

## ***Stepper Motor System with Medium Torque Drive***

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Tests performed:

1. Torque versus Regulated Current
2. Maximum RPM
3. Thermal Imaging
4. Current waveforms using 12V, 700mA, 100 RPM
  - a. Full step, fast decay with synchronous rectification
  - b. Full step, fast decay without synchronous rectification
  - c. Full step, mixed decay (DECAY = 1V)
  - d. Full step, mixed decay (DECAY = 1.3V)
  - e. Full step, slow decay
  - f. 1/2 microstep, fast decay with synchronous rectification
  - g. 1/2 microstep, fast decay without synchronous rectification
  - h. 1/2 microstep, mixed decay (DECAY = 1V)
  - i. 1/2 microstep, mixed decay (DECAY = 1.3V)
  - j. 1/2 microstep, slow decay
  - k. 1/4 microstep, fast decay with synchronous rectification
  - l. 1/4 microstep, fast decay without synchronous rectification
  - m. 1/4 microstep, mixed decay (DECAY = 1V)
  - n. 1/4 microstep, mixed decay (DECAY = 1.3V)
  - o. 1/4 microstep, slow decay
  - p. 1/8 microstep, fast decay with synchronous rectification
  - q. 1/8 microstep, fast decay without synchronous rectification
  - r. 1/8 microstep, mixed decay (DECAY = 1V)
  - s. 1/8 microstep, mixed decay (DECAY = 1.3V)
  - t. 1/8 microstep, slow decay
5. Current ramp rate versus VM
  - a. VM = 8V
  - b. VM = 12V
  - c. VM = 20V
6. Current regulation (zoomed-in)
  - a. Fast decay with synchronous rectification,  $t_{\text{OFF}} = 20\mu\text{s}$
  - b. Fast decay with synchronous rectification,  $t_{\text{OFF}} = 47\mu\text{s}$
  - c. Fast decay without synchronous rectification,  $t_{\text{OFF}} = 47\mu\text{s}$
  - d. Mixed decay (DECAY = 1V),  $t_{\text{OFF}} = 47\mu\text{s}$
  - e. Mixed decay (DECAY = 1.3V),  $t_{\text{OFF}} = 47\mu\text{s}$
  - f. Slow decay,  $t_{\text{OFF}} = 47\mu\text{s}$
  - g.  $t_{\text{BLANK}} = 1.4\mu\text{s}$ , Fast decay
  - h.  $t_{\text{BLANK}} = 1.4\mu\text{s}$ , Mixed decay (DECAY = 1V)
  - i.  $t_{\text{BLANK}} = 1.4\mu\text{s}$ , Mixed decay (DECAY = 1.7V)
  - j.  $t_{\text{BLANK}} = 7\mu\text{s}$ , Fast decay
  - k.  $t_{\text{BLANK}} = 7\mu\text{s}$ , Mixed decay (DECAY = 1V)
  - l.  $t_{\text{BLANK}} = 7\mu\text{s}$ , Mixed decay (DECAY = 1.7V)

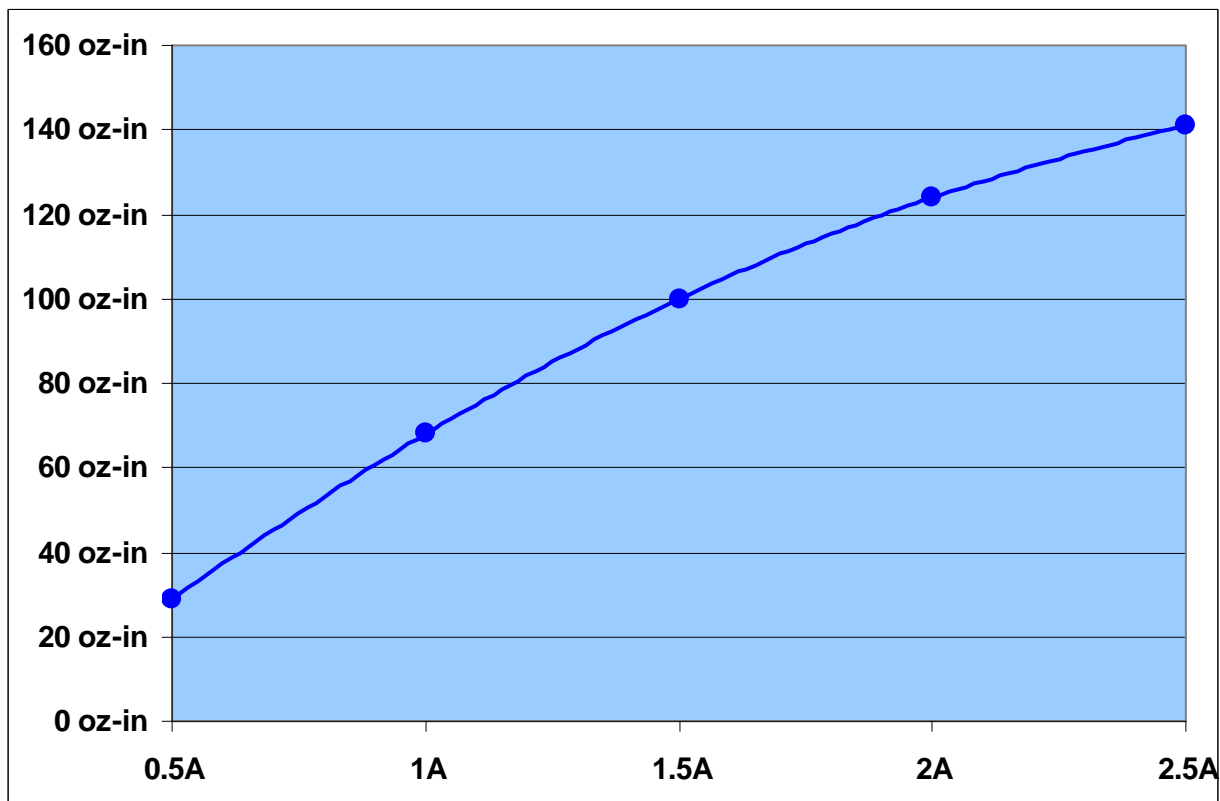
### Recommended baseline settings:

1/8 microstep, synchronous rectification enabled, mixed decay with DECAY = 1V,  
 $I_{CHOP} = 700\text{mA}$ ,  $t_{OFF} = 47\mu\text{s}$ ,  $t_{BLANK} = 1.4\mu\text{s}$ , STEP frequency = 2.7kHz.

### Section 1: Torque versus Regulated Current

Data was collected at 60 RPM, 1/2 microstep, using a magnetic particle brake load. Loading was increased until rotor stall. These torque values are approximations.

$I_{CHOP}$	Torque	
0.5A	29 oz-in	205 mNm
1A	68 oz-in	480 mNm
1.5A	100 oz-in	703 mNm
2A	124 oz-in	876 mNm
2.5A	141 oz-in	994 mNm



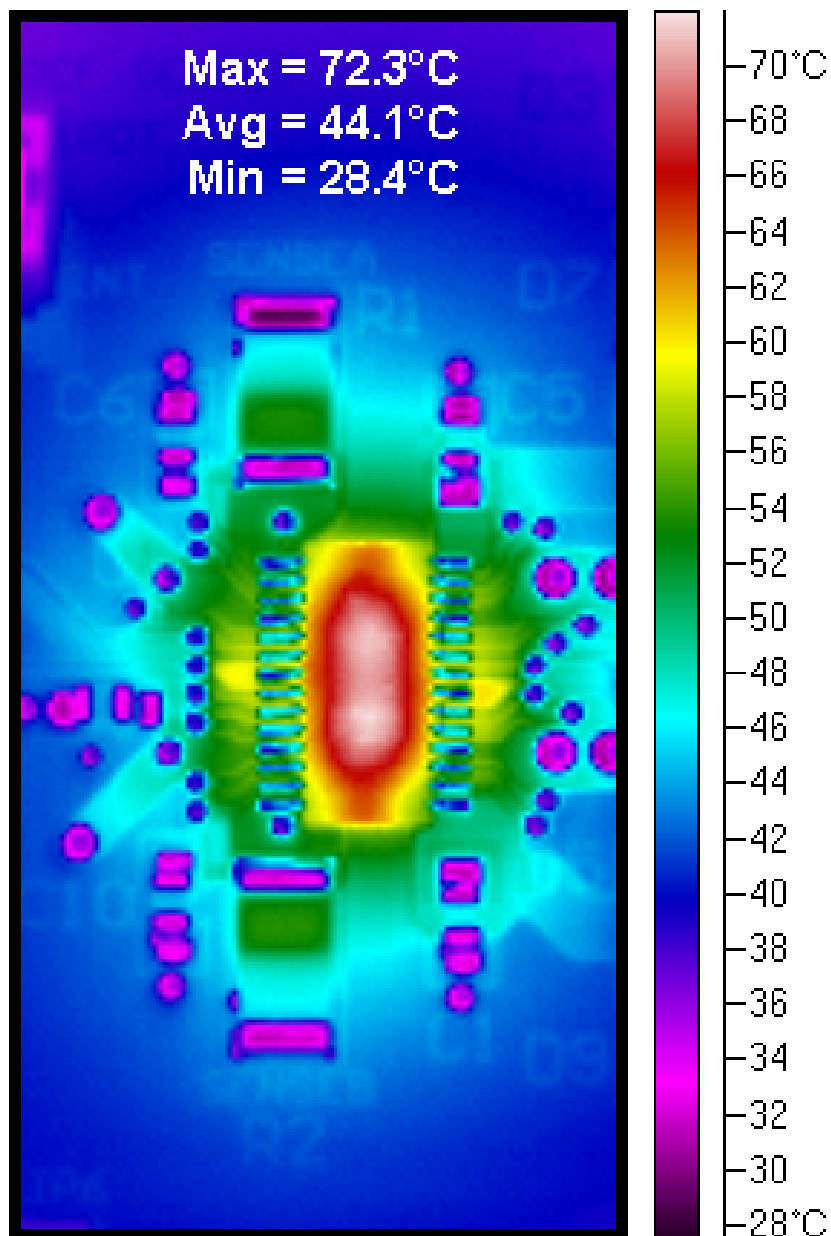
## Section 2: Maximum RPM

Using  $V_M = 12V$ , 1/8 microstepping, and  $I_{CHOP} = 0.92A$ :

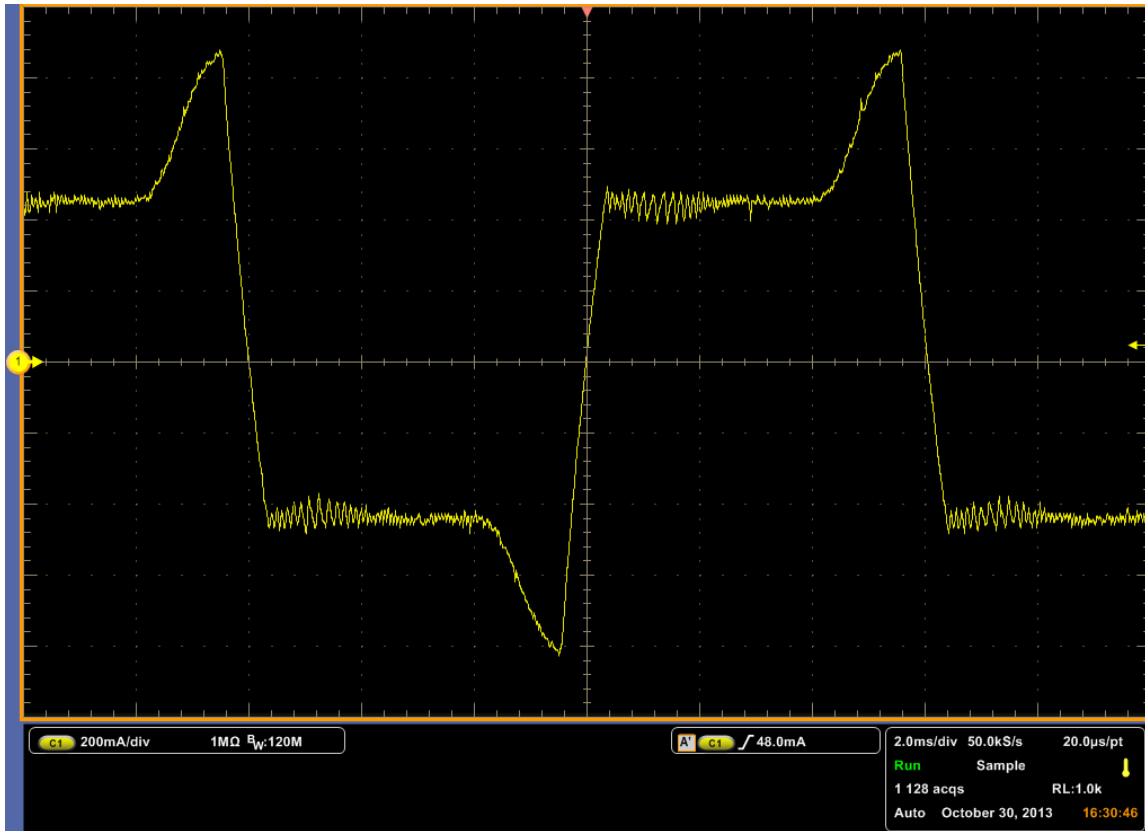
855 RPM

## Section 3: Thermal Imaging

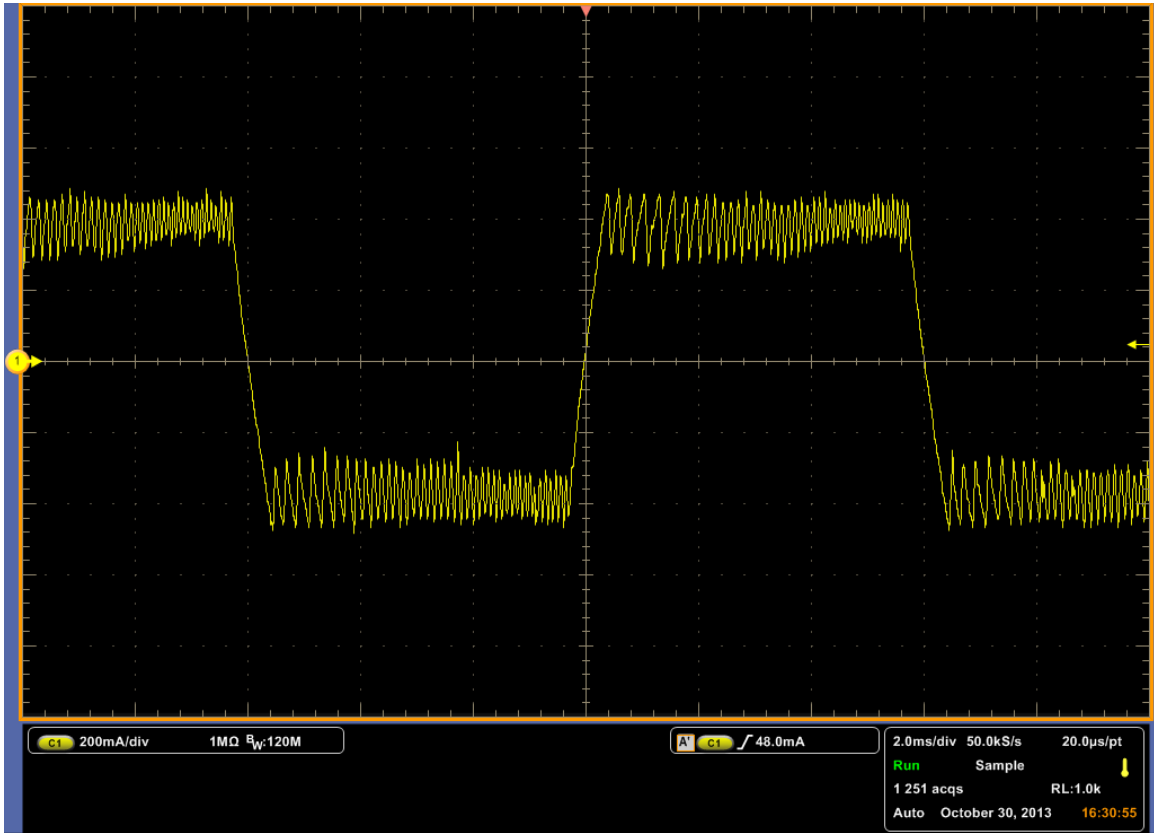
Data was collected with  $V_M = 12V$ ,  $I_{CHOP} = 2.5A$ .



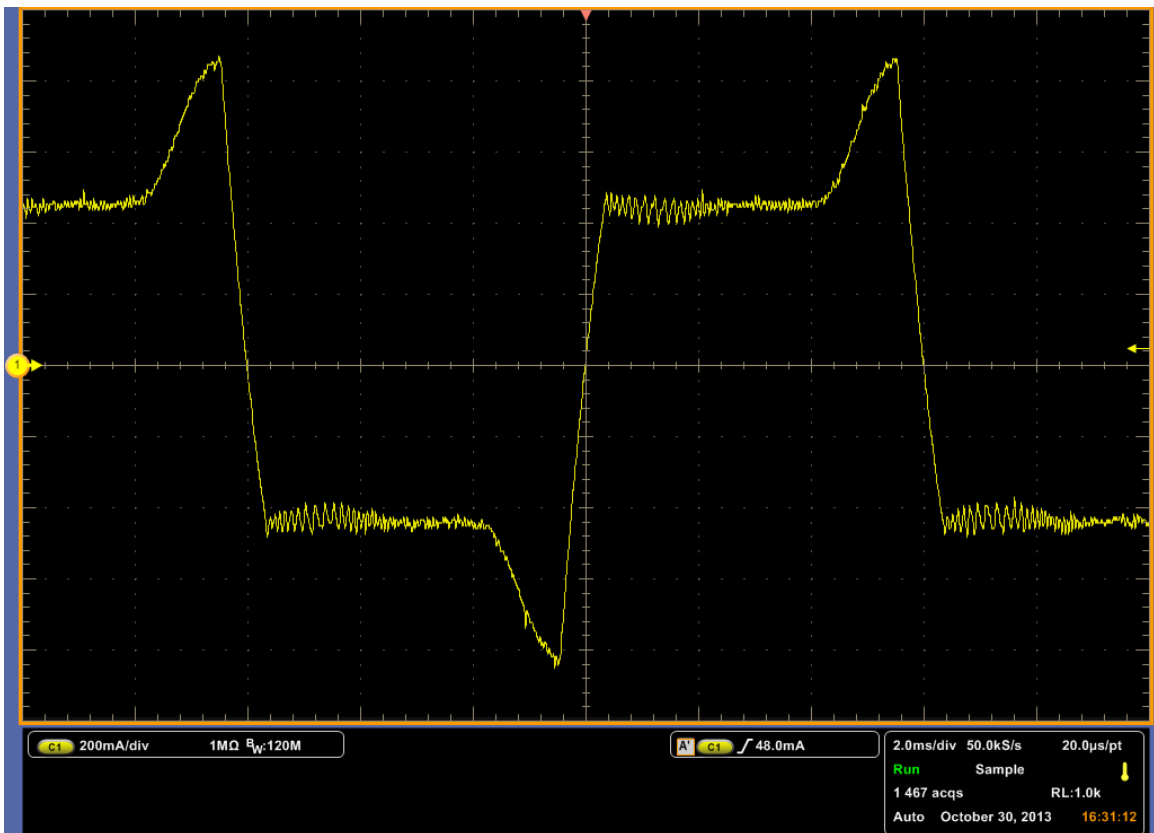
## Section 4: Current waveforms using 12V, 700mA, 100 RPM



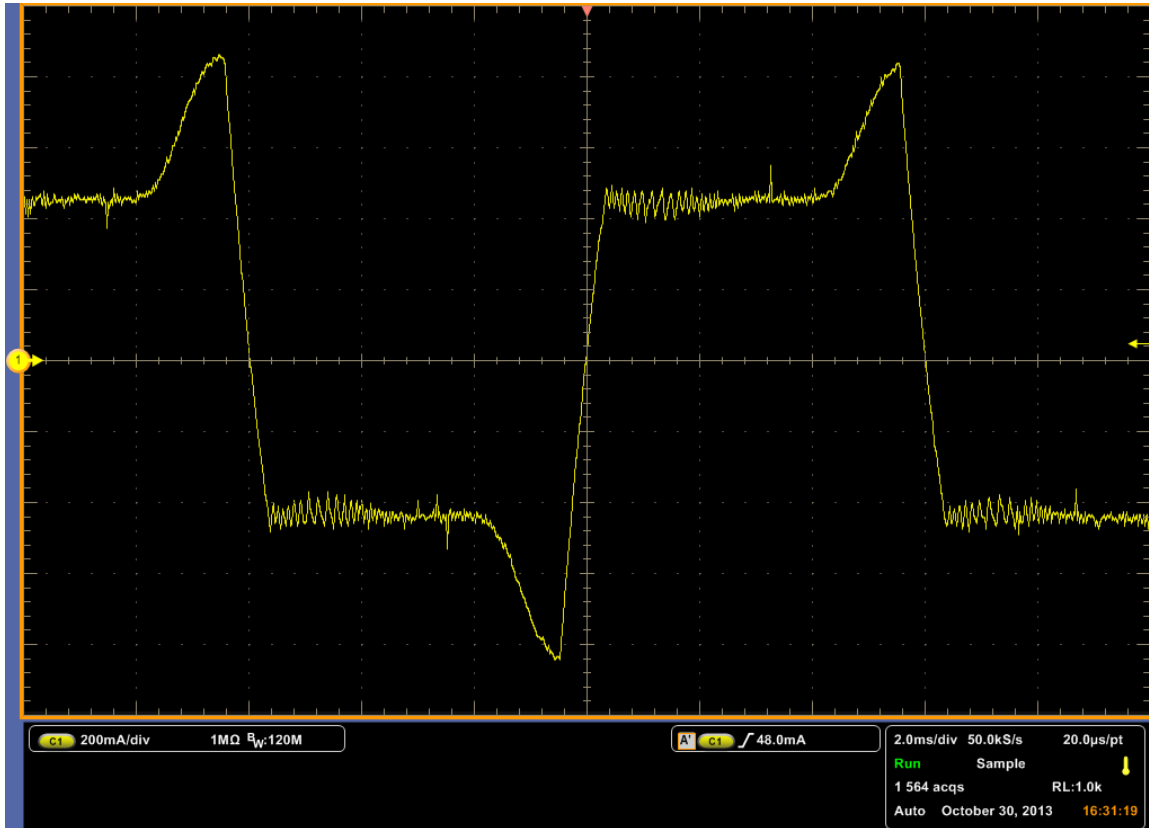
Full step, fast decay with synchronous rectification



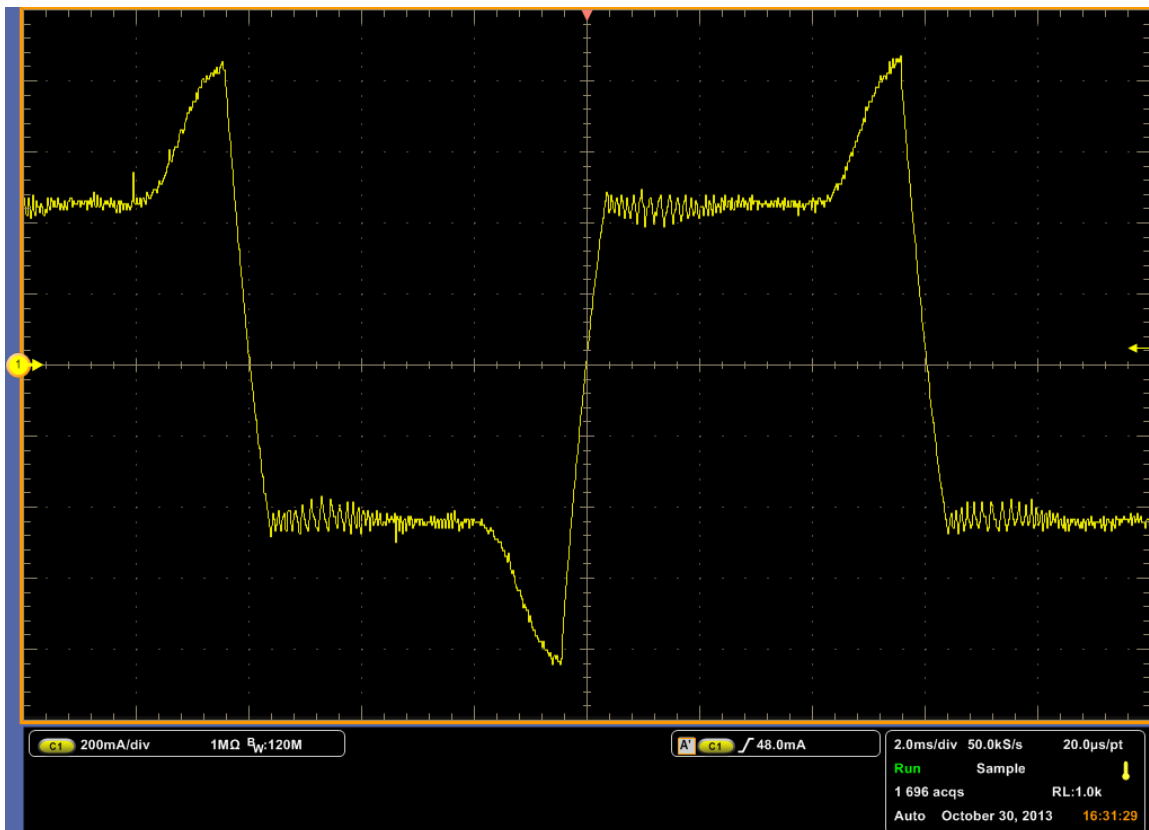
Full step, fast decay without synchronous rectification



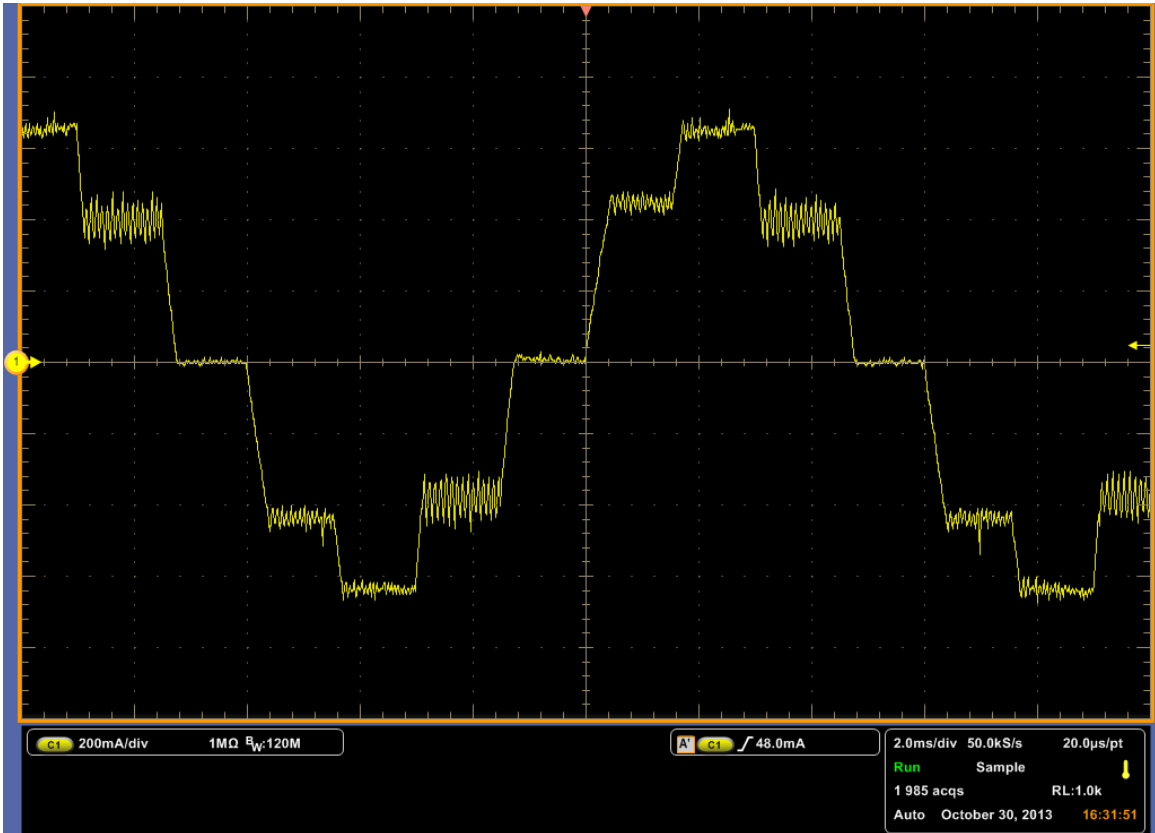
Full step, mixed decay (DECAY = 1V)



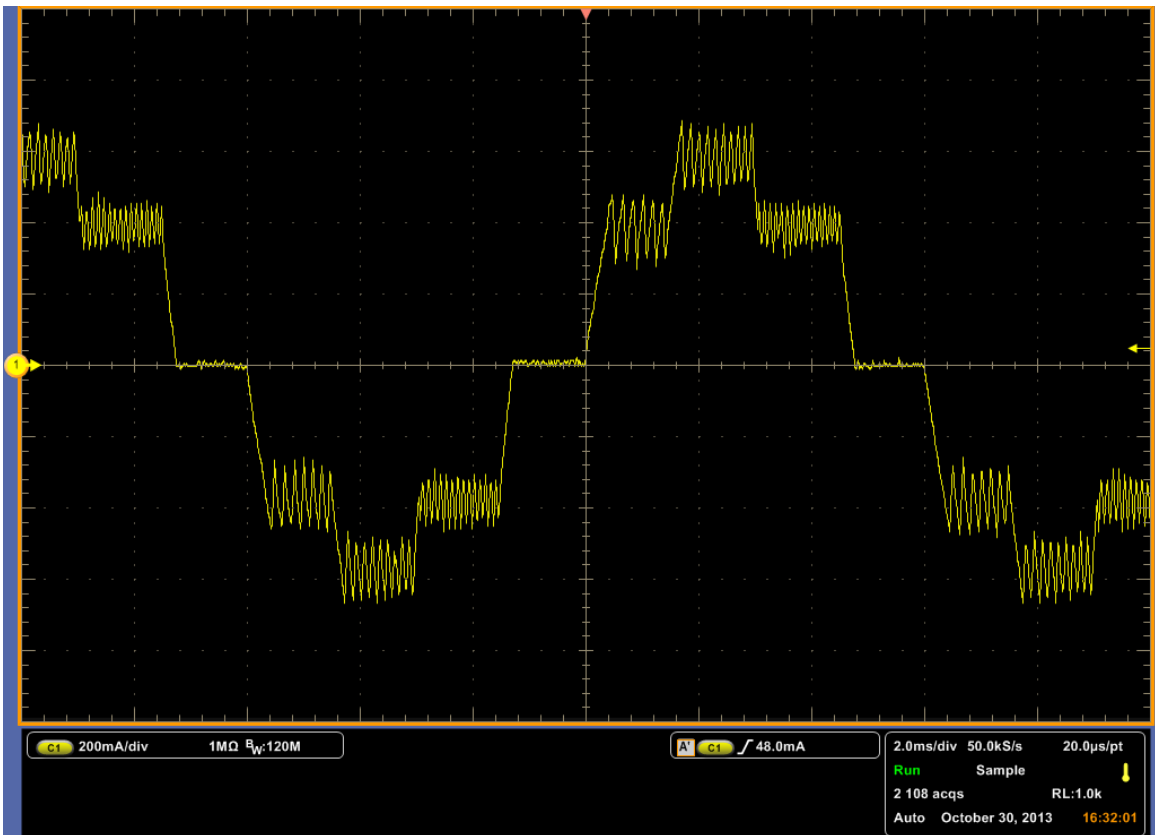
Full step, mixed decay (DECAY = 1.3V)



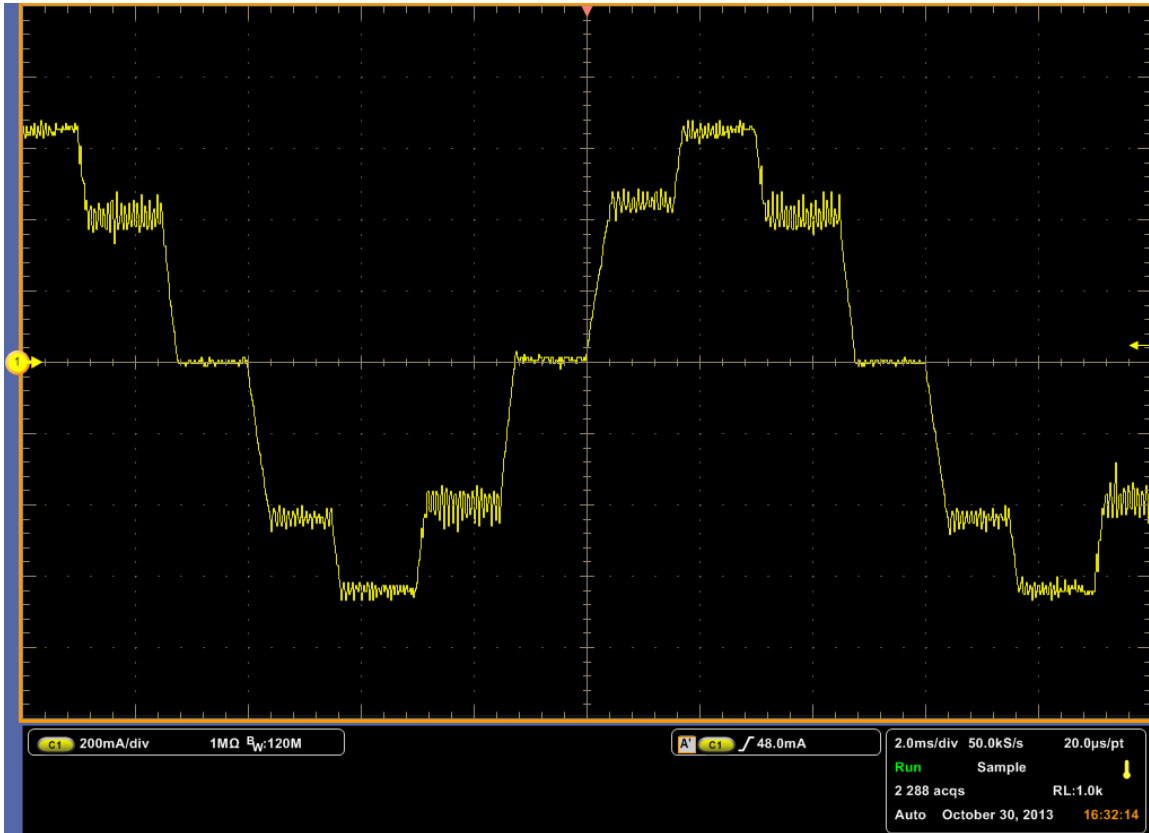
Full step, slow decay



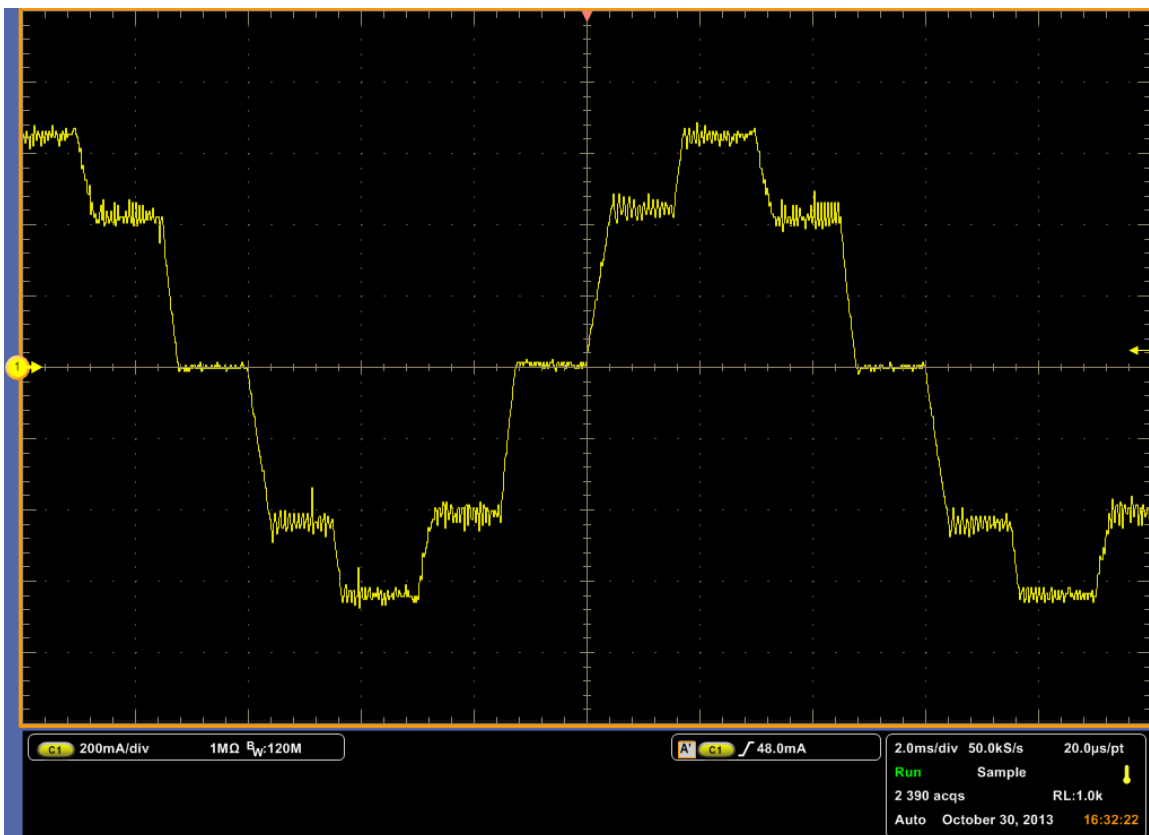
1/2 microstep, fast decay with synchronous rectification



1/2 microstep, fast decay without synchronous rectification

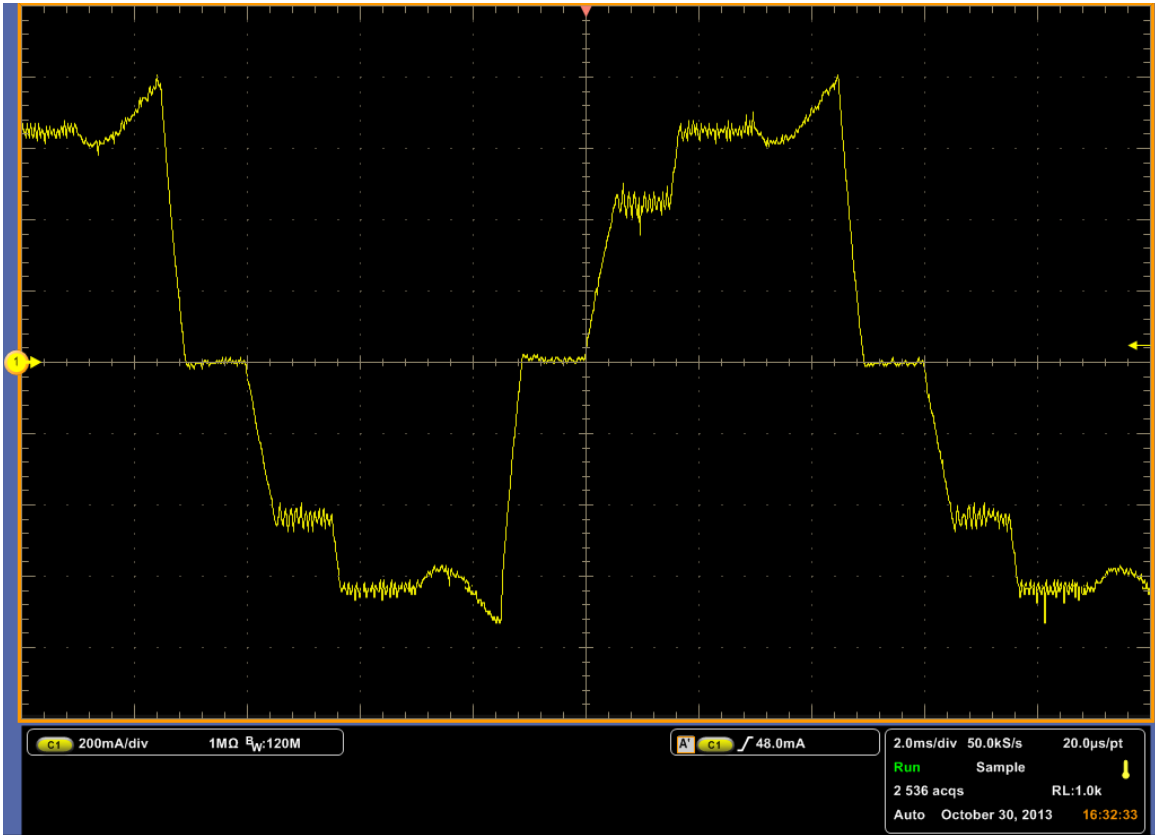


1/2 microstep, mixed decay (DECAY = 1V)

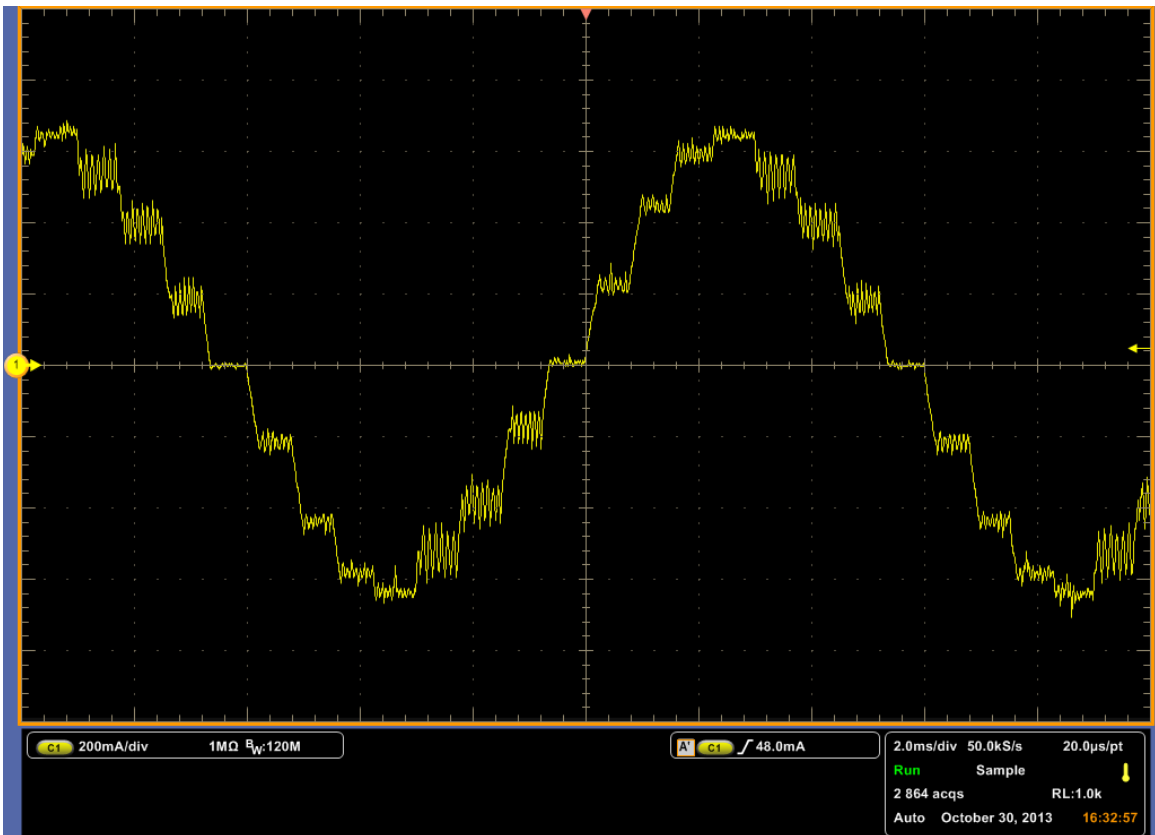


1/2 microstep, mixed decay (DECAY = 1.3V)

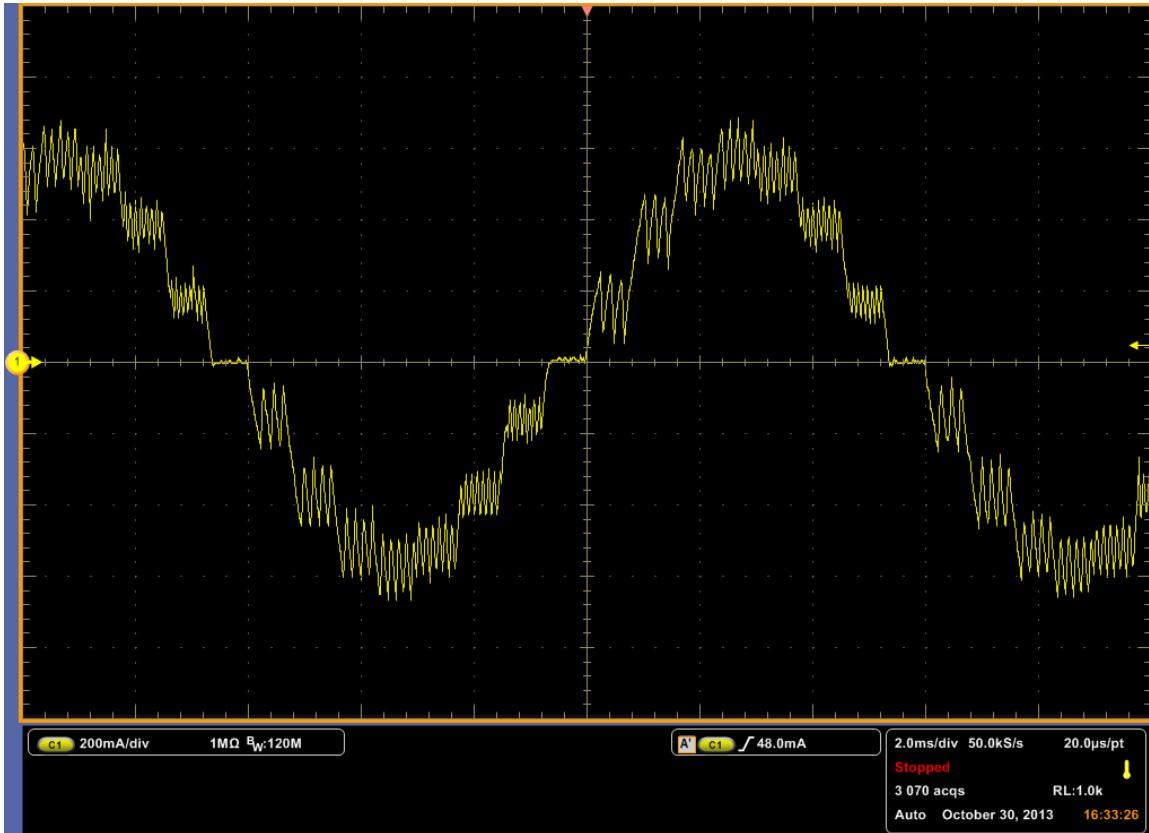




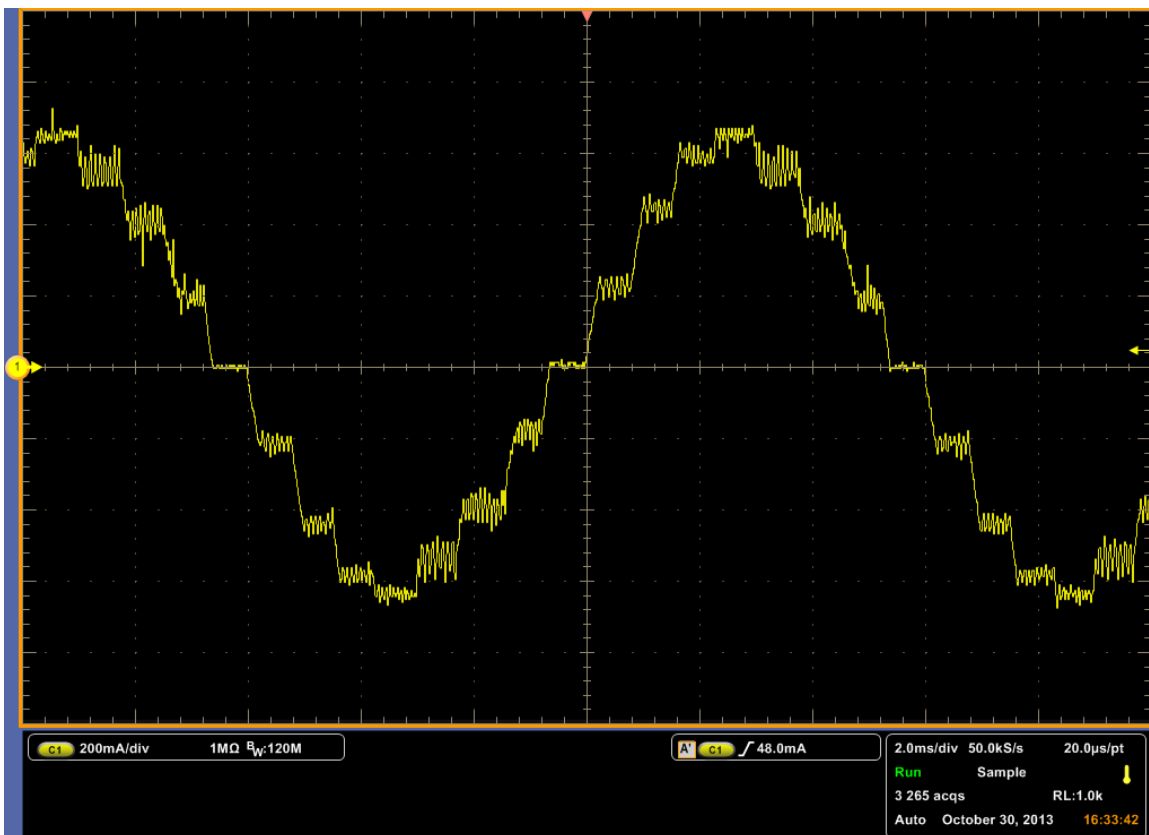
1/2 microstep, slow decay



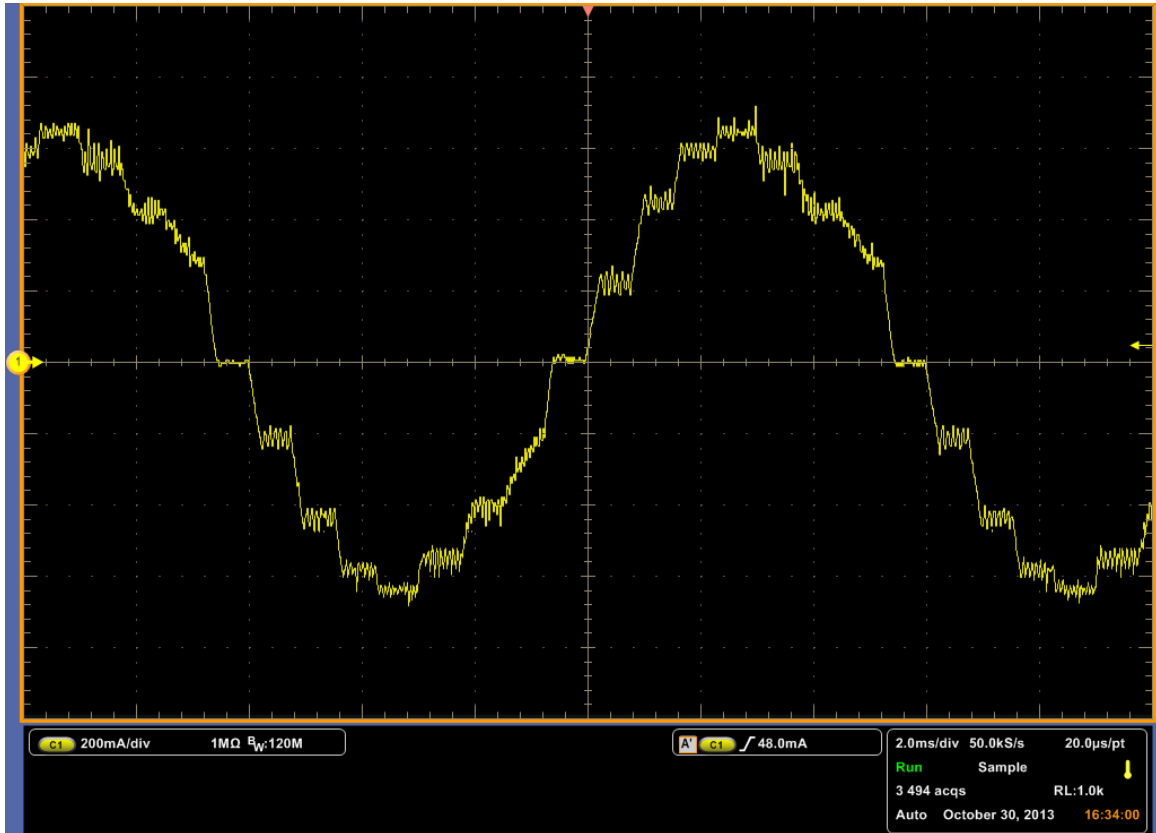
1/4 microstep, fast decay with synchronous rectification



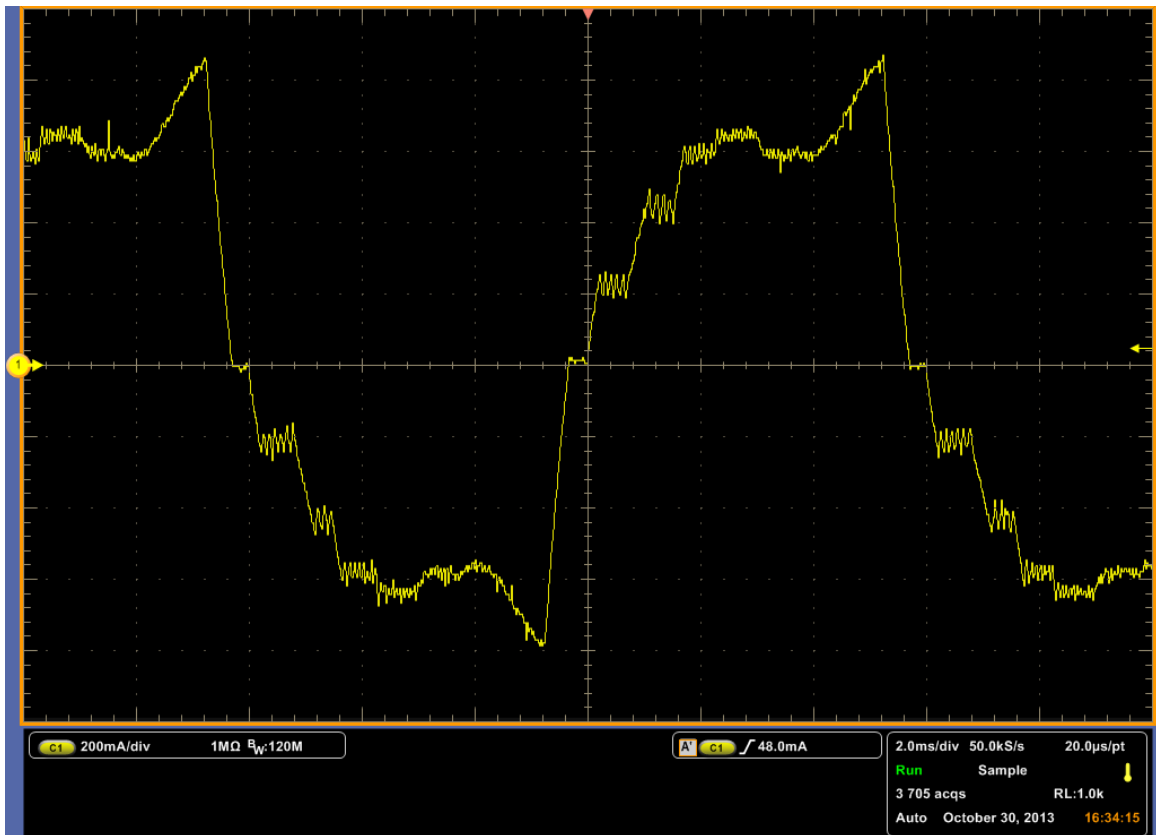
1/4 microstep, fast decay without synchronous rectification



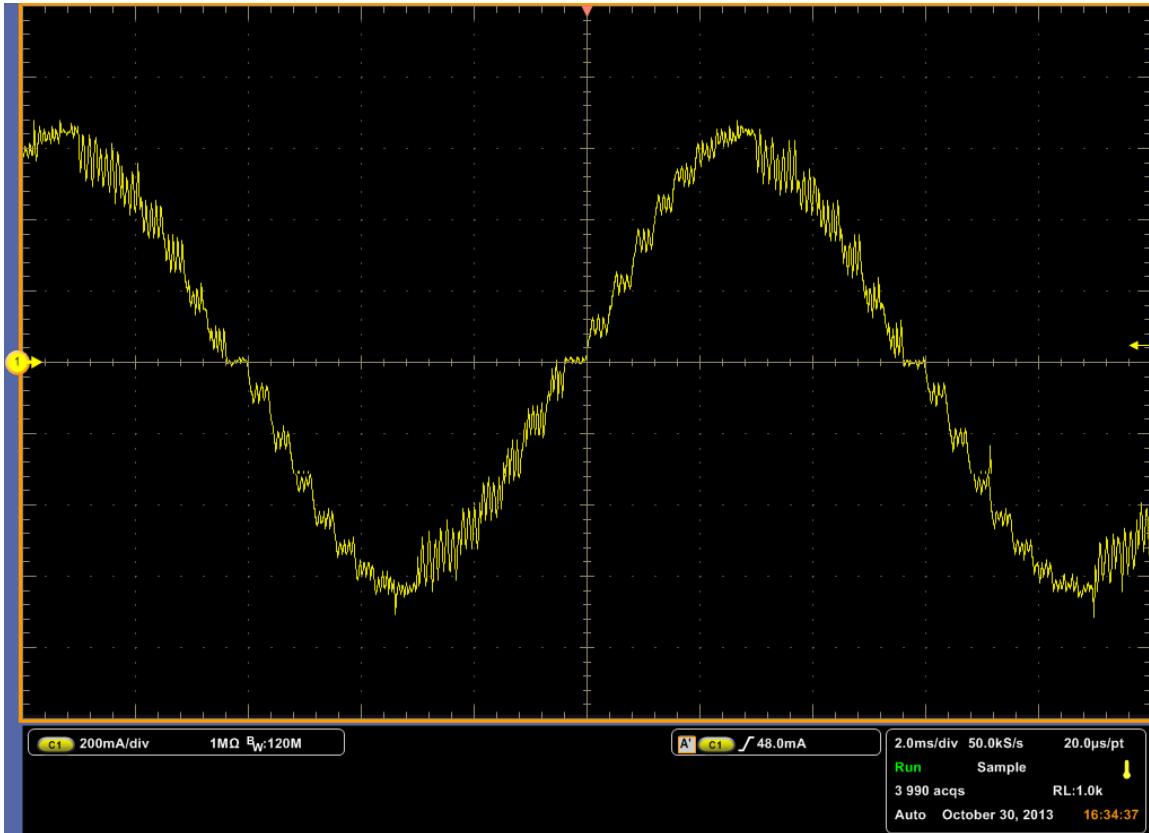
1/4 microstep, mixed decay (DECAY = 1V)



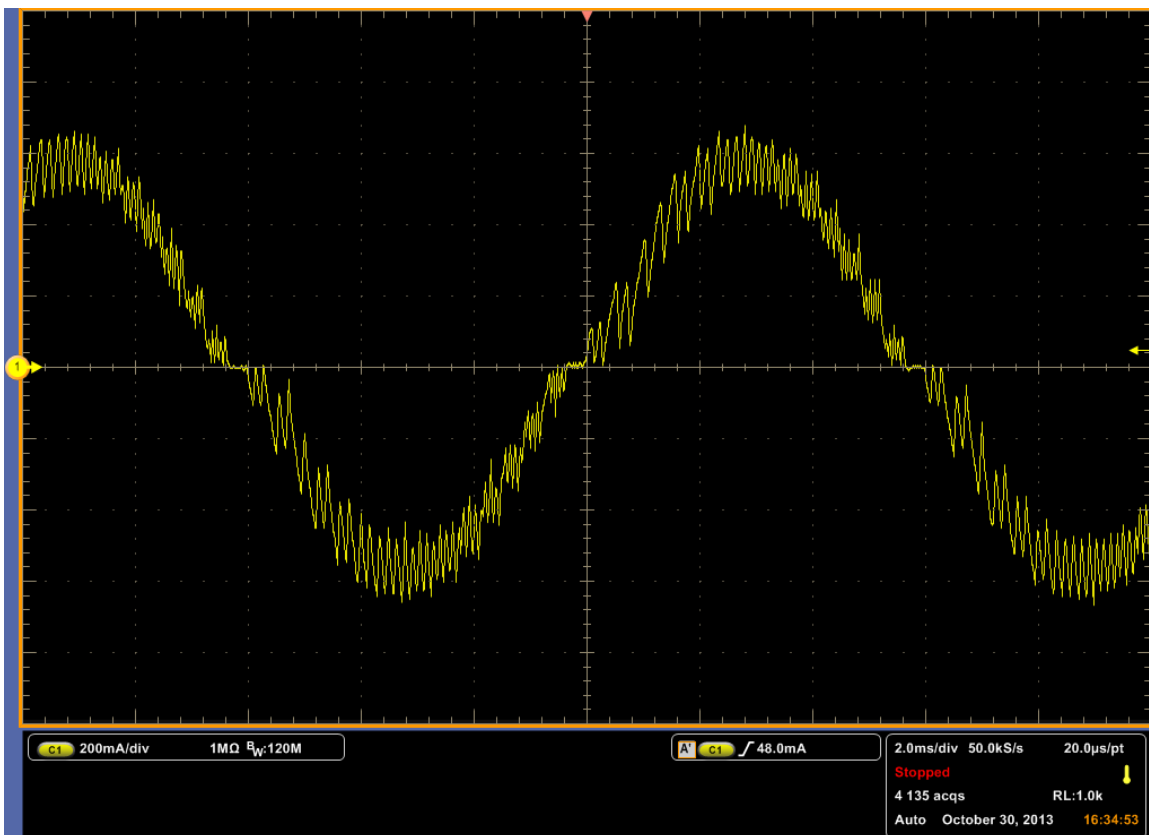
1/4 microstep, mixed decay (DECAY = 1.3V)



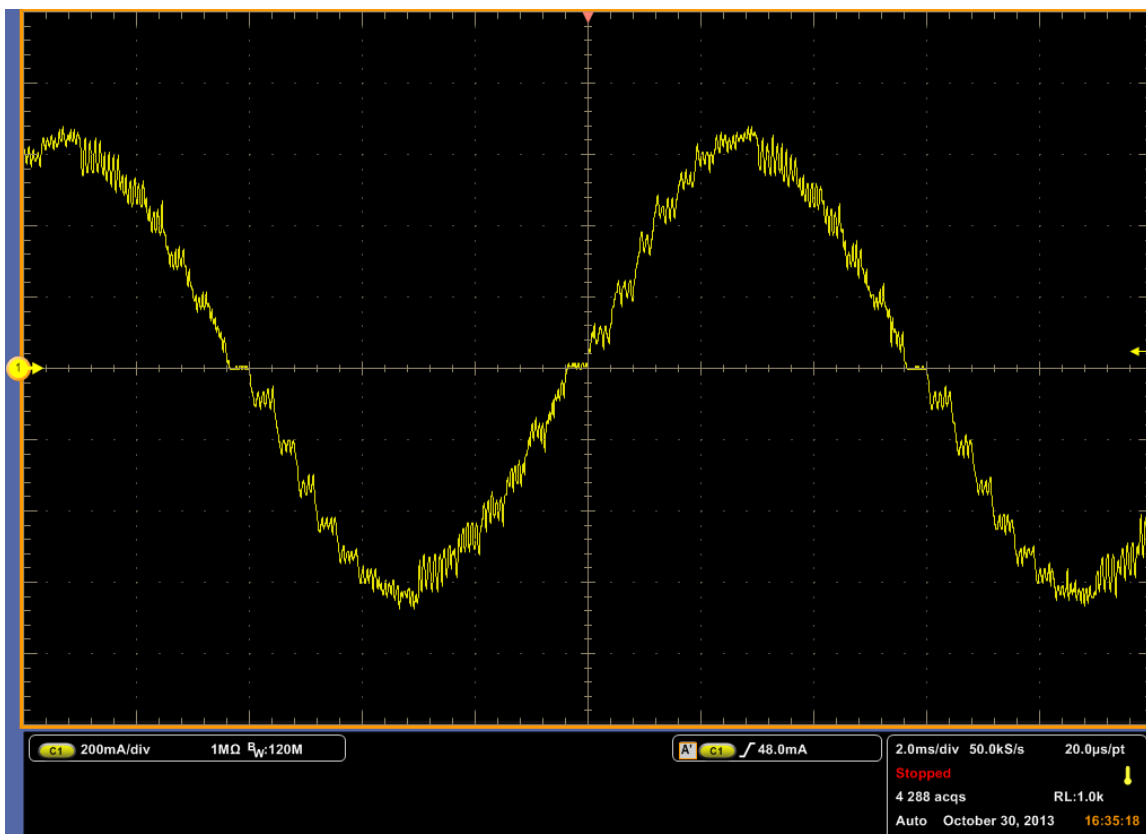
1/4 microstep, slow decay



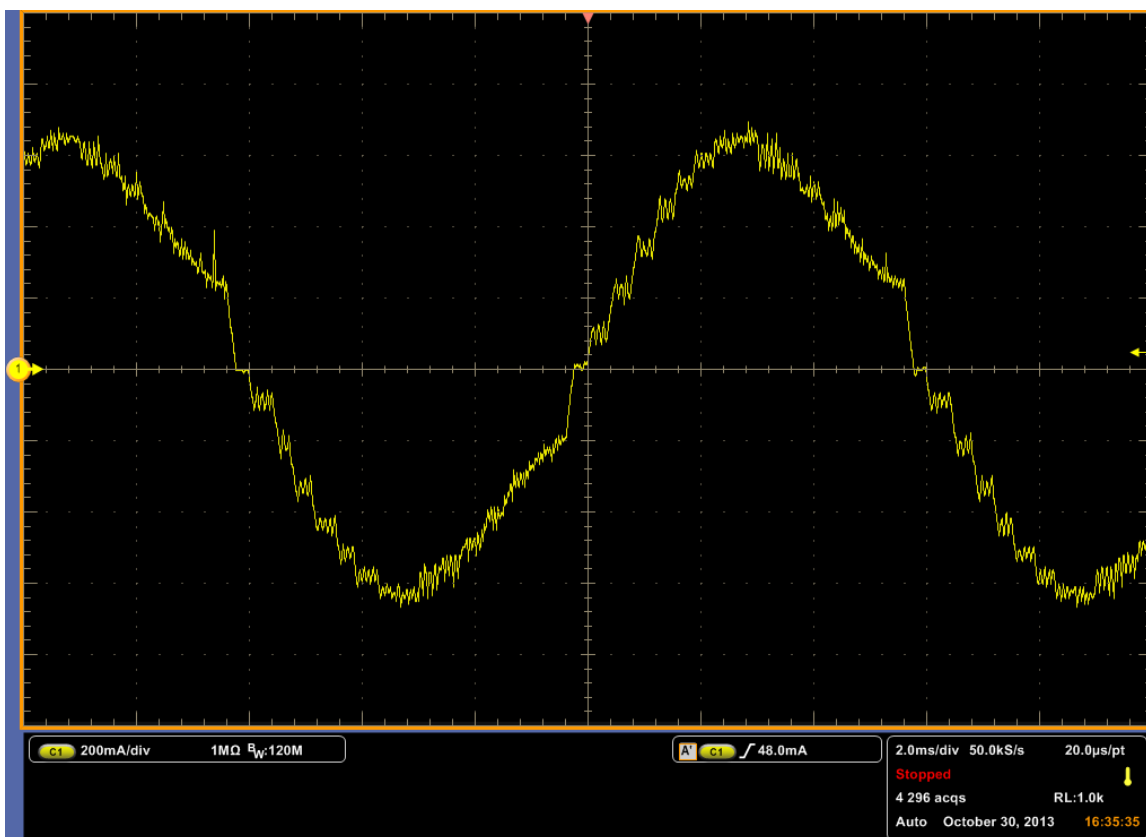
1/8 microstep, fast decay with synchronous rectification



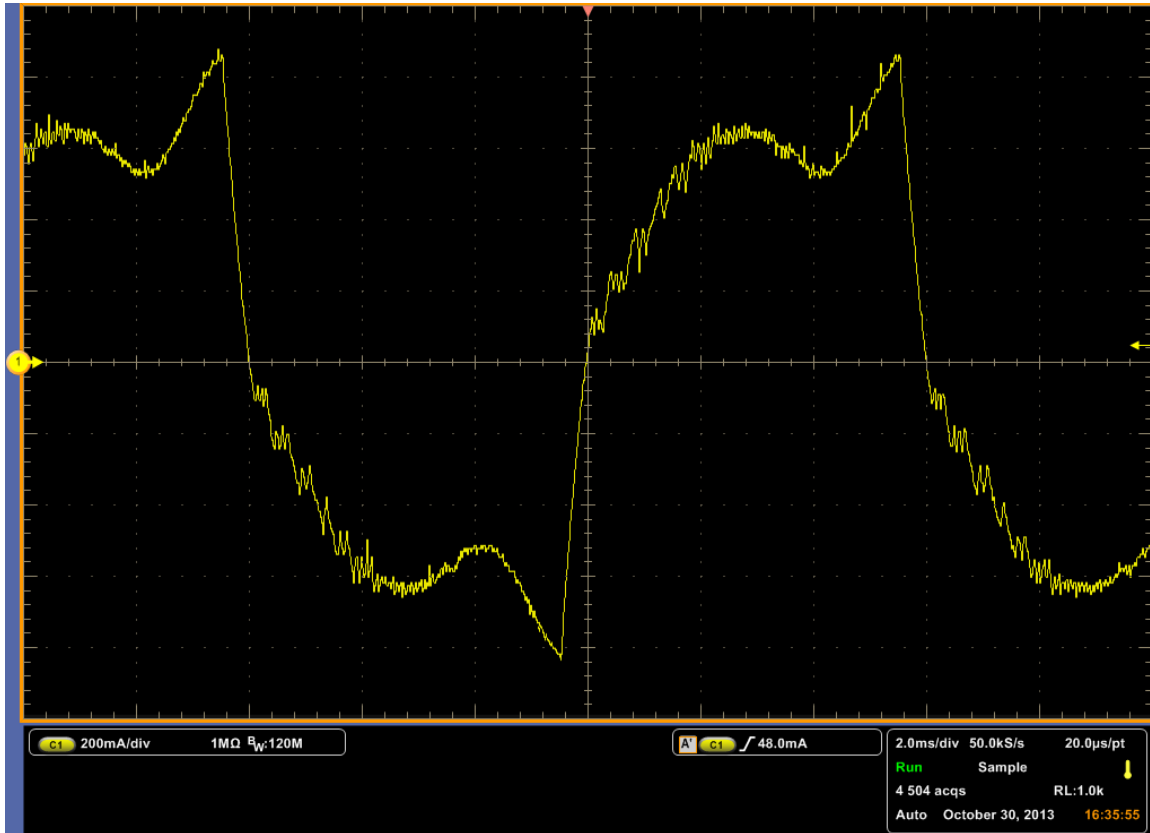
1/8 microstep, fast decay without synchronous rectification



1/8 microstep, mixed decay (DECAY = 1V)

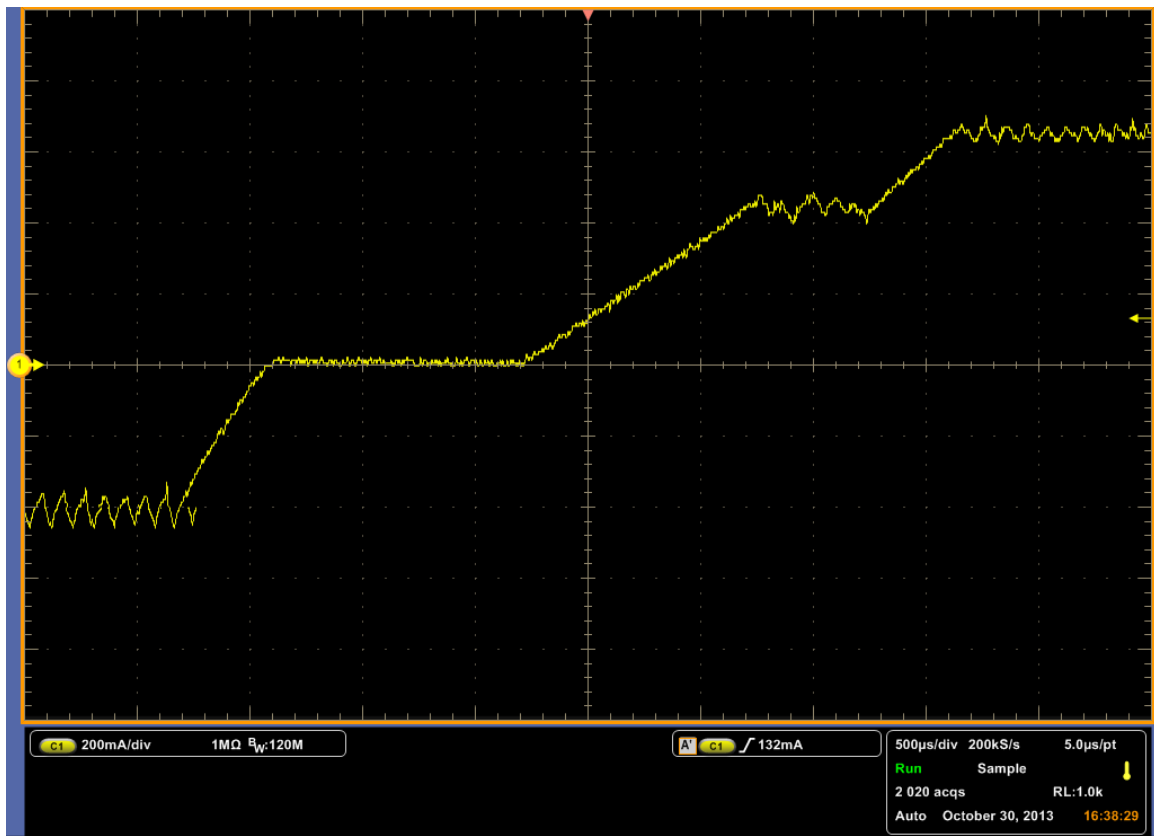


1/8 microstep, mixed decay (DECAY = 1.3V)

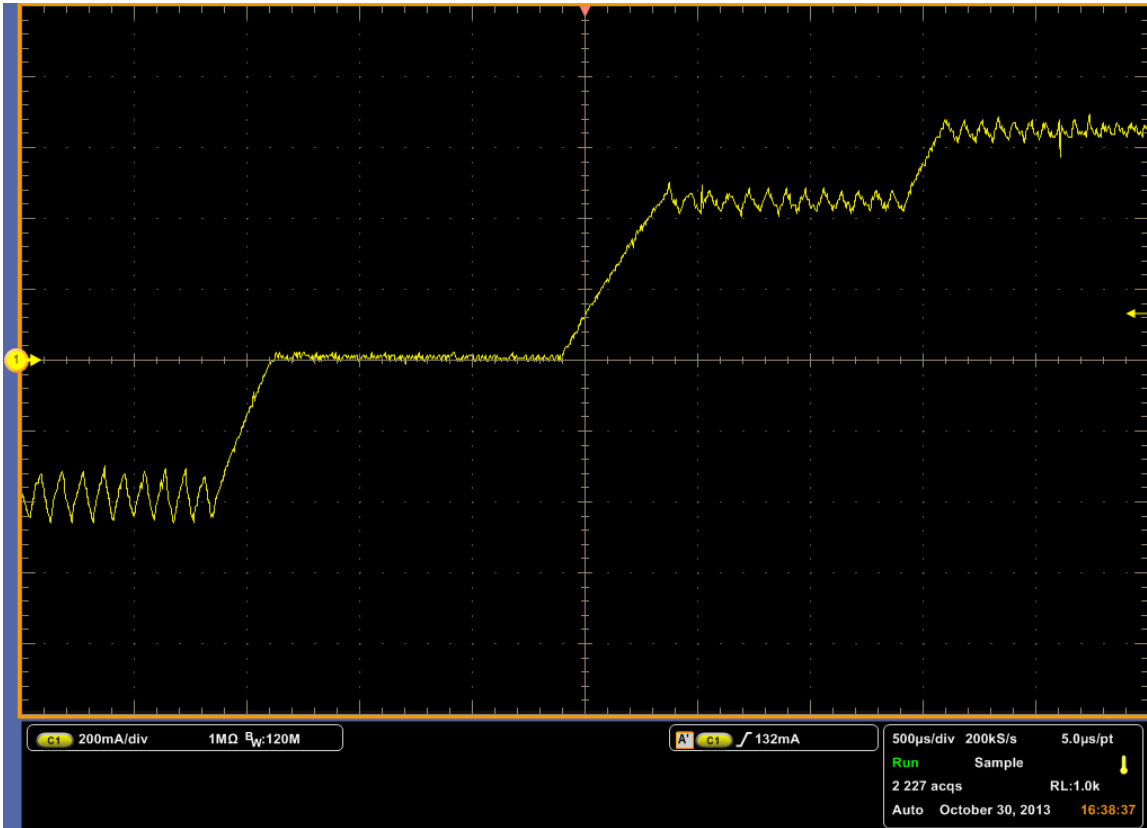


1/8 microstep, slow decay

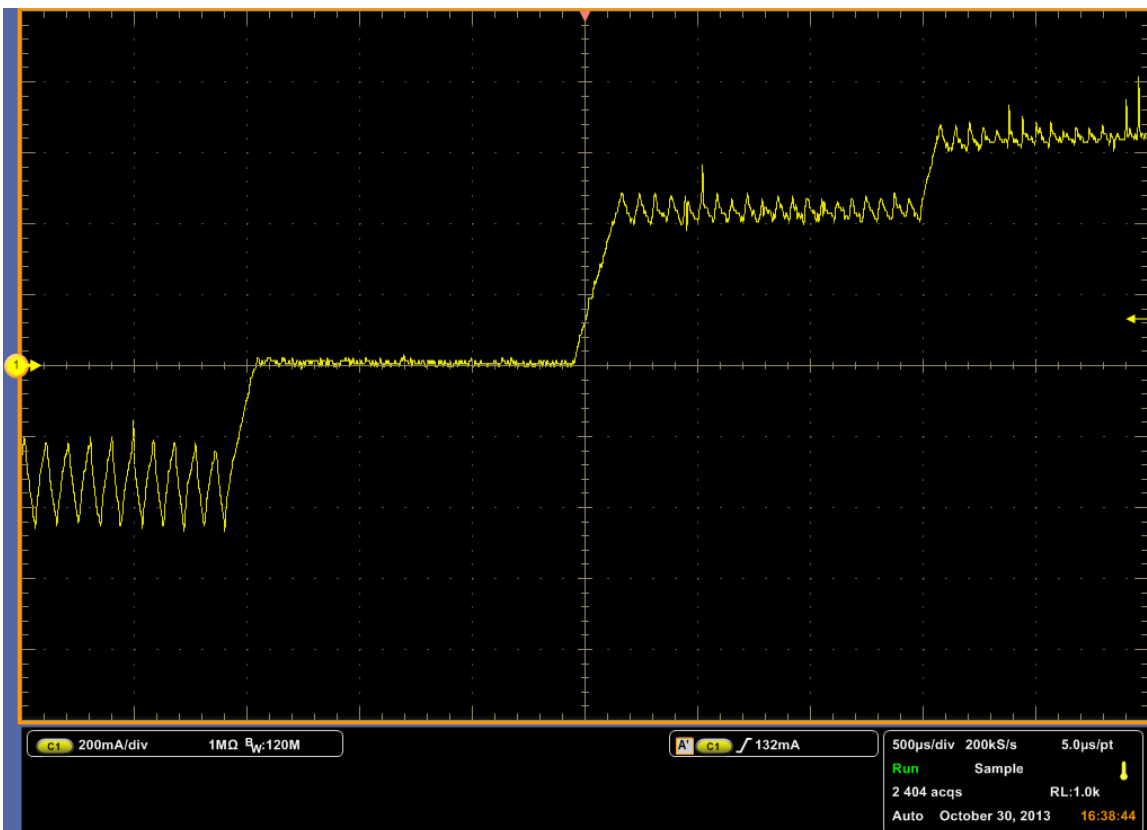
## Section 5: Current ramp rate versus VM



VM = 8V



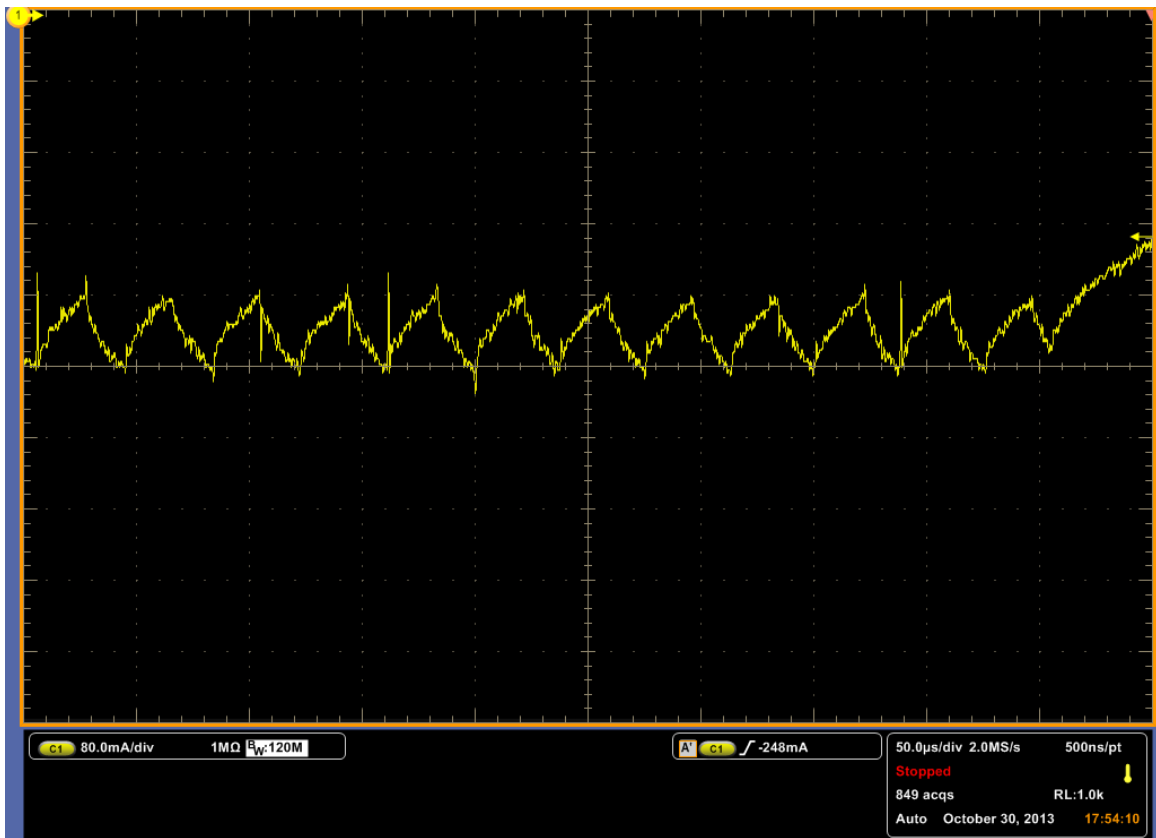
VM = 12V



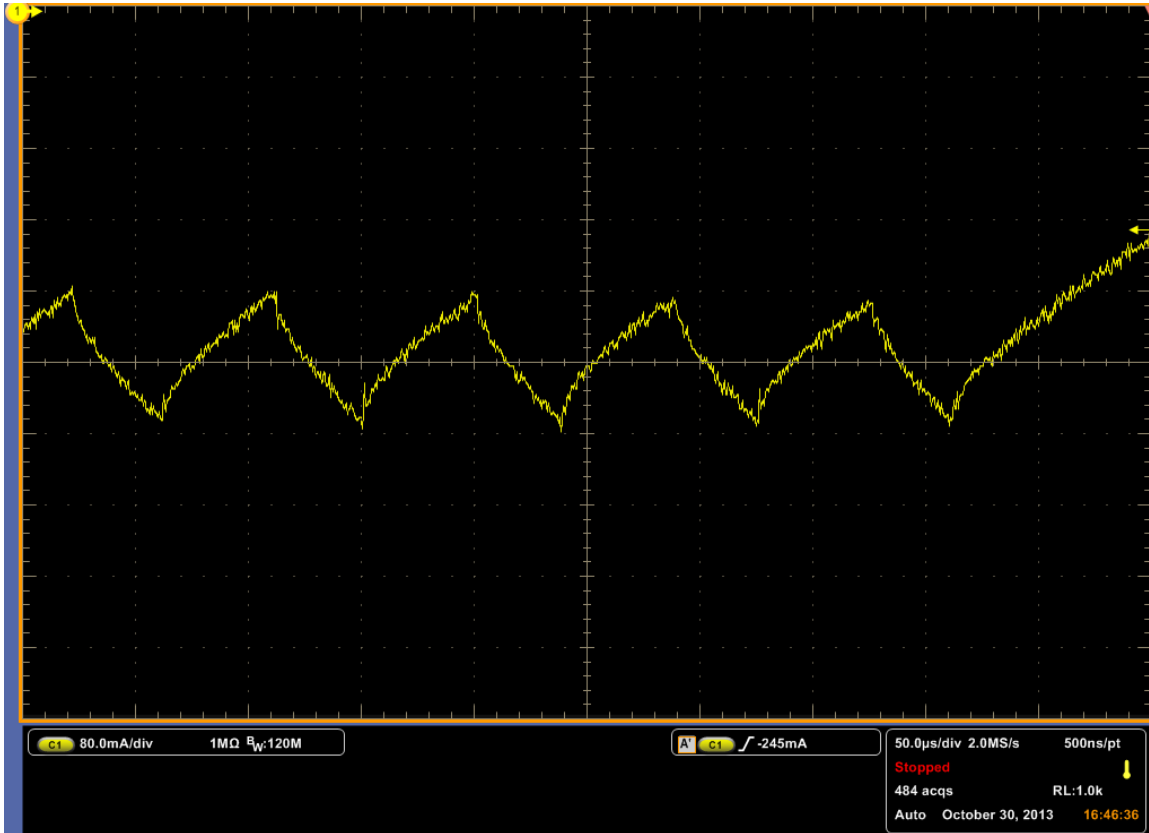
VM = 20V



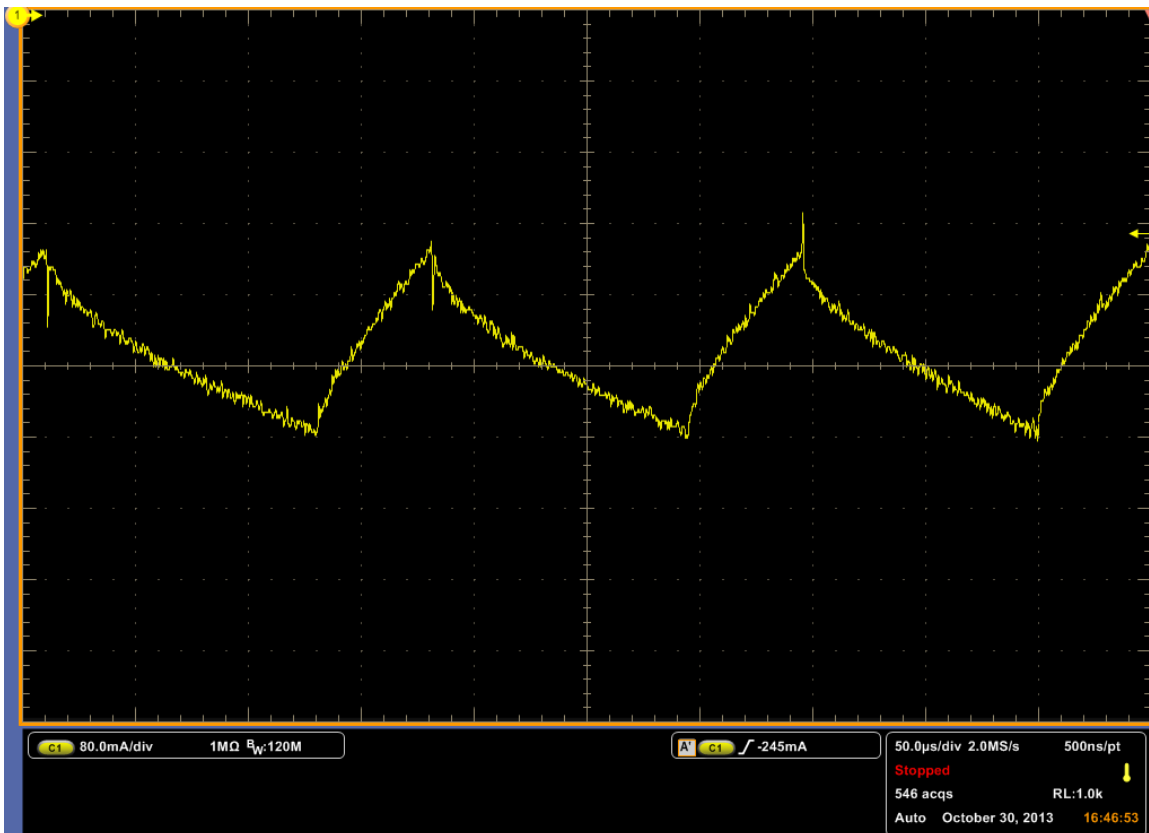
## Section 6: Current regulation (zoomed-in)



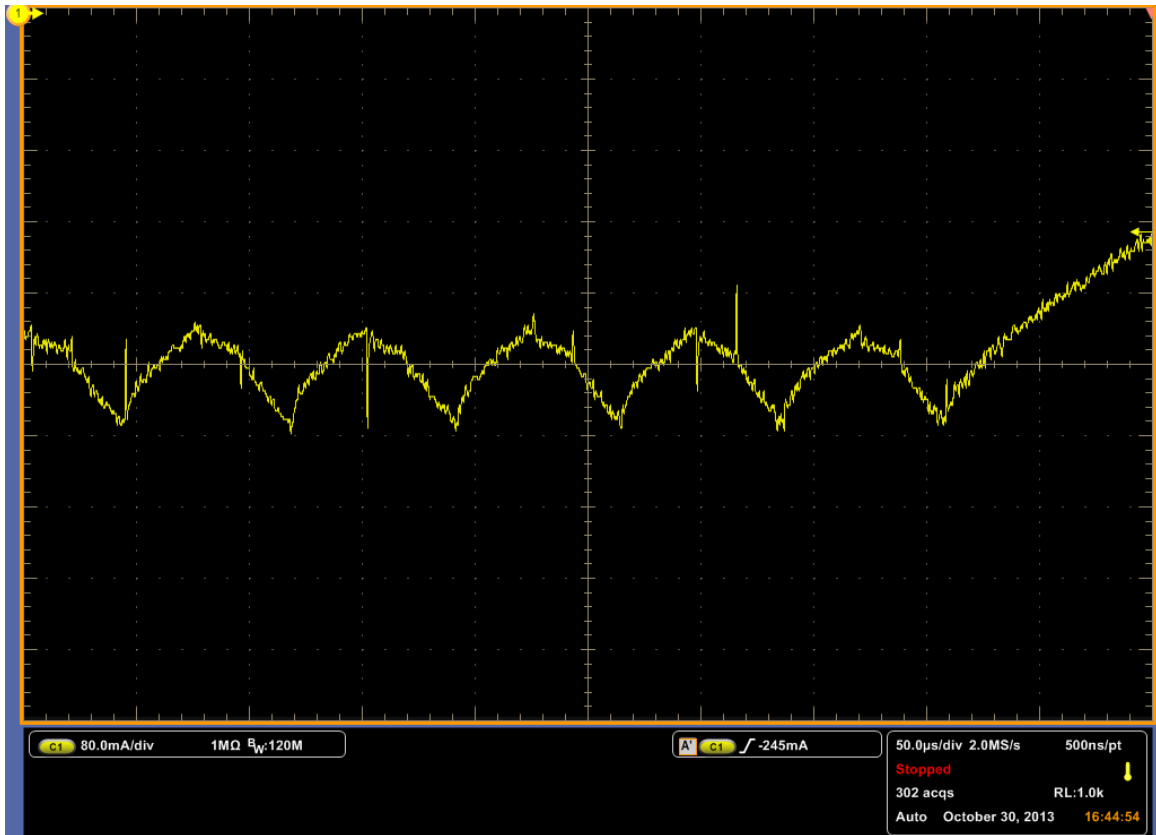
Fast decay with synchronous rectification,  $t_{OFF} = 20\mu s$



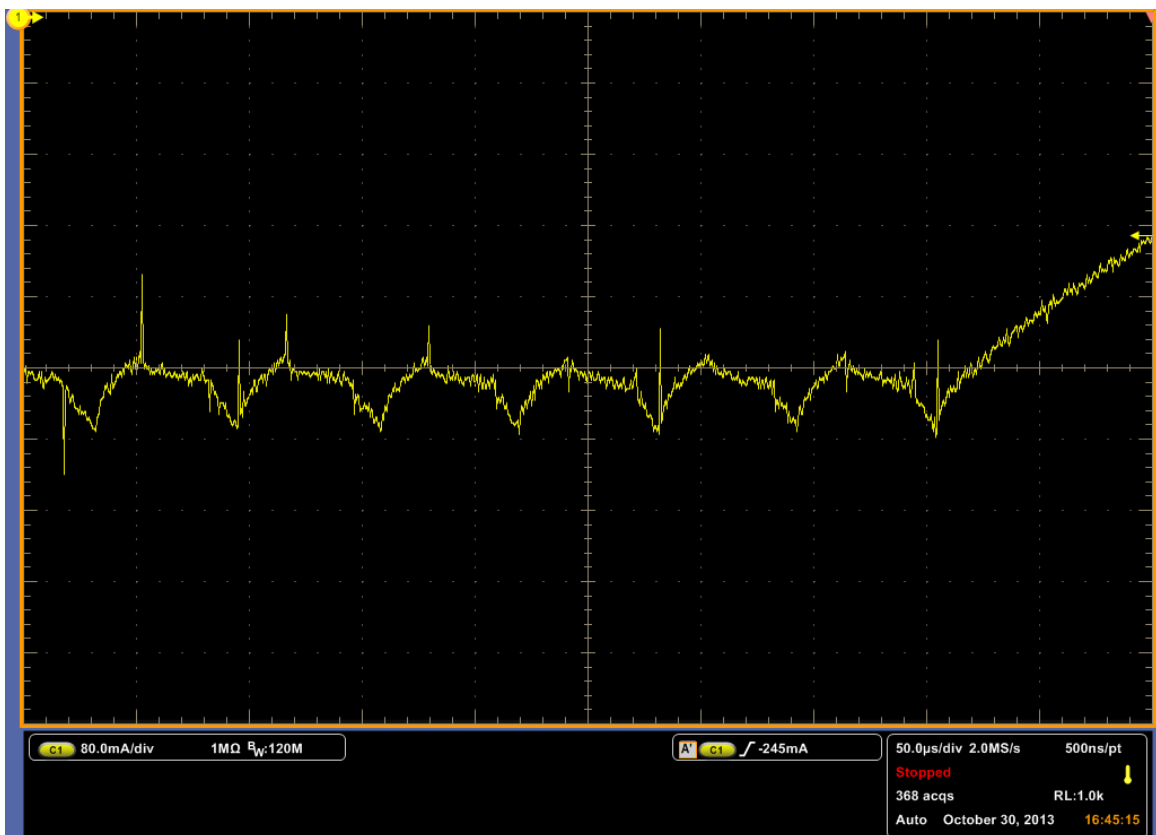
Fast decay with synchronous rectification,  $t_{OFF} = 47\mu s$



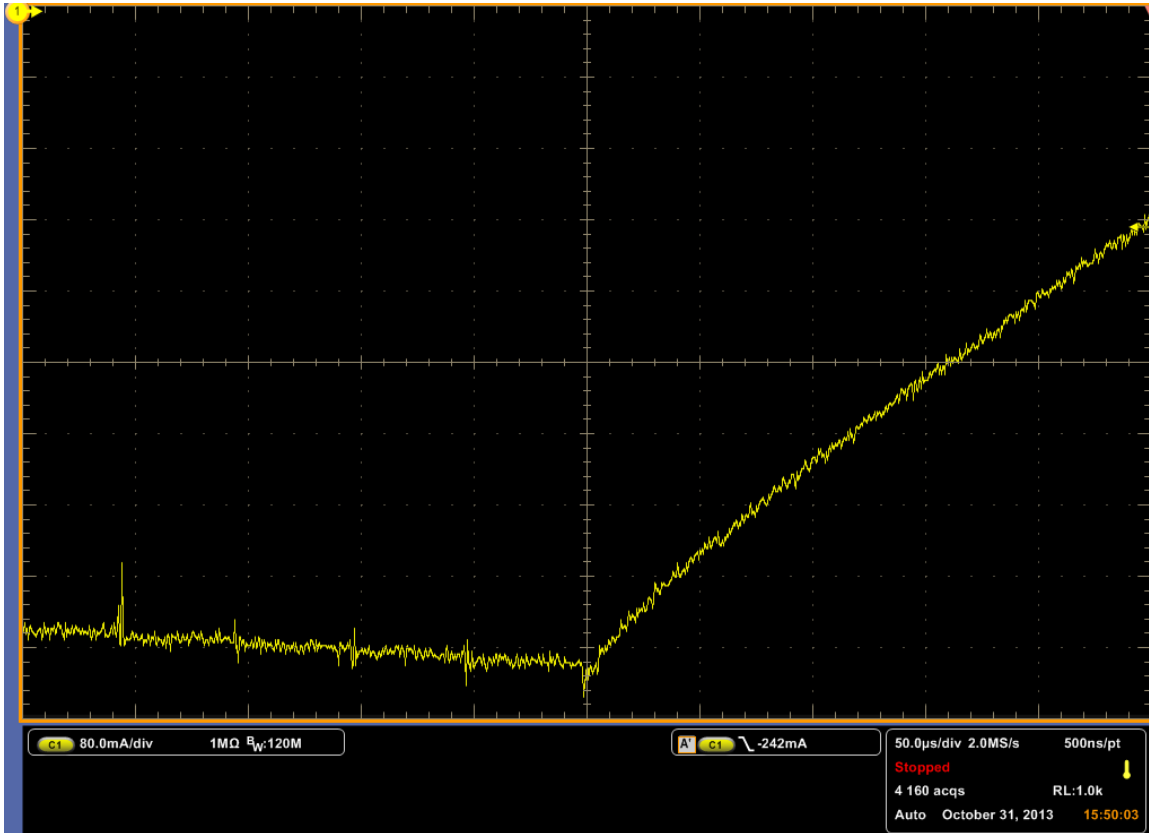
Fast decay without synchronous rectification,  $t_{OFF} = 47\mu s$



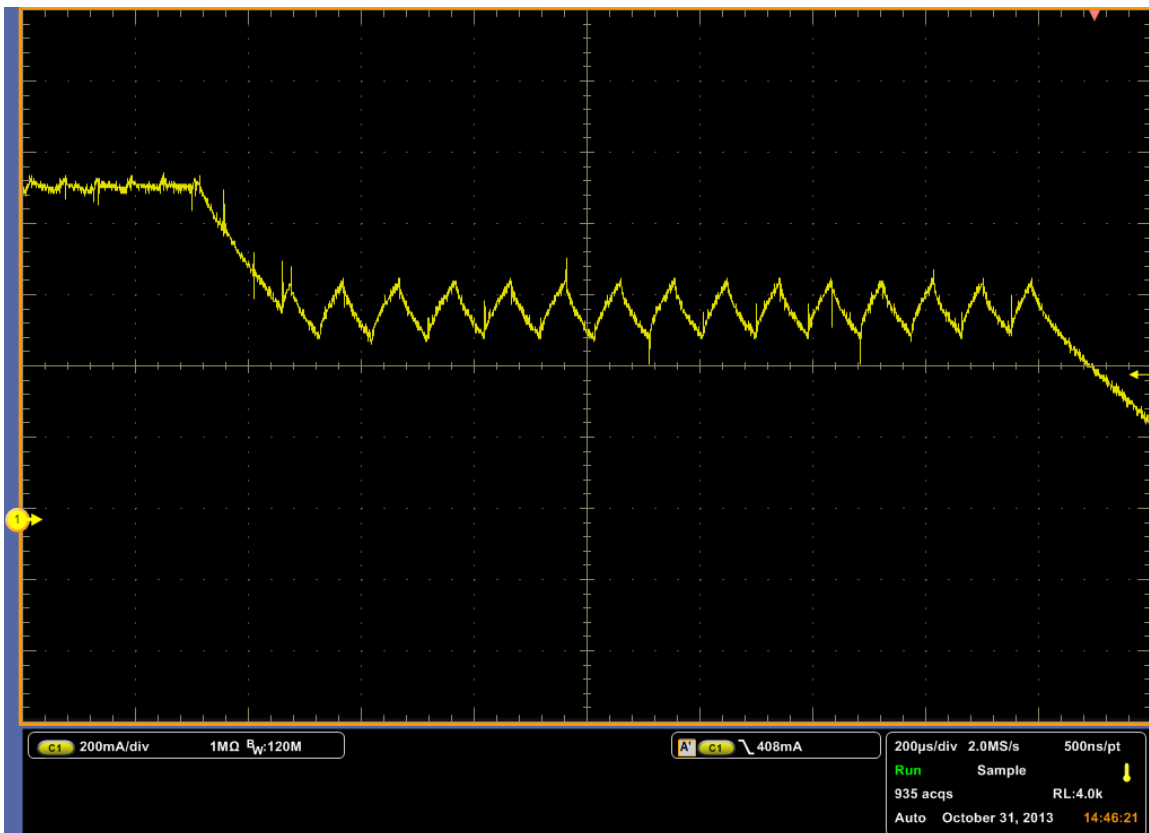
Mixed decay (DECAY = 1V),  $t_{OFF} = 47\mu s$



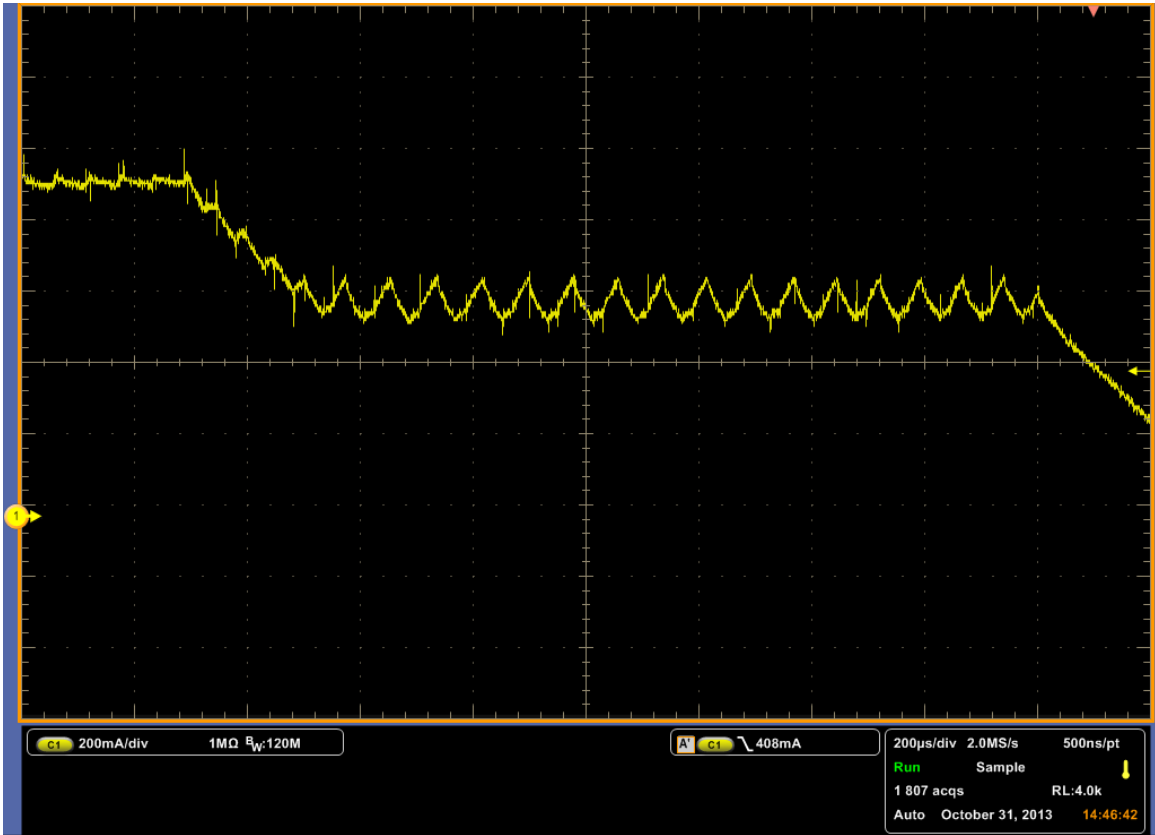
Mixed decay (DECAY = 1.3V),  $t_{OFF} = 47\mu s$



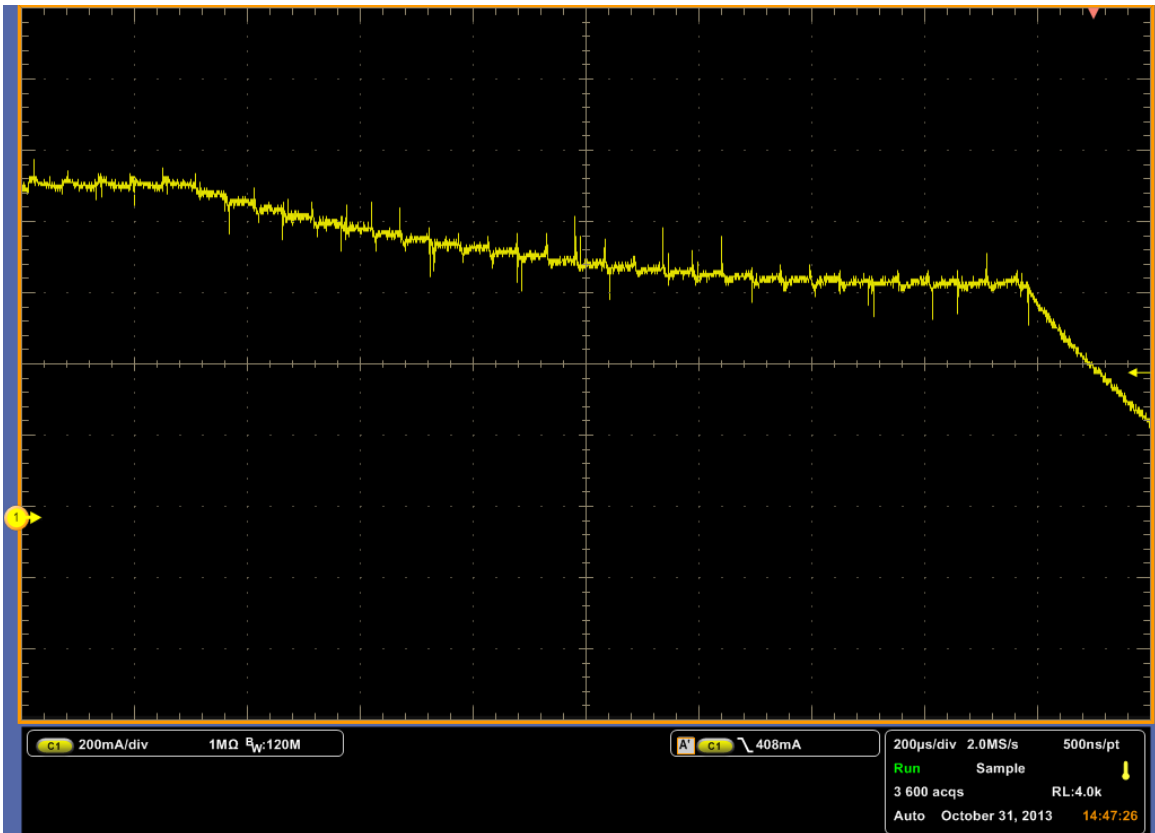
Slow decay,  $t_{OFF} = 47\mu s$



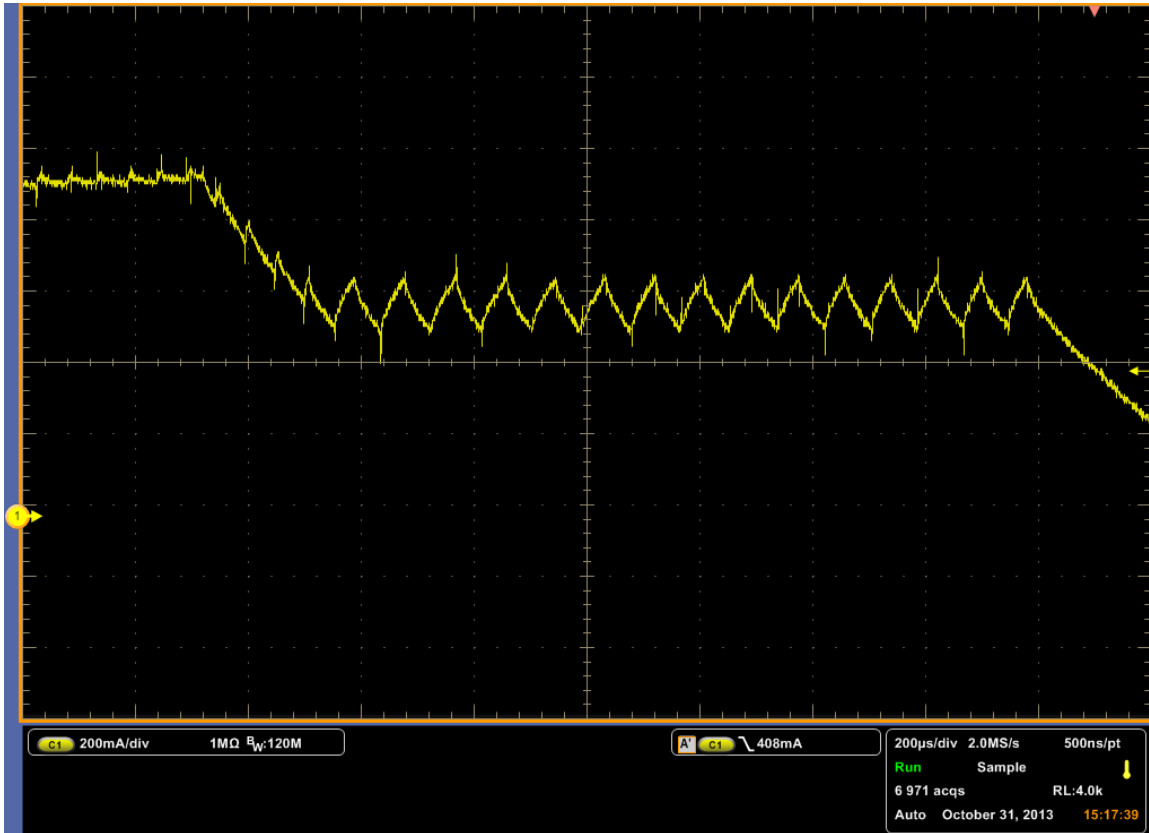
$t_{BLANK} = 1.4\mu s$ , Fast decay



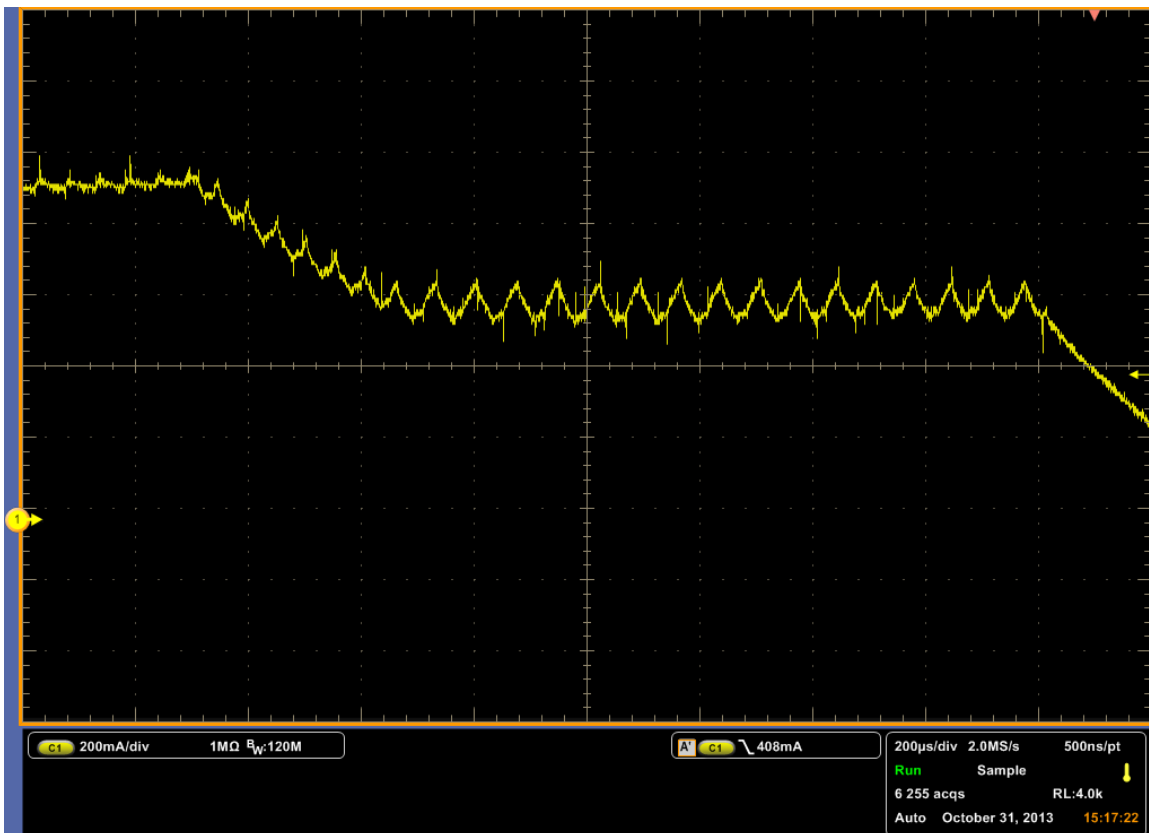
$t_{BLANK} = 1.4\mu s$ , Mixed decay (DECAY = 1V)



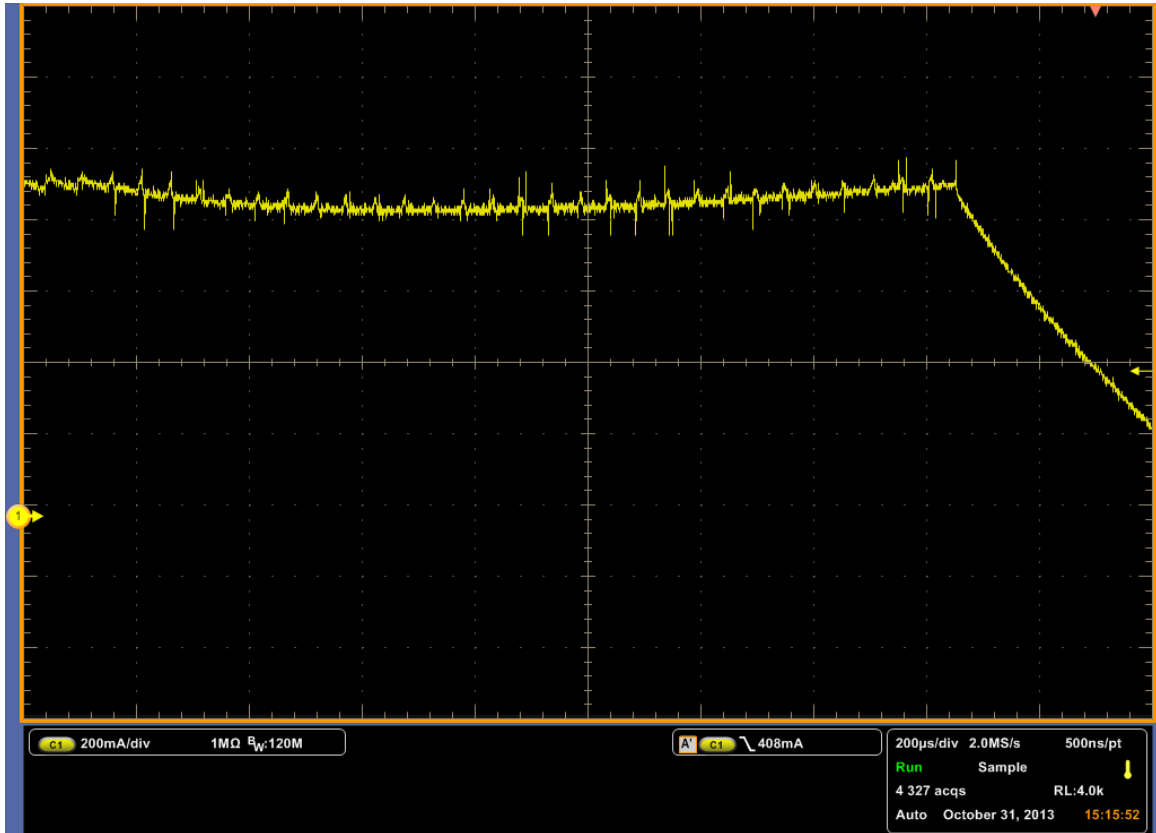
$t_{BLANK} = 1.4\mu s$ , Mixed decay (DECAY = 1.7V)



$t_{\text{BLANK}} = 7\mu\text{s}$ , Fast decay



$t_{\text{BLANK}} = 7\mu\text{s}$ , Mixed decay (DECAY = 1V)



$t_{\text{BLANK}} = 7\mu\text{s}$ , Mixed decay (DECAY = 1.7V)

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