



Battery Management Solutions

The Final Steps to Production

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October 23, 2014

bq40z50

Features

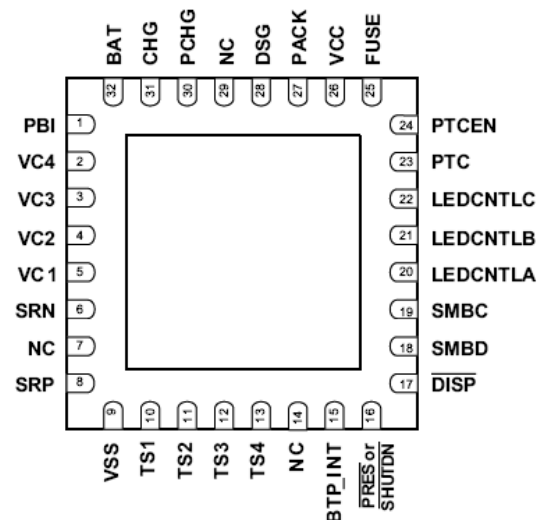
- Integrated AFE Safety Protector
 - Programmable
 - Voltage, Current, Temperature, Cell Imbalance
 - Charge, Impedance, Qmax
- N-channel FET drive
- Next Generation IT gauging
- Turbo Mode management
- Advanced Charging Algorithm
 - JEITA
 - Enhanced Charging
 - cell balancing at rest or while charging
- Diagnostic Lifetime Data
- Black box recorder
- SHA-1 Authentication
- LED (up to 5) support option
- 32-lead 4x4 QFN package

Applications

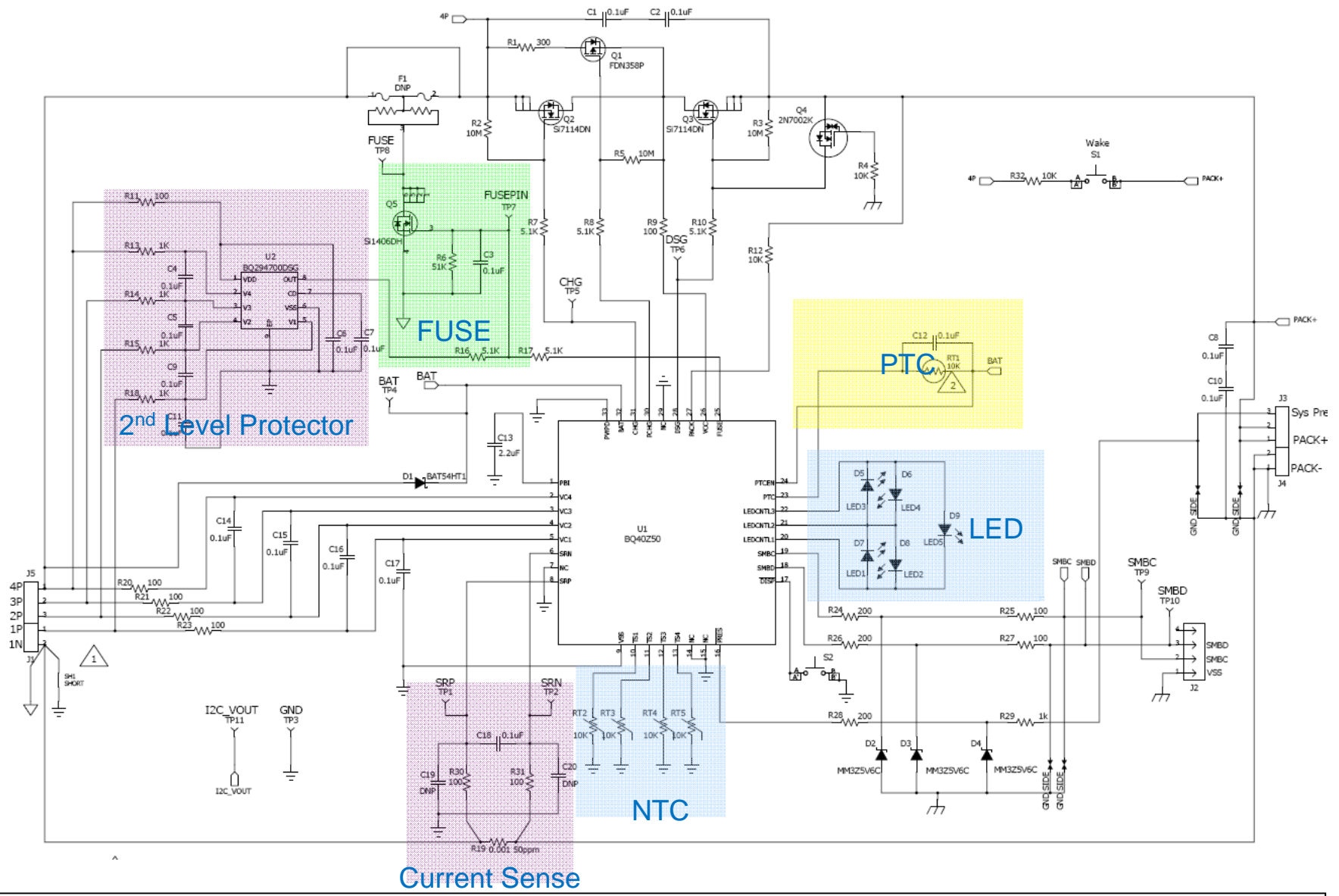
- Business Notebook PCs
- Medical and Test Equipment
- Portable Instruments

Benefits

- Reduce BOM count and PCB area with application flexibility and wide array of safety functions
- Ease of use, high gauging accuracy & complex charging profile support
- Analysis of returned battery packs
- Lower BOM cost
- Reduce BOM count
- Anti-counterfeiting
- For applications requiring LED drivers
- Compact footprint



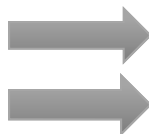
bq40z50 Schematic



The New Tools

bqEvaluation

bqMTester



bqStudio

bqProduction

- **Consistent looks across device families.**
- **No longer required to run the full setup program for each device.
Transfer a 50 kbyte file versus a 50 Mbyte setup program!!**
- **The tools use a standardized evaluation platform and it are customized for each device with a .bqz file.**
- **The chemistry files take much less disk space and are much faster to update.**



bqStudio

Battery Management Studio (bqStudio)

File View AutoCycle Window Help

Registers Data Memory Calibration Chemistry Firmware Advanced Comm SMB Watch Data Graph Errors

Dashboard

EV2300 Version:3.1m

SMB

bq40z50 4500_0_12 Addr: 0x17 23.0 degC

11686 mV 64%

Registers

Registers

Name	Value	Units	Log	Scan
Manufacturer Access	0x6100	hex	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Remaining Cap. Alarm	300	mAh	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Remaining Time Alarm	10	min	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
At Rate	0	mA	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
At Rate Time To Full	65535	min	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
At Rate Time To Empty	65535	min	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
At Rate OK	1	-	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Temperature	23.0	degC	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Voltage	11681	mV	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Current	3	mA	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Average Current	0	mA	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Max Error	100	%	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Relative State of Charge	64	%	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Absolute State of Charge	57	%	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Remaining Capacity	2475	mAh	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Full charge Capacity	3893	mAh	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Run time To Empty	65535	min	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Average Time to Empty	65535	min	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Name	Value	Units	Log	Scan
Cell 4 Current	0	mA	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 1 Power	0	cW	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 2 Power	0	cW	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 3 Power	0	cW	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 4 Power	0	cW	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Power	0	cW	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Average Power	0	cW	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Int Temperature	20.3	degC	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
TS1 Temperature	23.0	degC	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
TS2 Temperature	22.8	degC	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
TS3 Temperature	23.0	degC	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
TS4 Temperature	23.0	degC	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell Temperature	23.0	degC	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
FET Temperature	22.8	degC	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Fit Rem Q	2475	mAh	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Fit Rem E	2663	cWh	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Fit Full Chg Q	3893	mAh	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Fit Full Chg E	4317	cWh	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Name	Value	Units	Log	Scan
PackGrid	0	-	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 1 Grid	0	-	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 2 Grid	0	-	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 3 Grid	0	-	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 4 Grid	0	-	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
StateTime	21	s	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 1 DOD0	6848	-	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 2 DOD0	6768	-	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 3 DOD0	6496	-	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 4 DOD0	0	-	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
DOD0 Passed Q	0	mAh	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
DOD0 Passed E	0	cWh	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
DOD0 Time	0	h/16	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 1 DODEOC	1216	-	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 2 DODEOC	1216	-	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 3 DODEOC	1216	-	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 4 DODEOC	0	-	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Cell 1 QMax	4400	mAh	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Bit Registers

Name	Value	Log	Scan	Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Battery Mode	0x6081	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	CapM	ChgM	AM	RSVD	RSVD	RSVD	PB	CC	CF	RSVD	RSVD	RSVD	RSVD	RSVD	PBS	ICC
Battery Status	0x48C0	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	OCA	TCA	RSVD	OTA	TDA	RSVD	RCA	RTA	INIT	DSG	FC	FD	EC3	EC2	EC1	EC0
Operation Status A	0x6100	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	SLEEP	XCHG	XDSG	PF	SS	SDV	SEC1	SEC0	BTP_INT	RSVD	FUSE	RSVD	PCHG	CHG	DSG	PRES
Operation Status B	0x0000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	RSVD	RSVD	EMSHUT	CB	SLPCC	SLPAD	SMBLCAL	INIT	SLEEPM	XL	CAL_O...	CAL	AUTO...	AUTH	LED	SDM
Temp Range	0x08	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	OT	HT	STH	RT	STL	LT	UT
Charging Status	0x0004	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	CCC	CVR	CCR	VCT	MCHG	SU	IN	HV	MV	LV
Gauging Status	0x00	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	RSVD	RSVD	RSVD	RSVD	RSVD	RSVD	CCC	CVR	CCR	VCT	MCHG	SU	IN	HV	MV	LV
IT Status	0x0004	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	RSVD	RSVD	RSVD	OCVFR	LDMD	RX	QMAX	VDQ	CF	DSG	EDV	BAL_EN	TC	TD	FC	FD
Manufacturing Status	0x0000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	RSVD	RSVD	RSVD	OCVFR	LDMD	RX	QMAX	VDQ	CF	DSG	EDV	BAL_EN	TC	TD	FC	FD
Safety Alert A+B	0x0000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	CAL_EN	LT_TEST	RSVD	RSVD	RSVD	LED_EN	FUSE_EN	BBR_EN	PF_EN	LF_EN	FET_EN	GAUGE...	DSG_T...	CHG_T...	PCHG...	
Safety Status A+B	0x0000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	RSVD	CLVNC	OTD	OTC	ASCDL	RSVD	ASCDL	ASCDL	ASCDL	AOLDL	AOLDL	OCD2	OCD1	OCC2	OCC1	COV
Safety Alert C+D	0x0000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	RSVD	CLVNC	OTD	OTC	ASCDL	ASCDL	ASCDL	ASCDL	AOLDL	AOLDL	OCD2	OCD1	OCC2	OCC1	COV	CLV
Safety Status C+D	0x0000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	RSVD	RSVD	RSVD	RSVD	UTD	UTC	PCHGC	CHGV	CHGC	OC	CTOS	RSVD	PTOS	RSVD	RSVD	OTF
PF Alert A+B	0x0000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	RSVD	RSVD	RSVD	RSVD	UTD	UTC	PCHGC	CHGV	CHGC	OC	CTOS	RSVD	PTO	HWDF	OTF	
PF Status A+B	0x0000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	RSVD	RSVD	RSVD	VIMA	VIMR	CD	IMP	CB	QIM	SOTF	RSVD	SOT	SOC	SOC	SOV	SUV
PF Alert C+D	0x0000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	RSVD	RSVD	RSVD	VIMA	VIMR	CD	IMP	CB	QIM	SOTF	RSVD	SOT	SOC	SOC	SOV	SUV
PF Status C+D	0x0000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	TS4	TS3	TS2	TS1	RSVD	RSVD	OPNCELL	RSVD	RSVD	2LV	AFEC	AFER	FUSE	RSVD	DFETF	CFETF
LSStatus	0	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	TS4	TS3	TS2	TS1	RSVD	DFW	OPNCELL	IFC	PTC	2LV	AFEC	AFER	FUSE	RSVD	DFETF	CFETF



bqProduction

bqProduction SBB

File Admin Window Help

Station Setup Configuration

Configuration

Configure the calibration types and tolerances here

Calibration Types

☒ Cell Voltage ☐ Batt Voltage ☐ Pack Voltage
☐ Temperature ☐ Int Sensor ☐ Ext1 Sensor ☐ Ext2 Sensor ☐ Ext3 Sensor ☐ Ext4 Sensor
☐ Pack Current ☐ Board Offset

Voltage

Reference Gain: 12101 mV
% Error: 20

Current

Sense Resistor: 1.0 mOhm
% Error: 50

Temperature

Max Offset: 25.0 degC

Target Selection

Target: 4500_0_12-bq40z50.bqz
☐ Program Srec ☐ Program DF Image
C:\Users\ao176037\Desktop\40z50.srec

Dynamic Pack Data

☒ Starting Serial No. 1 ☐ Skip on error
☐ Date 2014-08-29 ☐ Use current Date

Configure VTI

VTI Update
☐ Allow VTI Update when Locked

Test Status

☒ Log Test Status to File C:\Users\ao176037\Desktop\40z50.log

Save Configuration

MultiStation Tester

VTI Update

Test Status

Message	Status
Start Test	
Tested	0
Passed	0
Failed	0
Passed/Hour	0

Test Log

Test No.	Station ID	TimeStamp	Serial No.	Error Code
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Design Process

Identify Product Requirements

- No. of series cells
- No. of parallel cells
- Protection required
- Special requirements
- Chemistry

Select Gauging Solution

- Gauging Algorithm
- Protection
- Cell balancing
- Select ChemID

Breadboard Concept

- TI EVMs
- ChemID Verification
- Preliminary Optimization Cycle
- Run test cycles
- Tweak parameters

Develop System Platform

- Custom PCB
- Final Optimization Cycle
- Run test cycles
- Setup golden file

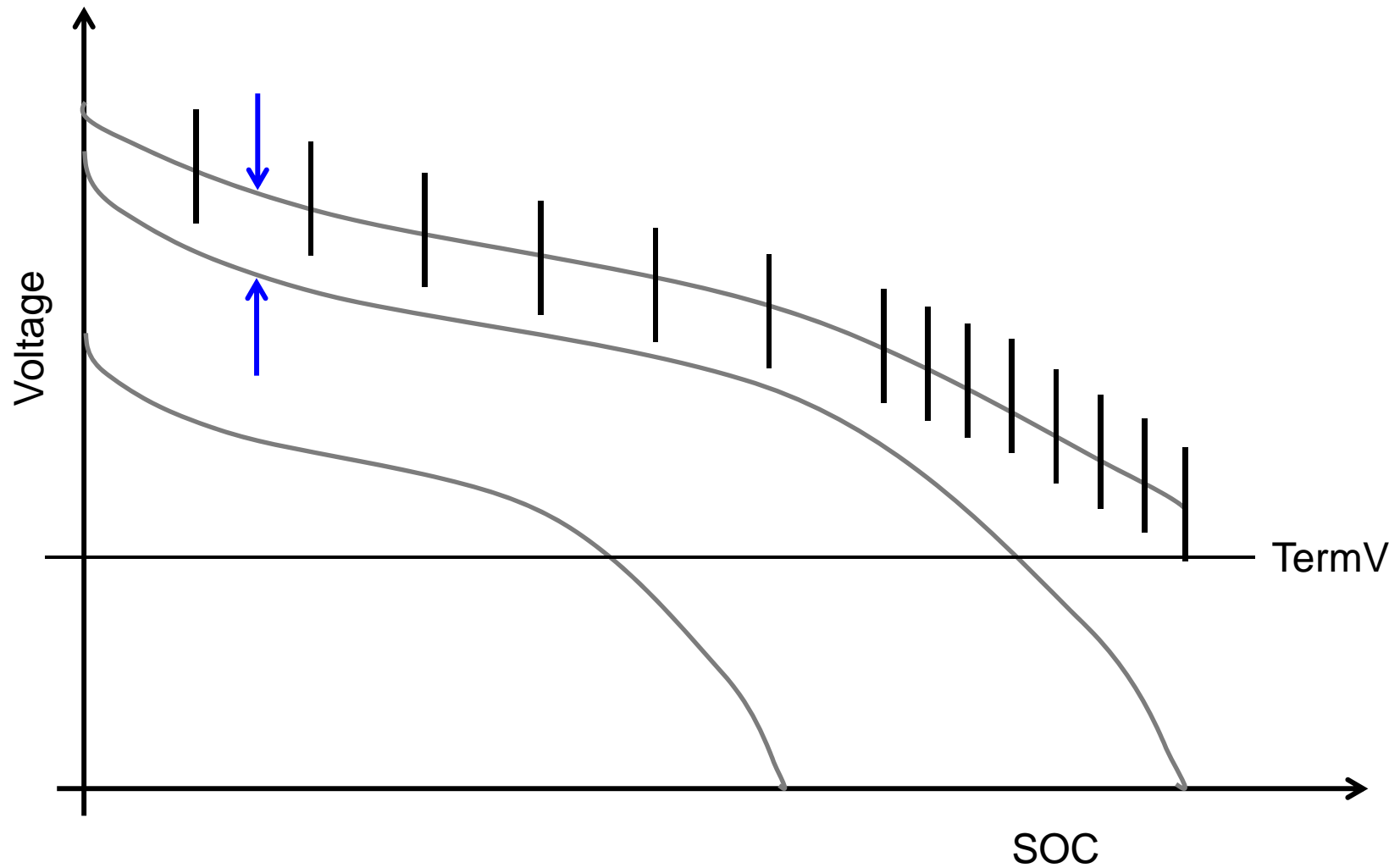
Develop Production Tools

- bqProduction
- bqMTester
- Custom tools

Production



Discharge Rate



SREC File

bqEvaluation Program

file types:

- .senc: Contains the full flash memory.
- .dfi: Contains the full data flash memory.
- .rom: Contains the full data flash memory and header information.
- .gg Contains the data flash parameters that the user can change.
- .chem Contains the chemistry data.

bqStudio Program

file types:

- .srec: Contains the full flash memory. Formatted in industry standard Motorola S-record format.
- .gg.csv: Contains the data flash parameters that the user can change. **Formatted in CSV, but edit with a text editor to import into the device.**
- chemdat2: Contains the chemistry data.
- chemdat4:
- chemdat6:
- chemdat8:



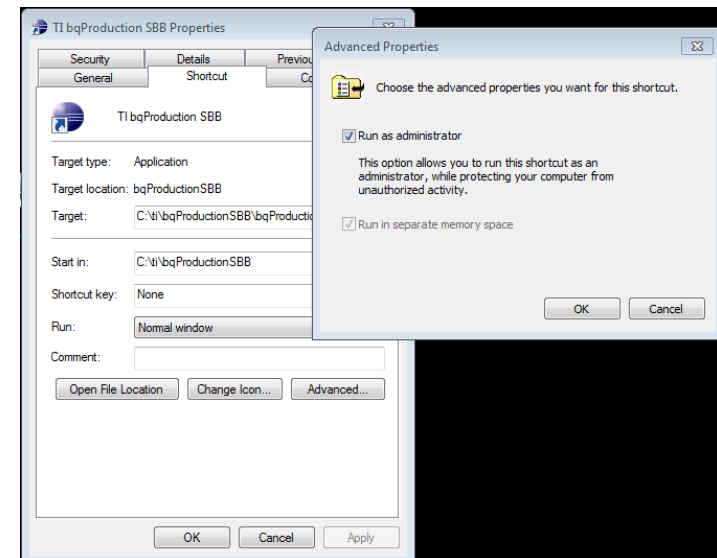
Golden File

- Run the Optimization Cycle to update Qmax and the Ra-table.
- Go to the **Data Flash** window and press the **Read All** button.
- Export the gg.csv file
- Edit the gg.csv file using a text editor. e.g. Notepad. Do not use Excel.
- Set the Update Status to 02 and set the Cycle Count to 0.
- Load the default .srec file into the device.
- Load the ChemID into the device.
- Load your modified gg.csv file into the device and press the Write All button.
- Save the golden .srec file.

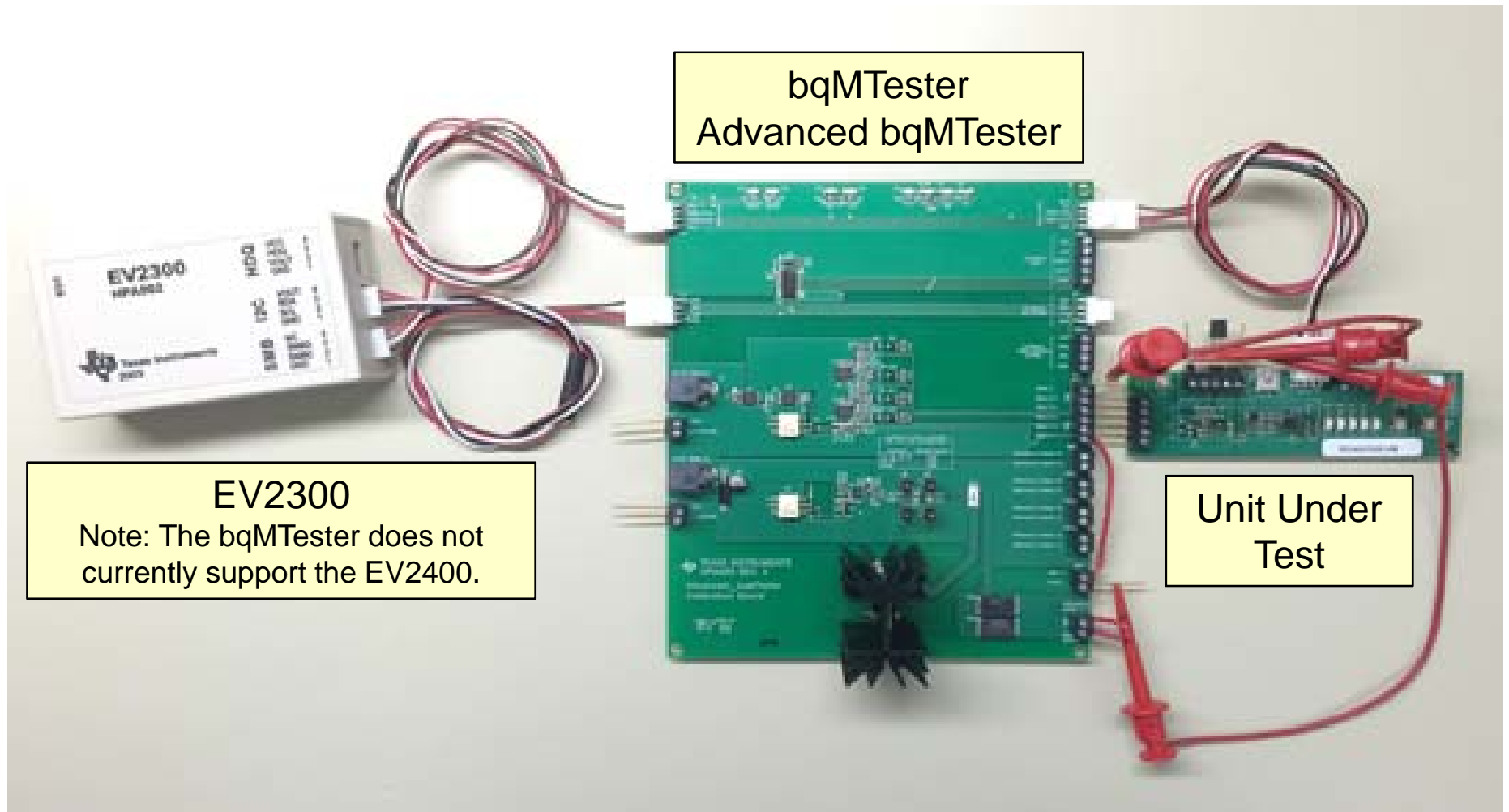


bqProduction

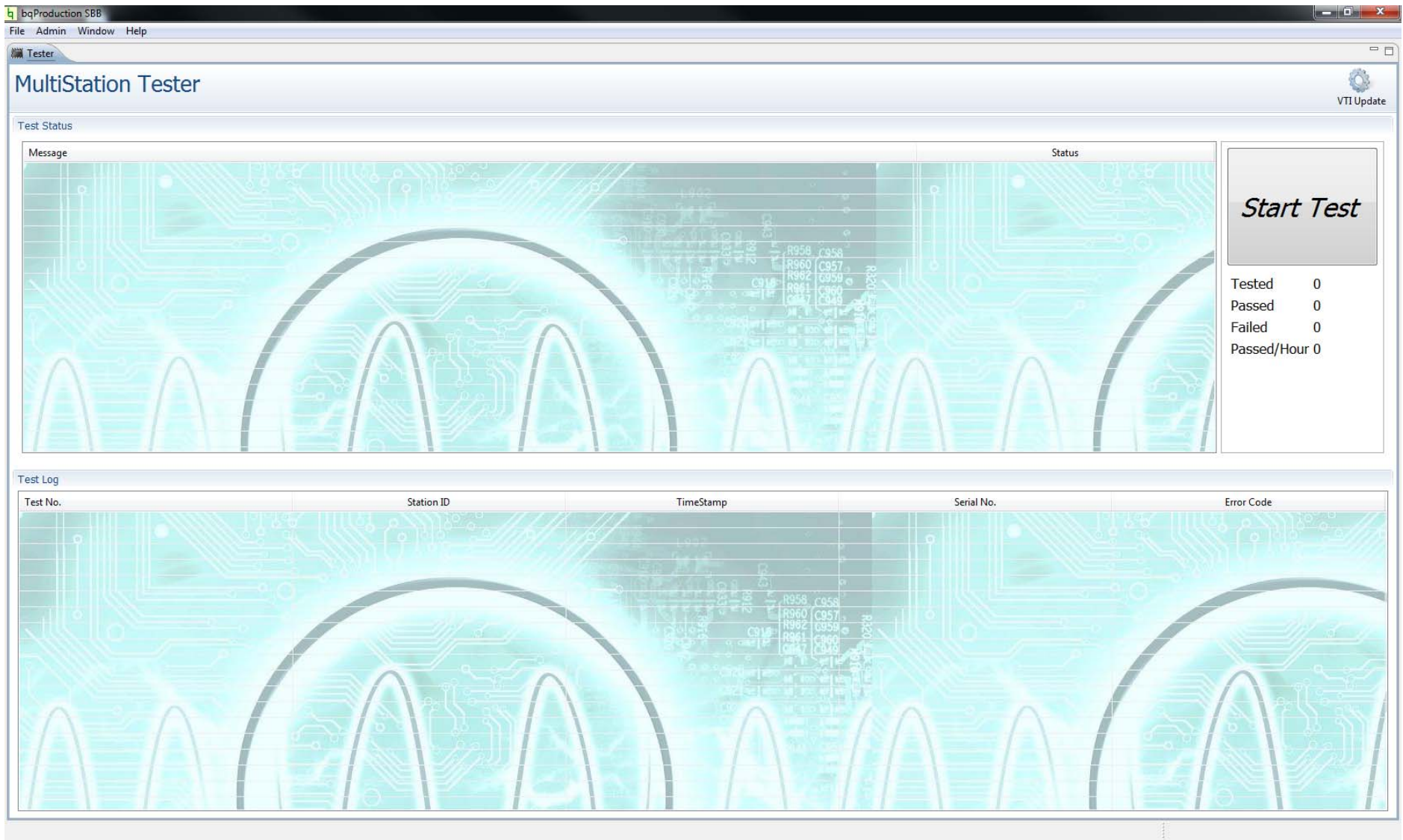
- The bqProduction setup program can be downloaded from the TI website. Search for bqProduction.
- Download and run the setup program.
- The files will be stored at C:\ti\bqProductionSBB.
- The shortcut should get placed on your desktop.
- Right click the icon and select Properties.
- Select Advanced and check the “Run as Administrator” box.
- Select OK to exit the configuration tool.



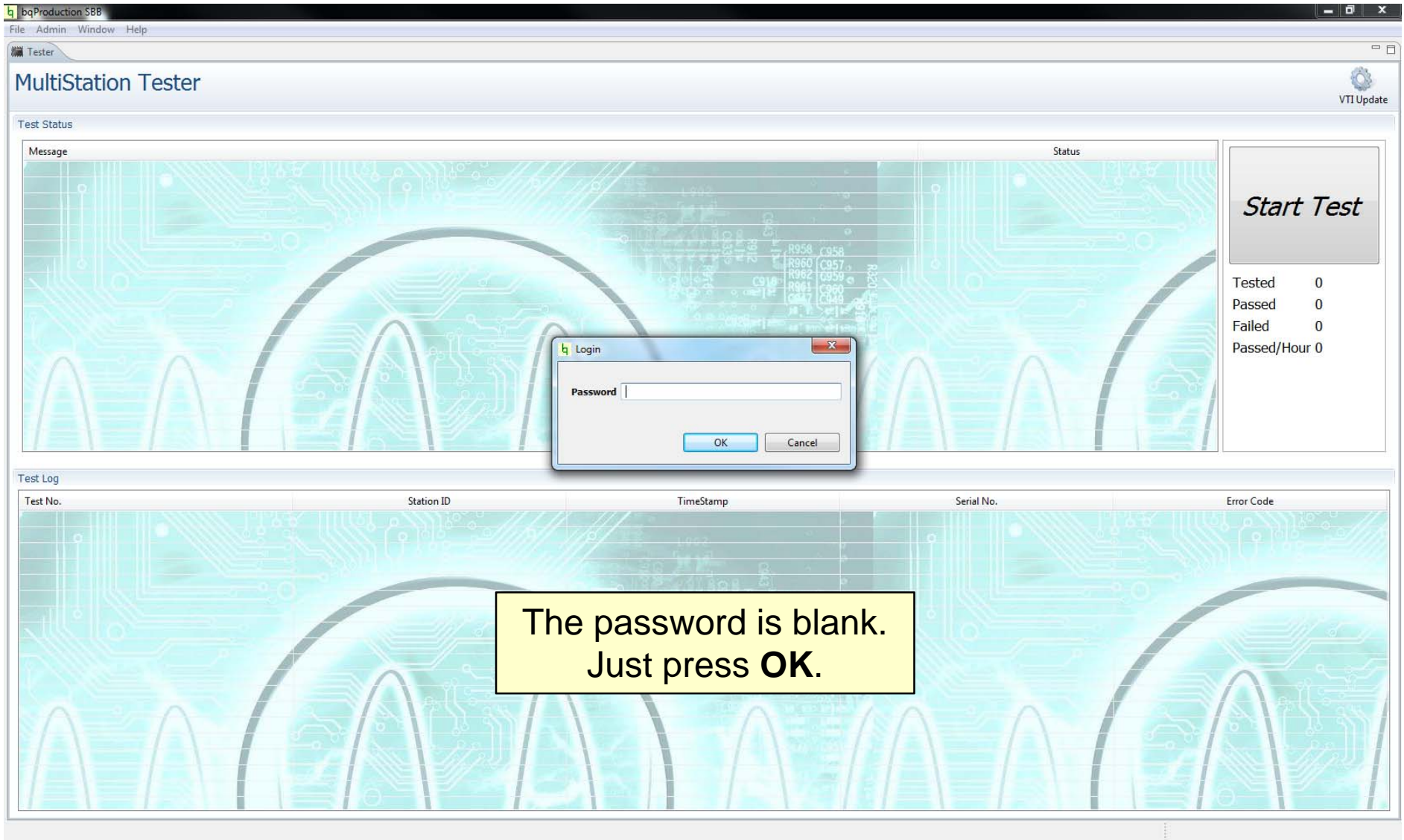
Items Needed



bqProduction



bqProduction



bqProduction

The screenshot displays the bqProduction SBB software interface. The main window is titled "Station Setup" and contains a table for configuring individual stations. The table has columns for "Adapter No.", "Station Id", "Cal Board Found", "Use for Test", and "Flash LED's". The first row shows "Adapter No." 1, "Station Id" bq40z50, "Cal Board Found" with an unchecked checkbox, "Use for Test" with a checked checkbox, and "Flash LED's" with an unchecked checkbox. A yellow callout box with a black border is overlaid on the table, containing three bullet points: "Select the **Scan Boards** button.", "You can rename the **Station list** names", and "Check the **Flash LEDs** box to verify the setup." To the right of the main window is a smaller window titled "MultiStation Tester". It has a "Test Status" section with a "Start Test" button and a table showing "Tested", "Passed", "Failed", and "Passed/Hour" all at 0. Below this is a "Test Log" section with a table header: "Test No.", "Station ID", "TimeStamp", "Serial No.", and "Error Code". The background of the software interface features a circuit board pattern.

- Select the **Scan Boards** button.
- You can rename the **Station list** names
- Check the **Flash LEDs** box to verify the setup.



bqProduction

The screenshot displays the bqProduction SBB software interface. The main window is titled "Configuration" and contains sections for "Calibration Types", "Voltage", "Current", "Dynamic Pack Data", "VTI Update", and "Test Status". A "VTI Configuration (1 of 1)" dialog box is open, showing fields for "Station Name", "Voltage", "Current", and "Temperature". The "Voltage" section includes "Cell", "Batt", and "Pack" values. The "Temperature" section includes "Int", "Ext1", "Ext2", "Ext3", and "Ext4" values. The "Current" section includes a "Current" value. The "VTI Update" section includes a "VTI Update" checkbox and a "Set VTI Password" button. The "Test Status" section includes a "Log Test Status to File" checkbox and a file path.

Calibration Types

- ☒ Cell Voltage
- ☒ Batt Voltage
- ☒ Pack Voltage
- ☒ Temperature
- ☒ Int Sensor
- ☒ Ext1 Sensor
- ☒ Ext2 Sensor
- ☒ Ext3 Sensor
- ☒ Ext4 Sensor
- ☒ Pack Current
- ☒ Board Offset

Voltage

Reference Gain: 12101
% Error: 20

Current

Sense Resistor: 1.0
% Error: 50

Dynamic Pack Data

☒ Starting Serial No. 2
☐ Date: 2014-08-29

VTI Configuration (1 of 1)

Station Name: bq40z50

Voltage

Cell: 8722 mV
Batt: 14735 mV
Pack: 14731 mV

Temperature

Int: 24.0 degC
Ext1: 25.0 degC
Ext2: 25.0 degC
Ext3: 25.0 degC
Ext4: 25.0 degC

Current

Current: -2000 mA

VTI Update

☒ Allow VTI Update when Locked
Set VTI Password

Test Status

☒ Log Test Status to File: C:\Users\ao176037\Desktop\40z50.log

MultiStation Tester

Test Status

Message Status

Start Test

Tested: 0
Passed: 0
Failed: 0
Passed/Hour: 0

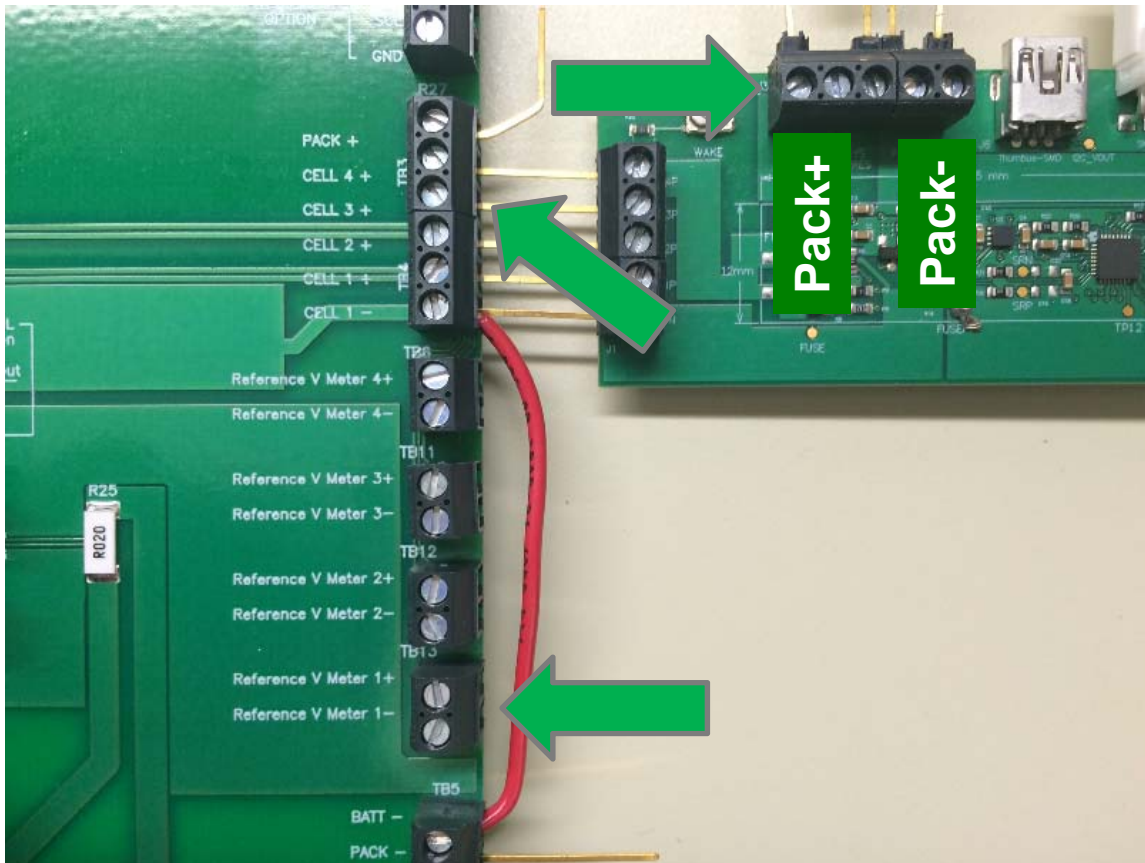
Test Log

Test No.	Station ID	TimeStamp	Serial No.	Error Code
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- Select the parameters to be calibrated.
- Press the **Save Configuration** button.
- Press the **Configure VTI** button and update the parameters.



bqProduction



Voltage Calibration:

Measure the Cell Voltage from CELL1+ to CELL1- or the Cell1 Reference V meter port.

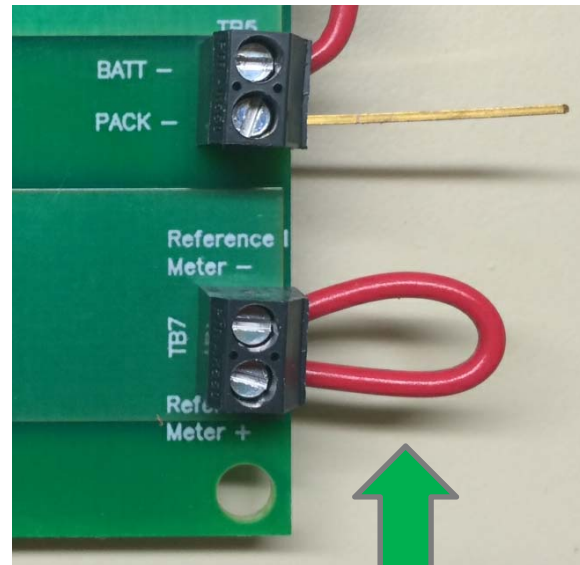
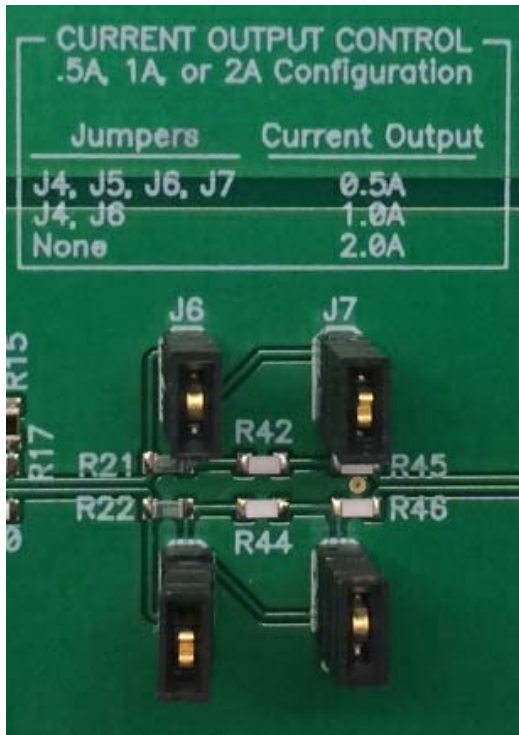
Measure the Battery Voltage from CELL1- to PACK+.

Measure the Pack Voltage from Pack+ to Pack-.

Enter the data into the **Configure VTI** screen.



bqProduction



Replace shunt with
current meter.

Current Calibration:

Set the CURRENT OUTPUT CONTROL jumpers to select the calibration current.

Replace the TB7 shunt with a current meter.

Measure the discharge current.

Enter the data into the **Configure VTI** screen.



bqProduction

The screenshot displays the bqProduction SBB software interface. The main window is titled "Configuration" and contains sections for "Calibration Types", "Voltage", "Current", and "Dynamic Pack Data". A "VTI Configuration (1 of 1)" dialog box is open, showing fields for "Station Name", "Voltage", "Current", and "Temperature". The "Finish" button is highlighted in the dialog box. A yellow box with the text "Select the **Finish** button." points to the "Finish" button. The background of the main window shows a circuit board pattern.

Configuration

Configure the calibration types and tolerances here

Calibration Types

- ☒ Cell Voltage
- ☒ Batt Voltage
- ☒ Pack Voltage
- ☒ Temperature
- ☒ Int Sensor
- ☒ Ext1 Sensor
- ☒ Ext2 Sensor
- ☒ Ext3 Sensor
- ☒ Ext4 Sensor
- ☒ Pack Current
- ☒ Board Offset

Voltage

Reference Gain: 12101

% Error: 20

Current

Sense Resistor: 1.0

% Error: 50

Dynamic Pack Data

☒ Starting Serial No. 2

☐ Date: 2014-08-29

VTI Configuration (1 of 1)

Station Name: bq40z50

Voltage

Cell: 8722 mV

Batt: 14735 mV

Pack: 14731 mV

Temperature

Int: 24.0 degC

Ext1: 25.0 degC

Ext2: 25.0 degC

Ext3: 25.0 degC

Ext4: 25.0 degC

Current

-2000 mA

Buttons: Previous, **Finish**, Cancel

VTI Update

☒ Allow VTI Update when Locked

Set VTI Password

Test Status

☒ Log Test Status to File: C:\Users\ao176037\Desktop\40z50.log

MultiStation Tester

Test Status

Message: Status

Start Test

Tested: 0

Passed: 0

Failed: 0

Passed/Hour: 0

Test Log

Test No.	Station ID	TimeStamp	Serial No.	Error Code
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bqProduction

bqProduction SBB

File Admin Window Help

Tester

MultiStation Tester

VTI Update

Test Status

Message

Operation executed successfully.

Status

Passed

Start Test

Tested 2
Passed 2
Failed 0
Passed/Hour 94

Test Log

Test No.	Station ID	TimeStamp	Serial No.	Error Code
1	Station 1	2014-10-08 09:03:44.267	2	0
2	Station 1	2014-10-08 09:04:09.837	3	0

Select the Start Test button to execute the test.



Demonstration

bqProduction





Questions

