



<b>Customer:</b>	<b>onsemi Customer</b>
<b>Board Info:</b>	<b>60V to 100V BLDC Motor Drive</b>
<b>Power Rail:</b>	<b>96V, 1200W</b>
<b>Date:</b>	<b>9/8/2021</b>

Design Summary	
<b>Design Name/OPN:</b>	<b>STR-60-100V-BLDC-MDK-GEVB</b>
<b>Controller</b>	Xilinx
<b>Driver</b>	NCP81075
<b>Power</b>	HS x 1 NTMFS7D5N15MC
<b>Stage 3x</b>	LS x 1 NTMFS7D5N15MC
<b>Efficiency</b>	NA
<b>Control</b>	6-Step Trapezoidal
<b>Switch Type</b>	Unipolar
<b>Switching</b>	20kHz

<b>Design Notes:</b>	Generic Reference Design
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## Summary

Specifications	Value	Unit	Comments
Input Ripple	2.6	V	At 1200W
Bootstrap Ripple	2800	mV	At 1200W
Max Efficiency	NA	%	At W
Max Temperature	73	°C	At 1200W
OCP Limit (HW)	45	A	Adjustable SW OCP
Test Speed	3000	RPM	
PWM Frequency	20	kHz	At 1200W Load
Max Power	1200	W	Power Stage Output
Test Voltage	96	V	

U-Phase			
Dead Time (ON)	94.4	ns	
Dead Time (OFF)	86.9	ns	
Max SWN Ring	128	V	

V-Phase			
Dead Time (ON)	94.6	ns	
Dead Time (OFF)	85.5	ns	
Max SWN Ring	131.2	V	

W-Phase			
Dead Time (ON)	91.9	ns	
Dead Time (OFF)	88.6	ns	
Max SWN Ring	129.6	V	

**Test Power Supply**

Chroma - 62012P-80-60
From measured data
Design information
Overwrite for custom configuration
Not applicable

**Test Setup**



**Test Motor**

Test Motor #1	MFR	MFRPN	
	ATO	110WD-M04030-96V	
Specifications	Value	Unit	Comments
Rated Voltage	96	V	
BEMF/Torque Constant	0.254966	V-s/rad	
Stator Inductance	334	mL	
Stator Resistance	829	mΩ	
Pole Pairs	4		
Rated Speed	3000	RPM	
Rated Torque	4	N·m	
Rated Power	1200	W	
Rotor Inertia	0.00065	kg·m <sup>2</sup>	
Winding Type	Wye		
Shaft Diameter	19	mm	
Sensors	Hall		

Test Motor #2	MFR	MFRPN	Comments
	MotorMFR	MOTOR_P#	
Specifications	Value	Unit	
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			

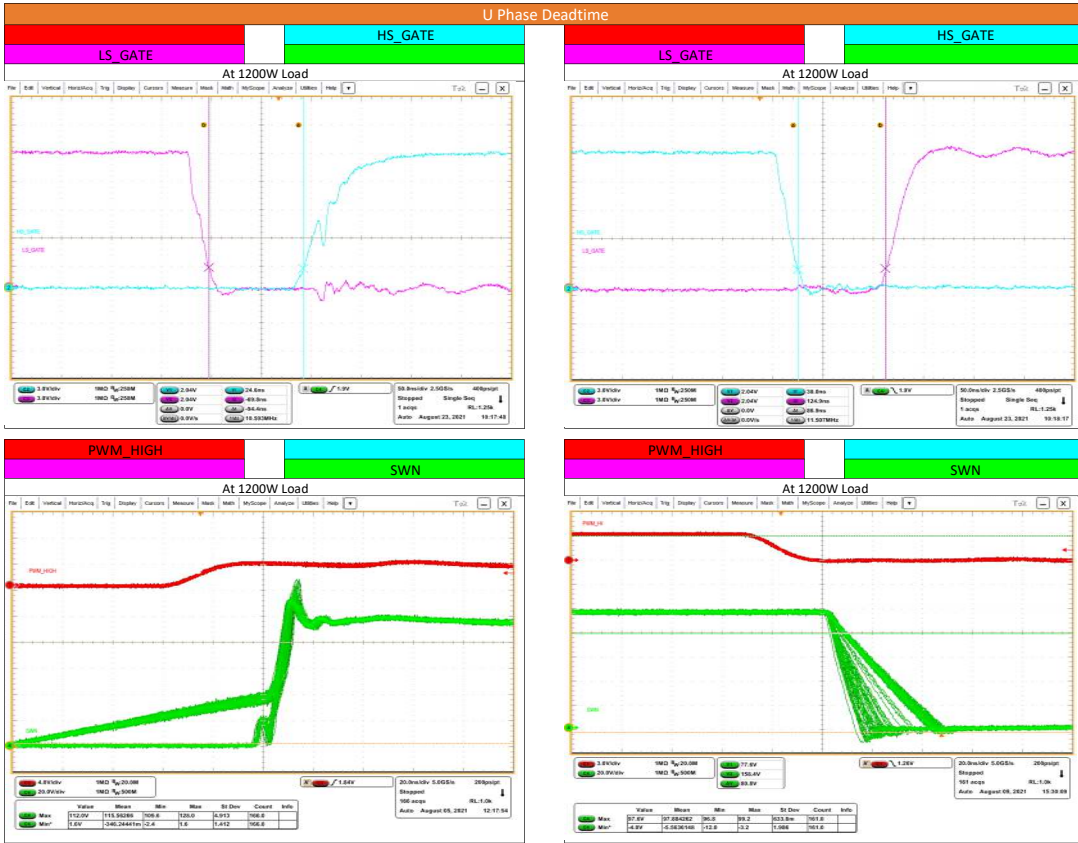
Test Motor #3	MFR	MFRPN	Comments
	MotorMFR	MOTOR_P#	
Specifications	Value	Unit	
BEMF/Torque Constant		N·m	
Stator Inductance		mL	
Stator Resistance		mΩ	
Pole Pairs			
Rated Speed		RPM	
Rated Torque		N·m	
Rated Power		W	
Rotor Inertia			
Winding Type			
Shaft Diameter		mm	
Sensors			

**Test Motor**

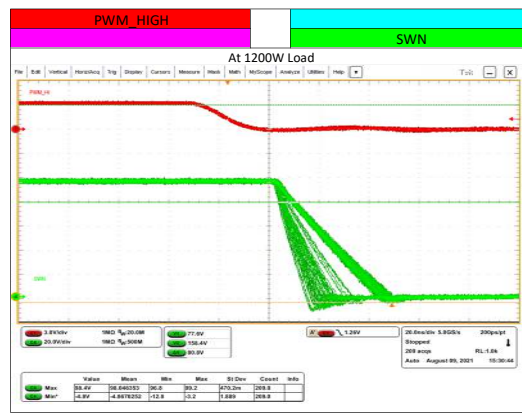
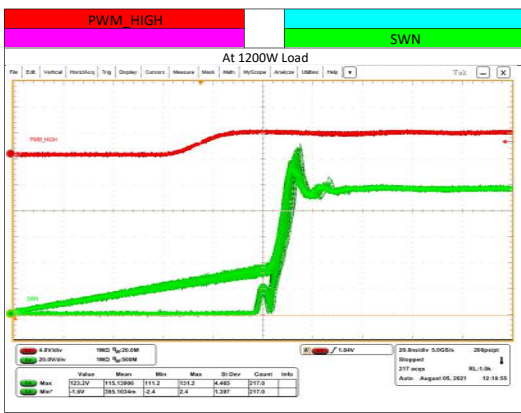
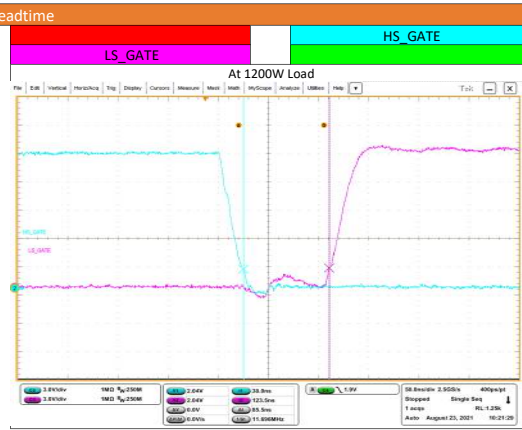
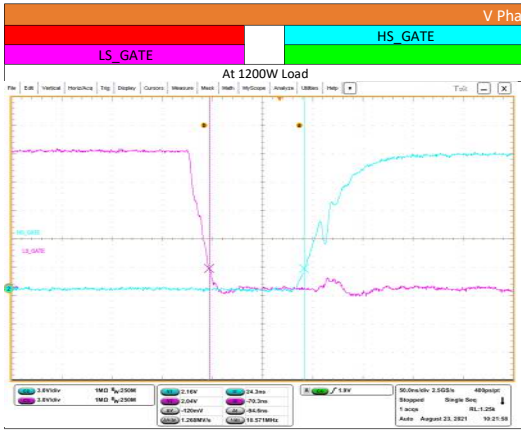


Switching Waveforms

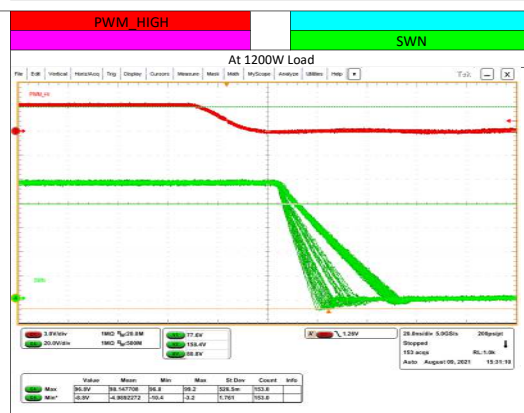
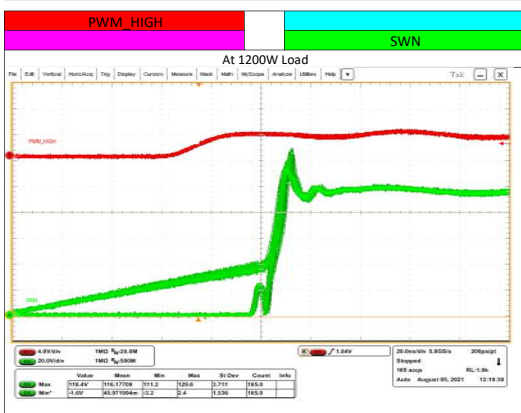
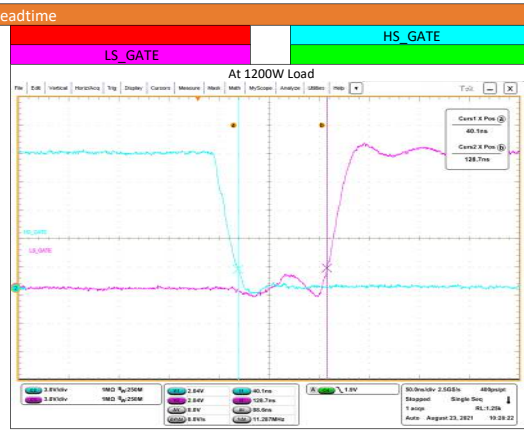
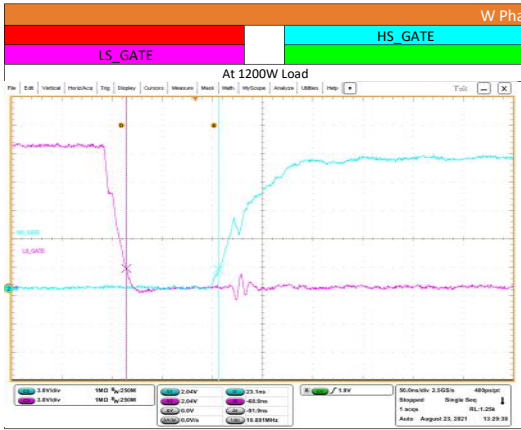
Phase	Deadtime		Max Ringing	Min Ringing
	OFF	ON		
U	87 ns	94 ns	128.00 V	-12.0 V
V	86 ns	95 ns	131.20 V	-12.0 V
W	89 ns	92 ns	129.60 V	-10.4 V



V Phase Deadtime

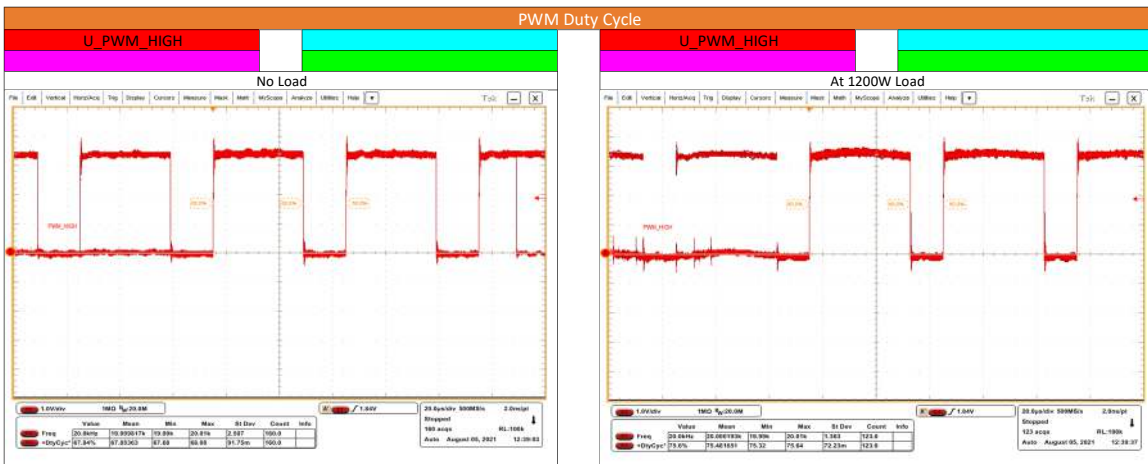
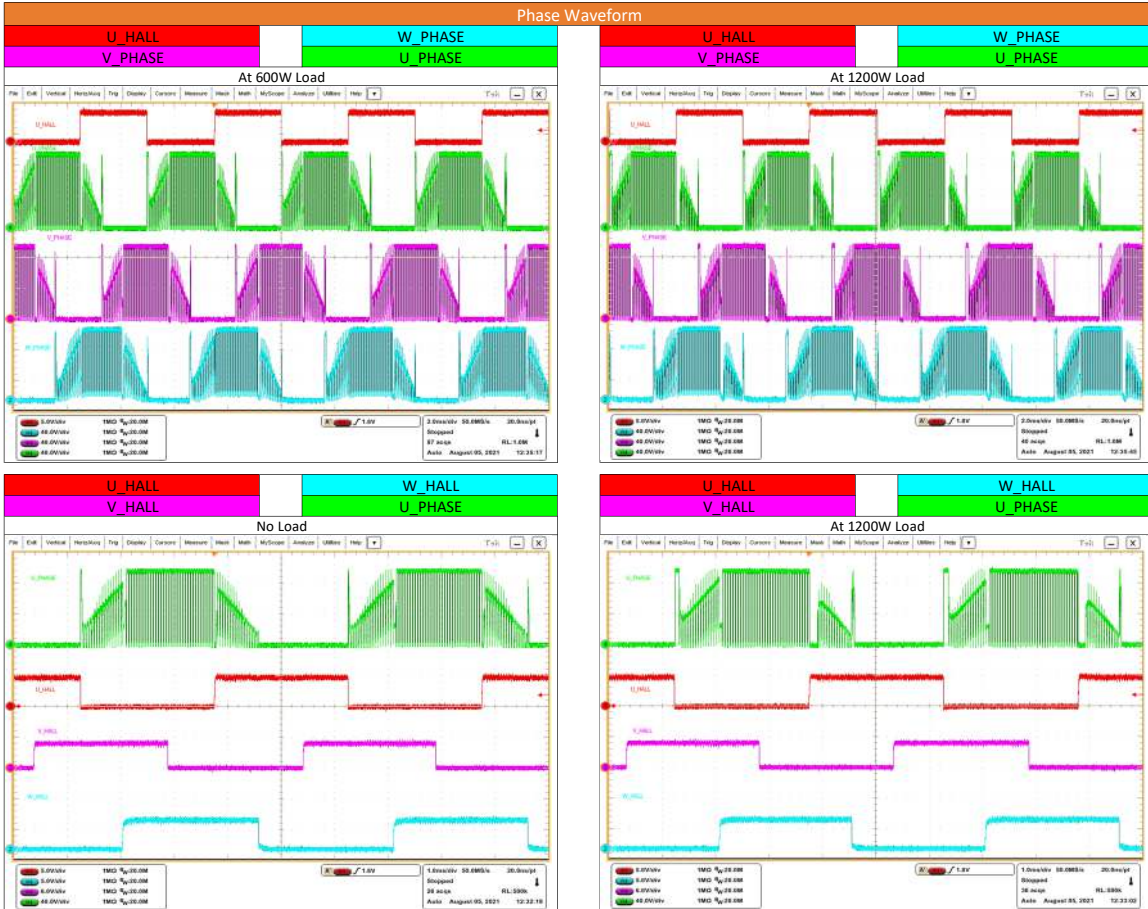


W Phase Deadtime



Modulation

	PWM Frequency	Duty Cycle
No load	20.0 kHz	67.8 %
1200 W	20.0 kHz	75.4 %

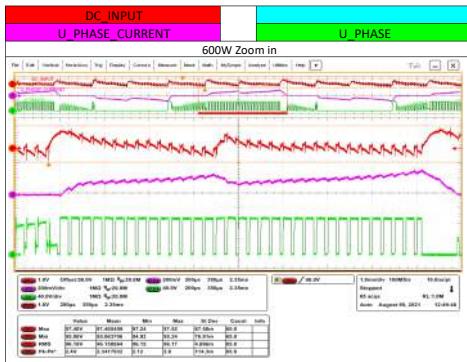
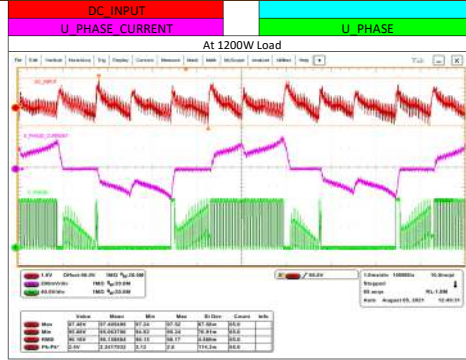
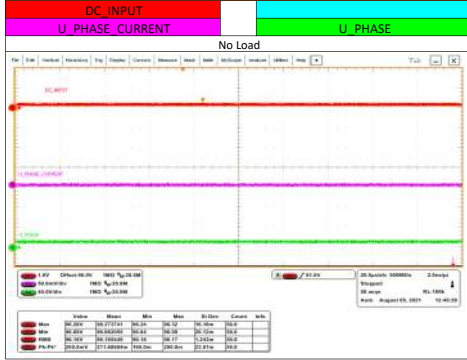




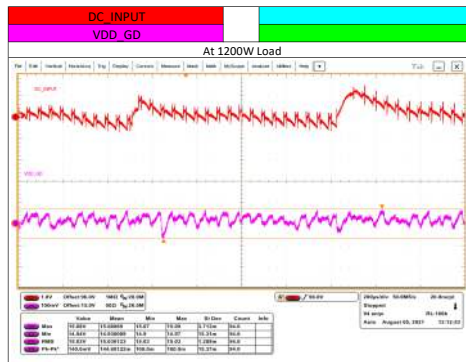
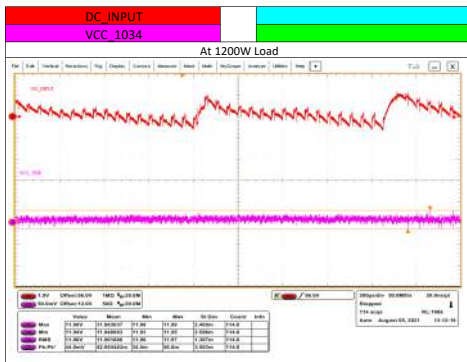
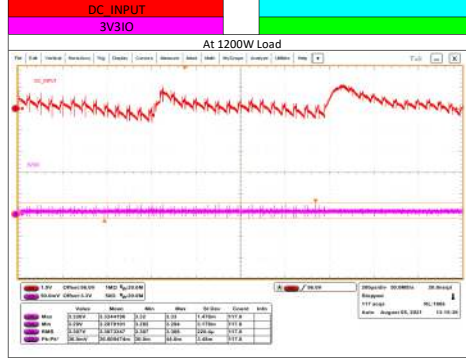
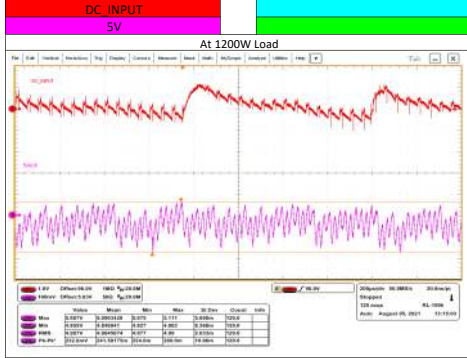
DC Voltages

DC Input Voltage Ripples			Bootstrap Capacitor Voltage at		
Load	Vout RMS	Vout PKPK	Phase	Vout RMS	Vout PKPK
No Load	96.15V	0.28V	U	14.28V	2800mV
			V	14.32V	2720mV
			W	14.37V	2600mV
1200W	96.15V	2.60V			

DC Input Ripple

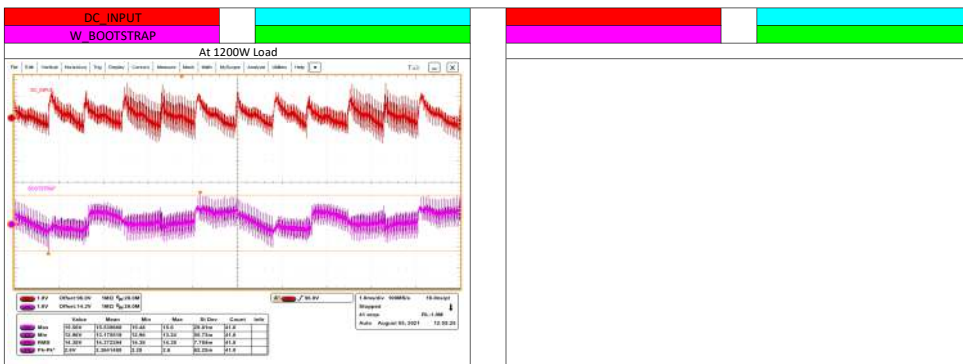


Auxiliary Power Rail Ripple at 1200W

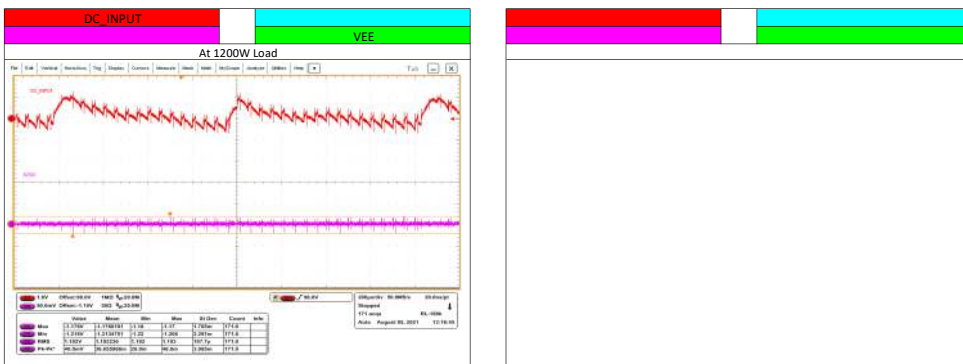
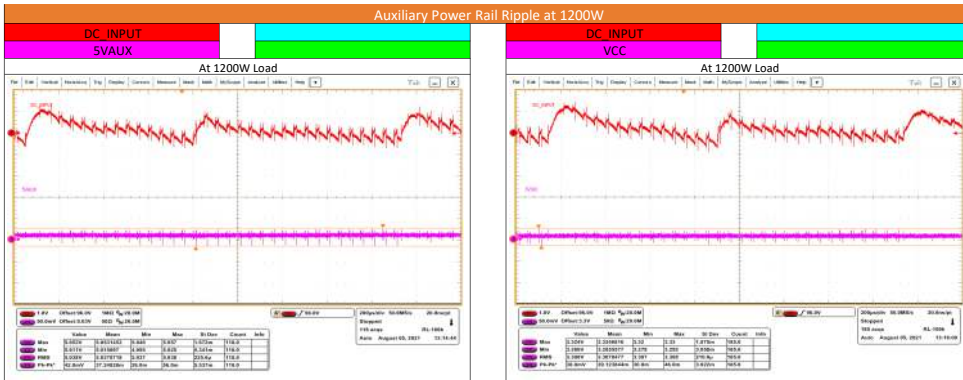




Gate Drive Voltage Ripple (Across BST Capacitor)



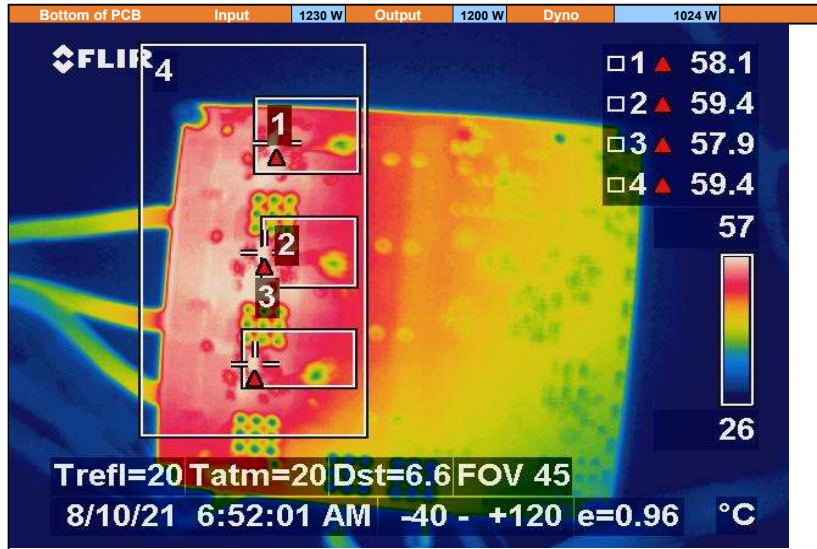
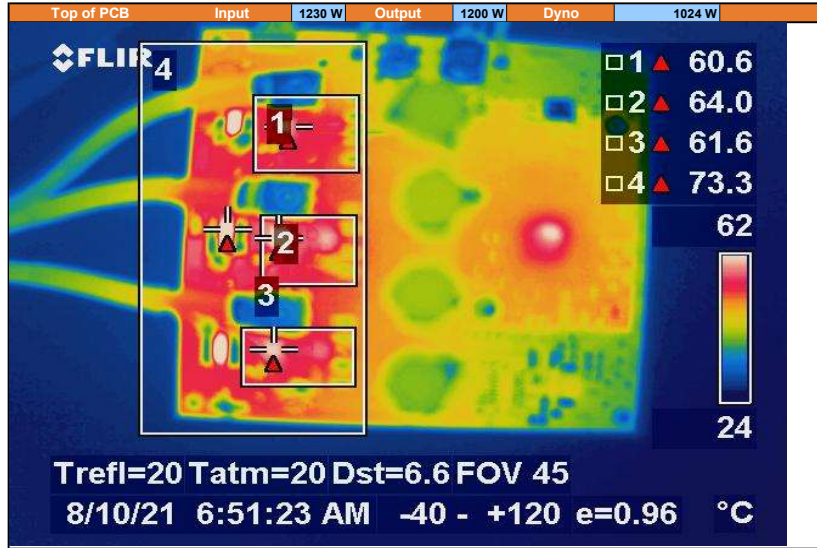
Auxiliary Power Rail Ripple at 1200W



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	57.0 °C	34.0 °C	1	Driver (W)	58.1 °C	35.1 °C
		LS FET	60.6 °C	37.6 °C	2	Driver (V)	59.4 °C	36.4 °C
2	V Phase	HS FET	60.2 °C	37.2 °C	3	Driver (U)	57.9 °C	34.9 °C
		LS FET	64.0 °C	41.0 °C	4	Entire Power Stage	59.4 °C	36.4 °C
3	W Phase	HS FET	58.2 °C	35.2 °C				
		LS FET	61.6 °C	38.6 °C				
4	Entire Power Stage	73.3 °C	50.3 °C					
Max Temp / Rise =				73.3 °C / 50.3 °C	Max Temp / Rise = 59.4 °C / 36.4 °C			



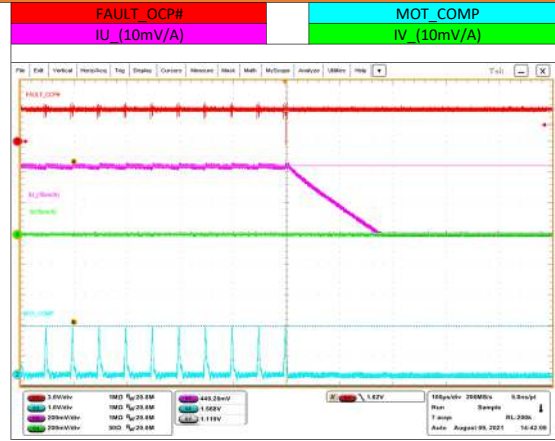
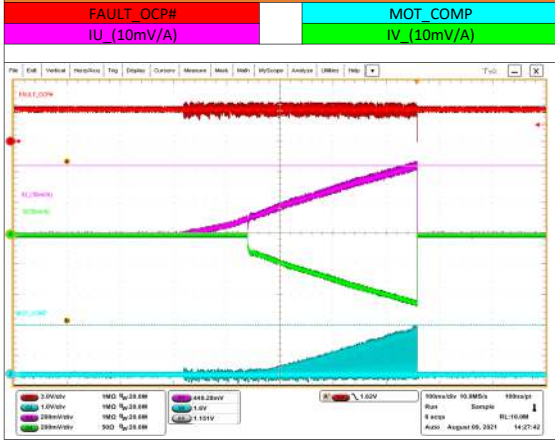
Start-up / Shut-down



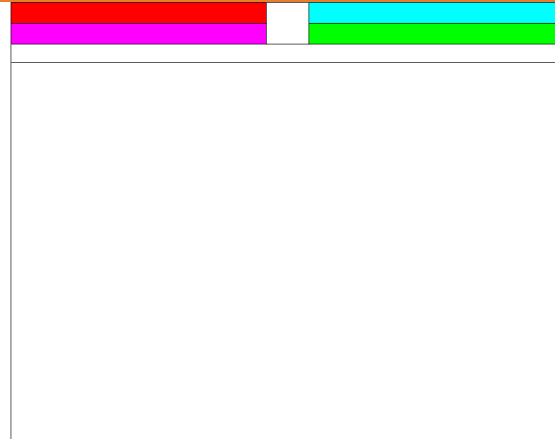
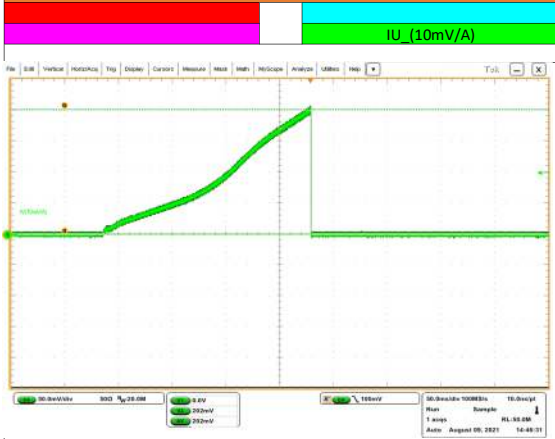
Protection

	Set Point	Current	Set Point	Trip Point	
NW	40 A	45 A	98.0 V	99.00 V	No Load
SW	20 A	20 A	98.0 V	98.88 V	1200 W

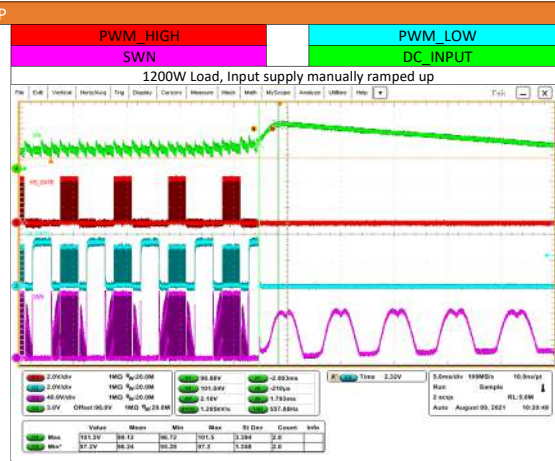
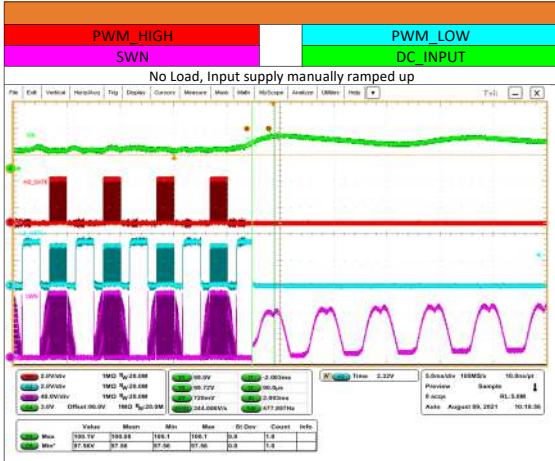
Hardware OCP



Software OCP



OVP





Current Sense

