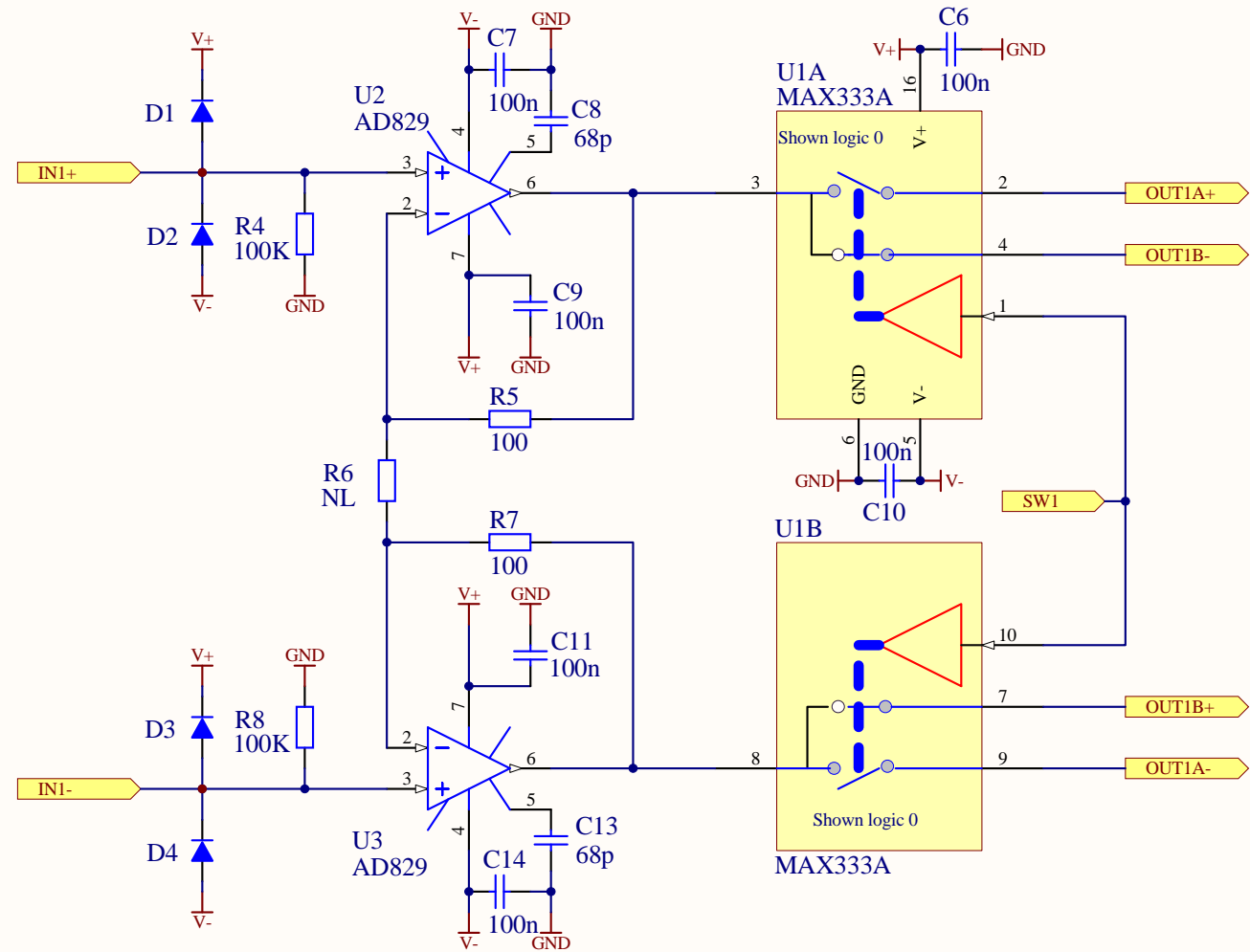
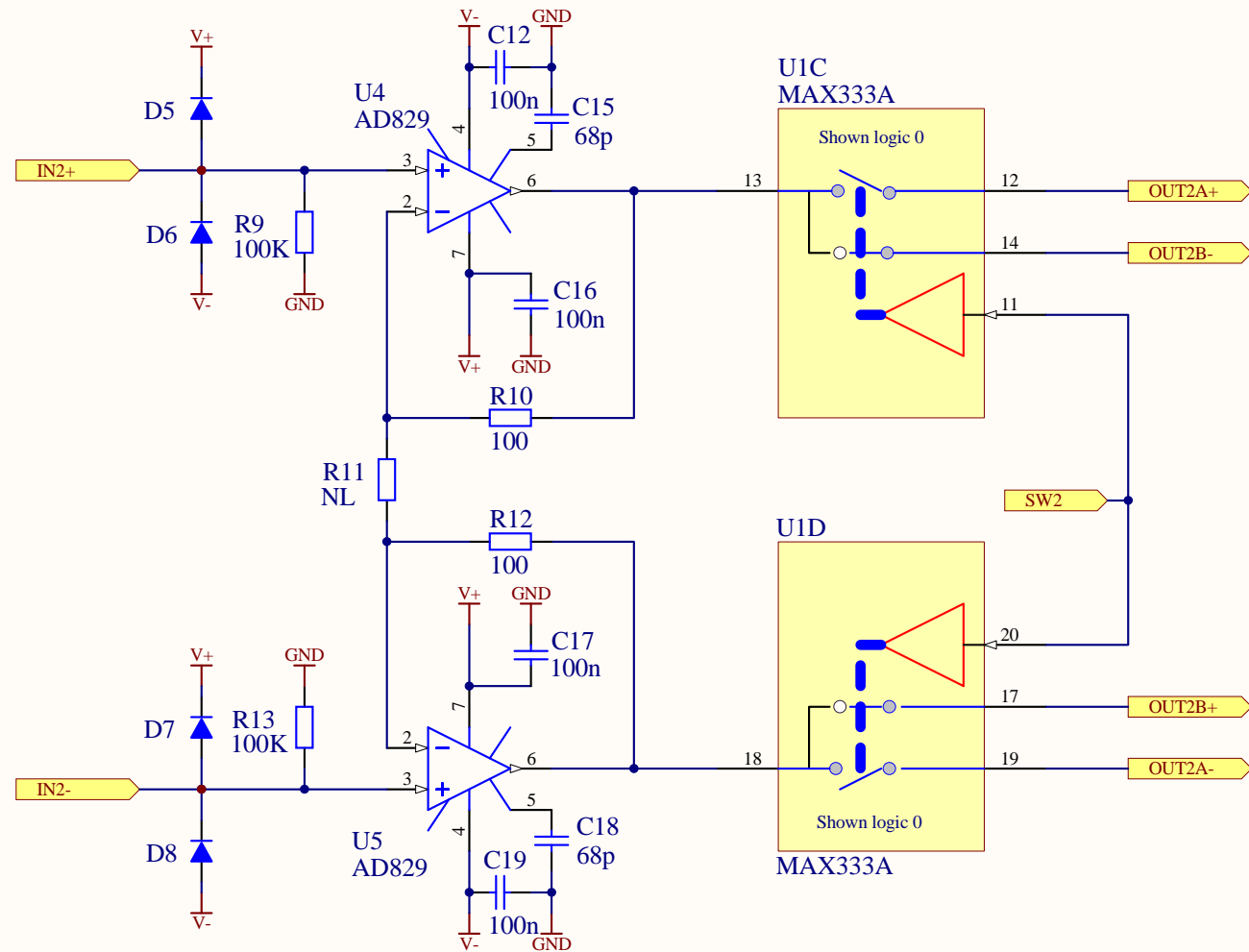
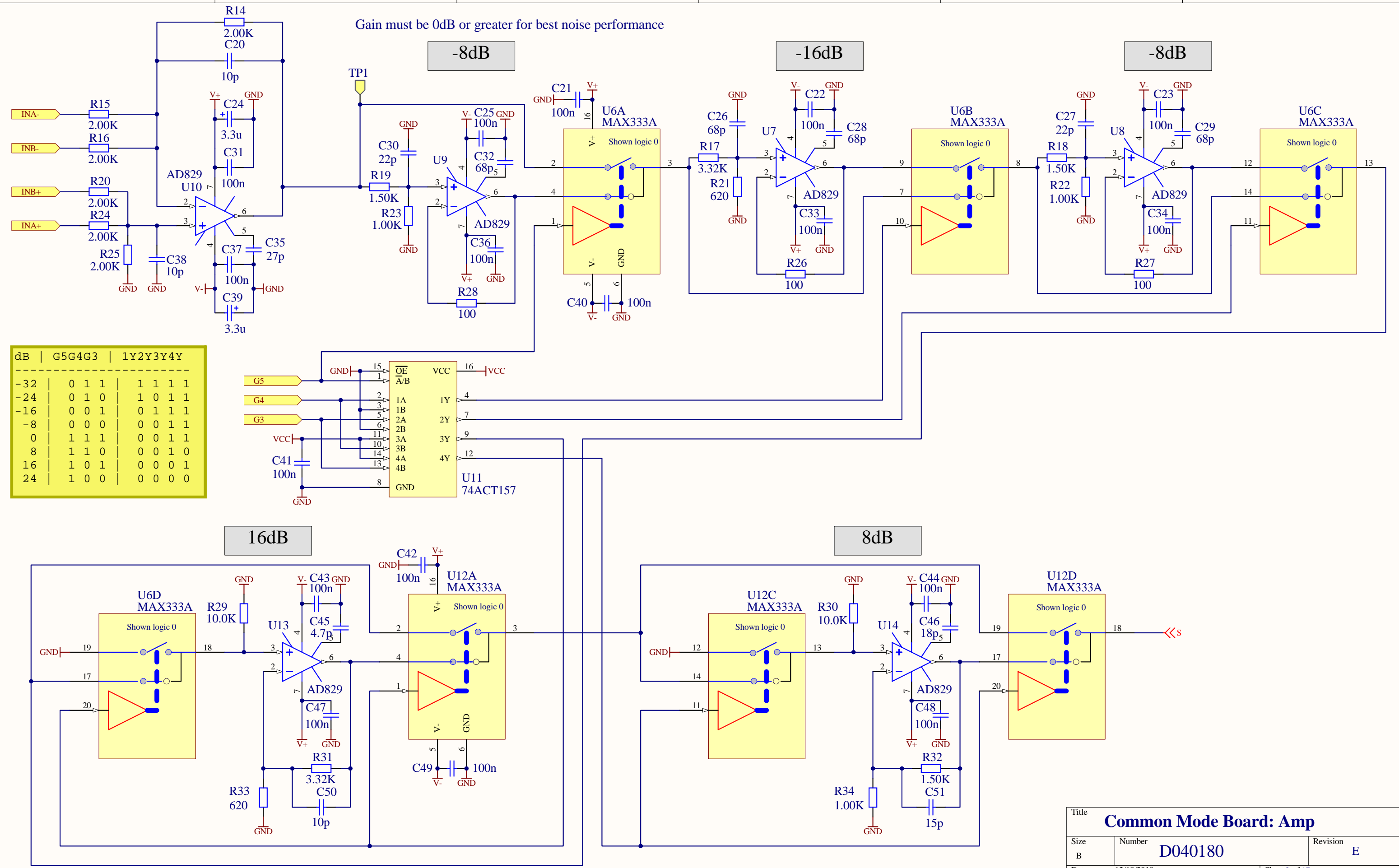


Title		
<b>Common Mode Board</b>		
Size	Number	Revision
B	D040180	E
Date:	12/18/2010	Sheet 1 of 17
File:	C:\Users\d...\.CM0.SchDoc	Drawn By: Daniel Sigg

For small input signals add gain to these instrumentation amplifier stages.



Title		
<b>Common Mode Board: Input</b>		
Size	Number	Revision
B	D040180	E
Date:	12/18/2010	Sheet 2 of 17
File:	C:\Users\...\CMI.SchDoc	Drawn By: Daniel Sigg



Gain must be 0dB or greater for best noise performance

-8dB

-16dB

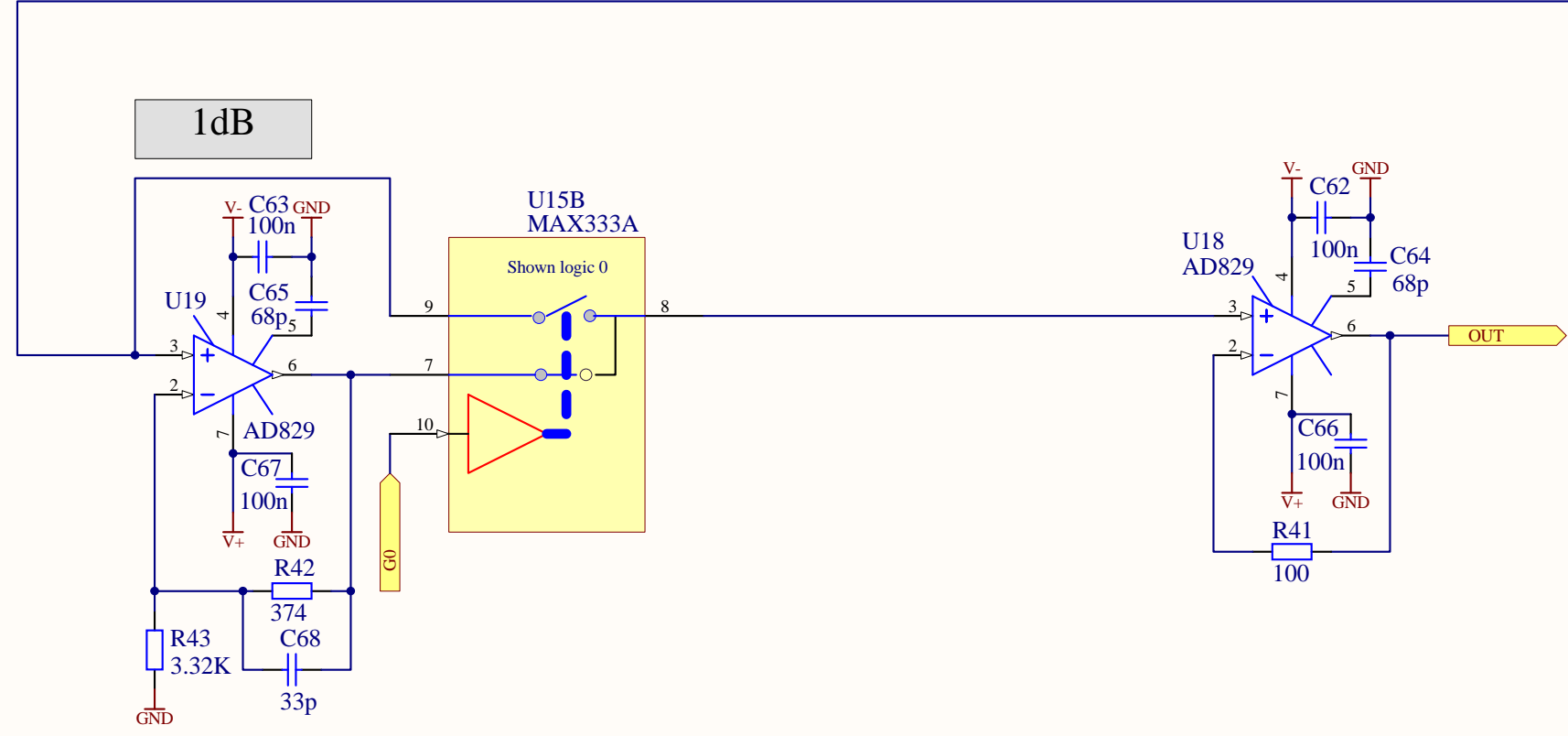
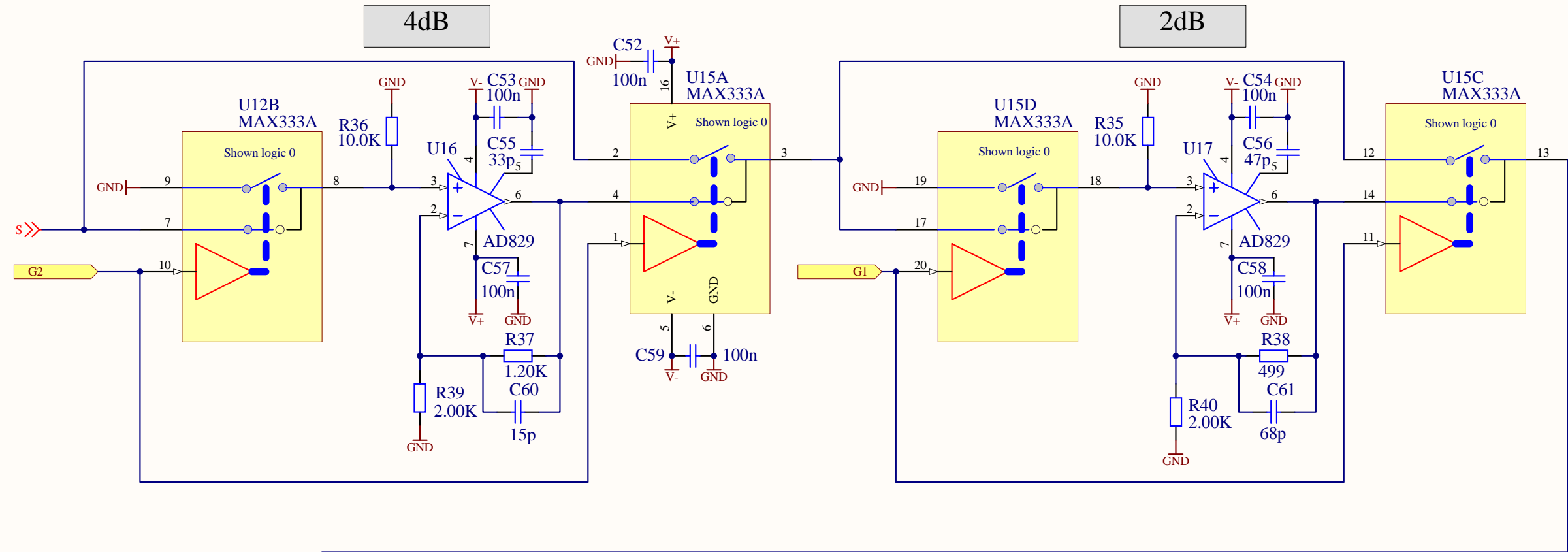
-8dB

16dB

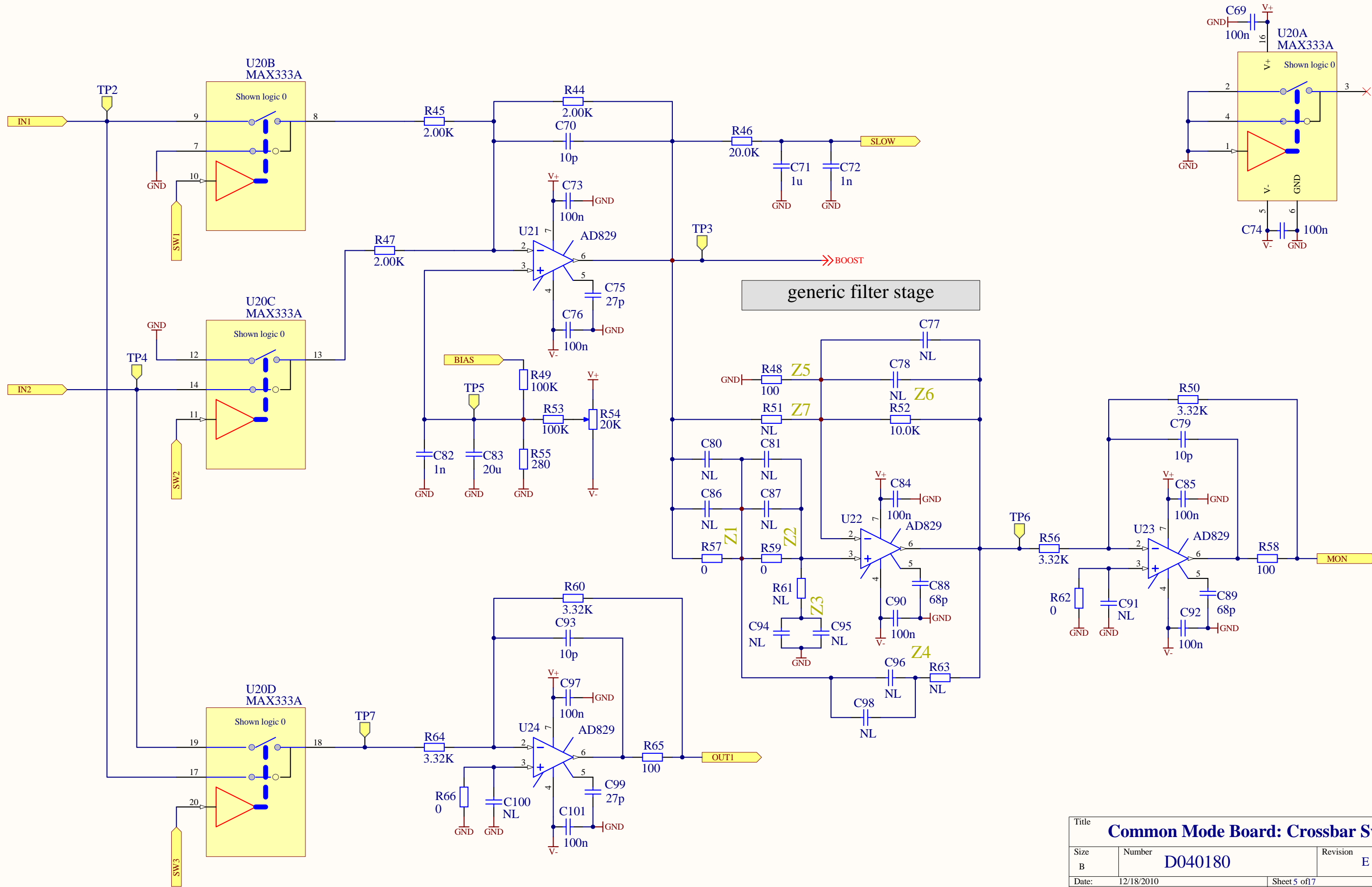
8dB

dB	G5G4G3	1Y2Y3Y4Y
-32	0 1 1	1 1 1 1
-24	0 1 0	1 0 1 1
-16	0 0 1	0 1 1 1
-8	0 0 0	0 0 1 1
0	1 1 1	0 0 1 1
8	1 1 0	0 0 1 0
16	1 0 1	0 0 0 1
24	1 0 0	0 0 0 0

Title <b>Common Mode Board: Amp</b>		
Size B	Number <b>D040180</b>	Revision E
Date: 12/18/2010	Sheet 3 of 17	
File: C:\Users\...\CM2A.SchDoc	Drawn By: Daniel Sigg	



Title		
<b>Common Mode Board: Amp</b>		
Size	Number	Revision
B	D040180	E
Date:	12/18/2010	Sheet 4 of 17
File:	C:\Users\...\CM2B.SchDoc	Drawn By: Daniel Sigg



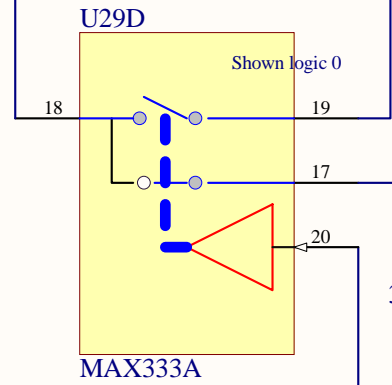
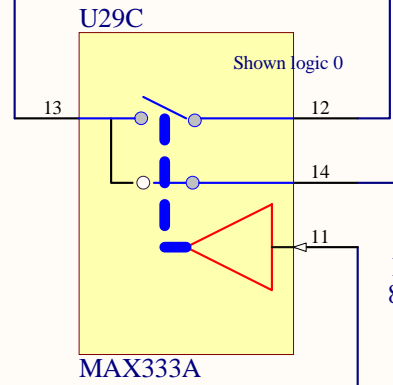
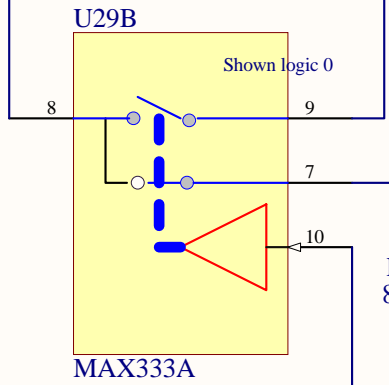
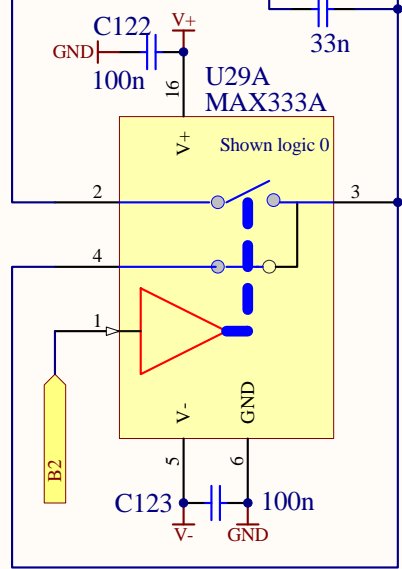
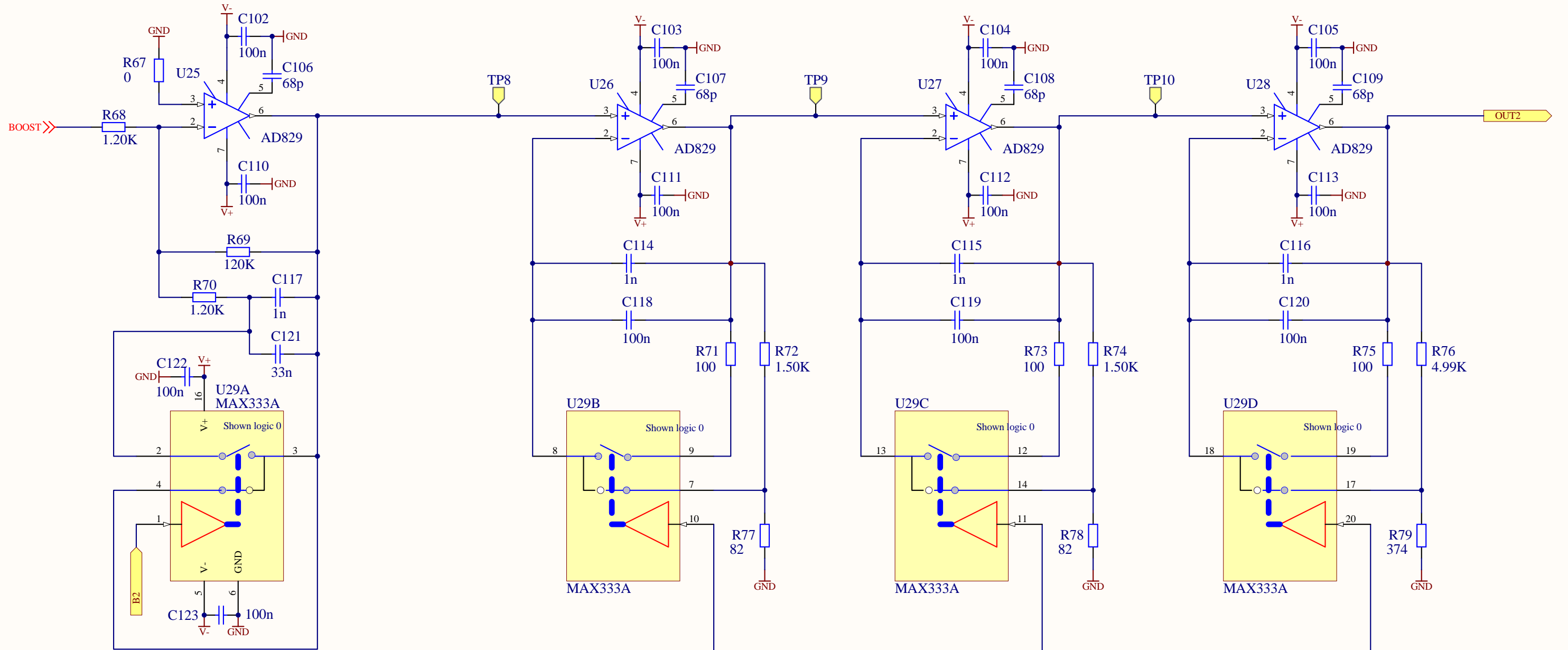
Title		
<b>Common Mode Board: Crossbar Switch</b>		
Size	Number	Revision
B	D040180	E
Date:	12/18/2010	Sheet 5 of 7
File:	C:\Users\...\CM3A.SchDoc	Drawn By: Daniel Sigg

40Hz/4kHz pole/zero pair

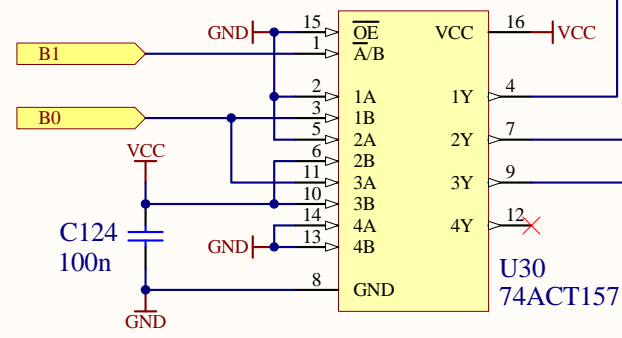
1kHz/20kHz pole/zero pair

1kHz/20kHz pole/zero pair

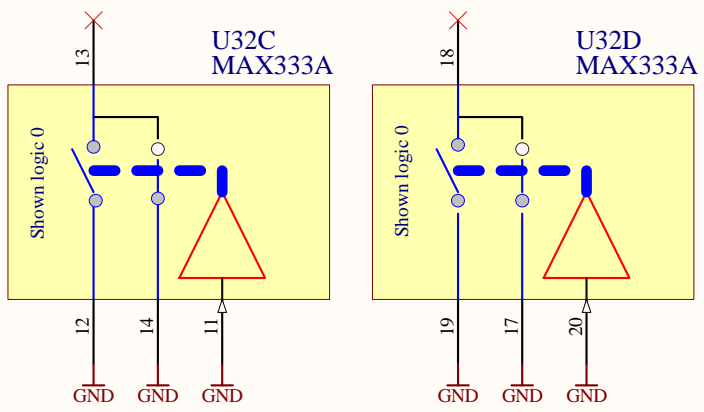
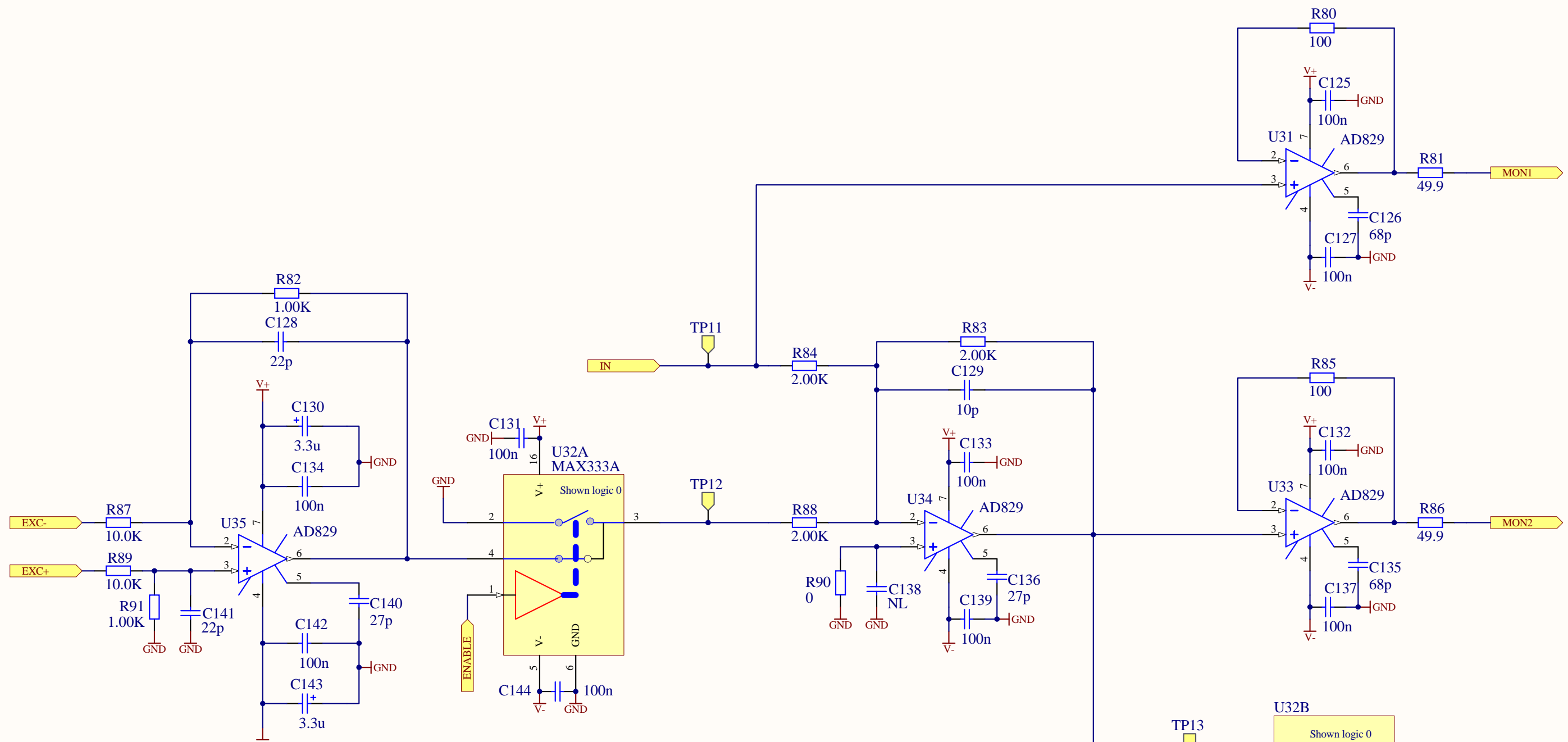
300Hz/4.5kHz pole/zero pair



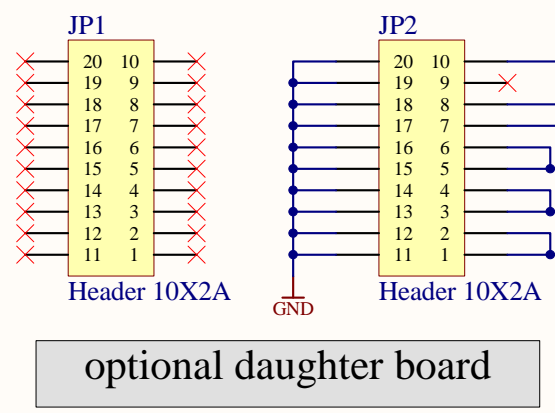
Boosts	B1B0	1Y2Y3Y
0	1 1	1 1 1
1	1 0	0 1 1
2	0 1	0 0 1
3	0 0	0 0 0



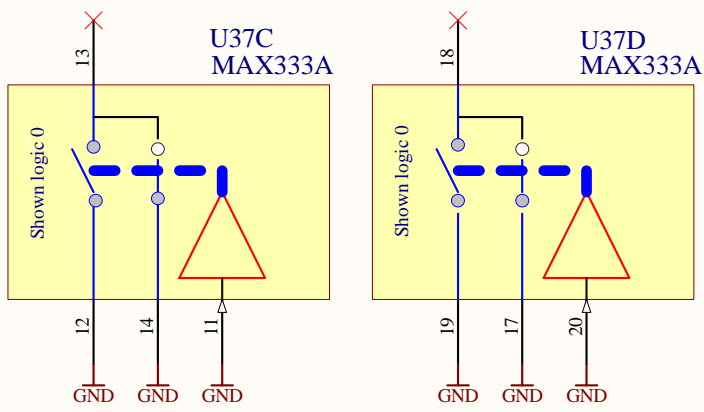
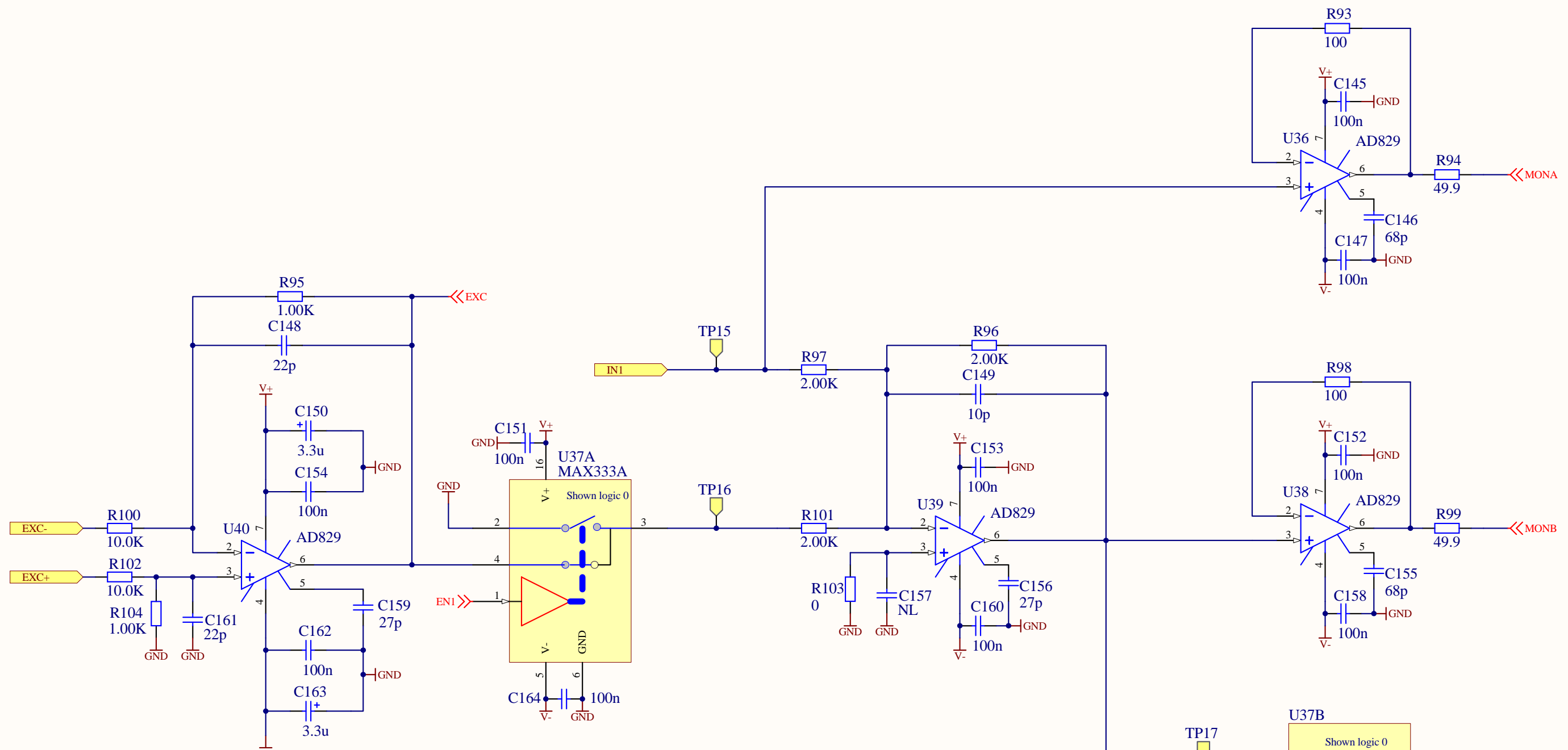
Title		
<b>Common Mode Board: Boost</b>		
Size	Number	Revision
B	D040180	E
Date:	12/18/2010	Sheet 6 of 17
File:	C:\Users\...\CM3B.SchDoc	Drawn By: Daniel Sigg



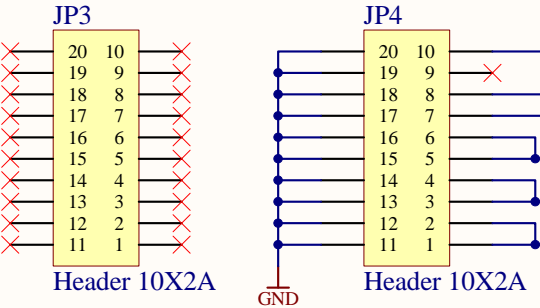
- M1 M3 standoff, 12mm
- M2 M3 pan, 8mm
- M3 M3 standoff, 12mm
- M4 M3 pan, 8mm
- M5 M3 standoff, 12mm
- M6 M3 pan, 8mm
- M7 M3 standoff, 12mm
- M8 M3 pan, 8mm
- M9 M3 standoff, 12mm
- M10 M3 pan, 8mm
- M11 M3 standoff, 12mm
- M12 M3 pan, 8mm
- M13 M3 pan, 8mm
- M14 M3 pan, 8mm
- M15 M3 pan, 8mm
- M16 M3 pan, 8mm
- M17 M3 pan, 8mm
- M18 M3 pan, 8mm
- McMaster-Carr  
90317A115



Title <b>Common Mode Board: Com. Excitation</b>		
Size B	Number <b>D040180</b>	Revision E
Date: 12/18/2010	Sheet 7 of 17	
File: C:\Users\...\CM4A.SchDoc	Drawn By: Daniel Sigg	



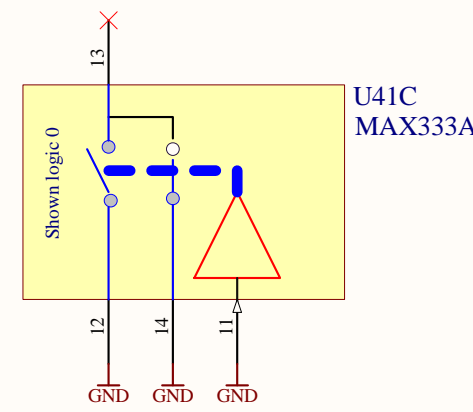
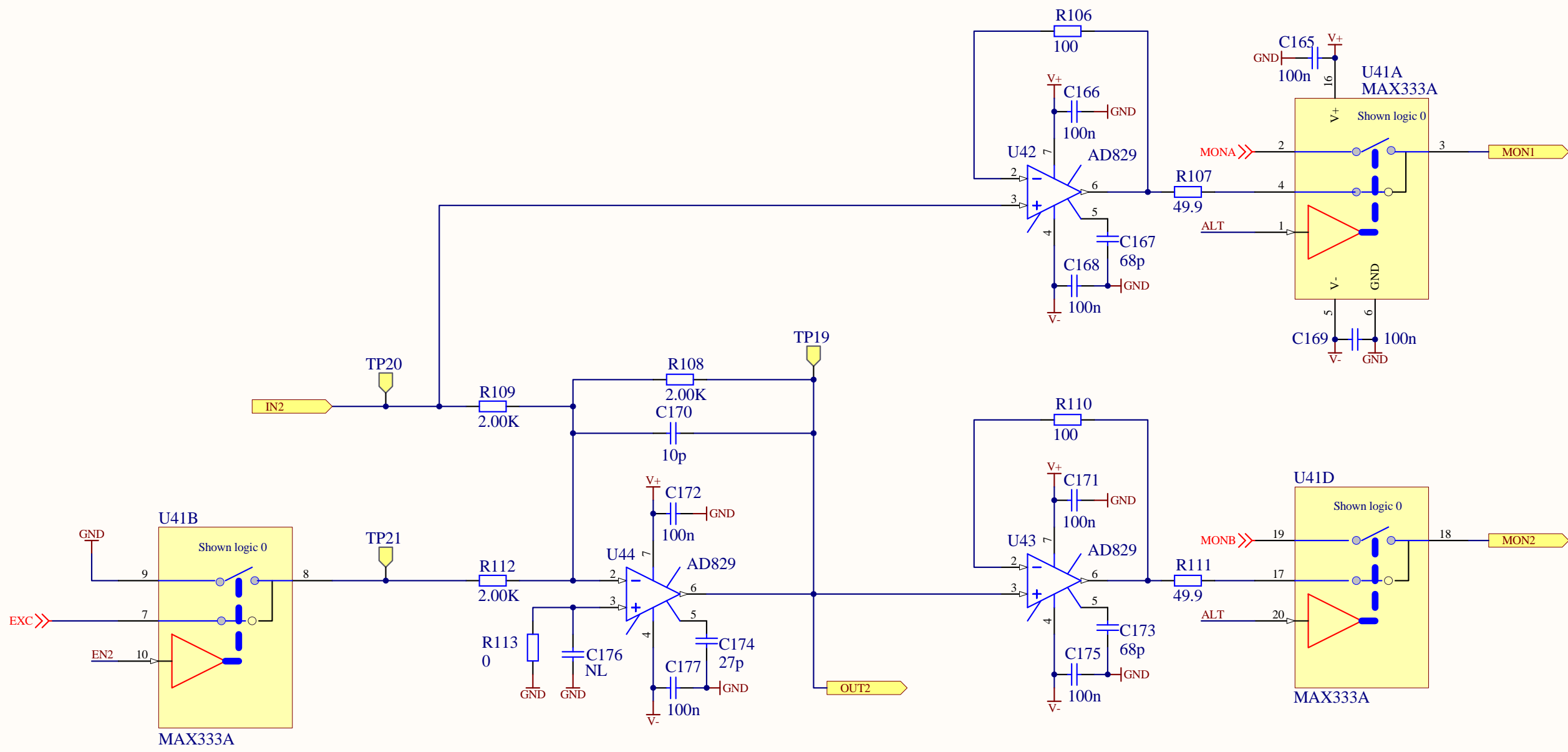
- M19 M3 standoff, 12mm
- M20 M3 pan, 8mm
- M21 M3 standoff, 12mm
- M22 M3 pan, 8mm
- M23 M3 standoff, 12mm
- M24 M3 pan, 8mm
- M25 M3 standoff, 12mm
- M26 M3 pan, 8mm
- M27 M3 standoff, 12mm
- M28 M3 pan, 8mm
- M29 M3 standoff, 12mm
- M30 M3 pan, 8mm
- Digi-Key 24434K-ND
- M31 M3 pan, 8mm
- M32 M3 pan, 8mm
- M33 M3 pan, 8mm
- M34 M3 pan, 8mm
- M35 M3 pan, 8mm
- M36 M3 pan, 8mm
- McMaster-Carr 90317A115



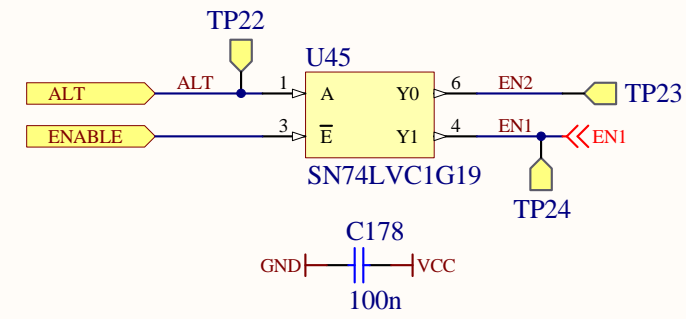
optional daughter board

Title <b>Common Mode Board: Fast Excitation</b>		
Size B	Number <b>D040180</b>	Revision E
Date: 12/18/2010	Sheet 8 of 17	
File: C:\Users\...\CM4B.SchDoc	Drawn By: Daniel Sigg	



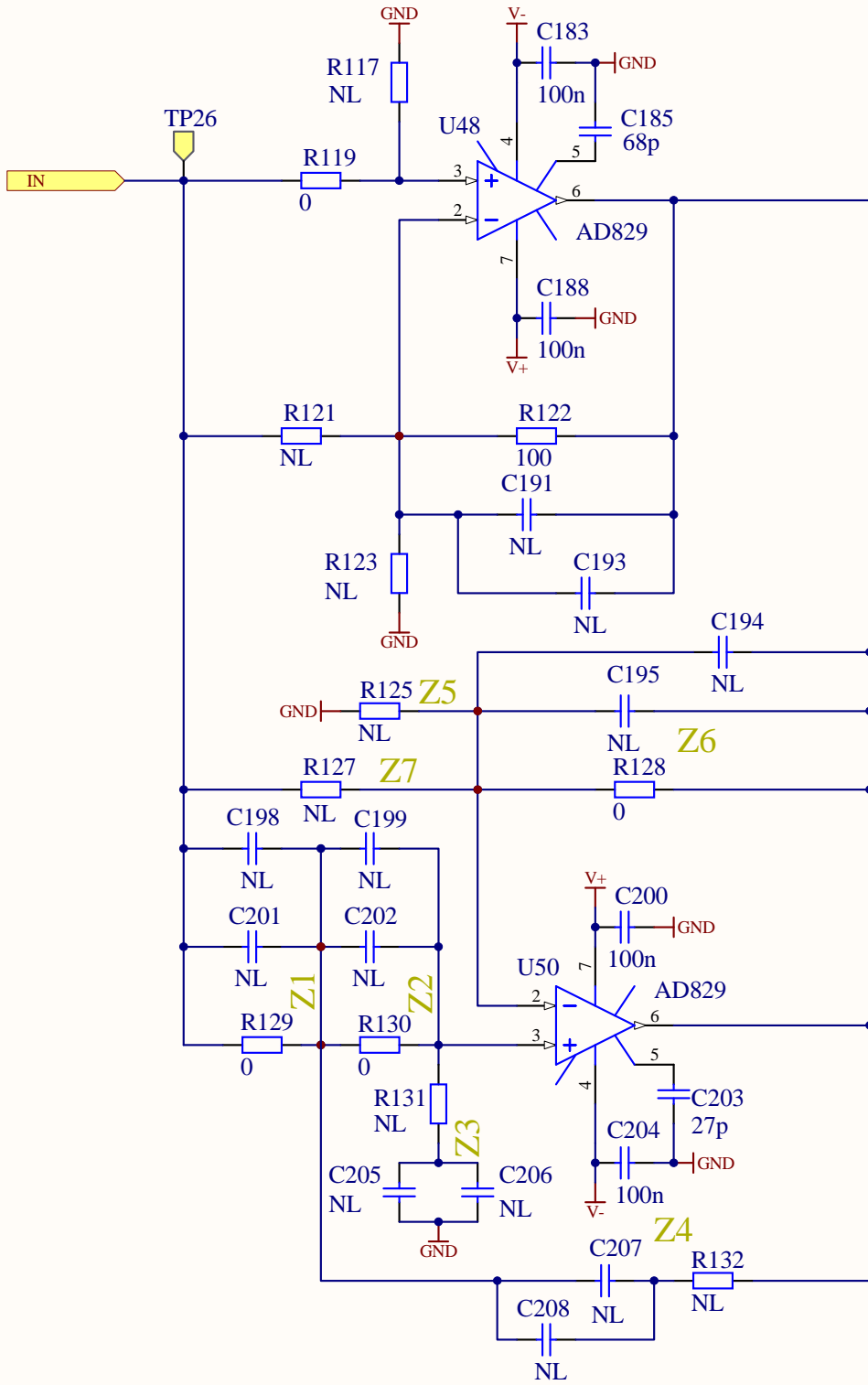


ENABLE	ALT	PATH	EN1	EN2
1	1	FAST	1	1
0	1	FAST	0	1
1	0	SLOW	1	1
0	0	SLOW	1	0

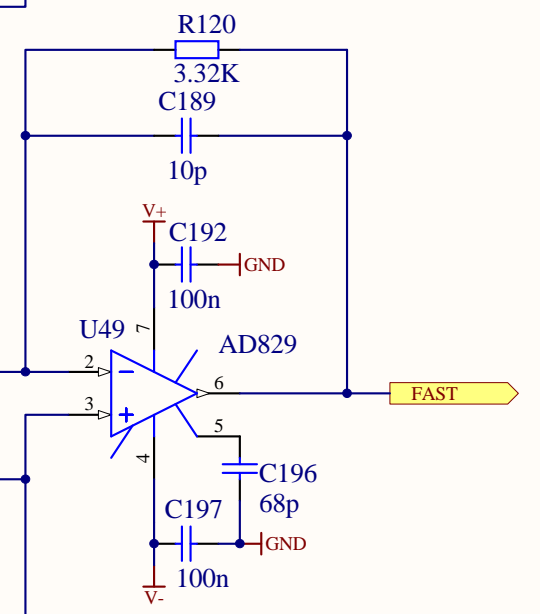
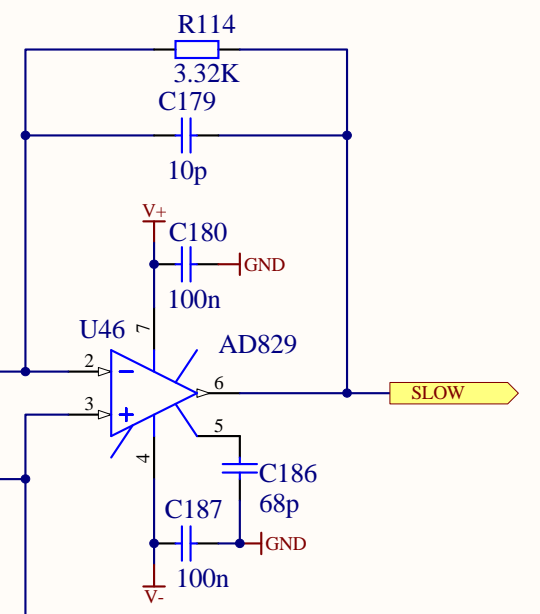
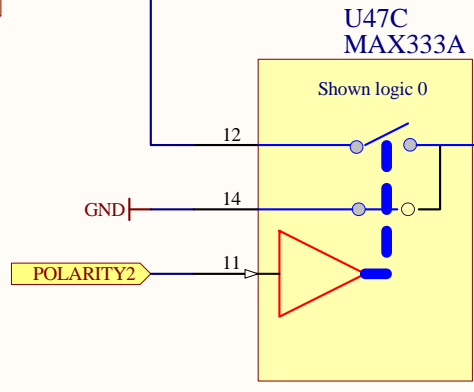
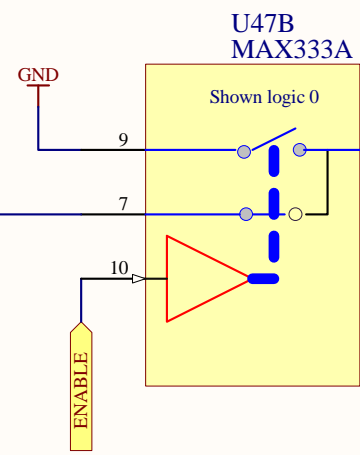
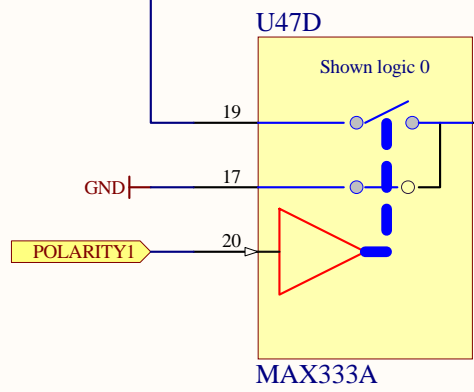
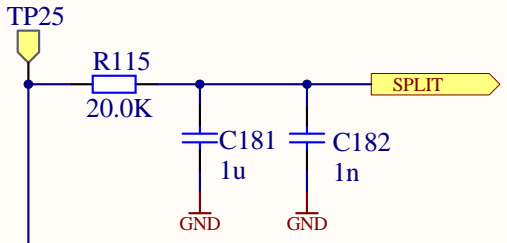
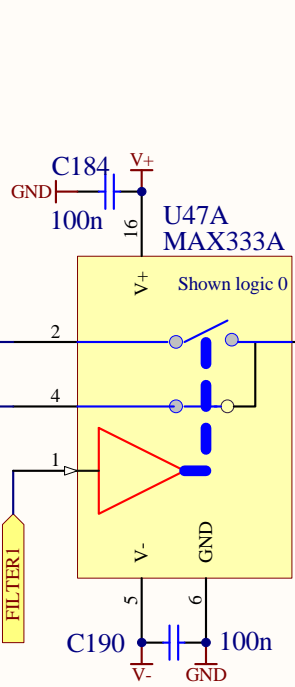


Title			<b>Common Mode Board: Slow Excitation</b>		
Size	Number	Revision			
B	D040180	E			
Date:	12/18/2010	Sheet 9 of 17			
File:	C:\Users\...\CM4C.SchDoc	Drawn By: Daniel Sigg			

4kHz/17kHz pole/zero pair (MC):  
 Z5: 374  
 Z6: 33n || 1.2K



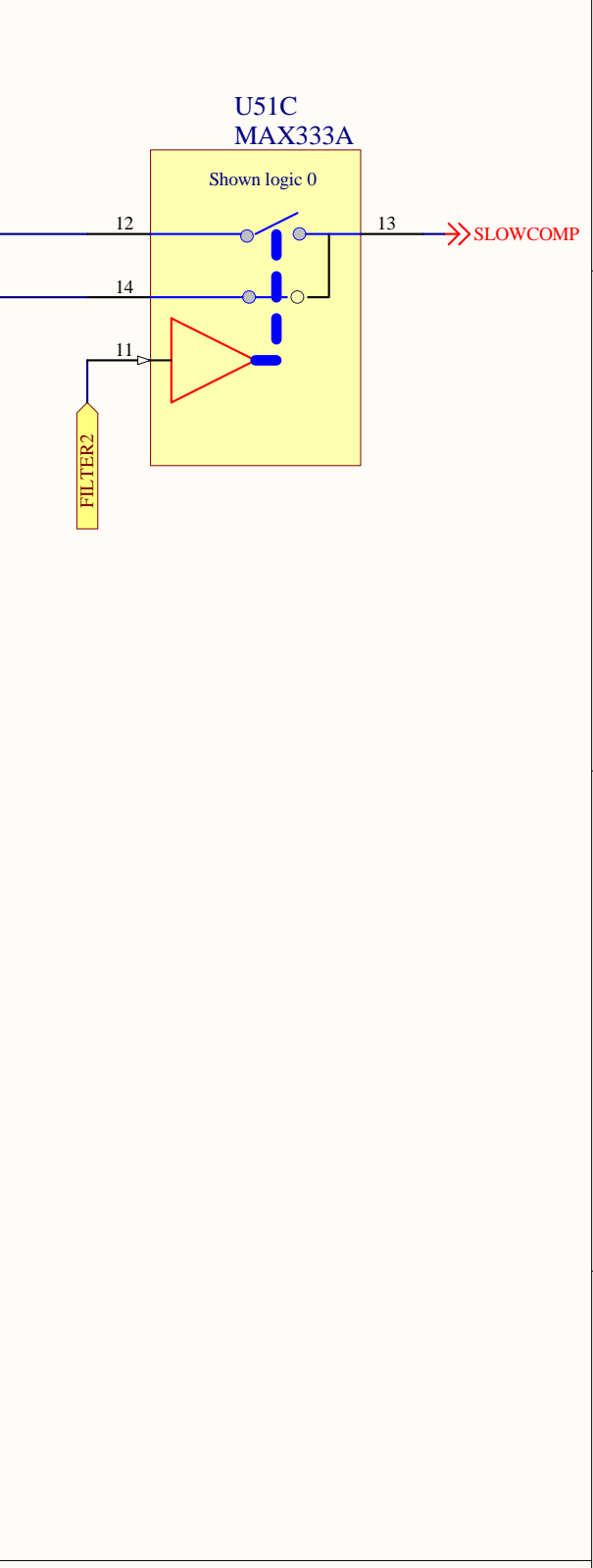
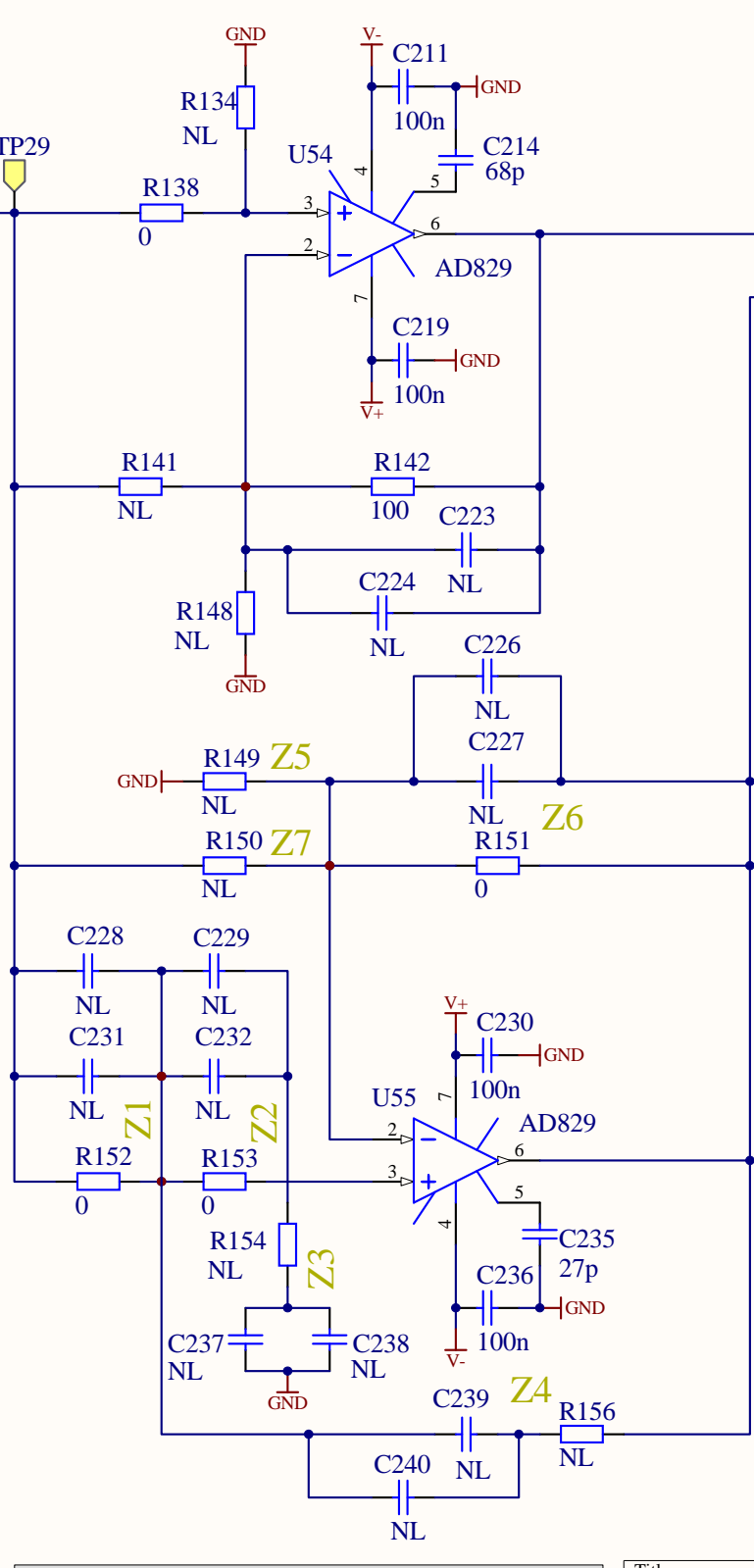
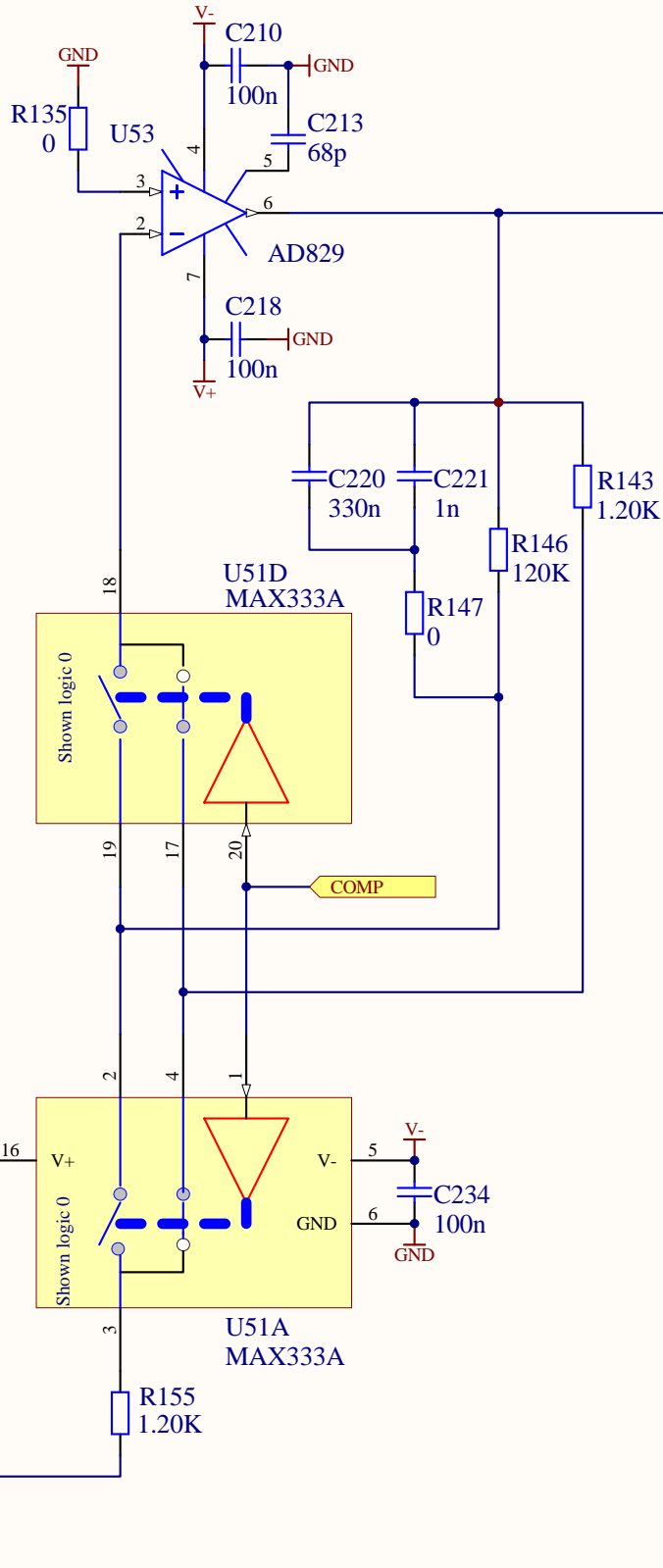
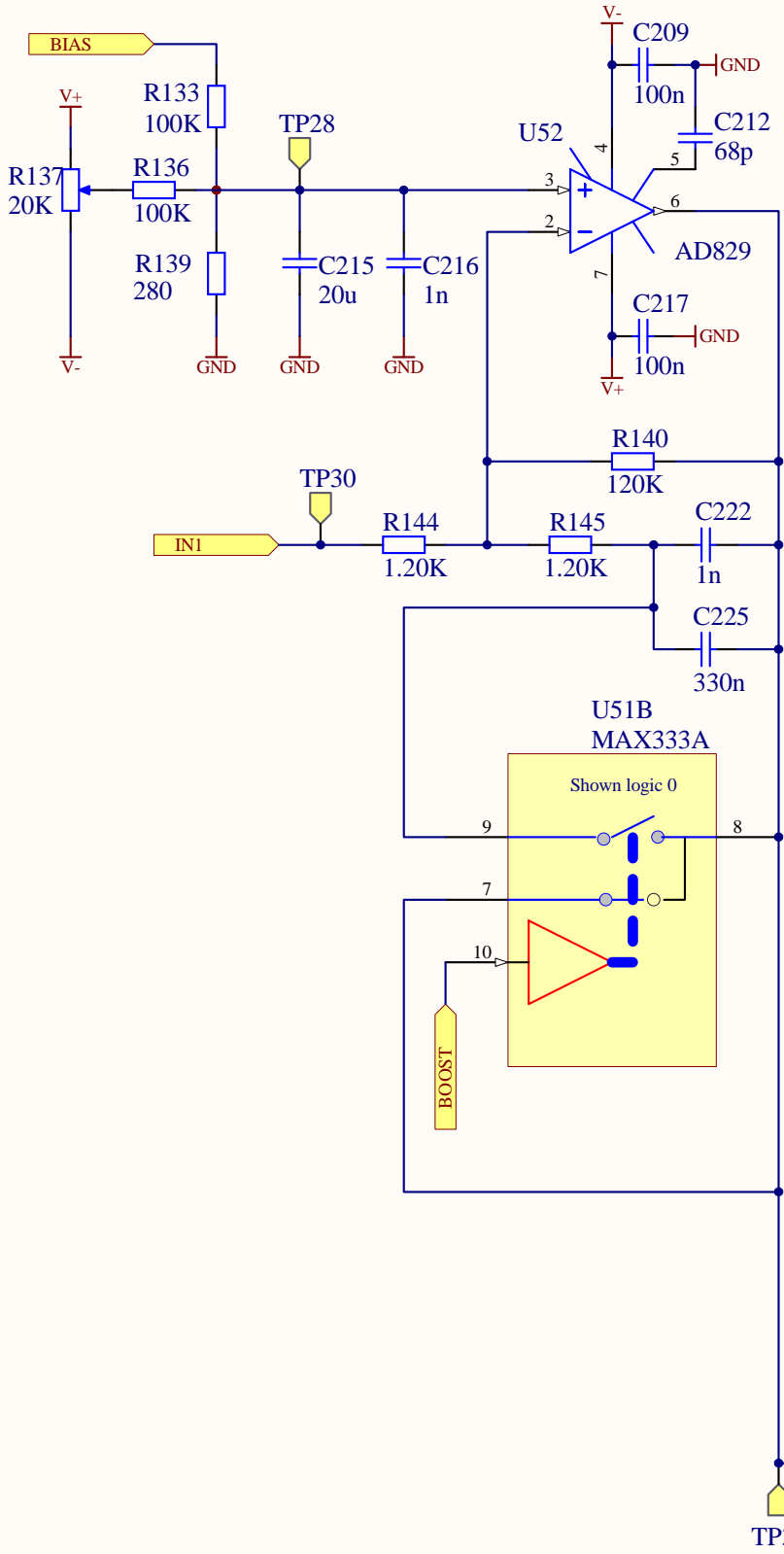
generic filter stage



Title		
<b>Common Mode Board: Servo Split</b>		
Size	Number	Revision
B	D040180	E
Date:	12/18/2010	Sheet 10 of 17
File:	C:\Users\d...CM5A.SchDoc	Drawn By: Daniel Sigg

4Hz/400Hz pole/zero pair

4Hz pole



generic filter stage

Title			<b>Common Mode Board: Slow</b>		
Size	Number			Revision	
B	D040180			E	
Date:	12/18/2010	Sheet 11 of 17			
File:	C:\Users\d...CM5B.SchDoc	Drawn By: Daniel Sigg			

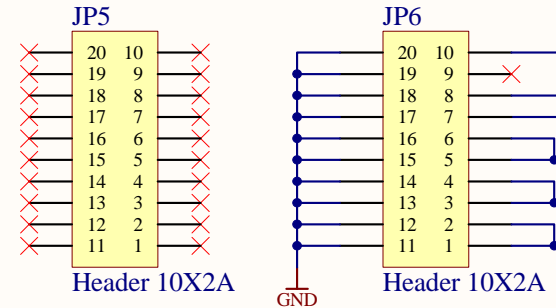
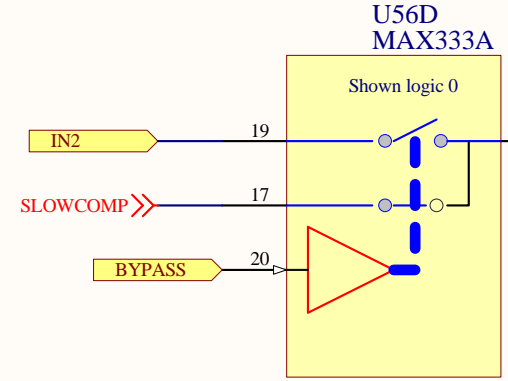
generic filter stage  
 2 real zeros at 10Hz  
 2 real poles at 100Hz  
 dc gain of 0.1

ground option path (ALS):  
 Z1: 0

100kHz pole

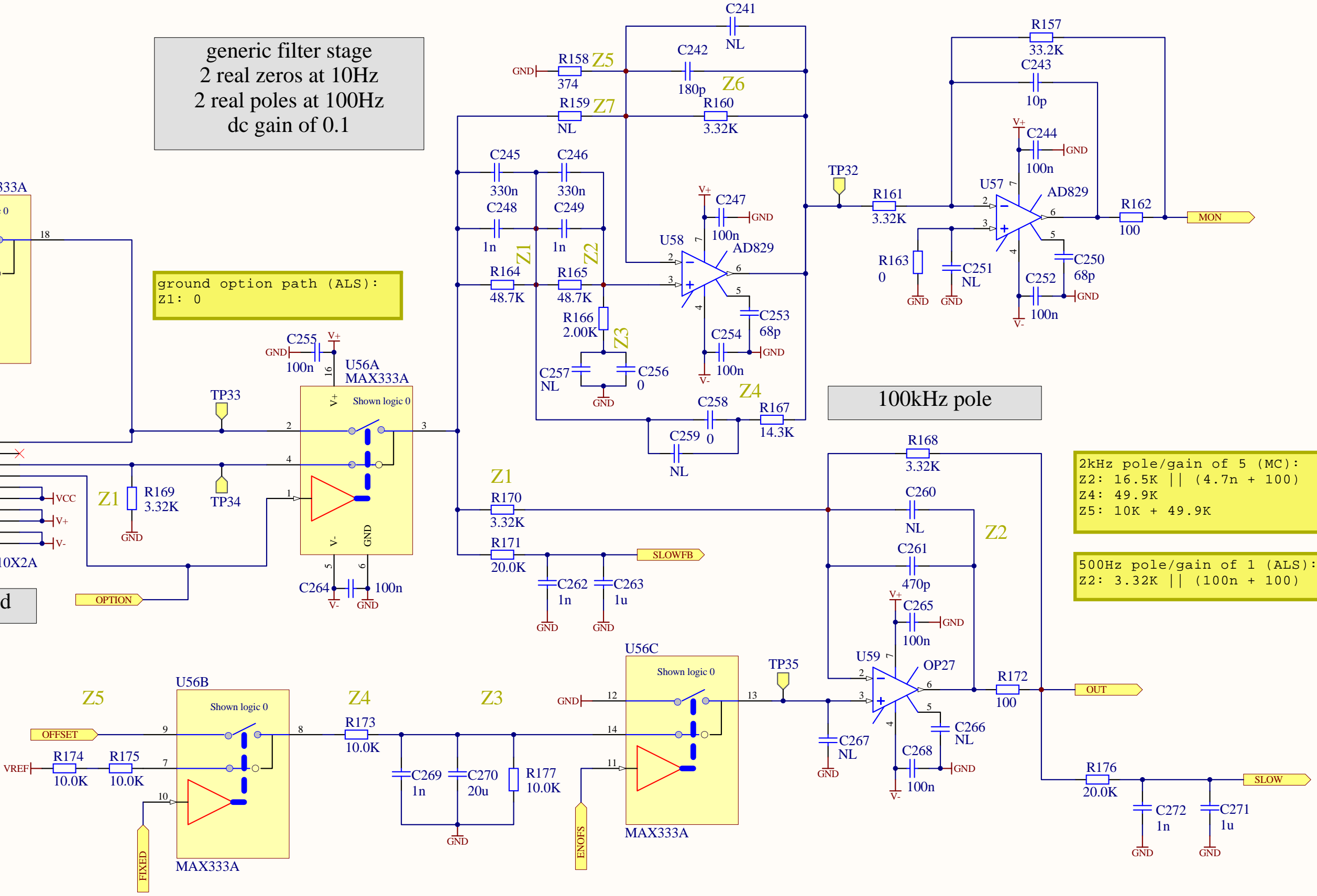
2kHz pole/gain of 5 (MC):  
 Z2: 16.5K || (4.7n + 100)  
 Z4: 49.9K  
 Z5: 10K + 49.9K

500Hz pole/gain of 1 (ALS):  
 Z2: 3.32K || (100n + 100)



optional daughter board

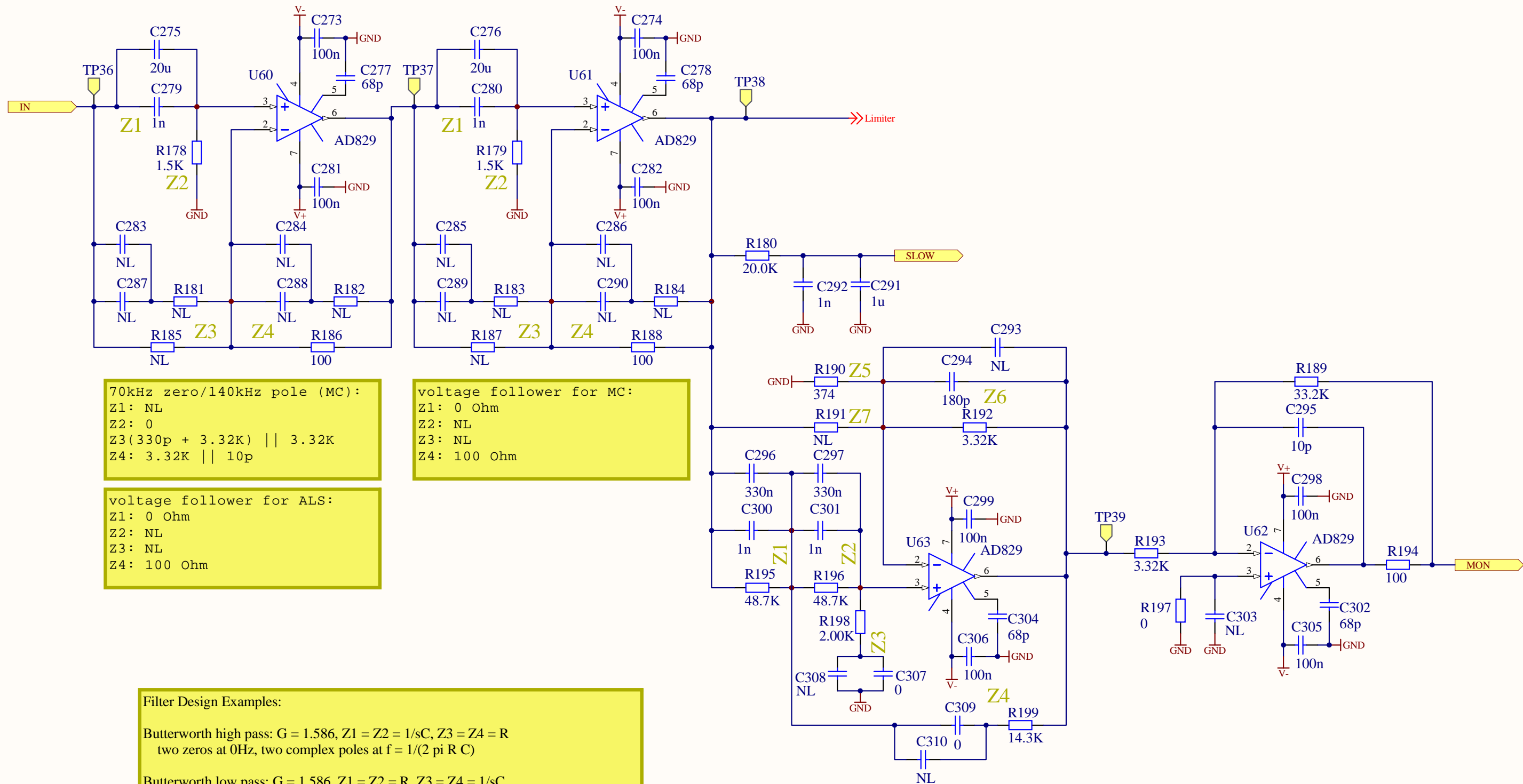
- M37 M3 standoff, 12mm
- M38 M3 pan, 8mm
- M39 M3 standoff, 12mm
- M40 M3 pan, 8mm
- M41 M3 standoff, 12mm
- M42 M3 pan, 8mm
- M43 M3 standoff, 12mm
- M44 M3 pan, 8mm
- M45 M3 standoff, 12mm
- M46 M3 pan, 8mm
- M47 M3 standoff, 12mm
- M48 M3 pan, 8mm
- Digi-Key 24434K-ND
- M49 M3 pan, 8mm
- M50 M3 pan, 8mm
- M51 M3 pan, 8mm
- M52 M3 pan, 8mm
- M53 M3 pan, 8mm
- M54 M3 pan, 8mm
- McMaster-Carr 90317A115



Title <b>Common Mode Board: Slow</b>		
Size B	Number <b>D040180</b>	Revision E
Date: 12/18/2010	Sheet 12 of 17	
File: C:\Users\...\CM5C.SchDoc	Drawn By: Daniel Sigg	

5Hz high pass

5Hz high pass



70kHz zero/140kHz pole (MC):  
 Z1: NL  
 Z2: 0  
 Z3(330p + 3.32K) || 3.32K  
 Z4: 3.32K || 10p

voltage follower for MC:  
 Z1: 0 Ohm  
 Z2: NL  
 Z3: NL  
 Z4: 100 Ohm

voltage follower for ALS:  
 Z1: 0 Ohm  
 Z2: NL  
 Z3: NL  
 Z4: 100 Ohm

Filter Design Examples:

Butterworth high pass:  $G = 1.586$ ,  $Z1 = Z2 = 1/sC$ ,  $Z3 = Z4 = R$   
 two zeros at 0Hz, two complex poles at  $f = 1/(2 \pi R C)$

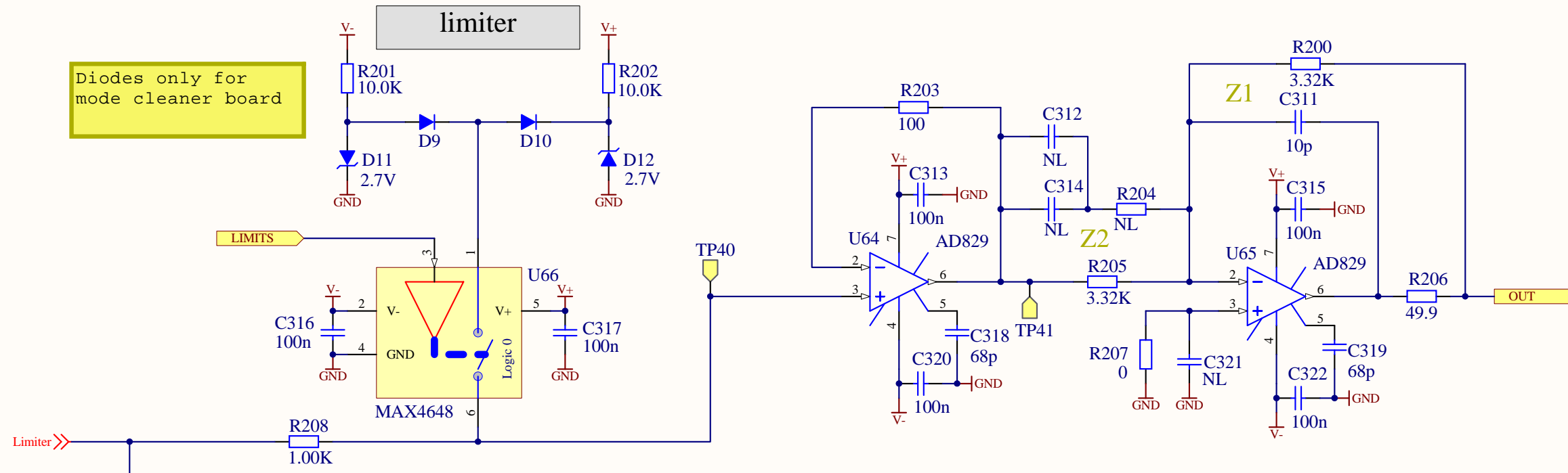
Butterworth low pass:  $G = 1.586$ ,  $Z1 = Z2 = R$ ,  $Z3 = Z4 = 1/sC$   
 two complex poles at  $f = 1/(2 \pi R C)$

Whitening:  $G = 1$ ,  $Z1 = Z2 = (1/sC) || R2$ ,  $Z3 = Z4 = R1$   
 two real zeros at  $f = 1/(2 \pi R2 C)$ , two real poles at  $f = 1/(2 \pi (R1 || R2) C)$

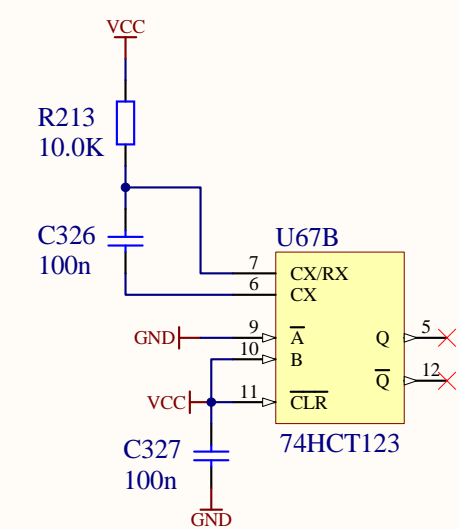
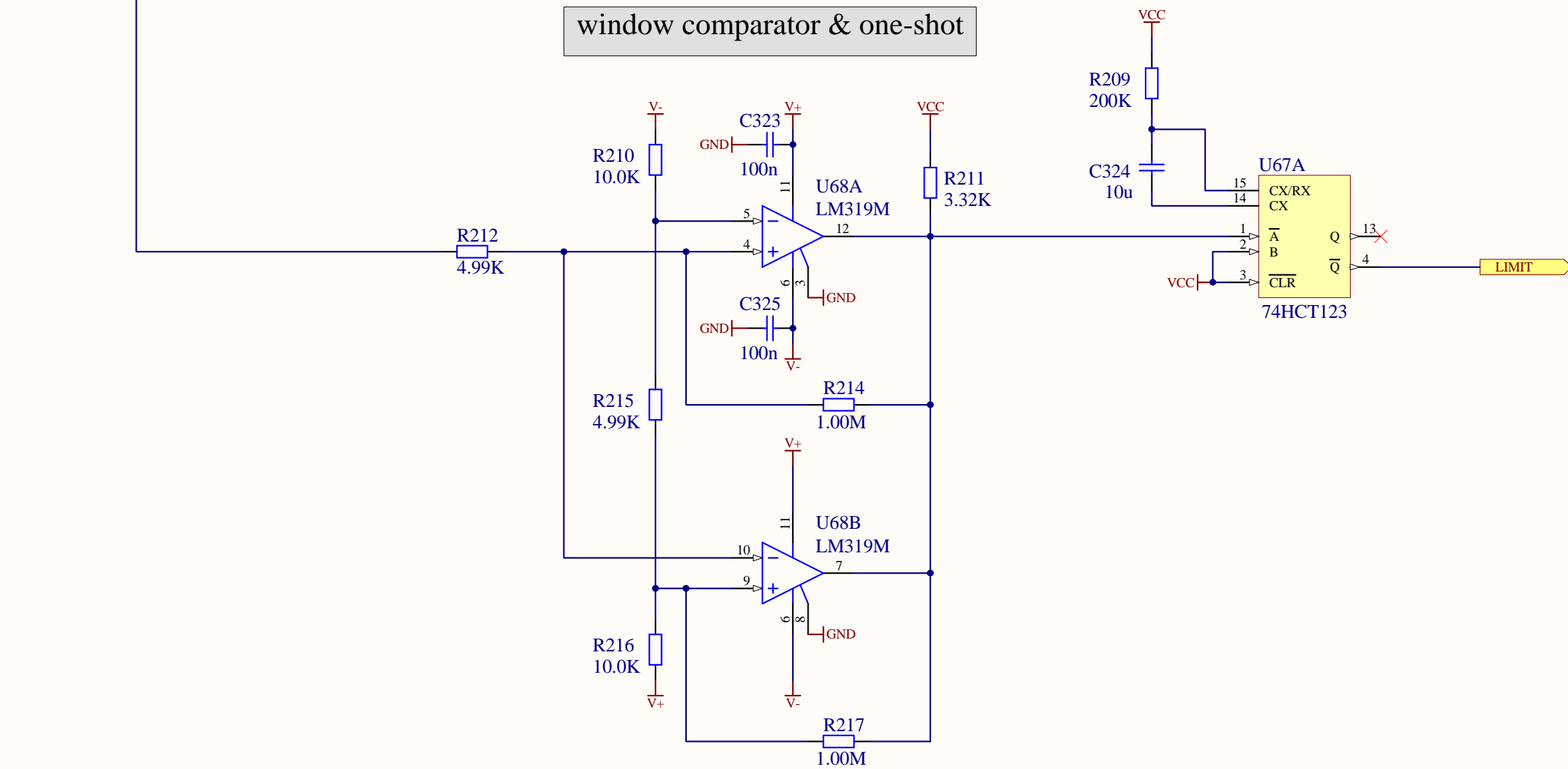
Dewhiteninig:  $G = 1$ ,  $Z1 = Z2 = R1$ ,  $Z3 = Z4 = 1/sC + R2$   
 two real poles at  $f = 1/(2 \pi (R1 + R2) C)$ , two real zeros at  $f = 1/(2 \pi R2 C)$

generic filter stage  
 2 real zeros at 10Hz  
 2 real poles at 100Hz  
 dc gain of 0.1

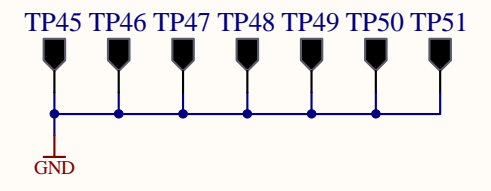
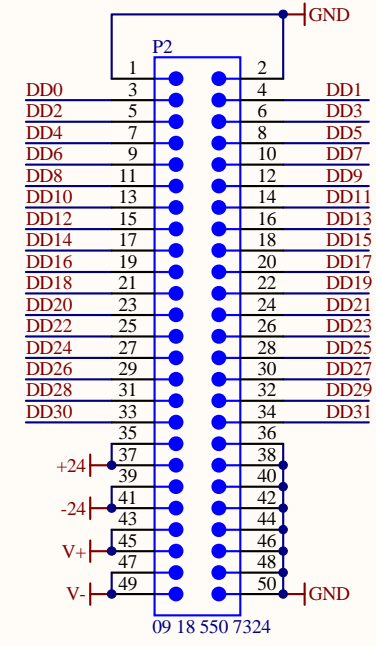
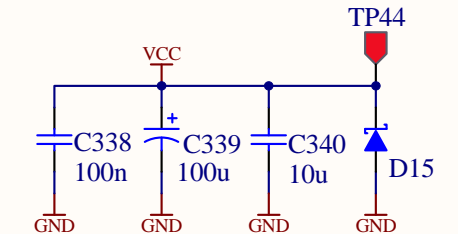
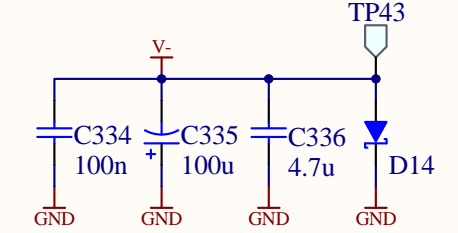
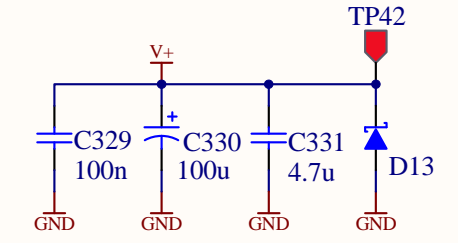
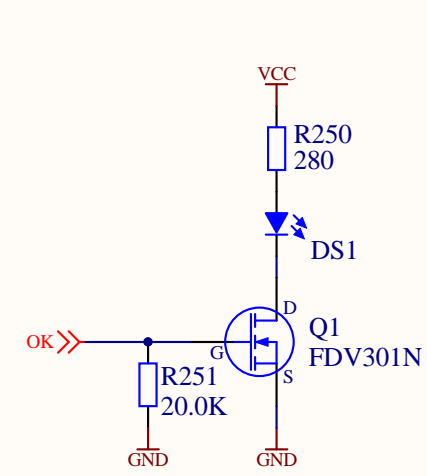
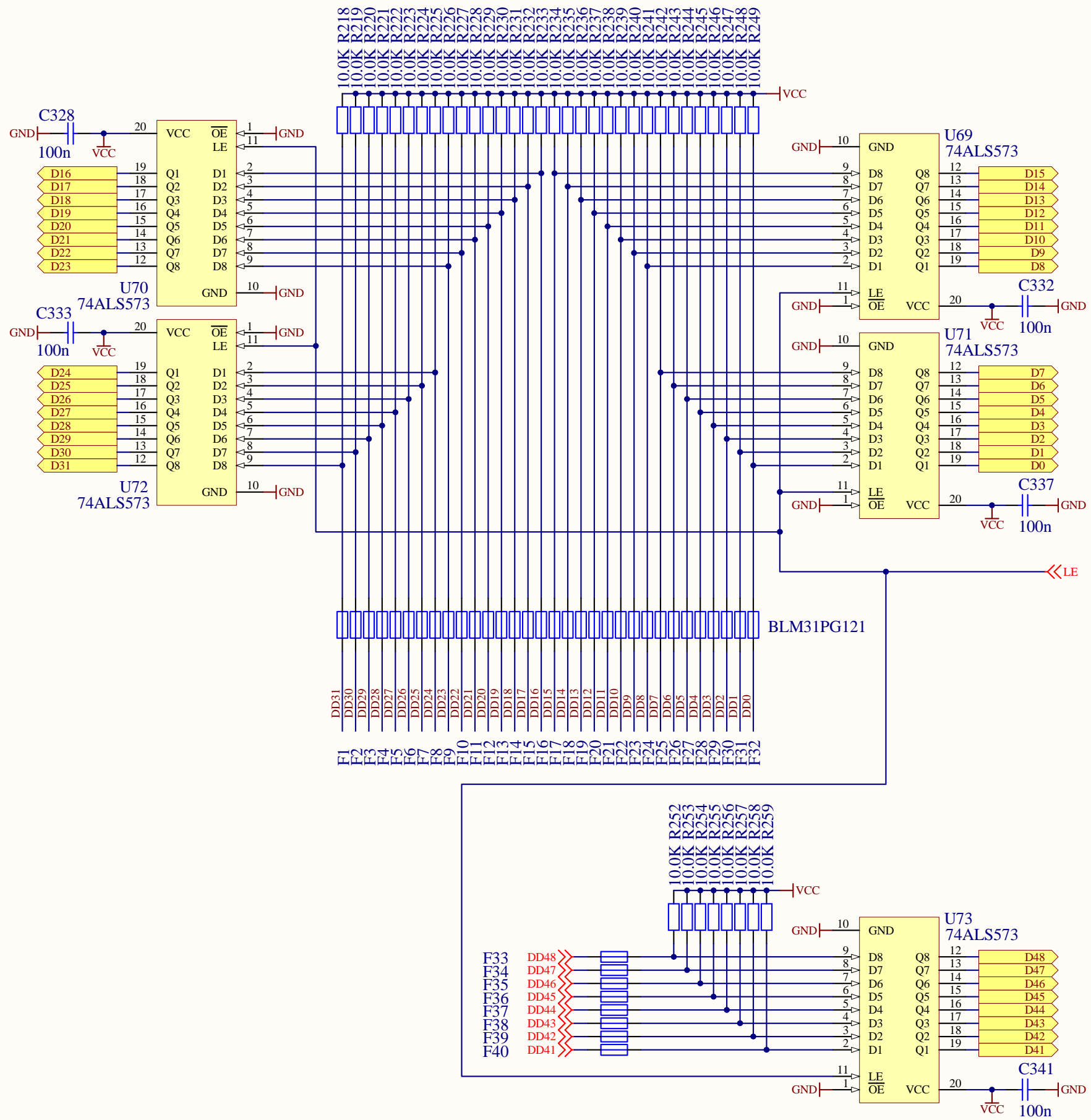
Title		
<b>Common Mode Board: Fast Path</b>		
Size	Number	Revision
B	D040180	E
Date:	12/18/2010	Sheet 13 of 17
File:	C:\Users\d...CM6A.SchDoc	Drawn By: Daniel Sigg



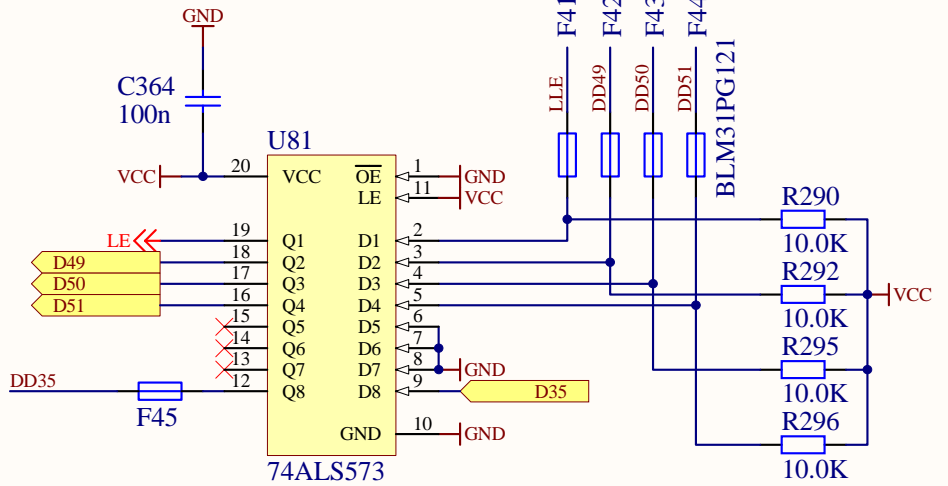
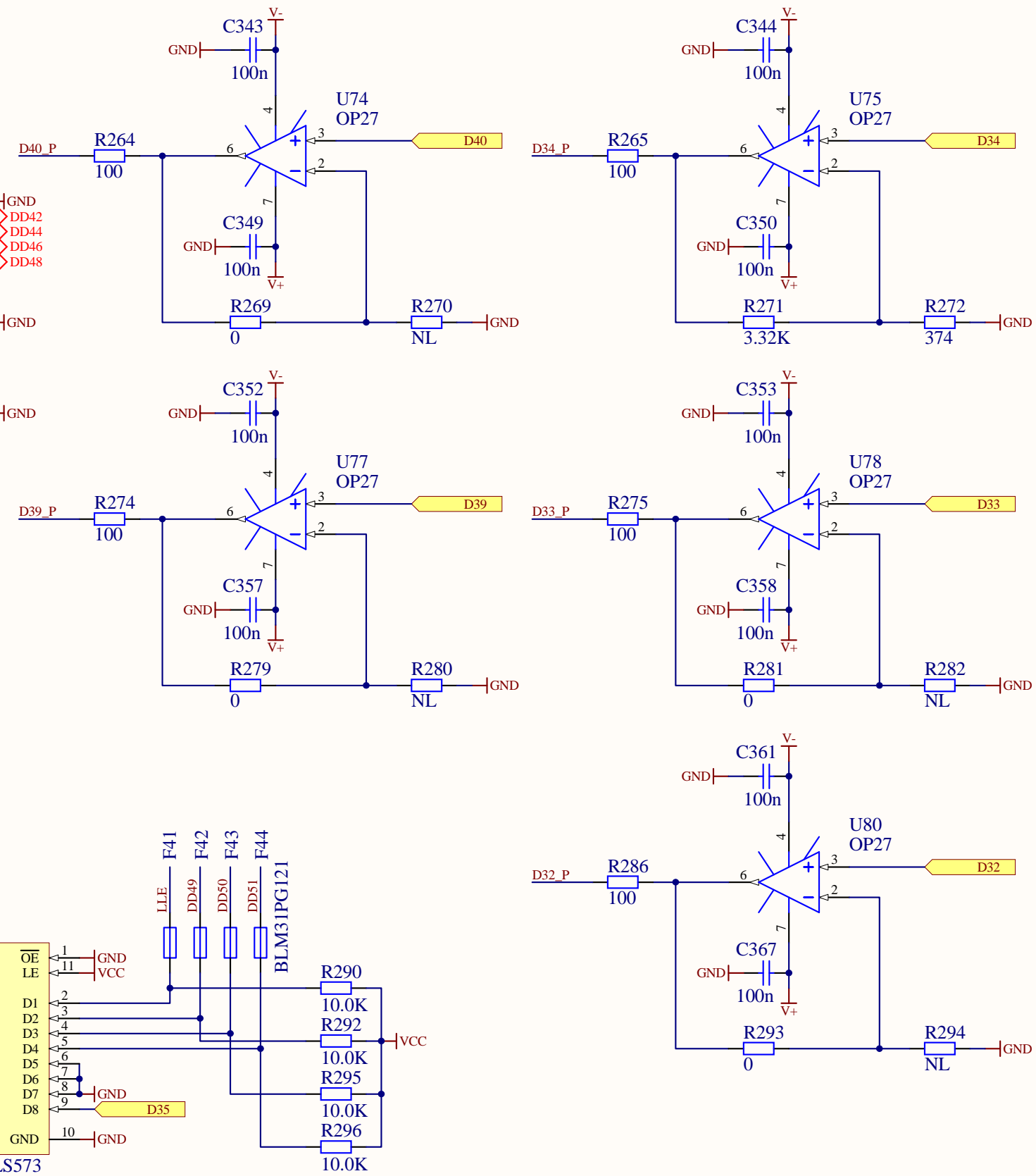
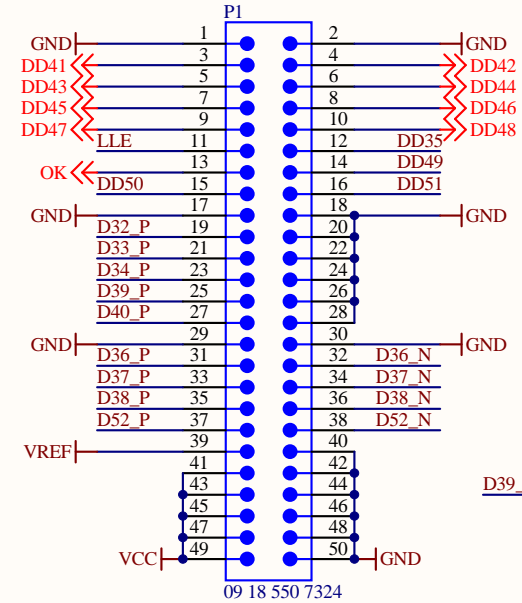
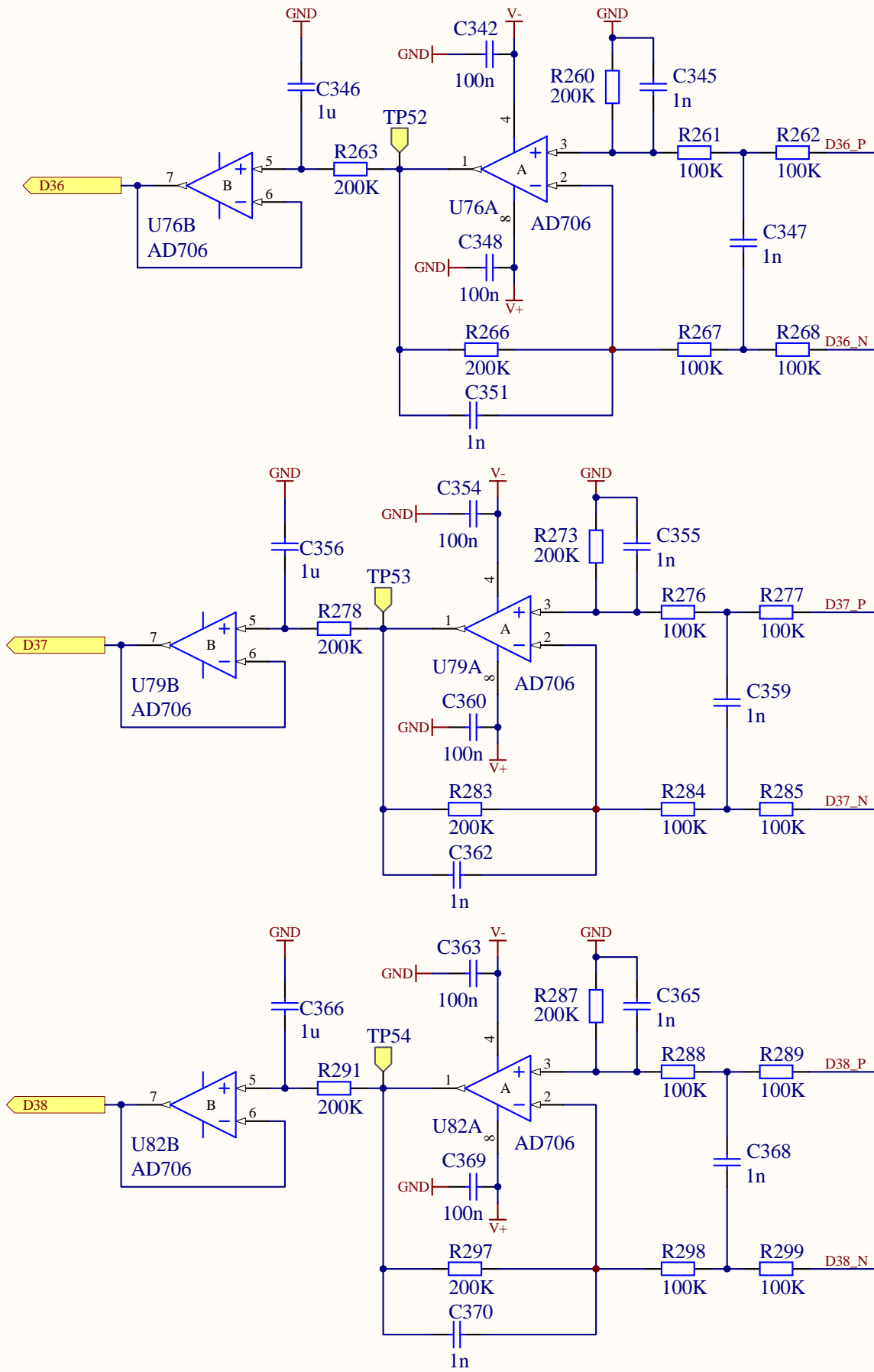
window comparator & one-shot



Title		
<b>Common Mode Board: Output Limiter</b>		
Size	Number	Revision
B	D040180	E
Date:	12/18/2010	Sheet 14 of 17
File:	C:\Users\d...\.CM6B.SchDoc	Drawn By: Daniel Sigg

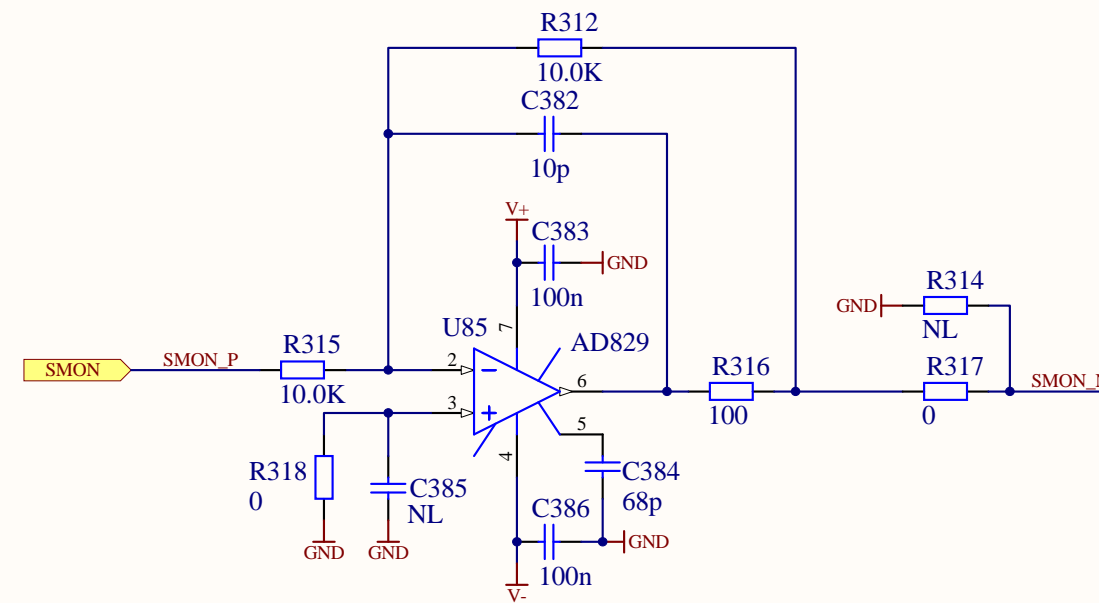
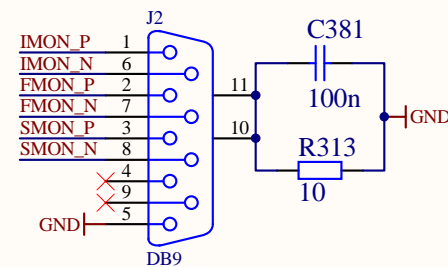
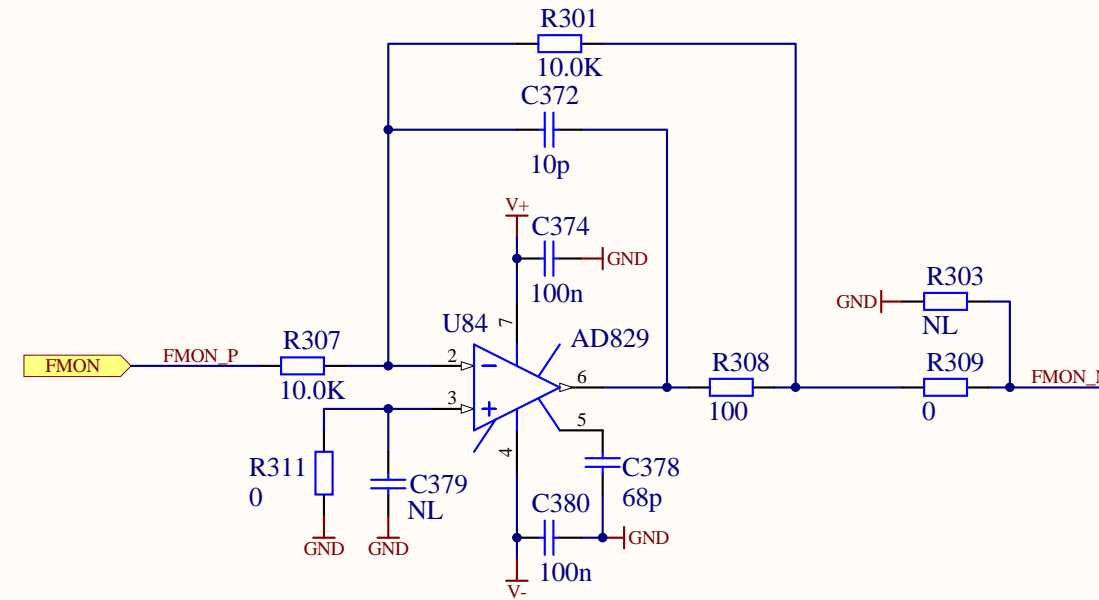
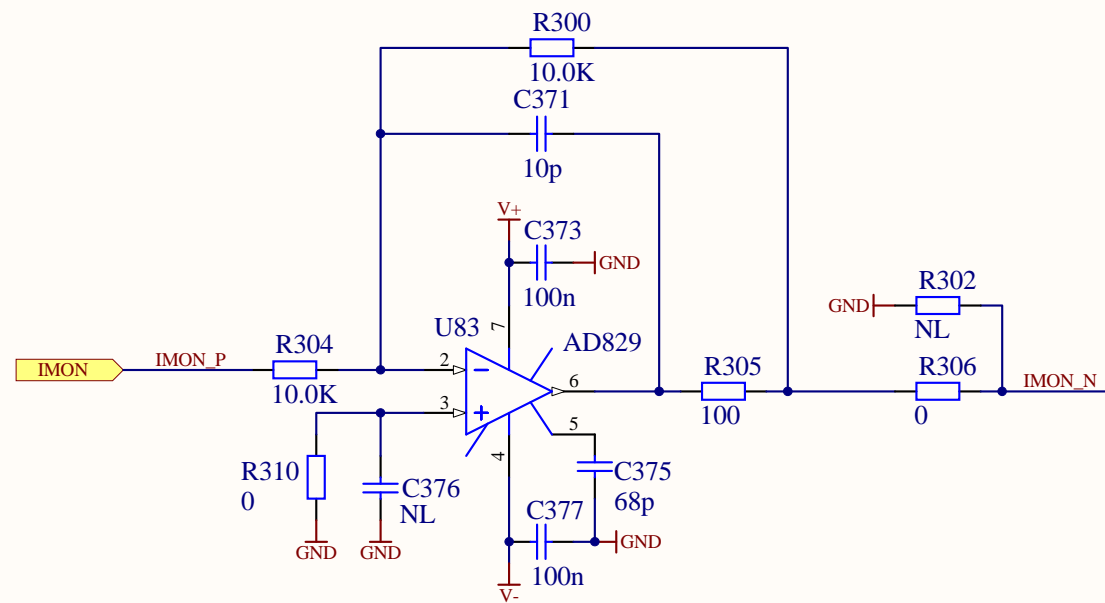


Title		
<b>Common Mode Board: Backplane(P1)</b>		
Size	Number	Revision
B	D040180	E
Date:	12/18/2010	Sheet 15 of 17
File:	C:\Users\...\CM7A.SchDoc	Drawn By: Daniel Sigg



Title		
<b>Common Mode Board: Backplane(P2)</b>		
Size	Number	Revision
B	D040180	E
Date:	12/18/2010	Sheet 16 of 17
File:	C:\Users\...\CM7B.SchDoc	Drawn By: Daniel Sigg





Title		
<b>Common Mode Board: DAQ</b>		
Size	Number	Revision
B	D040180	E
Date:	12/18/2010	Sheet 17 of 17
File:	C:\Users\...\CM8.SchDoc	Drawn By: Daniel Sigg