Industrial battery monitors: BQ76942 / BQ76952 device overview

BQ76942 / BQ76952 features

Monitoring	• Digital voltage, current, and temperature measurements, integrated coulomb counter
Protections	• Primary protection for OV, UV, OTC, OTD, UTC, UTD, OTF, OW, SCD, OCD1,2,3, OCC, cell balancing, watchdog, and more. Integrated secondary protection.
FET drivers	• Integrated charge pump & drivers for high-side protection NFETs
Cell balancing	• Integrated passive cell balancing up to 50mA, support for external passive balancing
Prechg / Predsg	• Support for high-side PFET-based precharge and predischarge modes
Integrated LDOs	• Dual LDOs programmable as 5V / 3.3V / 3.0V / 2.5V / 1.8V, up to 45mA each
Communications	• Support for I2C, SPI, & HDQ interfaces
High voltage tolerance	• High voltage tolerance of 85V absolute maximum on select pins

TEXAS INSTRUMENTS

BQ76942 / BQ76952 feature highlights

Protection redundancy

Standalone HW based protection

Autonomous or host controlled recovery

Accurate & advanced pack measurement

ADC accuracy @ +/- 10mV over 0C – 60C

Fast data refresh rate 22.5ms to 63ms

Synchronized V/I measurement

Separate Coulomb Counter for continuous current measurement

Power modes

NORMAL Mode (~250uA)

SLEEP Modes (20 - 60uA) Wake by current, charger, or comms

DEEPSLEEP Modes (10 - 14uA) Wake by charger or selected comms

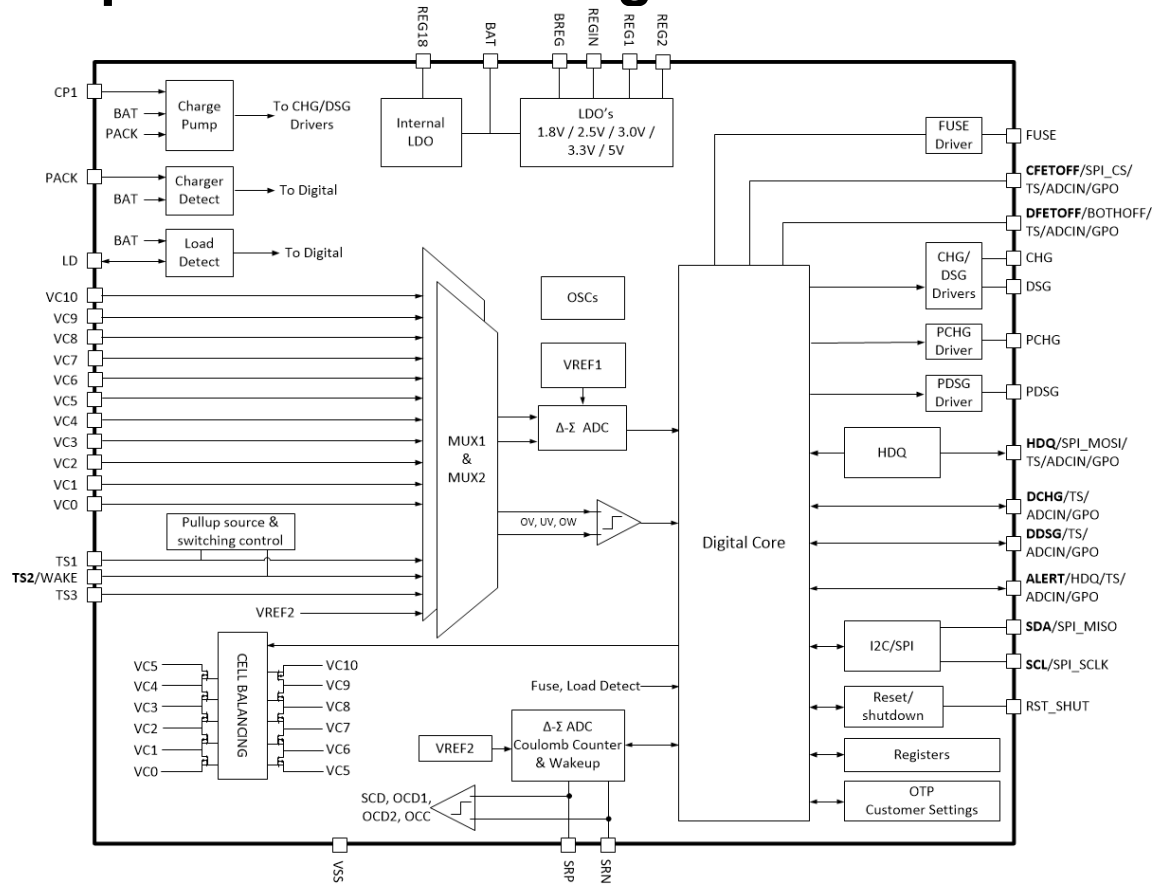**SHUTDOWN (SHIP) Mode** All circuitry shutdown Wake by charger attach or TS2 pulldown

BOM savings

Integrated nFET driver

High side protection – No need for comm isolation
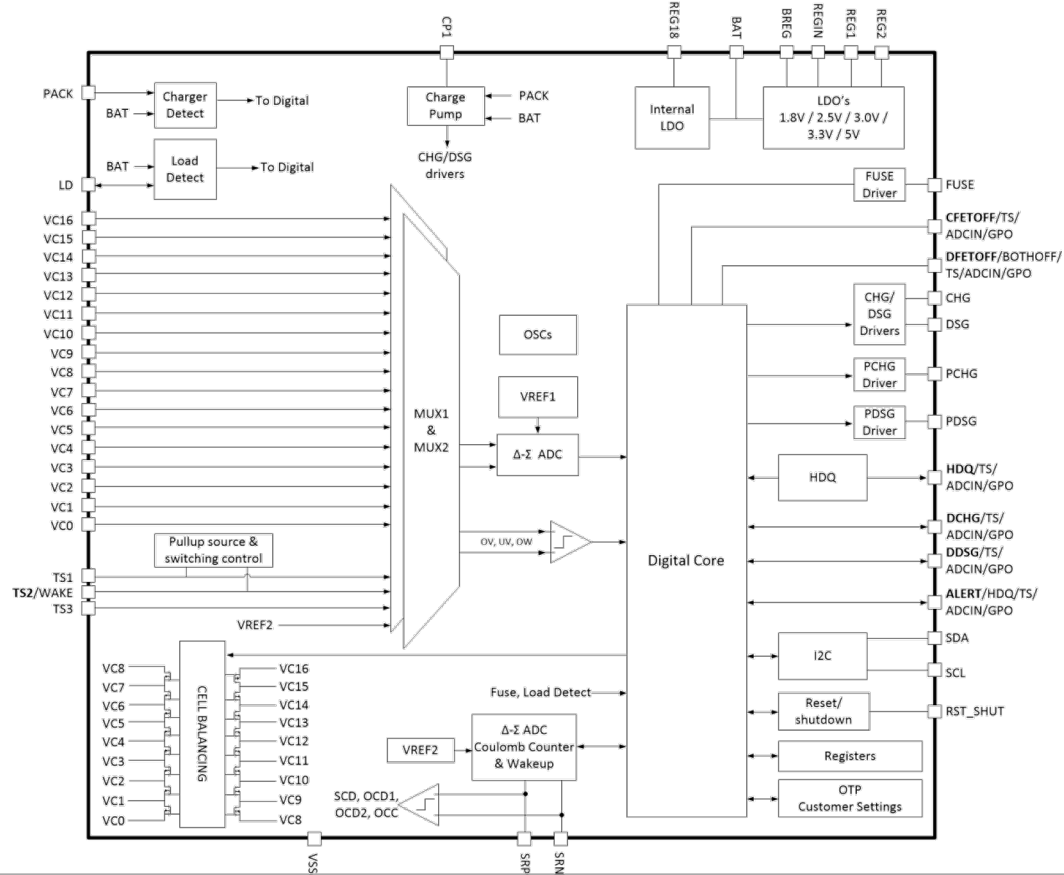
Dual programmable LDO, up to 45mA each

TEXAS INSTRUMENTS

BQ76942
3S - 10S monitor + protector block diagram

BQ76952
3S - 16S monitor + protector block diagram
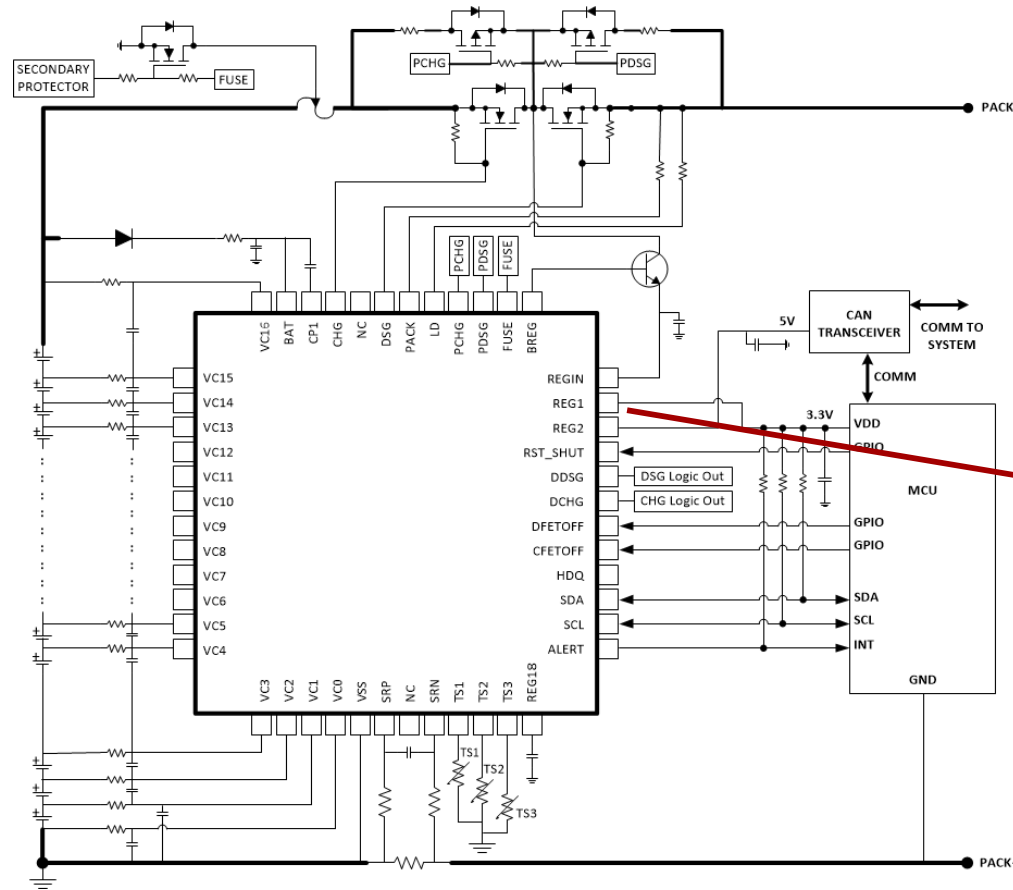
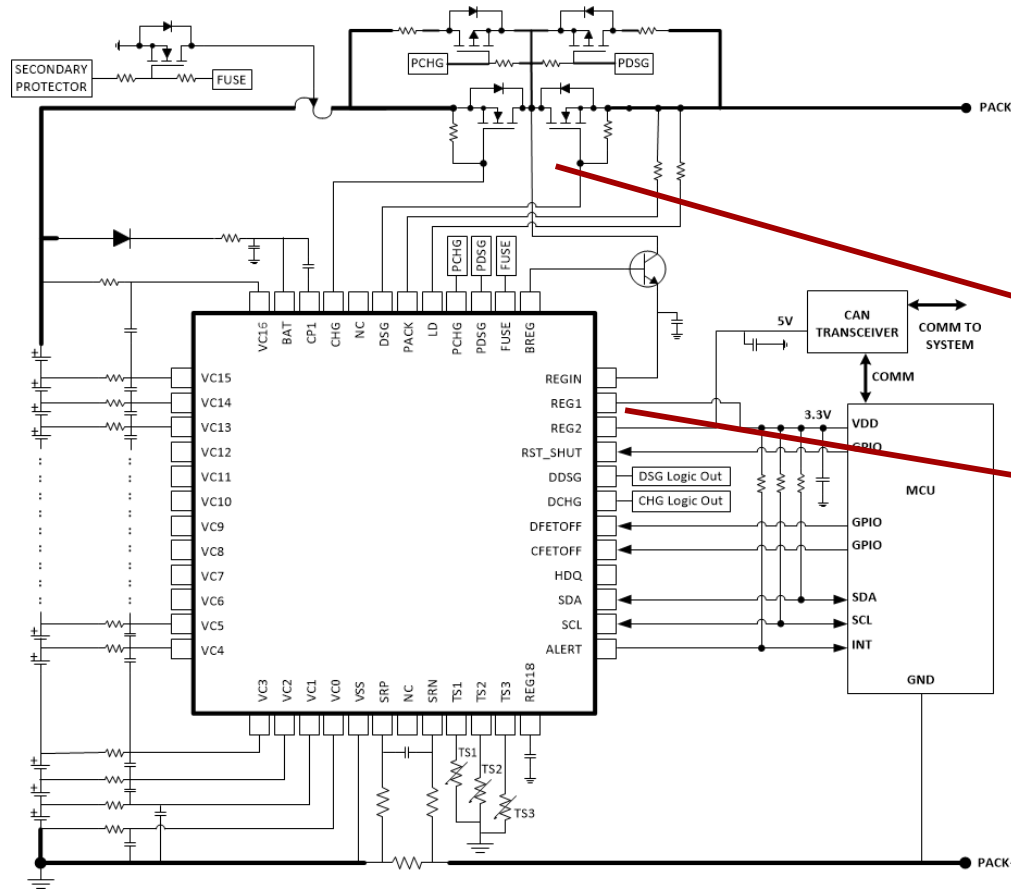![Texas Instruments logo]

BQ76952: 16S simplified schematic

BQ76952: 16S simplified schematic

Programmable REG1 and REG2 (1.8V / 2.5V / 3.0V / 3.3V / 5V) e.g., to power CAN transceiver or MCU

TEXAS INSTRUMENTS

BQ76952: 16S simplified schematic

Integrated high-side NFET drivers

Programmable REG1 and REG2 (1.8V / 2.5V / 3.0V / 3.3V / 5V) e.g., to power CAN transceiver or MCU

TEXAS INSTRUMENTS

BQ76952: 16S simplified schematic

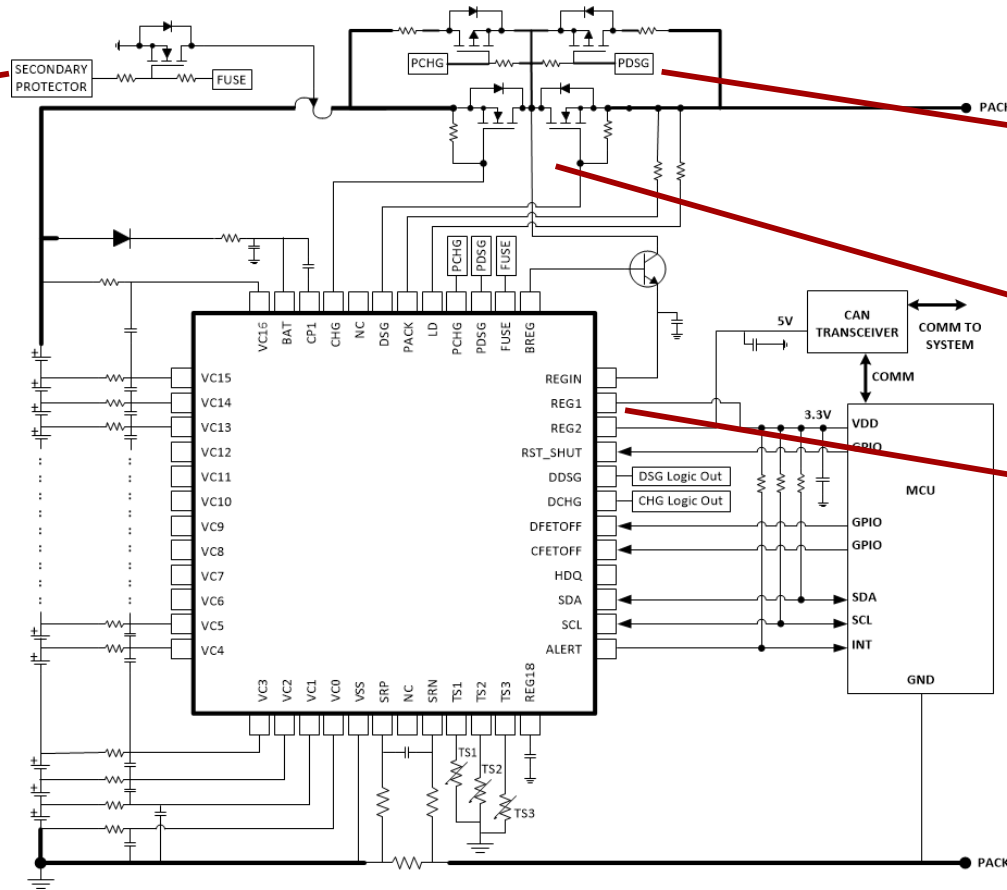Integrated PFET drivers e.g. to slowly charge up the capacitive load at system startup

Integrated high-side NFET drivers

Programmable REG1 and REG2 (1.8V / 2.5V / 3.0V / 3.3V / 5V) e.g., to power CAN transceiver or MCU

TEXAS INSTRUMENTS

BQ76952: 16S simplified schematic

Secondary protection
Works with external secondary protector

Integrated PFET drivers
e.g. to slowly charge up the capacitive load at system startup

Integrated high-side NFET drivers

Programmable REG1 and REG2 (1.8V / 2.5V / 3.0V / 3.3V / 5V) e.g., to power CAN transceiver or MCU

TEXAS INSTRUMENTS

BQ76952: 16S simplified schematic

Secondary protection
Works with external secondary protector

Integrated CB FETs
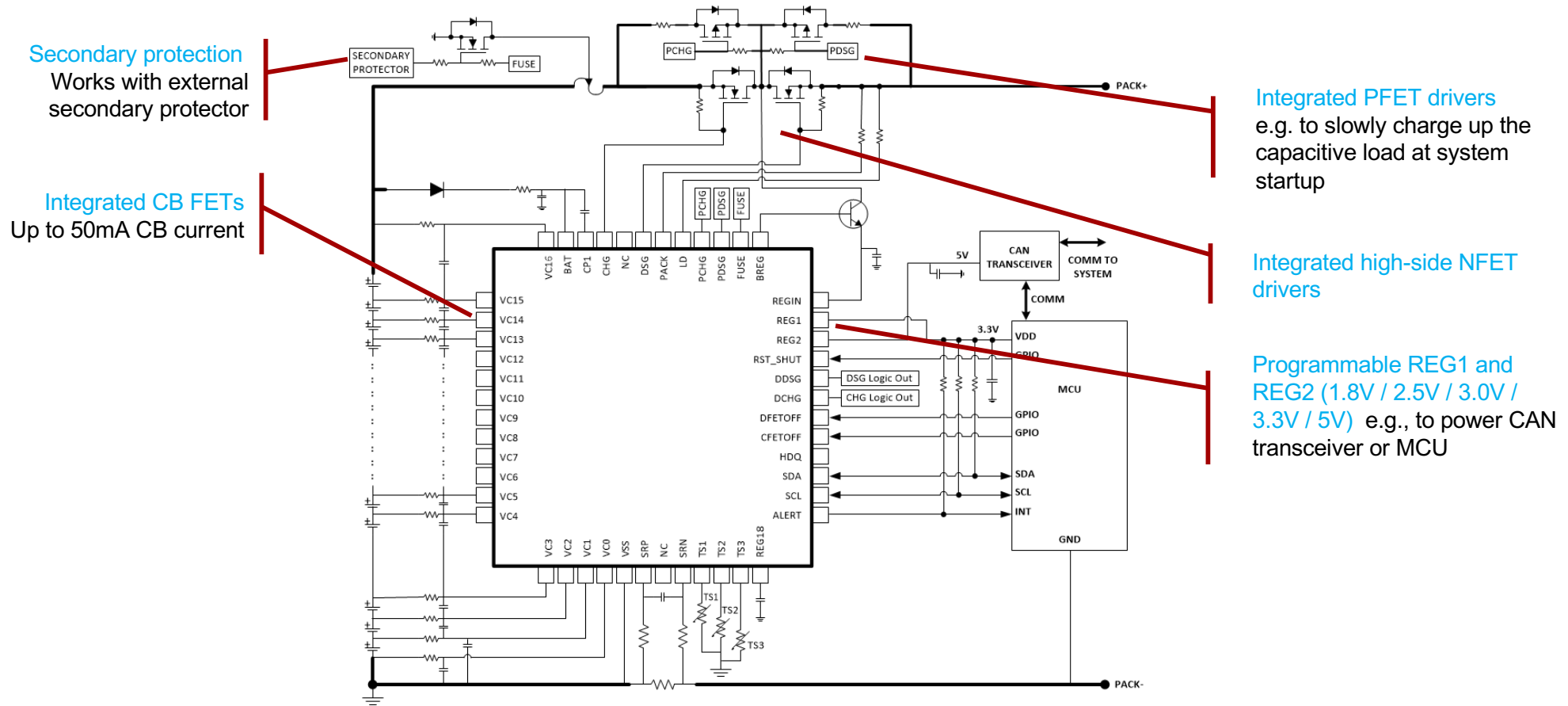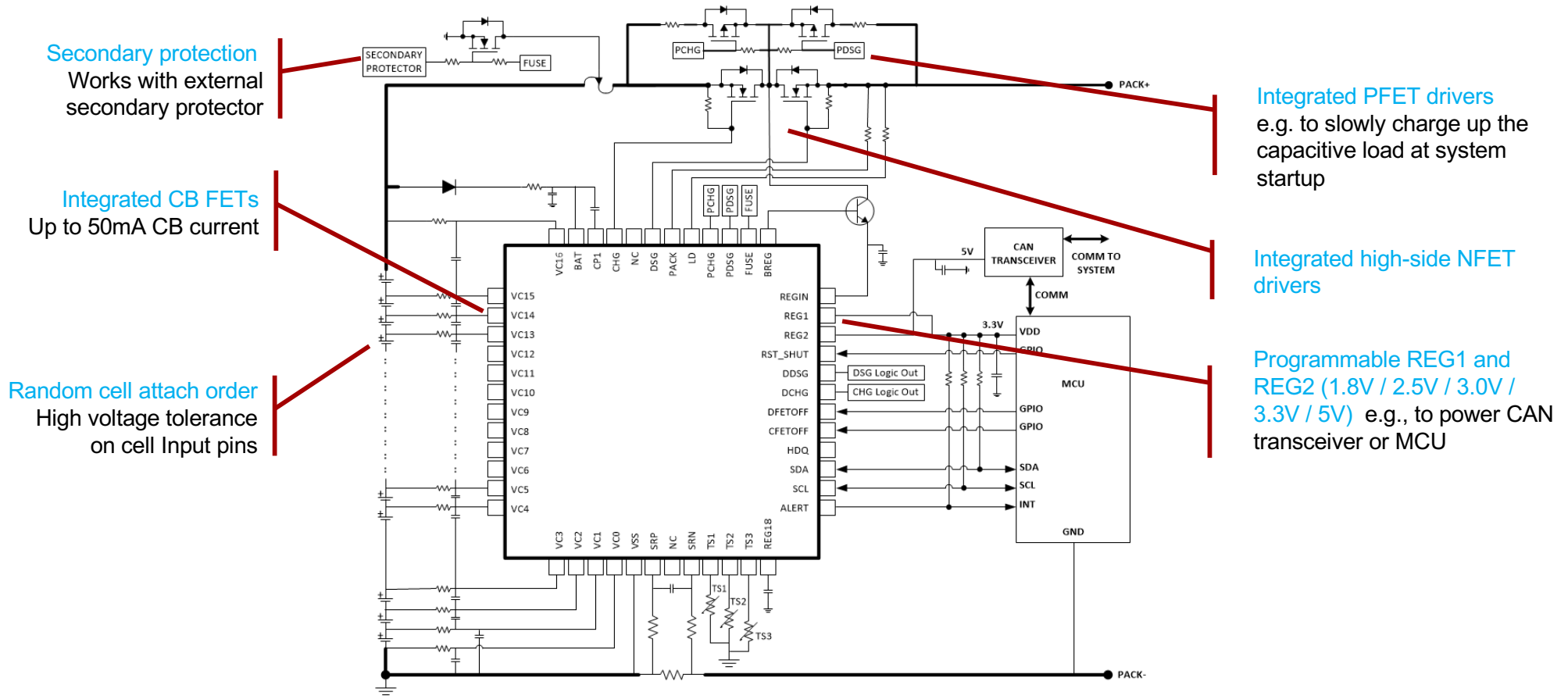Up to 50mA CB current

Integrated PFET drivers
e.g. to slowly charge up the capacitive load at system startup

Integrated high-side NFET drivers

Programmable REG1 and REG2 (1.8V / 2.5V / 3.0V / 3.3V / 5V) e.g., to power CAN transceiver or MCU

TEXAS INSTRUMENTS

BQ76952: 16S simplified schematic

Secondary protection
Works with external secondary protector

Integrated CB FETs
Up to 50mA CB current

Random cell attach order
High voltage tolerance on cell Input pins

Integrated PFET drivers
e.g. to slowly charge up the capacitive load at system startup

Integrated high-side NFET drivers

Programmable REG1 and REG2 (1.8V / 2.5V / 3.0V / 3.3V / 5V) e.g., to power CAN transceiver or MCU

TEXAS INSTRUMENTS

BQ76952: 16S simplified schematic

Secondary protection
Works with external secondary protector
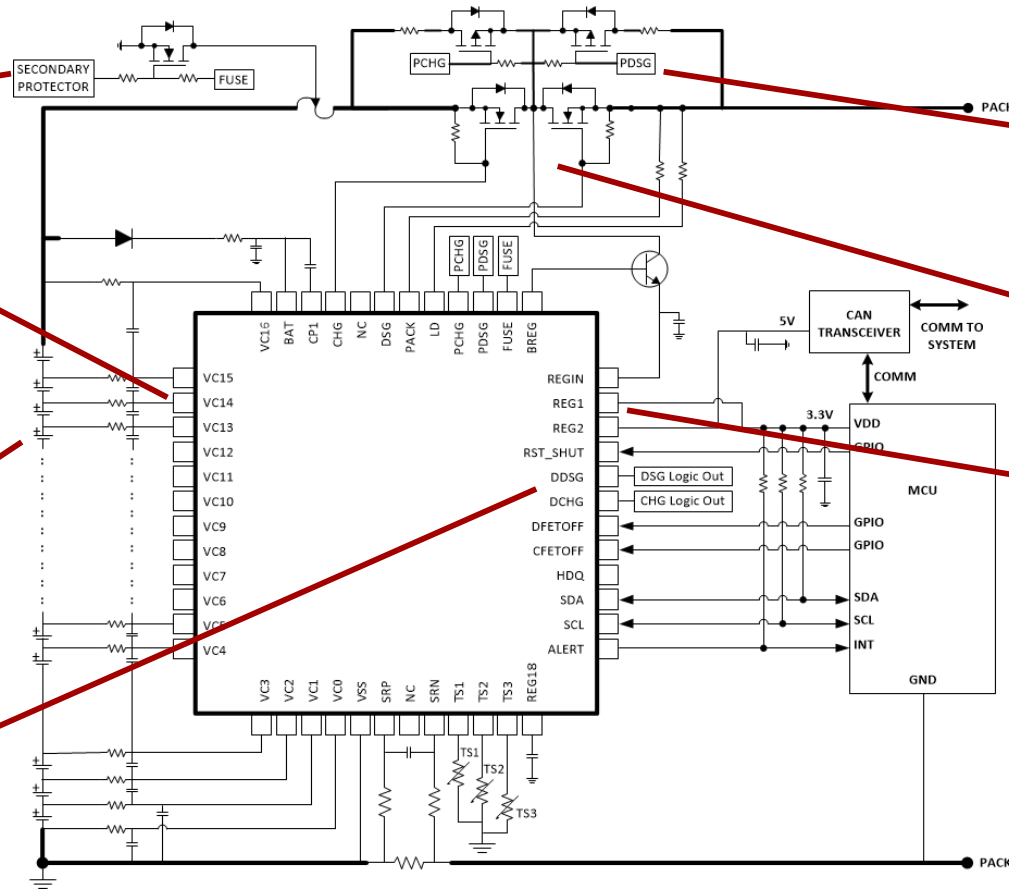
Integrated CB FETs
Up to 50mA CB current

Random cell attach order
High voltage tolerance on cell Input pins

Digital CHG and DSG output
Can use as alternative charge/discharge fault signal

Integrated PFET drivers
e.g. to slowly charge up the capacitive load at system startup

Integrated high-side NFET drivers

Programmable REG1 and REG2 (1.8V / 2.5V / 3.0V / 3.3V / 5V) e.g., to power CAN transceiver or MCU

TEXAS INSTRUMENTS

BQ76952: 16S simplified schematic

Secondary protection
Works with external secondary protector
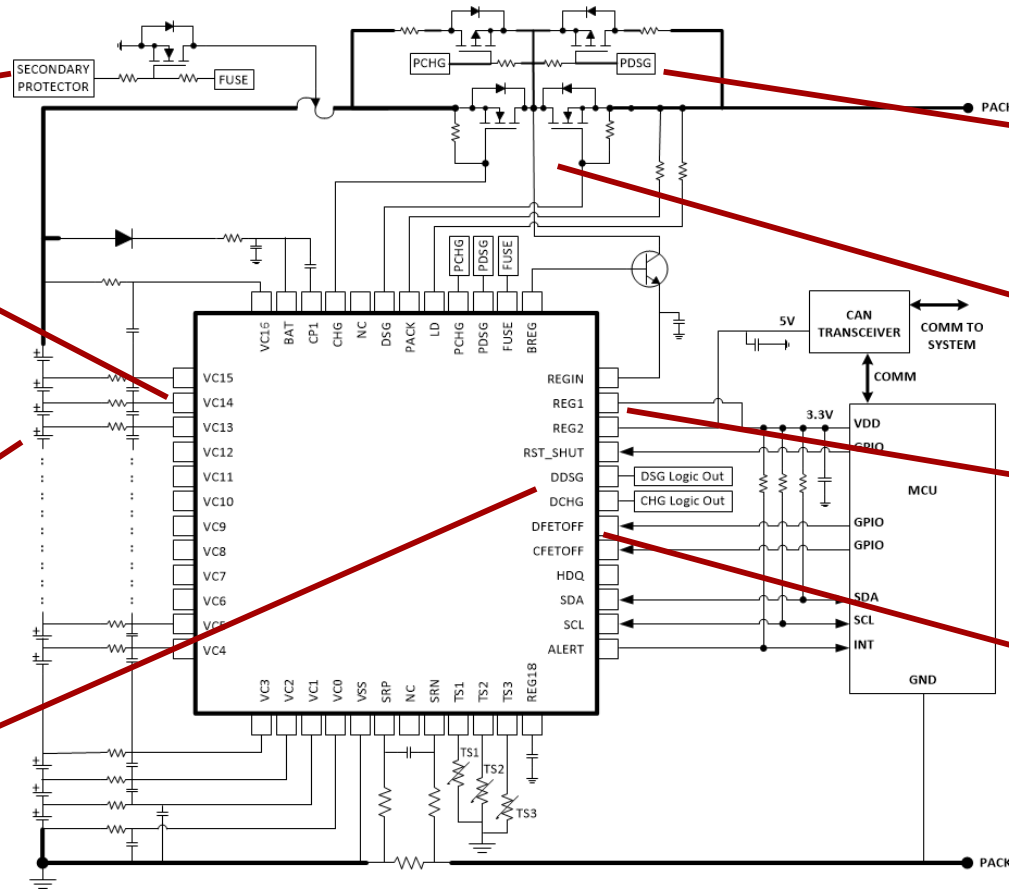
Integrated CB FETs
Up to 50mA CB current

Random cell attach order
High voltage tolerance on cell Input pins

Digital CHG and DSG output
Can use as alternative charge/discharge fault signal

Integrated PFET drivers
e.g. to slowly charge up the capacitive load at system startup

Integrated high-side NFET drivers

Programmable REG1 and REG2 (1.8V / 2.5V / 3.0V / 3.3V / 5V) e.g., to power CAN transceiver or MCU

External HW shutdown or reset control and fast FETOFF control

TEXAS INSTRUMENTS

BQ76952: 16S simplified schematic

Secondary protection
Works with external secondary protector
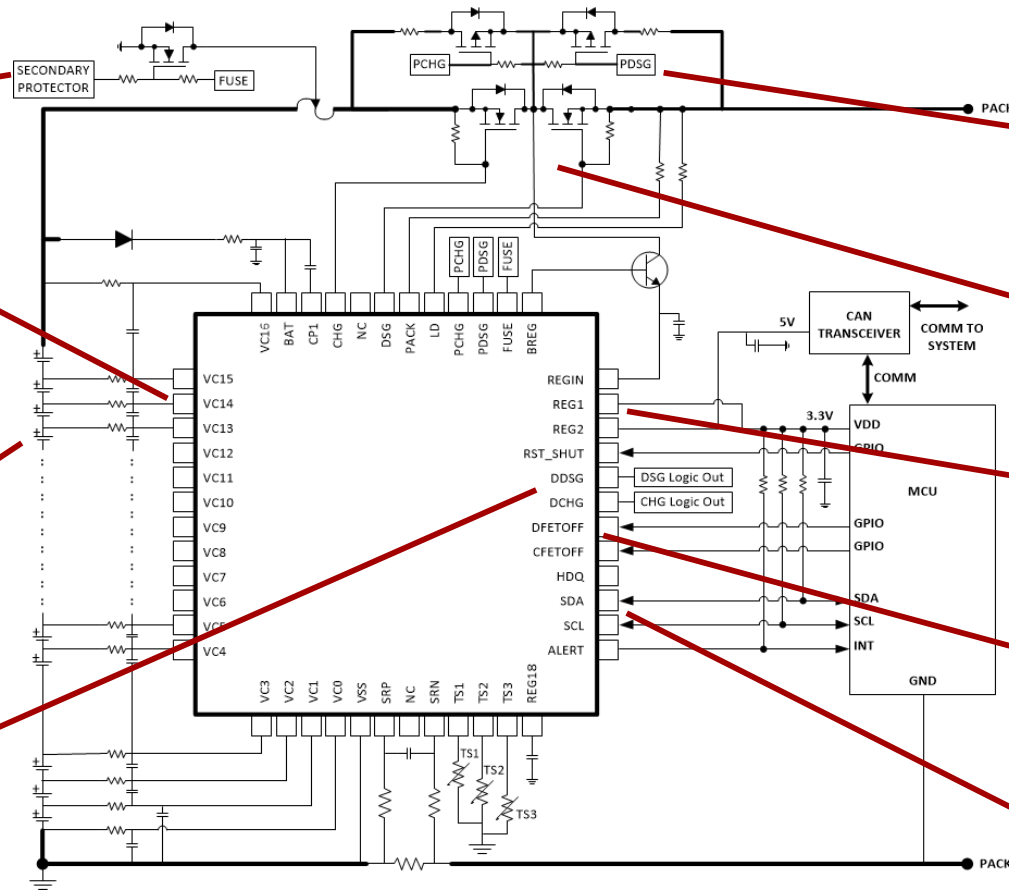
Integrated CB FETs
Up to 50mA CB current

Random cell attach order
High voltage tolerance on cell Input pins

Digital CHG and DSG output
Can use as alternative charge/discharge fault signal

Integrated PFET drivers
e.g. to slowly charge up the capacitive load at system startup

Integrated high-side NFET drivers

Programmable REG1 and REG2 (1.8V / 2.5V / 3.0V / 3.3V / 5V) e.g., to power CAN transceiver or MCU

External HW shutdown or reset control and fast FETOFF control

I2C or HDQ or SPI

TEXAS INSTRUMENTS

BQ76942 / BQ76952 power modes

System Benefit

NORMAL Mode ~250uA
- All protections enabled
- DFET & CFET on
- Regular voltage, current, and temperature measurements
- LDO programmable

- Highest performance for system active state
- Full protections, V / I / T data collected continuously

SLEEP Mode 20 – 60uA
- Most protections still enabled
- DFET on (multiple modes), CFET off
- ADC intermittent, CC in current wake detect mode
- LDO programmable (can keep MCU powered)
- Wake by current / comm / charger / reset

- Optimized for system idle state
- MCU can be in low power mode without compromising safety
- V / I / T data collected periodically

DEEPSLEEP Mode 10 – 14uA
- Most circuits off, FETs off
- No ADC/CC, no protection
- LDO programmable (can keep MCU powered)
- Wake by selected comms / charger / reset signal

- Optimized for system low power state
- Lowest power mode while still providing LDO operation to keep MCU powered

SHUTDOWN Mode <1uA
- All circuitry off (except wakeup detector)
- No measurements, no protections
- LDO powered off
- Wake by pulling TS2 to and / or charger attach

- Lowest power mode for shipping, storage, or long-term power-down

Different power modes meeting different system needs

BQ76942 / BQ76952
Programmable Dual LDO

- External NPN drops voltage from top-of-stack level to ~5.5V pre-regulator level (REGIN)

- REG1 and REG2 draw input from REGIN, provide programmable outputs from 1.8V to 5.0V.

- Includes option for customer to provide REGIN from external DC/DC.
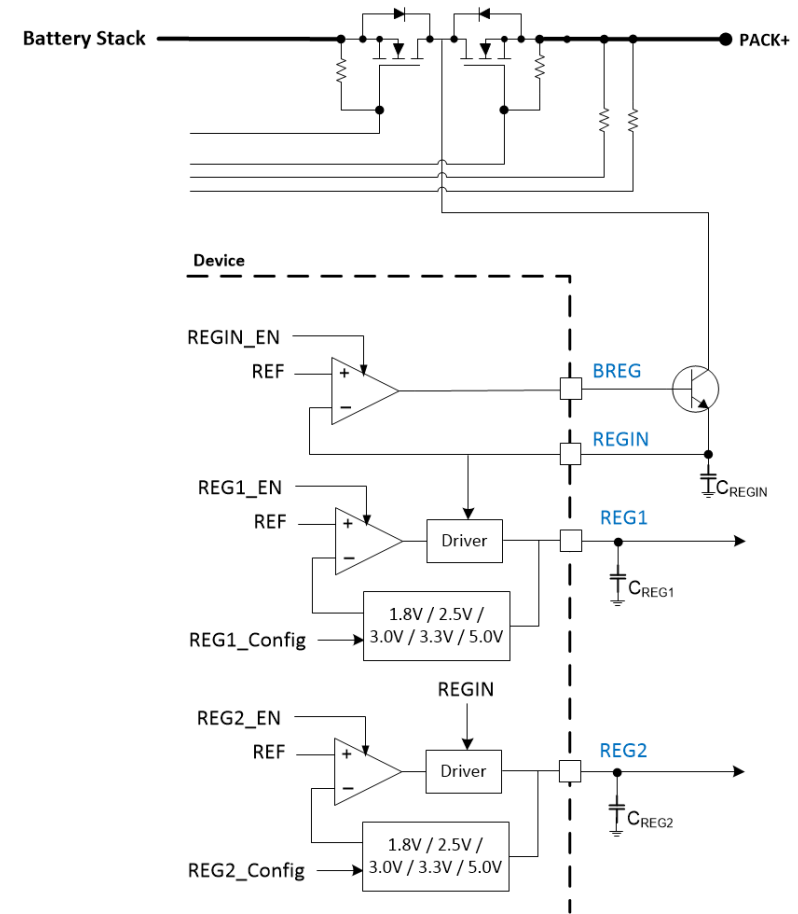
BQ76942 / BQ76952 protections

- Protection through combination of comparators and ADC
- Support for MCU mode (recovery by MCU control), Standalone mode (auto-recovery)
- Fault signal interrupt to MCU
- OTP programmable default protection setting

Function		Range	Delay	Recovery Method (Standalone mode)
Voltage	COV	1.0V – 5.5V, 50mV steps	10ms ~ 6762ms, 3.3ms steps	Voltage hysteresis (100mV, 200mV)
	CUV	1.0V – 4V, 50mV steps	10ms ~ 6762ms, 3.3ms steps	Voltage hysteresis (100mV, 200mV) and/or load removal
Current	OCC	4mV – 124mV, 2mV steps	10ms ~ 426ms	Load attach and/or delay
	OCD1/2	-4mV – -200mV, 2mV steps	10ms ~ 426ms	Load removal and/or delay
	OCD3	-32768 – -4000-userA, 1-userA steps	1s ~ 255s	Load removal and/or delay
	SCD	10mV ~ 500mV	8us, 15us ~ 450us, 15us steps	Load removal and/or delay
	OVL, OCDL, SCDL	Various	Various	Delay & more

BQ76942 / BQ76952 protections

Function		Range	Delay	Recovery Method (Standalone mode)
Temperature	OTC	-40C – 120C, 1C steps	1s ~ 255s	Temperature recovery threshold -40C ~ 120C, 1C steps
	OTD	-40C – 120C, 1C steps	1s ~ 255s	Temperature recovery threshold -40C ~ 120C, 1C steps
	UTC	-40C – 120C, 1C steps	1s ~ 255s	Temperature recovery threshold -40C ~ 120C, 1C steps
	UTD	-40C – 120C, 1C steps	1s ~ 255s	Temperature recovery threshold -40C ~ 120C, 1C steps
	UTINT	-40C – 120C, 1C steps	1s ~ 255s	Temperature recovery threshold -40C ~ 120C, 1C steps
	OTINT	-40C – 120C, 1C steps	1s ~ 255s	Temperature recovery threshold -40C ~ 120C, 1C steps
	OTF	0C – 150C, 1C steps	1s ~ 255s	Temperature recovery threshold 0C ~ 150C, 1C steps
Host Watchdog	HWP	1s ~ 65535s		Valid communications occurs
Pre-charge Timeout	PTO	1s ~ 65535s		Pre-charge ends when timeout occurs

TEXAS INSTRUMENTS

BQ76942 / BQ76952 permanent fail

- Programmable options to trigger fuse
- OTP programmable default protection setting

Function		Range	Delay
Cell Open Wire	COW	Programmable check interval, triggers SOV/SUV	1s ~ 255s
Charge FET Fail	CFETF	10mA ~ 5000mA charging while CFET driven off	1s ~ 255s
Discharge FET Fail	DFETF	-10mA ~ -5000mA discharging while DFET driven off	1s ~ 255s
Second Level Fail	2LVLF	Detects fuse drive	1s ~ 255s
Voltage	SOV	1mV – 32767mV, 1mV steps	1s ~ 255s
	SUV	1mV – 32767mV, 1mV steps	1s ~ 255s
Current	SOCC	1-userA ~ 32767-userA (userA can be 0.1 / 1 / 10 / 100mA)	1s ~ 255s
	SOCD	-32767-userA ~ -1-userA	1s ~ 255s
Temperature	SOTC	-40C – 120C, 1C steps	1s ~ 255s
	SOTF	0C – 150C, 1C steps	1s ~ 255s
Voltage Imbalance	VIMR	1mV ~ 5500mV	1s ~ 255s
	VIMA	1mV ~ 5500mV	1s ~ 255s
OTP Memory Signature	OTPF		
Various diagnostics	Stuck mux checks, internal oscillator check, Cu deposition, stack vs cell voltage check, etc.		