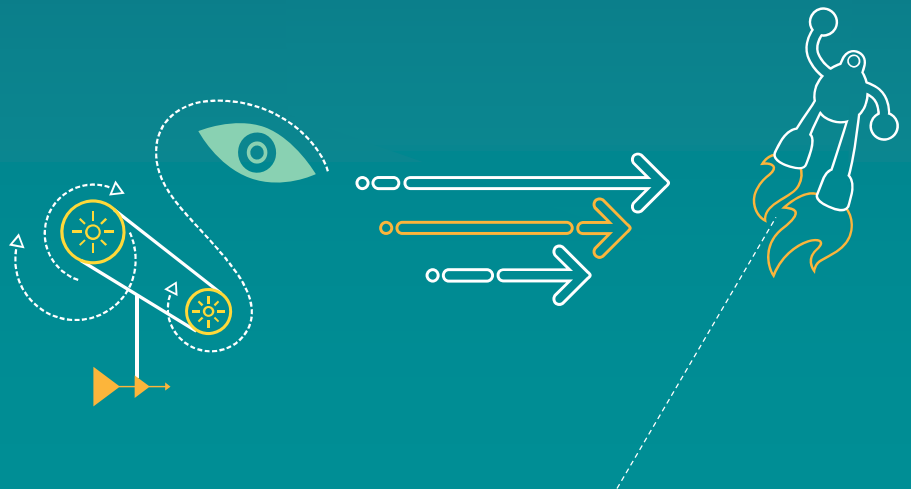
HW Apps

Feb 3, 2015

PM8916 5 V Boost Optimization

Qualcomm Technologies, Inc.



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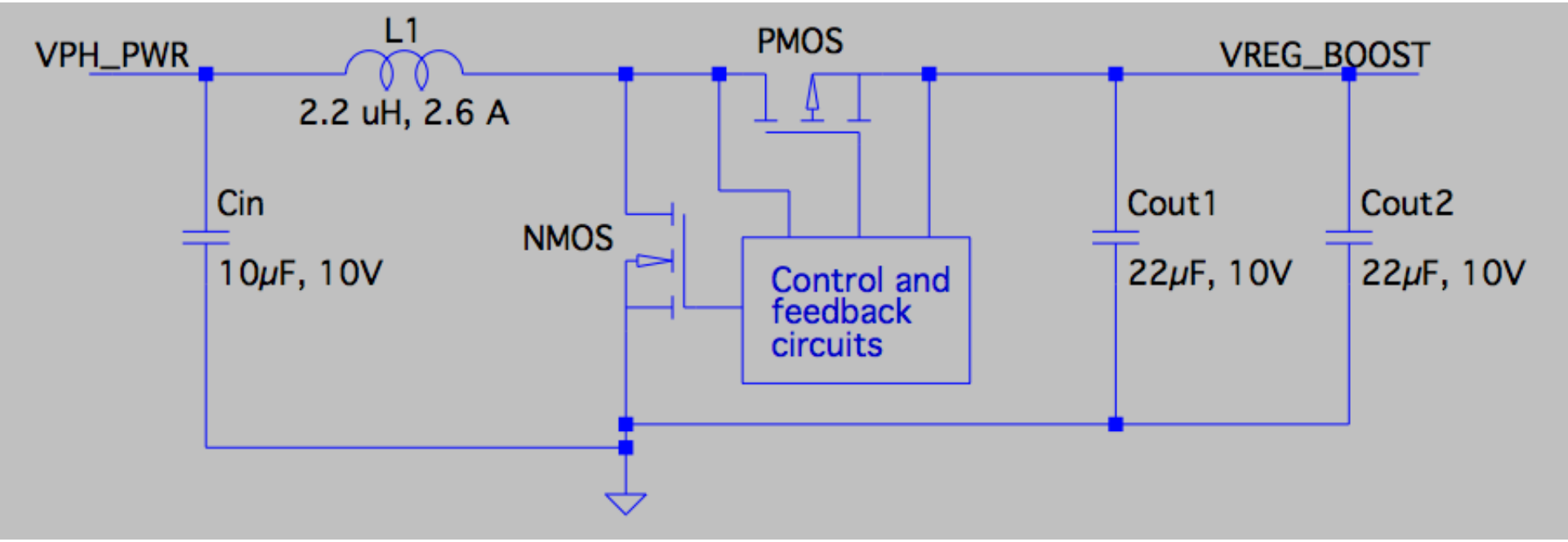
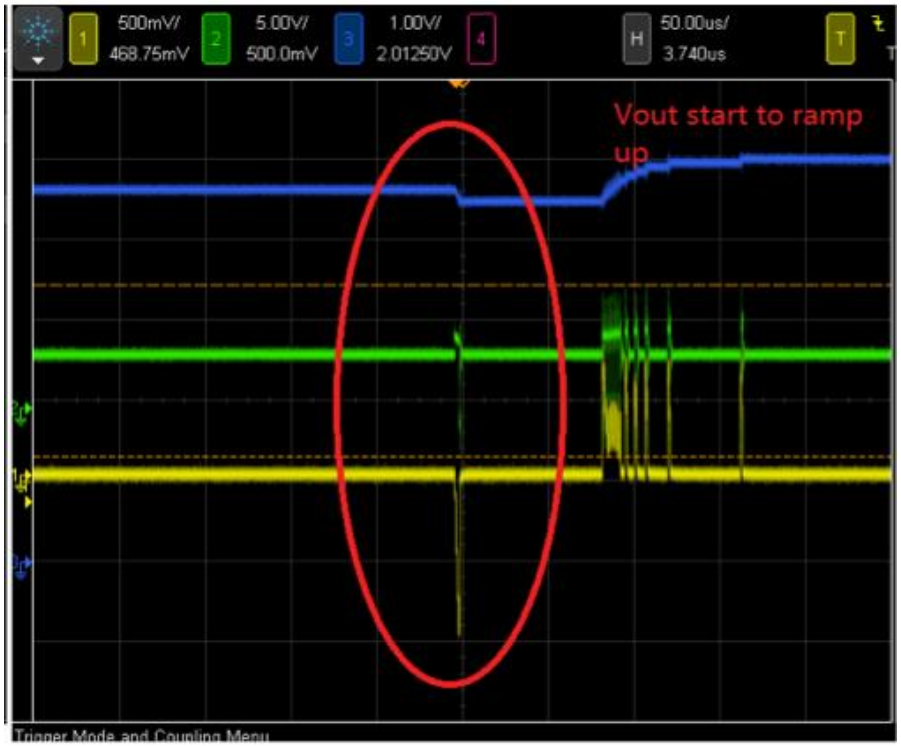
Issue Description

- PM8916 has a 5 V synchronous boost that can be used to drive Earphone and Speakerphone PAs.
- The boost, if used, is enabled by the audio codec driver:
  - In Speakerphone mode, the boost is used to boost the input voltage to 5V.
  - In Earphone mode, the boost is used to bypass the input voltage to output.
  - When the handset changes from Speakerphone to Earphone mode, audio codec driver transitions the boost from boost to bypass mode. This results in current consumption savings.



Issue Description

- It has been observed that certain conditions can result in negative current in the power FETs:
  1. Boost is turned ON, then turned OFF and then quickly turned back ON.
  2. Boost is switched from boost mode to bypass mode with no load.
- An example plot below shows the negative current in the NFET during rapid boost turn on → turn off → turn on event.
- Proper SW sequencing can prevent the occurrence of negative current in the power FETs.



Ch1	Current through NMOS FET
Ch2	VSW_BOOST
Ch3	VREG_BOOST

System Impact

- The negative currents in the power FETs during the conditions listed before can cause reliability issues including boost damage (worst case situation).

- QTI is internally performing tests to determine the impact of the negative current but so far has not been to induce boost damage.

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QTI Recommendations

QTI has come up with following SW workarounds that can prevent the negative currents in the boost power FETs.

- Option 1-A (BOOST_ON_FOREVER) → Keep boost ON all the time; disable bypass mode
  - The boost in enabled during handset boot and left ON all the time the handset is ON.
  - Boost is prevented from changing mode from boost to bypass when handset transitions from Speakerphone mode to Earphone mode.

- Option 1-B (BOOST_ALWAYS) → Enable / disable the boost as required by audio codec driver; disable bypass mode
  - The boost in enabled by audio codec in both Earphone and Speakerphone mode.
  - Boost is prevented from changing mode from boost to bypass when handset transitions from Speakerphone mode to Earphone mode.

- Option 2 (BYPASS_ALWAYS) → Enable / disable the boost in bypass mode as required by audio code driver
  - The boost is put in bypass mode when enabled by audio codec driver in both Earphone and Speakerphone mode.

QTI Recommendations

- Table below shows comparison between the various options (see appendix for bench performance data)
- QTI recommends customers to pick option Option 1-A. It is known that customers using Option 1-A do not see the boost damage.
- Customers can integrate the workaround through SW CR# 787385.

#	Boost behavior	Pros ☺	Cons ☹
Option 1-A (BOOST_ON_ FOREVER)	• On all the time the handset is ON • Bypass mode disabled	• No turning ON and OFF of boost by audio codec driver • No transition from boot to bypass when going from Speakerphone to Earphone mode • Better Earphone performance • No impact on Speakerphone performance	• Additional consumption penalty of ~550 uA all the time.
Option 1-B (BOOST_ ALWAYS)	• On/Off as required by audio codec • Bypass mode disabled	• No transition from boot to bypass when going from Speakerphone to Earphone mode • Better Earphone performance • No impact on Speakerphone performance	• Additional current consumption of ~550 uA in Earphone mode
Option 2 (BYPASS_ ALWAYS)	• On/Off in bypass mode as required by audio codec	• No switching of the boost • Inductor can be replaced by short to save component cost • No impact on Earphone performance. • Current savings of ~550 uA in Speakerphone mode	• Speakerphone PA output power reduced resulting in decrease in speaker loudness

SW configuration

- Note, CR# 787385 has dependency with **CR#748109**, please make sure it is present in the SW as well.
- How to select the each option in SW
  - Modify the mixer path xml file, adding below line to “initial mixer settings” in the front of this file.
    - <ctl name="Boost Option" value=”<mode value>” />
    - <mode value> can be:
      - BOOST_SWITCH: default mode, will switch boost mode and bypass mode.
      - BOOST_ALWAYS: enable boost mode when CODEC is active.
      - BYPASS_ALWAYS: enable bypass mode when CODEC is active.
      - BOOST_ON_FOREVER (new added): support boost–always on from boot-up.

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Additional Recommendations

- Additionally QTI strongly recommends customers to use recommended components for desired performance of the 5 V boost.
  1. Recommended inductor is 2.2 µH (TFM201610AHM-2R2M) that has a typical Isat of 2.6 A and typical DCR of 0.142 Ω. Customers should use this or inductor with better specification.
  2. Two 22 uF, 10 V, 0603 caps are required at the output of boost to ensure stability. Customer can refer to MSM8916/36/39 reference schematic to get a list of recommended parts for this component.
  3. Recommended input capacitor is 22 uF, 10 V, 0603 cap. Customer can refer to MSM8916/36/39 reference schematic to get a list of recommended parts for this component.

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Appendix

Option 1-A / 1-B – Disable Mode Switching

- Bench Characterization of Earphone PA with boost in boost mode.

EAR Standby Power Consumption (Input = -200dBFS)										
S/N	IDD active w/ SBL (mA)	IDD BBYP (mA)	IDD BON V9 (mA)	IDD BON V10 (mA)	IDD BBYP Delta (mA)	IDD BON V9 Delta (mA)	IDD BON V10 Delta (mA)	PWR BBYP Delta (mW)	PWR BON V9 Delta (mW)	PWR BON V10 Delta (mW)
474	4.94	6.87	7.5	8.15	1.93	2.56	3.21	7.141	9.472	11.877
486	4.97	6.84	7.52	8.11	1.87	2.55	3.14	6.919	9.435	11.618
504	5.45	7.35	8.02	8.85	1.9	2.57	3.4	7.03	9.509	12.58
516	5.01	6.86	7.53	8.15	1.85	2.52	3.14	6.845	9.324	11.618

EAR Power Consumption @ 0.1mW output power										
S/N	IDD active w/ SBL (mA)	IDD BBYP (mA)	IDD BON V9 (mA)	IDD BON V10 (mA)	IDD BBYP Delta (mA)	IDD BON V9 Delta (mA)	IDD BON V10 Delta (mA)	PWR BBYP Delta (mW)	PWR BON V9 Delta (mW)	PWR BON V10 Delta (mW)
474	4.94	8.27	9.67	10.5	3.33	4.73	5.56	12.321	17.501	20.572
486	4.97	8.25	9.6	10.43	3.28	4.63	5.46	12.136	17.131	20.202
504	5.45	8.72	10.24	11.22	3.27	4.79	5.77	12.099	17.723	21.349
516	5.01	8.25	9.66	10.53	3.24	4.65	5.52	11.988	17.205	20.424

EAR G6 R32 BBYP vs BON								
	CnP (uV)		IMD		SNDR		ORN	
S/N	BBYP	BON	BBYP	BON	BBYP	BON	BBYP	BON
1	227.65	249	87	91	90	93	7.1	7.1
2	206.31	234.78	85	91	89	93	7.2	7.2
3	405.5	362.81	87	91	8	94	7.1	7.1
4	718.53	576.25	84	90	88	93	7.2	7.2

V9 → Boost output at 5V
V10 → Boost output at 5.5V

Current consumption is measured at the battery

Option 2 – Put boost in bypass mode

- Bench Characterization of Speakerphone PA with boost in bypass mode.

Parameter	Test Conditions	BBYP				VBAT			
		Min	Typ	Max	Units	Min	Typ	Max	Units
Absolute gain error	Input = -20dBFS, 1.02kHz	-0.5		0.5	dB	-0.5		0.5	dB
Receive Noise	A-weighted;input=-999dBFS		56	100	µVrms		50	100	µVrms
THD+N	Pout=500mW,1KHz,VDD_SPKR=3.6V		-67	-40	dB		-79	-40	dB
	Pout=1W,1KHz,VDD_SPKR=4.2V		-23	-20	dB		-36	-20	dB
Output power (Pout)	VDD=3.6V THD+N≤1%;15µH+8Ω+15µH	574	615		mW	670	690		mW
	VDD=3.8V THD+N≤1%;15µH+8Ω+15µH	649	693		mW	698	720		mW
	VDD=4.2V THD+N≤1%;15µH+8Ω+15µH	807	855		mW	929	956		mW
Power supply rejection	200 mVpp sine wave imposed on PMIC_BATT; digital input = -999 dBFS								
	f = 217 Hz	60	75		dB	60	79		dB
	f = 1 kHz	60	75		dB	60	79		dB
	f = 10 kHz	40	75		dB	40	50		dB
	f = 20 kHz	40	70		dB	40	50		dB
Efficiency	VDD=3.7V,Pout= 500mW; 15µH+8Ω+15µH	82	85.2		%	85	89		%
Click and Pop	No signal, turn on/off, mute/unmute, A-weighted		0.6	10	mVpp		0.6	10	mVpp

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