
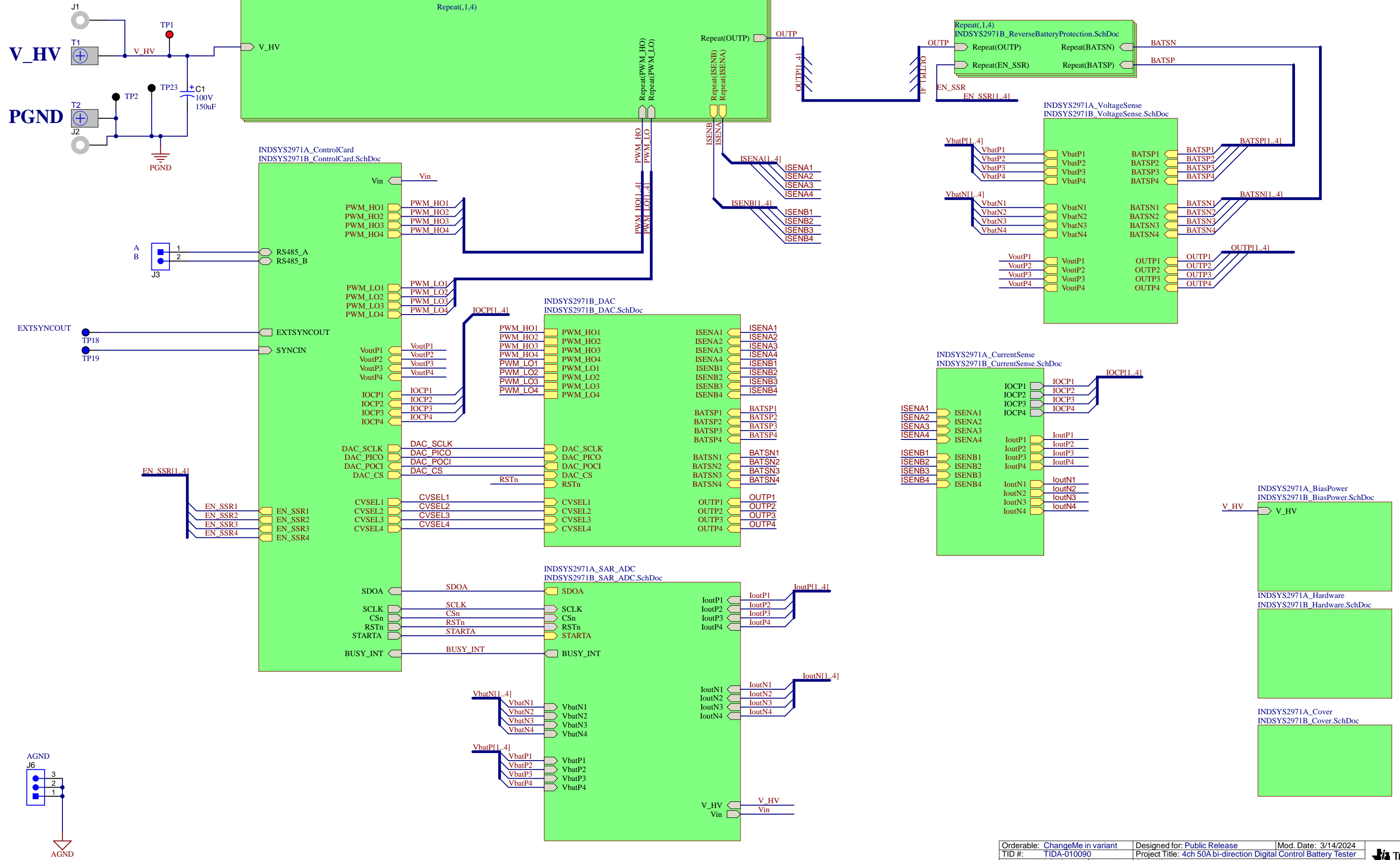


Texas Instruments and/or its licensors do not warrant the accuracy or completeness of this specification or any information contained therein. Texas Instruments and/or its licensors do not warrant that this design will meet the specifications, will be suitable for your application or fit for any particular purpose, or will operate in an implementation. Texas Instruments and/or its licensors do not warrant that the design is production worthy. You should completely validate and test your design implementation to confirm the system functionality for your application.

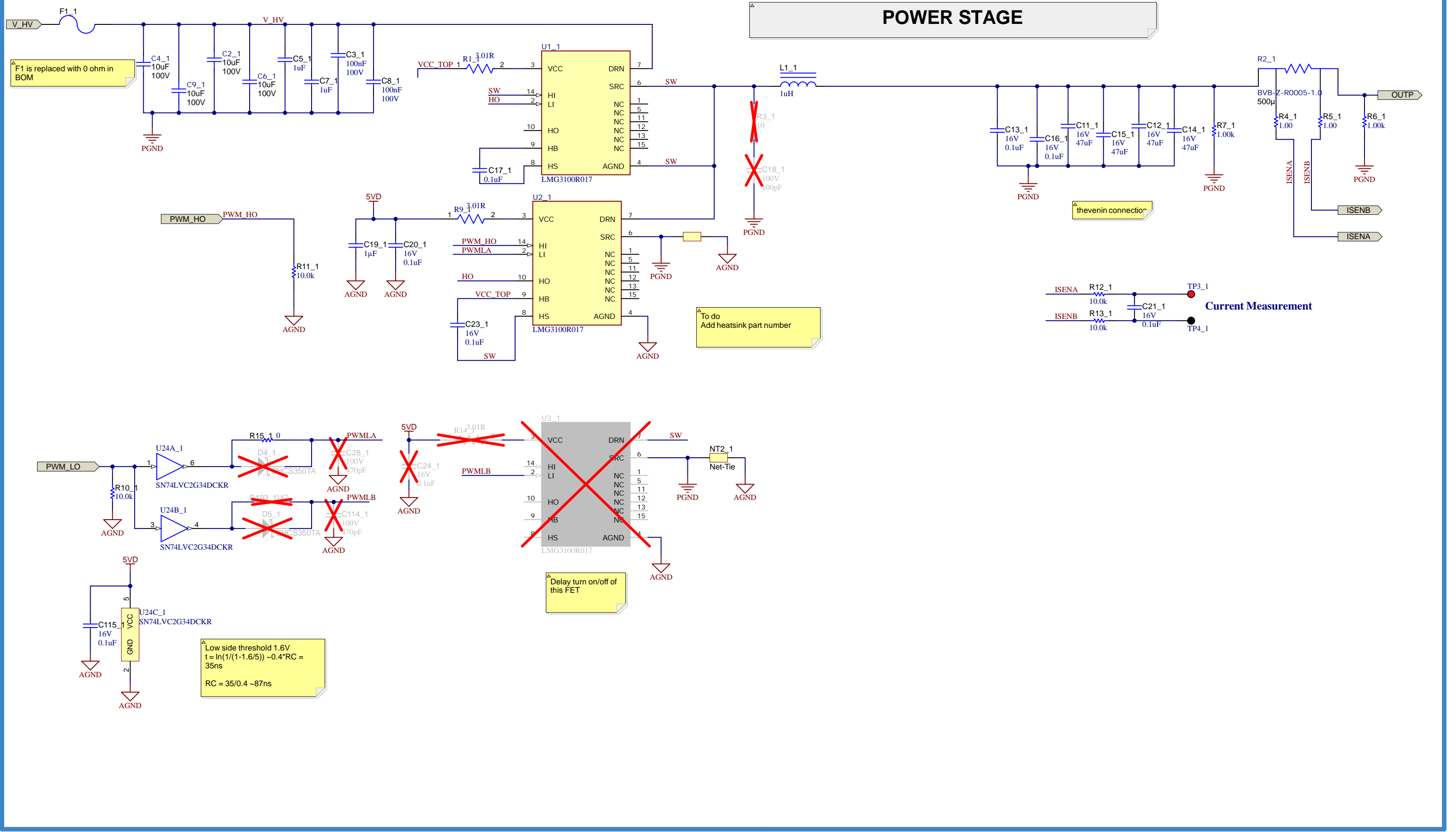
Orderable: ChangeMe in variant	Designed for: Public Release	Mod. Date: 10/22/2024	 TEXAS INSTRUMENTS http://www.ti.com <small>© Texas Instruments 2023</small>
TID #: TIDA-010090	Project Title: 4ch 50A bi-direction Digital Control Battery Tester		
Number: INDSYS-2971 Rev: B	Sheet Title:		
SVN Rev: Not in version control	Assembly Variant: 001	Sheet: 1 of 11	
Drawn By: Zhu Jingquan	File: INDSYS2971B_Cover.SchDoc	Size: B	
Engineer: Zhu Jingquan	Contact: http://www.ti.com/support		



Texas Instruments and/or its licensors do not warrant the accuracy or completeness of this specification or any information contained therein. Texas Instruments and/or its licensors do not warrant that this design will meet the specifications, will be suitable for your application or fit for any particular purpose, or will operate in an implementation. Texas Instruments and/or its licensors do not warrant that the design is production worthy. You should completely validate and test your design implementation to confirm the system functionality for your application.

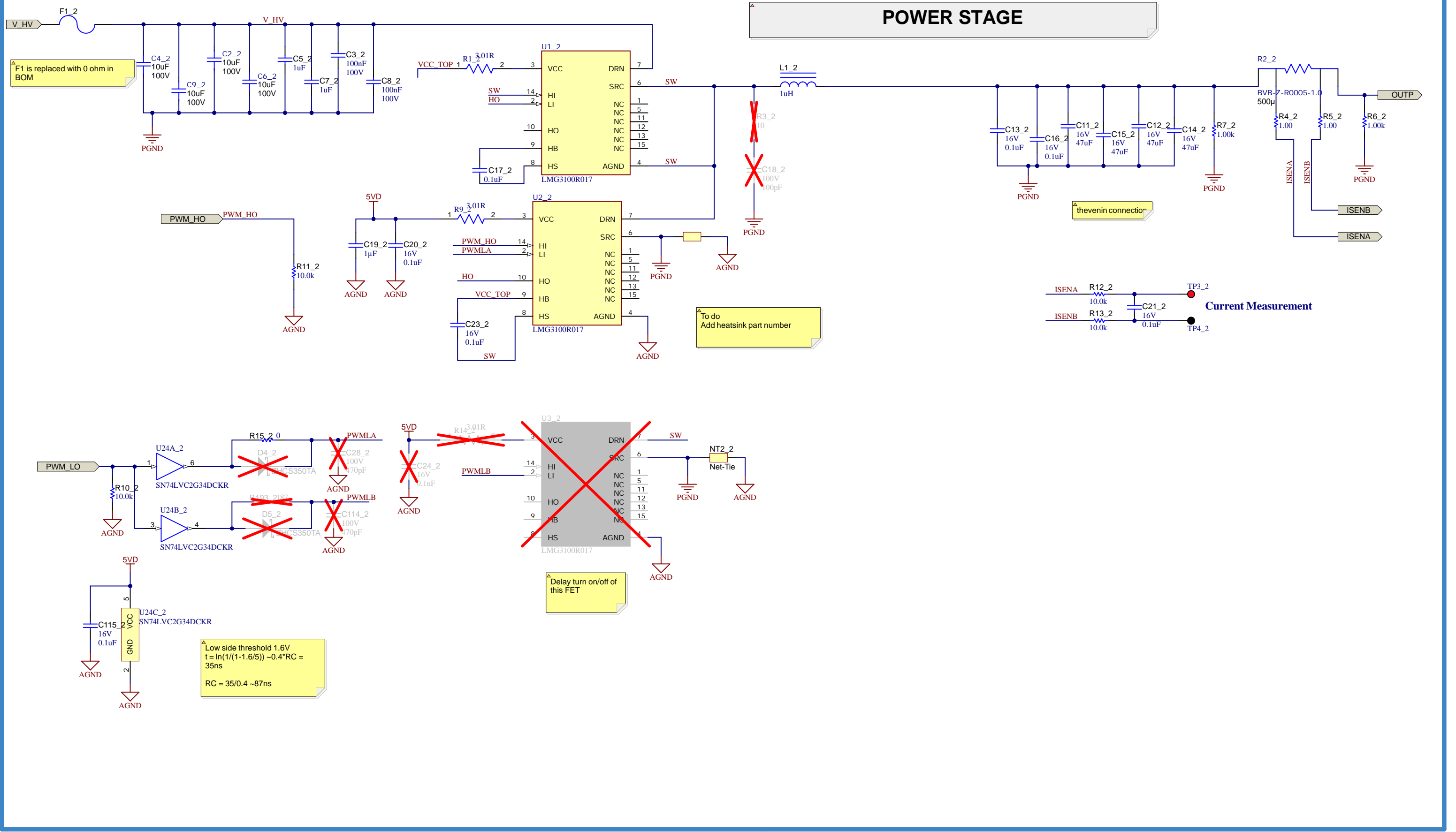
Orderable: ChangeMe in variant	Designed for: Public Release	Mod. Date: 3/14/2024	 http://www.ti.com
TID #: TIDA-010090	Project Title: 4ch 50A bi-direction Digital Control Battery Tester	Sheet: 2 of 11	
Number: INDSYS-2971 Rev: B	Sheet Title:	Size: B	
SVN Rev: Not in version control	File: INDSYS2971B.SchDoc	Contact: http://www.ti.com/support	
Drawn By:	Engineer: Zhu Jingquan		





Low side threshold 1.6V
 $t = \ln(1/(1-1.6/5)) - 0.4 * RC = 35ns$
 $RC = 35/0.4 \sim 87ns$

Texas Instruments and/or its licensors do not warrant the accuracy or completeness of this specification or any information contained therein. Texas Instruments and/or its licensors do not warrant that this design will meet the specifications, will be suitable for your application or fit for any particular purpose, or will operate in an implementation. Texas Instruments and/or its licensors do not warrant that the design is production worthy. You should completely validate and test your design implementation to confirm the system functionality for your application.

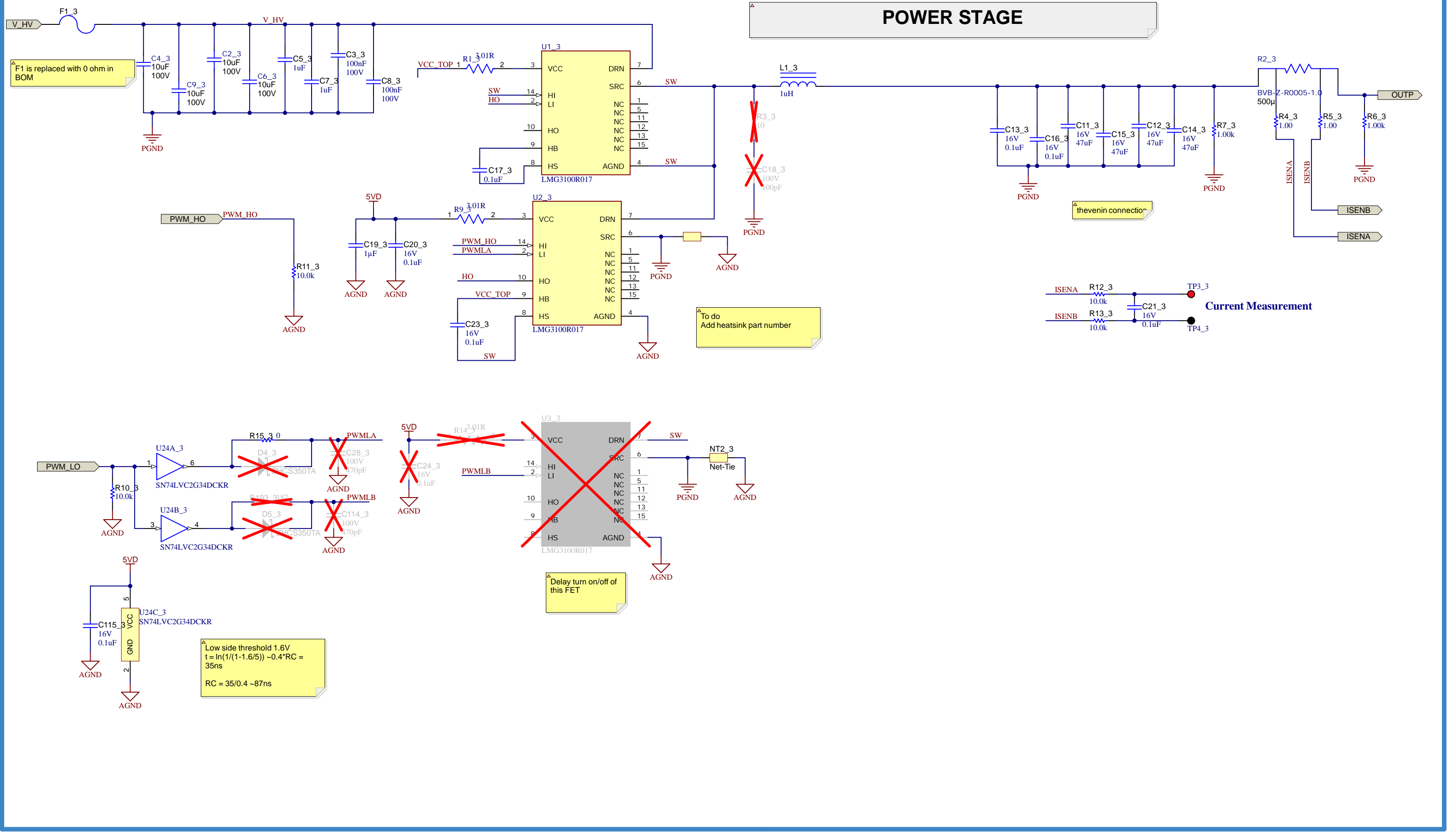


Low side threshold 1.6V
 $t = \ln(1/(1-1.6/5)) - 0.4 * RC = 35ns$
 $RC = 35/0.4 \sim 87ns$

Orderable: ChangeMe in variant	Designed for: Public Release	Mod. Date: 10/22/2024
TID #: TIDA-010090	Project Title: 4ch 50A bi-direction Digital Control Battery Tester	
Number: INDSYS-2971 Rev: B	Sheet Title:	
SVN Rev: Not in version control	Assembly Variant: 001	Sheet: 3 of 11
Drawn By: Battery test	File: INDSYS2971B_PowerStage.SchDoc	Size: B
Engineer: Zhu Jingquan	Contact: http://www.ti.com/support	

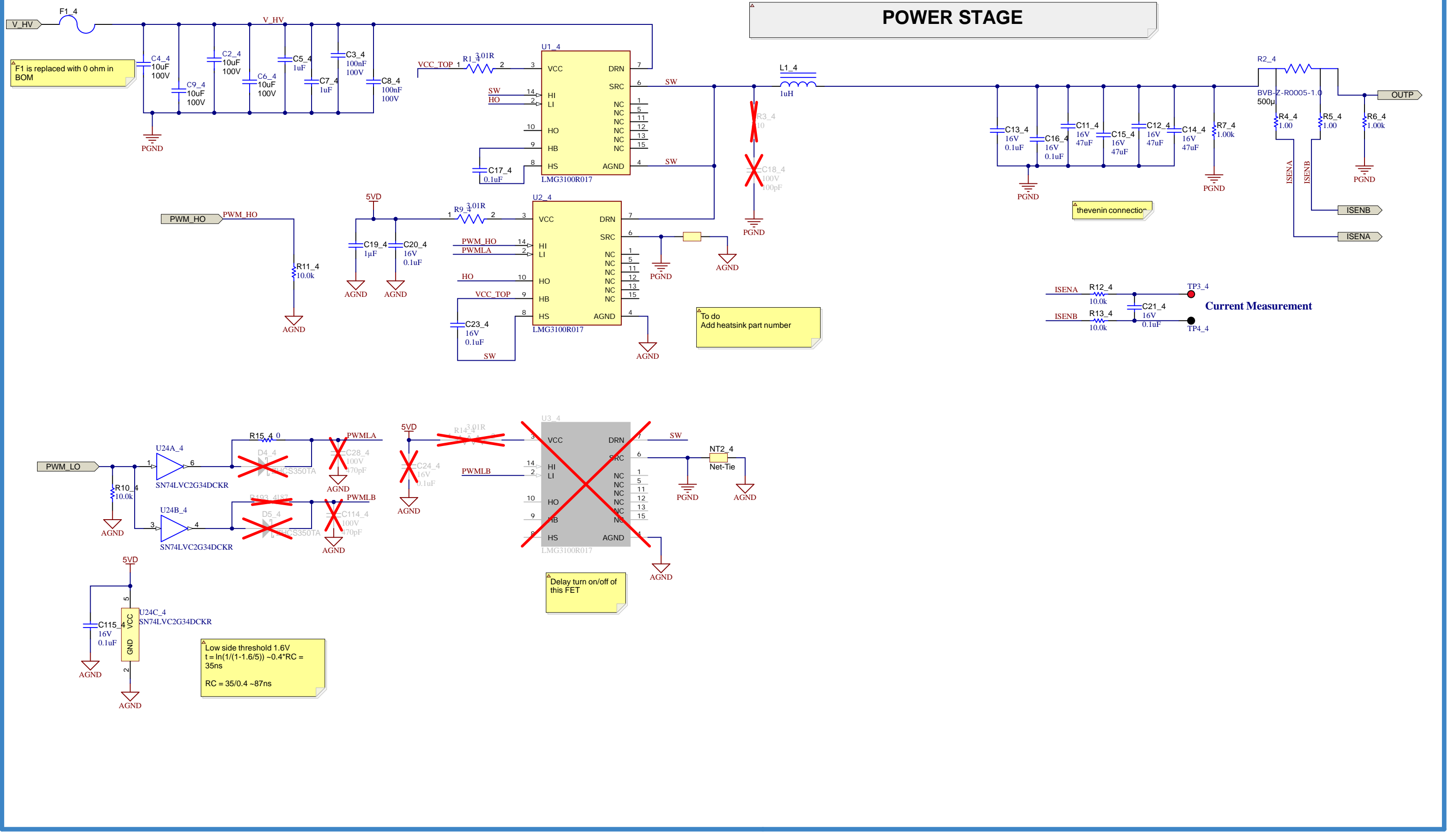
Texas Instruments and/or its licensors do not warrant the accuracy or completeness of this specification or any information contained therein. Texas Instruments and/or its licensors do not warrant that this design will meet the specifications, will be suitable for your application or fit for any particular purpose, or will operate in an implementation. Texas Instruments and/or its licensors do not warrant that the design is production worthy. You should completely validate and test your design implementation to confirm the system functionality for your application.



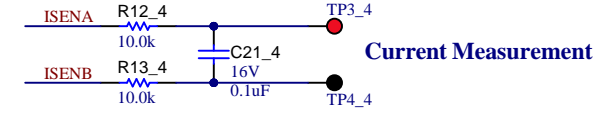


Texas Instruments and/or its licensors do not warrant the accuracy or completeness of this specification or any information contained therein. Texas Instruments and/or its licensors do not warrant that this design will meet the specifications, will be suitable for your application or fit for any particular purpose, or will operate in an implementation. Texas Instruments and/or its licensors do not warrant that the design is production worthy. You should completely validate and test your design implementation to confirm the system functionality for your application.

Orderable: ChangeMe in variant	Designed for: Public Release	Mod. Date: 10/22/2024
TID #: TIDA-010090	Project Title: 4ch 50A bi-direction Digital Control Battery Tester	
Number: INDSYS-2971 Rev: B	Sheet Title:	
SVN Rev: Not in version control	Assembly Variant: 001	Sheet: 3 of 11
Drawn By: Battery test	File: INDSYS2971B_PowerStage.SchDoc	Size: B
Engineer: Zhu Jingquan	Contact: http://www.ti.com/support	



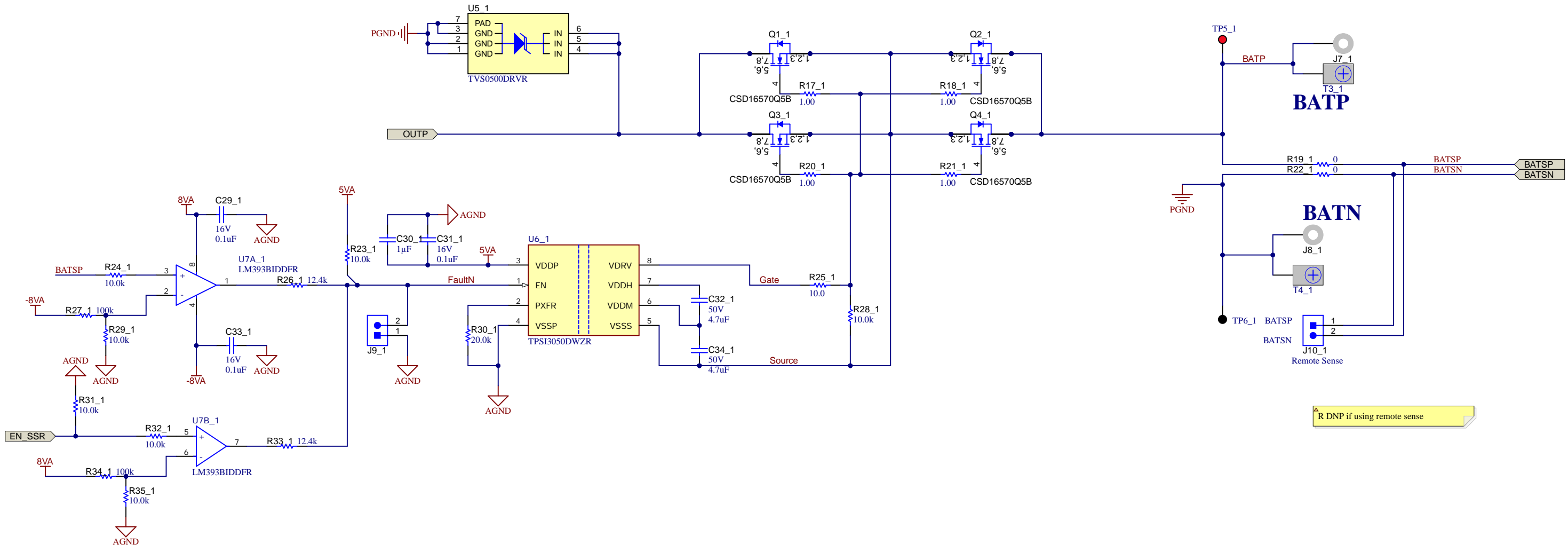
POWER STAGE



Low side threshold 1.6V
 $t = \ln(1/(1-1.6/5)) - 0.4 * RC = 35ns$
 $RC = 35/0.4 \sim 87ns$

Texas Instruments and/or its licensors do not warrant the accuracy or completeness of this specification or any information contained therein. Texas Instruments and/or its licensors do not warrant that this design will meet the specifications, will be suitable for your application or fit for any particular purpose, or will operate in an implementation. Texas Instruments and/or its licensors do not warrant that the design is production worthy. You should completely validate and test your design implementation to confirm the system functionality for your application.

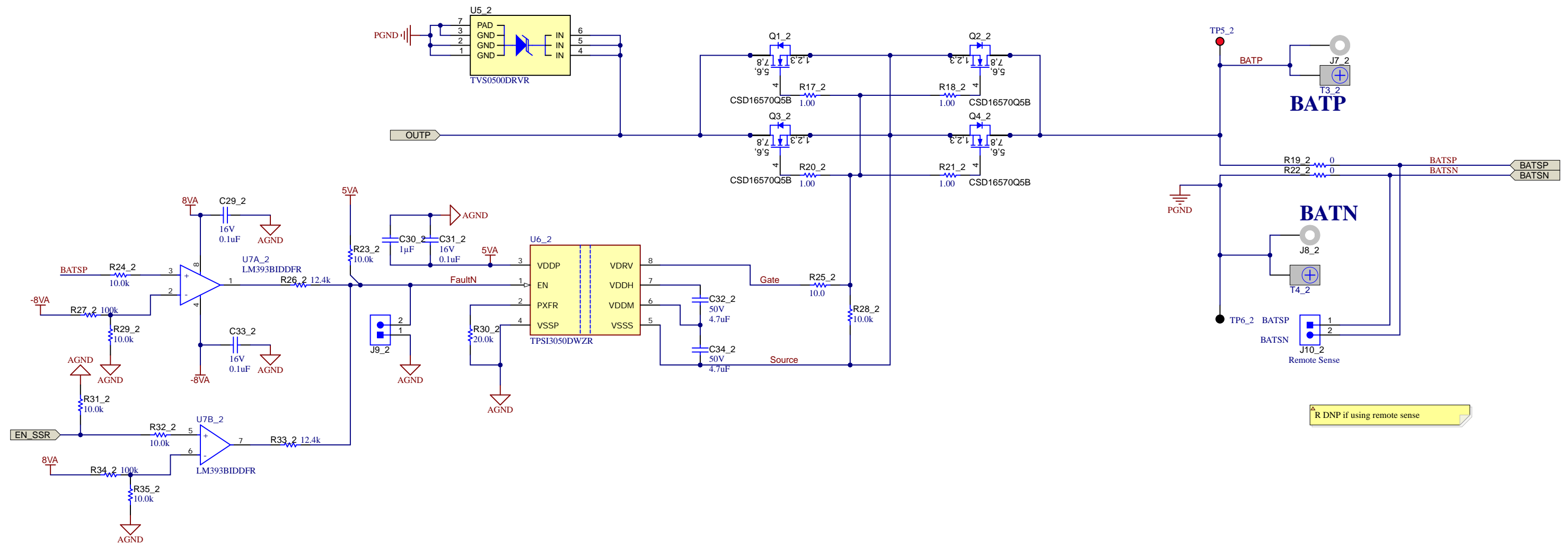
REVERSE BATTERY PROTECTION



Texas Instruments and/or its licensors do not warrant the accuracy or completeness of this specification or any information contained therein. Texas Instruments and/or its licensors do not warrant that this design will meet the specifications, will be suitable for your application or fit for any particular purpose, or will operate in an implementation. Texas Instruments and/or its licensors do not warrant that the design is production worthy. You should completely validate and test your design implementation to confirm the system functionality for your application.

Orderable: ChangeMe in variant	Designed for: Public Release	Mod. Date: 3/13/2024	 TEXAS INSTRUMENTS http://www.ti.com © Texas Instruments 2023
TID #: TIDA-010090	Project Title: 4ch 50A bi-direction Digital Control Battery Tester		
Number: INDSYS-2971 Rev: B	Sheet Title:		
SVN Rev: Not in version control	Assembly Variant: 001	Sheet: 4 of 11	
Drawn By: Battery test	File: INDSYS2971B_ReverseBatteryProtection.SchDoc	Size: B	
Engineer: Zhu Jingquan	Contact: http://www.ti.com/support		

REVERSE BATTERY PROTECTION



R DNP if using remote sense

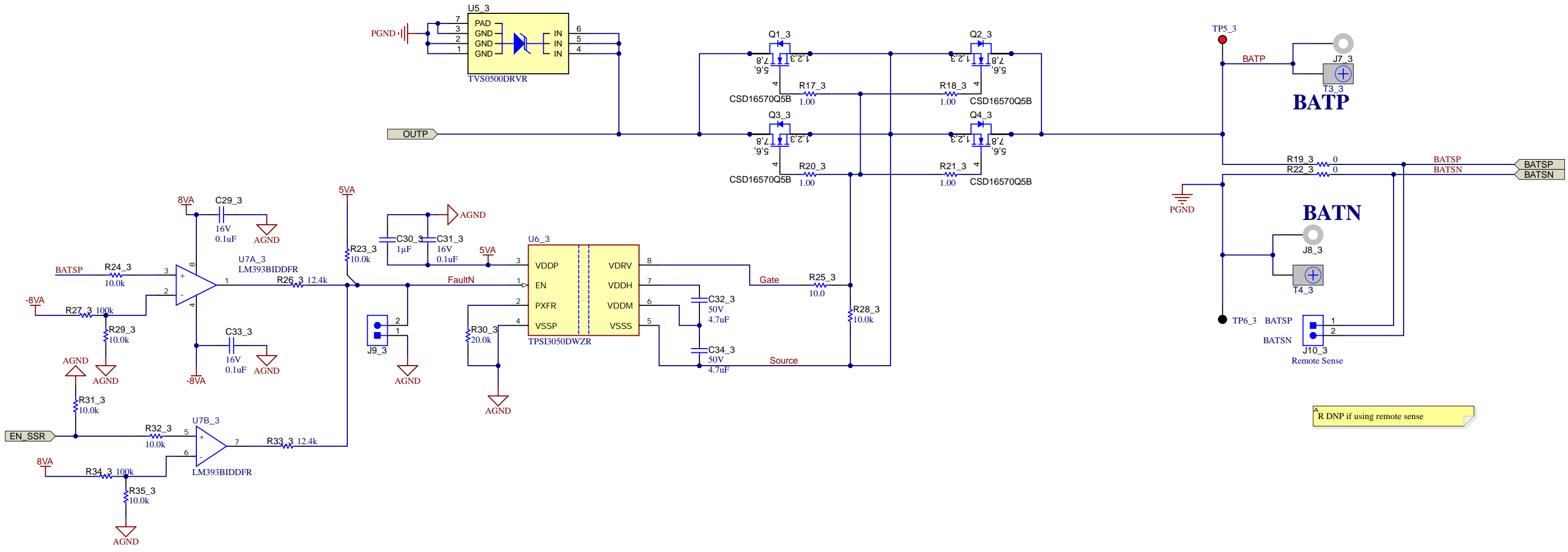
Texas Instruments and/or its licensors do not warrant the accuracy or completeness of this specification or any information contained therein. Texas Instruments and/or its licensors do not warrant that this design will meet the specifications, will be suitable for your application or fit for any particular purpose, or will operate in an implementation. Texas Instruments and/or its licensors do not warrant that the design is production worthy. You should completely validate and test your design implementation to confirm the system functionality for your application.

Orderable: ChangeMe in variant	Designed for: Public Release	Mod. Date: 3/13/2024
TID #: TIDA-010090	Project Title: 4ch 50A bi-direction Digital Control Battery Tester	
Number: INDSYS-2971 Rev: B	Sheet Title:	
SVN Rev: Not in version control	Assembly Variant: 001	Sheet: 4 of 11
Drawn By: Battery test	File: INDSYS2971B_ReverseBatteryProtection.SchDoc	Size: B
Engineer: Zhu Jingquan	Contact: http://www.ti.com/support	



© Texas Instruments 2023

REVERSE BATTERY PROTECTION



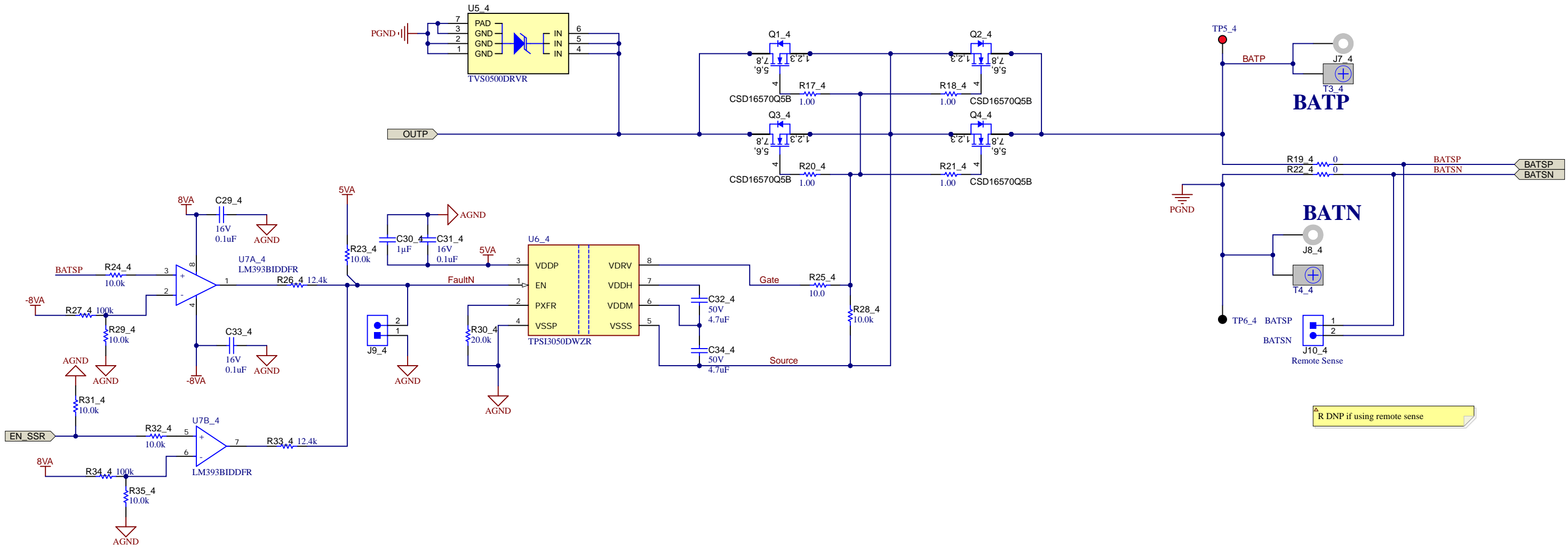
A R DNP if using remote sense

Texas Instruments and/or its licensors do not warrant the accuracy or completeness of this specification or any information contained therein. Texas Instruments and/or its licensors do not warrant that this design will meet the specifications, will be suitable for your application or fit for any particular purpose, or will operate in an implementation. Texas Instruments and/or its licensors do not warrant that the design is production worthy. You should completely validate and test your design implementation to confirm the system functionality for your application.

Orderable: ChangeMe in variant	Designed for: Public Release	Mod. Date: 3/13/2024
TID #: TIDA-010090	Project Title: 4ch 50A bi-direction Digital Control Battery Tester	
Number: INDSYS-2971 Rev: B	Sheet Title:	
SVN Rev: Not in version control	Assembly Variant: 001	Sheet: 4 of 11
Drawn By: Battery test	File: INDSYS2971B_ReverseBatteryProtection.SchDoc	Size: B
Engineer: Zhu Jingquan	Contact: http://www.ti.com/support	



REVERSE BATTERY PROTECTION



R DNP if using remote sense

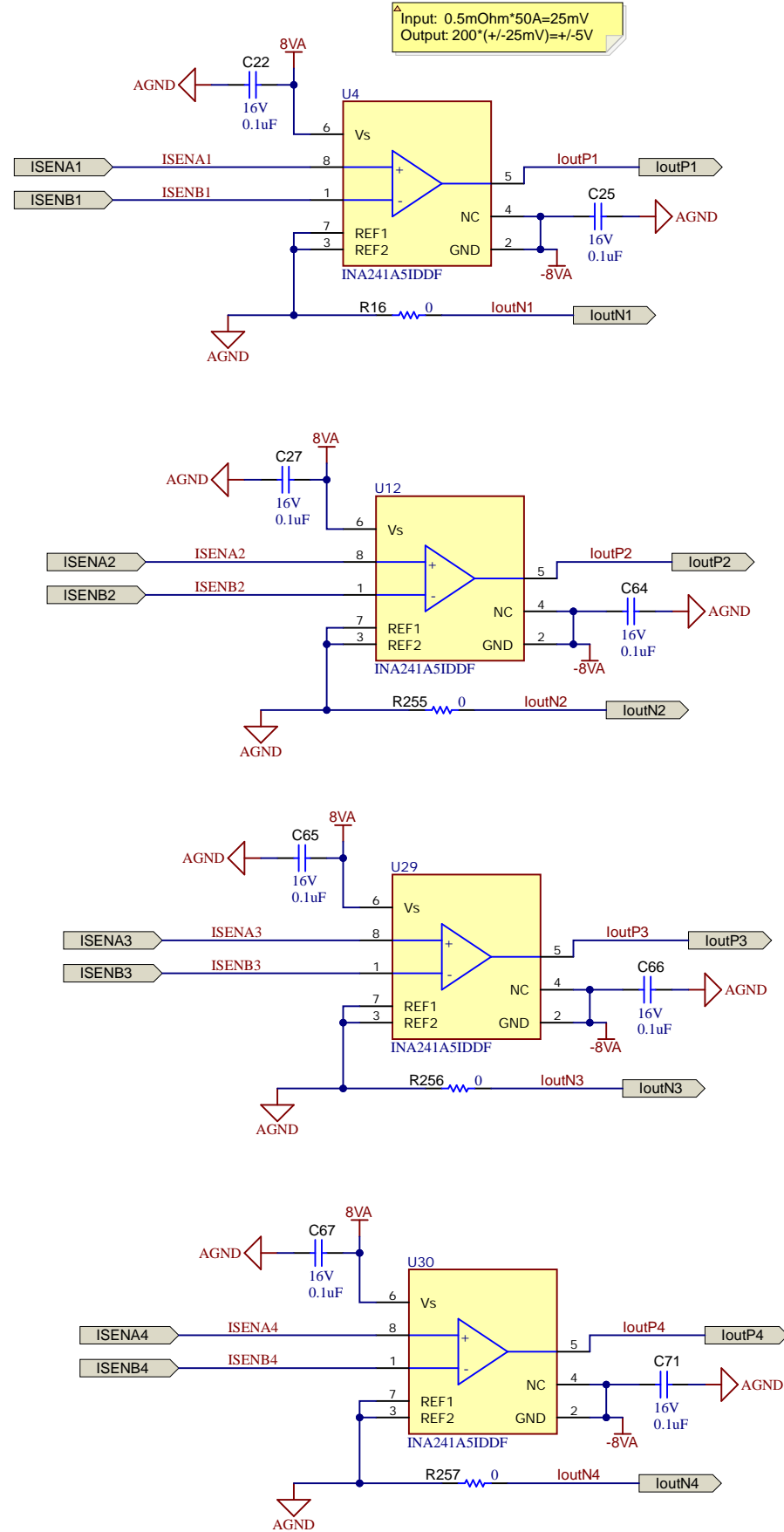
Texas Instruments and/or its licensors do not warrant the accuracy or completeness of this specification or any information contained therein. Texas Instruments and/or its licensors do not warrant that this design will meet the specifications, will be suitable for your application or fit for any particular purpose, or will operate in an implementation. Texas Instruments and/or its licensors do not warrant that the design is production worthy. You should completely validate and test your design implementation to confirm the system functionality for your application.

Orderable: ChangeMe in variant	Designed for: Public Release	Mod. Date: 3/13/2024
TID #: TIDA-010090	Project Title: 4ch 50A bi-direction Digital Control Battery Tester	
Number: INDSYS-2971 Rev: B	Sheet Title:	
SVN Rev: Not in version control	Assembly Variant: 001	Sheet: 4 of 11
Drawn By: Battery test	File: INDSYS2971B_ReverseBatteryProtection.SchDoc	Size: B
Engineer: Zhu Jingquan	Contact: http://www.ti.com/support	

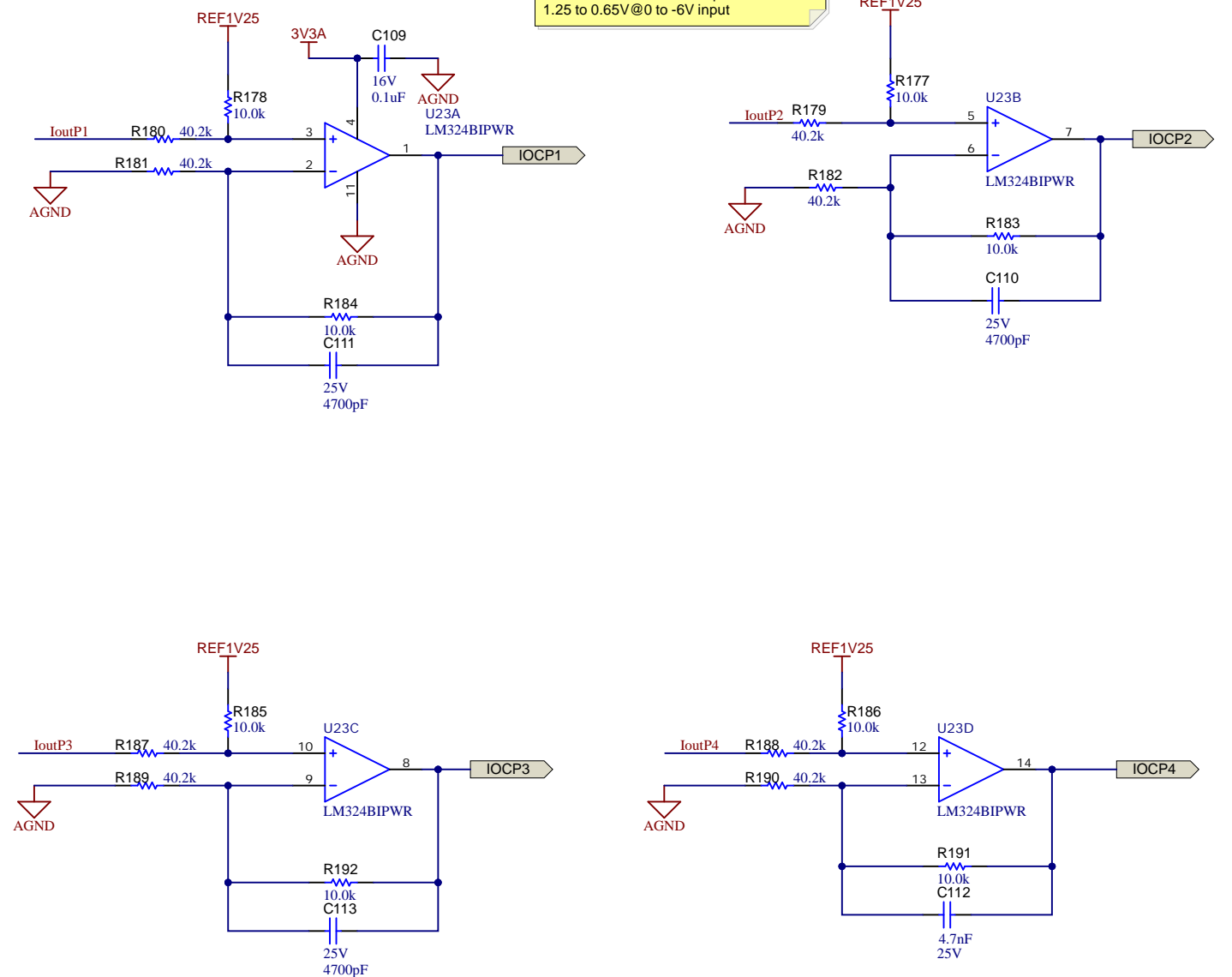


Current sensing

Input: $0.5\text{m}\Omega \cdot 50\text{A} = 25\text{mV}$
Output: $200 \cdot (\pm 25\text{mV}) = \pm 5\text{V}$



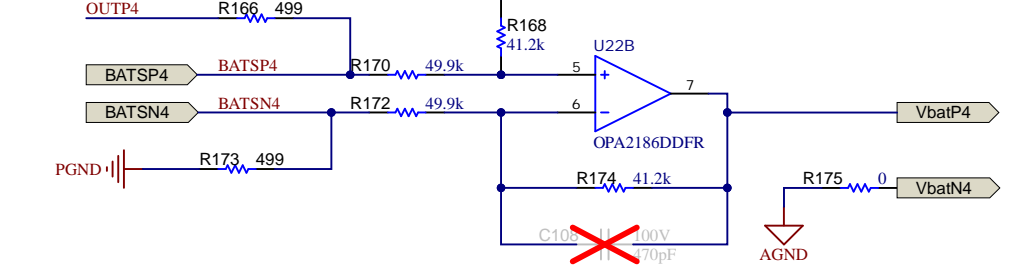
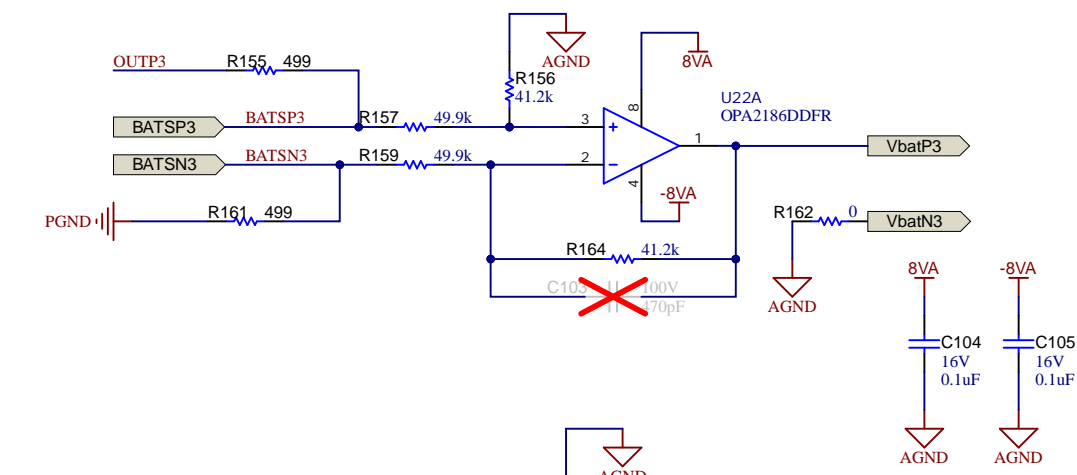
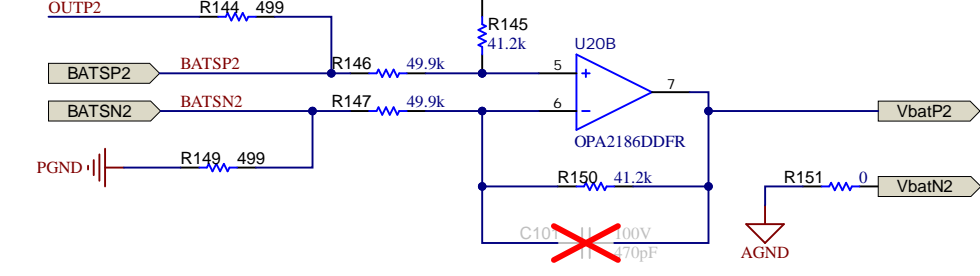
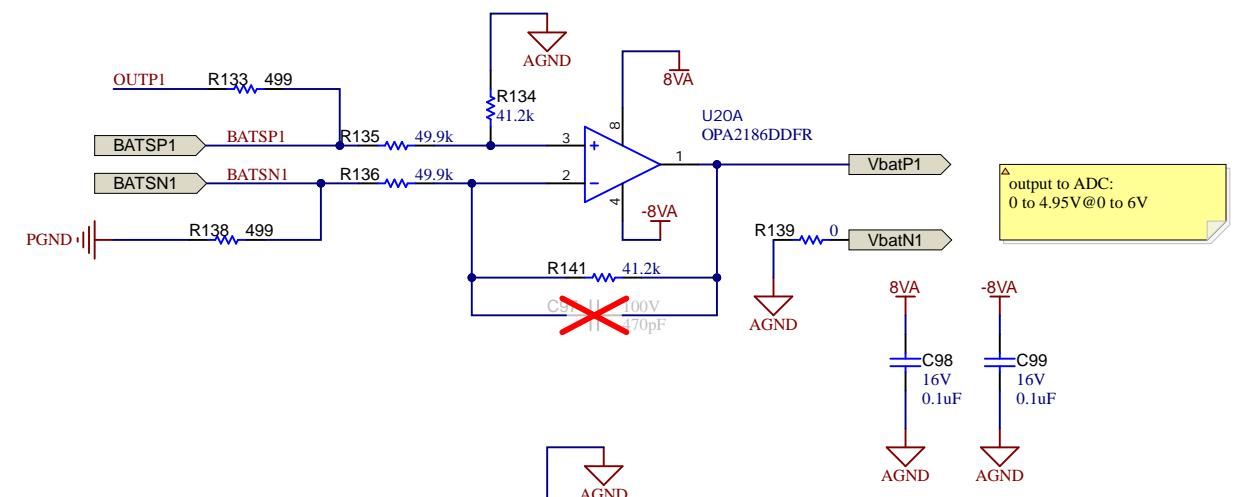
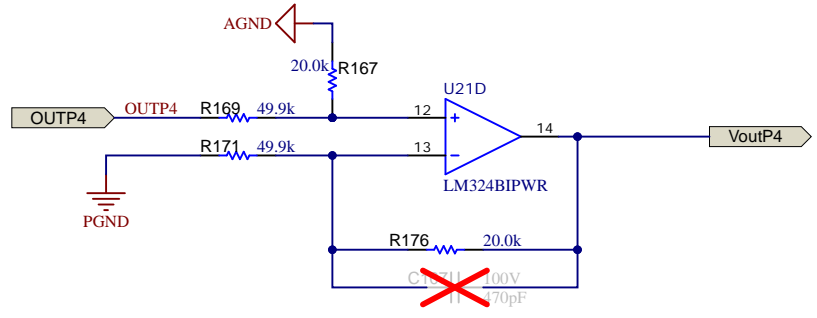
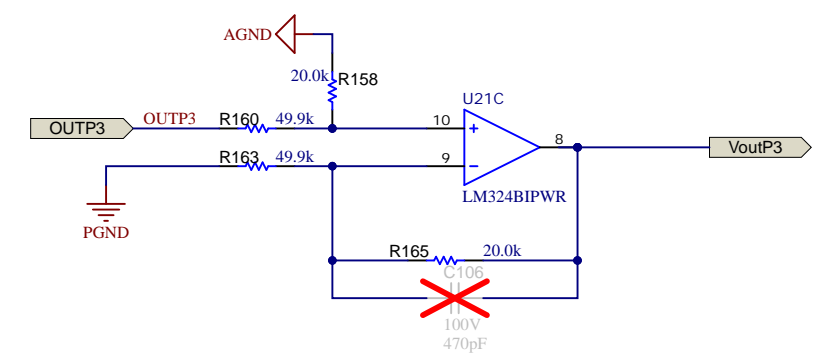
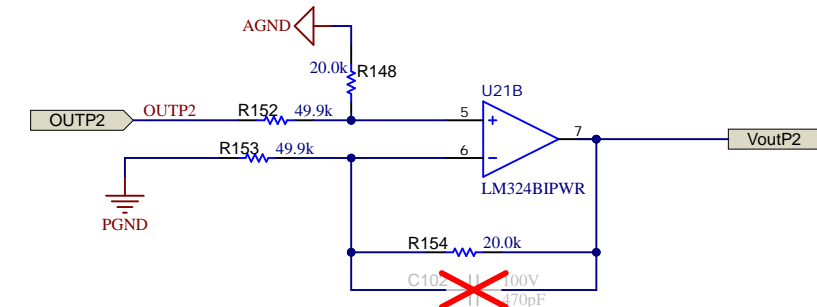
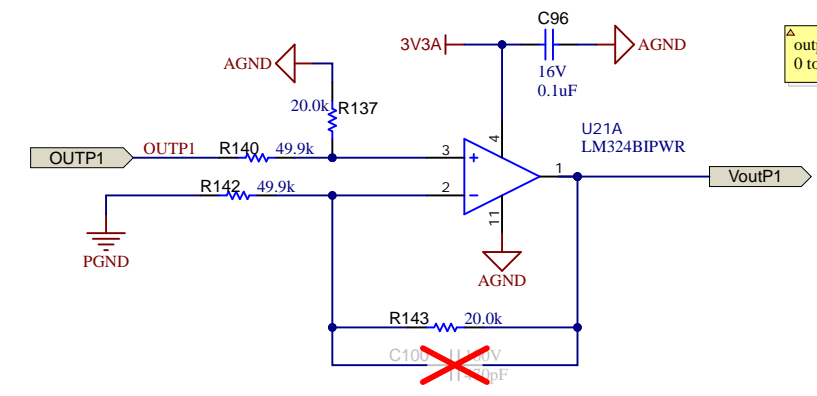
Output: 1.25 to 1.85V @ 0 to $+6\text{V}$ input
 1.25 to 0.65V @ 0 to -6V input



Texas Instruments and/or its licensors do not warrant the accuracy or completeness of this specification or any information contained therein. Texas Instruments and/or its licensors do not warrant that this design will meet the specifications, will be suitable for your application or fit for any particular purpose, or will operate in an implementation. Texas Instruments and/or its licensors do not warrant that the design is production worthy. You should completely validate and test your design implementation to confirm the system functionality for your application.

Orderable: ChangeMe in variant	Designed for: Public Release	Mod. Date: 3/13/2024	<p>TEXAS INSTRUMENTS</p> <p>http://www.ti.com</p> <p>© Texas Instruments 2023</p>
TID #: TIDA-010090	Project Title: 4ch 50A bi-direction Digital Control Battery Tester	Sheet: 5 of 11	
Number: INDSYS-2971 Rev: B	Sheet Title:	Size: B	
SVN Rev: Not in version control	Assembly Variant: 001		
Drawn By: Battery test	File: INDSYS2971B_CurrentSense.SchDoc		
Engineer: Zhu Jingquan	Contact: http://www.ti.com/support		

Voltage sense: Remote and local



Texas Instruments and/or its licensors do not warrant the accuracy or completeness of this specification or any information contained therein. Texas Instruments and/or its licensors do not warrant that this design will meet the specifications, will be suitable for your application or fit for any particular purpose, or will operate in an implementation. Texas Instruments and/or its licensors do not warrant that the design is production worthy. You should completely validate and test your design implementation to confirm the system functionality for your application.

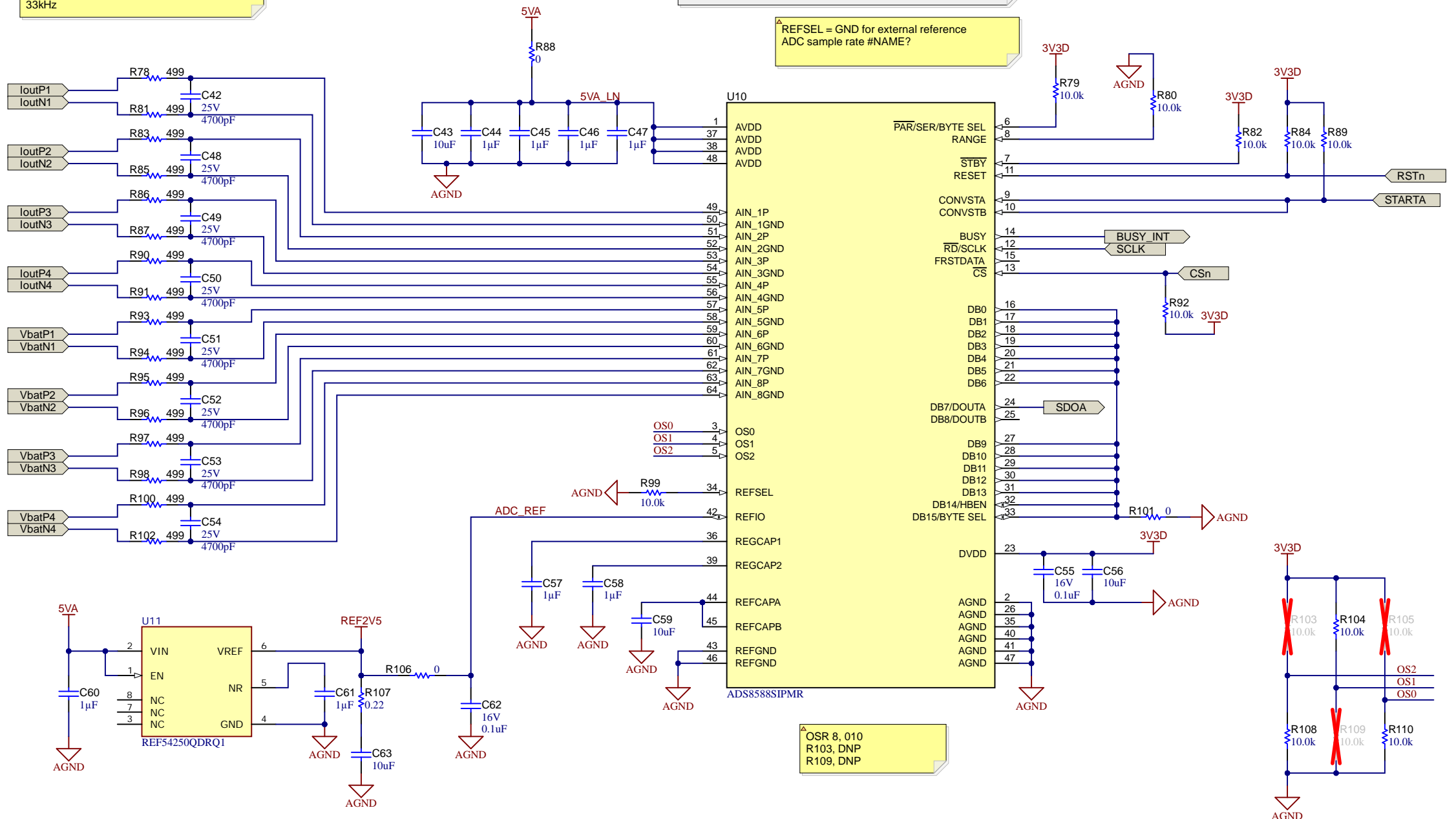
Orderable: ChangeMe in variant	Designed for: Public Release	Mod. Date: 3/7/2024
TID #: TIDA-010090	Project Title: 4ch 50A bi-direction Digital Control Battery Tester	
Number: INDSYS-2971 Rev: B	Sheet Title:	
SVN Rev: Not in version control	Assembly Variant: 001	Sheet: 6 of 11
Drawn By: Battery test	File: INDSYS2971B_VoltageSense.SchDoc	Size: B
Engineer: Zhu Jingquan	Contact: http://www.ti.com/support	



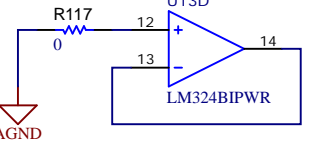
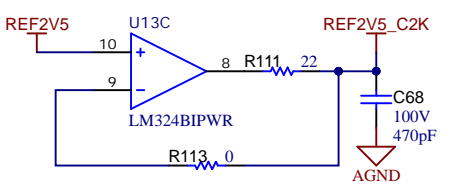
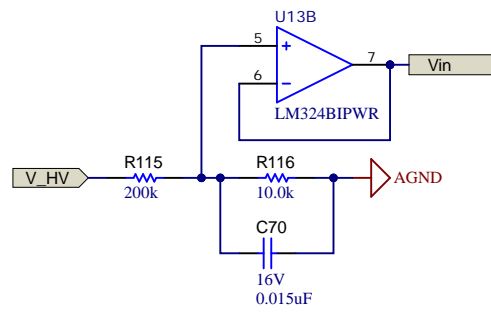
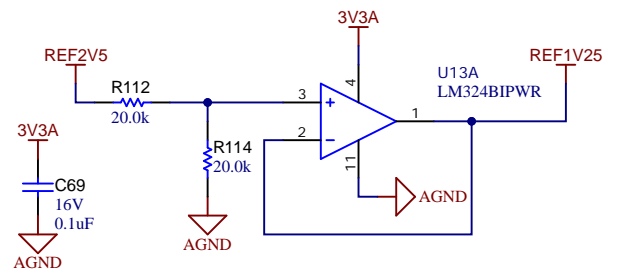
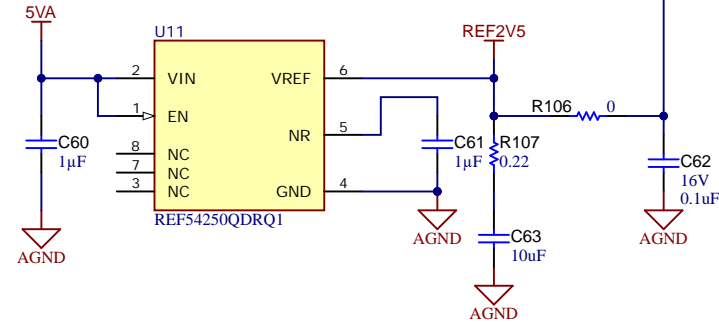
Filter cut-off
33kHz

SAR ADC SCHEMATIC

REFSEL = GND for external reference
ADC sample rate #NAME?



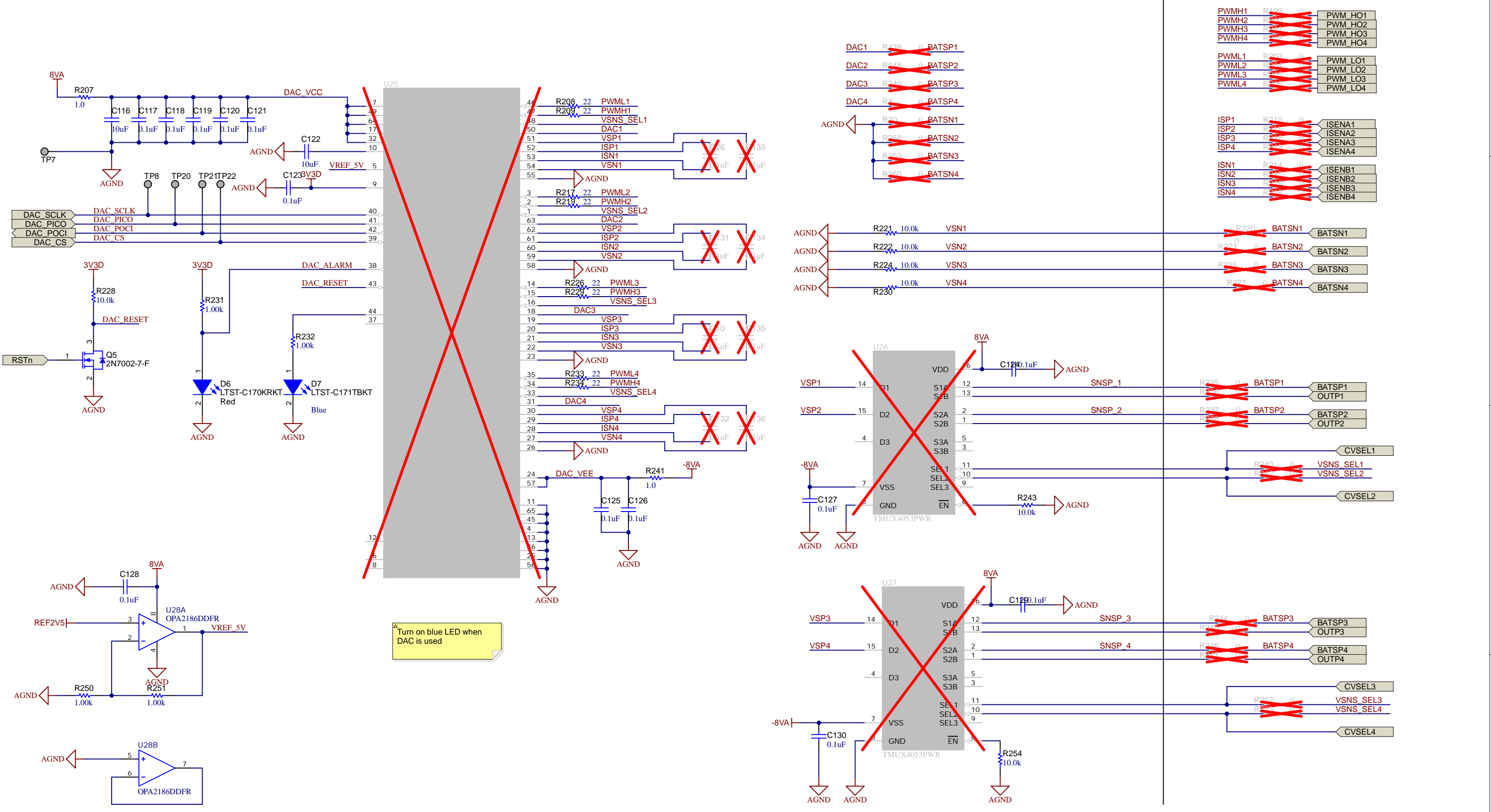
OSR 8, 010
R103, DNP
R109, DNP



Texas Instruments and/or its licensors do not warrant the accuracy or completeness of this specification or any information contained therein. Texas Instruments and/or its licensors do not warrant that this design will meet the specifications, will be suitable for your application or fit for any particular purpose, or will operate in an implementation. Texas Instruments and/or its licensors do not warrant that the design is production worthy. You should completely validate and test your design implementation to confirm the system functionality for your application.

SPI to PWM

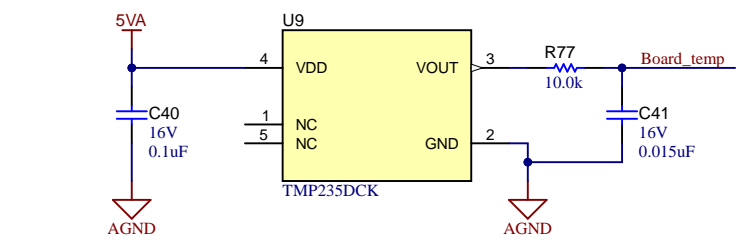
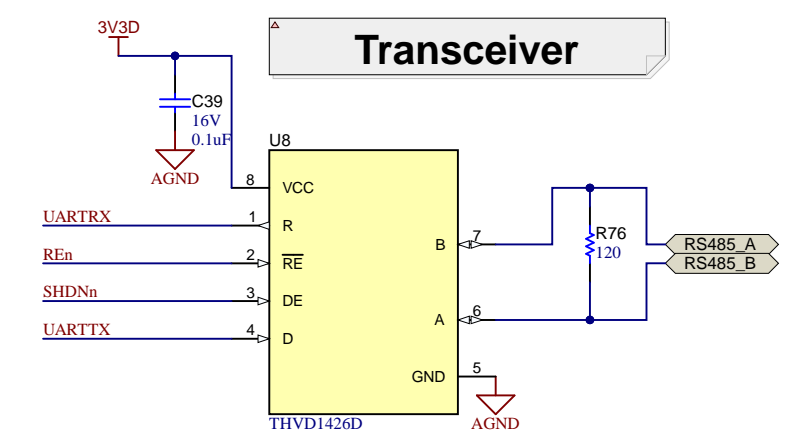
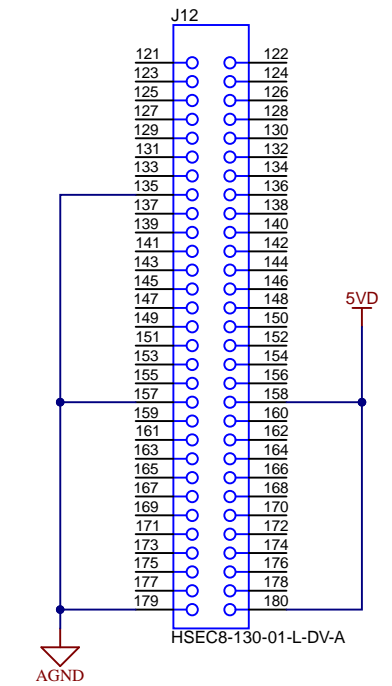
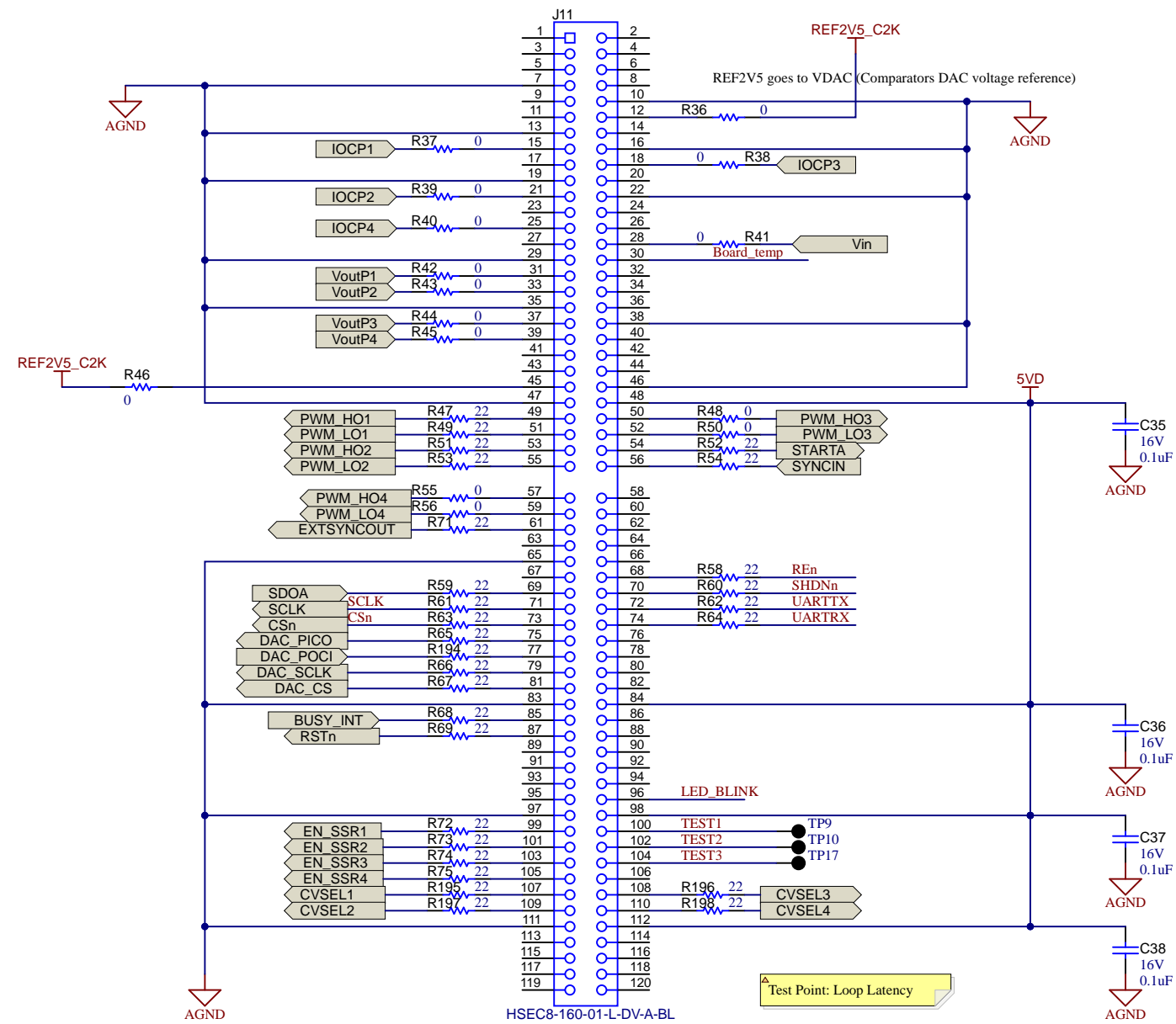
Place these zero ohm resistors close to the source
DNP these resistors if DAC is not used



Turn on blue LED when DAC is used

Texas Instruments and/or its licensors do not warrant the accuracy or completeness of this specification or any information contained therein. Texas Instruments and/or its licensors do not warrant that this design will meet the specifications, will be suitable for your application or fit for any particular purpose, or will operate in an implementation. Texas Instruments and/or its licensors do not warrant that the design is production worthy. You should completely validate and test your design implementation to confirm the system functionality for your application.

CONTROL CARD PIN MAPPING_F28P65x

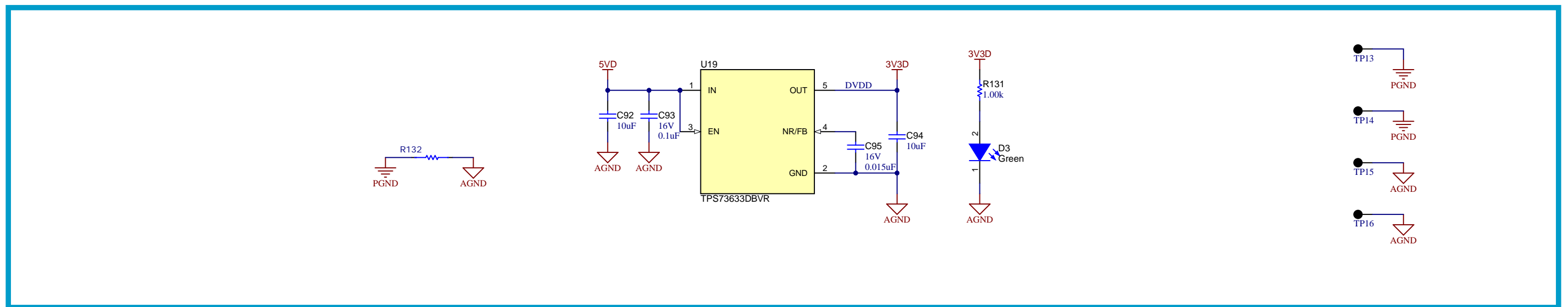
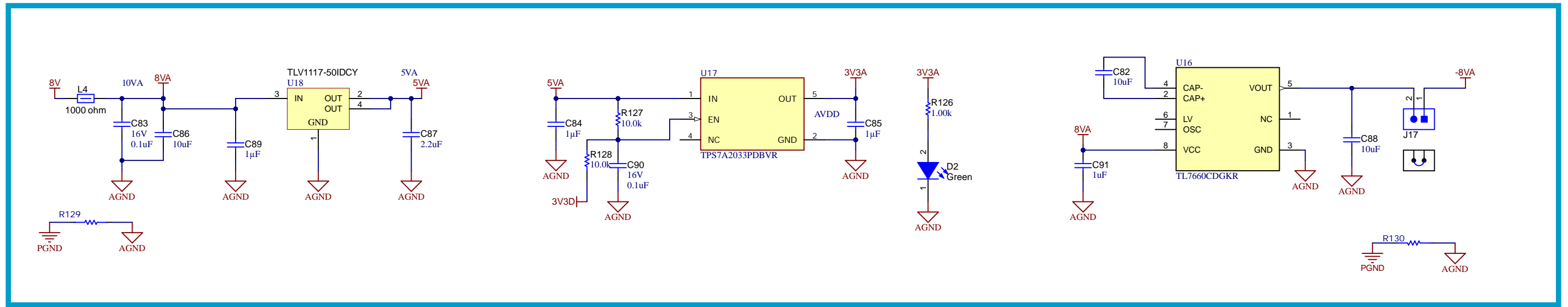
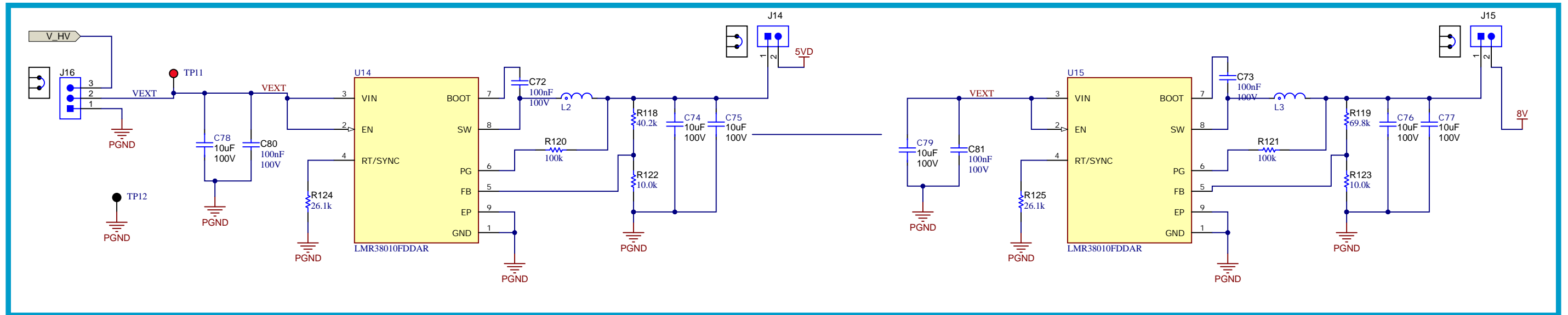


Texas Instruments and/or its licensors do not warrant the accuracy or completeness of this specification or any information contained therein. Texas Instruments and/or its licensors do not warrant that this design will meet the specifications, will be suitable for your application or fit for any particular purpose, or will operate in an implementation. Texas Instruments and/or its licensors do not warrant that the design is production worthy. You should completely validate and test your design implementation to confirm the system functionality for your application.

Orderable: ChangeMe in variant	Designed for: Public Release	Mod. Date: 3/18/2024
TID #: TIDA-010090	Project Title: 4ch 50A bi-direction Digital Control Battery Tester	
Number: INDSYS-2971 Rev: B	Sheet Title:	
SVN Rev: Not in version control	Assembly Variant: 001	Sheet: 9 of 11
Drawn By: Battery test	File: INDSYS2971B_ControlCard.SchDoc	Size: B
Engineer: Zhu Jingquan	Contact: http://www.ti.com/support	

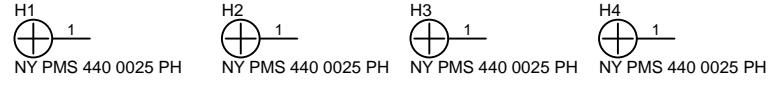
TEXAS INSTRUMENTS
http://www.ti.com
© Texas Instruments 2023

BIAS POWER



Texas Instruments and/or its licensors do not warrant the accuracy or completeness of this specification or any information contained therein. Texas Instruments and/or its licensors do not warrant that this design will meet the specifications, will be suitable for your application or fit for any particular purpose, or will operate in an implementation. Texas Instruments and/or its licensors do not warrant that the design is production worthy. You should completely validate and test your design implementation to confirm the system functionality for your application.

Orderable: ChangeMe in variant	Designed for: Public Release	Mod. Date: 3/14/2024
TID #: TIDA-010090	Project Title: 4ch 50A bi-direction Digital Control Battery Tester	
Number: INDSYS-2971 Rev: B	Sheet Title:	
SVN Rev: Not in version control	Assembly Variant: 001	Sheet: 10 of 11
Drawn By: Battery test	File: INDSYS2971B_BiasPower.SchDoc	Size: B
Engineer: Zhu Jingquan	Contact: http://www.ti.com/support	



PCB Number: INDSYS-2971
PCB Rev: B

PCB LOGO
Texas Instruments



PCB LOGO
FCC disclaimer

PCB LOGO
WEEE logo



LBL1
PCB Label
THT-14-423-10
Size: 0.65" x 0.20 "

Variant/Label Table	
Variant	Label Text
001	ChangeMe!
002	ChangeMe!

You should delete the nylon screws/standoffs and/or the bumpers as needed for your design (or substitute other parts from Hardware.IntLib). Bumpers are cheaper, but provide less clearance.

Deleting anything else from this page may result in your EVM submission being rejected (until you add them back).

Update the Label Text in the Label Table as needed for each Assembly Variant.

You should delete this note too.

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.

Texas Instruments and/or its licensors do not warrant the accuracy or completeness of this specification or any information contained therein. Texas Instruments and/or its licensors do not warrant that this design will meet the specifications, will be suitable for your application or fit for any particular purpose, or will operate in an implementation. Texas Instruments and/or its licensors do not warrant that the design is production worthy. You should completely validate and test your design implementation to confirm the system functionality for your application.

Orderable: ChangeMe in variant	Designed for: Public Release	Mod. Date: 3/8/2024	<p>TEXAS INSTRUMENTS http://www.ti.com © Texas Instruments 2023</p>
TID #: TIDA-010090	Project Title: 4ch 50A bi-direction Digital Control Battery Tester		
Number: INDSYS-2971 Rev: B	Sheet Title:		
SVN Rev: Not in version control	Assembly Variant: 001	Sheet: 11 of 11	
Drawn By: Battery test	File: INDSYS2971B_Hardware.SchDoc	Size: B	
Engineer: Zhu Jingquan	Contact: http://www.ti.com/support		

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to [TI's Terms of Sale](#) or other applicable terms available either on [ti.com](https://www.ti.com) or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2024, Texas Instruments Incorporated