Application Report
SLUA785–January 2017

bq76PL455A-Q1 Use-Case Scenarios

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ABSTRACT

The bq76PL455A-Q1 is used several different ways for system creation. This document describes the known ways a bq76PL455A-Q1 is used in a battery pack.

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1 Use Cases

Here are some of the known ways a bq76PL455A-Q1 can be used in a battery pack.

- Daisy-chain (mid-pack)
- Daisy-chain – multiple bq76PL455A-Q1 devices on same board
- Daisy-chain communications bridge
- Single-ended (48 V)
- Reduced cell count (6–15 cells)
- Multi-drop communication
- Active balancing

1.1 Daisy-Chain Communications Bridge

This use case implements a bq76PL455A-Q1 used simply for bridging the host controller UART to the daisy-chain interface connected to all stacked ICs.

Highlights:

- VP supplied from bq76PL455A-Q1 regulator
- VIO supplied by MCU VDDIO

1.1.1 Simplified System Diagram

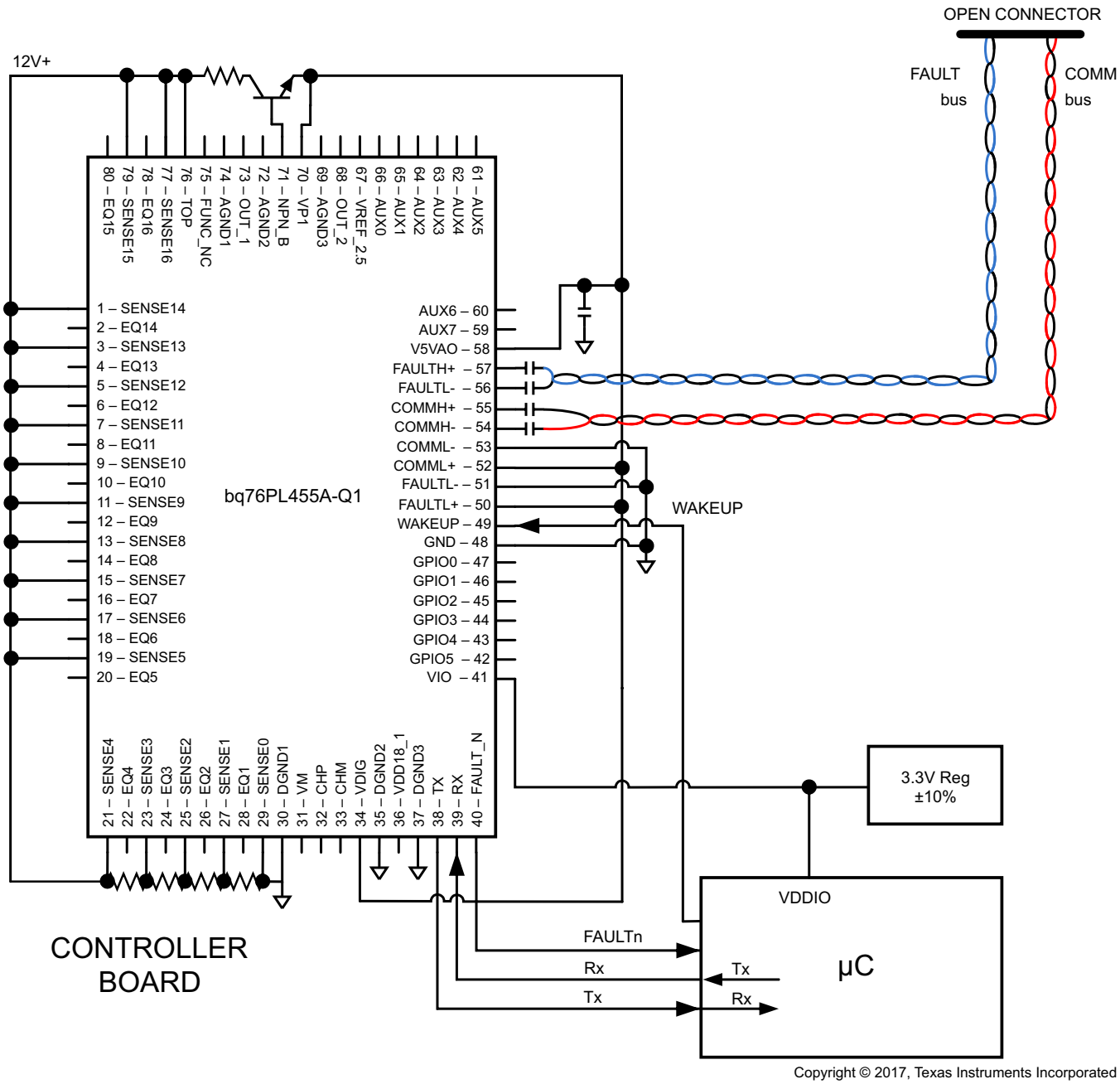

Figure 1. Daisy-Chain Communication Bridge System Architecture

1.1.2 Schematic

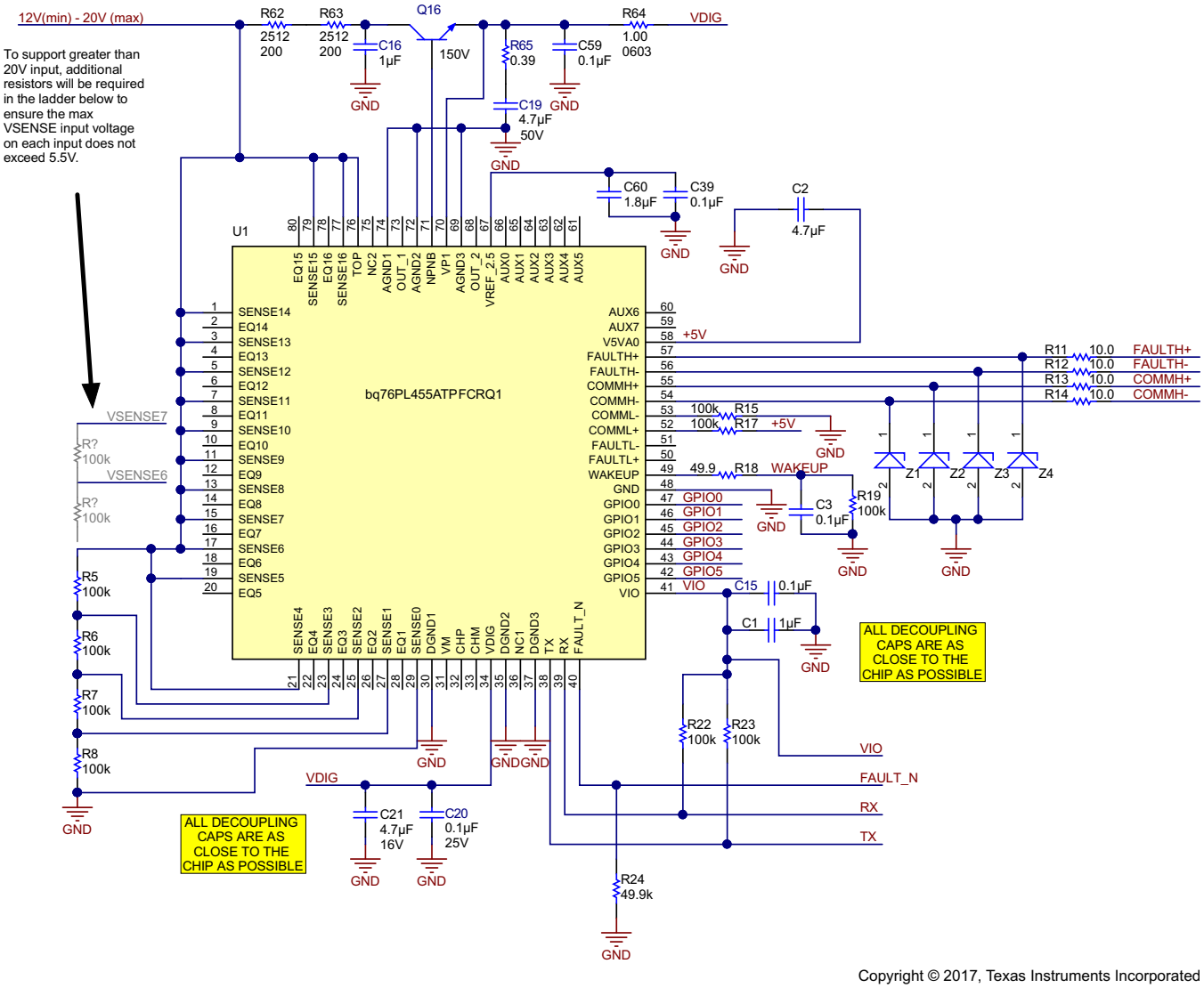

Figure 2. Daisy-Chain Communication Bridge Schematic - bq76PL455A-Q1

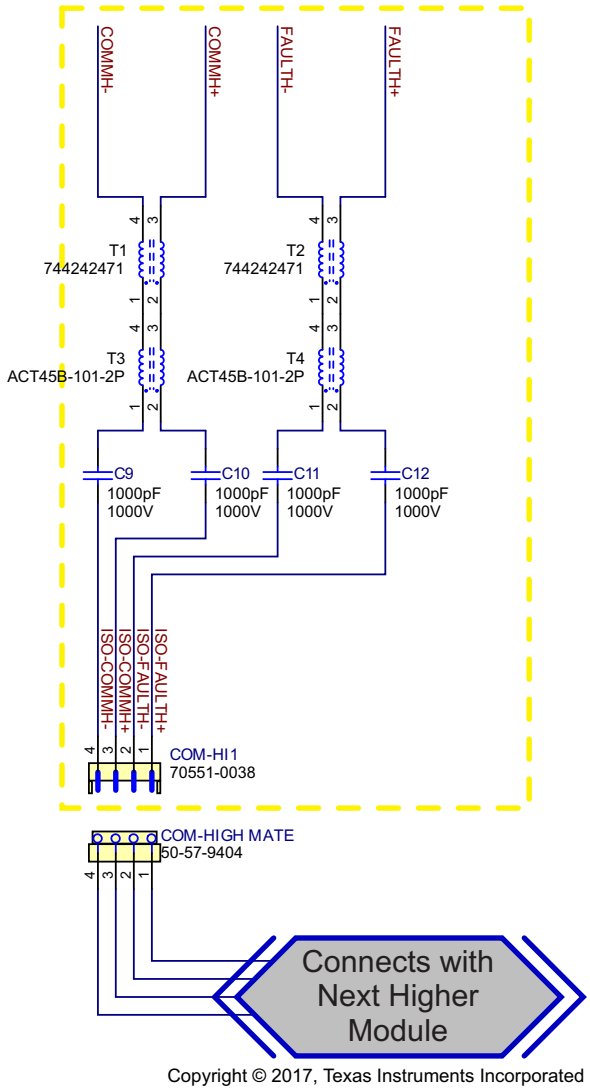

Figure 3. Daisy-Chain Communication Bridge Schematic - Communications

1.1.3 Daisy-Chain Communication Bill Of Materials

Table 1 lists the BOM.

Table 1. Daisy-Chain Communication Bridge Bill Of Materials

Part Number	Description	Designator	Package Reference	Qty	Comp Type	Manufacturer	Value
GRM188R71C105KA12D	CAP, CERM, 1 µF, 16V, +/-10%, X7R, 0603	C1	0603	1	Capacitor	Murata	1 µF
GRM21BR71C475KA73L	CAP, CERM, 4.7 µF, 16V, +/-10%, X7R, 0805	C2, C21	0805	2	Capacitor	Murata	4.7 µF
C0603X104K3RACTU	CAP, CERM, 0.1 µF, 25V, +10/%, X7R, 0603	C3, C15, C20, C39, C59	0603	5	Capacitor	Kemet	0.1 µF
CC1206KKX7RCBB102	CAP, CERM, 1000 pF, 1000V, +/-10%, X7R, 1206	C9, C10, C11, C12	1206	4	Capacitor	Yageo America	1000 pF
GRM31CR72A105KA01L	CAP, CERM, 1 µF, 100V, +/-10%, X7R, 1206	C16	1206	1	Capacitor	Murata	1 µF
GRM31CR71H475KA12L	CAP, CERM, 4.7 µF, 50V, +/-10%, X7R, 1206	C19	1206	1	Capacitor	Murata	4.7 µF
C1210C185K3RACTU	CAP, CERM, 1.8 µF, 25V, +/-10%, X7R, 1210	C60	1210	1	Capacitor	Kemet	1.8 µF
70551-0038	Headers & Wire Housings SL R/A Latch Hdr /Sp Split Pg 15 SAu 4Ckt	COM-HI1	70551-0038	1	Connector	Molex	
ZXTN4004KTC	TRANS 150V 1A NPN LED DRVR TO252	Q16	DPAK	1	NPN Transistor	Diodes/Zetex	
CRCW0603100KJNEA	RES, 100 k, 5%, 0.1 W, 0603	R5, R6, R7, R8	0603	4	Resistor	Vishay-Dale	100k
CRCW120610R0FKEA	RES, 10.0 ohm, 1%, 0.25W, 1206	R11, R12, R13, R14	1206	4	Resistor	Vishay-Dale	10.0
RC0603FR-07100KL	RES, 100k ohm, 1%, 0.1W, 0603	R15, R17, R19, R22, R23	0603	5	Resistor	Yageo America	100k
CRCW060349R9FKEA	RES, 49.9 ohm, 1%, 0.1W, 0603	R18	0603	1	Resistor	Vishay-Dale	49.9
RC0603FR-0749K9L	RES, 49.9k ohm, 1%, 0.1W, 0603	R24	0603	1	Resistor	Yageo America	49.9k
CRCW2512200RJNEG	RES 200 OHM 1W 5% 2512 SMD	R62, R63	2512	2	Resistor	Vishay/Dale	200
RC0603FR-071RL	RES, 1.00 ohm, 1%, 0.1W, 0603	R64	0603	1	Resistor	Yageo America	1.00
ERJ-3RQFR39V	RES, 0.39 ohm, 1%, 0.1W, 0603	R65	0603	1	Resistor	Panasonic	0.39
744242471	CHOKE COMMON MODE 2200 OHM .4A	T1, T2	744242xxx	2	Common Mode Choke	Wurth	
ACT45B-101-2P	CHOKE COMMON MODE 5800 OHM .15A	T3, T4	ACT45B	2	Common Mode Choke	TDK	
bq76PL455ATPFCRQ1	16 Cell Battery Monitor with Passive Cell Balancing, PFC0080A	U1	PFC0080A	1	IC	Texas Instruments	
PESD5V0U1UA,115	DIODE ESD PROT UNI 5V SOD323-2	Z1, Z2, Z3, Z4	SOD-323	4	TVS ESD diode	NXP	

1.2 Daisy-Chain Only (Mid-Pack)

This implementation is the typical mid-stack position. Each individual bq76PL455A-Q1 on its own PCB, connected in a daisy-chain configuration with the host controller via additional bq76PL455A-Q1 'communications bridge'.

This is the typical use case for large packs (>16 series cells), described in detail in the bq76PL455A-Q1 datasheet.

The daisy-chain cable introduces a possible coupling path for noise into the system, and requires some additional filtering for reliable operation. The recommended circuits are shown in Figure 1 and Figure 2.

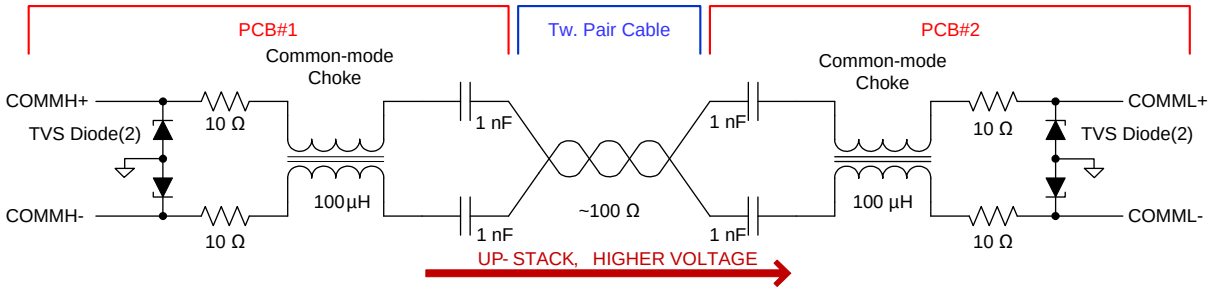

Figure 4. Daisy-Chain Cable Minimum Circuit

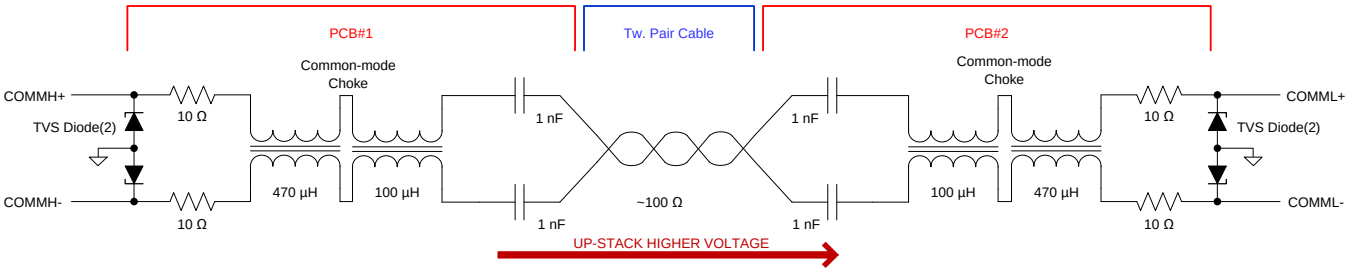

Figure 5. Daisy-Chain Cable Circuit With Additional Filter

1.2.1 Simplified System Diagram

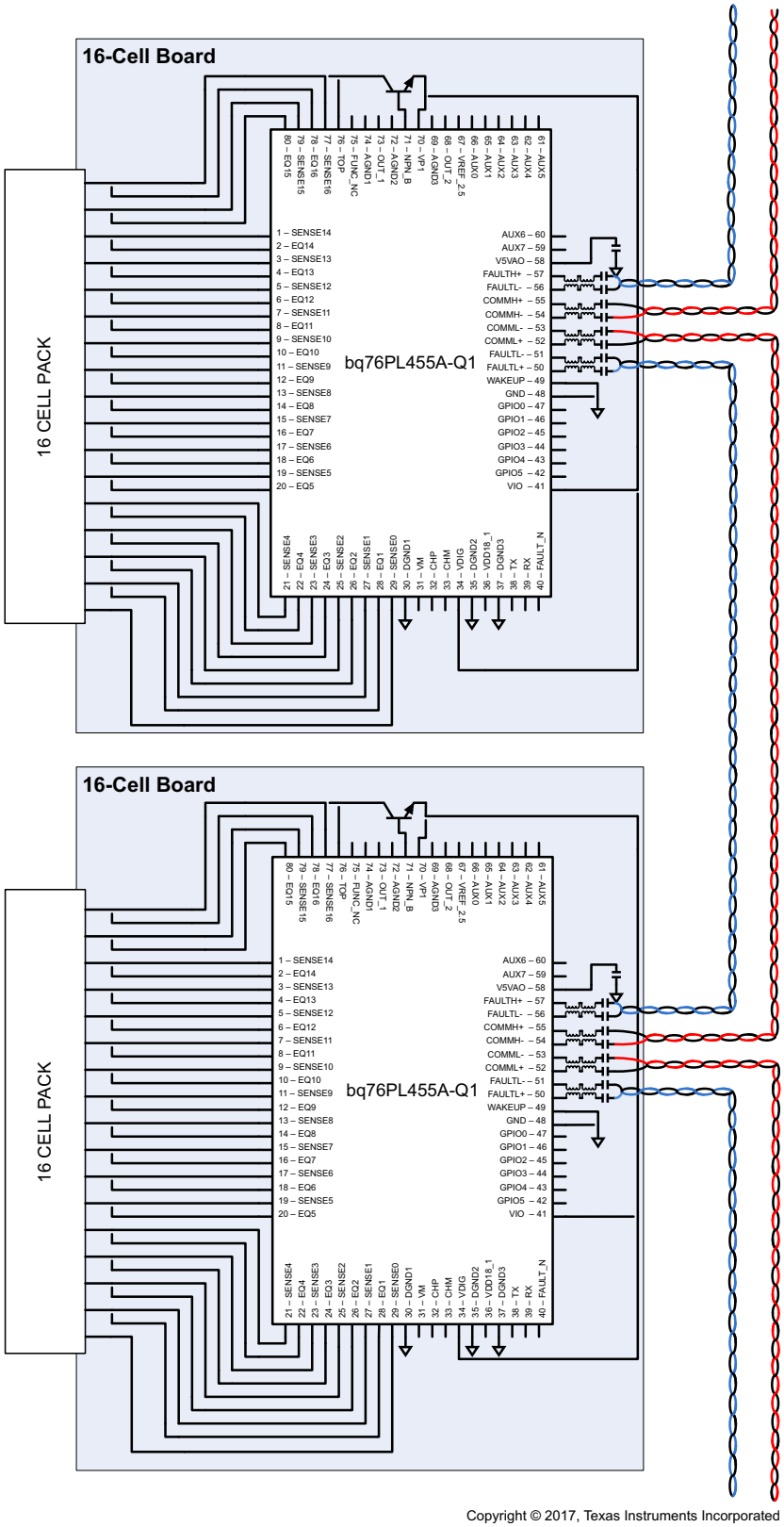

Figure 6. Daisy-Chain System Architecture

1.2.2 Schematic

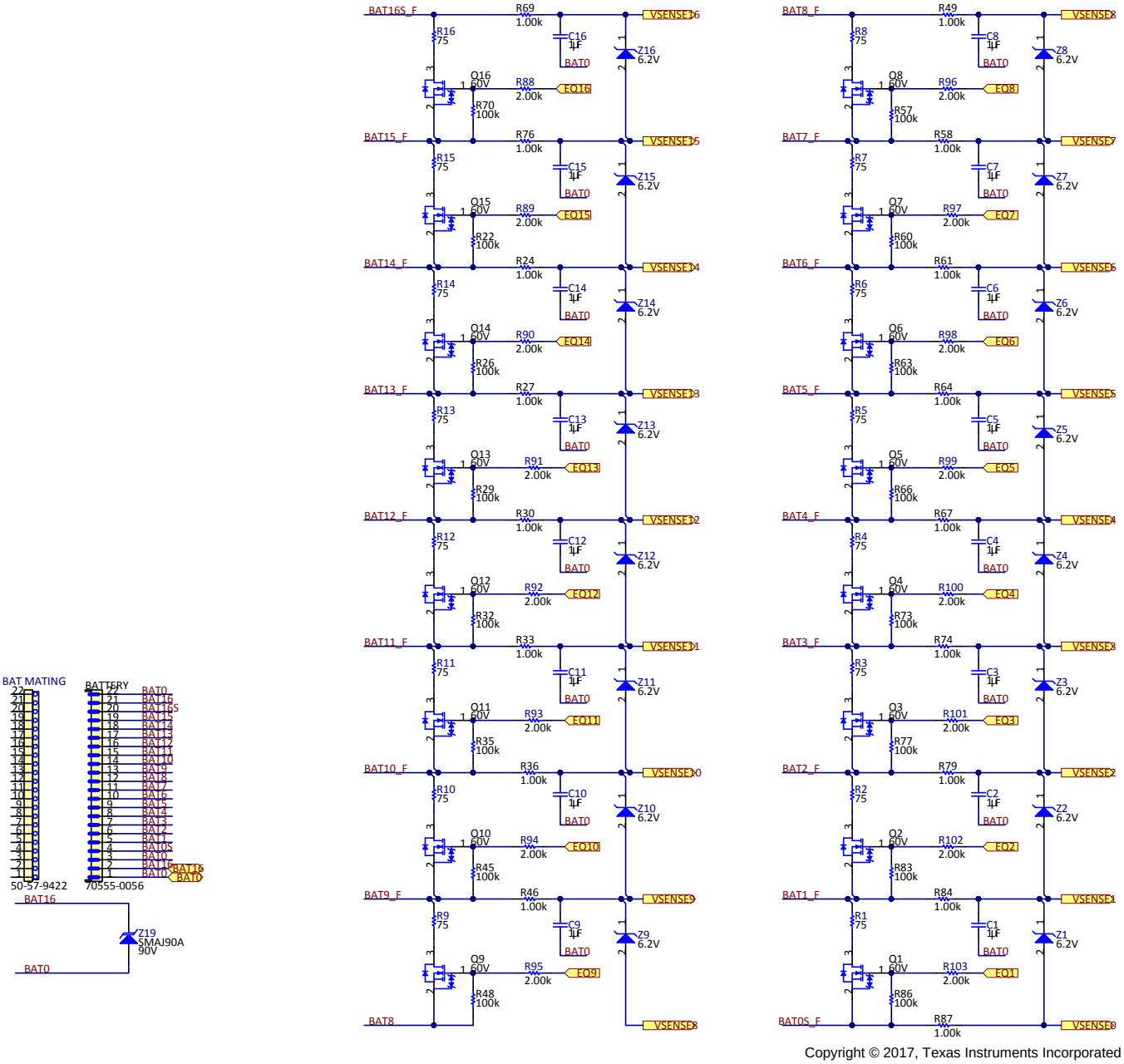

Figure 7. Daisy-Chain Schematic - Battery Connections

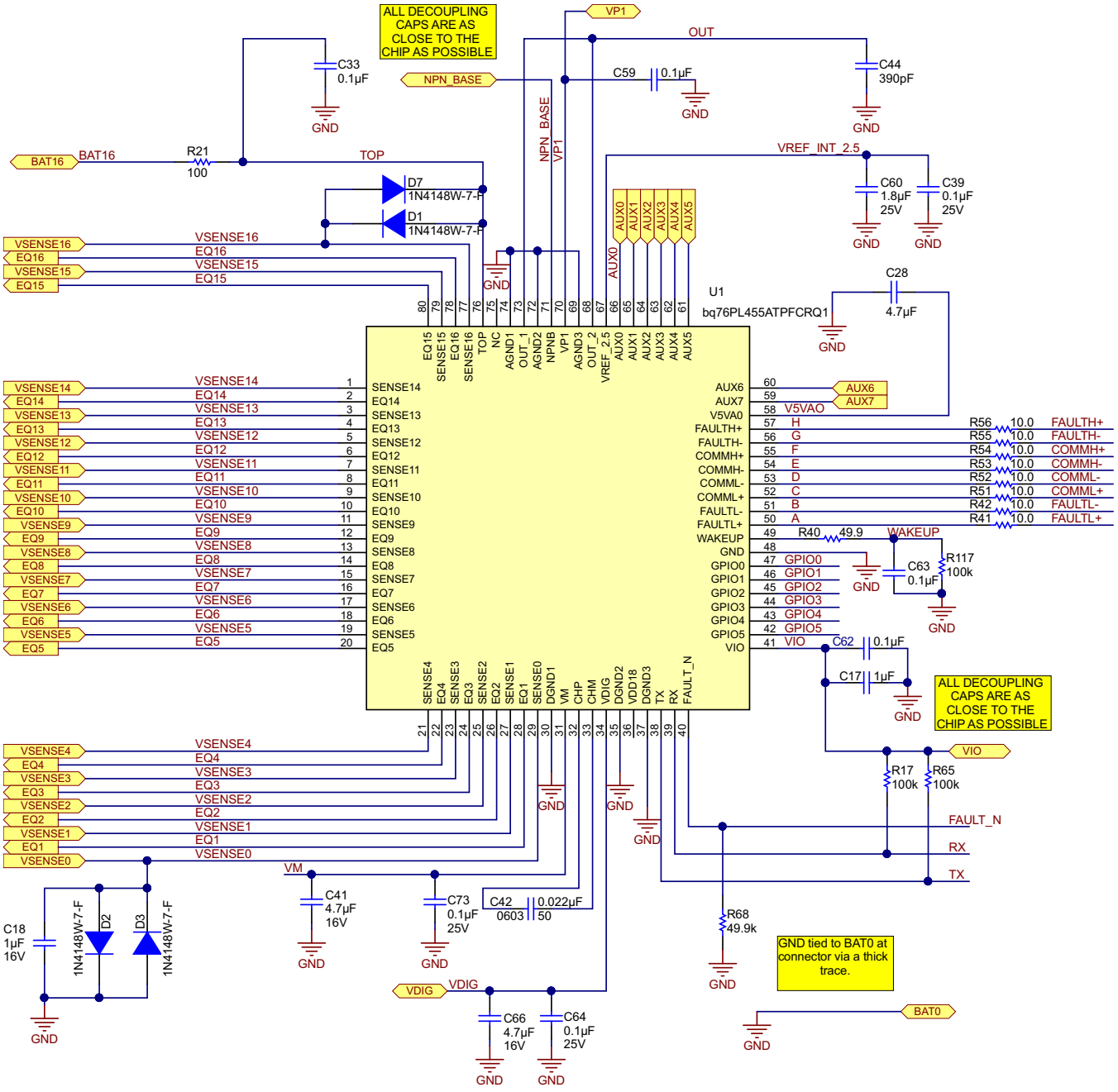

Figure 8. Daisy-Chain Schematic - bq76PL455A-Q1

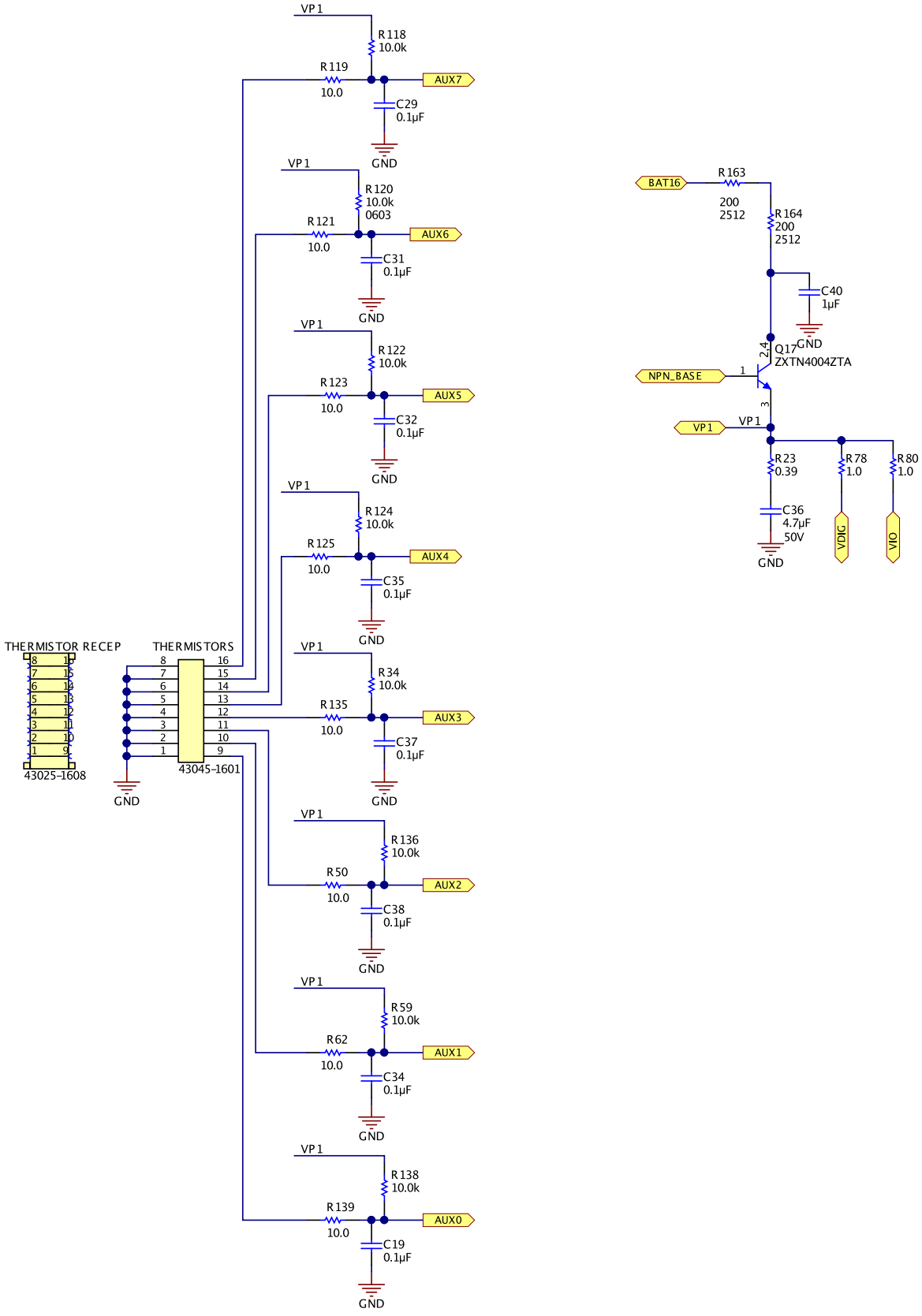

Figure 9. Daisy-Chain Schematic - AUX Inputs and Power Supply

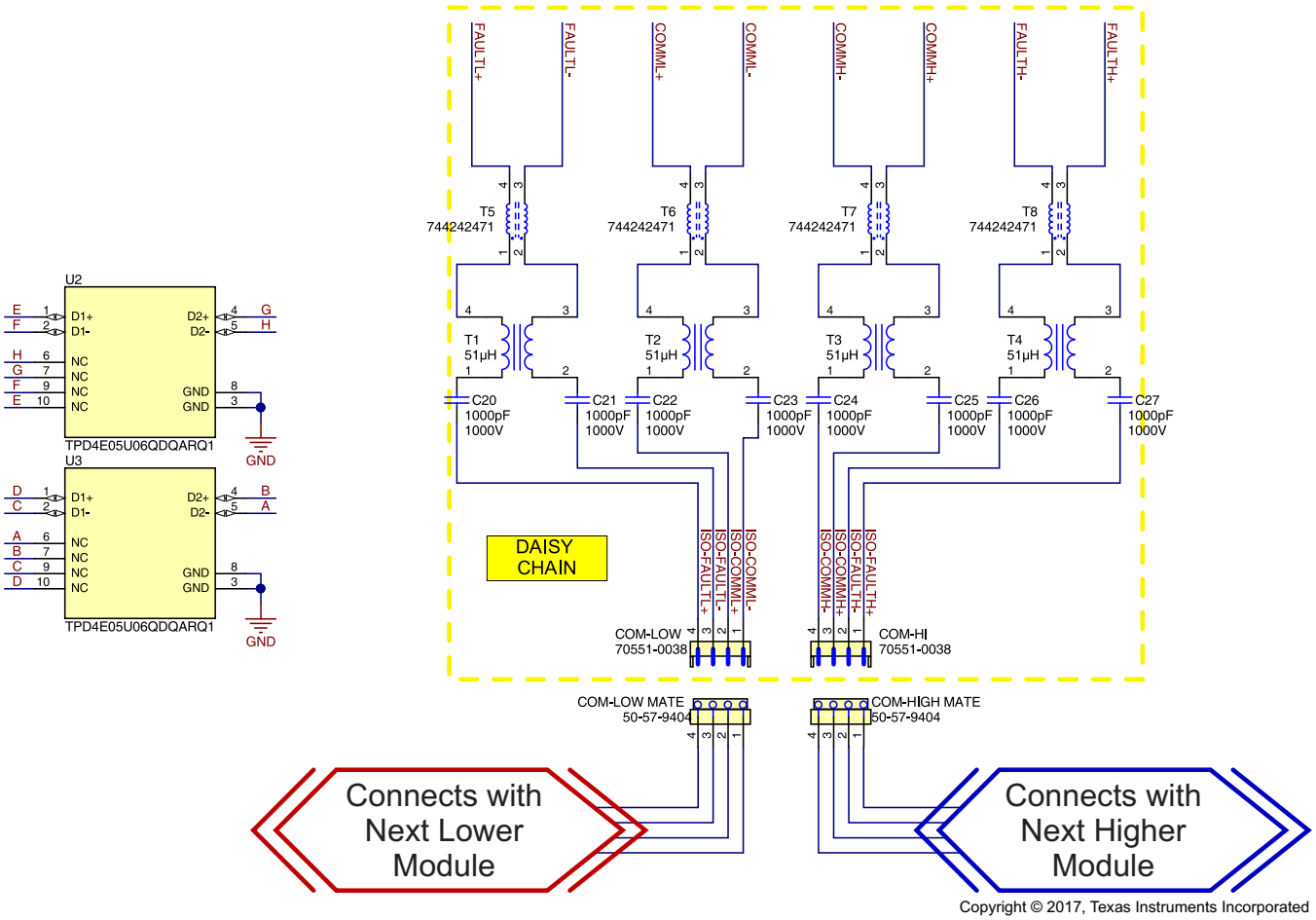

Figure 10. Daisy-Chain Schematic - Communications

1.2.3 Bill Of Materials

Table 2 lists the BOM.

Table 2. Daisy-Chain Bill Of Materials

Part Number	Description	Designator	Package Reference	Qty	Comp Type	Manufacturer	Value
70555-0056	2.54mm Pitch SL Crimp Housing, Single Row, 22 Circuits	BATTERY	70555-0056	1	Connector	Molex	
GRM32CR72A105KA35L	CAP, CERM, 1 µF, 100 V, +/- 10%, X7R, 1210	C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16	1210	16	Capacitor	Murata	1 µF
GRM188R71C105KA12D	CAP, CERM, 1 µF, 16V, +/-10%, X7R, 0603	C17	0603	1	Capacitor	Murata	1 µF
C1608X7R1C105K	CAP, CERM, 1 µF, 16V, +/-10%, X7R, 0603	C18	0603	1	Capacitor	TDK	1 µF
C0805C104K1RACTU	CAP, CERM, 0.1 µF, 100 V	C19, C29, C31, C32, C33, C34, C35, C37, C38	0805	9	Capacitor	Kemet	0.1 µF
CC1206KKX7RCBB102	CAP, CERM, 1000 pF, 1000V, +/-10%, X7R, 1206	C20, C21, C22, C23, C24, C25, C26, C27	1206	8	Capacitor	Yageo America	1000 pF
GRM21BR71C475KA73L	CAP, CERM, 4.7 µF, 16V, +/-10%, X7R, 0805	C28, C41, C66	0805	3	Capacitor	Murata	4.7 µF
GRM31CR71H475KA12L	CAP, CERM, 4.7 µF, 50V, +/-10%, X7R, 1206	C36	1206	1	Capacitor	Murata	4.7 µF
C0603X104K3RACTU	CAP, CERM, 0.1 µF, 25V, +10/%, X7R, 0603	C39, C59, C62, C63, C64, C73	0603	6	Capacitor	Kemet	0.1 µF
GRM31CR72A105KA01L	CAP, CERM, 1 µF, 100V, +/-10%, X7R, 1206	C40	1206	1	Capacitor	Murata	1 µF
C1608X7R1H223K	CAP, CERM, 0.022 µF, 50V, +/-10%, X7R, 0603	C42	0603	1	Capacitor	TDK	0.022 µF
08055A391JAT2A	CAP, CERM, 390 pF, 50V, +/-5%, C0G/NP0, 0805	C44	0805	1	Capacitor	AVX	390 pF
C1210C185K3RACTU	CAP, CERM, 1.8 µF, 25V, +/-10%, X7R, 1210	C60	1210	1	Capacitor	Kemet	1.8 µF
70551-0038	Headers & Wire Housings SL R/A Latch Hdr /Sp Split Pg 15 SAu 4Ckt	COM-HI, COM-LOW	70551-0038	2	Connector	Molex	
1N4148W-7-F	Diode, Ultrafast, 100V, 0.15A, SOD-123	D1, D2, D3, D7	SOD-123	4	Diode	Diodes Inc.	1.25V
2V7002KT1G	MOSFET, N-CH, 60V, 0.38A, SOT-23	Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8, Q9, Q10, Q11, Q12, Q13, Q14, Q15, Q16	SOT-23	16	MOSFET	ON Semiconductor	60V
ZXTN4004ZTA	Transistor, NPN, 150 V, 1 A, SOT-89	Q17	SOT-89	1	BJT	Diodes Inc.	150 V
CRCW251275R0JNEG	RES, 75, 5%, 1 W, 2512	R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, R12, R13, R14, R15, R16	2512	16	Resistor	Vishay-Dale	75
CRCW0603100KJNEA	RES, 100 k, 5%, 0.1 W, 0603	R17, R22, R26, R29, R32, R35, R45, R48, R57, R60, R63, R65, R66, R70, R73, R77, R83, R86, R117	0603	19	Resistor	Vishay-Dale	100k
CRCW1206100RFKEA	RES, 100 ohm, 1%, 0.25W, 1206	R21	1206	1	Resistor	Vishay-Dale	100

Table 2. Daisy-Chain Bill Of Materials (continued)

Part Number	Description	Designator	Package Reference	Qty	Comp Type	Manufacturer	Value
ERJ-3RQFR39V	RES, 0.39 ohm, 1%, 0.1W, 0603	R23	0603	1	Resistor	Panasonic	0.39
CRCW06031K00FKEA	RES, 1.00 k, 1%, 0.1 W, 0603	R24, R27, R30, R33, R36, R46, R49, R58, R61, R64, R67, R69, R74, R76, R79, R84, R87	0603	17	Resistor	Vishay-Dale	1.00k
CRCW060310K0FKEA	RES, 10.0k ohm, 1%, 0.1W, 0603	R34, R59, R118, R120, R122, R124, R136, R138	0603	8	Resistor	Vishay-Dale	10.0k
CRCW060349R9FKEA	RES, 49.9 ohm, 1%, 0.1W, 0603	R40	0603	1	Resistor	Vishay-Dale	49.9
CRCW120610R0FKEA	RES, 10.0 ohm, 1%, 0.25W, 1206	R41, R42, R51, R52, R53, R54, R55, R56	1206	8	Resistor	Vishay-Dale	10.0
CRCW060310R0FKEA	RES, 10.0 ohm, 1%, 0.1W, 0603	R50, R62, R119, R121, R123, R125, R135, R139	0603	8	Resistor	Vishay-Dale	10.0
RC0603FR-0749K9L	RES, 49.9k ohm, 1%, 0.1W, 0603	R68	0603	1	Resistor	Yageo America	49.9k
CRCW06031R00JNEA	RES, 1.0, 5%, 0.1 W, 0603	R78, R80	0603	2	Resistor	Vishay-Dale	1.0
CRCW06032K00FKEA	RES, 2.00k ohm, 1%, 0.1W, 0603	R88, R89, R90, R91, R92, R93, R94, R95, R96, R97, R98, R99, R100, R101, R102, R103	0603	16	Resistor	Vishay-Dale	2.00k
CRCW2512200RJNEG	RES, 200, 5%, 1 W, 2512	R163, R164	2512	2	Resistor	Vishay-Dale	200
ACT45B-510-2P-TL003	Coupled inductor, 51 µH, 0.2 A, 1 ohm, SMD	T1, T2, T3, T4	4.5x2.8x3.2mm	4	Coupled Inductor	TDK	51uH
744242471	CHOKE COMMON MODE 2200 OHM .4A	T5, T6, T7, T8	744242xxx	4	Common Mode Choke	Wurth	
43025-1608	Headers & Wire Housings MicroFit 3.0 DR Rcpt 16Ckt GW HF	THERMISTOR RECEP		1	Connector	Molex	
43045-1601	Headers & Wire Housings 16 CKT R/A SMT HDR	THERMISTORS	43045-1601	1	Connector	Molex	
bq76PL455ATPFCRQ1	16 Cell Battery Stack Monitor with Passive Cell Balancing	U1	VHB80A	1	Used in BOM report	NSC	
TPD4E05U06QDQARQ1	1, 4, 6 CHANNEL PROTECTION SOLUTION FOR SUPER-SPEED (UP TO 6 GBPS) INTERFACE, DQA0010A	U2, U3	DQA0010A	2	IC	Texas Instruments	
DDZ6V2B-7	DIODE ZENER 6.2V 500MW SOD-123	Z1, Z2, Z3, Z4, Z5, Z6, Z7, Z8, Z9, Z10, Z11, Z12, Z13, Z14, Z15, Z16	SOD-123	16	Zener	Diodes Inc	6.2V
SMAJ90A	Diode, TVS, Uni, 90 V, 400 W, SMA	Z19	SMA	1	TVS	Littelfuse	90V

1.3 Daisy-Chain (Multiple bq76PL455A-Q1 Devices on Same Board)

This section describes the case where multiple bq76PL455A-Q1 devices are on the same PCB, with only the lowest and highest stacked bq76PL455A-Q1's connecting with the daisy-chain cable. This configuration can help reduce the overall cost of a design by reducing the number of components, cables and PCB boards.

Between the bq76PL455A-Q1 devices on the same PCB, a reduced external circuit is all that is required. The recommended circuit is shown in Figure 11.

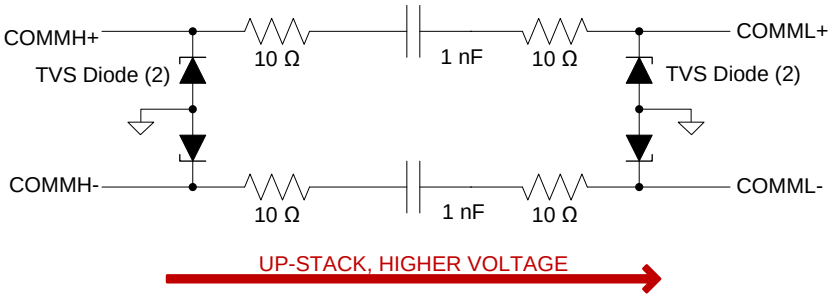

Figure 11. Daisy-Chain Circuit Between bq76PL455A-Q1 ICs on Same PCB

1.3.1 Simplified System Diagram

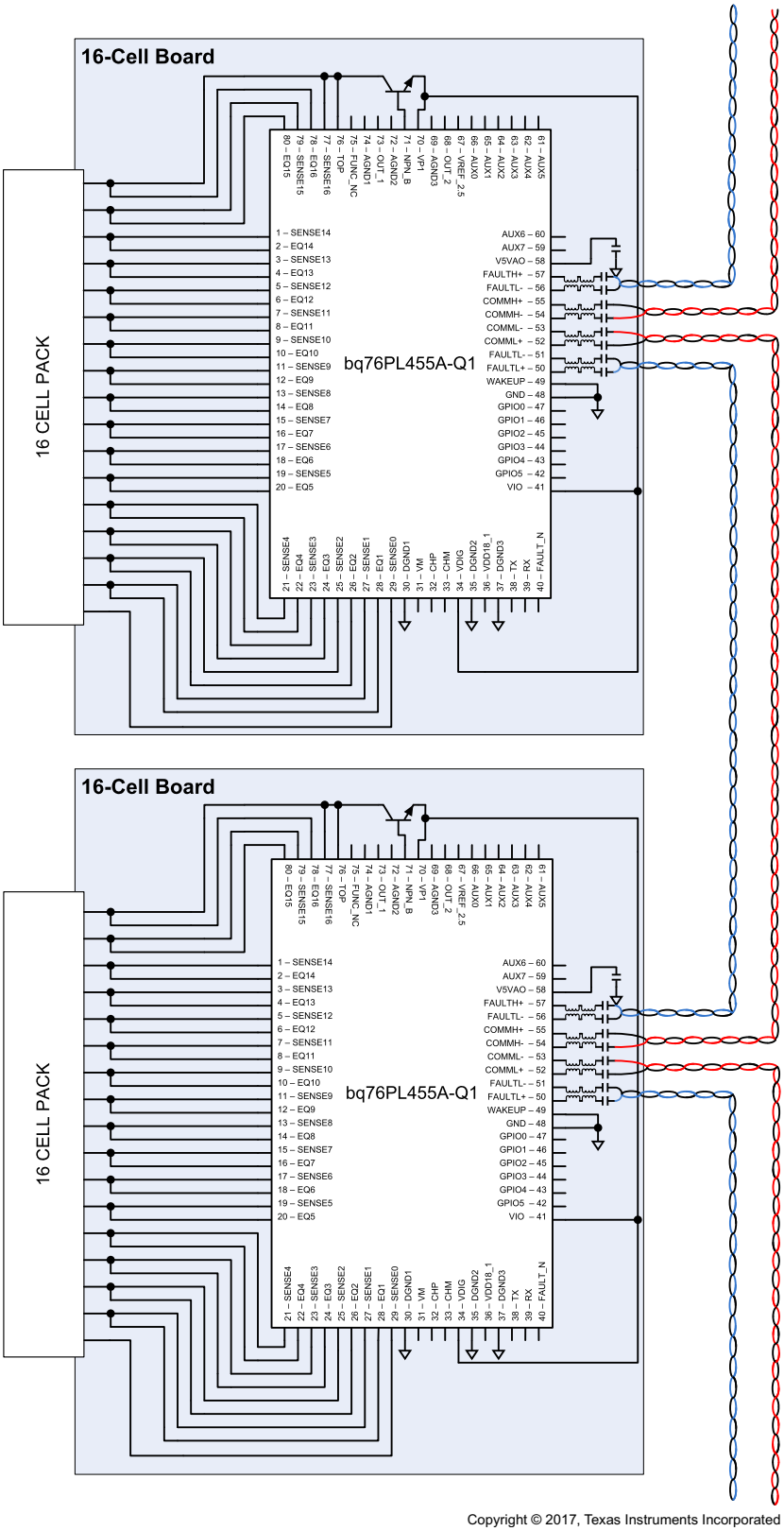

Figure 12. Daisy-Chain System Architecture

1.4 Single-Ended to Daisy-Chain (16 Cell)

This is the typical use case for packs up to 16 series cells, described in detail in the bq76PL455A-Q1 datasheet.

Highlights:

- 12-V minimum, up to 16 cells supported (see Section 1.5 for more details on using less than 16 cells)
- VP supplied from bq76PL455A-Q1 regulator
- VIO supplied by MCU VDDIO

1.4.1 Simplified System Diagram

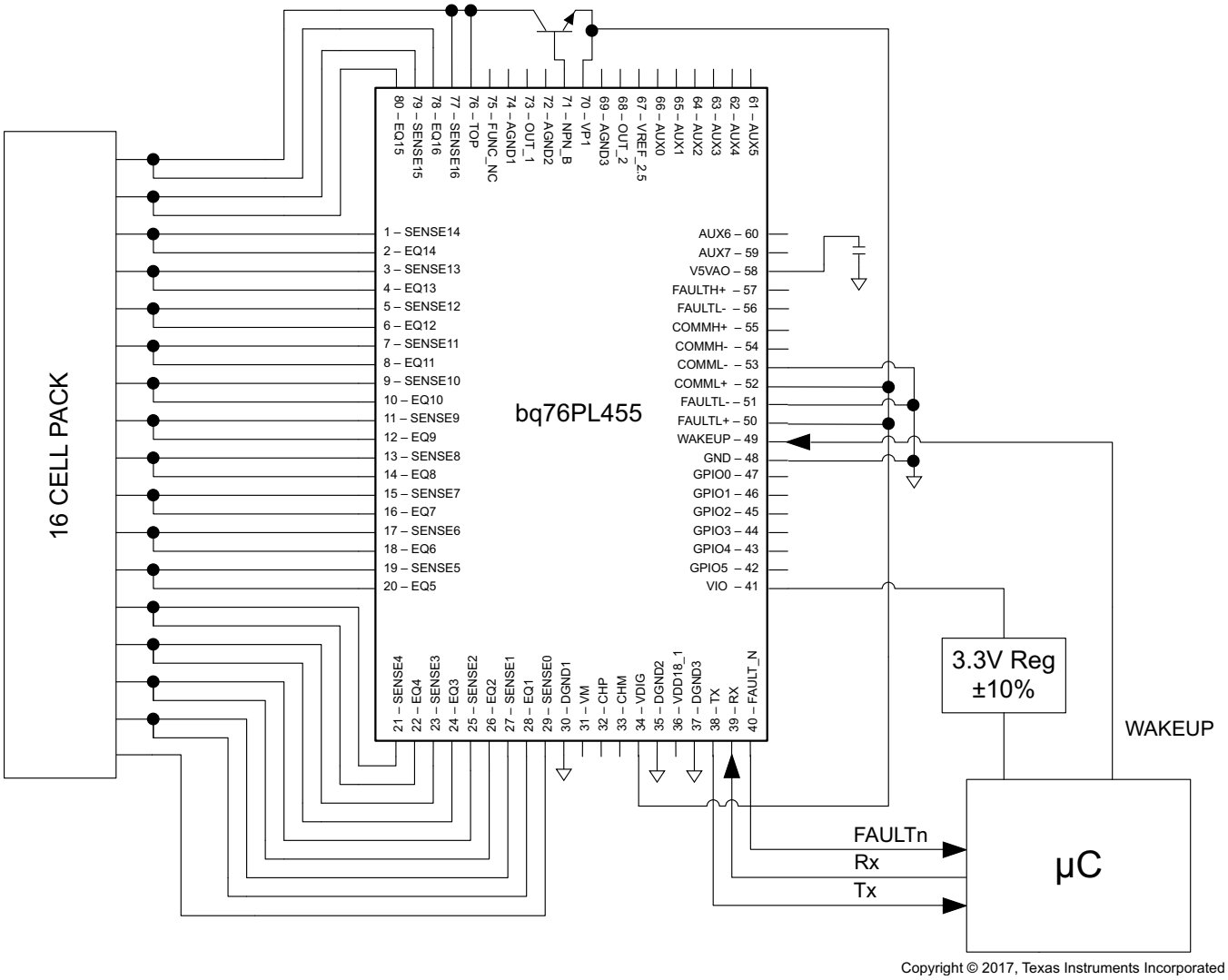

Figure 13. Single-Ended to Daisy-Chain System Architecture

1.4.2 Schematic

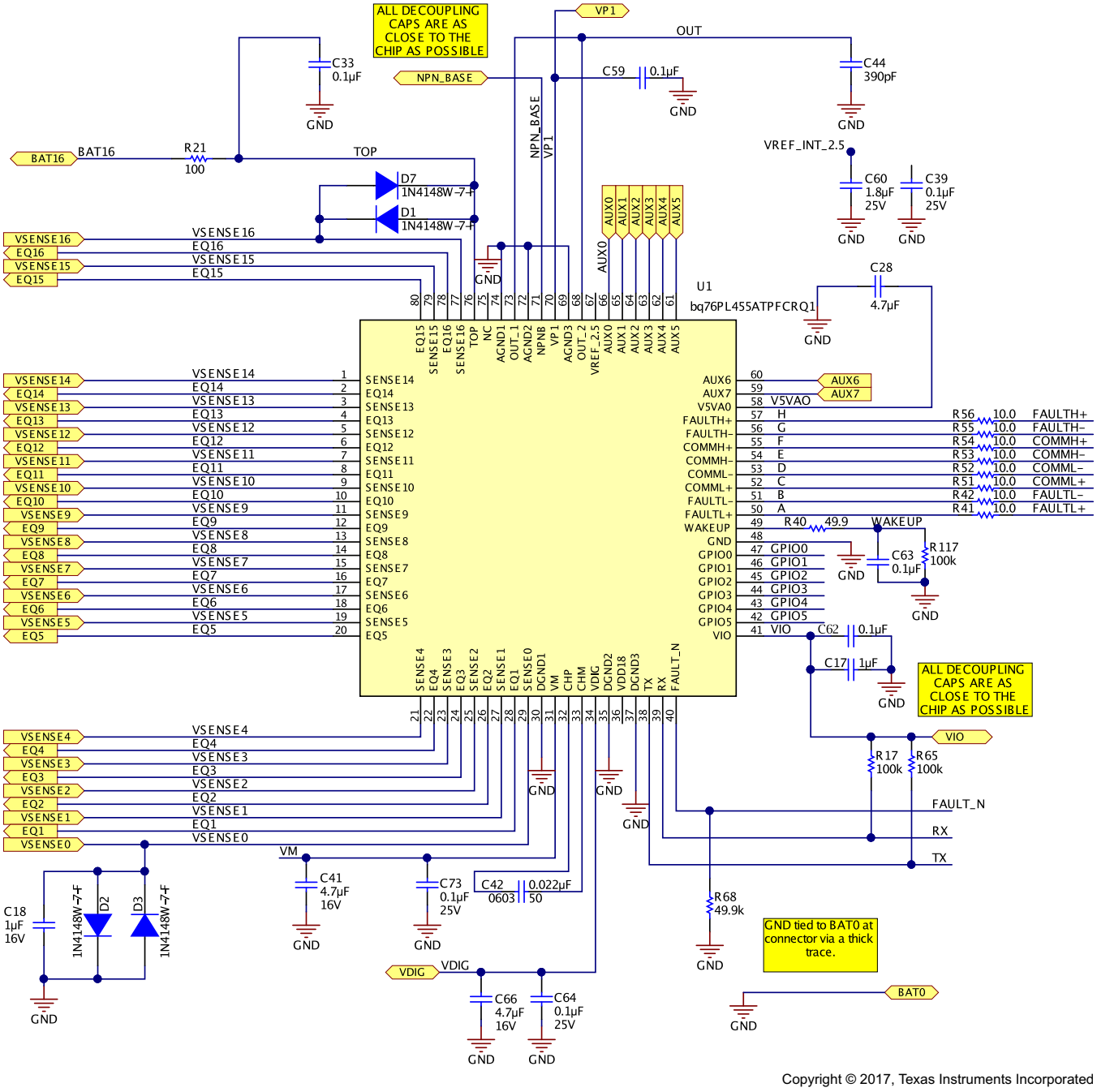

Figure 14. Single-Ended to Daisy-Chain Schematic - bq76PL455A-Q1

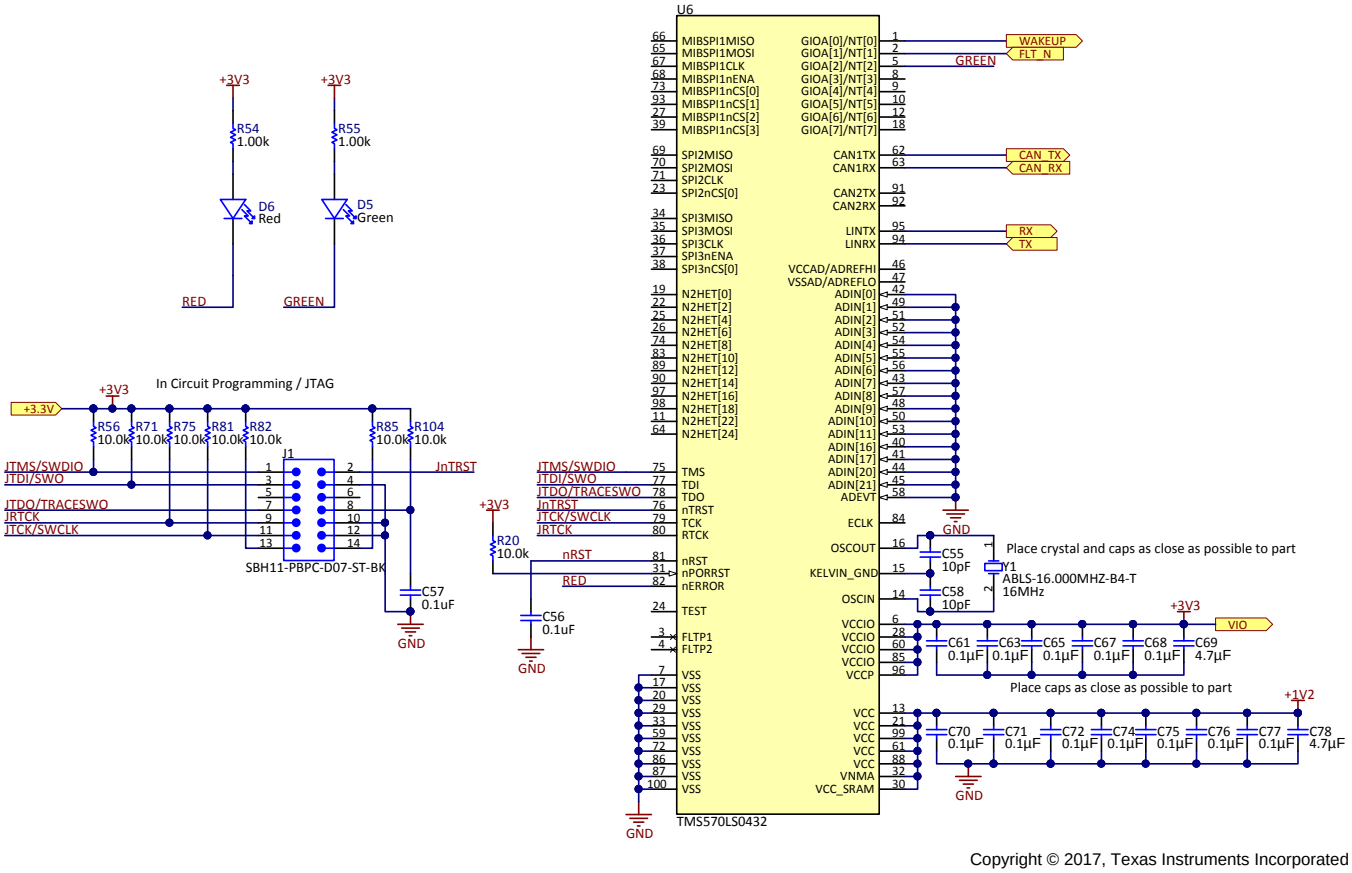

Figure 15. Single-Ended to Daisy-Chain Schematic - Microcontroller

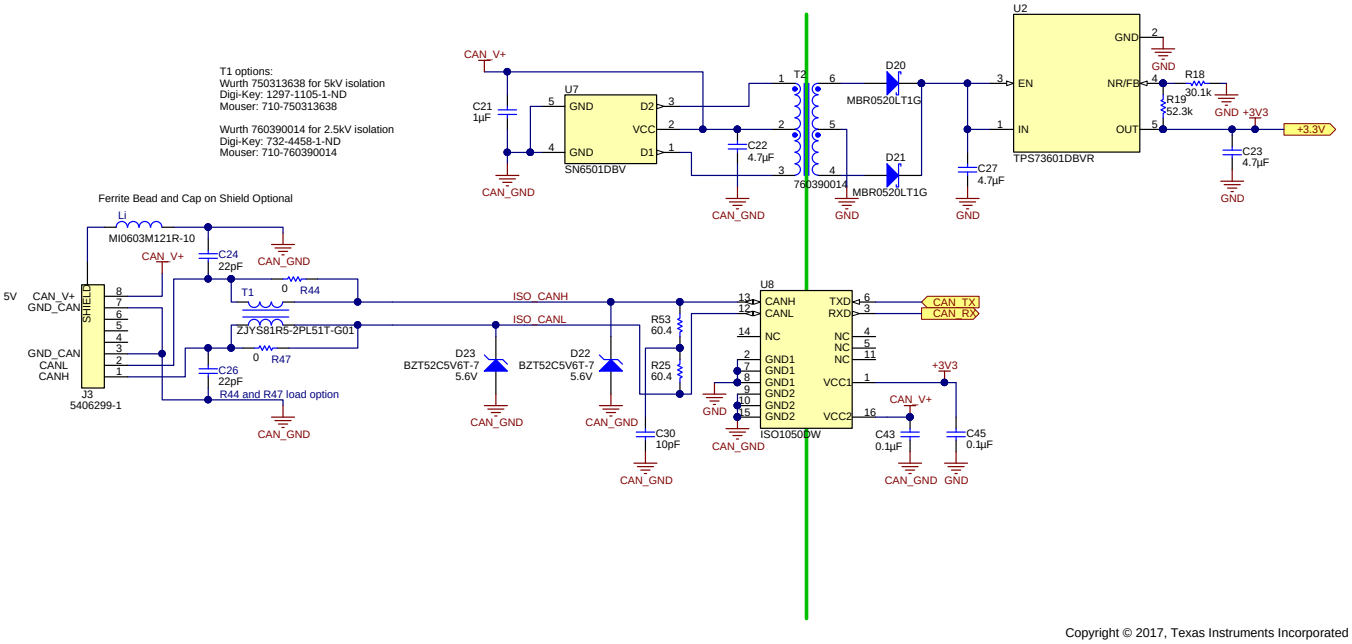

Figure 16. Single-Ended to Daisy-Chain Schematic - Host Communications

1.4.3 Single-Ended Bill Of Materials

Table 3 lists the BOM.

Table 3. Single-Ended Bill Of Materials

Part Number	Description	Designator	Package Reference	Qty	Comp Type	Manufacturer	Value
70555-0056	2.54mm Pitch SL Crimp Housing, Single Row, 22 Circuits	BATTERY	70555-0056	1	Connector	Molex	
C0805C104K1RACTU	CAP, CERM, 0.1 µF, 100V, +/-10%, X7R, 0805	C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16, C33	0805	17	Capacitor	Kemet	0.1 µF
GRM188R71C105KA12D	CAP, CERM, 1 µF, 16V, +/-10%, X7R, 0603	C17, C21	0603	2	Capacitor	Murata	1 µF
C1608X7R1C105K	CAP, CERM, 1 µF, 16V, +/-10%, X7R, 0603	C18	0603	1	Capacitor	TDK	1 µF
C1608X7R1H104K	CAP, CERM, 0.1 µF, 50V, +/-10%, X7R, 0603	C19, C29, C31, C32, C34, C35, C37, C38	0603	8	Capacitor	TDK	0.1 µF
C0603X104K3RACTU	CAP, CERM, 0.1 µF, 25V, +10/%, X7R, 0603	C20, C39, C59, C62, C64, C73	0603	6	Capacitor	Kemet	0.1 µF
CGB3B1X5R1A475K055AC	CAP, CERM, 4.7 µF, 10 V, +/- 10%, X5R, 0603	C22, C23, C27	0603	3	Capacitor	TDK	4.7 µF
06035A220JAT2A	CAP, CERM, 22 pF, 50V, +/-5%, C0G/NP0, 0603	C24, C26	0603	2	Capacitor	AVX	22 pF
GRM21BR71C475KA73L	CAP, CERM, 4.7 µF, 16V, +/-10%, X7R, 0805	C28, C41, C66, C69, C78	0805	5	Capacitor	Murata	4.7 µF
C1608C0G1H100D	CAP, CERM, 10 pF, 50 V, +/- 5%, C0G/NP0, 0603	C30, C55, C58	0603	3	Capacitor	TDK	10 pF
GRM31CR71H475KA12L	CAP, CERM, 4.7 µF, 50V, +/-10%, X7R, 1206	C36	1206	1	Capacitor	Murata	4.7 µF
GRM31CR72A105KA01L	CAP, CERM, 1 µF, 100V, +/-10%, X7R, 1206	C40	1206	1	Capacitor	Murata	1 µF
C1608X7R1H223K	CAP, CERM, 0.022 µF, 50V, +/-10%, X7R, 0603	C42	0603	1	Capacitor	TDK	0.022 µF
C0805C104K5RACAUTO	CAP, CERM, 0.1 µF, 50 V, +/- 5%, X7R, 0805	C43, C45	0805	2	Capacitor	Kemet	0.1 µF
08055A391JAT2A	CAP, CERM, 390 pF, 50V, +/-5%, C0G/NP0, 0805	C44	0805	1	Capacitor	AVX	390 pF
C1608X7R1C104K	CAP, CERM, 0.1 µF, 16V, +/-10%, X7R, 0603	C56, C57, C61, C63, C65, C67, C68, C70, C71, C72, C74, C75, C76, C77	0603	14	Capacitor	TDK	0.1 µF
C1210C185K3RACTU	CAP, CERM, 1.8 µF, 25V, +/-10%, X7R, 1210	C60	1210	1	Capacitor	Kemet	1.8 µF
1N4148W-7-F	Diode, Ultrafast, 100V, 0.15A, SOD-123	D1, D2, D3, D7	SOD-123	4	Diode	Diodes Inc.	1.25V
HSMG-C150	LED 570NM GREEN DIFF 1206 SMD	D5	1206	1	LED	Avago Technologies	Green
HSMH-C150	LED 660NM RED DIFF 1206 SMD	D6	1206	1	LED	Avago Technologies	Red

Table 3. Single-Ended Bill Of Materials (continued)

Part Number	Description	Designator	Package Reference	Qty	Comp Type	Manufacturer	Value
MBR0520LT1G	Diode, Schottky, 20V, 0.5A, SOD-123	D20, D21	SOD-123	2	Diode	ON Semiconductor	20V
BZT52C5V6T-7	Diode, Zener, 5.6 V, 300 mW, SOD-523	D22, D23	SOD-523	2	Zener	Diodes Inc.	5.6V
SBH11-PBPC-D07-ST-BK	Header (shrouded), 100 mil, 7x2, Gold plated, TH	J1	7x2 Shrouded Header	1	Connector	Sullins Connector Solutions	
5406299-1	CONN RJ45 MOD JACK 8-8 RT/A PCB with SHIELD	J3		1	RJ45	Tyco	
MI0603M121R-10	Ferrite bead, 120mOhm, 2A, 0603	L1		1		Steward	
2V7002KT1G	MOSFET, N-CH, 60V, 0.38A, SOT-23	Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8, Q9, Q10, Q11, Q12, Q13, Q14, Q15, Q16	SOT-23	16	MOSFET	ON Semiconductor	60V
ZXTN4004KTC	TRANS 150V 1A NPN LED DRVR TO252	Q17	DPAK	1	NPN Transistor	Diodes/Zetex	
CRCW251275R0FKEG	RES 75 OHM 1W 1% 2512 SMD	R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, R12, R13, R14, R15, R16	2512	16	Resistor	Vishay/Dale	75
RC0603FR-07100KL	RES, 100k ohm, 1%, 0.1W, 0603	R17, R22, R26, R29, R32, R35, R41, R42, R45, R48, R57, R60, R63, R65, R66, R70, R73, R77, R83, R86, R117	0603	21	Resistor	Yageo America	100k
CRCW060330K1FKEA	RES, 30.1 k, 1%, 0.1 W, 0603	R18	0603	1	Resistor	Vishay-Dale	30.1k
CRCW060352K3FKEA	RES, 52.3 k, 1%, 0.1 W, 0603	R19	0603	1	Resistor	Vishay-Dale	52.3k
CRCW060310K0FKEA	RES, 10.0k ohm, 1%, 0.1W, 0603	R20, R34, R56, R59, R71, R75, R81, R82, R85, R104, R118, R120, R122, R124, R136, R138	0603	16	Resistor	Vishay-Dale	10.0k
CRCW1206100RFKEA	RES, 100 ohm, 1%, 0.25W, 1206	R21	1206	1	Resistor	Vishay-Dale	100
ERJ-3RQFR39V	RES, 0.39 ohm, 1%, 0.1W, 0603	R23	0603	1	Resistor	Panasonic	0.39
CRCW0603100RFKEA	RES, 100 ohm, 1%, 0.1W, 0603	R24, R27, R30, R33, R36, R46, R49, R58, R61, R64, R67, R69, R74, R76, R79, R84, R87	0603	17	Resistor	Vishay-Dale	100
CRCW080560R4FKEA	RES, 60.4, 1%, 0.125 W, 0805	R25, R53	0805	2	Resistor	Vishay-Dale	60.4
CRCW060349R9FKEA	RES, 49.9 ohm, 1%, 0.1W, 0603	R40	0603	1	Resistor	Vishay-Dale	49.9
CRCW06030000Z0EA	RES, 0 ohm, 5%, 0.1W	R44, R47	0603	2	Resistor	Vishay-Dale	0
CRCW060310R0FKEA	RES, 10.0 ohm, 1%, 0.1W, 0603	R50, R62, R119, R121, R123, R125, R135, R139	0603	8	Resistor	Vishay-Dale	10.0
CRCW06031K00FKEA	RES, 1.00k ohm, 1%, 0.1W, 0603	R54, R55	0603	2	Resistor	Vishay-Dale	1.00k
RC0603FR-0749K9L	RES, 49.9k ohm, 1%, 0.1W, 0603	R68	0603	1	Resistor	Yageo America	49.9k
RC0603FR-071RL	RES, 1.00 ohm, 1%, 0.1W, 0603	R78	0603	1	Resistor	Yageo America	1.00
CRCW06032K00FKEA	RES, 2.00k ohm, 1%, 0.1W, 0603	R88, R89, R90, R91, R92, R93, R94, R95, R96, R97, R98, R99, R100, R101, R102, R103	0603	16	Resistor	Vishay-Dale	2.00k
CRCW2512200RJNEG	RES 200 OHM 1W 5% 2512 SMD	R163, R164	2512	2	Resistor	Vishay/Dale	200
760390014	Transformer, 340uH, SMT	T2	12.7x9.14x7.62 mm	1	Transformer	Wurth Elektronik eiSos	340uH

Table 3. Single-Ended Bill Of Materials (continued)

Part Number	Description	Designator	Package Reference	Qty	Comp Type	Manufacturer	Value
43045-1601	MOLEX CONN RECEPT 16POS 3MM VERT DUAL	THERMISTORS	43045-1601	1	Connector	Molex	
bq76PL455ATPFCRQ1	16 Cell Battery Monitor with Passive Cell Balancing, PFC0080A	U1	PFC0080A	1	IC	Texas Instruments	
TPS73601DBVR	Cap-Free, NMOS, 400mA Low-Dropout Regulator with Reverse Current Protection, DBV0005A	U2	DBV0005A	1	IC	Texas Instruments	
TMS570LS0432	Hercules ARM Cortex-R4 Microcontroller	U6		1			
SN6501DBV	Transformer Driver for Isolated Power Supplies, DBV0005A	U7	DBV0005A	1	IC	Texas Instruments	
ISO1050DW	Isolated CAN Transceiver, -55 to 105 degC, 16-pin SOIC (DW), Green (RoHS & no Sb/Br)	U8	DW0016A	1		Texas Instruments	
ABLS-16.000MHZ-B4-T	Crystal, 16MHz, 18 pF, SMD	Y1	Crystal, 11.4x4.3x3.8mm	1	Crystal	Abracon Corporation	
DDZ6V2B-7	DIODE ZENER 6.2V 500MW SOD-123	Z1, Z2, Z3, Z4, Z5, Z6, Z7, Z8, Z9, Z10, Z11, Z12, Z13, Z14, Z15, Z16	SOD-123	16	Zener	Diodes Inc	6.2V
SMAJ90A	DIODE TVS 90V 400W UNI 5% SMA	Z19	SMA	1	Diode TVS	Littelfuse Inc	

1.5 Reduced Cell Count

This is the typical use case for less than 16 series cells.

Highlights:

- 12-V minimum, up to 16 cells supported
- VP supplied from bq76PL455A-Q1 regulator
- VIO supplied by MCU VDDIO

1.5.1 Simplified System Diagram

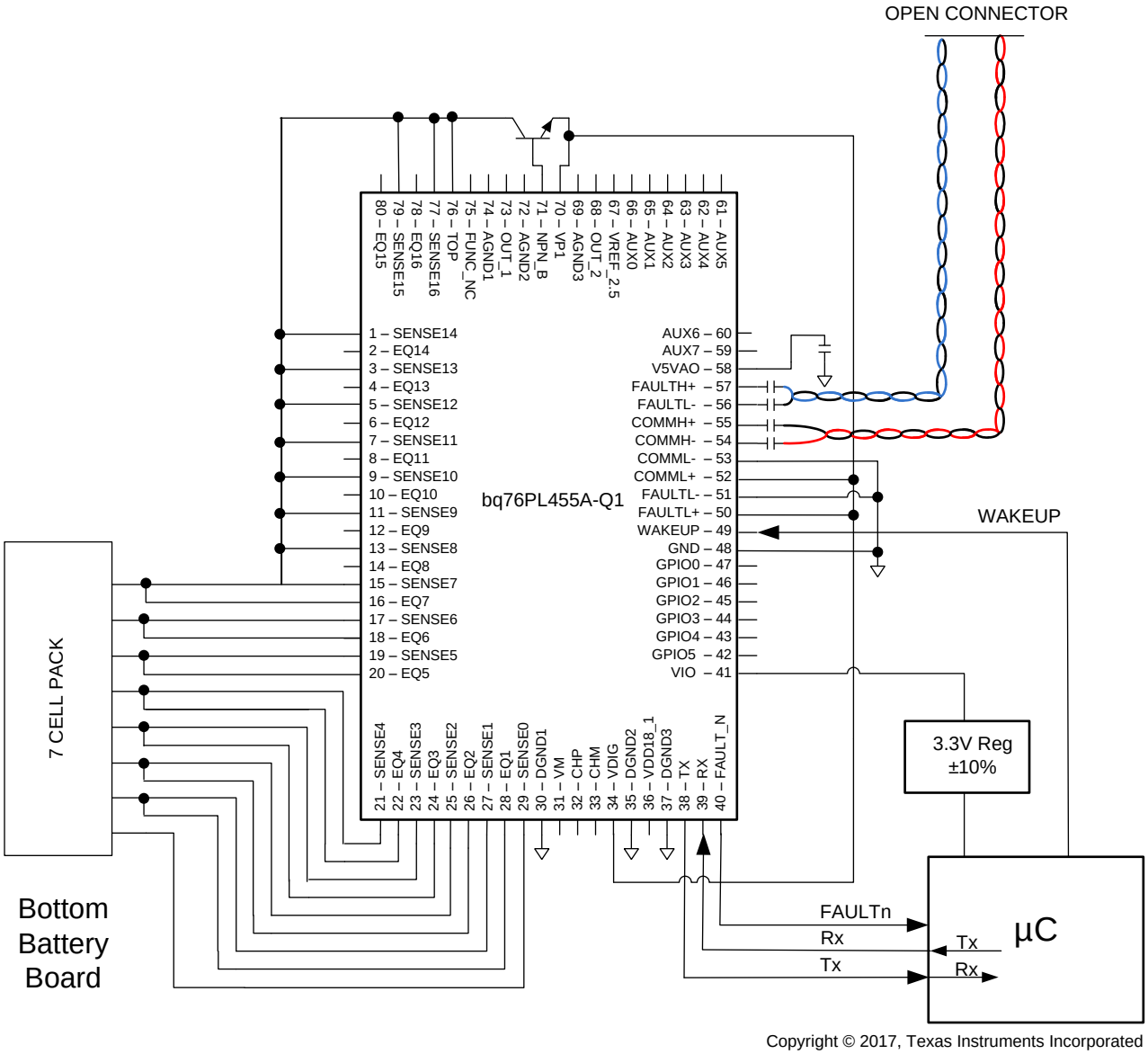

Figure 17. Reduced Cell-Count System Architecture

1.6 48-V Single-Ended

This is the typical use case for 14 series cells, no-daisy-chain, with MCU and isolated CAN communication.

1.6.1 Simplified System Diagram

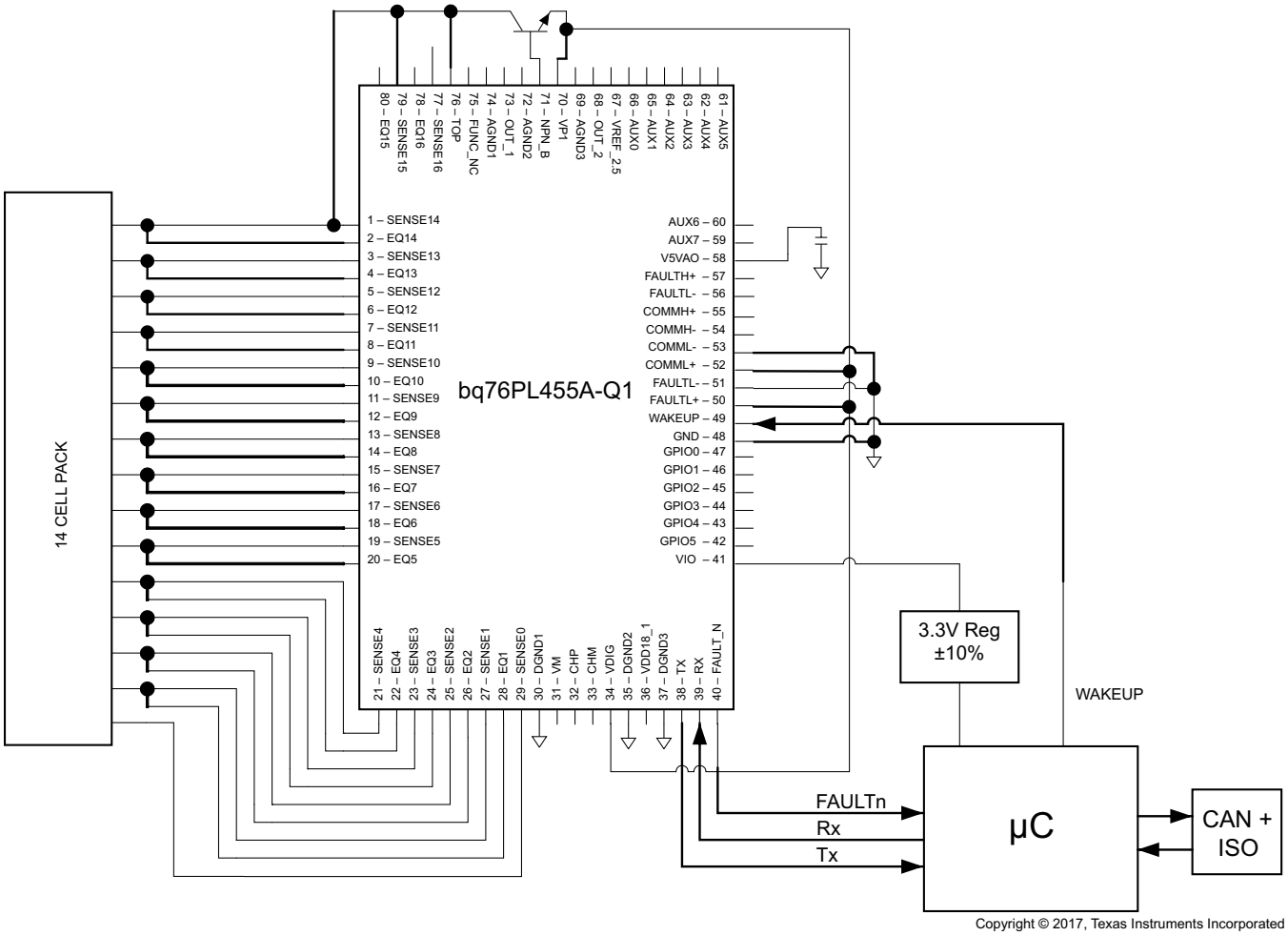

Figure 18. 48-V Single-Ended System Architecture

1.7 Multi-Drop Communication Schemes

The bq76PL455A-Q1 can be connected in a multi-drop configuration, with a shared microcontroller as shown in Figure 1, or a microcontroller local to each module as shown in Figure 2.

The multi-drop configuration is shown in this section. The ISO1050 is a good device which incorporates both differential transceiver and isolation. An isolated supply is required for the isolator, but since an isolated 36-V supply is already present, a 5-V supply can be regulated from that. Each device must use GPIO addressing (or be preprogrammed to a unique address). As each IC acts as a single-ended device, each IC also needs to be individually written or read, as broadcast or group packets would not work.

It is important that the WAKEUP signal generated by the isolated transformer-based circuit is clamped to not exceed the absolute maximum rating described in the datasheet.

1.7.1 Simplified System Diagrams

There are several solutions that are possible:

- Shared microcontroller
- Local microcontroller
- Local isolated microcontroller

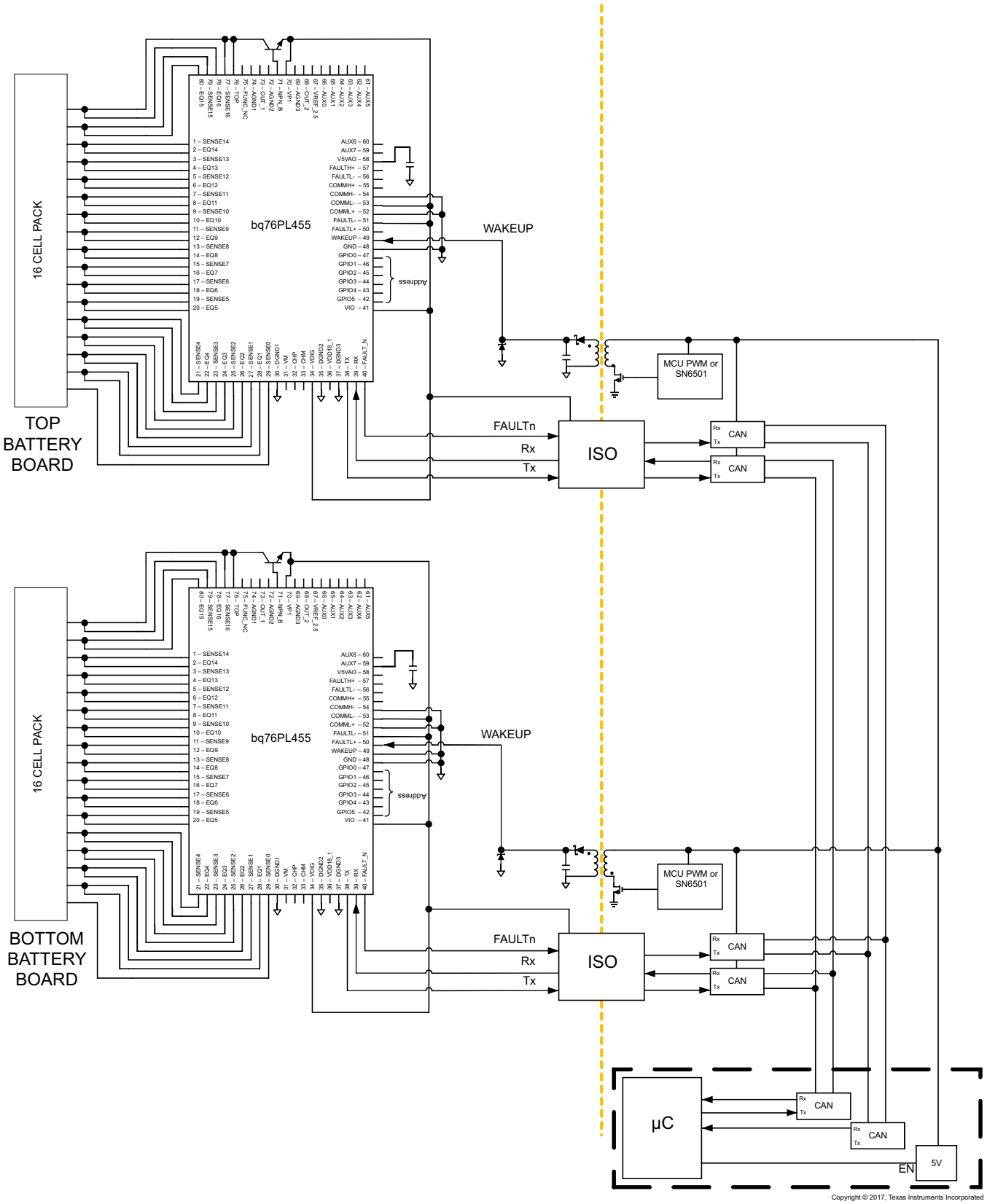

Figure 19. Multi-Drop Communication With Shared Microcontroller System Architecture

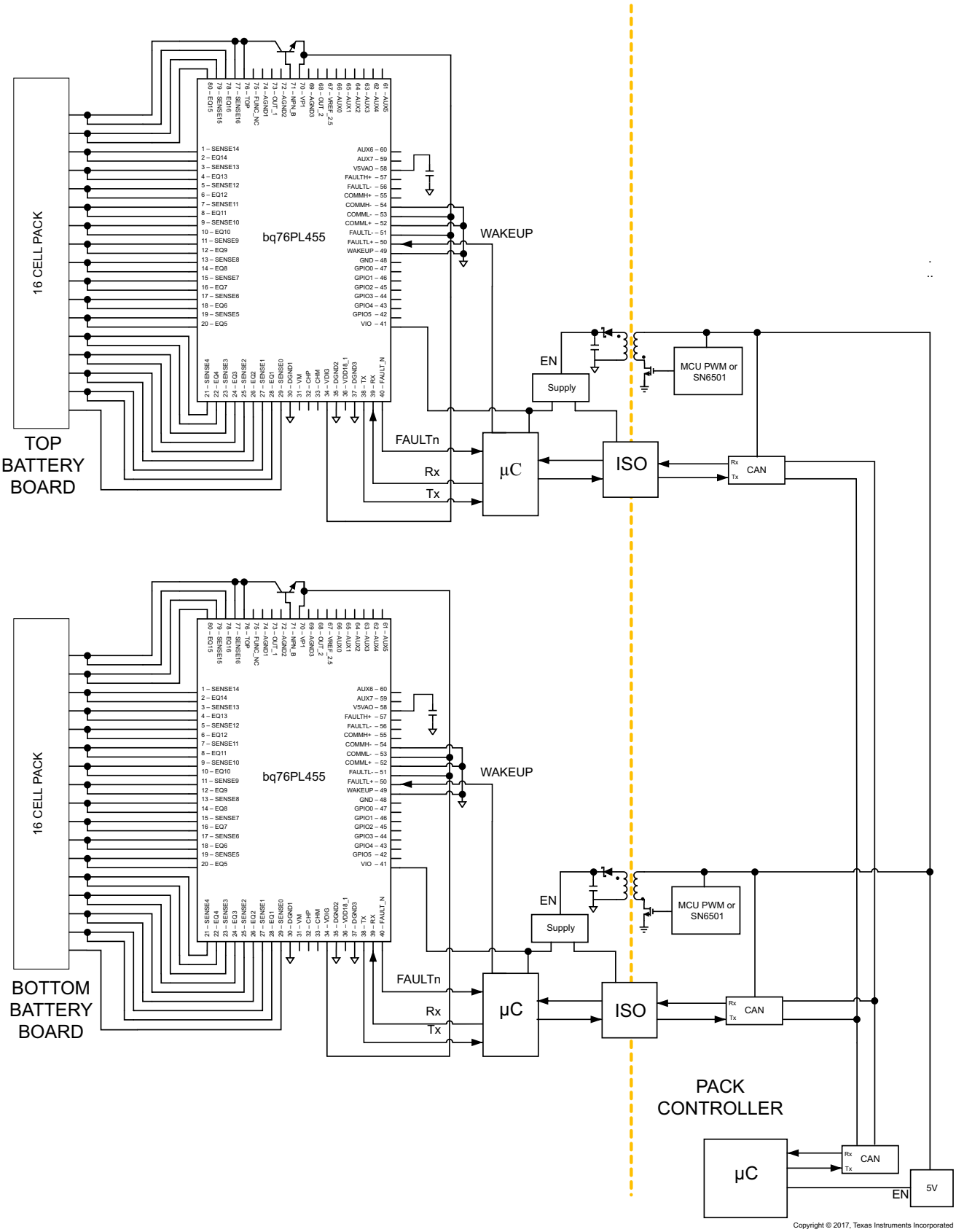

Figure 20. Multi-Drop Communication With Local Microcontroller System Architecture

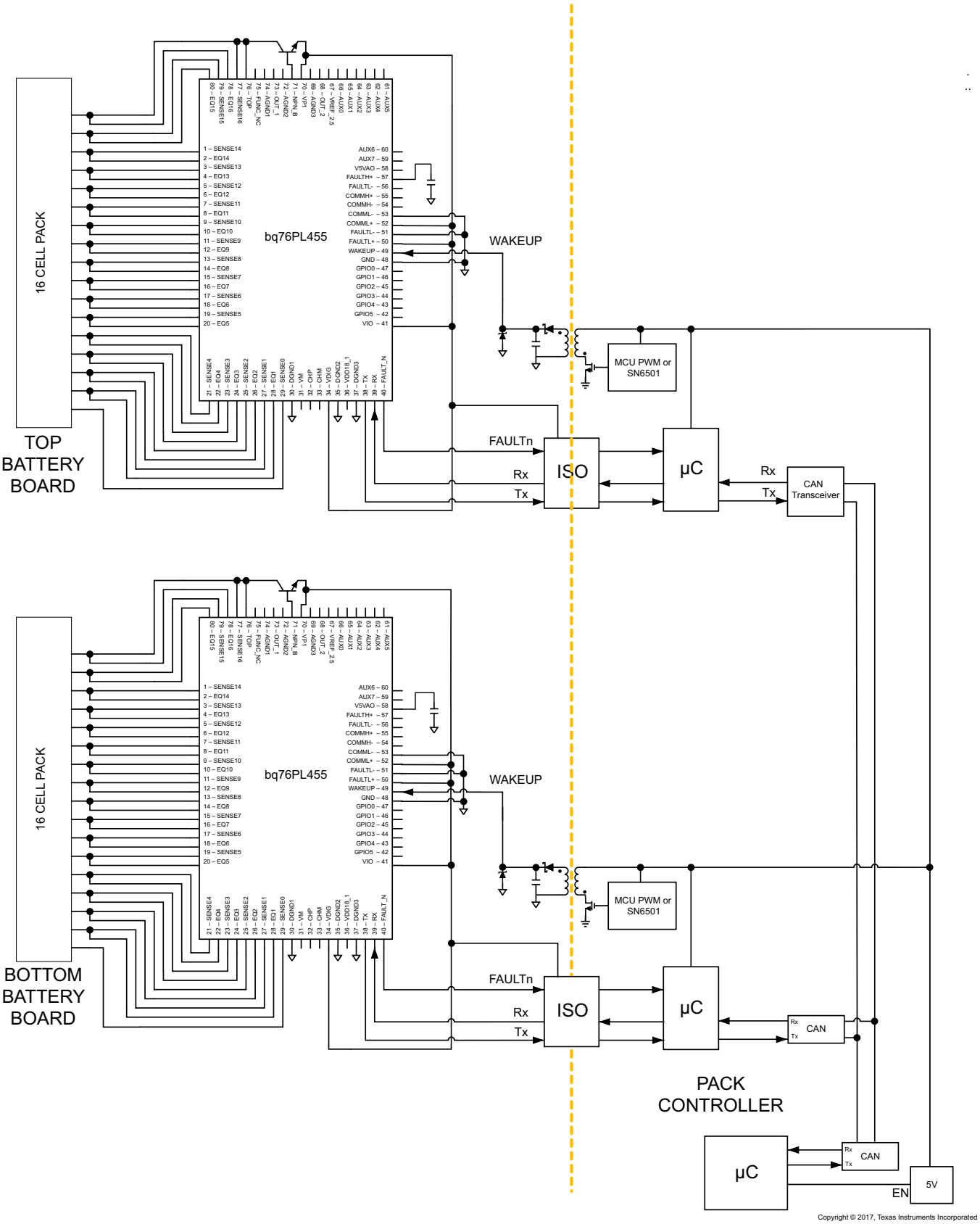

Figure 21. Multi-Drop Communication With Local Isolated Microcontroller System Architecture

1.8 Active Balance

The bq76PL455A-Q1 can also be used as the monitor and protector for an active cell balance battery management system with the addition of the EMB1428Q and EMB1499Q devices.

In the application described in Figure 15, an external microcontroller is used to control the EMB1428Q via SPI.

Highlights:

- 12-V minimum, up to 16 cells supported
- VP supplied from bq76PL455A-Q1 regulator
- VIO supplied by MCU VDDIO

1.8.1 Simplified System Diagram

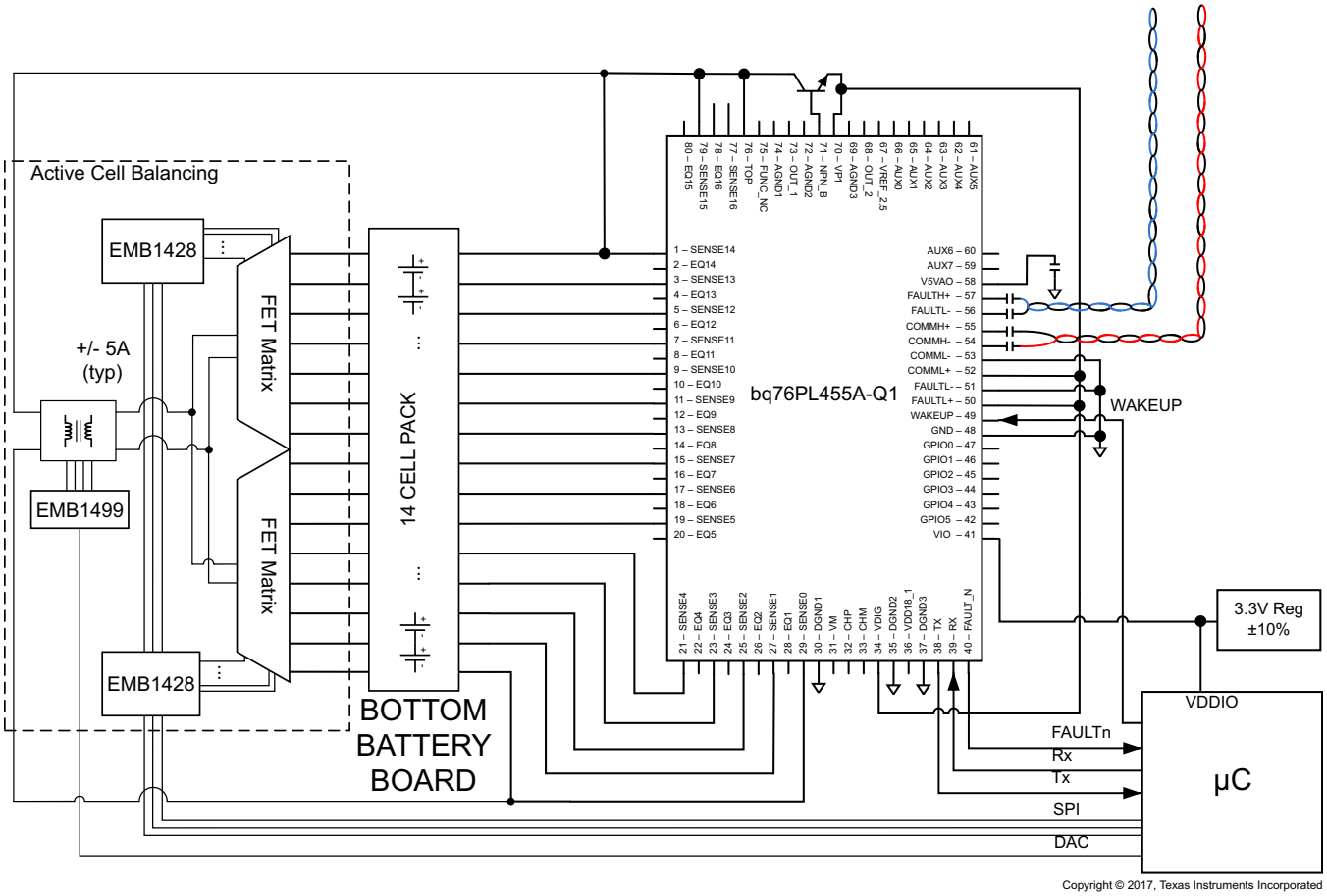

Figure 22. 14-Cell Active Cell Balance System Architecture

1.8.2 Schematic

A 16-channel solution with a bq76PL455A-Q1 sharing a single, isolated bi-directional DC-DC is described in TIDA-00817. Other implementations of the active balance bi-directional DC-DC are possible as well, as shown in the 14-cell, dual bi-directional converter solution described in TIDA-00239.

1.8.3 Bill Of Materials

Please refer to the *TI Designs* links in the previous section for schematics and BOM.

2 Sub-Circuits

2.1 Front-End Circuit

The front-end circuit is shown overall in Figure 23, and in more detail in Figure 24.

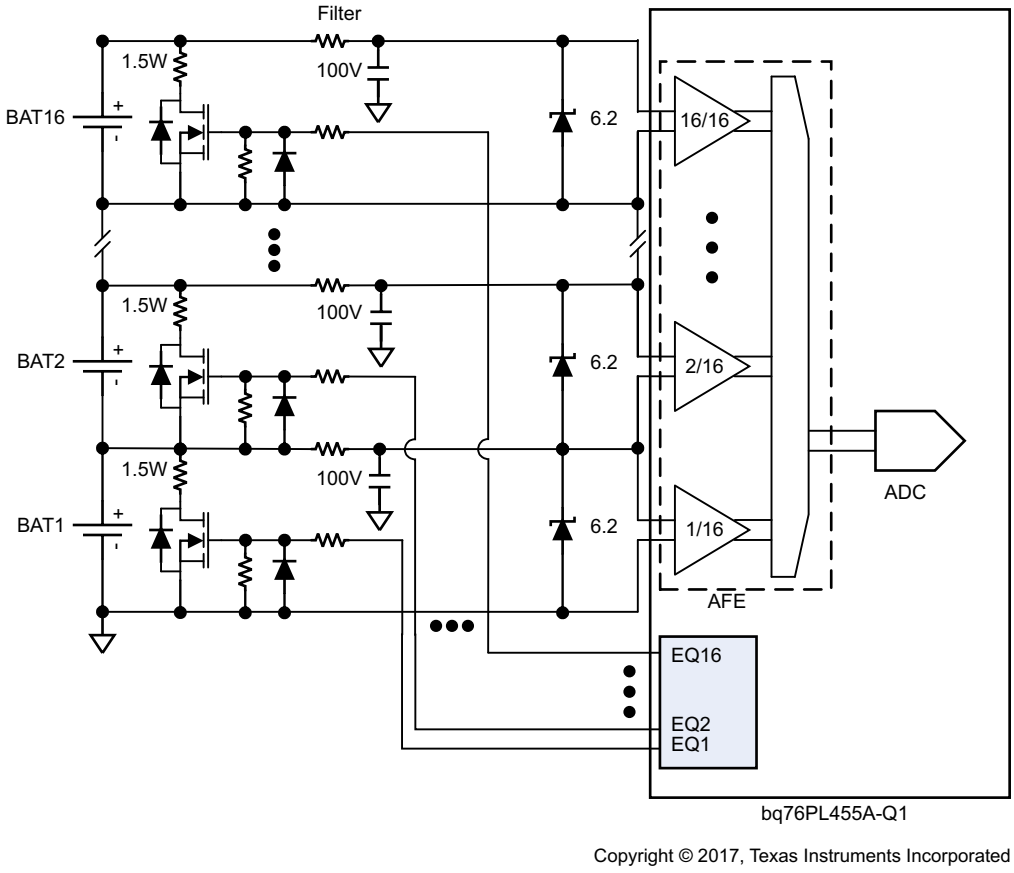

Figure 23. Front-End Circuit

The recommendations for each component in the following circuit are:

- Rin - Recommended to be 100–1000 Ω, with as low as possible corresponding Cin capacitor value to achieve the desired filter response.
- Cin - Recommended to be 0.1 µF or greater, with corresponding Rin series resistor value to achieve the desired filter response.
- Zener protection diode selected for lowest possible reverse leakage at typical cell voltage range to reduce offset error on the VSENSE input. Zener diode placement close to the pin is critical for hot-plug survivability. The zener diode provides a path for in-rush current to charge adjacent channel input cap, bypassing the internal ESD diodes. The forward voltage of the zener diode also provides some input protection in reverse cell condition, with Rin limiting the zener current (power rating).
- Balance FET gate protection diode required for protection during hot-plug event (may be built-in to device).

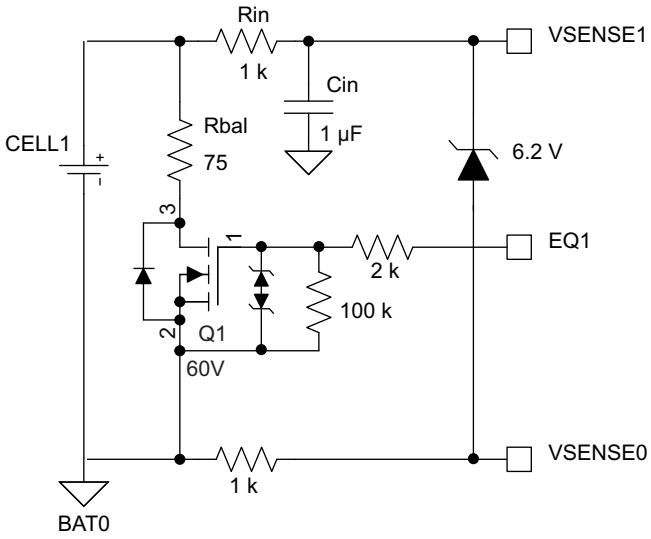

Figure 24. Front-End Circuit (One Channel Detail)

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