



Customer:	onsemi Customer
Board Info:	10V to 16V BLDC Motor Drive
Power Rail:	12V, 600W
Date:	9/15/2021

Design Summary		
Design Name/OPN:	STR-10-16V-BLDC-MDK-GEVB	
	Controller	Xilinx
	Driver	NCP81075
	Power	HS x 1
	Stage 3x	LS x 1
		NTMF54C302N
	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	3.76	V	At 600W
Bootstrap Ripple	2880	mV	At 600W
Max Efficiency	NA	%	At W
Max Temperature	121	°C	At 600W
OCP Limit (HW)	116	A	Adjustable SW OCP
Test Speed	1800	RPM	
PWM Frequency	20	kHz	At 600W Load
Max Power	600	W	Power Stage Output
Test Voltage	12	V	

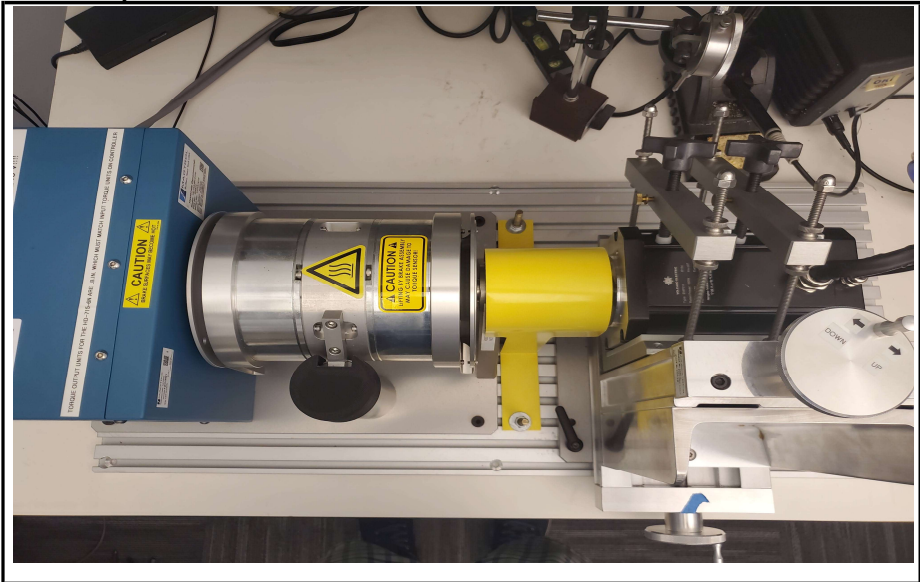
U-Phase			
Dead Time (ON)	70.4	ns	
Dead Time (OFF)	73.5	ns	
Max SWN Ring	19.4	V	

V-Phase			
Dead Time (ON)	73.1	ns	
Dead Time (OFF)	75.1	ns	
Max SWN Ring	18.3	V	

W-Phase			
Dead Time (ON)	70.4	ns	
Dead Time (OFF)	72.1	ns	
Max SWN Ring	19.44	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	
	Volcano Electric	VOL-BL06C12	
Specifications	Value	Unit	Comments
Rated Voltage	12	V	
BEMF/Torque Constant	0.0516	V-s/rad	
Stator Inductance	0.058	mL	
Stator Resistance	321	mΩ	
Pole Pairs	4		
Rated Speed	1800	RPM	
Rated Torque	3.18	N-m	
Rated Power	600	W	
Rotor Inertia			
Winding Type	Wye		
Shaft Diameter	20	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			

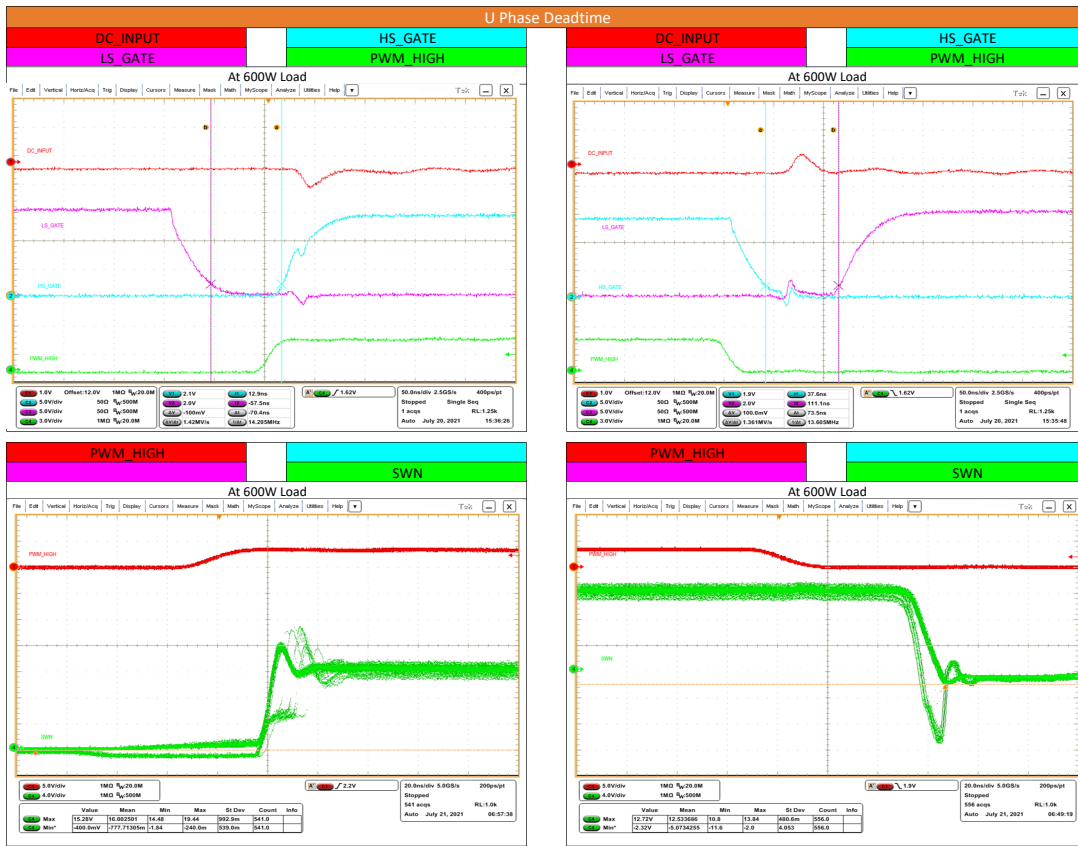
Test Motor #3	MFR	MFRPN	Comments
	MotorMFR	MOTOR_P#	
Specifications	Value	Unit	
BEMF/Torque Constant		N-m	
Stator Inductance		mL	
Stator Resistance		mΩ	
Pole Pairs			
Rated Speed		RPM	
Rated Torque		N-m	
Rated Power		W	
Rotor Inertia			
Winding Type			
Shaft Diameter		mm	
Sensors			

Test Motor

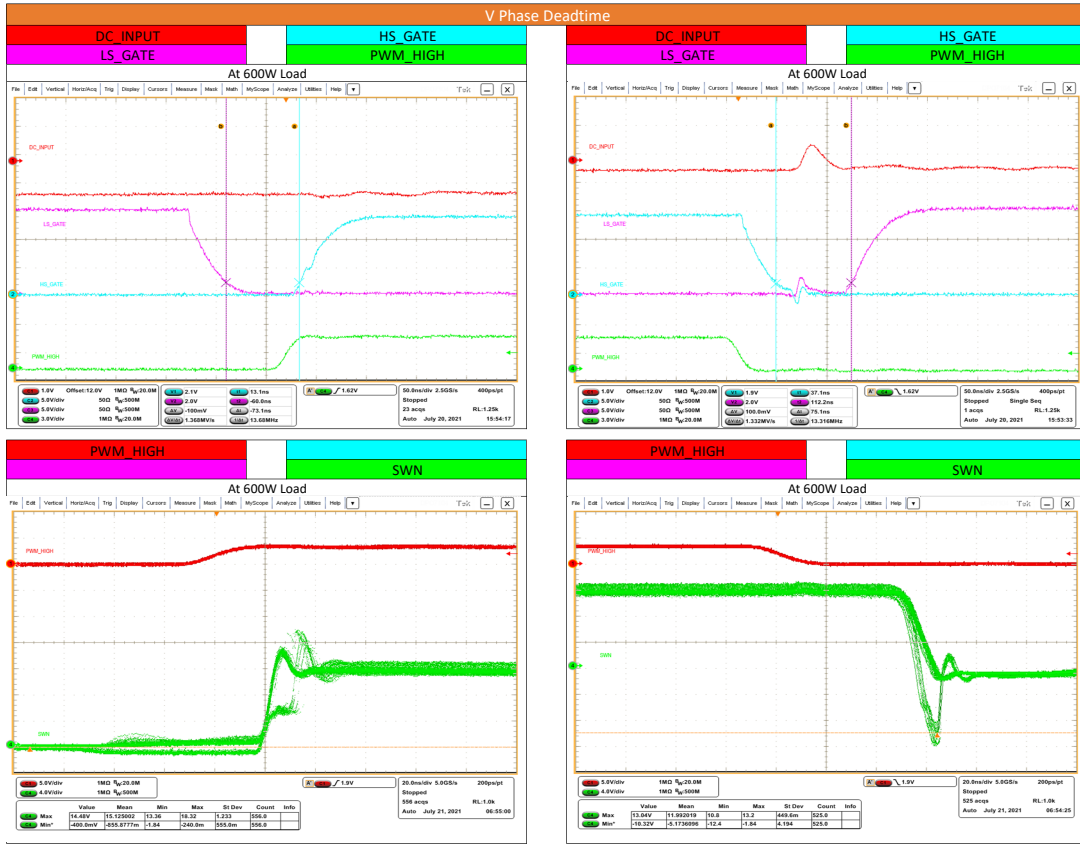


Switching Waveforms

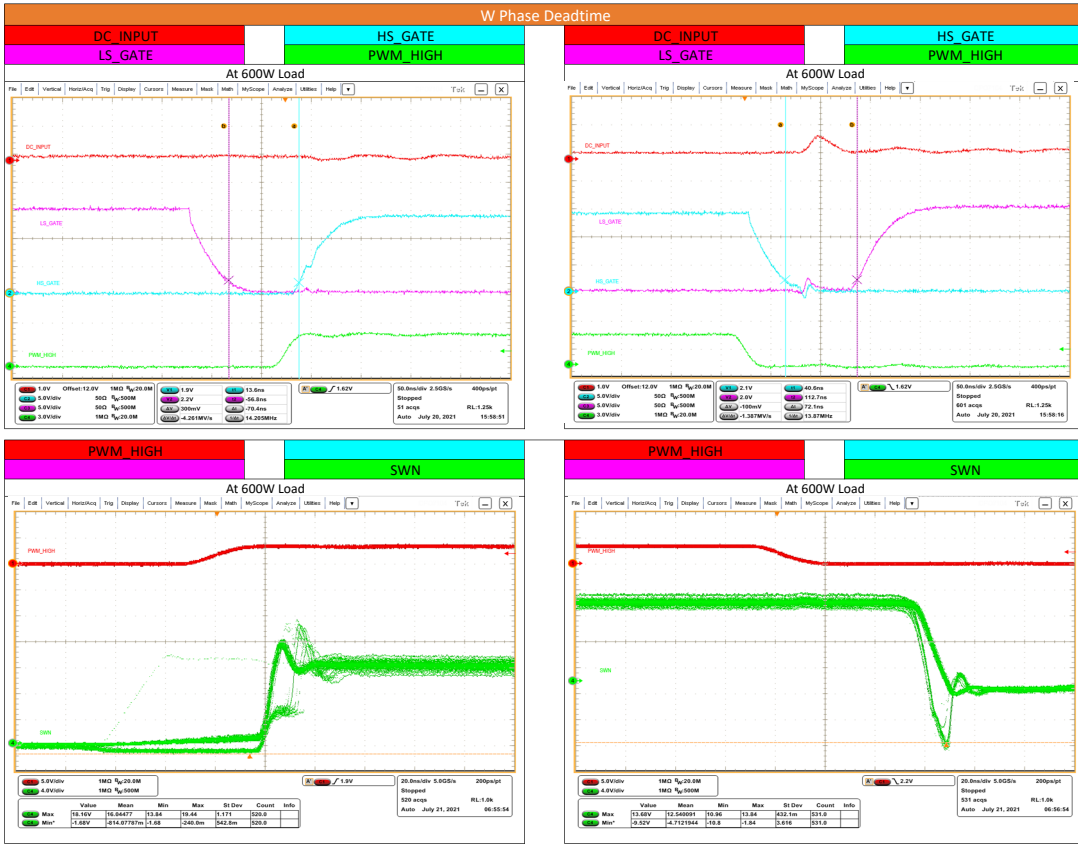
Phase	Deadline		Max Ringing	Min Ringing
	OFF	ON		
U	74 ns	70 ns	19.40 V	-11.6 V
V	75 ns	73 ns	18.30 V	-12.4 V
W	72 ns	70 ns	19.44 V	-10.8 V



V Phase Deadtime

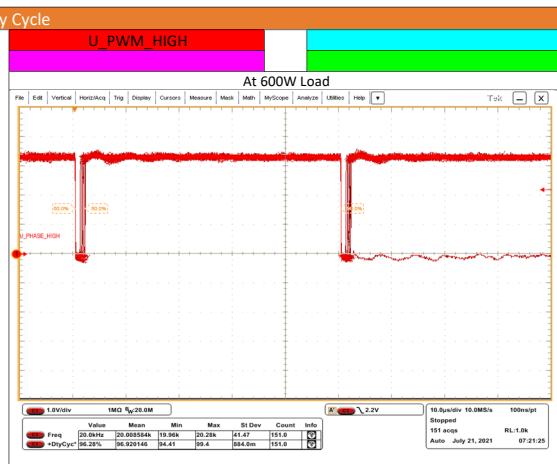
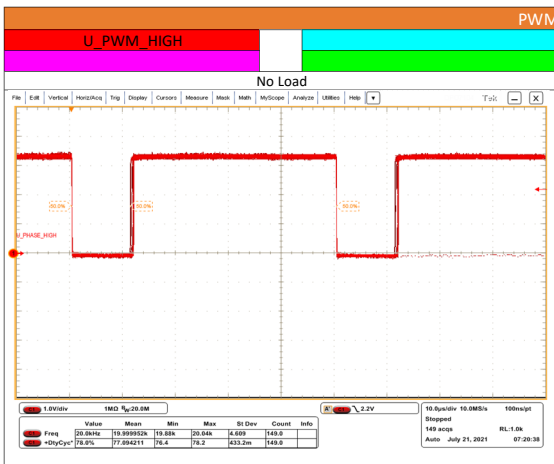
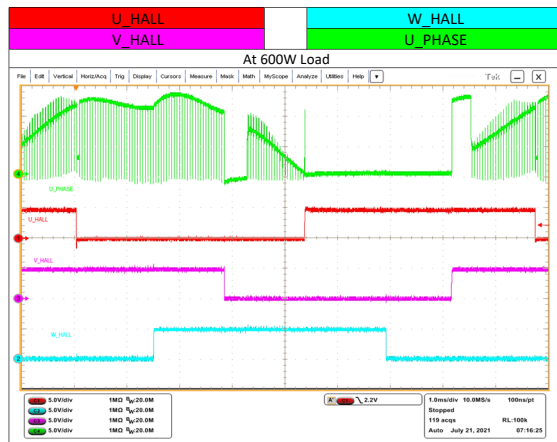
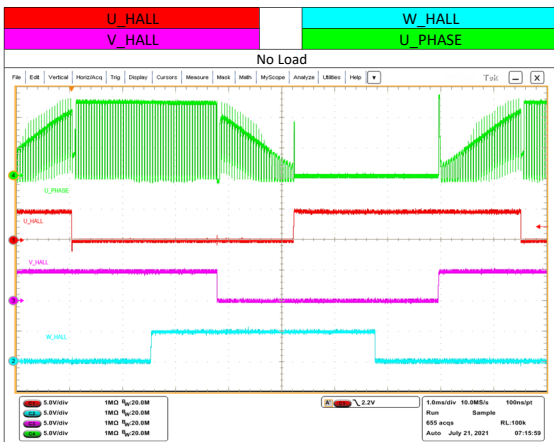
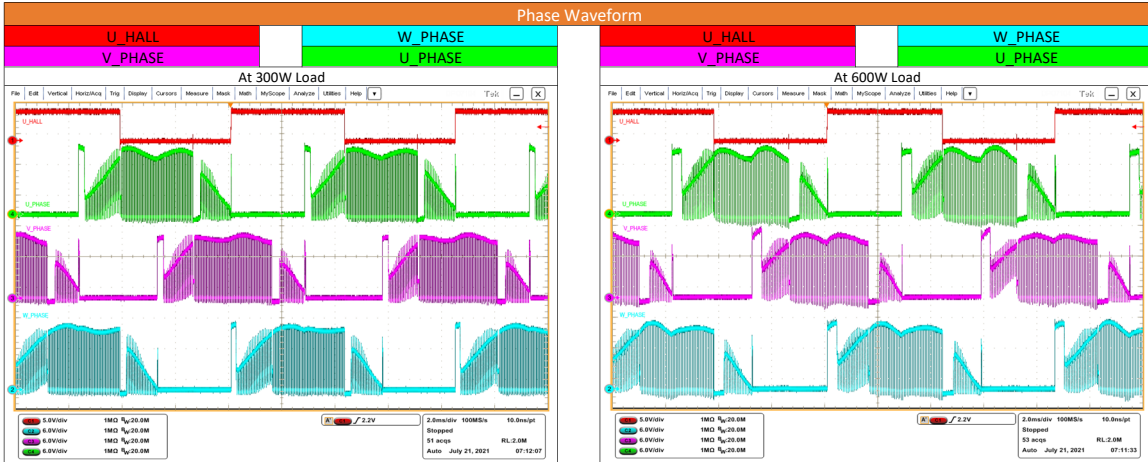


W Phase Deadtime



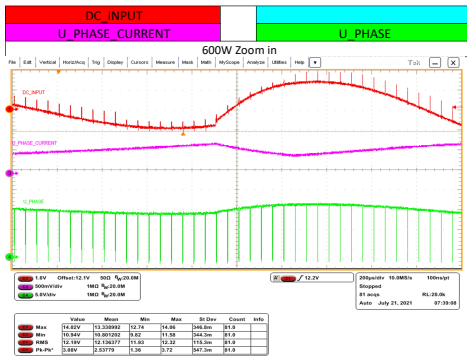
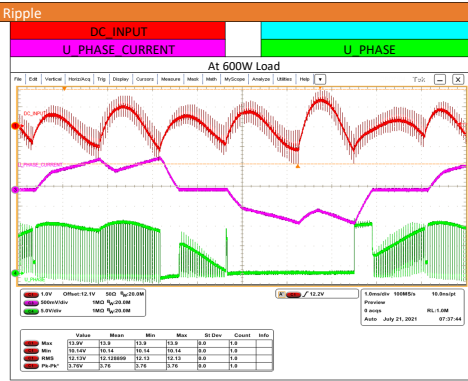
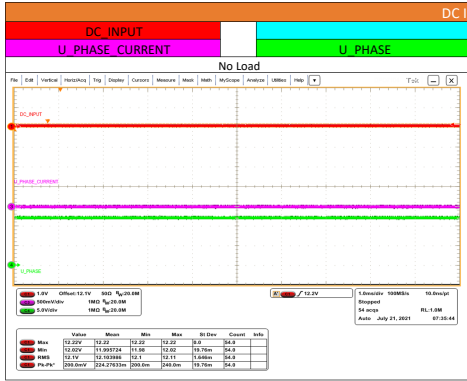
Modulation

	PWM Frequency	Duty Cycle
No load	20.0 kHz	77.1 %
600 W	20.0 kHz	96.9 %

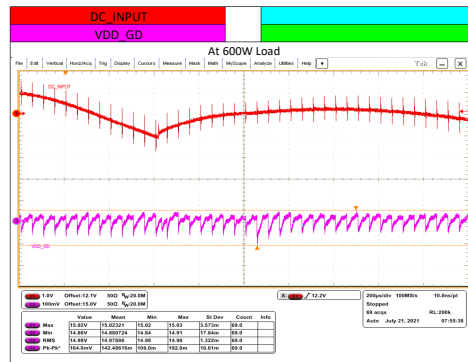
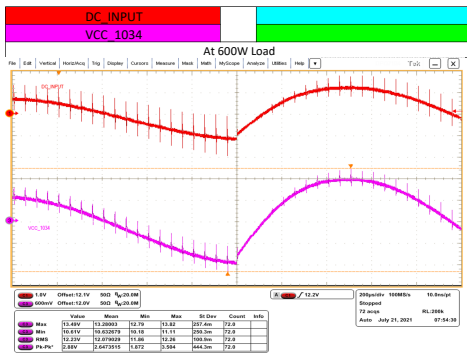
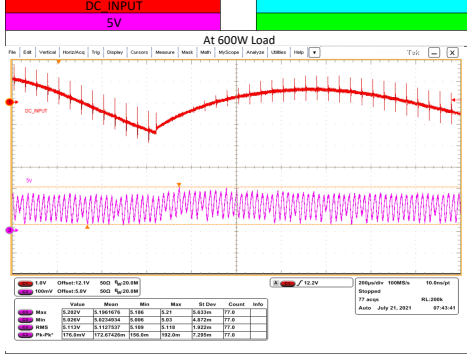


DC Voltages

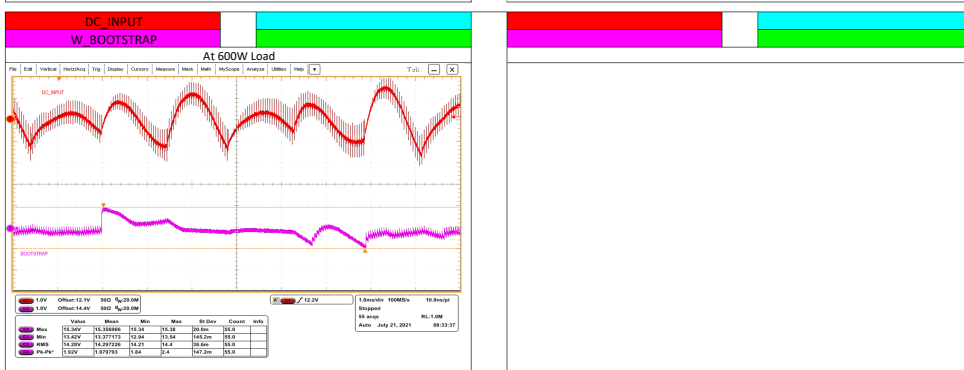
DC Input Voltage Ripples			Bootstrap Capacitor Voltage at		
Load	Vout RMS	Vout PKPK	Phase	Vout RMS	Vout PKPK
No Load	12.10V	0.24V	U	14.27V	2008 mV
			V	14.23V	2880 mV
			W	14.29V	2400 mV
600W	12.12V	3.76V			



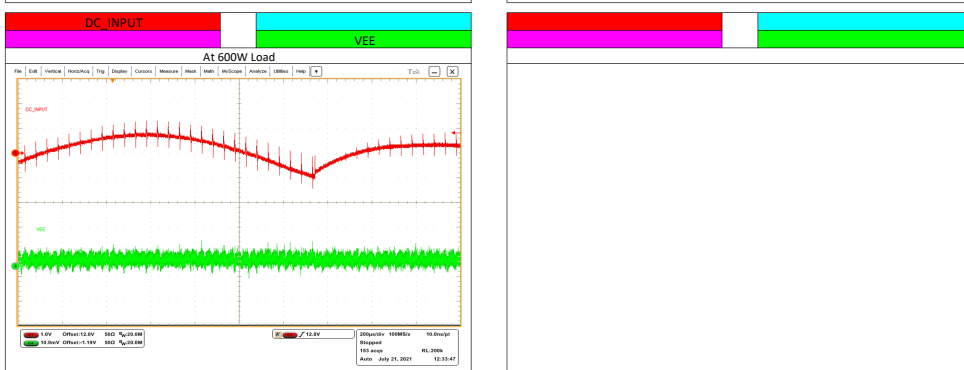
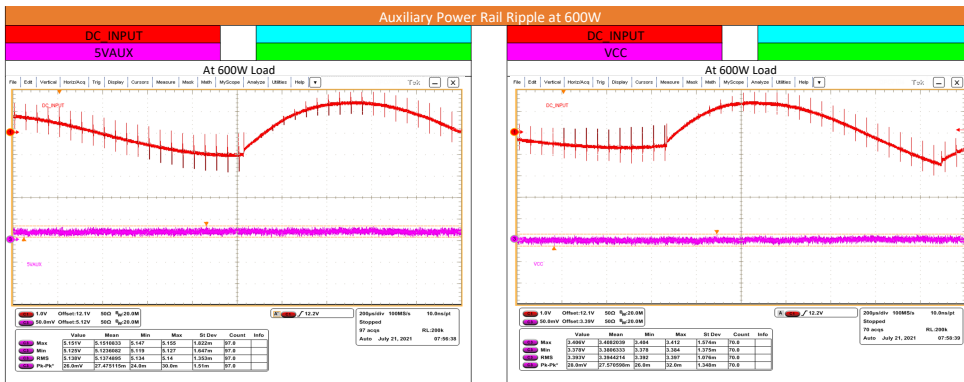
Auxiliary Power Rail Ripple at 600W



Gate Drive Voltage Ripple (Across BST Capacitor)



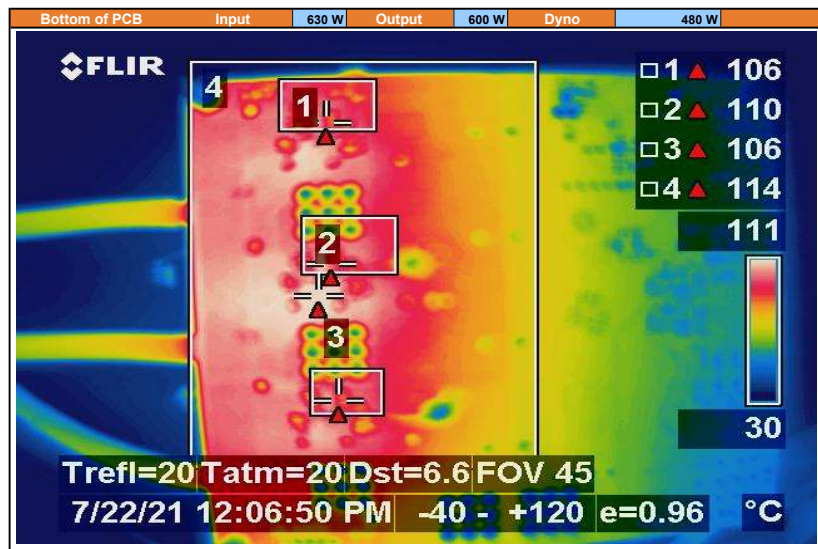
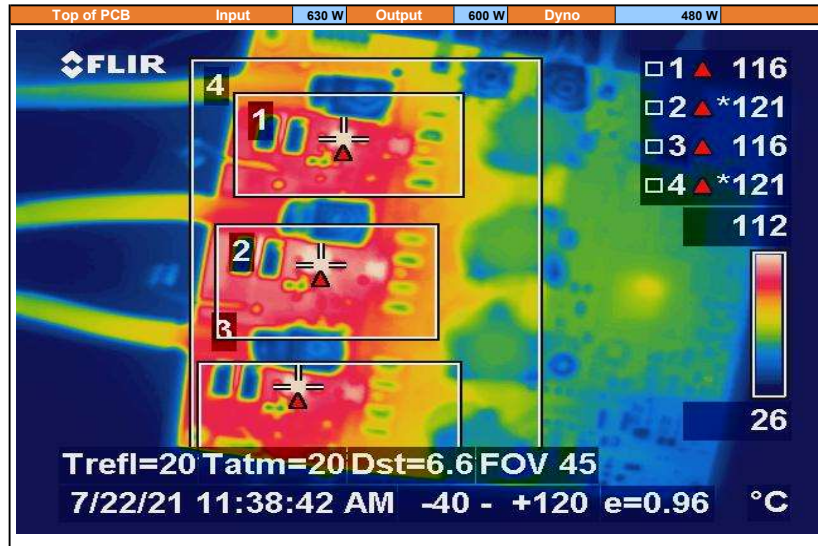
Auxiliary Power Rail Ripple at 600W



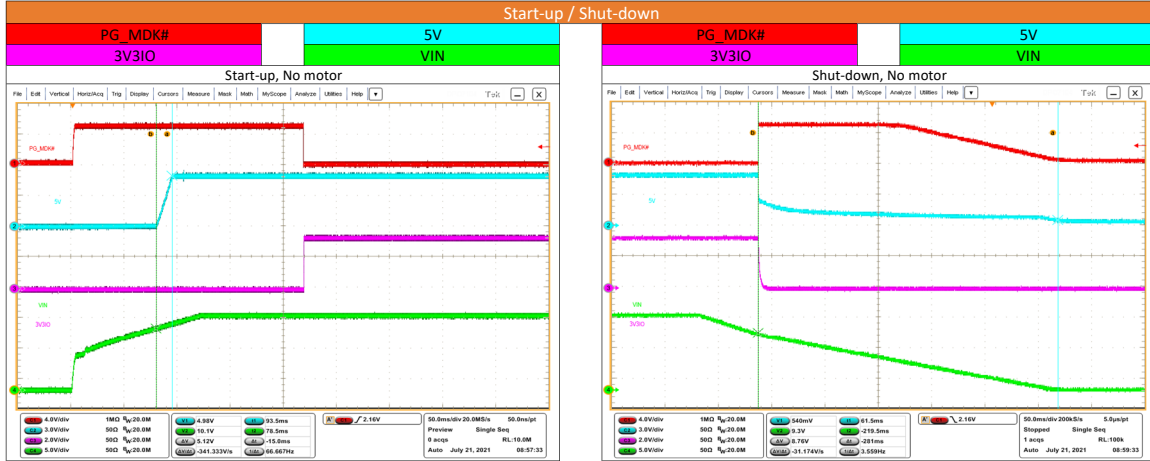
Thermals

Tsoak =	10 min
Ambient =	23.0 °C
Load =	600 W
Airflow =	0 lfm

Top of PCB					Bottom of PCB			
Area	Component	Temp	Rise		Area	Component	Temp	Rise
1	U Phase	HS FET	107.0 °C	84.0 °C	1	Driver (W)	106.0 °C	83.0 °C
		LS FET	116.0 °C	93.0 °C		2	Driver (V)	110.0 °C
2	V Phase	HS FET	113.0 °C	90.0 °C	3	Driver (U)	106.0 °C	83.0 °C
		LS FET	121.0 °C	98.0 °C		4	Entire Power Stage	114.0 °C
3	W Phase	HS FET	108.0 °C	85.0 °C				
		LS FET	116.0 °C	93.0 °C				
4	Entire Power Stage	HS FET	121.0 °C	98.0 °C				
		LS FET	116.0 °C	93.0 °C				
Max Temp / Rise =					Max Temp / Rise =		114.0 °C	91.0 °C



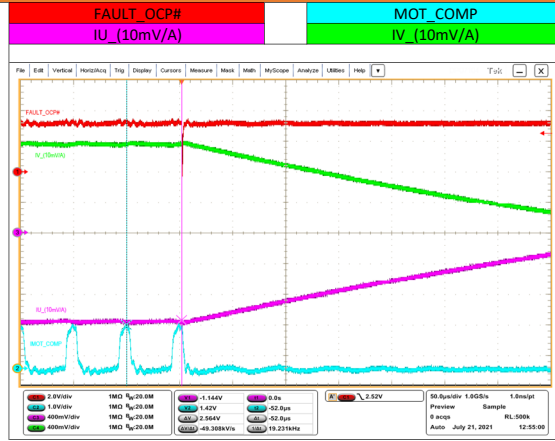
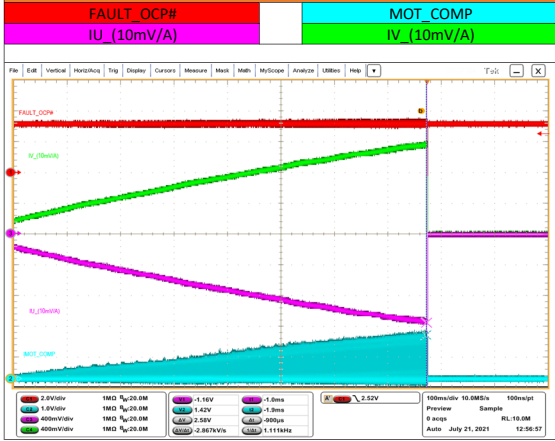
Start-up / Shut-down



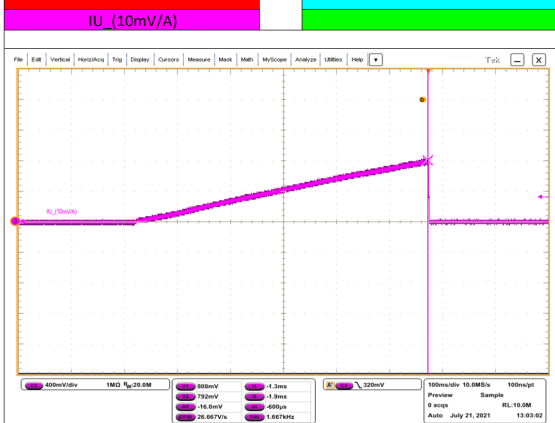
Protection

	Set Point	Current	Set Point	Trip Point	
NW	120 A	115 A	14.0 V	14.28 V	No Load
SW	80 A	81 A	14.0 V	13.88 V	600 W

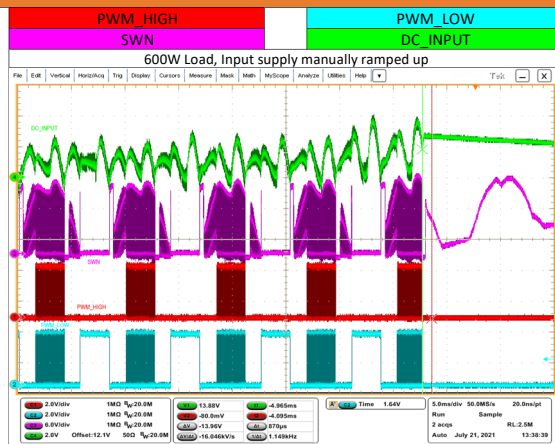
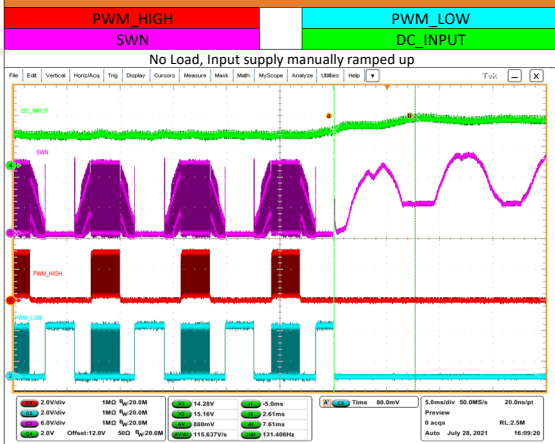
Hardware OCP



Software OCP



OVP



Current Sense

