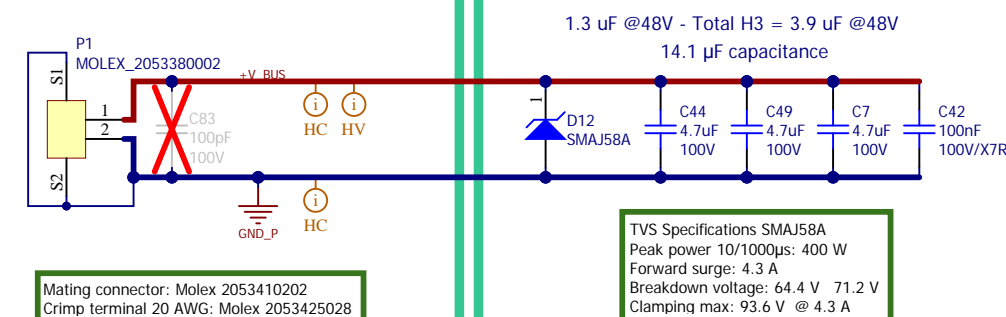


## Power Supply Connector



## DC Bus Input Stage

## Motor Connector

## Assembly Holes

## 5V DC/DC step down converter

## Motor temperature input

## I/Os protections

## EtherCAT & Safety Inputs (Daisy chain)

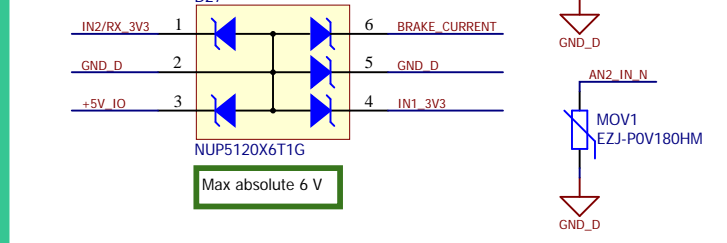
## I/Os Supply

## Digital halls (3.3 V pull-up)

## 3.3 V and 1.8 V DC/DCs

## Digital inputs and outputs

## Digital Inputs 5 V tolerant (3.3V levels)



## Feedbacks Connector

## Feedback ESD Protections

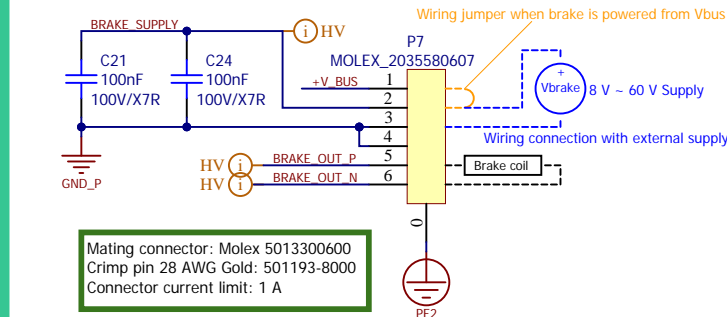
## PCB Elements

## PCB Elements

## Absolute encoder

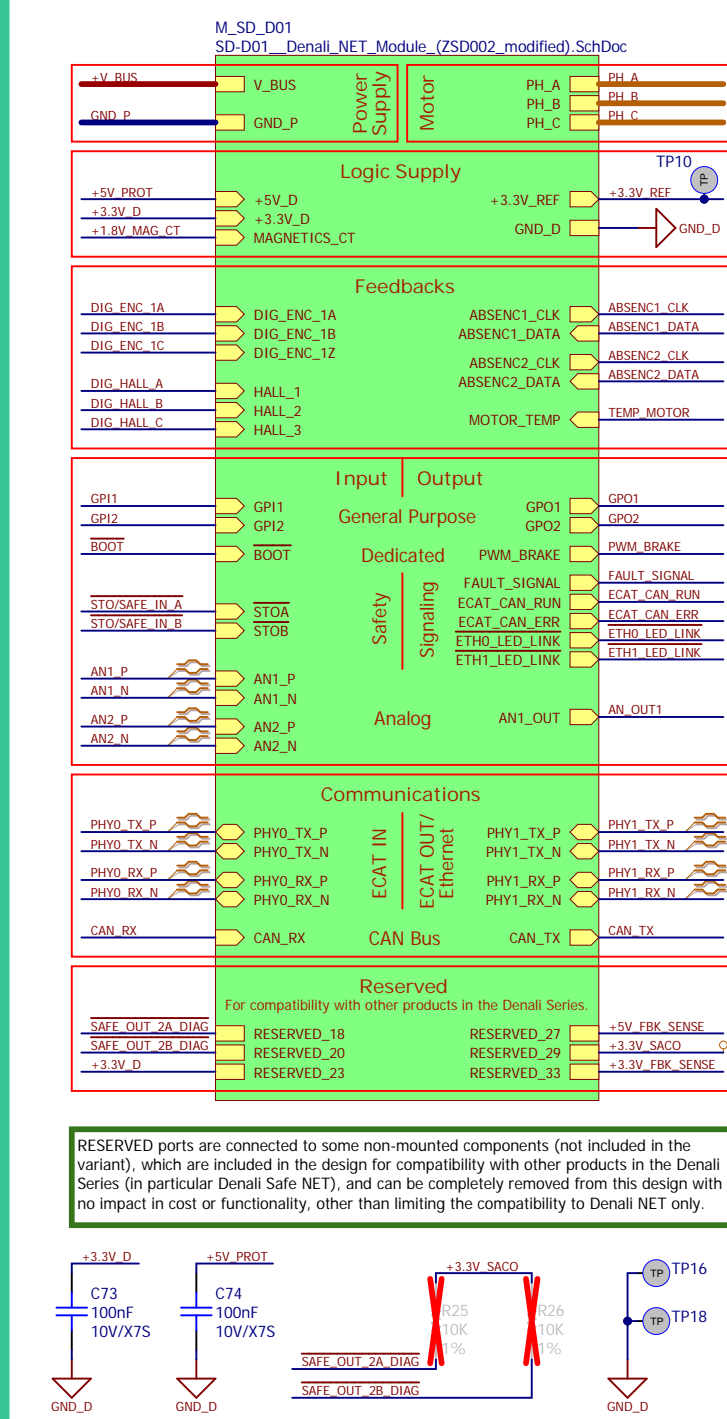
## Brake Circuit

## Brake connector



## Incremental encoder

## B2B connector to DEN-NET/DEN-FS



## Digital outputs

## Ethernet / EtherCAT

## Voltage Monitors

## Feedback supply

## Safety Isolated Interface (Dual Channel)

## ESD protections

## I/Os + CAN

## Ethernet / EtherCAT

## Analog inputs ±10V±11 V range

## Analog Output 3.3V

## LEDs

## Feedbacks Connector

## Feedback ESD Protections

## PCB Elements

## PCB Elements

## Absolute encoder

## Brake Circuit

## Brake connector

## Incremental encoder

## B2B connector to DEN-NET/DEN-FS

ATTENTION PINOUT!  
This connector should not be confused with EVEREST-XCR or CAPITAN-XCR Connectors. They have different functionalities and pinouts. Wrong connection can cause damage!

ATTENTION PINOUT!  
This connector must not be confused with EVEREST-XCR or CAPITAN-XCR Connectors, which have different same number pin pins, but different pinout. Wrong connection can cause damage!

ATTENTION!  
This module does NOT have the typical gain of 0.330 and ±10V range seen in previous designs like EVE or CAP-XCR. It can read approximately ±11 V to avoid saturation when reading ±10 V.

OPA2316 has indefinite short-circuit capacity (~ 40 mA). Output DC impedance is estimated ~25 Ω

No need to buffer (as in EVR XCR) since the signal is not used for boot

RESERVED ports are connected to some non-mounted components (not included in the variant), which are included in the design for compatibility with other products in the Denali Series (in particular Denali Safe Net), and can be completely removed from this design with no impact in cost or functionality, other than limiting the compatibility to Denali NET only.

## Clearances and creepages for IEC 61800-5-1

### Basic insulation (PE to anything)

**CLEARANCE**, Assuming system voltage 100 V, overvoltage category II, 2000 m altitude, considering always > 30 kHz

On external layers (pollution degree 2): 0.25 mm (Assuming > 30 kHz)

On internal layers (pollution degree 1): 0.125 mm (AC > 30 kHz)

**CREEPAGE** on PCB

On external layers > 0.160 mm (less critical than clearance)

On internal layers > 0.1 mm (less critical than clearance)

**CREEPAGE** to chassis (non-PWB element)

On external layers > 0.630 mm (Assuming insulating material I with pollution degree 2 and working voltage  $\leq 63$  V)

**PCB as barrier** (vertical insulation between internal layers)

Impulse voltage requirement for reinforced insulation: 800 V

Considering 50 kV/mm dielectric strenght of FR4 and 0.023 mm (0.065-0.042) ultra worst case prepreg thickness

Coplanar internal layer can be consider basic insulation. The thinnest prepreg can withstand 1150 V > 800 V.

### Reinforced insulation (Ethernet nets to the rest)

**CLEARANCE**, Compliant with IEEE 802.3 Impulse 2400 V 1.2/50 $\mu$ s -> Impulse voltage 800 V

On external layers (pollution degree 2): 0.500 mm (Assuming > 30 kHz)

On internal layers (pollution degree 1): 0.500 mm (AC > 30 kHz)

**PCB as barrier** (vertical insulation between internal layers)

Impulse voltage requirement for reinforced insulation: 1500 V

Considering 50 kV/mm dielectric strenght of FR4 and 0.023 mm (0.065 mm prepreg - 0.042 mm copper) ultra worst case prepreg thickness

One empty layer must be added to ensure reinforced insulation. Each layer can withstand 1150 V < 1500 V.

### Reinforced insulation (STO nets to the rest)

**CLEARANCE**, Isolation voltage 500 Vrms -> Impulse voltage 500 V

On external layers (pollution degree 2): 0.250 mm (Assuming > 30 kHz)

On internal layers (pollution degree 1): 0.125 mm (AC > 30 kHz)

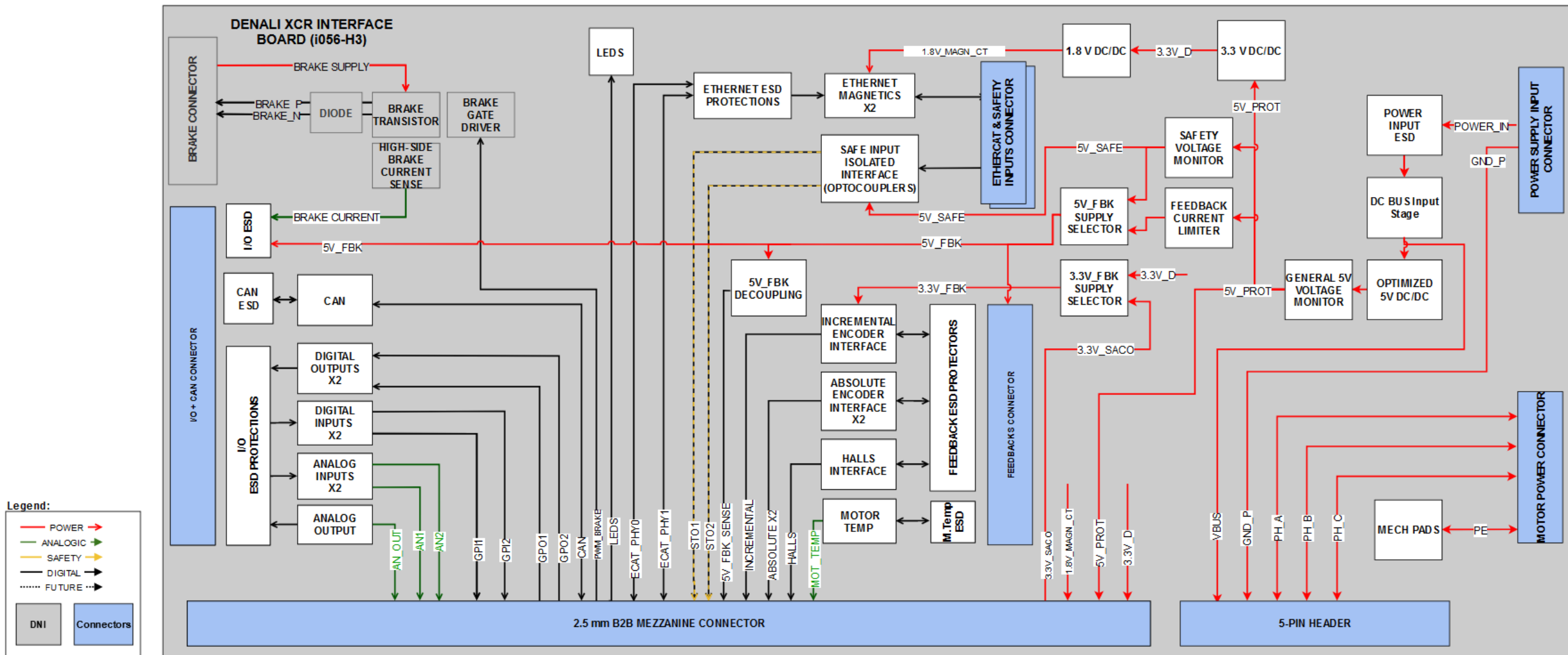
**PCB as barrier** (vertical insulation between internal layers)

Impulse voltage requirement for reinforced insulation: 1500 V

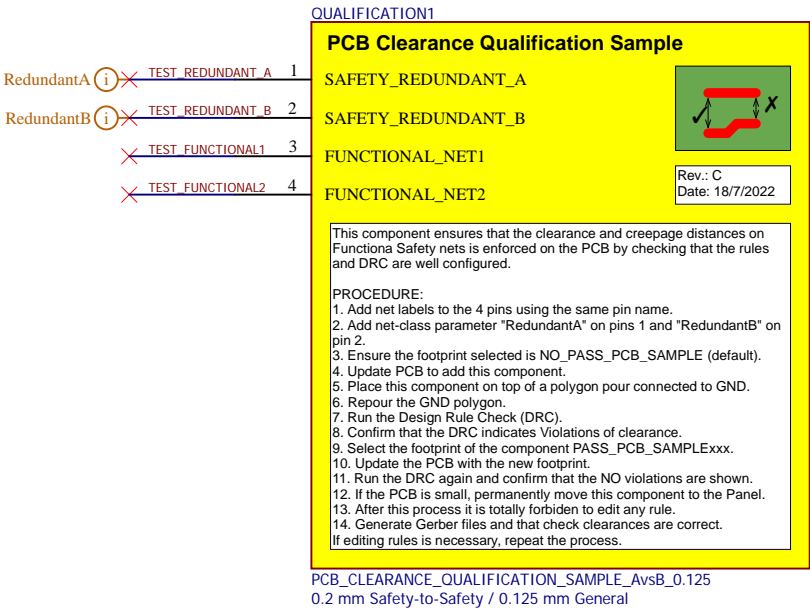
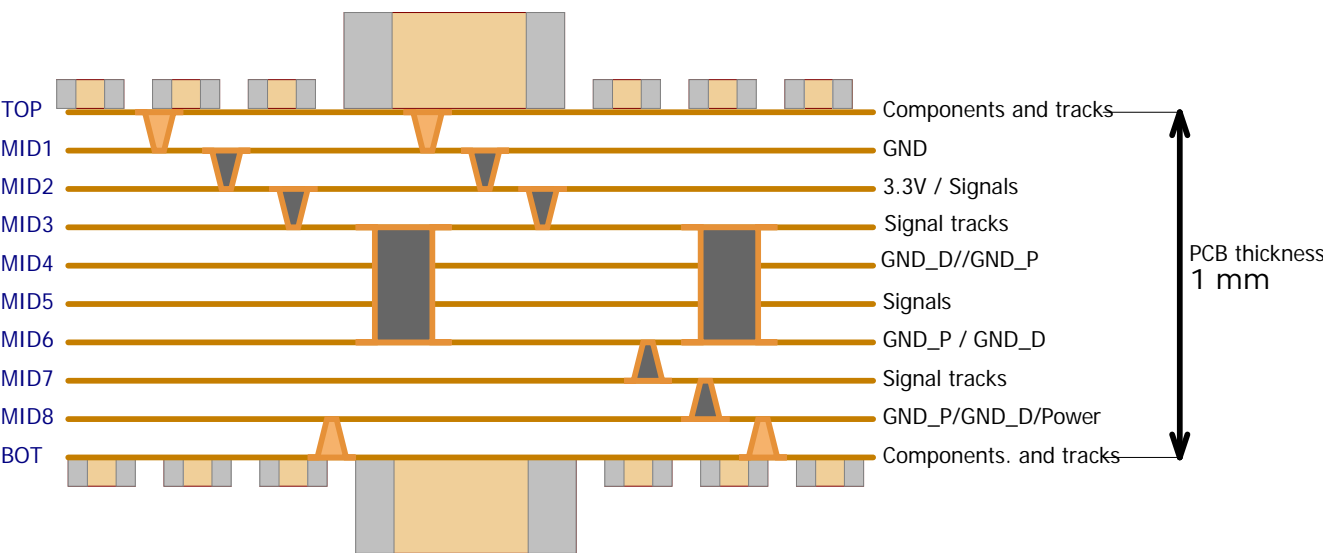
Considering 50 kV/mm dielectric strenght of FR4 and 0.023 mm (0.065 mm prepreg - 0.042 mm copper) ultra worst case prepreg thickness

One empty layer must be added to ensure reinforced insulation. Each layer can withstand 1150 V < 1500 V.

## Architecture

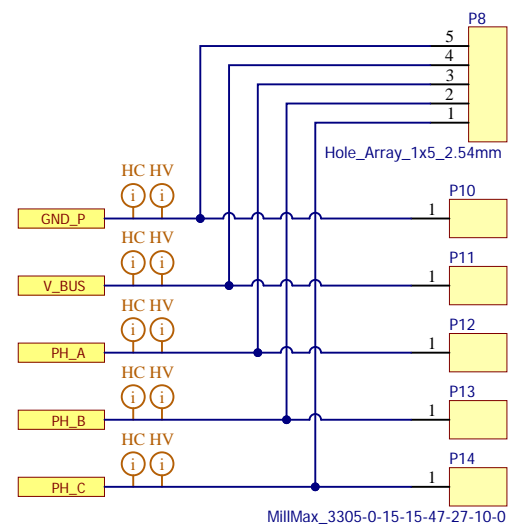


## PCB Layerstack (not to scale)





Power Contacts



Instructions:

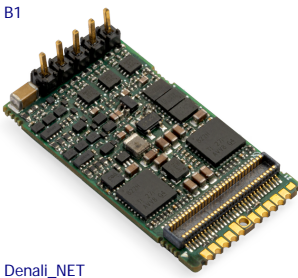
2 power terminal options: leave the selected one, remove the other:

<--Option 1: Soldered terminals  
+ PRO: Denali rated current (5 A)  
+ PRO: Extra heat dissipation  
+ CON: Denali cannot be unplugged

<--Option 2: pluggable terminals  
+ Pro: Denali can be unplugged  
+ CON: additional cost  
+ CON: Current limited to 4.5 A

It is recommended to select pluggable in prototypes phase, and soldered once the design is mature.

Denali NET Servo Drive



Pin header (DEN-NET): TSW-105-05-G-S  
Pin header (DEN-S-NET): TSW-105-07-G-S (longer pins)

Signal Connectors to Denali NET



RESERVED ports are included here for compatibility with other products in the Denali Series (in particular, Denali Safe NET), which may require external components connected to pins not used by the Denali NET (DNC). If no cross-compatibility is required, these ports and nets can be removed and marked as No ERC.

PCB Recommendations

Clearance & Creepage

Environmental conditions:  
Pollution degree II  
Overvoltage category II

Nets non-related to safety:  
Min. clearance: 0.125 mm  
Min. creepage (Denali): 0.1 mm  
Min. creepage (Capitan): 0.1 mm  
Min. creepage (Everest): 0.144 mm

Protective Earth (PE) to non-accessible nets:  
Min. clearance: 0.25 mm  
Min. creepage (Denali): 0.063 mm  
Min. creepage (Capitan): 0.063 mm  
Min. creepage (Everest): 0.1 mm

Protective Earth (PE) to user-accessible nets:  
Min. clearance: 0.625 mm  
Min. creepage (Denali): 0.126 mm  
Min. creepage (Capitan): 0.126 mm  
Min. creepage (Everest): 0.2 mm

\*Capitan and Everest data indicated for compatibility between products.

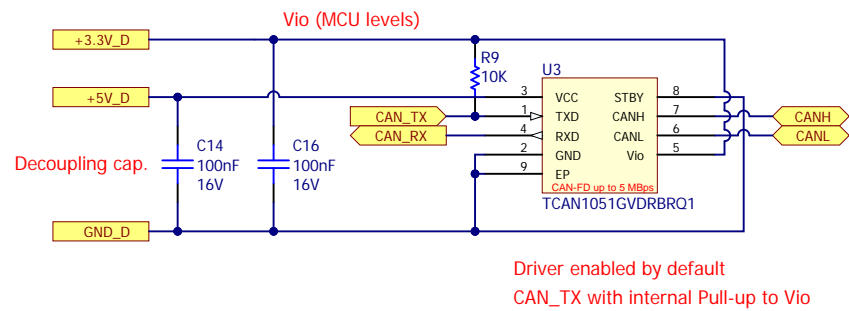
Recommended Layer Stack

Layer Stack definition (6 layers):  
TOP: components, tracks and GND\_D.  
MID1: GND\_D.  
MID2: signal tracks, GND\_D.  
MID3: power supplies.  
MID4: signal tracks, GND\_D.  
BOT: components, tracks and GND\_D.

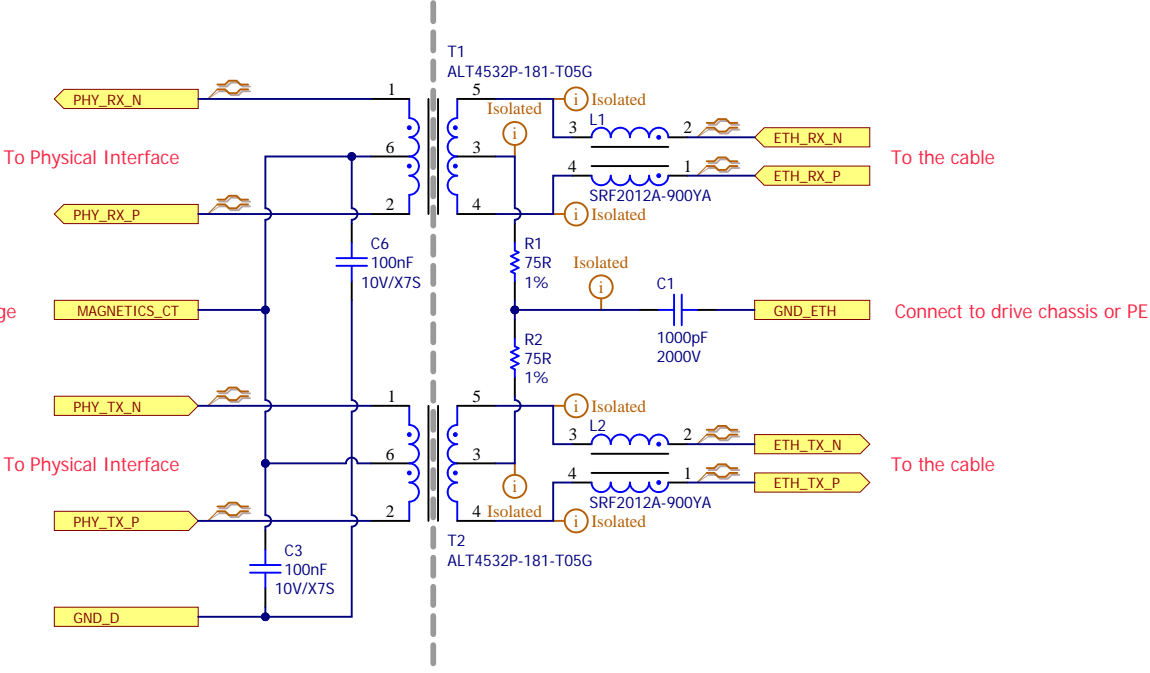
Height limits under the Denali NET

Board to board height is 2.54mm.  
Do not place any component taller than 1 mm under the Denali NET.

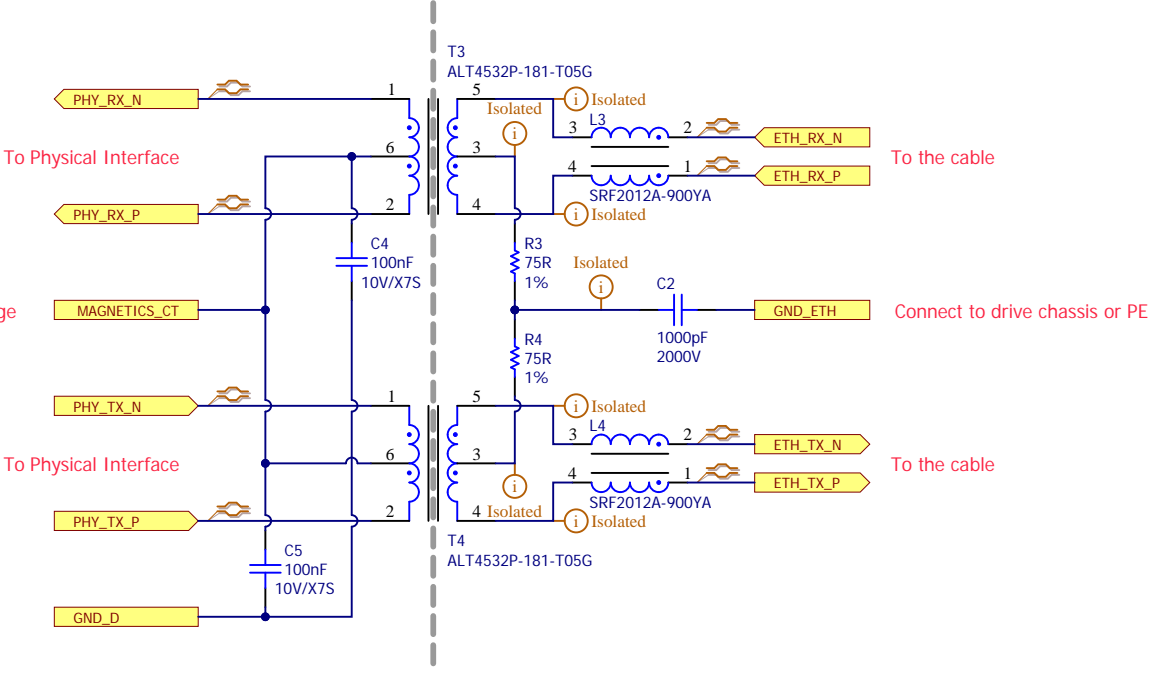
Find instructions on layer MECHANICAL 15.

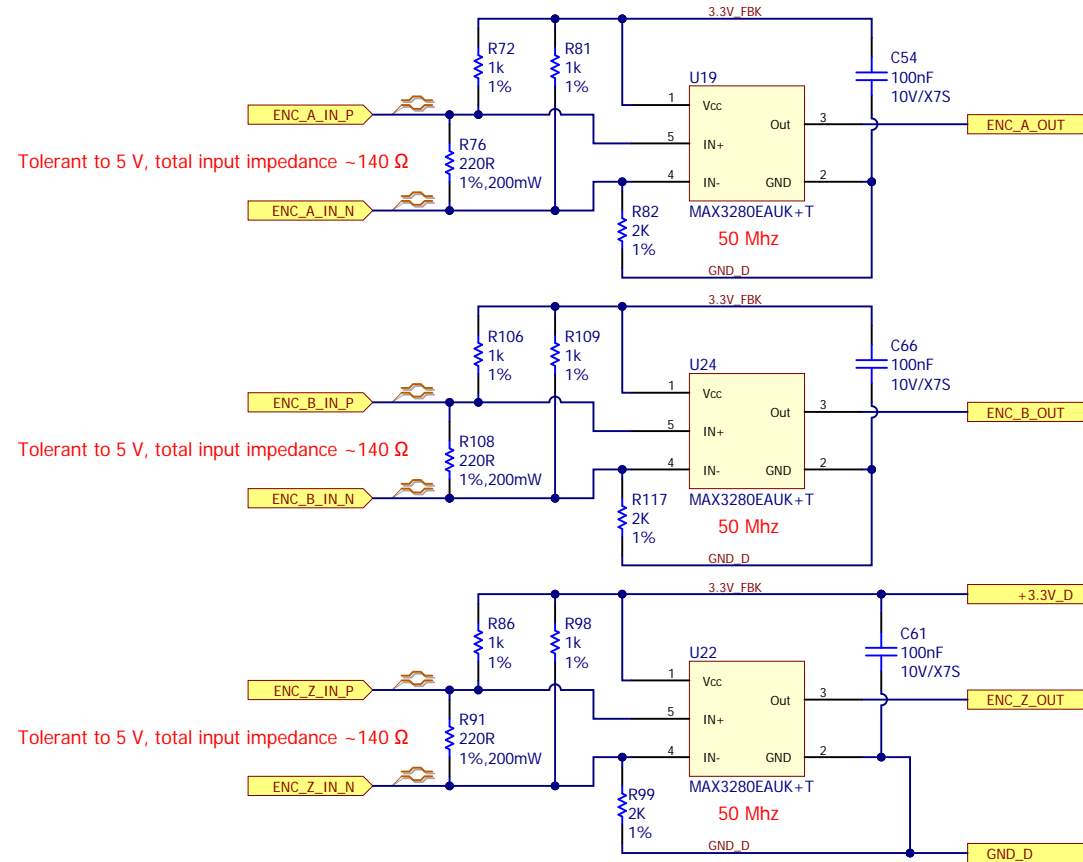


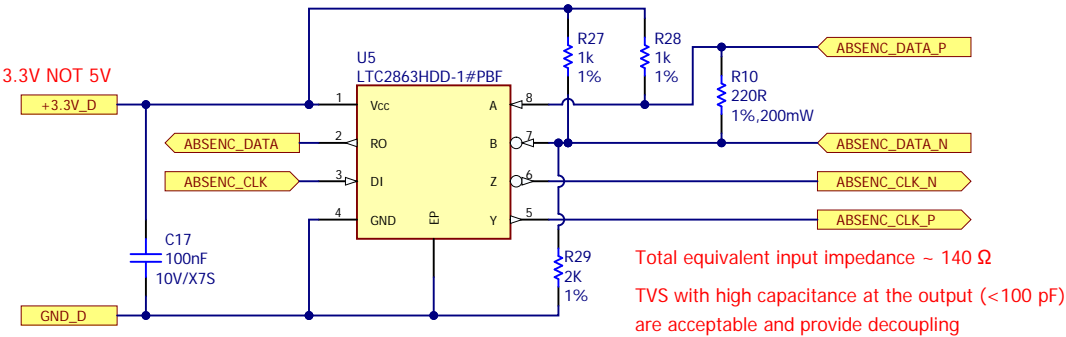
Typically 3.3V but could be lower voltage  
for low power applications (1.8 V)



Typically 3.3V but could be lower voltage  
for low power applications (1.8 V)

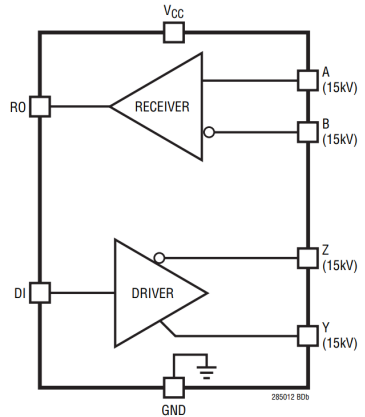




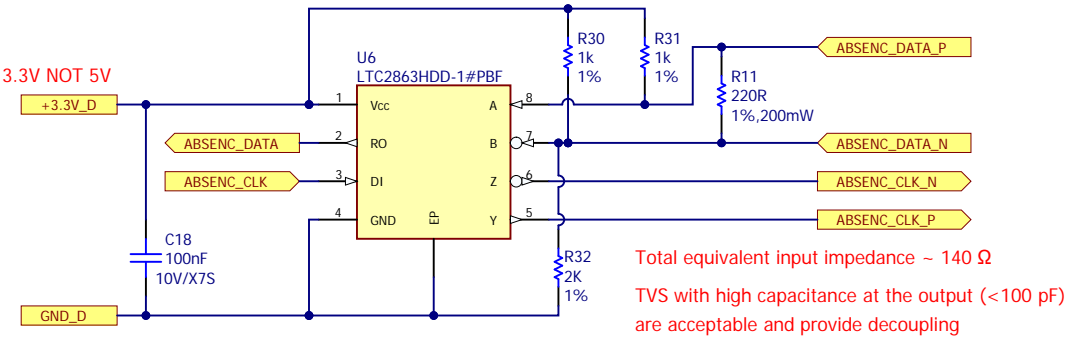


Total equivalent input impedance ~ 140  $\Omega$   
TVS with high capacitance at the output (<100 pF)  
are acceptable and provide decoupling

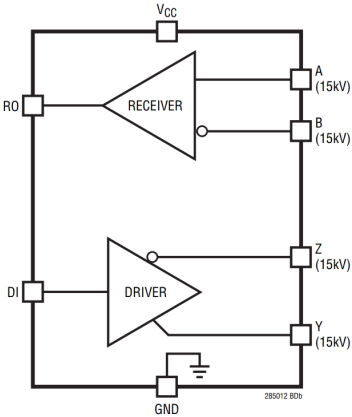
LTC2851

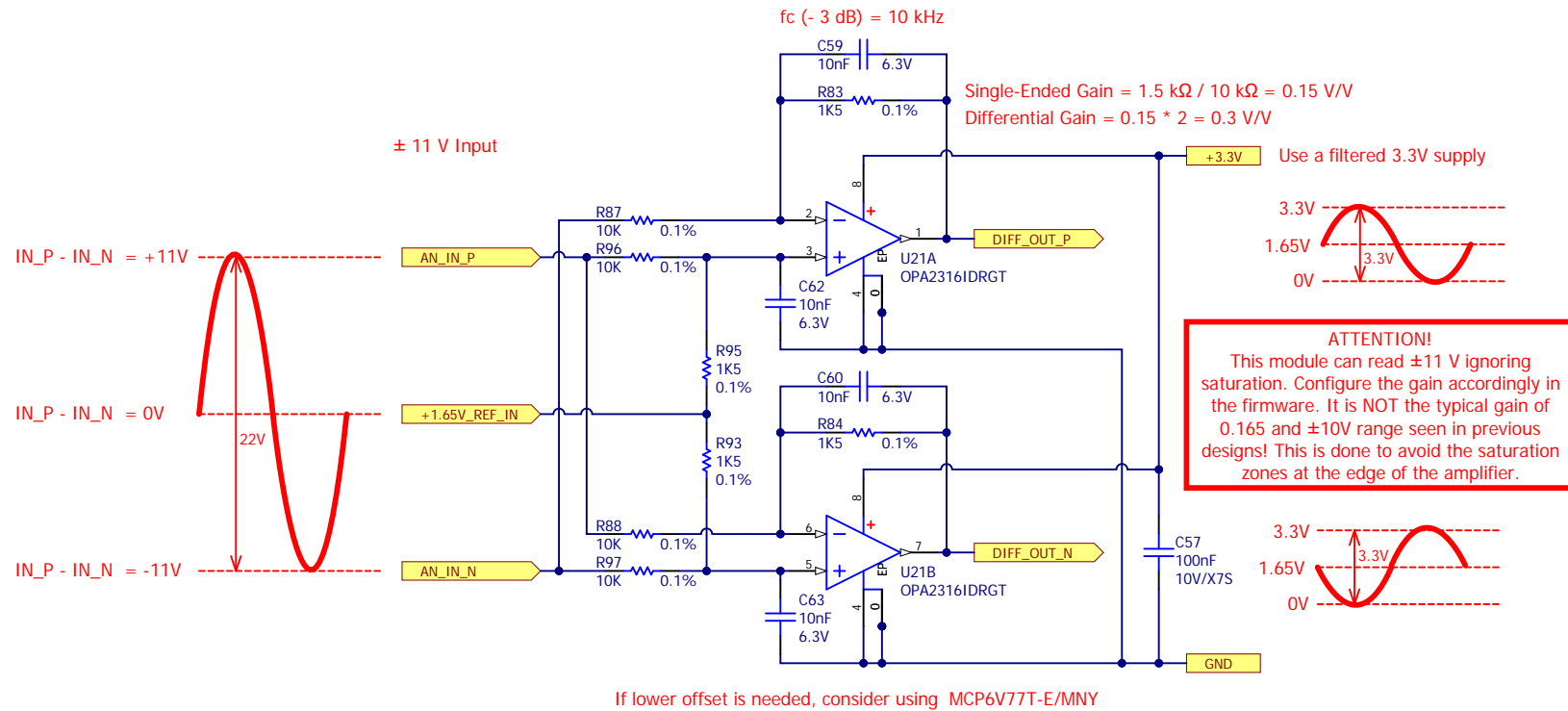




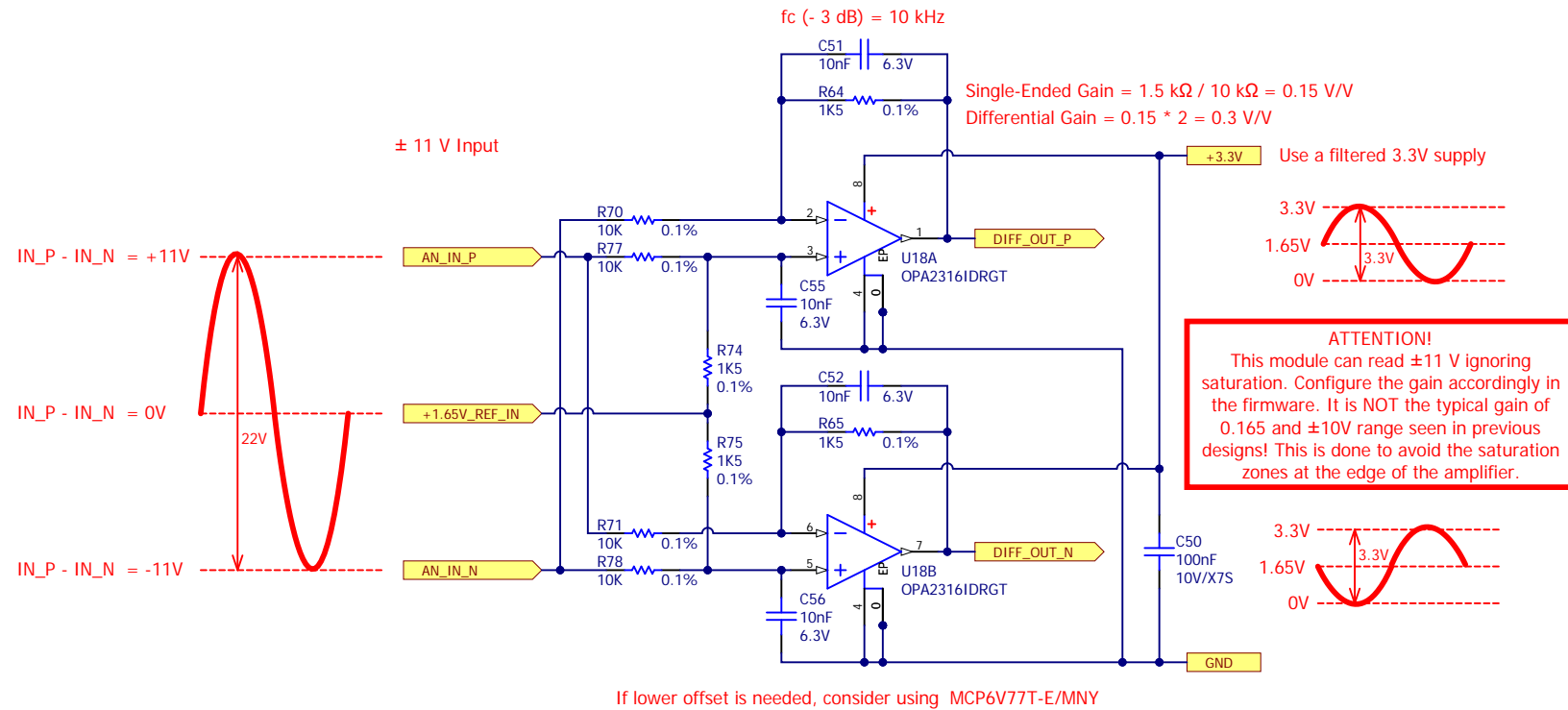


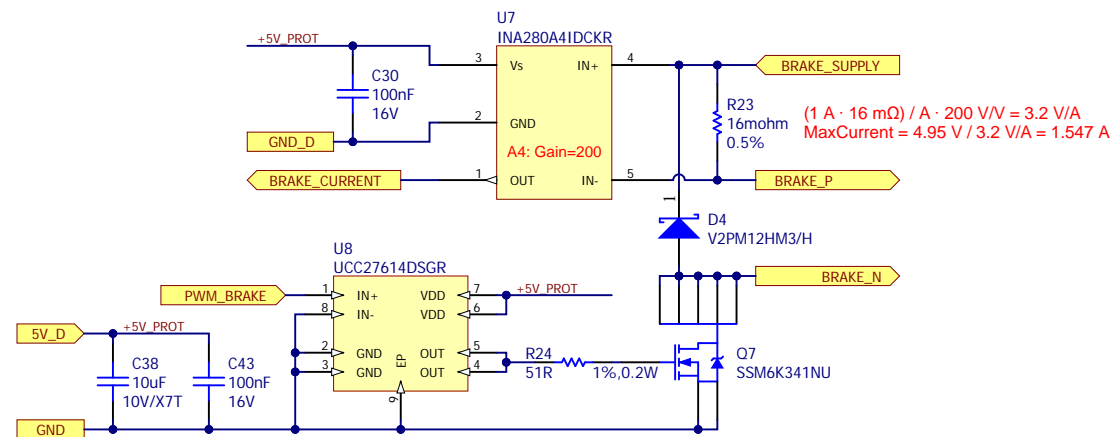
LTC2851



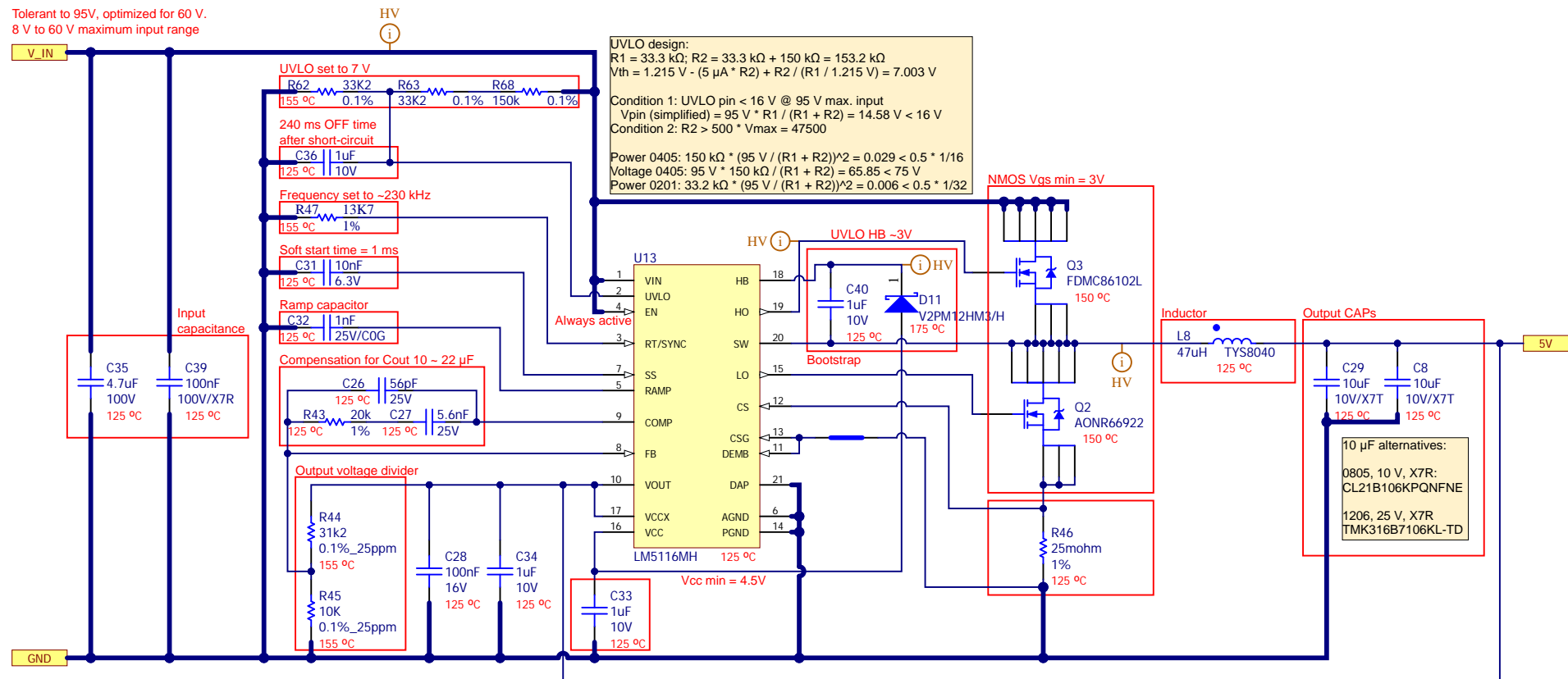


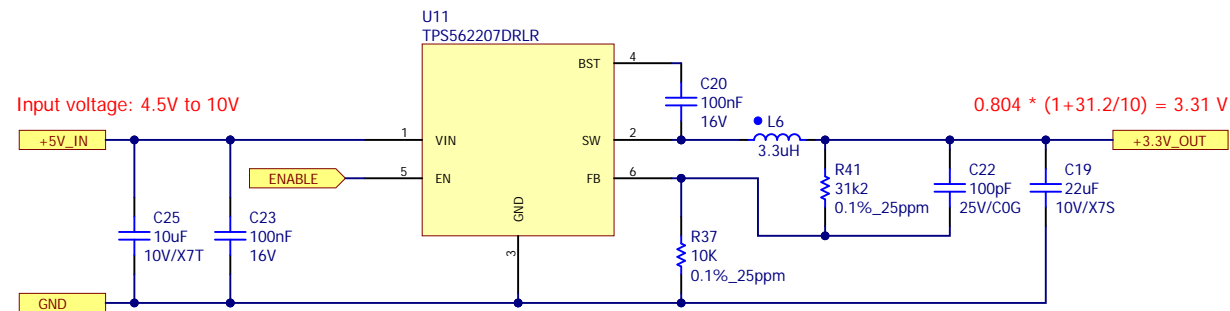
Instance 1





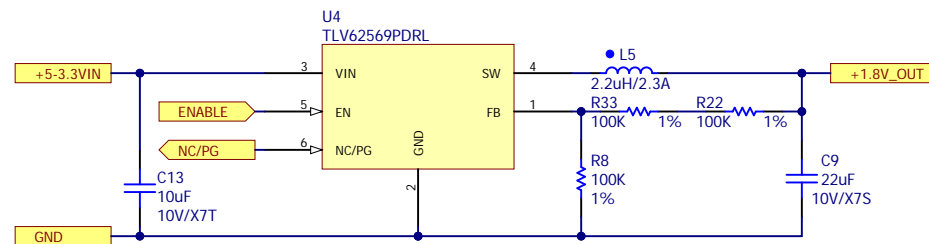
Tolerant to 95V, optimized for 60 V.  
8 V to 60 V maximum input range





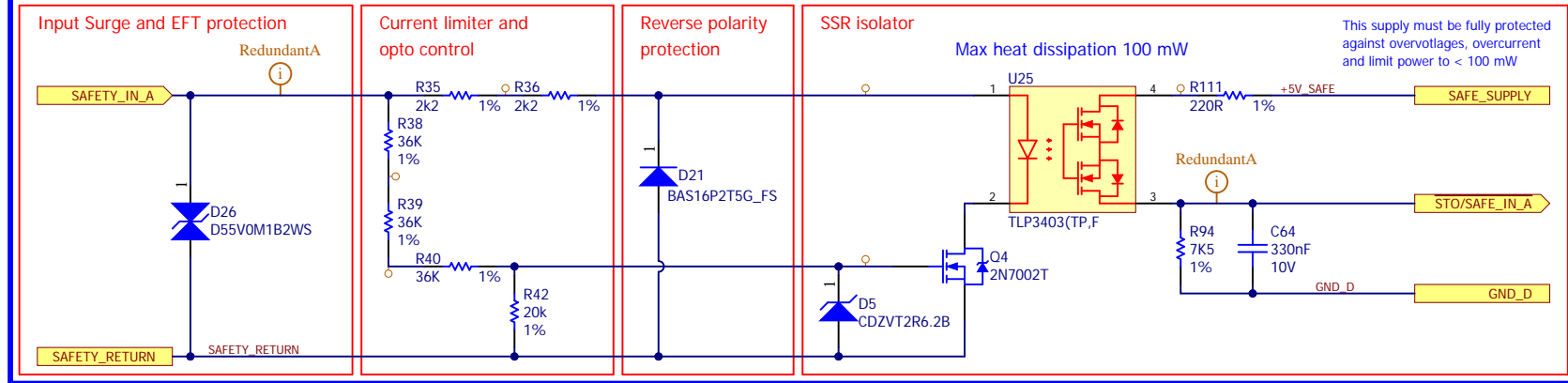
Alternative part numbers (direct replacement): RT6252AHGH6F, TPS562207S, TPS562207DRLR



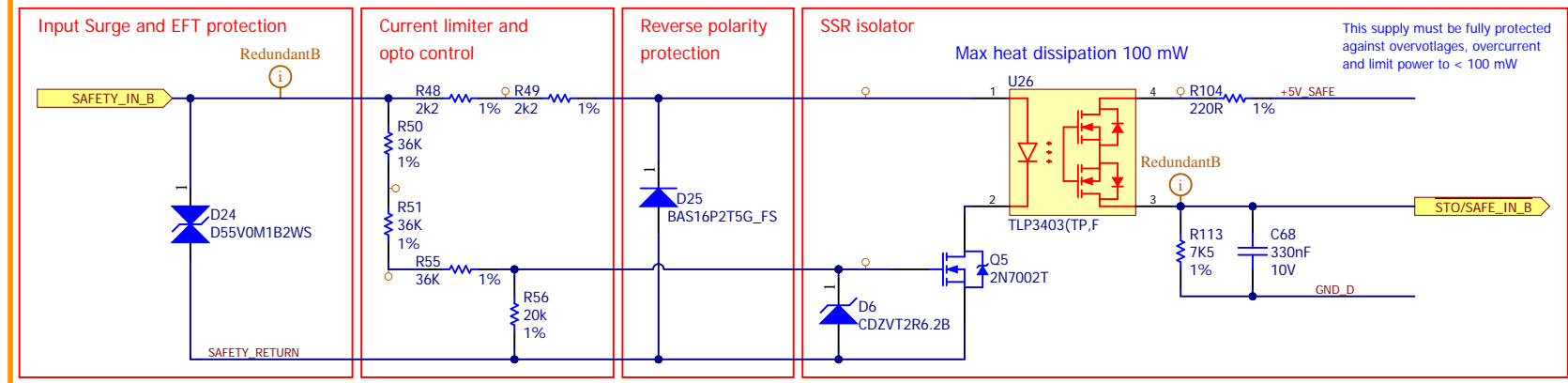


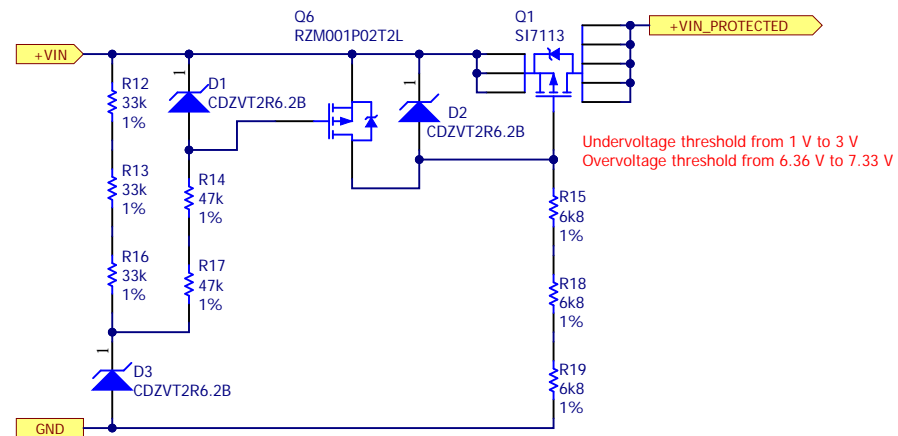
Power Good signal. Open drain output. Leave floating if not used.

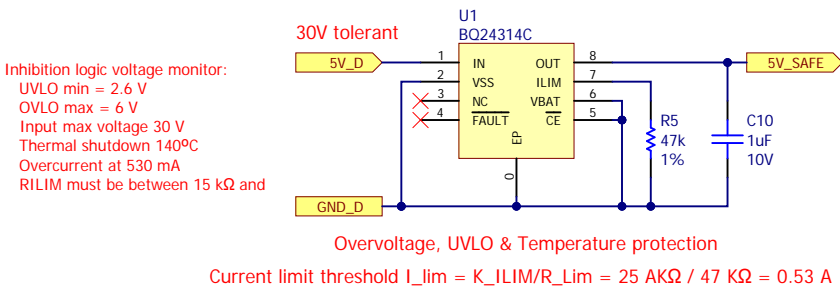
## CHANNEL A (Acts on low side power stage transistors)



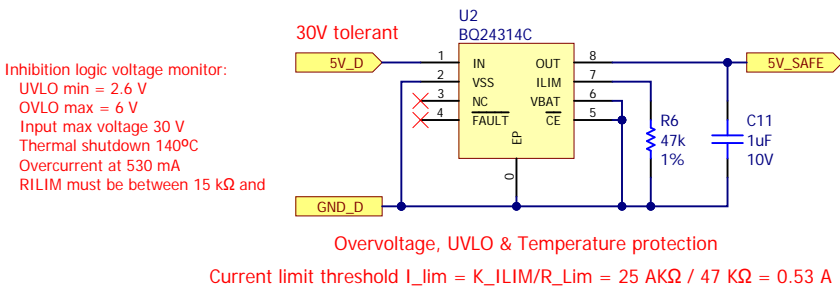
## CHANNEL B (Acts on high side power stage transistors)







INPUT OVERCURRENT PROTECTION				
I <sub>OCP</sub>	Input overcurrent protection threshold range		300	1500 mA
I <sub>OCP</sub>	Input overcurrent protection threshold	CE = Low, R <sub>ILIM</sub> = 24.9 kΩ, 3 V ≤ V <sub>IN</sub> < V <sub>OVP</sub> - V <sub>hys</sub> (OVP)	900	1000 1100 mA
K <sub>ILIM</sub>	Programmable current limit factor		25	kΩ
t <sub>BLANK</sub> (OCP)	Blanking time, input overcurrent detected		176	μs
t <sub>REC</sub> (OCP)	Recovery time from input overcurrent condition		64	ms



INPUT OVERCURRENT PROTECTION					
I <sub>OCP</sub>	Input overcurrent protection threshold range		300	1500	mA
I <sub>OCP</sub>	Input overcurrent protection threshold	CE = Low, R <sub>ILIM</sub> = 24.9 kΩ, 3 V ≤ V <sub>IN</sub> < V <sub>OVP</sub> - V <sub>hys</sub> (OVP)	900	1000	1100 mA
K <sub>ILIM</sub>	Programmable current limit factor		25		kΩ
t <sub>BLANK</sub> (OCP)	Blanking time, input overcurrent detected		176		μs
t <sub>REC</sub> (OCP)	Recovery time from input overcurrent condition		64		ms