system)

The circuit in Figure 4 shows how to implement a completely isolated design. None of the components are shared and a failure in any part of one circuit will not affect the operation of the other. By also not sharing input noise filter components, the failure of the IC due to an input failure or an open circuit will not affect the protection provided by the other circuit.

PACKING METHOD



SO8: plastic small outline package; 8 leads; body width 3.9 mm



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

UNIT	A max.	A_1	A_2	B_2	b_p	c	D(1)	E(2)	e	H_E		L_p				y		θ
mm	1.73	0.25 0.10	1.45 1.25	4.95 4.80	0.51 0.33	0.25 0.19	4.95 4.80	4.0 3.8	1.27	6.2 5.8		1.27 0.38				0.076		8° 0°
inches	0.068	0.010 0.004	0.057 0.049	0.189 0.195	0.013 0.020	0.0100 0.0075	0.20 0.19	0.16 0.15	0.050	0.244 0.228		0.050 0.015				0.003		

Notes

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES			
	IEC	JEDEC	EIAJ	
SO8	076E03	MS-012		

REVISION HISTORY

Rev	Date	Description
_1	20021010	**Product data; initial version.** Engineering Change Notice 853-2296 27198 (date: 20021003).

2 to 4 cell redundant Lithium-ion overcharge monitor

NE57606

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