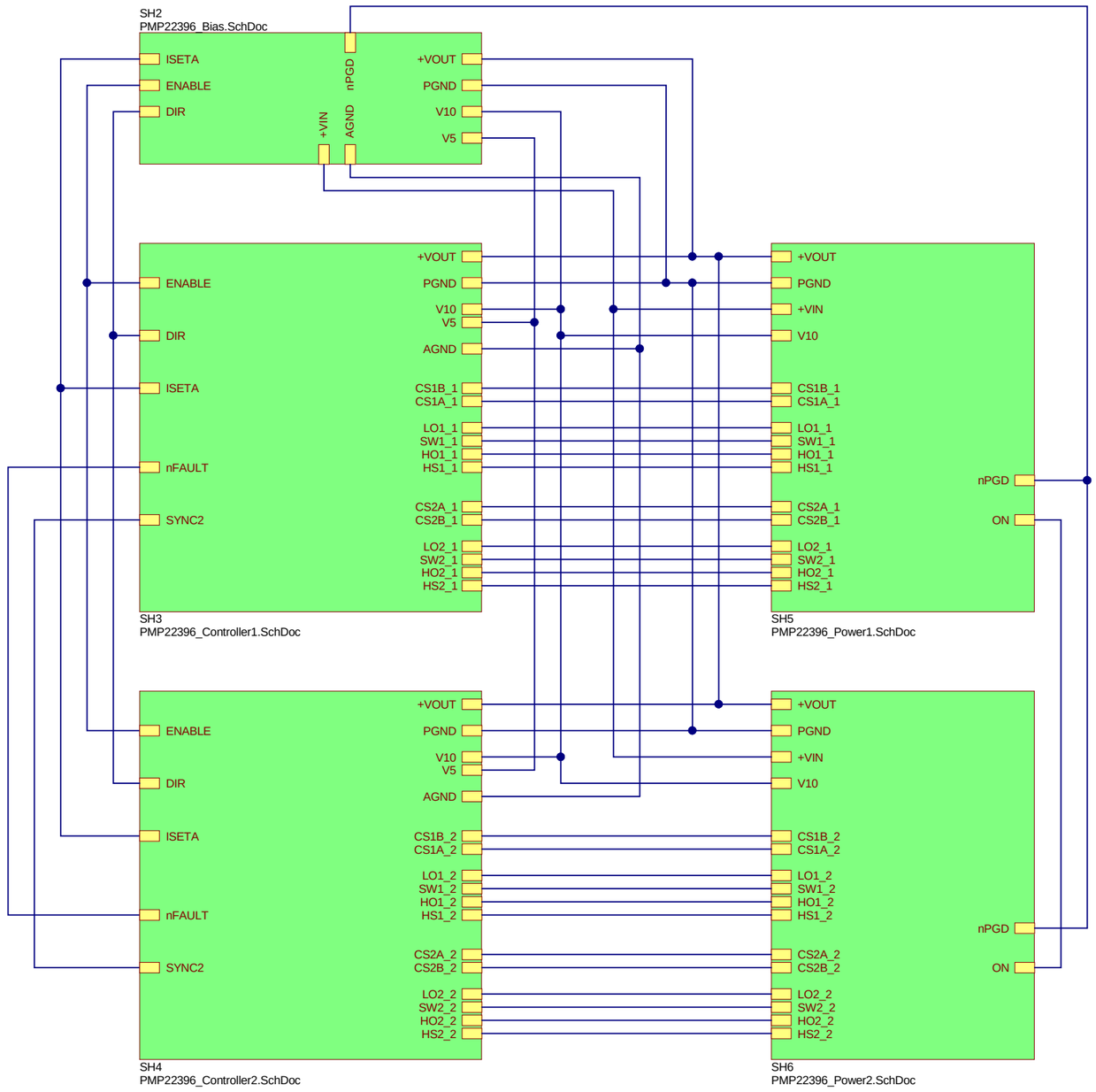
SH7
PMP22396_HW.SchDoc

Input Voltage = 8Vin to 18Vin

48Vout @ 51.25A

Fsw = 200KHz/phase =
800KHz with 4-phases interleaved



Revision History

Revision	Notes
A	3/11/20 Initial design
B	5/13/20 Move CS offset resistors to CSA. Change input and output filter damping resistors. Add input ceramic capacitors.

Note: Built on Rev A printed circuit board.

Orderable: N/A	Designed for:	Mod. Date: 5/13/2020
TID #: PMP22396	Project Title: 1800W 4-Phase Bi-Directional Converter	
Number: PMP22396 Rev: B	Sheet Title: Block Diagram	
SVN Rev: Not in version control	Assembly Variant: 001	Sheet: 1 of 7
Drawn By:	File: PMP22396_Cover.SchDoc	Size: B
Engineer: R. Sheehan	Contact: http://www.ti.com/support	

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Bias Supply Input Voltage = 8Vin to 36Vin

Bias Power for LM5170 Controllers

+VIN
D1 FSV560 60V
C1 50V 2.2uF
C2 50V 2.2uF
C3 50V 2.2uF
PGND
R1 4.99
C5 100V 100nF
U1 LM5001IDRQ1
VIN SW COMP FB GND EN RT VCC
L1 MSD1278-104ML 100uH
SW_Bias
C4 50V 2.2uF
D2 FSV560 60V
10V @ 200mA
V10
C6 25V 10µF
C7 25V 10µF
R3 10.0
R5 7.15k
R6 1.00k
R2 10.0k
C8 22nF 100V
C9 100V 220pF
R4 24.9k
C10 1µF 35V
J1 SD
Shut Down
SHUT DOWN
Installed = OFF
OPEN = ON

FET Qg = 20nC each (at Vgs = 10V)
Total Qg = (24 FETs)*(20nC each FET) = 480nC
I_driver = (200kHz)*(480nC) = 0.096A
Gate drive power = 0.096A * 10V = 0.96W

Negtative offset for DCM boost mode regulation at no load
R7 DNP 1.00M
R8 DNP 100k
D3 DNP BAS316,115
C11 DNP 10pF 100V
DNP C14 100V 1000pF
DNP C15 100V 1000pF
D4 DNP BAS316,115

Direction Control

+VOUT
C16 0.1uF 100V
U3 TLV7031DBVR
R9 100k
R10 10.0k
R12 100k
R13 5.23k
R14 10.0k
NT1 Net-Tie
DIR
J2 VOP
R15 100
D5 BAS316,115

Output Voltage Control

R16 45.3k
C17 100pF
C18 100nF 100V
R17 24.9k
R18 3.32k
U4 LM8261M5/NOPB
ISETA
R22 6.81k
R24 10.0k
D6 BAS316,115
C19 0.1uF 100V
3.3Vref
R23 20.0k
REF
C21 220nF 50V
R26 20.0
Q3 2N7002E-T1-E3
R20 2.43k
R21 1.96k
2.5V
U5 ATL431LIBQDBZR
C20 1000pF 100V
R27 6.19k
NT2 Net-Tie

U2 TPS70950DBVR
IN OUT EN NC GND
C12 1uF 100V
C13 2.2µF 16V
R11 10.0k
Installed = OFF
OPEN = ON
J3 EN
ENABLE
R19 100k
Q1 2N7002E-T1-E3
Q2 2N7002E-T1-E3
R25 100k
D7 MMSZ5240BS-7-F 10V
nPGD

AGND

Orderable: N/A		Designed for:	Mod. Date: 5/13/2020
TID #: PMP22396		Project Title: 1800W 4-Phase Bi-Directional Converter	
Number: PMP22396	Rev: B	Sheet Title: Bias Supply	
SVN Rev: Not in version control		Assembly Variant: 001	Sheet: 2 of 7
Drawn By:		File: PMP22396_Bias.SchDoc	Size: B
Engineer: R. Sheehan		Contact: http://www.ti.com/support	

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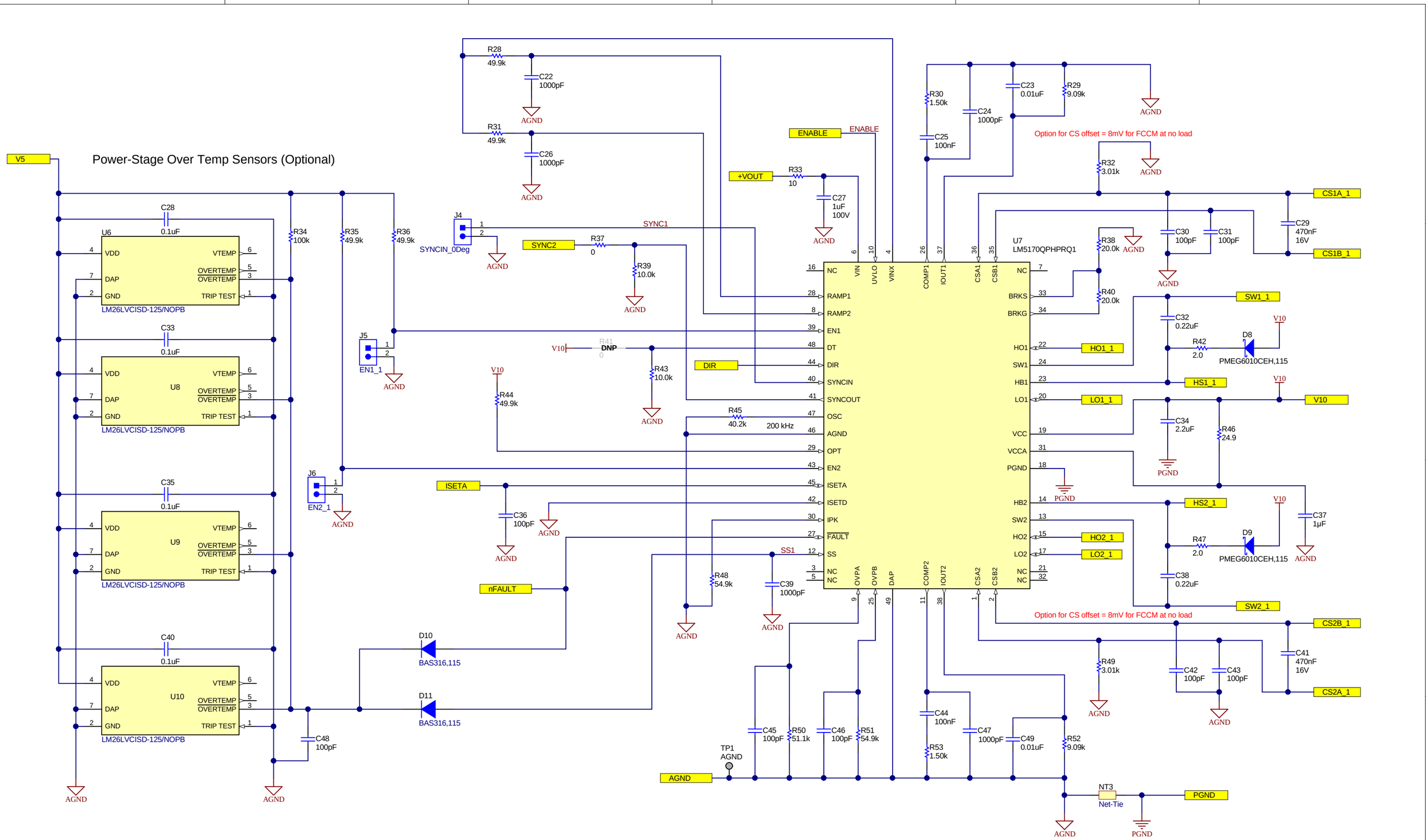
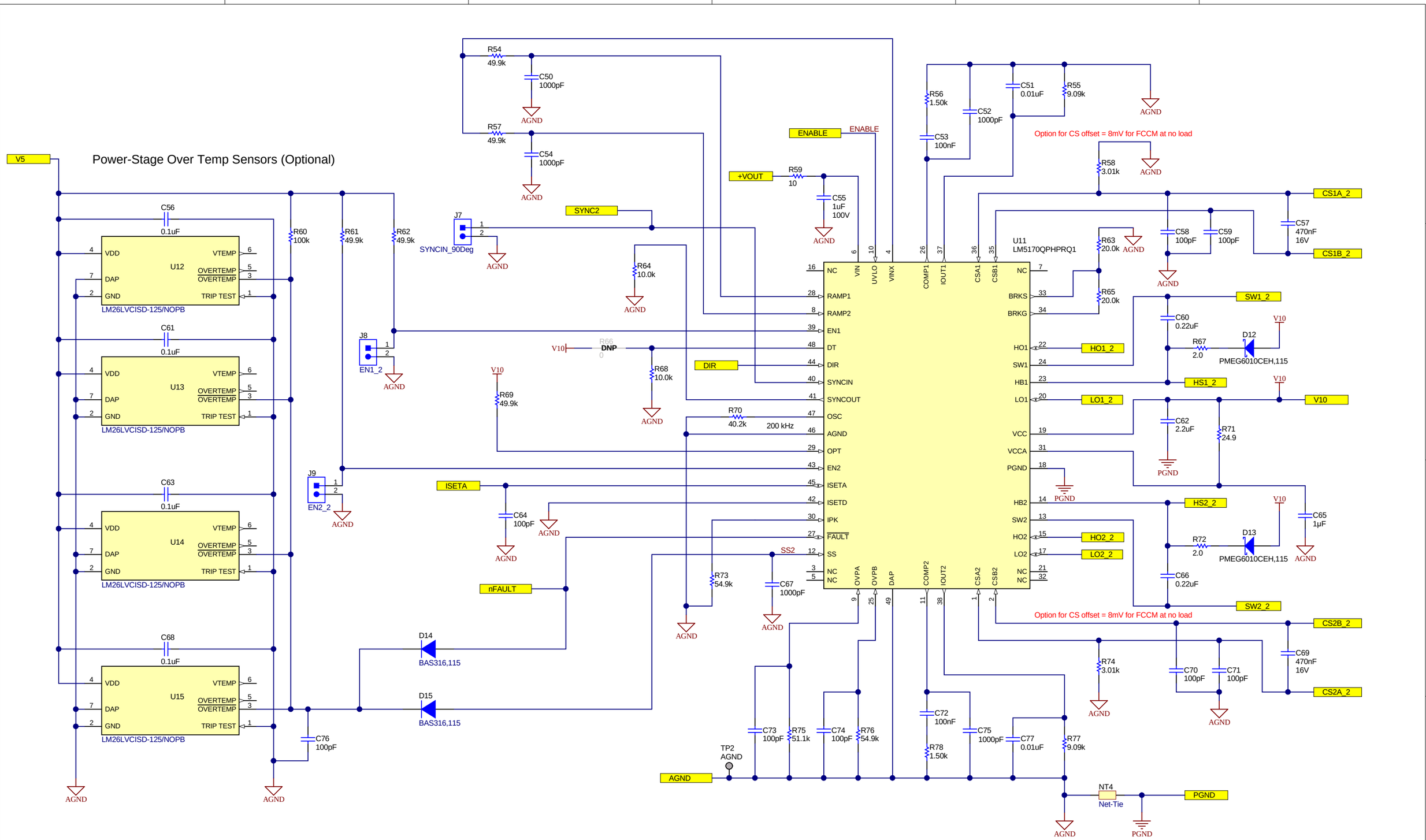


Orderable: N/A		Designed for:	Mod. Date: 5/13/2020
TID #: PMP22396		Project Title: 1800W 4-Phase Bi-Directional Converter	
Number: PMP22396	Rev: B	Sheet Title: Controller	
SVN Rev: Not in version control		Assembly Variant: 001	Sheet: 3 of 7
Drawn By:		File: PMP22396_Controller1.SchDoc	Size: B
Engineer: R. Sheehan		Contact: http://www.ti.com/support	



Orderable: N/A		Designed for:	Mod. Date: 5/13/2020
TID #: PMP22396		Project Title: 1800W 4-Phase Bi-Directional Converter	
Number: PMP22396	Rev: B	Sheet Title: Controller	
SVN Rev: Not in version control		Assembly Variant: 001	Sheet: 4 of 7
Drawn By:		File: PMP22396_Controller2.SchDoc	Size: B
Engineer: R. Sheehan		Contact: http://www.ti.com/support	

<--- Direction of Conversion<--- Input Voltage = 8Vin to 18Vin Steady State

HS1_1 HS2_1 HO1_1 HO2_1 SW1_1 SW2_1 LO1_1 LO2_1 V10

Q4 Q5 Q6 Q7 Q8 Q9 NVMFS5C670NLWFAFT1G

Q10 Q11 Q12 Q13 Q14 Q15 FMMT618TA

Q16 Q17 Q18 Q19 Q20 Q21 FMMT718TA

Q22 Q23 Q24 Q25 Q26 Q27 NVMFS5C670NLWFAFT1G

Q28 Q29 Q32 Q33 Q34 Q35 FMMT618TA

Q36 Q37 Q38 Q39 Q40 Q41 FMMT718TA

TP3 SW1_1 TP4 PGND TP5 SW2_1 TP6 PGND

L2 L3 7443763521033 MNT_1 MNT_2

L4 220nH

R79 R101 700µ R81 R82 R102 R103 2.0

CS1B_1 CS1A_1 CS2B_1 CS2A_1

R80 10.0 C84 100pF 100V R104 10.0 C94 100pF 100V

C78 C79 C80 C81 C82 C83 C85 C86 C87 C88 C89 C90 0.22uF

R83 R84 R85 R86 R87 R88 R89 R90 R91 R92 R93 R94 R95 R96 R97 R98 R99 R100 R105 R106 R107 R108 R109 R110 R111 R112 R113 R114 R115 R116 R117 R118 R119 R120 R121 R122 2.0 49.9k 10

C91 35V 330uF C92 35V 330uF R123 0.2 C93 10µF 25V C93A 10µF 25V C95 10µF 25V C95A 10µF 25V

NVMFS5C406NLT1G Q30 Q31 Q42 Q43 Q44 Q45 Q46 Q47

R124 R125 R126 R127 R131 R132 R135 R136 10

Q48 MMBTA06-7-F

D18 D19 D20 BAS316,115

R133 2.0k R141 2.0k C123 1000pF R142 10k

C96 DNP DNP C122 100nF 100V

+VIN nPGD ON

J10 +VIN J11 +VOUT J12 PGND J13 GND J14 ON

T1 +VOUT T2 +VIN T3 PGND T4 PGND

TP7 +VIN TP8 +VOUT TP9 PGND TP10 PGND

C97 C98 C99 C110 C111 C112 100uF 63V

C100 C101 C102 C103 C104 C105 C106 C107 C114 C115 C116 C117 C118 C119 C120 C121 50V 10µF

C108 10µF 25V C113 10µF 25V

L5 1uH R138 2.0 R139 2.0

D16 BAS316,115 D17 SMBJ28A-13-F 28V D21 FSV560 60V

R128 49.9k R134 100k C109 0.1uF 100V R137 12.1k R140 2.94k R129 6.34k R130 100k

U16 LM5060Q1MMX/NOPB VIN UVLO OVP EN SENSE GATE OUT PGD TIMER GND

Orderable: N/A	Designed for:	Mod. Date: 5/13/2020
TID #: PMP22396	Project Title: 1800W 4-Phase Bi-Directional Converter	
Number: PMP22396 Rev: B	Sheet Title: Power Stage	
SVN Rev: Not in version control	Assembly Variant: 001	Sheet: 5 of 7
Drawn By:	File: PMP22396_Power1.SchDoc	Size: B
Engineer: R. Sheehan	Contact: http://www.ti.com/support	

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<--- Direction of Conversion<---

HS1_2 · HS2_2 · HO1_2 · HO2_2 · SW1_2 · SW2_2 · LO1_2 · LO2_2 · V10 · PGND · +VIN · +VOUT · ON · nPGD

Q49, Q50, Q51, Q52, Q53, Q54, Q55, Q56, Q57, Q58, Q59, Q60, Q61, Q62, Q63, Q64, Q65, Q66 — NVMFS5C670NLWFAFT1G / FMMT618TA / FMMT718TA

Q67, Q68, Q69, Q70, Q71, Q72, Q73, Q74, Q75, Q76, Q77, Q78, Q79, Q80, Q81, Q82, Q83, Q84, Q85, Q86 — NVMFS5C670NLWFAFT1G / FMMT618TA / FMMT718TA

Q87, Q88, Q89, Q90, Q91, Q92 — NVMFS5C406NLT1G

Q93 — MMBTA06-7-F

TP11 SW1_2 · TP12 PGND · TP13 SW2_2 · TP14 PGND · TP15 +VOUT · TP16 PGND

L6, L7 — 7443763521033 (MNT_1 / MNT_2)

L8 — 220nH

L9 — 1uH

U17 — LM5060Q1MMX/NOPB (VIN, UVLO, OVP, EN, SENSE, GATE, OUT, PGD, TIMER, GND)

D22 BAS316,115 · D23 BAS316,115 · D24 BAS316,115 · D25 BAS316,115

R143 700µ · R145 2.0 · R146 2.0 · R165 700µ · R166 2.0 · R167 2.0 · CS1B_2 · CS1A_2 · CS2B_2 · CS2A_2

R144 10.0 · C130 100pF 100V · R168 10.0 · C140 100pF 100V

C137 35V 330uF · C138 35V 330uF · R187 0.2 · C139 10µF 25V · C139A 10µF 25V · C141 10µF 25V · C141A 10µF 25V · C154 10µF 25V · C159 10µF 25V

C143 100uF 63V · C144 100uF 63V · C156 100uF 63V · C157 100uF 63V · C145 100uF 63V · C158 100uF 63V · C146–C153 50V 10µF · C160–C167 50V 10µF

R192 49.9k · R193 6.34k · R194 100k · R197 2.0k · R198 100k · R201 12.1k · R202 2.0 · R203 2.0 · R204 2.94k · R205 2.0k · R206 10k · C155 0.1uF 100V · C168 100nF 100V · C169 1000pF

DNP

Orderable: N/A	Designed for:	Mod. Date: 5/13/2020	
TID #: PMP22396	Project Title: 1800W 4-Phase Bi-Directional Converter		
Number: PMP22396 Rev: B	Sheet Title: Power Stage		
SVN Rev: Not in version control	Assembly Variant: 001	Sheet: 6 of 7	
Drawn By:	File: PMP22396_Power2.SchDoc	Size: B	
Engineer: R. Sheehan	Contact: http://www.ti.com/support		

H1 1
NY PMS 440 0025 PH

H2 1
NY PMS 440 0025 PH

H3 1
NY PMS 440 0025 PH

H4 1
NY PMS 440 0025 PH

H5
Nut

H6
Nut

H7
Nut

H8
Nut

DNP
FID1

DNP
FID2

DNP
FID3

PCB Number: PMP22396
PCB Rev: A

PCB
LOGO
FCC disclaimer


LOGO2


LOGO3


LOGO4

LBL1
PCB Label

Label Table	
Variant	Label Text
001	NVMFS5C670NL
002	NVMFS5C628NL

ZZ1
Label Assembly Note
This Assembly Note is for PCB labels only

ZZ2
Assembly Note
These assemblies are ESD sensitive, ESD precautions shall be observed.

ZZ3
Assembly Note
These assemblies must be clean and free from flux and all contaminants. Use of no clean flux is not acceptable.

ZZ4
Assembly Note
These assemblies must comply with workmanship standards IPC-A-610 Class 2, unless otherwise specified.

Orderable: N/A		Designed for:	Mod. Date: 1/7/2020
TID #: PMP22396		Project Title: 1800W 4-Phase Bi-Directional Converter	
Number: PMP22396	Rev: B	Sheet Title: Hardware	
SVN Rev: Not in version control		Assembly Variant: 001	Sheet: 7 of 7
Drawn By:		File: PMP22396_HW.SchDoc	Size: B
Engineer: R. Sheehan		Contact: http://www.ti.com/support	

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