HPA603 (>7-cell Li-ion/LiFePO4 battery charger) evaluation

1. Introduction

EVM Features

- **Evaluation Module for High Voltage Synchronous Buck Charger with bq24610/bq24630**
- **User-programmable up to 50V Battery Voltage and 5A charging current**
- **Input Operating Range up to 57V**
- **Test Points for Key Signals Available for Testing Purpose. Easy Probe Hook-up.**
- **Jumpers Available. Easy to Change Connections.**
- **The input voltage range is limited by the Input bias supply circuit. The charging voltage range is limited by the charging current sensor. If charger needs a higher input voltage or a higher charging voltage, please change those circuits.**

If need a 16 cell battery charger with 80V input, Please update those components and circuits:

Change list:	**VCC bias supply**	**Current sense circuit**	**U4B input OVP**	**R23 (Vbat setting)**	**L1 value (Keep ΔI)**	**Power FET**
HPA603 schematic (figure1)	**TPS54060**	**INA169**	**R7 23.2k (57V OVP)**	**R23: 464k**	**22uH**	**80V Si7852**
80Vin/16cell Li-ion battery Charger schematic (FYI only)	**Any 100V input; 10Vout@150mA bias supply**	**ZDS1009**	**R7 174k (100V OVP)**	**R23: 953k**	**47uH**	**100V SiR846**

General Description

The bq24610 is highly integrated Li-ion or Li-polymer switch-mode battery charge controllers. The bq24630 is highly integrated switch-mode battery charge controllers designed specifically to charge Lithium Phosphate battery chemistries.

This EVM offer a constant-frequency synchronous PWM controller with high accuracy charge current and voltage regulation, termination, charge preconditioning, and charge status monitoring,

This EVM charges the battery in three phases: preconditioning, constant current, and constant voltage. Charge is terminated when the current reches a minimum user-selectable level. A programmable charge timer provides a safety backup for charge termination. It automatically restarts the charge cycle if the battery voltage falls below an internal threshold, and shuts down when the input voltage falls below the battery voltage.

I/O Description

Table 1: I/O description

Jack	Description
J1–VIN	positive input
J1–GND	Input ground
J2–TS1	Temperature Qualification bias Voltage
J2–TS	Temperature Qualification Voltage Input
J2–GND	Ground
J2–BAT	Connected to battery pack
JP1– VREF	3.3V VREF

JP1– CHGEN	Charge enable pin

Controls and Key Parameters Setting

Recommended Operating Conditions

Table 2: Recommended Operating Conditions

Jack	Description	Factory Setting
JP1	CHGEN is pulled low and the output is disabled when Jumper is on.	Jumper On

Symbol	Description	Minimum	Typical	Maximum	Unit	Notes
Supply voltage, V_{IN}	Input voltage from ac adapter input	35	48	57	V	
Battery voltage, V_{BAT}	Voltage applied at VBAT terminal	8.4	33.6		V	
Supply current, I_{AC}	Maximum input current from input	0		4.5	A	
Charge current, I_{chrg}	Battery charge current	2	3	5	A	
Operating junction temperature range, T_J		0		125	°C	

2. Schematic

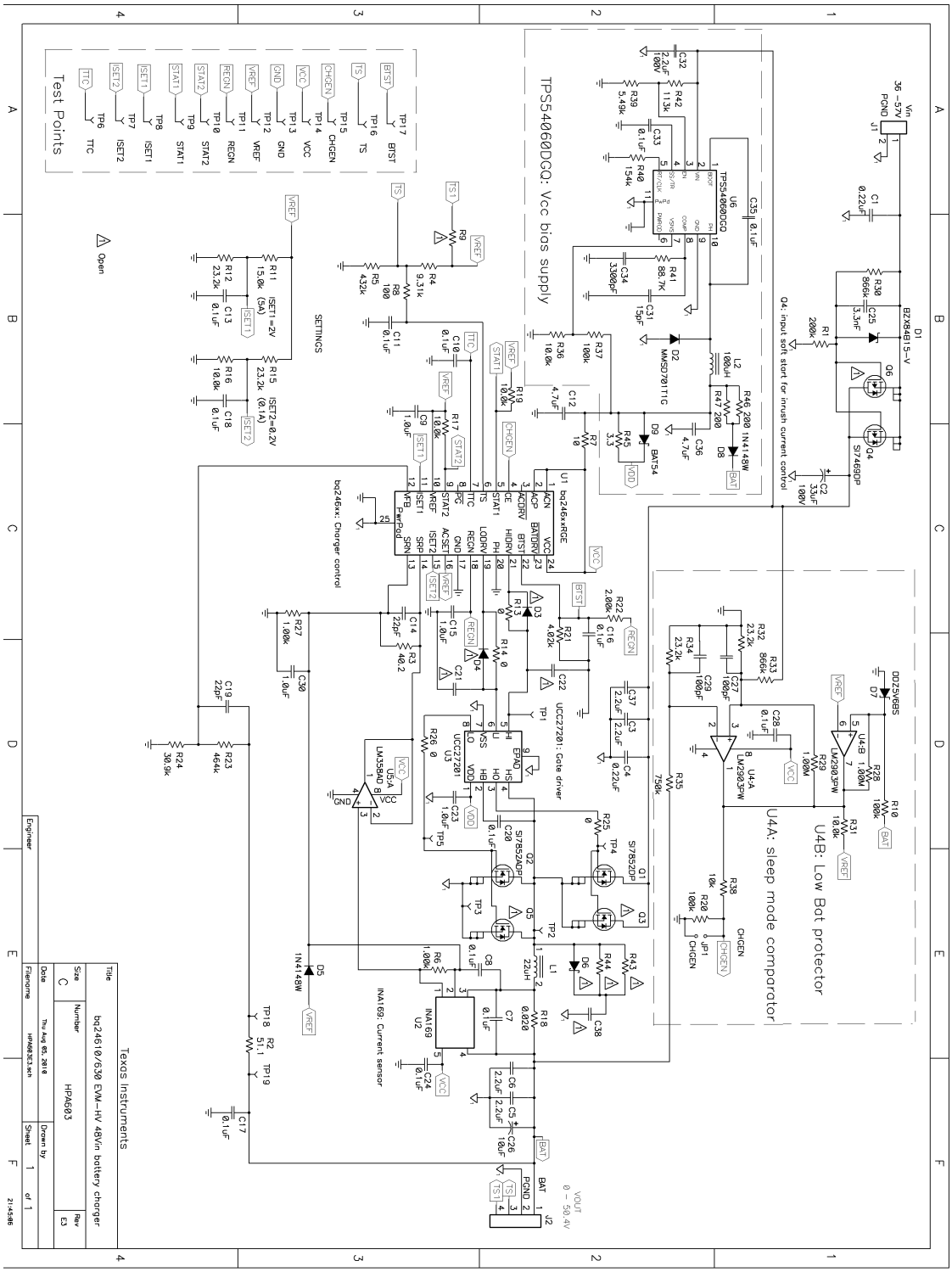


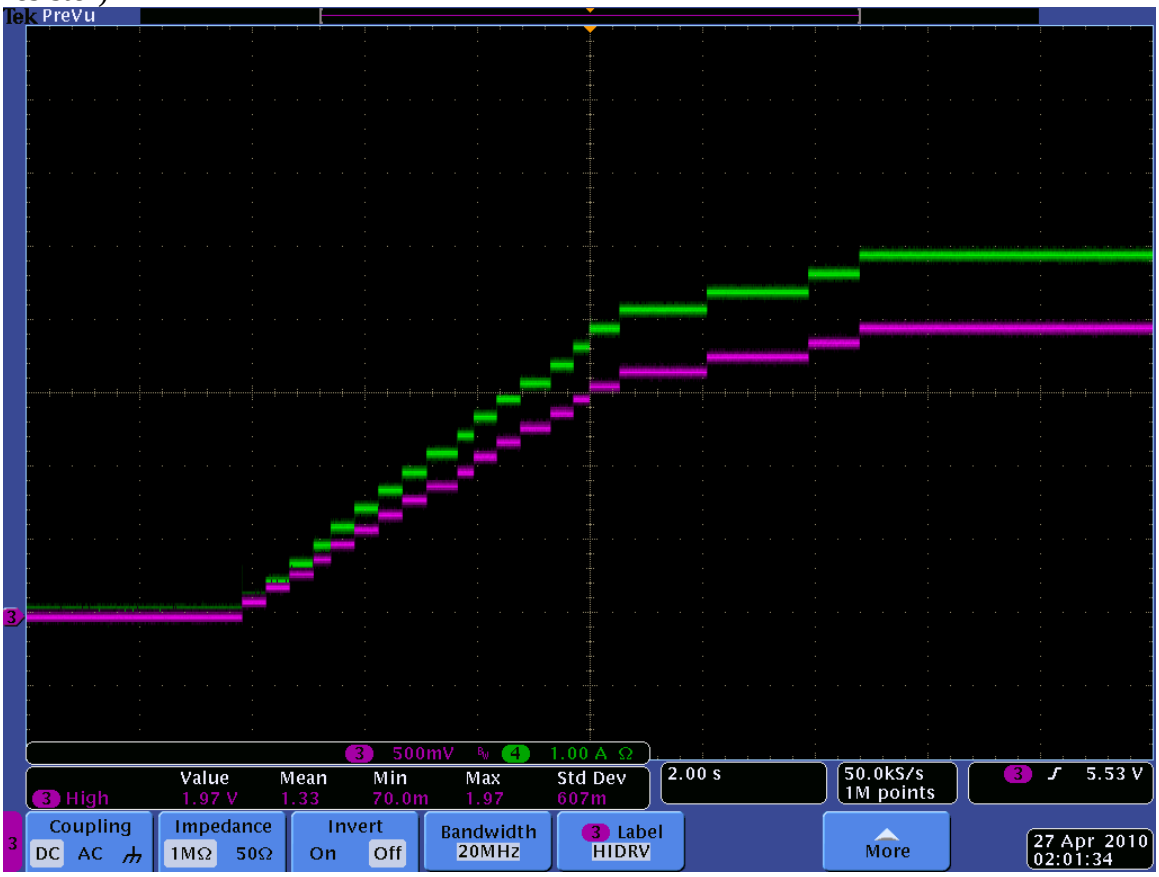
Figure 1: HPA603 schematic
57Vin 8-cell Li-ion battery charger

3. Test result

3.1 ISET1 control IBAT

3.1.1 ISET1 vs IBAT waveform

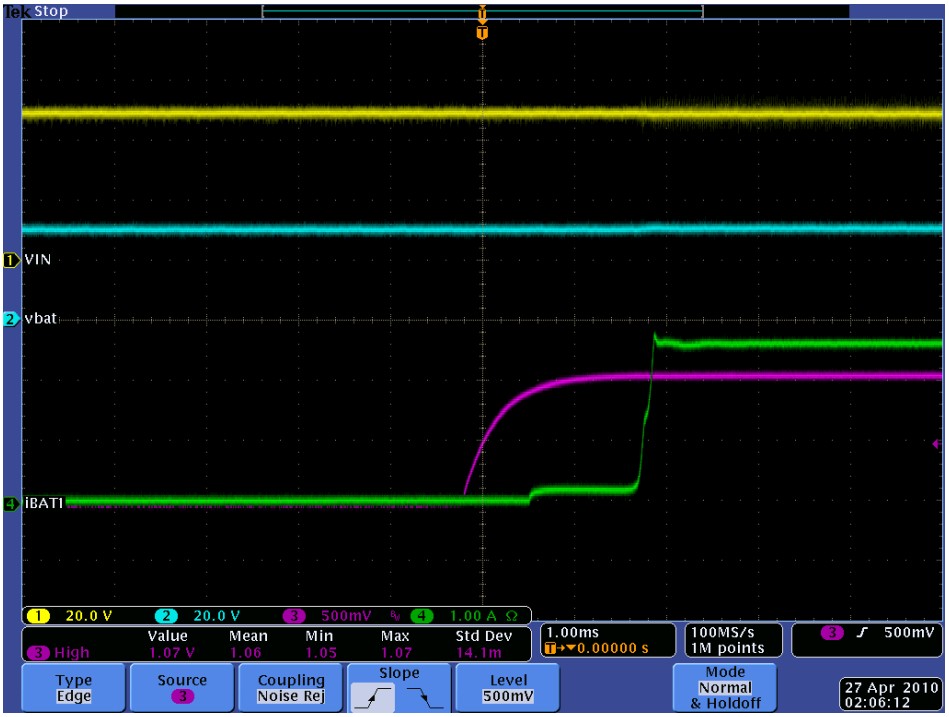
IBAT are proportional to ISET1. The ratio follows the datasheet equation.
Ch3 (Pink): From 0V to 2V. Ch4 (Green): From 0A to full range 5A (20mohm sense resistor)



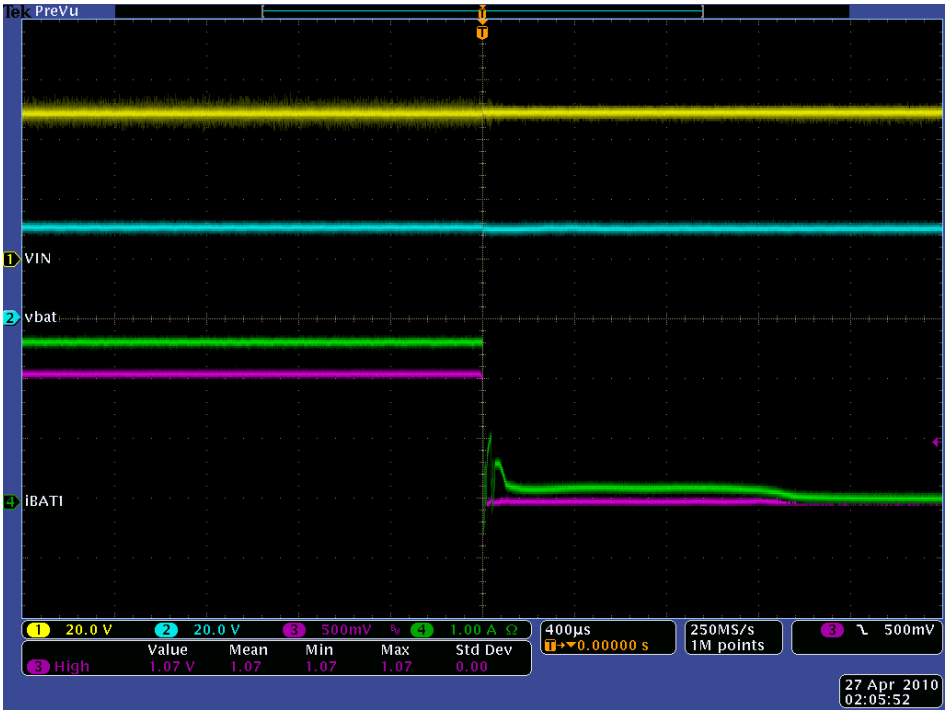
3.1.2 ISET1 transient

Ch1 (yellow): Vin; Ch2 (blue): Vbat; Ch3 (pink): ISET1; ch4 (green): IBAT

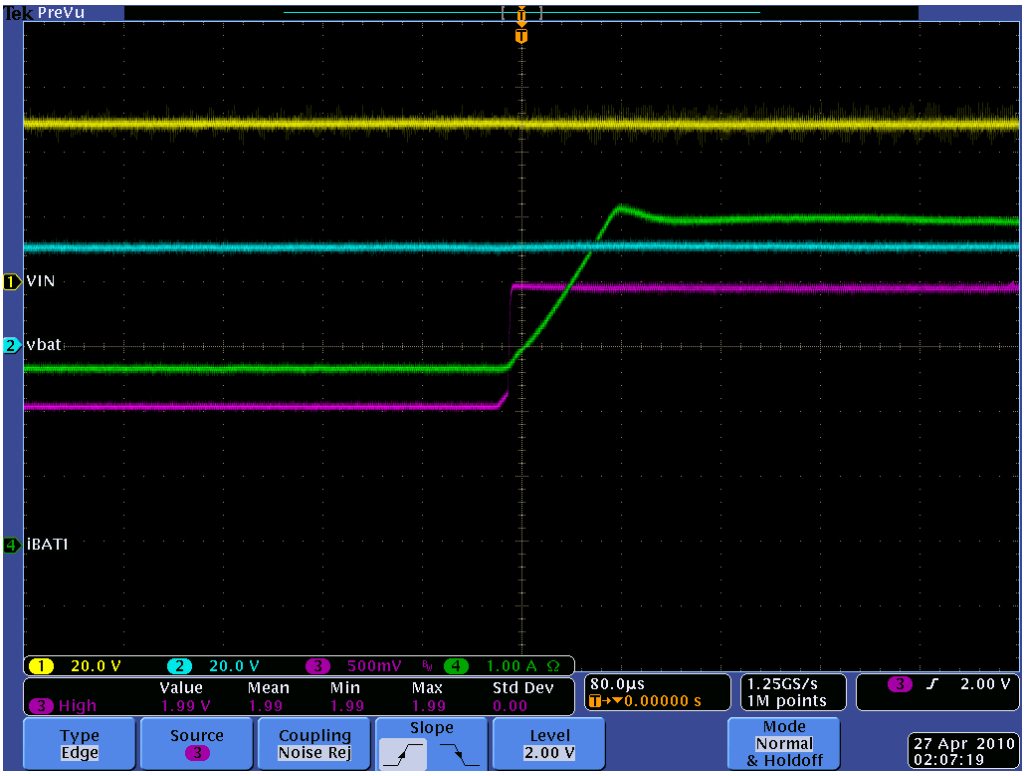
ISET1 from 0V to 1V



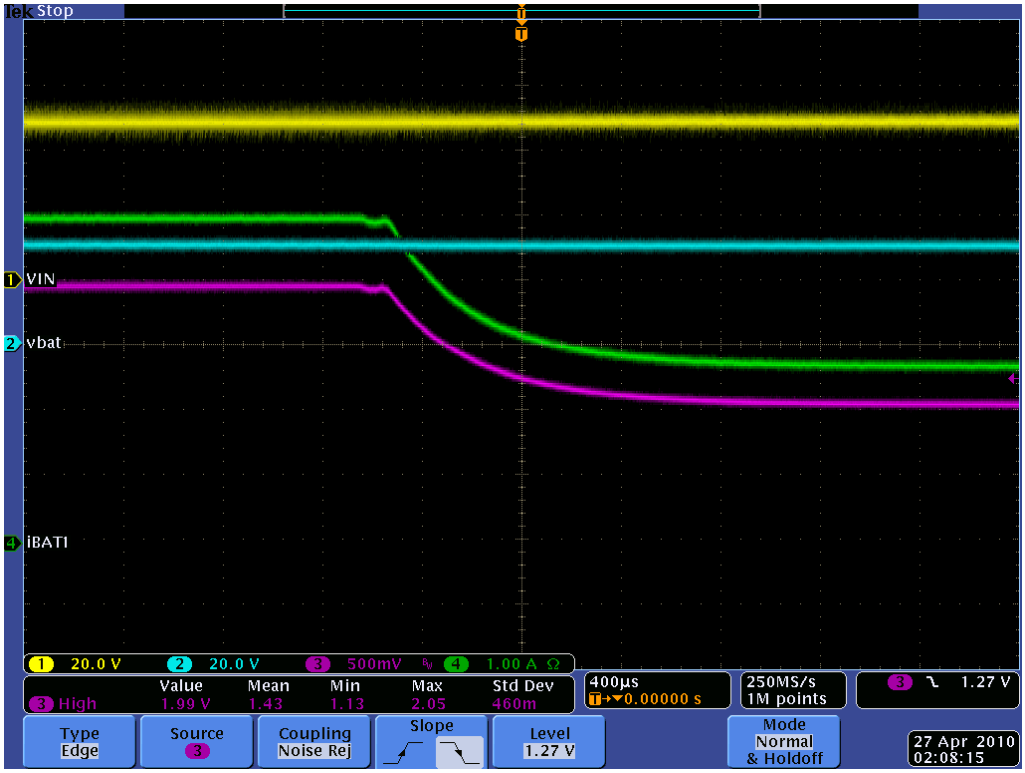
ISET1 from 1V to 0V



ISET1 from 1V to 2V



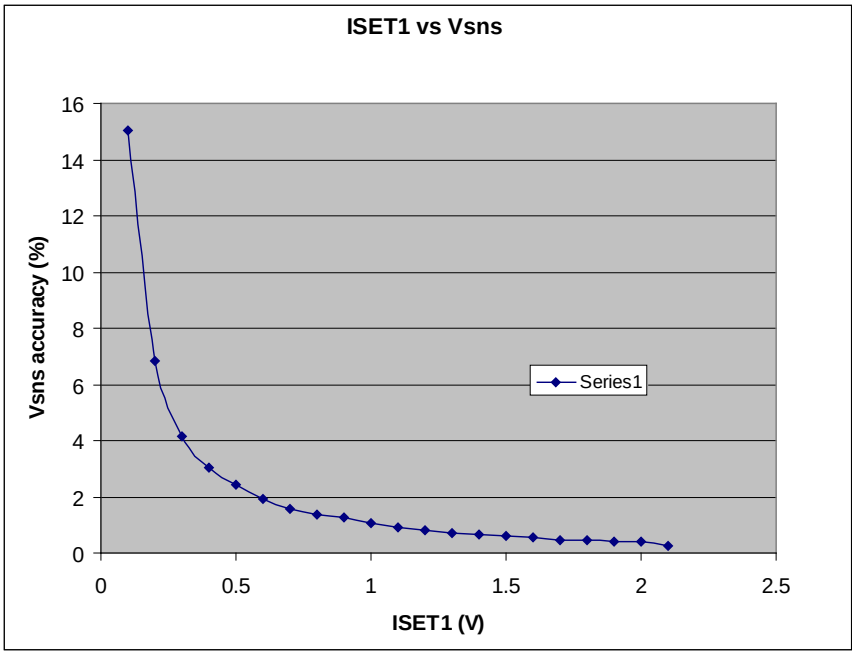
ISET1 from 2V to 1V



3.1.3 ISET1 accuracy

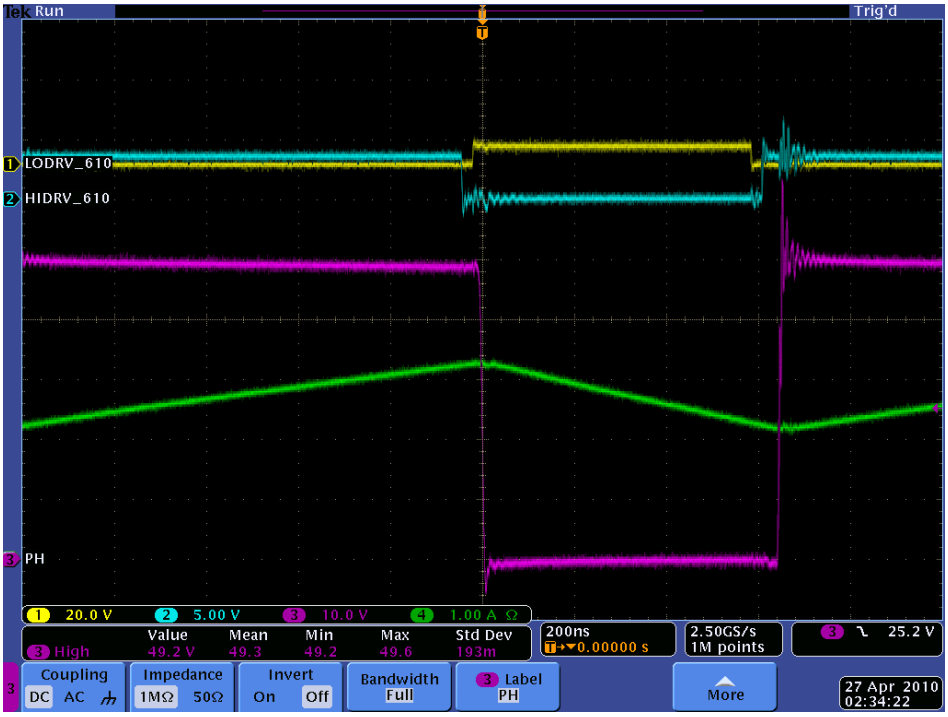
Vin=48V; Vout=32V; Rsense=20mohm

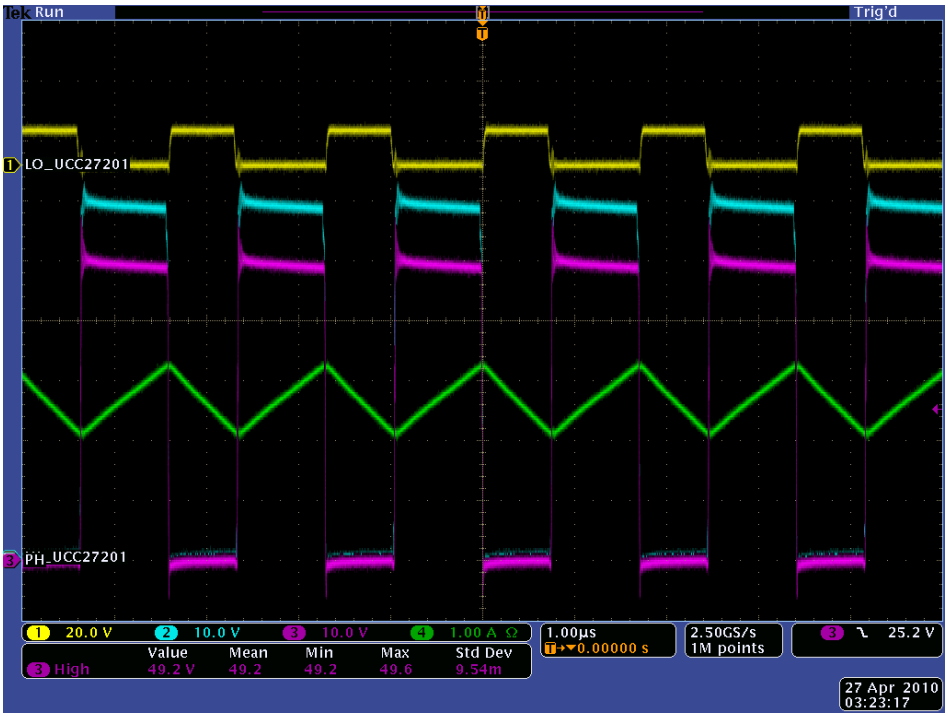
ISET1/V	Vsns/mV	ISET1 set Vsns/mV	Accuracy
2.3	110.41	115	-3.9913
2.2	109.02	110	-0.89091
2.1	105.24	105	0.228571
2	100.38	100	0.38
1.9004	95.39	95.02	0.389392
1.8002	90.4	90.01	0.433285
1.7003	85.42	85.015	0.476387
1.6001	80.44	80.005	0.543716
1.5	75.44	75	0.586667
1.3999	70.45	69.995	0.650046
1.2997	65.46	64.985	0.730938
1.1996	60.47	59.98	0.816939
1.0997	55.49	54.985	0.918432
0.9996	50.5	49.98	1.040416
0.899	45.51	44.95	1.245829
0.7994	40.52	39.97	1.376032
0.699	35.49	34.95	1.545064
0.599	30.52	29.95	1.903172
0.499	25.555	24.95	2.42485
0.399	20.558	19.95	3.047619
0.299	15.57	14.95	4.147157
0.1988	10.62	9.94	6.841046
0.09874	5.68	4.937	15.04963

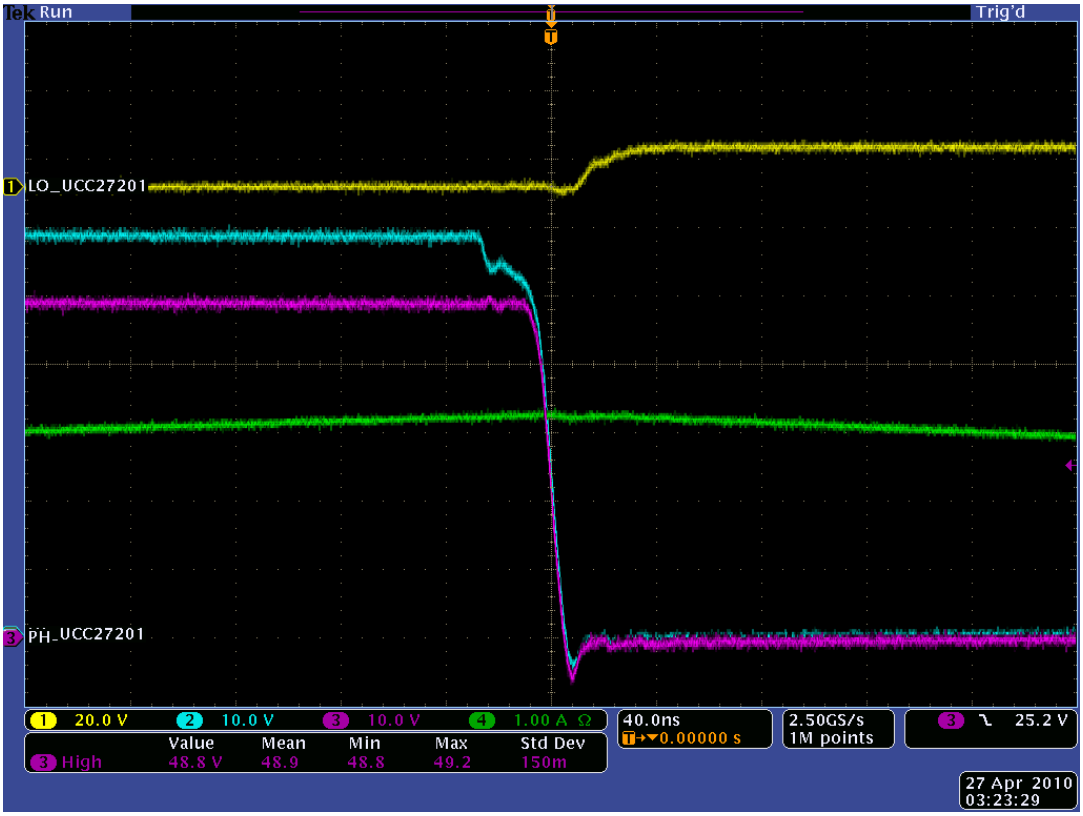


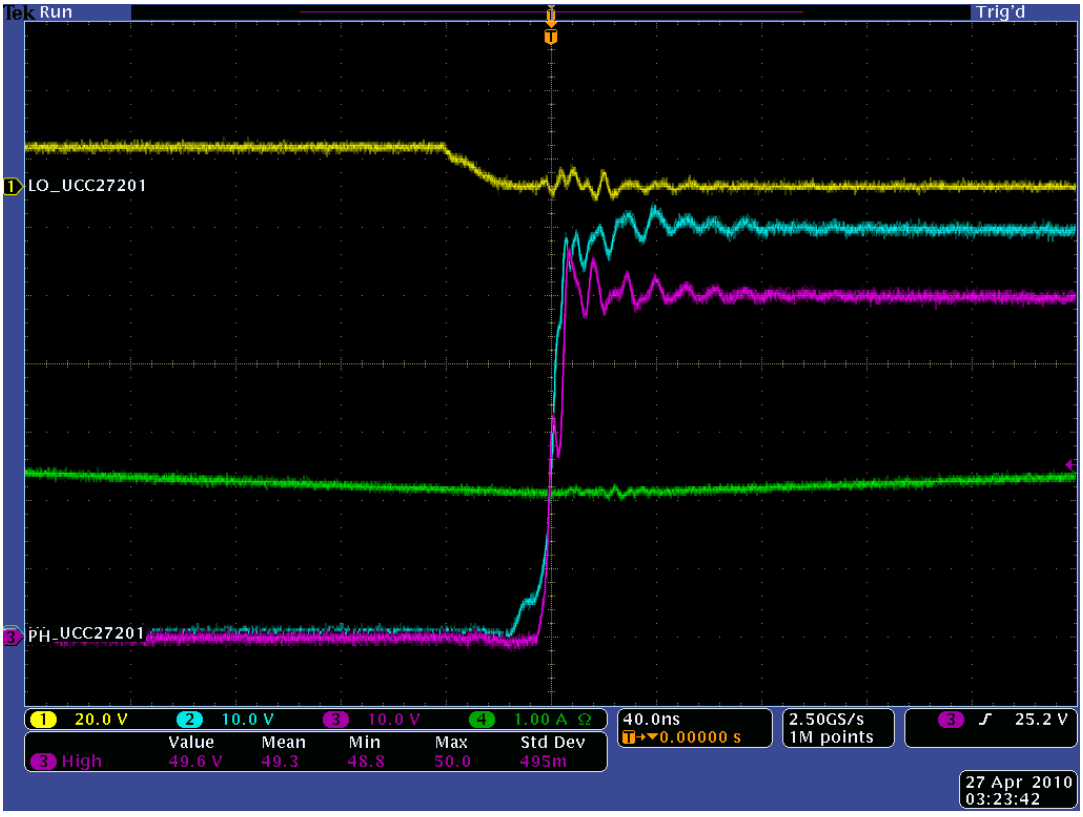
3.2 Switching waveform

Ch1 (yellow): LODRV; Ch2 (blue): HIDRV; Ch3 (pink): PH; ch4 (green): IL



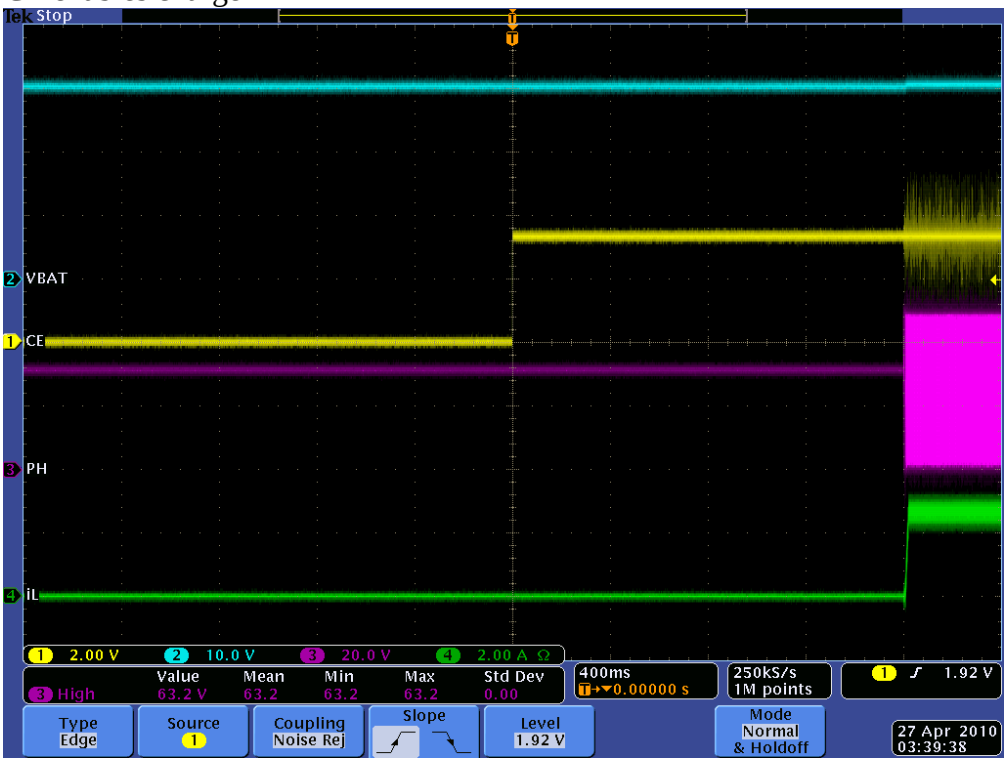



Tek Run
Trig'd
LO_UCC27201
PH_UCC27201
1 20.0 V
2 10.0 V
3 10.0 V
4 1.00 A Ω
Value Mean Min Max Std Dev
3 High 48.8 V 48.9 48.8 49.2 150m
40.0ns
0.00000 s
2.50GS/s
1M points
3 25.2 V
27 Apr 2010
03:23:29

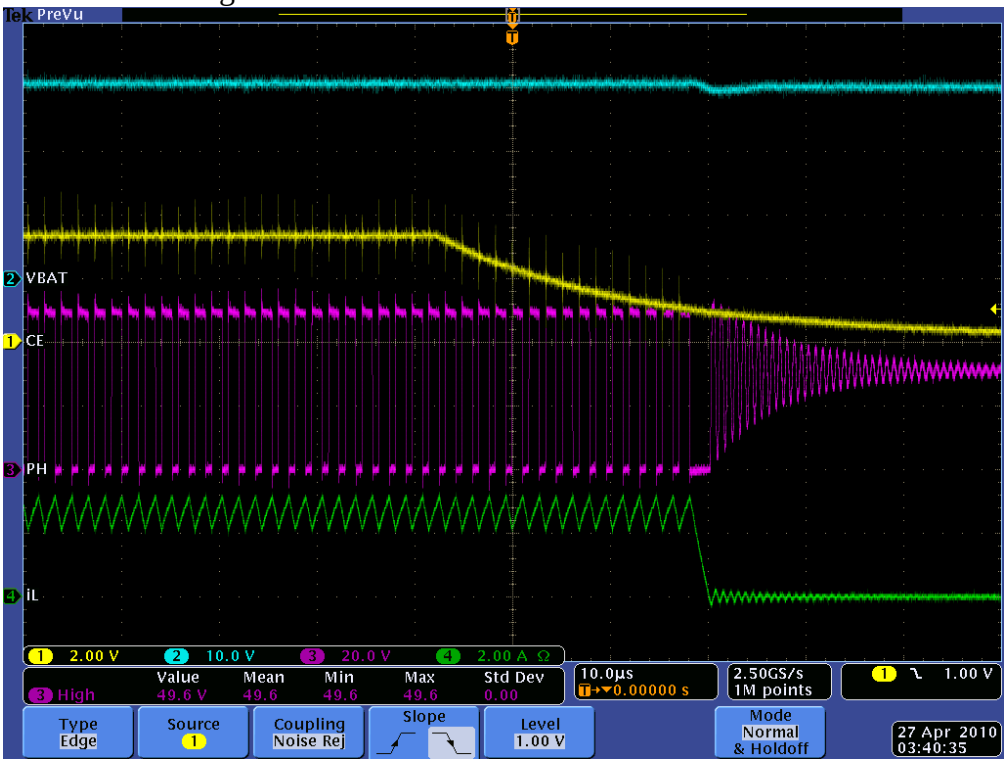

Tek Run
Trig'd
LO_UCC27201
PH_UCC27201
1 20.0 V
2 10.0 V
3 10.0 V
4 1.00 A Ω
Value Mean Min Max Std Dev
3 High 49.6 V 49.3 48.8 50.0 495m
40.0ns
0.00000 s
2.50GS/s
1M points
3 25.2 V
27 Apr 2010
03:23:42

3.3 Charger start-up or shut-down with CE control

CE enables charge



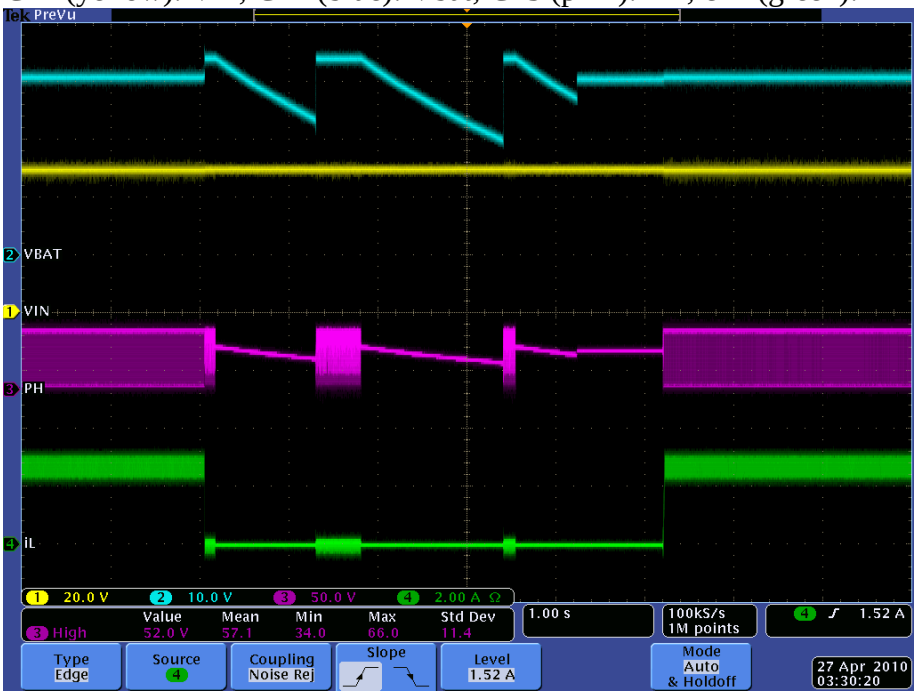
CE disables charge



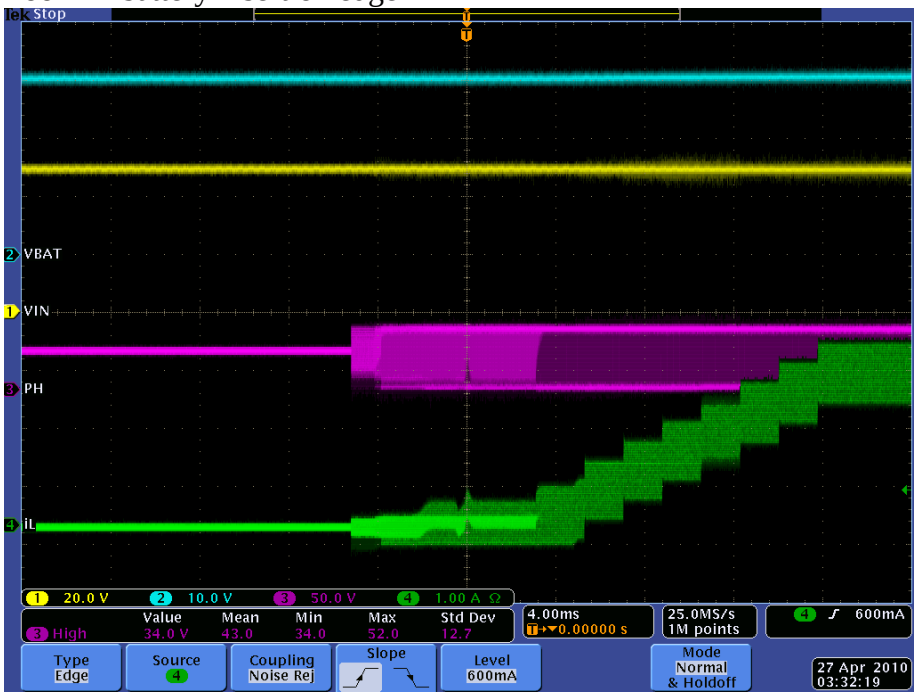
3.4 Battery insertion and removal

Battery removal and then insertion

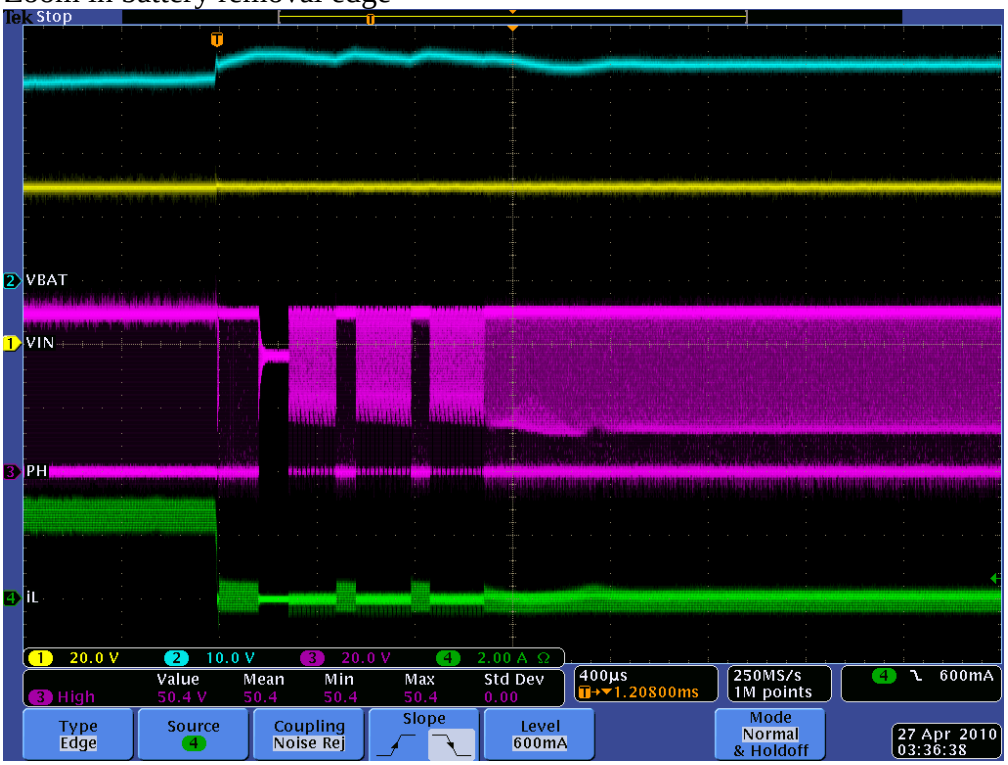
Ch1 (yellow): Vin; Ch2 (blue): Vbat; Ch3 (pink): PH; ch4 (green): IL



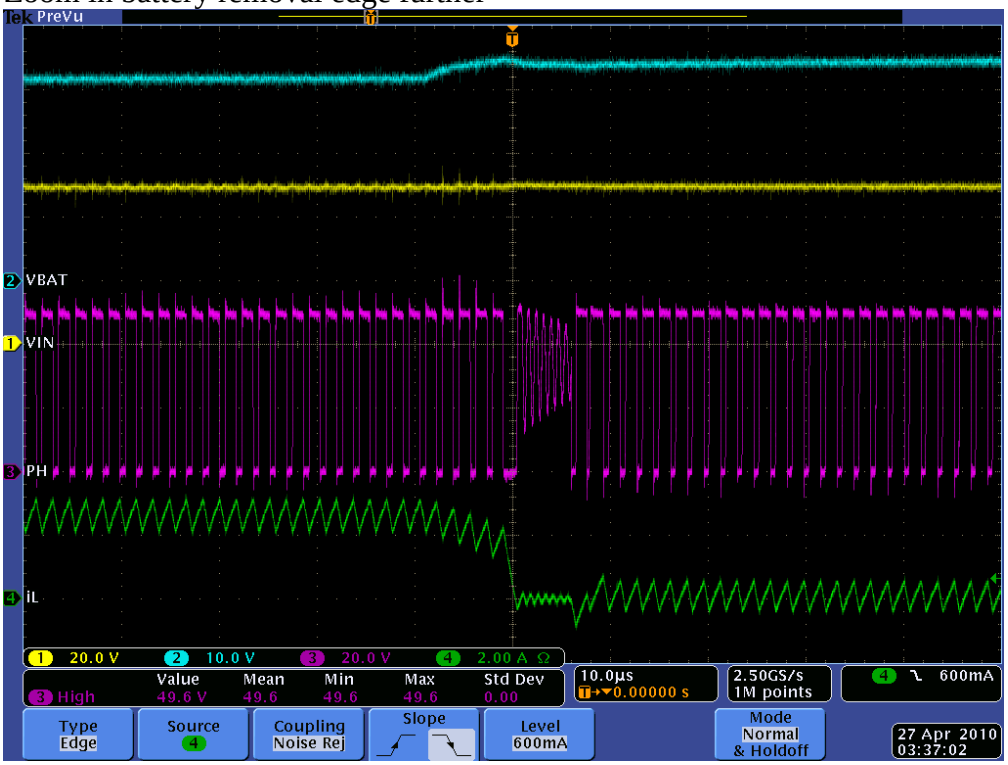
Zoom in battery insertion edge



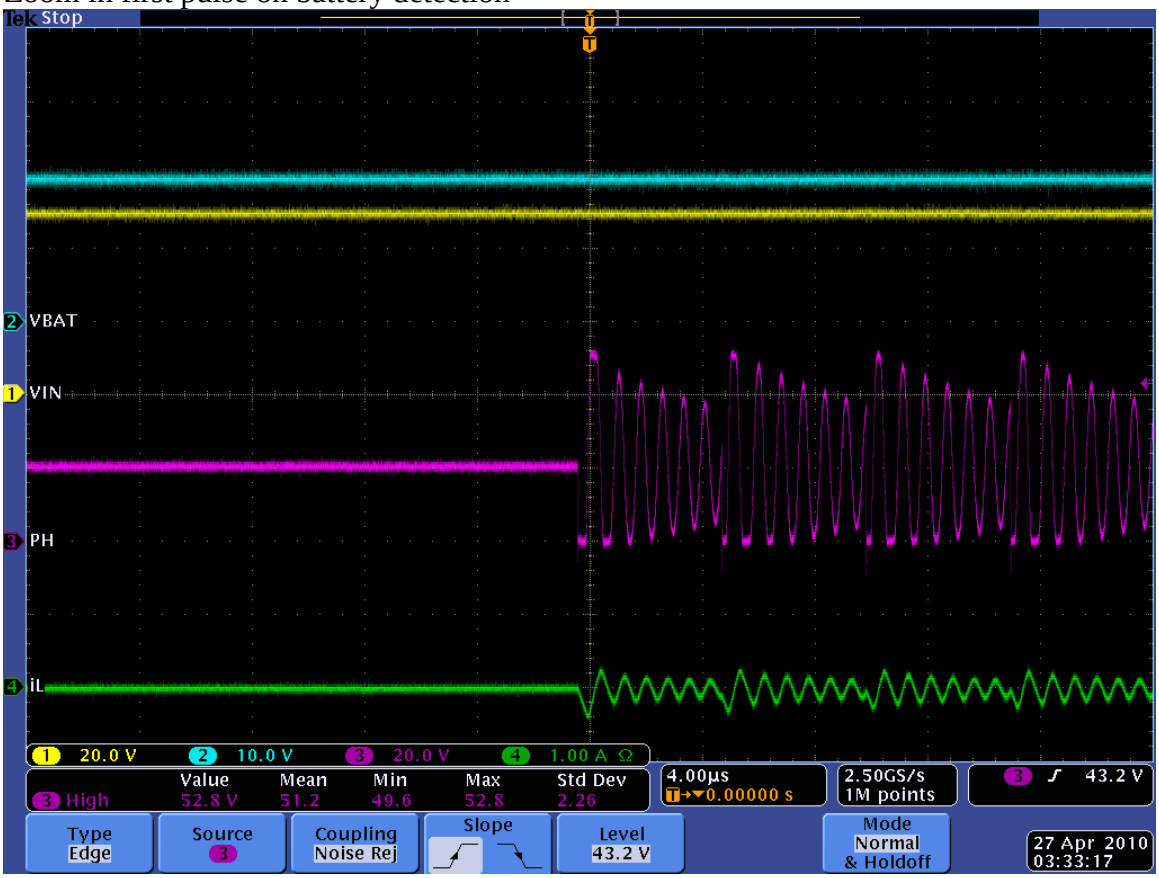
Zoom in battery removal edge



Zoom in battery removal edge further



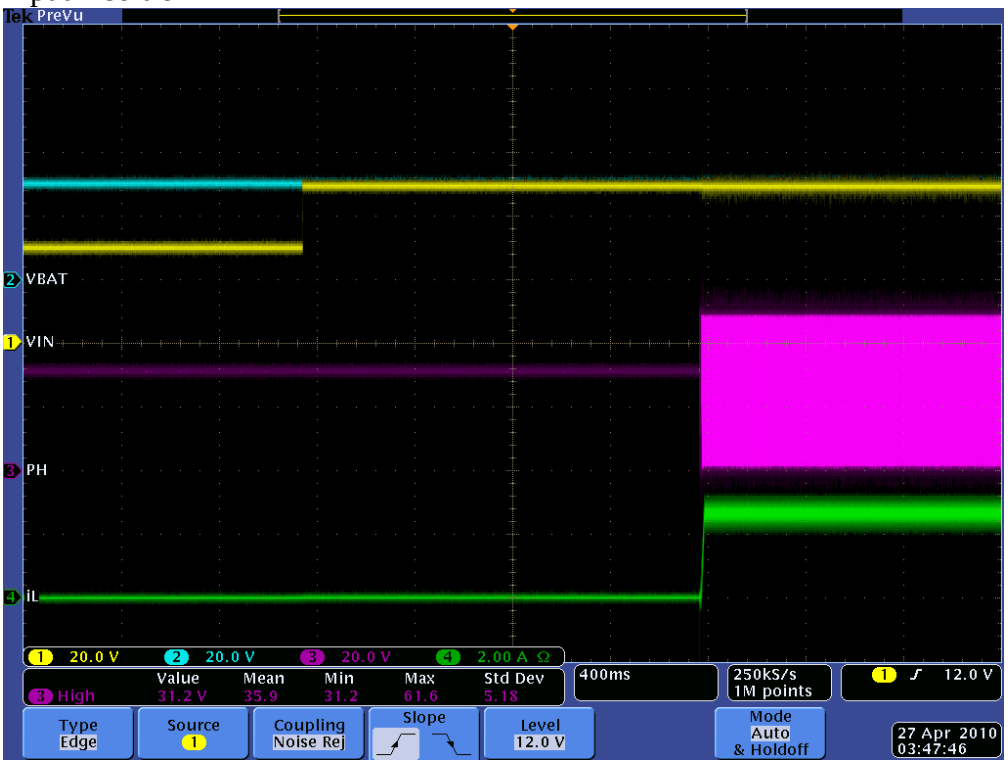
Zoom in first pulse on battery detection



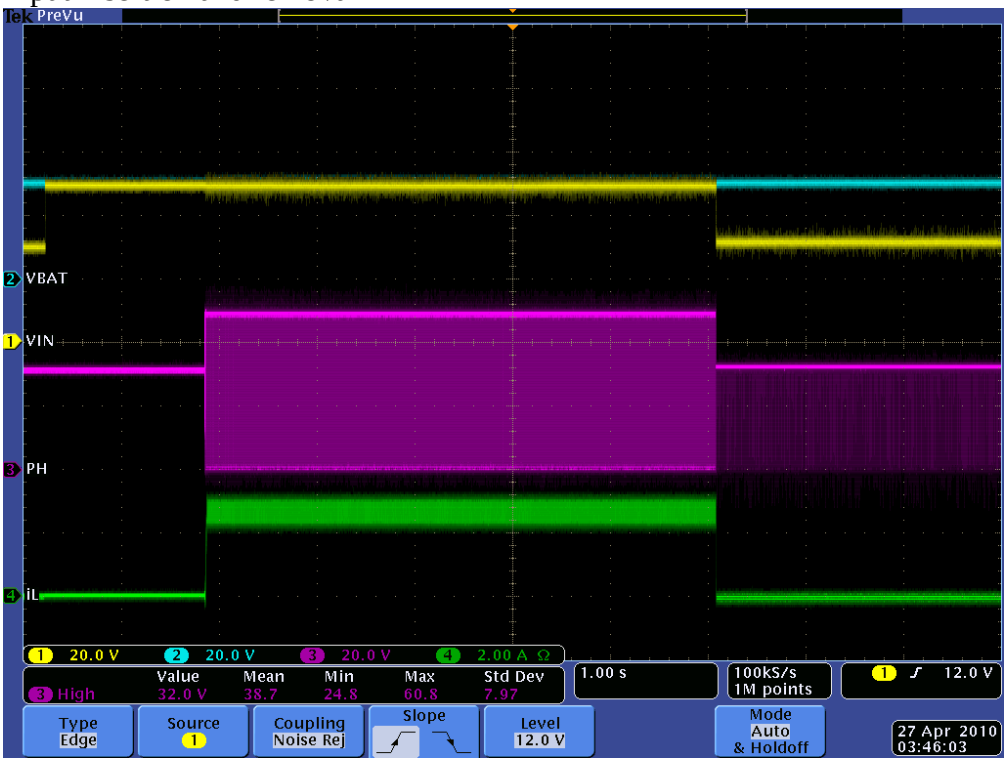
3.5 Input Insertion and removal

Ch1 (yellow): Vin; Ch2 (blue): Vbat; Ch3 (pink): PH; ch4 (green): IL

Input insertion



Input insertion and removal



3.6 Efficiency and power dissipation