Customer:	**onsemi Customer**
Board Info:	**30V to 60V BLDC Motor Drive**
Power Rail:	**48V, 1200W**
Date:	**9/8/2021**

Design Name/OPN:

Design Summary		
STR-30-60V-BLDC-MDK-GEVB		
Controller		Xilinx
Driver		NCP81075
Power Stage 3x	HS x 1	NTMFS6H800N
	LS x 1	NTMFS6H800N
Efficiency		NA
Control		6-Step Trapezoidal
Switch Type		Unipolar
Switching		20kHz

Design Notes:

Generic Reference Design

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Summary

Specifications	Value	Unit	Comments
Input Ripple	3.48	V	At 1200W
Bootstrap Ripple	2307	mV	At 1200W
Max Efficiency	NA	%	At W
Max Temperature	78	˚C	At 1200W
OCP Limit (HW)	82	A	Adjustable SW OCP
Test Speed	3000	RPM	
PWM Frequency	20	kHz	At 1200W Load
Max Power	1200	W	Power Stage Output
Test Voltage	48	V	

U-Phase			
Dead Time (ON)	79.5	ns	
Dead Time (OFF)	72.6	ns	
Max SWN Ring	58	V	

V-Phase			
Dead Time (ON)	79.4	ns	
Dead Time (OFF)	72.9	ns	
Max SWN Ring	54.8	V	

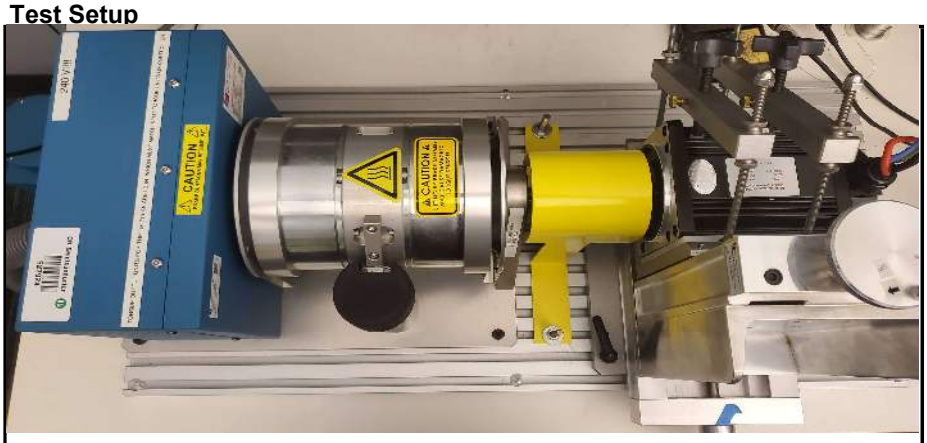
W-Phase			
Dead Time (ON)	79	ns	
Dead Time (OFF)	73.5	ns	
Max SWN Ring	53.6	V	

Test Power Supply

Chroma - 62012P-80-60

From measured data
Design information
Overwrite for custom configuration
Not applicable

Test Setup



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Test Motor

Test Motor #1	MFR	MFRPN	
	ATO	110WD-M0430-48V	
Specifications	**Value**	**Unit**	**Comments**
Rated Voltage	48	V	
BEMF/Torque Constant	0.127	V-s/rad	
Stator Inductance	0.085	mL	
Stator Resistance	0.433	mΩ	
Pole Pairs	4		
Rated Speed	3000	RPM	
Rated Torque	4	N·m	
Rated Power	1200	W	
Rotor Inertia			
Winding Type	Wye		
Shaft Diameter	20	mm	
Sensors	Hall		

Test Motor #2	MFR	MFRPN	
	MotorMFR	MOTOR_P#	
Specifications	**Value**	**Unit**	**Comments**
BEMF/Torque Constant		N·m	
Stator Inductance		mL	
Stator Resistance		mΩ	
Pole Pairs			
Rated Speed		RPM	
Rated Torque		N·m	
Rated Power		W	
Rotor Inertia			
Winding Type			
Shaft Diameter		mm	
Sensors			

Test Motor #3	MFR	MFRPN	
	MotorMFR	MOTOR_P#	
Specifications	**Value**	**Unit**	**Comments**
BEMF/Torque Constant		N·m	
Stator Inductance		mL	
Stator Resistance		mΩ	
Pole Pairs			
Rated Speed		RPM	
Rated Torque		N·m	
Rated Power		W	
Rotor Inertia			
Winding Type			
Shaft Diameter		mm	
Sensors			

Test Motor

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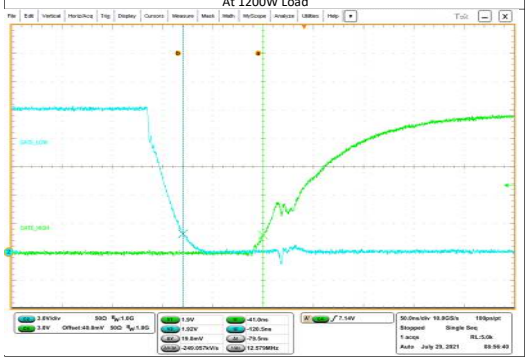
Switching Waveforms

Phase	Deadtime		Max Ringing	Min Ringing
	OFF	ON		
U	73 ns	80 ns	58.00 V	-10.2 V
V	73 ns	79 ns	54.80 V	-9.0 V
W	74 ns	79 ns	53.60 V	-11.4 V

U Phase Deadtime

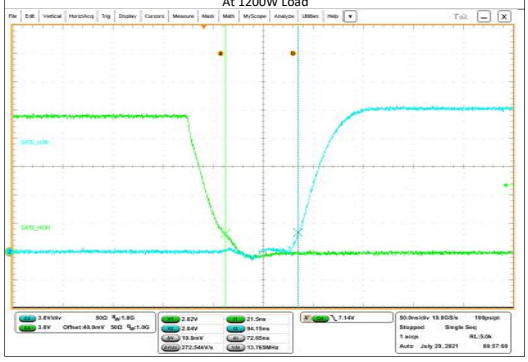
GATE_LOW
GATE_HIGH

At 1200W Load



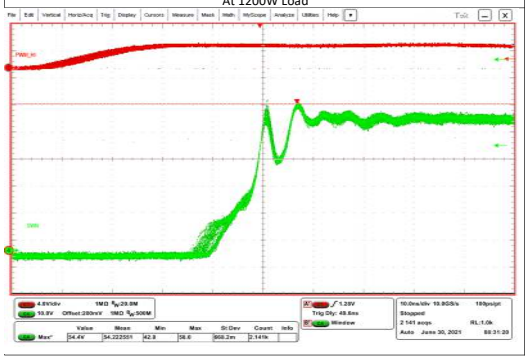
GATE_LOW
GATE_HIGH

At 1200W Load



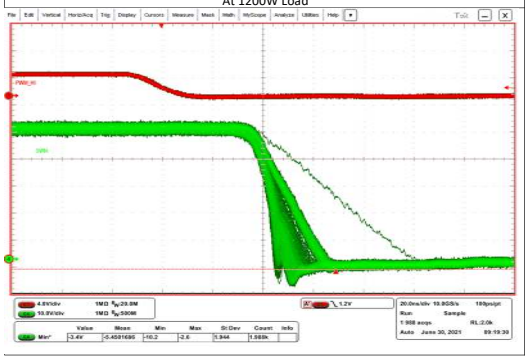
PWM_HIGH
SWN

At 1200W Load



PWM_HIGH
SWN

At 1200W Load

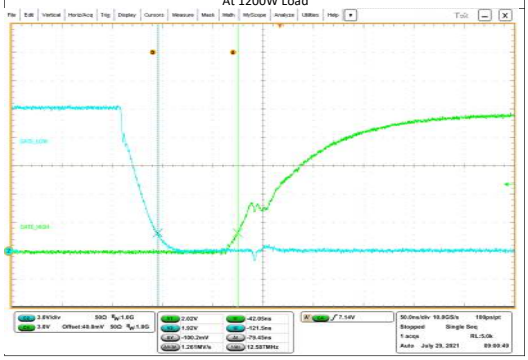


V Phase Deadtime

GATE_LOW

GATE_HIGH

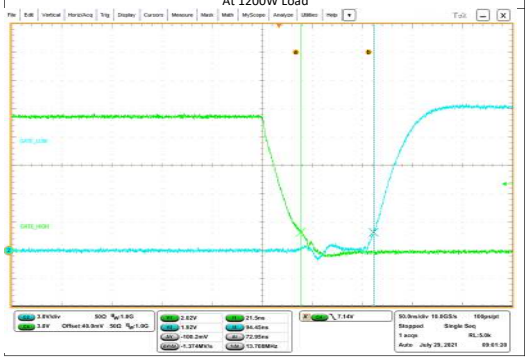
At 1200W Load



GATE_LOW

GATE_HIGH

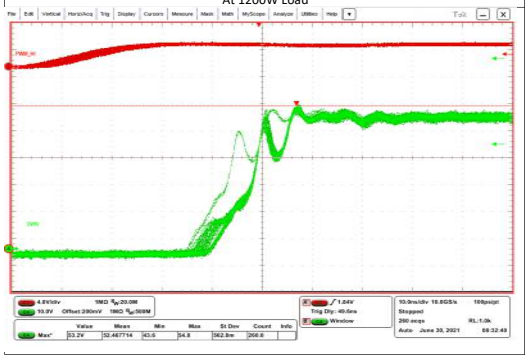
At 1200W Load



PWM_HIGH

SWN

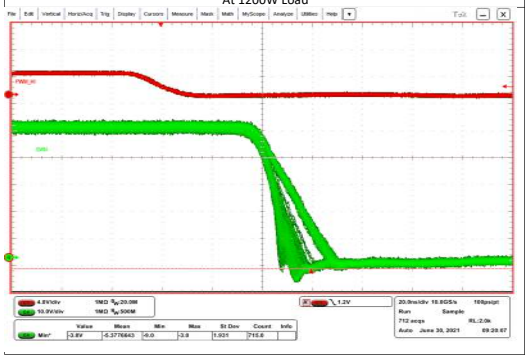
At 1200W Load



PWM_HIGH

SWN

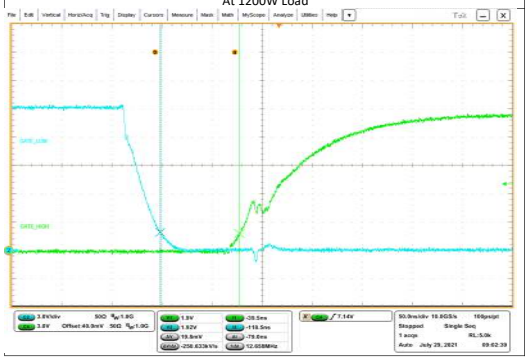
At 1200W Load



W Phase Deadtime

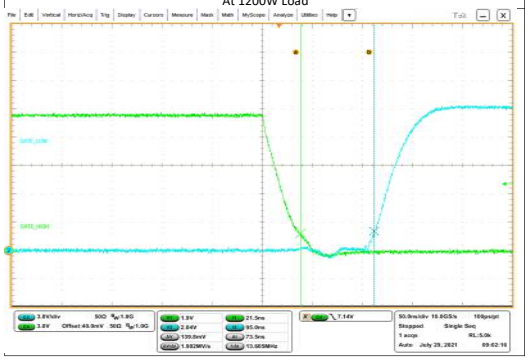
GATE_LOW
GATE_HIGH

At 1200W Load



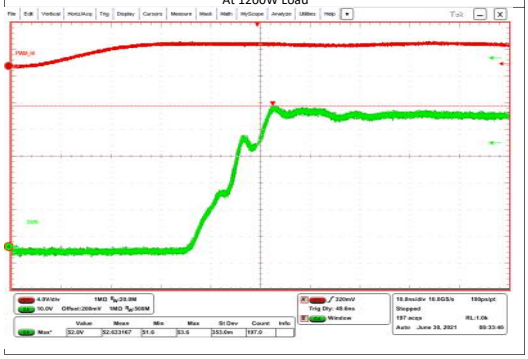
GATE_LOW
GATE_HIGH

At 1200W Load



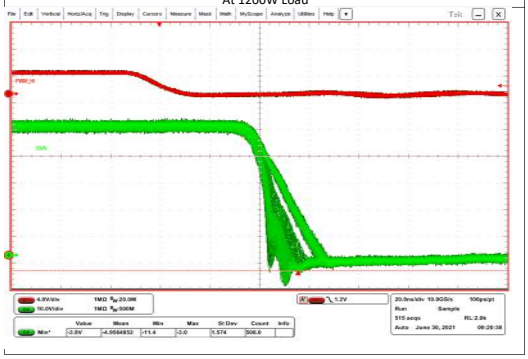
PWM_HIGH
SWN

At 1200W Load



PWM_HIGH
SWN

At 1200W Load



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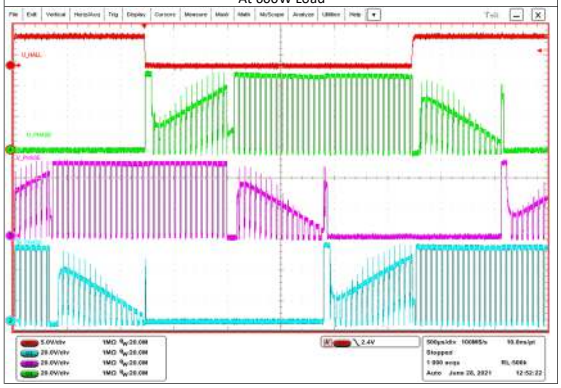
Modulation

	PWM Frequency	Duty Cycle
No Load	20.0 kHz	76.9 %
1200 W	20.0 kHz	85.6 %

Phase Waveform

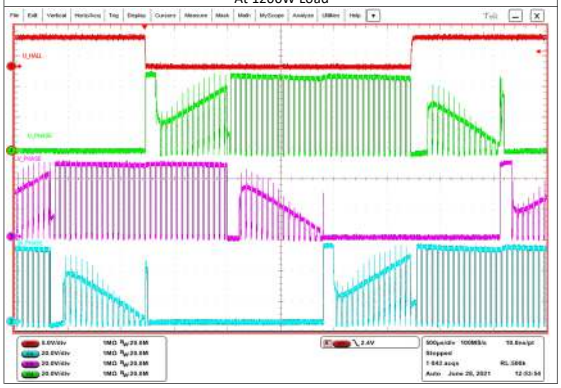
U_HALL W_PHASE
V_PHASE U_PHASE

At 600W Load



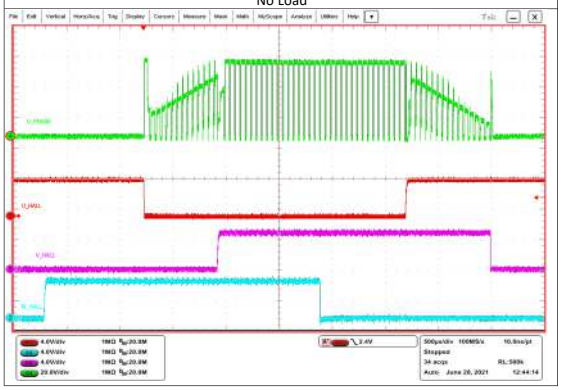
U_HALL W_PHASE
V_PHASE U_PHASE

At 1200W Load



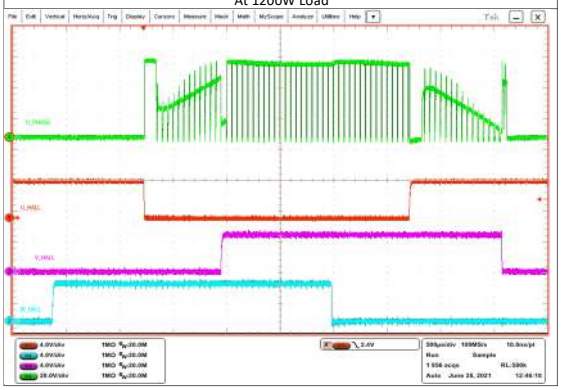
U_HALL W_HALL
V_HALL U_PHASE

No Load



U_HALL W_HALL
V_HALL U_PHASE

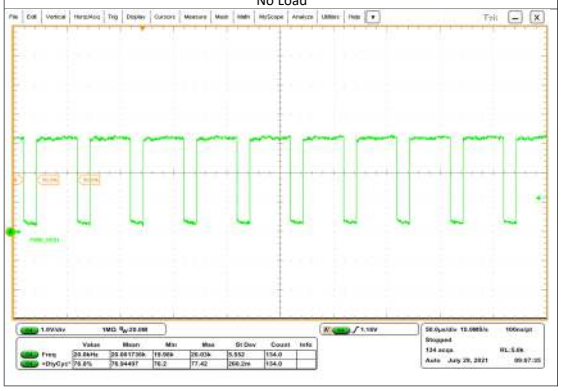
At 1200W Load



PWM Duty Cycle

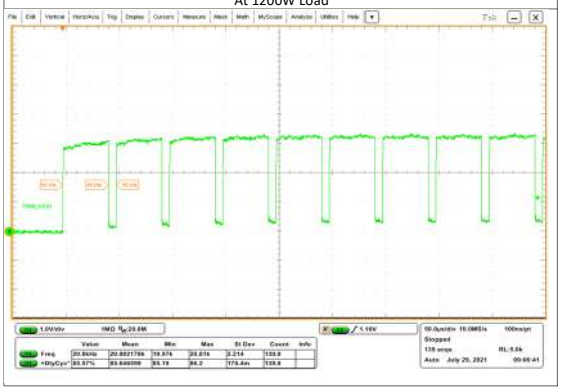
U_PWM_HIGH

No Load



U_PWM_HIGH

At 1200W Load



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DC Voltages

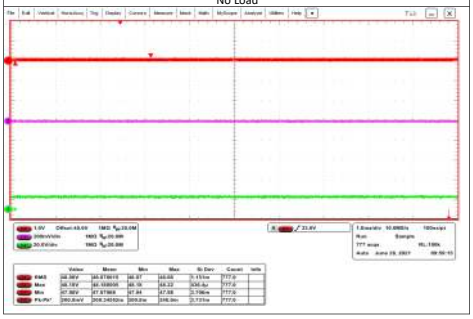
DC Input Voltage Ripple		
Load	Vout RMS	Vout PkPk
No Load	48.07 V	0.24 V
1200 W	48.00 V	3.48 V

Bootstrap Capacitor Voltage at		
Phase	Vout RMS	Vout PkPk
U	14.67 V	2039 mV
V	14.69 V	2264 mV
W	14.68 V	2307 mV

DC Input Ripple

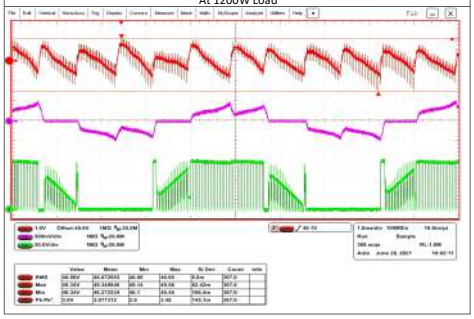
DC_INPUT / U_PHASE_CURRENT — U_PHASE

No Load



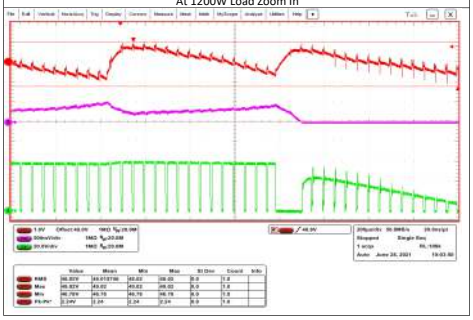
DC_INPUT / U_PHASE_CURRENT — U_PHASE

At 1200W Load



DC_INPUT / U_PHASE_CURRENT — U_PHASE

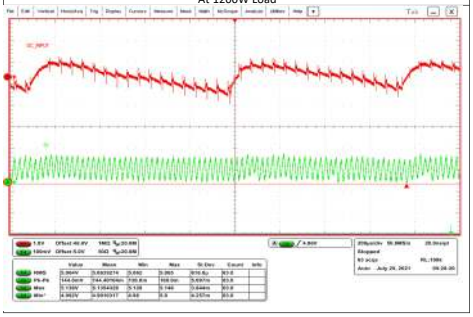
At 1200W Load Zoom In



Auxiliary Power Rail Ripple at 1200W

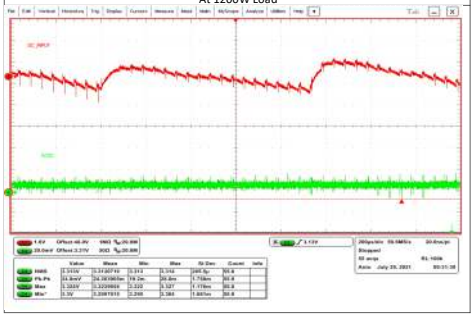
DC_INPUT — 5V

At 1200W Load



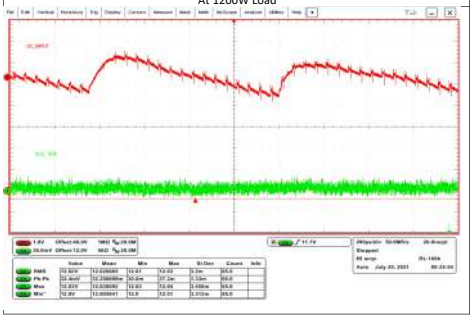
DC_INPUT — 3V3IO

At 1200W Load



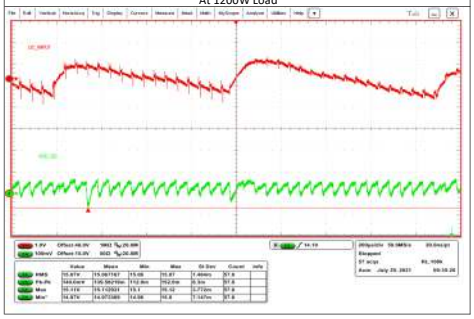
DC_INPUT — VCC_1034

At 1200W Load



DC_INPUT — VDD_GD

At 1200W Load

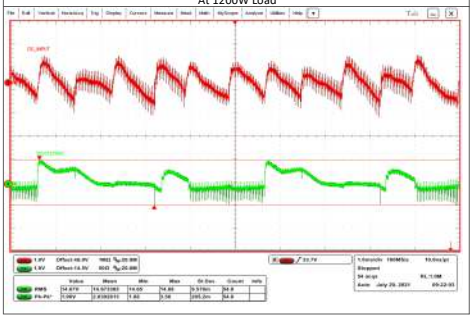


Gate Drive Voltage Ripple (Across BST Capacitor)

DC_INPUT

U_BOOTSTRAP

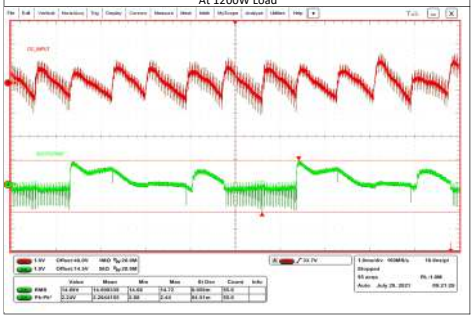
At 1200W Load



DC_INPUT

V_BOOTSTRAP

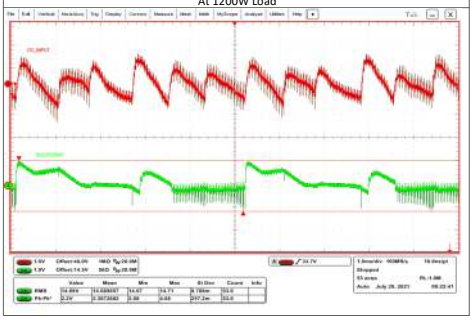
At 1200W Load



DC_INPUT

W_BOOTSTRAP

At 1200W Load

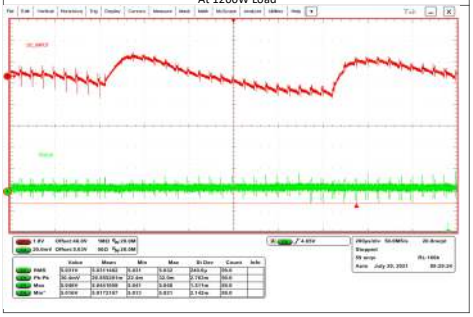


Auxiliary Power Rail Ripple at 1200W

DC_INPUT

5VAUX

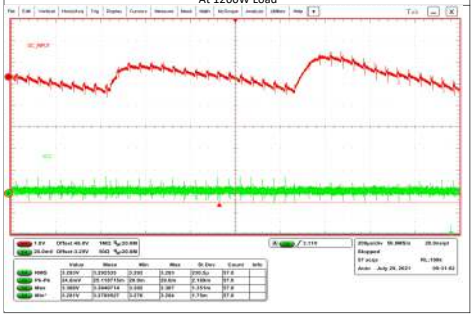
At 1200W Load



DC_INPUT

VCC

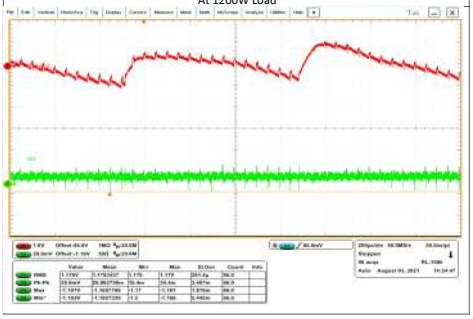
At 1200W Load



DC_INPUT

VEE

At 1200W Load



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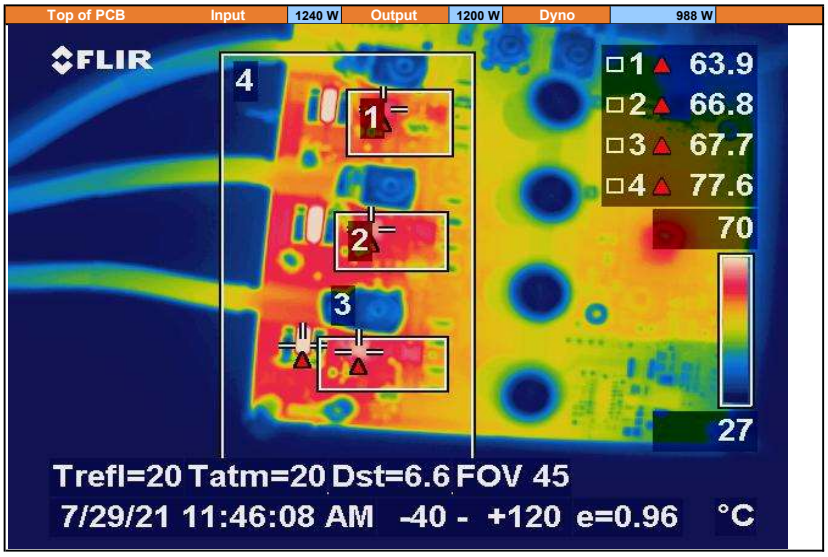
Thermals

Tsoak =	10 min
Ambient =	23.0 °C
Load =	1200 W
Airflow =	0 lfm

Top of PCB					Bottom of PCB			
Area	Component		Temp	Rise	Area	Component	Temp	Rise
1	U Phase	HS FET	60.7 °C	37.7 °C	1	Driver (W)	67.3 °C	44.3 °C
		LS FET	63.9 °C	40.9 °C	2	Driver (V)	67.6 °C	44.6 °C
2	V Phase	HS FET	63.7 °C	40.7 °C	3	Driver (U)	65.9 °C	42.9 °C
		LS FET	66.8 °C	43.8 °C	4	Entire Power Stage	67.6 °C	44.6 °C
3	W Phase	HS FET	64.9 °C	41.9 °C				
		LS FET	67.7 °C	44.7 °C				
4	Entire Power Stage		77.6 °C	54.6 °C				
Max Temp / Rise =			77.6 °C	54.6 °C	Max Temp / Rise =		67.6 °C	44.6 °C



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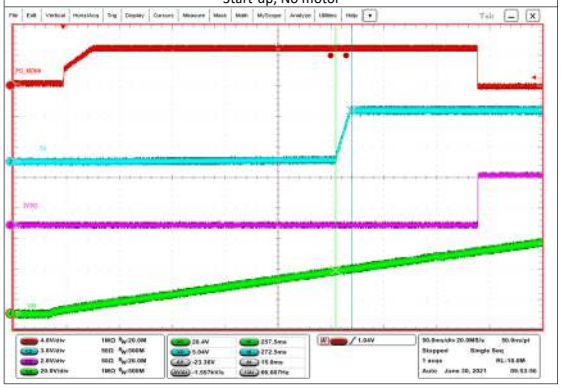
Start-up / Shut-down

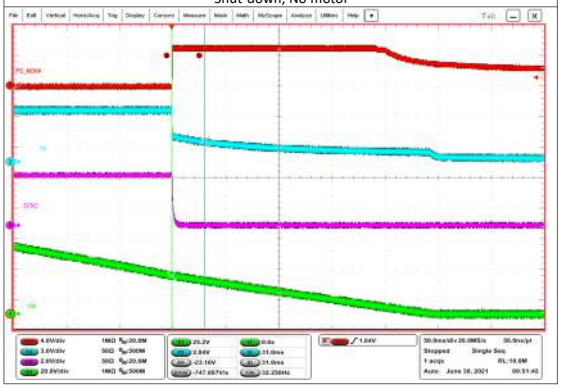
PG_MDK#	5V
3V3IO	VIN

Start-up, No motor



PG_MDK#	5V
3V3IO	VIN

Shut-down, No motor



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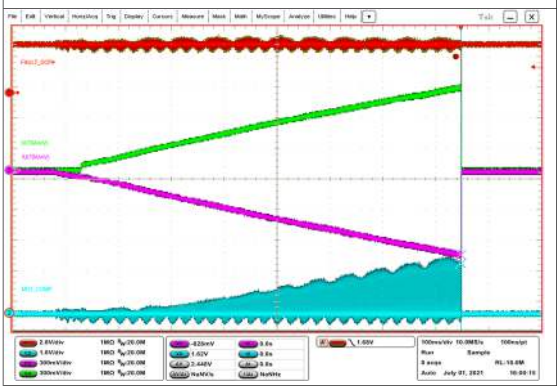
Protection

	Set Point	Current
HW	80 A	82 A
SW	25 A	25 A

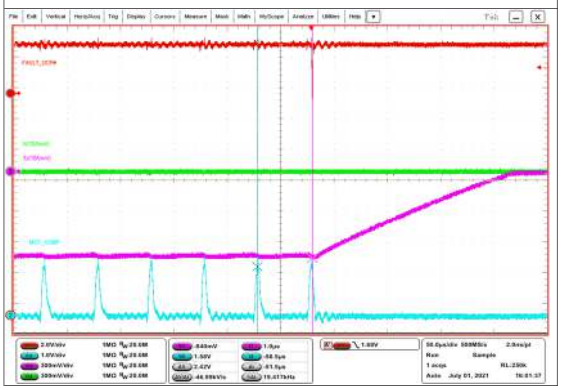
	Set Point	Trip Point	
SW	14.0 V	14.28 V	No Load
SW	14.0 V	13.88 V	1200 W

Hardware OCP

FAULT_OCP#
IU_(10mV/A)
MOT_COMP
IV_(10mV/A)

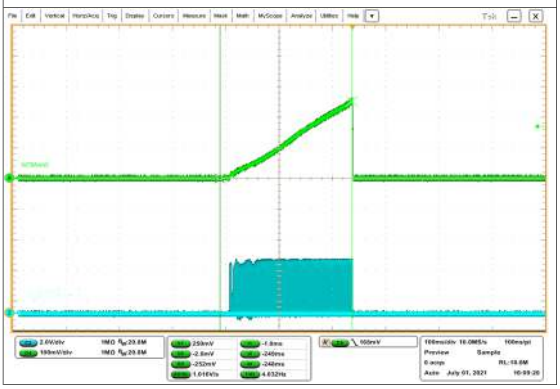


FAULT_OCP#
IU_(10mV/A)
MOT_COMP
IV_(10mV/A)



Software_OCP

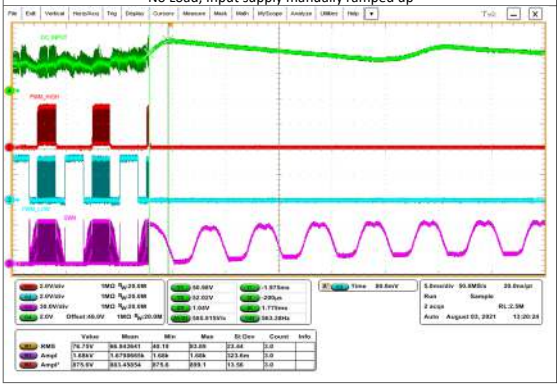
U_PWM_HIGH
IV(10A/mV)



OVP

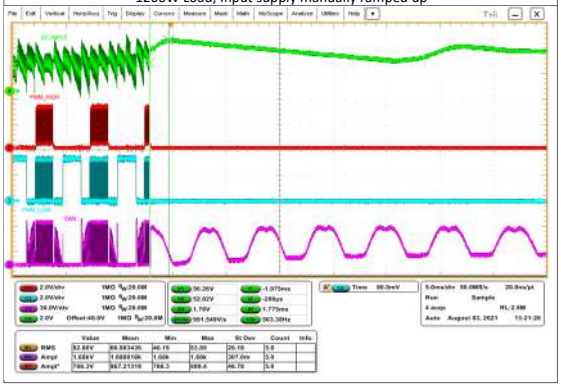
PWM_HIGH
SWN
PWM_LOW
DC_INPUT

No Load, Input supply manually ramped up



PWM_HIGH
SWN
PWM_LOW
DC_INPUT

1200W Load, Input supply manually ramped up



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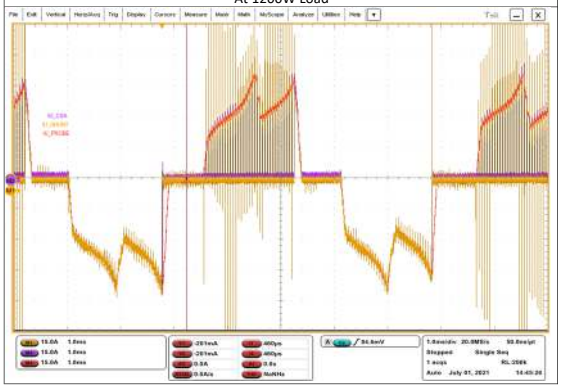
Current Sense

IU_PROBE

IU_CSA

IU_SHUNT

At 1200W Load

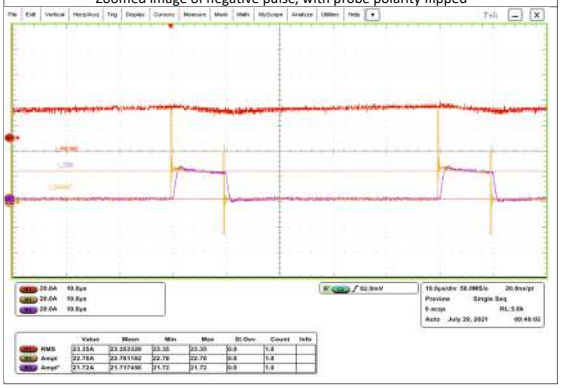


IU_PROBE

IU_CSA

IU_SHUNT

Zoomed image of negative pulse, with probe polarity flipped

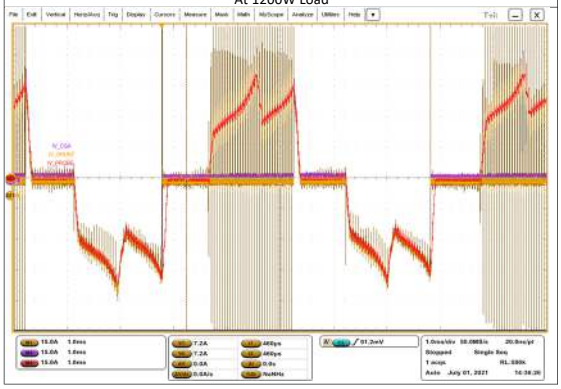


IV_PROBE

IV_CSA

IV_SHUNT

At 1200W Load

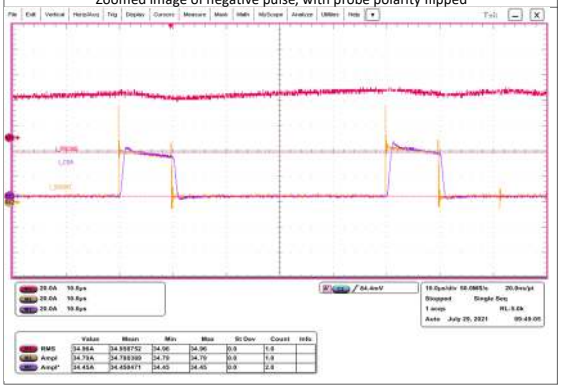


IV_PROBE

IV_CSA

IV_SHUNT

Zoomed image of negative pulse, with probe polarity flipped

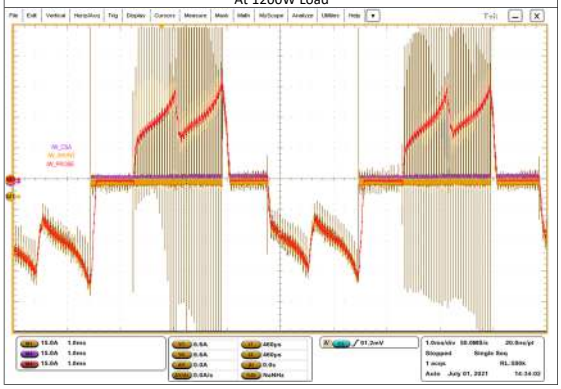


IW_PROBE

IW_CSA

IW_SHUNT

At 1200W Load



IW_PROBE

IW_CSA

IW_SHUNT

Zoomed image of negative pulse, with probe polarity flipped