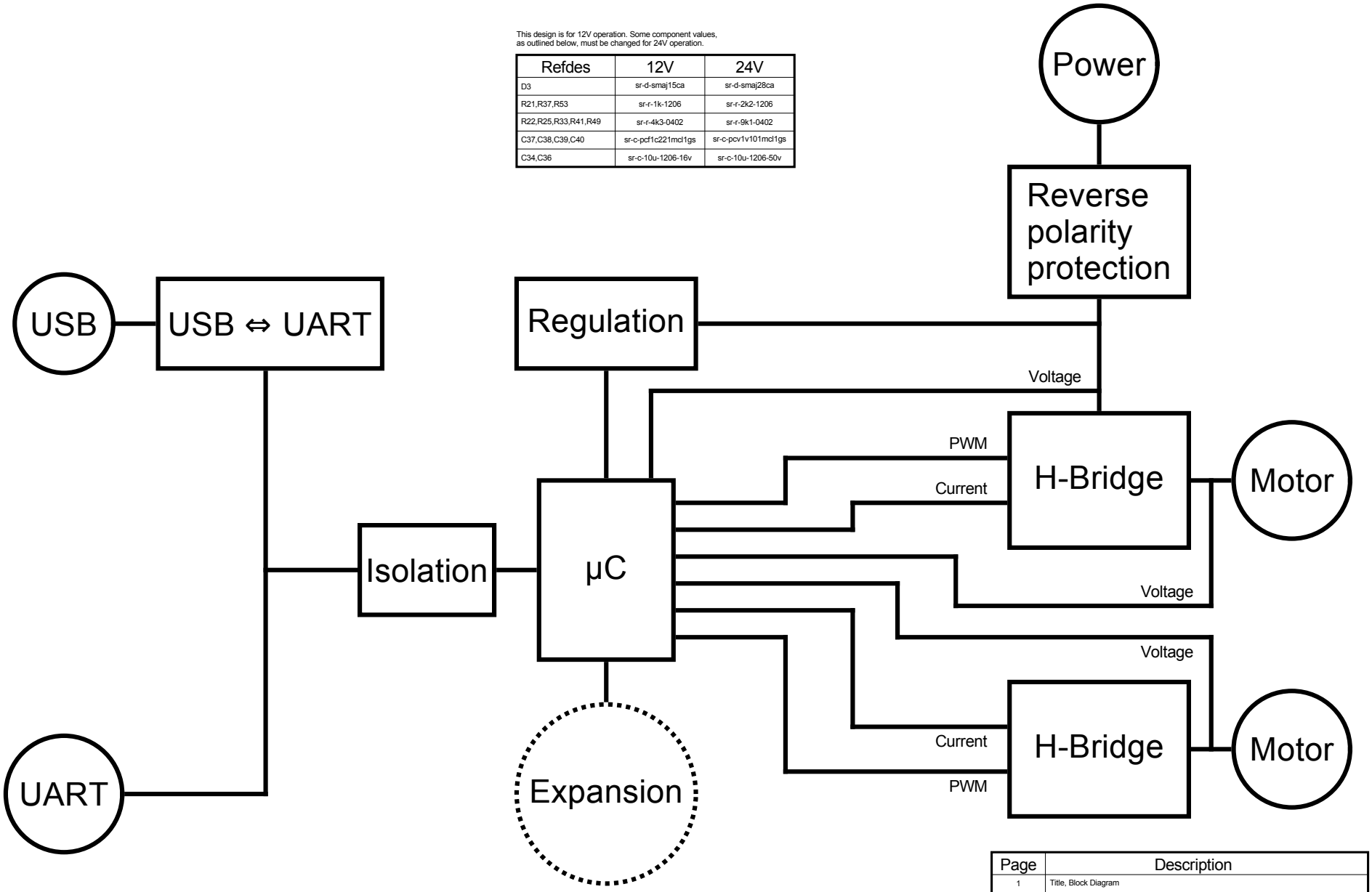
This design is for 12V operation. Some component values, as outlined below, must be changed for 24V operation.

Refdes	12V	24V
D3	sr-d-smaj15ca	sr-d-smaj28ca
R21,R37,R53	sr-r-1k-1206	sr-r-2k2-1206
R22,R25,R33,R41,R49	sr-r-4k3-0402	sr-r-9k1-0402
C37,C38,C39,C40	sr-c-pcf1c221mcl1gs	sr-c-pcv1v101mcl1gs
C34,C36	sr-c-10u-1206-16v	sr-c-10u-1206-50v



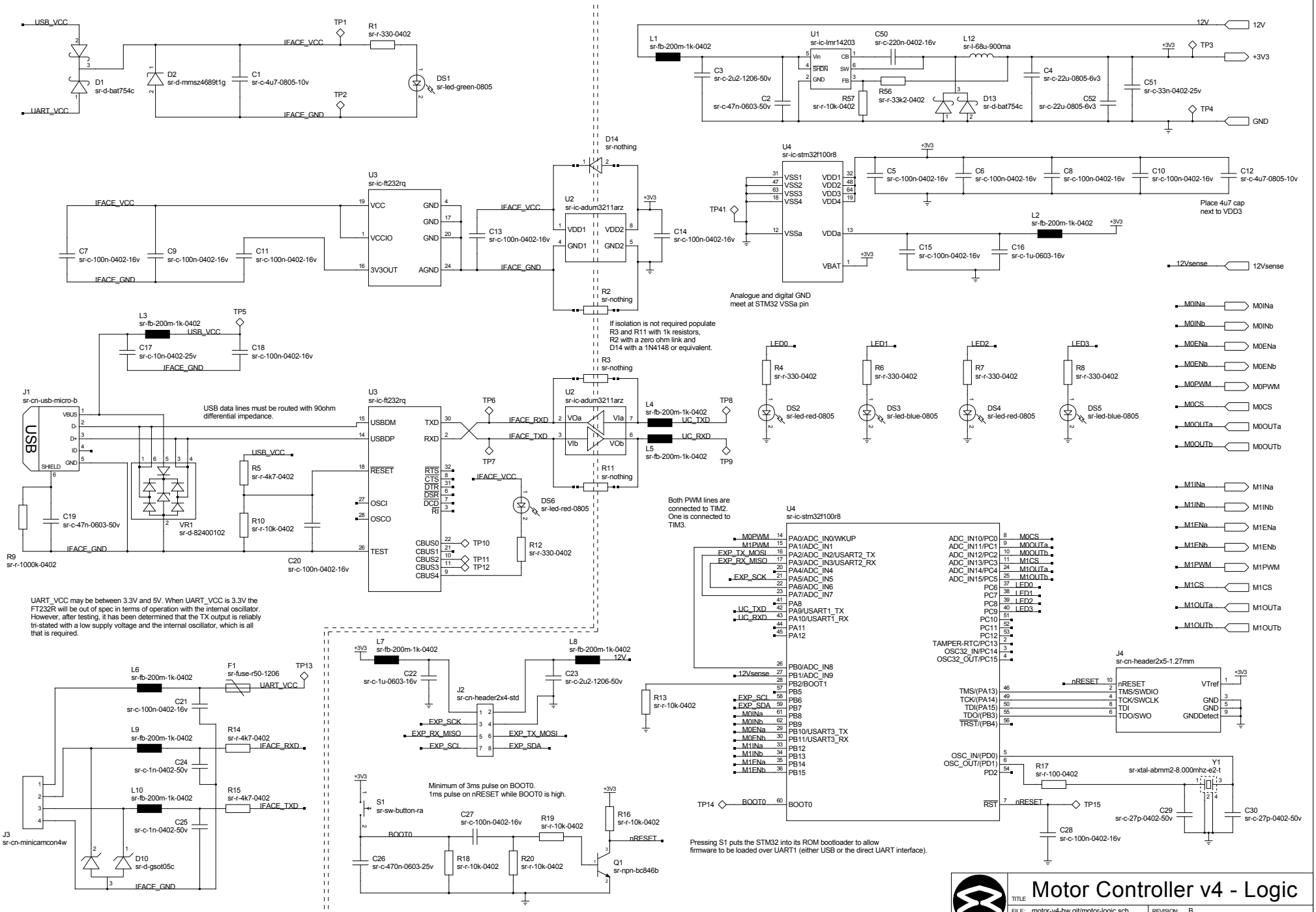
Page	Description
1	Title, Block Diagram
2	Logic (USB, UART, Isolation, Microcontroller)
3	Power (Reverse polarity protection, H-Bridges)

The full source of this design is available at:
https://www.studentrobotics.org/git/boards/motor-v4-hw.git

TITLE: Motor Controller v4

FILE: motor-v4-hw.git/motor-title.sch REVISION: B

PAGE 1 OF 3 DRAWN BY: Richard Barlow <richard@richardbarlow.co.uk>


USB_VCC
TP1
R1
sr-r-330-0402
IFACE_VCC
D1
sr-d-bat754c
D2
sr-d-mmsz4689t1g
C1
sr-c-4u7-0805-10v
DS1
sr-led-green-0805
TP2
UART_VCC
IFACE_GND
12V
L1
sr-fb-200m-1k-0402
U1
sr-ic-lmr14203
C50
sr-c-220n-0402-16v
L12
sr-l-68u-900ma
C3
sr-c-2u2-1206-50v
C2
sr-c-47n-0603-50v
R56
sr-r-33k2-0402
R57
sr-r-10k-0402
D13
sr-d-bat754c
C4
sr-c-22u-0805-6v3
C52
sr-c-22u-0805-6v3
C51
sr-c-33n-0402-25v
TP3
TP4
+3V3
GND
D14
sr-nothing
U3
sr-ic-ft232rq
U2
sr-ic-adum3211arz
U4
sr-ic-stm32f100r8
C7
sr-c-100n-0402-16v
C9
sr-c-100n-0402-16v
C11
sr-c-100n-0402-16v
C13
sr-c-100n-0402-16v
C14
sr-c-100n-0402-16v
C5
sr-c-100n-0402-16v
C6
sr-c-100n-0402-16v
C8
sr-c-100n-0402-16v
C10
sr-c-100n-0402-16v
C12
sr-c-4u7-0805-10v
Place 4u7 cap
next to VDD3
TP41
L2
sr-fb-200m-1k-0402
C15
sr-c-100n-0402-16v
C16
sr-c-1u-0603-16v
12Vsense
R2
sr-nothing
Analogue and digital GND
meet at STM32 VSSa pin
If isolation is not required populate
R3 and R11 with 1k resistors,
R2 with a zero ohm link and
D14 with a 1N4148 or equivalent.
L3
sr-fb-200m-1k-0402
TP5
C17
sr-c-10n-0402-25v
C18
sr-c-100n-0402-16v
R3
sr-nothing
R11
sr-nothing
LED0
LED1
LED2
LED3
R4
sr-r-330-0402
R6
sr-r-330-0402
R7
sr-r-330-0402
R8
sr-r-330-0402
DS2
sr-led-red-0805
DS3
sr-led-blue-0805
DS4
sr-led-red-0805
DS5
sr-led-blue-0805
M0INa
M0INb
M0ENa
M0ENb
M0PWM
M0CS
M0OUTa
M0OUTb
J1
sr-cn-usb-micro-b
USB data lines must be routed with 90ohm
differential impedance.
TP6
TP7
TP8
TP9
L4
sr-fb-200m-1k-0402
L5
sr-fb-200m-1k-0402
UC_TXD
UC_RXD
IFACE_RXD
IFACE_TXD
R5
sr-r-4k7-0402
R10
sr-r-10k-0402
C19
sr-c-47n-0603-50v
R9
sr-r-1000k-0402
VR1
sr-d-82400102
C20
sr-c-100n-0402-16v
DS6
sr-led-red-0805
R12
sr-r-330-0402
TP10
TP11
TP12
M1INa
M1INb
M1ENa
M1ENb
M1PWM
M1CS
M1OUTa
M1OUTb
Both PWM lines are
connected to TIM2.
One is connected to
TIM3.
UART_VCC may be between 3.3V and 5V. When UART_VCC is 3.3V the
FT232R will be out of spec in terms of operation with the internal oscillator.
However, after testing, it has been determined that the TX output is reliably
tri-stated with a low supply voltage and the internal oscillator, which is all
that is required.
L6
sr-fb-200m-1k-0402
F1
sr-fuse-r50-1206
TP13
C21
sr-c-100n-0402-16v
L9
sr-fb-200m-1k-0402
R14
sr-r-4k7-0402
C24
sr-c-1n-0402-50v
L10
sr-fb-200m-1k-0402
R15
sr-r-4k7-0402
C25
sr-c-1n-0402-50v
J3
sr-cn-minicamcon4w
D10
sr-d-gsot05c
L7
sr-fb-200m-1k-0402
L8
sr-fb-200m-1k-0402
C22
sr-c-1u-0603-16v
C23
sr-c-2u2-1206-50v
J2
sr-cn-header2x4-std
Minimum of 3ms pulse on BOOT0.
1ms pulse on nRESET while BOOT0 is high.
S1
sr-sw-button-ra
C27
sr-c-100n-0402-16v
R19
sr-r-10k-0402
R16
sr-r-10k-0402
C26
sr-c-470n-0603-25v
R18
sr-r-10k-0402
R20
sr-r-10k-0402
Q1
sr-npn-bc846b
R13
sr-r-10k-0402
J4
sr-cn-header2x5-1.27mm
R17
sr-r-100-0402
Y1
sr-xtal-abmm2-8.000mhz-e2-t
C29
sr-c-27p-0402-50v
C30
sr-c-27p-0402-50v
C28
sr-c-100n-0402-16v
TP14
TP15
Pressing S1 puts the STM32 into its ROM bootloader to allow
firmware to be loaded over UART1 (either USB or the direct UART interface).
TITLE
Motor Controller v4 - Logic
FILE: motor-v4-hw.git/motor-logic.sch
REVISION: B
PAGE 2 OF 3
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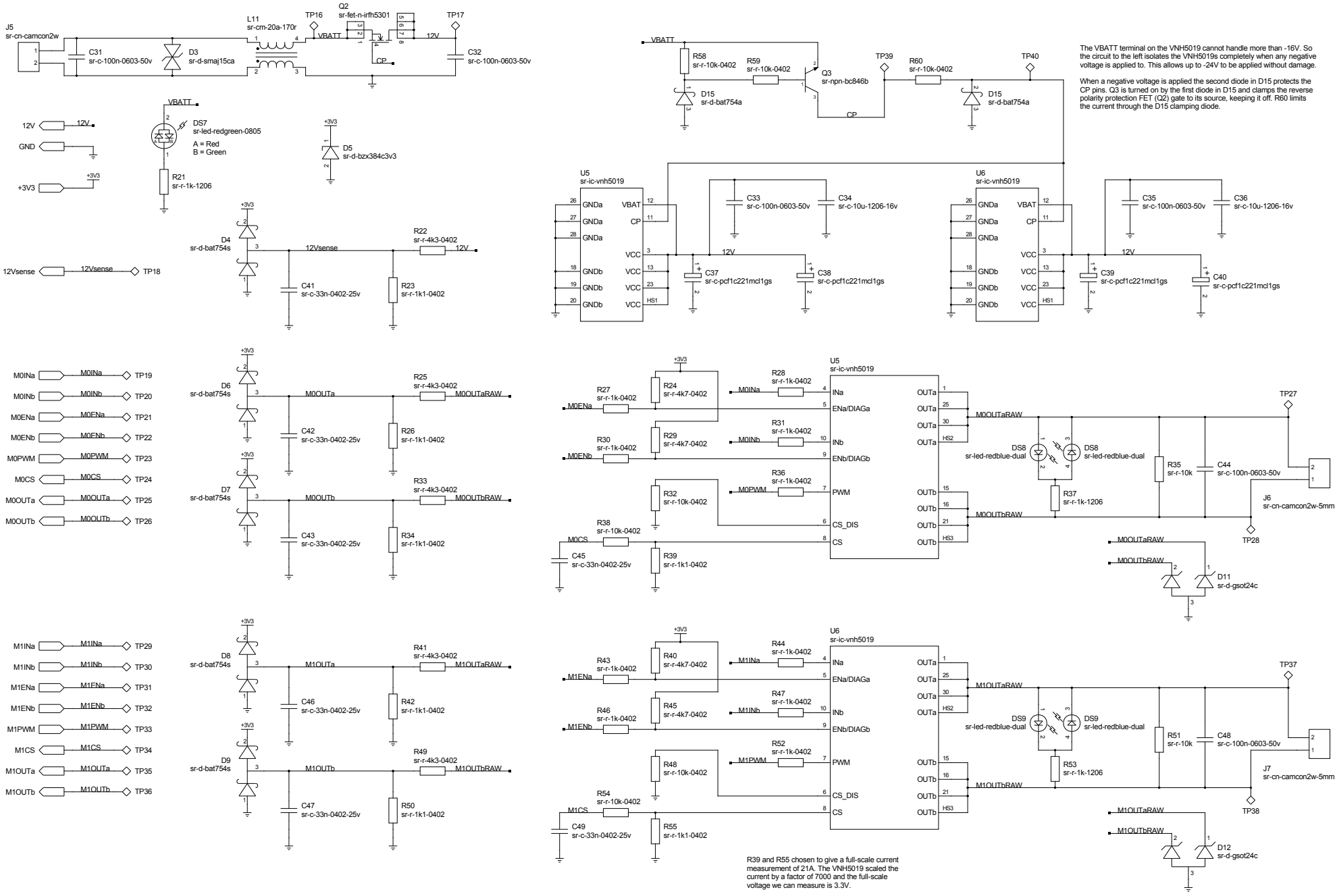

The VBATT terminal on the VNH5019 cannot handle more than -16V. So the circuit to the left isolates the VNH5019s completely when any negative voltage is applied to. This allows up to -24V to be applied without damage.

When a negative voltage is applied the second diode in D15 protects the CP pins. Q3 is turned on by the first diode in D15 and clamps the reverse polarity protection FET (Q2) gate to its source, keeping it off. R60 limits the current through the D15 clamping diode.

R39 and R55 chosen to give a full-scale current measurement of 21A. The VNH5019 scaled the current by a factor of 7000 and the full-scale voltage we can measure is 3.3V.

Motor Controller v4 - Power

TITLE	Motor Controller v4 - Power		
FILE:	motor-v4-hw.git/motor-power.sch	REVISION:	B
PAGE	3 OF 3	DRAWN BY:	Richard Barlow <richard@richardbarlow.co.uk>