Aluminum Capacitors

Power Management Solution
Integrated Supercapacitor Charger

By Gerald Tatschl

MAL219699001E3
ENYCAP™
Capacitance Range: 1 F to 100 F
**Voltage Range: 2.3 V to 3.2 V**
4 W Backup Power When Input Fails

DESCRIPTION

The MAL219699001E3 demonstration circuit is a fully transparent power management solution with a regulated 2 W output and integrated power backup. It provides a DC/DC regulator with a wide power input range from 4.0 V to 20 V and adjustable regulated output between 3.3 V and 5.0 V.

The integrated supercapacitor charger and backup boost regulator is optimized for use with ENYCAP™ supercapacitors as a backup energy storage device. The LTC3355 provides the supercapacitor with a programmable constant charging current from 35 mA to 600 mA and regulated cut-off voltage of 1.8 V to 3.2 V.

When the power input fails, the backup boost regulator supplies regulated output voltage until the charged energy of the supercapacitor is depleted. Power good and related control signals are available.
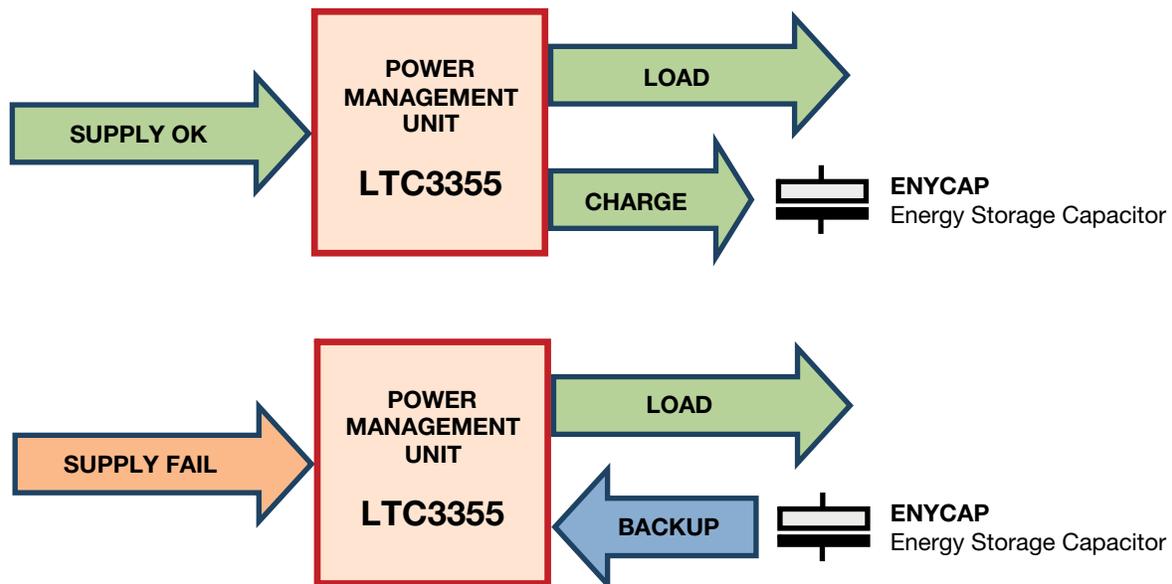

Note
- For the LTC 3355 datasheet, go to www.linear.com/product/LTC3355

For technical questions, contact: hybridstorage@vishay.com

TECHNICAL NOTE

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BOARD CHARACTERISTIC DATA (T_A = 25 °C)						
PARAMETER	**SYMBOL**	**CONDITIONS**	**MIN.**	**TYP.**	**MAX.**	**UNITS**
Input voltage range	V_{IN}		4.0		20.0	V
Output voltage	V_{OUT}					V
Supercap float voltage	V_{CAP}		1.8		3.2	V
Supercap charge current	I_{CHG}		0.03		0.6	A
Output current	I_{VOUT}	V_{IN} > 10.8 V, PFI ≥ 0.8 V, V_{OUT} = ± 1 %, I_{CHRG} = 0 A			1.0	A

BOARD
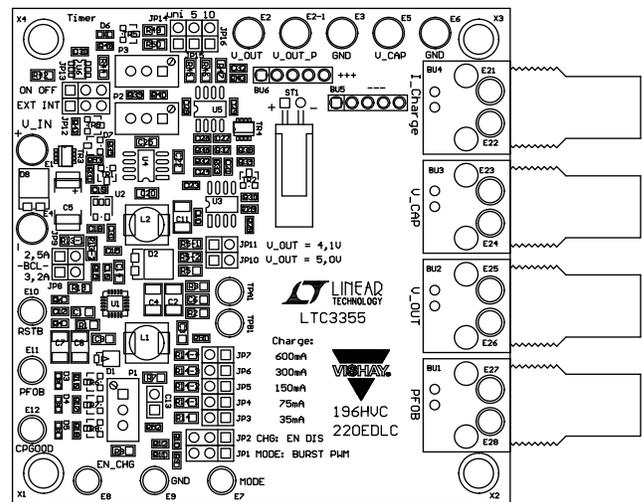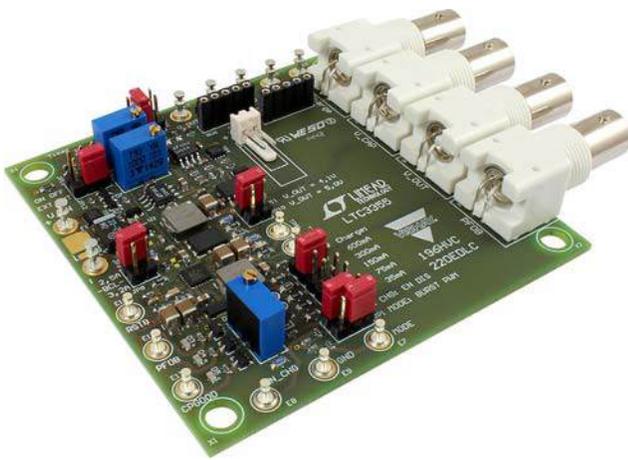
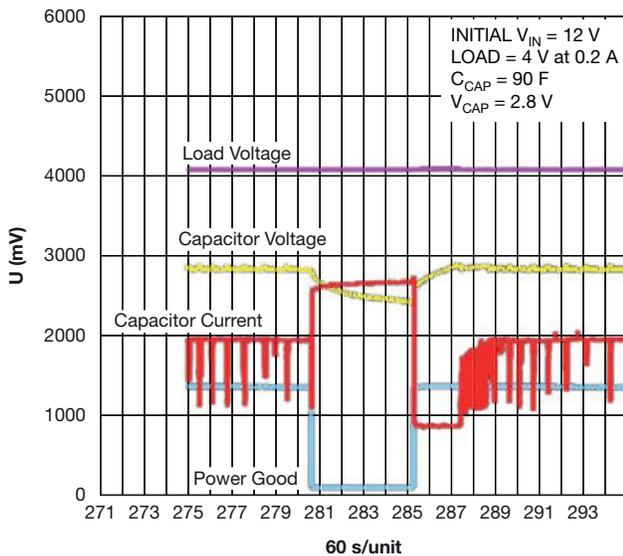## CHARACTERISTIC CHARGING AND POWER BACKUP

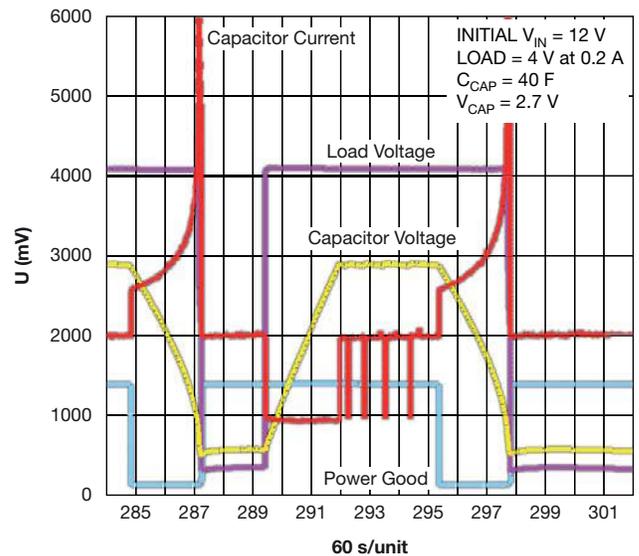Fig. 1A - 196HVC 90 F - 2.8 V Backup Time > 10 minutes

Fig. 1B - 220EDLC 40 F - 2.7 V Backup Time 2.5 minutes

TECHNICAL NOTE

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QUICK START PROCEDURE

Choose Output Voltage

JP10	JP11	V_{OUT}
Open	Open	3.31 V
Open	Closed	4.11 V
Closed	Open	5.02 V

Setup Boost Peak Current

JP8	JP9	IBSTPK
Open	Open	180 mA
Open	Closed	2.5 A
Closed	Open	3.2 A
Closed	Closed	5.5 A

Select Supercapacitor Charge Current

JUMPER	I_{CHG}
JP3	35 mA
JP4	75 mA
JP5	150 mA
JP6	300 mA
JP7	600 mA

Select Switching Modes

JP1 BRIDGE	MODE
None	See bridge 12
12	PWM mode
23	BURST mode
	or remote by E7

Enable / Disable SCAP Charger

JP2 BRIDGE	MODE
None	See bridge 12
12	Disabled
23	Enabled
	or remote by E8

Power Connections

1. Connect supercapacitor via connector ST1 or turrets E5 and E6 to the board.

2. Connect load via turrets E2-1 (V_OUT_P) or E2 (V_OUT) and E3 (GND) to the board. V_OUT_P is the protected output of V_OUT; it switches off when voltage V_{CAP} (supercapacitor) depletes below 1.2 V.

3. Connect supply via turrets E1 (V_IN) and E4 to the board.

Set Up Power Supply Backup Demonstration Mode

On board is a timer to periodically simulate the effect of a supply fail, causing an automatic switch into backup mode to seamlessly provide power to the external load.

By means of JP13, the user can select the supply mode:

JP13 BRIDGE	MODE
None	Timer
12	Supply always ON
23	Supply always OFF

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LISTING OF SIGNALS

V_IN	In		E1	Supply connection 4.0 V to 20 V
V_OUT	Out		E2	Output voltage to load
V_OUT_P	Out		E2-1	Protected output voltage to load, cut off when V_CAP is less than 1.2 V
V_CAP	In / Out		E5	Positive supercapacitor connection
GND	In / Out		E3, E4, E6	Ground
FB_08V	---	JP10, JP11		Programs the output voltage V_OUT (3.31 V, 4.11 V, 5.02 V)
IBSTPK	---	JP8, JP9		Boost peak current limit (180 mA, 2.5 A, 3.2 A, 5.5 A)
I_CHG	---	JP3, JP4, JP5, JP6, JP7		Programs the V_{CAP} charge current (35 mA, 75 mA, 150 mA, 300 mA, 600 mA)
TIMER	---	JP13		Power management mode: timer / on / off
MODE	In	JP1		This pin sets the buck and boost switching modes. A low is PWM mode, a high is BURST mode operation
			E7	*signal mode decoupled by 1k resistor for remote operation
EN_CHG	In	JP2		A high on this pin enables the supercapacitor charger
			E8	*signal mode decoupled by 1k resistor
RSTB	Out		E10	Output is high, when V_{OUT} is less than 92.5 % of the programmed regulation voltage
PFOB	Out		E11	Output is low, when V_{supply} fails. Boost converter is enabled and powers V_{OUT}
CPGOOD	Out		E12	Output is low, when V_{CAP} is higher than 92.5 % of the programmed capacitor voltage

LISTING OF CONNECTORS

BU1 (E27, E28)	PFOB monitor (BNC, turret)
BU2 (E25, E26)	U_OUT monitor (BNC, turret)
BU3 (E23, E24)	V_CAP monitor (BNC, turret)
BU4 (E21, E22)	I_Discharge monitor (BNC, turret)
BU5	Female connector (GND) to supercapacitor
BU6	Female connector (V_CAP) to supercapacitor
ST1	Male connector to supercapacitor (V_CAP and GND)

Note
- Turret positions E21 to E27 are optional and shared with the PNC connector.

DESCRIPTION OF LEDS

LED	COLOR	FUNCTION
D3	Red	Active when RSTB is high
D4	Red	Active when PFOB is high
D5	Red	Active when CPGOOD is high
D6	Yellow	Active when timer blocks supply

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PART LIST				
REFERENCE	**PART TYPE**	**PART DESCRIPTION**	**MANUFACTURER**	**PART NUMBER**
BU1 to BU4	BNC	BNC-connector 90°	Molex	Mouser #523-31-5431-10RFX
BU5, BU6	BU1x5	1x5 pol prec-pinheader RM 2.54 mm		
C1, C3	100 nF	50 V X7R ceramic capacitor 0805	Vishay	VJ0805Y104KXAA
C10, C19, C21, C23, C24	100 nF	25 V X7R ceramic capacitor 0603	Vishay	VJ0603Y104KXXA
C13	BU1x2	1x2 pol. pinheader, RM 2.54 mm		
C15	220 pF	25 V NP0 ceramic capacitor 0603	Vishay	VJ0603A221KXXA
C16	n.b.	25 V NP0 ceramic capacitor 0603	Vishay	
C17	1 nF	25 V X7R ceramic capacitor 0603	Vishay	VJ0603Y102KXXA
C18	n.b.	25 V X7R ceramic capacitor 0603	Vishay	
C2, C4, C7, C8, C11	22 µF	25 V X7R ceramic capacitor 1210		
C20, C22, C25	4.7 µF	10 V X7R ceramic capacitor 0805		
C26 to C32	100 nF	25 V X7R ceramic capacitor 0603	Vishay	VJ0603Y104KXXA
C5	22 µF	25 V 593D tantalum capacitor, D case	Vishay	293D226X9025D2T
C6	4.7 pF	25 V NP0 ceramic capacitor 0805	Vishay	VJ0805A47KXXA
C9, C14	1 µF	10 V X7R ceramic capacitor 0805	Vishay	VJ0805Y105KXQTW1BC
D1	SS2P4	2 A / 40 V Schottky rectifier, style SMP	Vishay	SS2P4-M3/84A
D2	SS5P3	5 A / 40 V Schottky rectifier, style SMPC	Vishay	SS5P3-M3/86A
D3 to D5	Red	LED red, TLMS1000, 0603	Vishay	TLMS1000-GS08
D6	Yellow	LED yellow, TLMY1000, 0603	Vishay	TLMY1000-GS08
D7	12 V	12 V small-signal Zener diodes, SOT-23	Vishay	BZX84C12-G3-08
D8	n.b.	5 A / 40 V Schottky rectifier, style SMPC	Vishay	SS5P4-M3/86A
E1 to E6, E2-1	2501	PCB pins	Mill-Max	Mouser #575-2501200800000
E21 to E28	n.b.	Turret	Mill-Max	Mouser #575-2308200440000
E7 to E12, TPA1,TPB1	2308	PCB pins	Mill-Max	Mouser #575-2308200440000
JP1, JP2, JP12, JP13	ST1x3	1x3 pol. pinheader, RM 2.54 mm		
JP3 to JP11, JP14 to JP16	ST1x2	1x2 pol. pinheader, RM 2.54 mm		
L1	22 µH	2.5 A high-current inductor, size 2525	Vishay	IHLP2525CZER220M11
L2	3.3 µH	13 A high-current inductor, size 2525	Vishay	IHLP2525BDER3R3M01
P1	470 kΩ	Potmeter vertical	Vishay	T93YA474KT20
P2	100 Ω	Potmeter vertical	Vishay	T93YA101KT20
P3	1 MΩ	Potmeter vertical	Vishay	T93YA105KT20
R1	30 mΩ	Power Metal Strip® resistor, 1 %, 0805	Vishay	WSL0805R0300FTA
R13	5.6 MΩ	Metal resistor, 1 %, 0805	Vishay	CRCW08055M60FKEA
R13-1	430 kΩ	Metal resistor, 1 %, 0805	Vishay	CRCW0805430kFKEA
R13-2	330 kΩ	Metal resistor, 1 %, 0805	Vishay	CRCW0805330kFKEA
R14	1.74 MΩ	Metal resistor, 1 %, 0805	Vishay	CRCW08051M74FKEA
R14-1	806 kΩ	Metal resistor, 1 %, 0805	Vishay	CRCW0805806kFKEA
R14-2	402 kΩ	Metal resistor, 1 %, 0805	Vishay	CRCW0805402kFKEA
R14-3	200 kΩ	Metal resistor, 1 %, 0805	Vishay	CRCW0805200kFKEA
R14-4	100 kΩ	Metal resistor, 1 %, 0805	Vishay	CRCW0805100kFKEA
R15	150 kΩ	Metal resistor, 1 %, 0603	Vishay	CRCW0603150kFKEA

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REFERENCE	**PART TYPE**	**PART DESCRIPTION**	**MANUFACTURER**	**PART NUMBER**
R2	20 Ω	Metal resistor, 1 %, 0805	Vishay	CRCW080520R0FKEA
R29, R30	470 kΩ	Metal resistor, 1 %, 0603	Vishay	CRCW0603470kFKEA
R3	470 kΩ	Metal resistor, 1 %, 0805	Vishay	CRCW0805470kFKEA
R31, R35, R38, R41	10 kΩ	Metal resistor, 1 %, 0603	Vishay	CRCW060310k0FKEA
R34	0 Ω	Metal resistor, 1 %, 0603	Vishay	CRCW06030000Z0EA
R37, R53	100 kΩ	Metal resistor, 1 %, 0603	Vishay	CRCW0603100kFKEA
R4	430 kΩ	Metal resistor, 1 %, 0603	Vishay	CRCW0603430kFKEA
R40, R43, R48, R51, R52	1 kΩ	Metal resistor, 1 %, 0603	Vishay	CRCW06031k00FKEA
R42	523 kΩ	Metal resistor, 1 %, 0805	Vishay	CRCW0805523kFKEA
R44	1 MΩ	Metal resistor, 1 %, 0805	Vishay	CRCW08051M00FKEA
R45	25.5 kΩ	Metal resistor, 1 %, 0805	Vishay	CRCW080525K5FKEA
R46	100 kΩ	Metal resistor, 1 %, 0805	Vishay	CRCW0805100kFKEA
R47	11 kΩ	Metal resistor, 1 %, 0805	Vishay	CRCW080511k0FKEA
R49	220 kΩ	Metal resistor, 1 %, 0805	Vishay	CRCW0805220kFKEA
R5, R50	150 kΩ	Metal resistor, 1 %, 0805	Vishay	CRCW0805150kFKEA
R5-1	470 kΩ	Metal resistor, 1 %, 0805	Vishay	CRCW0805470kFKEA
R5-2	430 kΩ	Metal resistor, 1 %, 0805	Vishay	CRCW0805430kFKEA
R6, R11, R12, R32, R33, R36	100 kΩ	Metal resistor, 1 %, 0603	Vishay	CRCW0603100kFKEA
R7	680 kΩ	Metal resistor, 1 %, 0805	Vishay	CRCW0805680kFKEA
R8	390 kΩ	Metal resistor, 1 %, 0805	Vishay	CRCW0805390kFKEA
R9, R10, R16 to R18, R28, R39	1 kΩ	Metal resistor, 1 %, 0603	Vishay	CRCW06031k00FKEA
ST1	PSL2L	2 pol connector 90°		
TR1, TR2	BC846B	NPN-transistor SOT-23		Mouser #771-BC846B235
TR3, TR4	SIS407DN	25 A / 20 V p-channel MOSFET, PowerPak-1212	Vishay	SIS407DN-T1-GE3
TR5	BSS138	N-channel MOSFET, SOT-23		
TR6 to TR9	MMUN2111	Digital PNP transistor, SOT-23		
U1	LTC3355EUF	20 V, 1 A buck DC/DC	LT	
U2	MIC5235-5.0YM5	5.0 V / 150 mA linear regulator, SOT-23/5	Micrel	
U3	ACS712 ELCTR-05B-T	5 A Hall-effect-based linear current sensor IC	Allegro	
U4	LTC1044CS8	Charge pump, SO-8	LT	
U5	LT1490ACS8	Rail-to-rail op amp, SO-8	LT	
U6	LTC6995CS6-1#TR MPBF	Long timer oscillator, SOT-23/6	LT	
X1 to X4	8832	Stacking spacer	Keystone	Mouser #534-8832
X6	196HVC	Vishay logo		

TECHNICAL NOTE

VISHAY®

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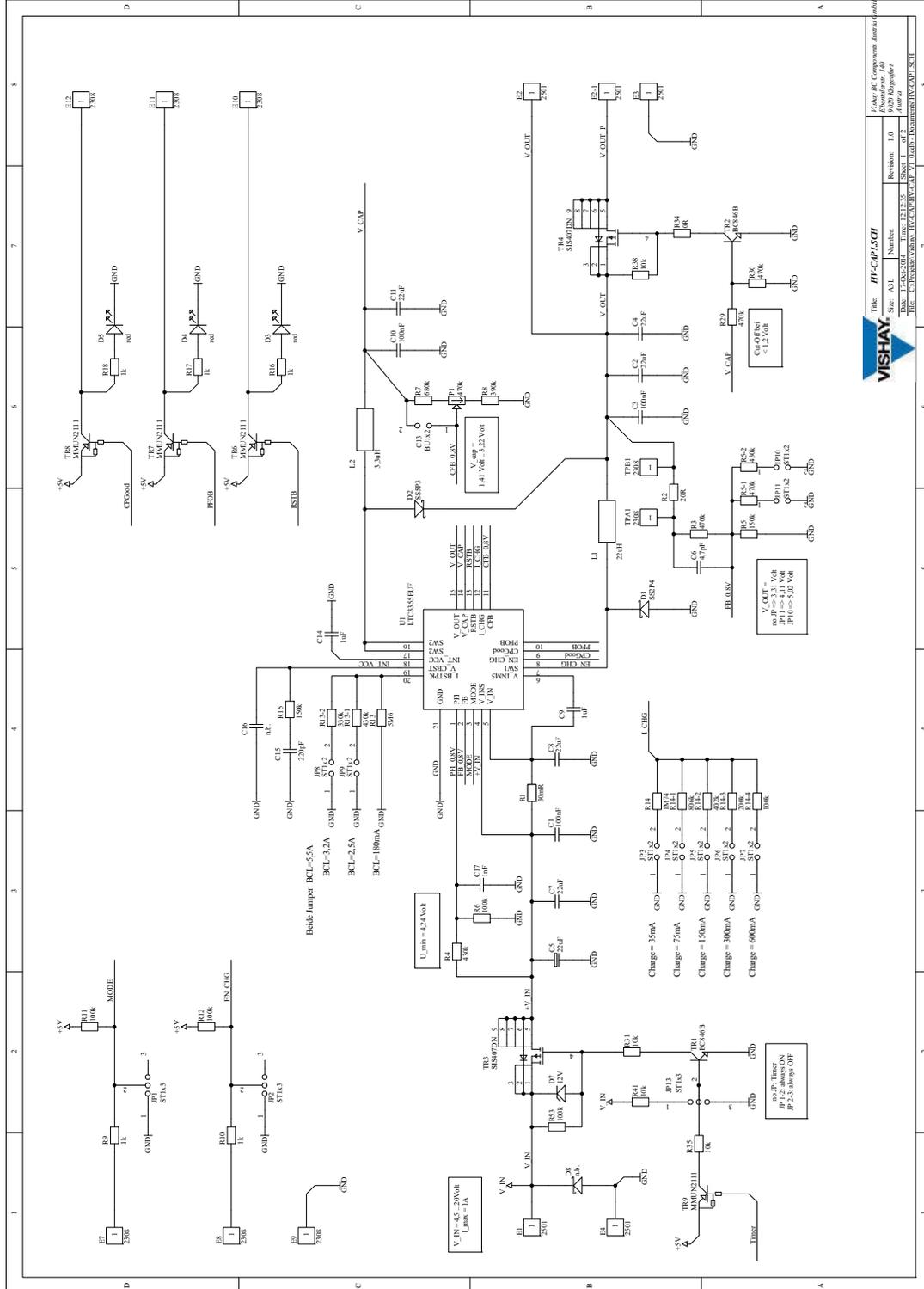
SCHEMATIC DIAGRAM

Fig. 2A

TECHNICAL NOTE

Power Management Solution
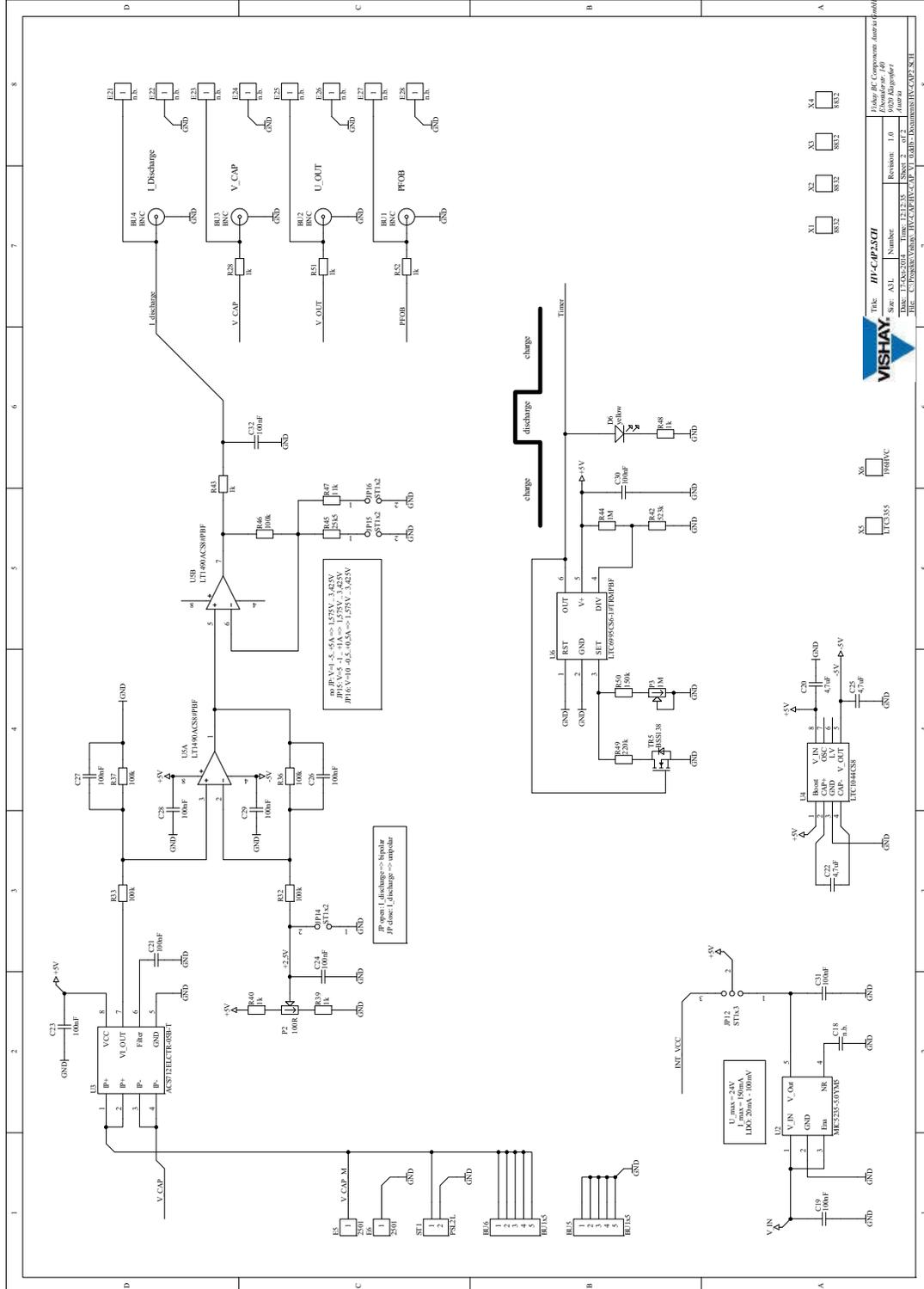# Integrated Supercapacitor Charger

SCHEMATIC DIAGRAM

Fig. 2B

TECHNICAL NOTE

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INCLUDED MATERIALS

ENYCAP Evaluation Kit^{TM} with LTC3555 from Linear Technology

1. Board: 80 mm x 80 mm
2. ENYCAP 196HVC 90 F - 2.8 V
3. ENYCAP 196HVC 15 F - 2.8 V
4. ENYCAP 220EDLC 40 F - 2.7 V
5. This document

Thank you for using and buying the ENYCAP evaluation board. If you need further information, please contact:

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TECHNICAL NOTE

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