BESC DRIVE schematic — half-bridge motor driver

Labels and component designators visible on the schematic:

- PWM_LOW, PWM_HIGH, DRV_EN, P_I, P_U
- 12V, VIN, VCC, PGND
- MURA160T3G or BYG20J
- R5_HB1 2.2E, D1_HB1 6A
- Cboot 10x gate charge
- C5_HB1 22u, C7_HB1 100n, R6_HB1 5E
- R7_HB1 5E, R9_HB1 51E
- C10_HB1 220p, C11_HB1 220p
- DRV1_HB1 UCC27714: 7 VDD, 1 HI, 2 LI, 4 EN/NC, 3 VSS, 9 HB, 10 HO, 11 HS, 6 LO, 5 COM
- place pulldown somewhere
- C8_HB1 220n
- Q1_HB1, Q2_HB1, Q3_HB1, Q4_HB1
- R1_HB1 3R01, R2_HB1 10k, R3_HB1 3R01, R4_HB1 10k
- R10_HB1 3R01, R11_HB1 10k, R12_HB1 3R01, R13_HB1 10k
- C1_HB1 4.7u 200V, C2_HB1 4.7u 200V, C3_HB1 4.7u 200V, C4_HB1 4.7u 200V, C37_HB1 4.7u 200V, C38_HB1 4.7u 200V
- PHASE
- +-200A HALL CURRENT SENSOR
- IC1_HB1 ACS773ECB-200B-PFF-T: 4 IN+, 1 VCC, 2 GND, 5 IN-, 3 VIOUT
- S1_HB1 PHASE SCREW
- R8_HB1 4k7, C9_HB1 100p
- R14_HB1 68k, P_U, R15_HB1 1k5
- C6_HB1 560uf 200V, C12_HB1 560uf 200V
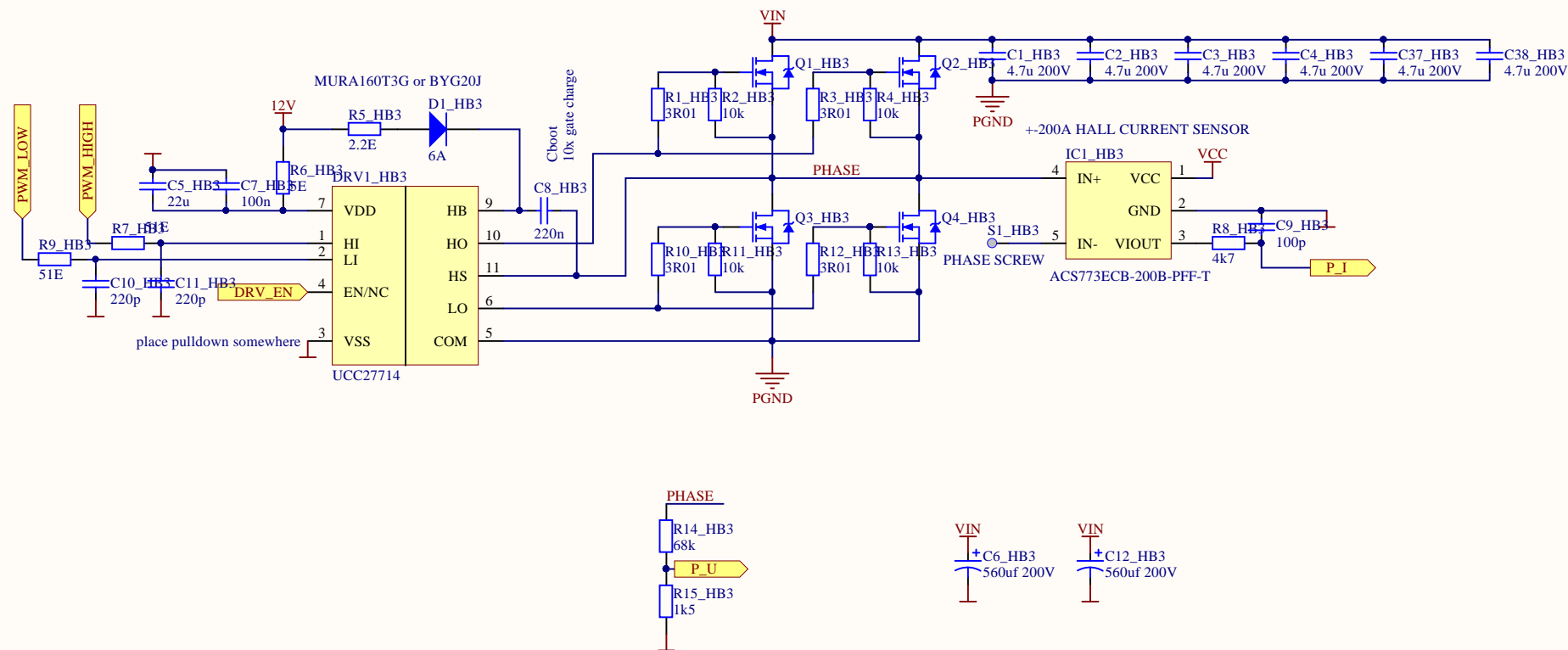
Title: BESC DRIVE
Size: A4
Revision: INIT
Date: 3.11.2018
File: A:\Documents\..\besc drive sch.SchDoc
Drawn By:

PWM_LOW
PWM_HIGH

MURA160T3G or BYG20J

12V

R5_HB2
2.2E

D1_HB2
6A

Cboot
10x gate charge

VIN

Q1_HB2   Q2_HB2

R1_HB2 R2_HB2   R3_HB2 R4_HB2
3R01   10k   3R01   10k

C1_HB2   C2_HB2   C3_HB2   C4_HB2   C37_HB2   C38_HB2
4.7u 200V 4.7u 200V 4.7u 200V 4.7u 200V 4.7u 200V 4.7u 200V

PGND

+-200A HALL CURRENT SENSOR

IC1_HB2   VCC

C5_HB2 C7_HB2
22u   100n

R6_HB2 5E

DRV1_HB2

7   VDD   HB   9

1   HI   HO   10

2   LI   HS   11

4   EN/NC   LO   6

3   VSS   COM 5

UCC27714

C8_HB2
220n

PHASE

4   IN+   VCC   1

GND   2

5   IN-   VIOUT 3

ACS773ECB-200B-PFF-T

R8_HB2   C9_HB2
4k7   100p

P_I

R7_HB2
R9_HB2
51E

51E

C10_HB2 C11_HB2
220p   220p

DRV_EN

place pulldown somewhere

Q3_HB2   Q4_HB2

R10_HB2 R11_HB2   R12_HB2 R13_HB2
3R01   10k   3R01   10k

S1_HB2
PHASE SCREW

PGND

PHASE

R14_HB2
68k

P_U

R15_HB2
1k5

VIN

C6_HB2
560uf 200V

VIN

C12_HB2
560uf 200V
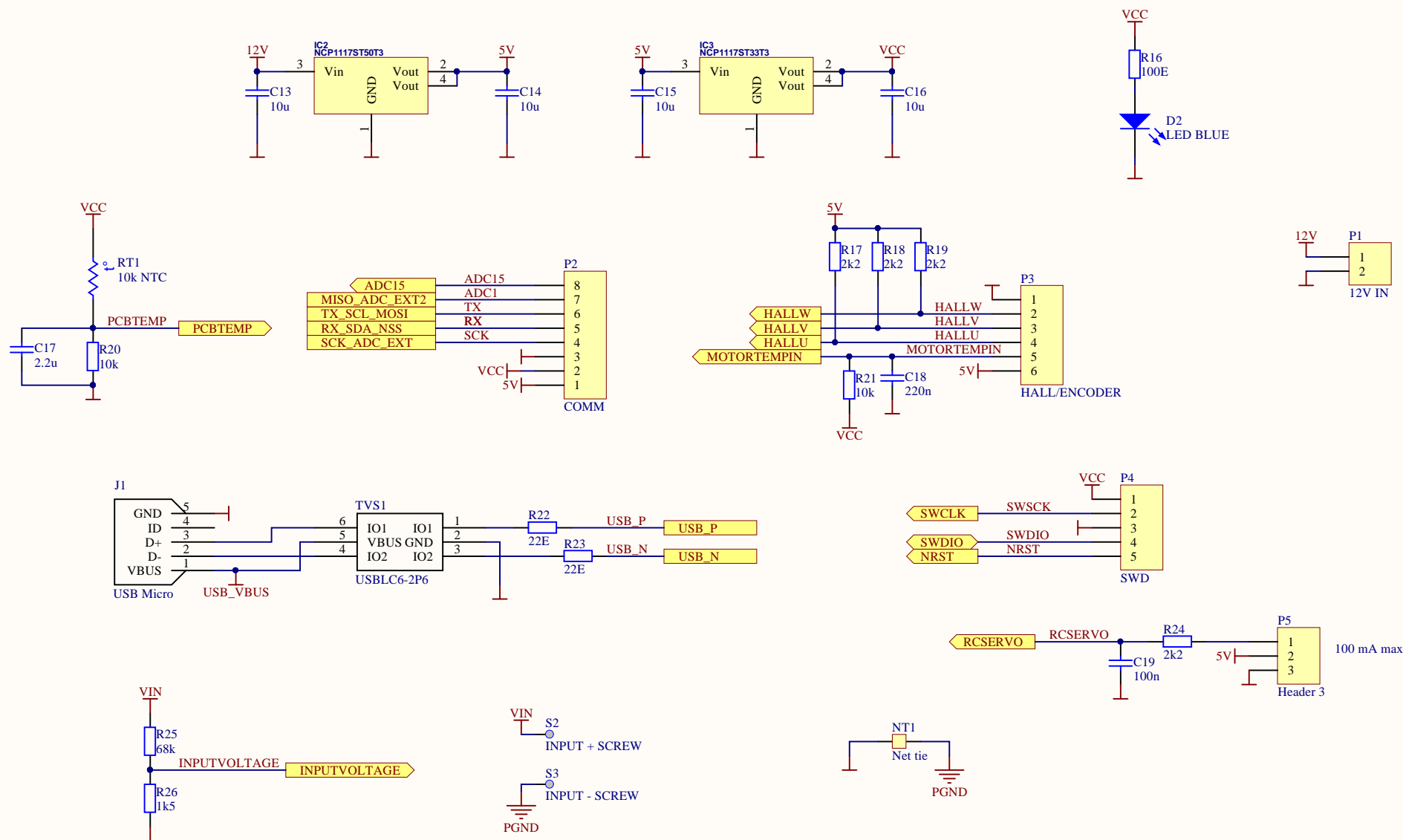
Title
BESC DRIVE

Size
A4

Number

Revision
INIT

Date: 3.11.2018   Sheet   of
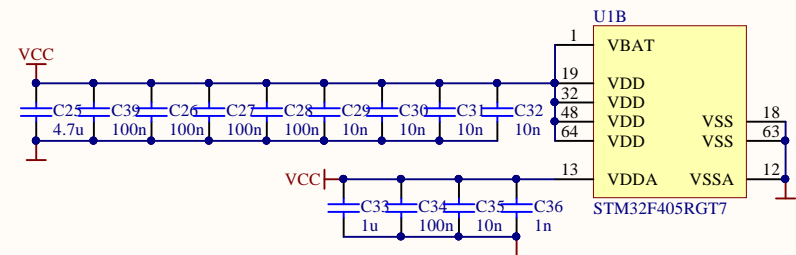File: A:\Documents\..\besc drive sch.SchDoc   Drawn By:
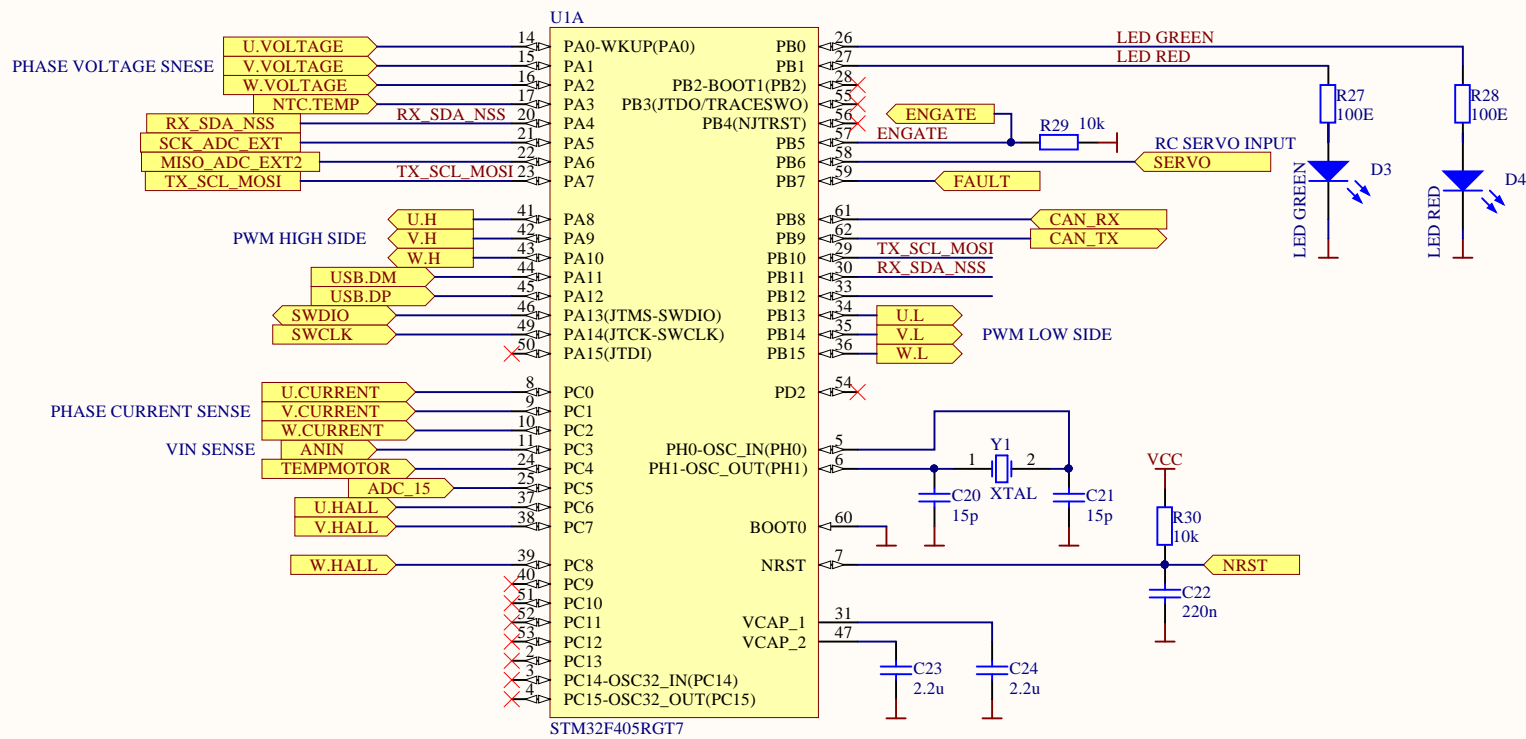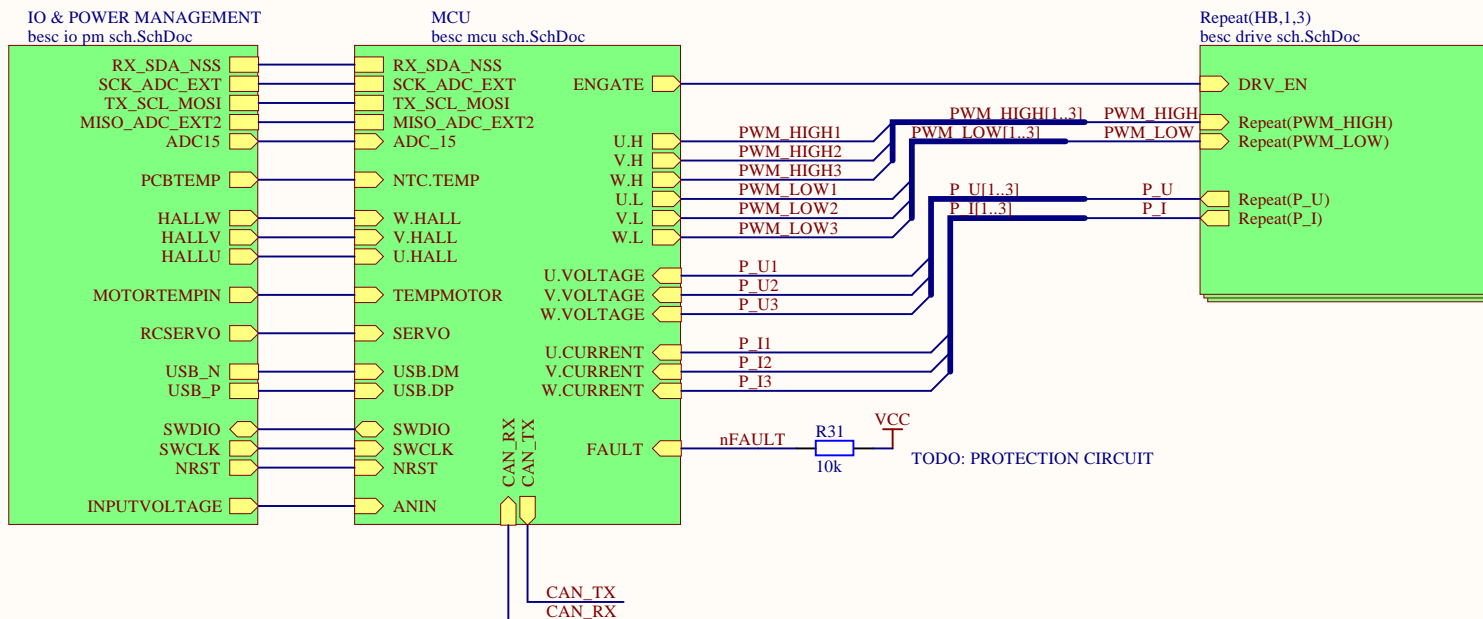
PWM_LOW

PWM_HIGH

VIN

MURA160T3G or BYG20J

Cboot
10x gate charge

12V

R5_HB3
2.2E

D1_HB3
6A

Q1_HB3

Q2_HB3

C1_HB3
4.7u 200V

C2_HB3
4.7u 200V

C3_HB3
4.7u 200V

C4_HB3
4.7u 200V

C37_HB3
4.7u 200V

C38_HB3
4.7u 200V

PGND

R1_HB3
3R01

R2_HB3
10k

R3_HB3
3R01

R4_HB3
10k

+-200A HALL CURRENT SENSOR

C5_HB3
22u

C7_HB3
100n

R6_HB3
5E

DRV1_HB3

C8_HB3
220n

PHASE

IC1_HB3

VCC

R7_HB3
81E

7 VDD   HB 9

1 HI   HO 10

2 LI   HS 11

R9_HB3
51E

4 EN/NC   LO 6

DRV_EN

3 VSS   COM 5

place pulldown somewhere

UCC27714

C10_HB3
220p

C11_HB3
220p

Q3_HB3

Q4_HB3

S1_HB3

PHASE SCREW

4 IN+   VCC 1

GND 2

5 IN- VIOUT 3

R8_HB3
4k7

C9_HB3
100p

P_I

R10_HB3
3R01

R11_HB3
10k

R12_HB3
3R01

R13_HB3
10k

ACS773ECB-200B-PFF-T

PGND

PHASE

R14_HB3
68k

P_U

VIN

C6_HB3
560uf 200V

VIN

C12_HB3
560uf 200V

R15_HB3
1k5

Title	BESC DRIVE		
Size	Number		Revision
A4			INIT
Date:	3.11.2018	Sheet	of
File:	A:\Documents\..\besc drive sch.SchDoc	Drawn By:	

BESC IO / POWER MANAGEMENT

Title	BESC IO / POWER MANAGEMENT		
Size	Number		Revision
A4			INIT
Date:	3.11.2018	Sheet	of
File:	A:\Documents\..\besc io pm sch.SchDoc	Drawn By:	

Voltage Regulators

IC2 NCP1117ST50T3 — 12V → 5V, C13 10u, C14 10u

IC3 NCP1117ST33T3 — 5V → VCC, C15 10u, C16 10u

LED

VCC — R16 100E — D2 LED BLUE

PCB Temperature

VCC — RT1 10k NTC — PCBTEMP
C17 2.2u, R20 10k

P2 COMM

Pin	Signal
8	ADC15
7	ADC1 (MISO_ADC_EXT2)
6	TX (TX_SCL_MOSI)
5	RX (RX_SDA_NSS)
4	SCK (SCK_ADC_EXT)
3	
2	VCC
1	5V

P3 HALL/ENCODER

R17 2k2, R18 2k2, R19 2k2 (pull-ups to 5V)

Pin	Signal
1	HALLW
2	HALLV
3	HALLU
4	MOTORTEMPIN
5	5V
6	

R21 10k, C18 220n → VCC

P1 12V IN

Pin
1
2

12V

USB Micro J1

Pin	Signal
5	GND
4	ID
3	D+
2	D-
1	VBUS

USB_VBUS

TVS1 USBLC6-2P6
R22 22E → USB_P
R23 22E → USB_N

P4 SWD

Pin	Signal
1	VCC
2	SWSCK (SWCLK)
3	
4	SWDIO
5	NRST

P5 Header 3

RCSERVO — R24 2k2 — C19 100n
5V

Pin
1
2
3

100 mA max

Input Voltage Divider

VIN — R25 68k — INPUTVOLTAGE — R26 1k5

VIN S2 INPUT + SCREW
S3 INPUT - SCREW — PGND

NT1 Net tie — PGND

U1A

PHASE VOLTAGE SNESE
- U.VOLTAGE — 14 — PA0-WKUP(PA0)
- V.VOLTAGE — 15 — PA1
- W.VOLTAGE — 16 — PA2
- NTC.TEMP — 17 — PA3
- RX_SDA_NSS — 20 — PA4
- SCK_ADC_EXT — 21 — PA5
- MISO_ADC_EXT2 — 22 — PA6
- TX_SCL_MOSI — 23 — PA7

- PB0 — 26 — LED GREEN
- PB1 — 27 — LED RED
- PB2-BOOT1(PB2) — 28
- PB3(JTDO/TRACESWO) — 55
- PB4(NJTRST) — 56
- PB5 — 57 — ENGATE
- PB6 — 58 — ENGATE — R29 10k — RC SERVO INPUT — SERVO
- PB7 — 59 — FAULT

PWM HIGH SIDE
- U.H — 41 — PA8
- V.H — 42 — PA9
- W.H — 43 — PA10
- USB.DM — 44 — PA11
- USB.DP — 45 — PA12
- SWDIO — 46 — PA13(JTMS-SWDIO)
- SWCLK — 49 — PA14(JTCK-SWCLK)
- 50 — PA15(JTDI)

- PB8 — 61 — CAN_RX
- PB9 — 62 — CAN_TX
- PB10 — 29 — TX_SCL_MOSI
- PB11 — 30 — RX_SDA_NSS
- PB12 — 33
- PB13 — 34 — U.L
- PB14 — 35 — V.L — PWM LOW SIDE
- PB15 — 36 — W.L

PHASE CURRENT SENSE
- U.CURRENT — 8 — PC0
- V.CURRENT — 9 — PC1
- W.CURRENT — 10 — PC2
- ANIN — 11 — PC3

VIN SENSE
- TEMPMOTOR — 24 — PC4
- ADC_15 — 25 — PC5
- U.HALL — 37 — PC6
- V.HALL — 38 — PC7
- W.HALL — 39 — PC8
- 40 — PC9
- 51 — PC10
- 52 — PC11
- 53 — PC12
- 2 — PC13
- 3 — PC14-OSC32_IN(PC14)
- 4 — PC15-OSC32_OUT(PC15)

- PD2 — 54

- PH0-OSC_IN(PH0) — 5
- PH1-OSC_OUT(PH1) — 6

- BOOT0 — 60
- NRST — 7

- VCAP_1 — 31
- VCAP_2 — 47

STM32F405RGT7

Y1 XTAL — 1 — 2
C20 15p   C21 15p

VCC
R30 10k
NRST
C22 220n

C23 2.2u   C24 2.2u

R27 100E   R28 100E
LED GREEN   LED RED
D3   D4

U1B

- VBAT — 1
- VDD — 19
- VDD — 32
- VDD — 48
- VDD — 64
- VSS — 18
- VSS — 63
- VDDA — 13
- VSSA — 12

STM32F405RGT7

VCC
- C25 4.7u
- C39 100n
- C26 100n
- C27 100n
- C28 100n
- C29 10n
- C30 10n
- C3 10n
- C32 10n

VCC
- C33 1u
- C34 100n
- C35 10n
- C36 1n

Title	BESC MCU	
Size A4	Number	Revision INIT
Date:	3.11.2018	Sheet of
File:	A:\Documents\..\besc mcu sch.SchDoc	Drawn By:

IO & POWER MANAGEMENT
besc io pm sch.SchDoc

RX_SDA_NSS	
SCK_ADC_EXT	
TX_SCL_MOSI	
MISO_ADC_EXT2	
ADC15	
PCBTEMP	
HALLW	
HALLV	
HALLU	
MOTORTEMPIN	
RCSERVO	
USB_N	
USB_P	
SWDIO	
SWCLK	
NRST	
INPUTVOLTAGE	

MCU
besc mcu sch.SchDoc

RX_SDA_NSS		ENGATE	
SCK_ADC_EXT			
TX_SCL_MOSI			
MISO_ADC_EXT2			
ADC_15		U.H	
		V.H	
NTC.TEMP		W.H	
		U.L	
W.HALL		V.L	
V.HALL		W.L	
U.HALL			
		U.VOLTAGE	
TEMPMOTOR		V.VOLTAGE	
		W.VOLTAGE	
SERVO			
		U.CURRENT	
USB.DM		V.CURRENT	
USB.DP		W.CURRENT	
SWDIO			
SWCLK		FAULT	
NRST			
ANIN			

CAN_RX
CAN_TX

Repeat(HB,1,3)
besc drive sch.SchDoc

DRV_EN	
Repeat(PWM_HIGH)	
Repeat(PWM_LOW)	
Repeat(P_U)	
Repeat(P_I)	

PWM_HIGH1
PWM_HIGH2
PWM_HIGH3
PWM_LOW1
PWM_LOW2
PWM_LOW3

PWM_HIGH[1..3]
PWM_LOW[1..3]

PWM_HIGH
PWM_LOW

P_U[1..3]
P_I[1..3]

P_U
P_I

P_U1
P_U2
P_U3

P_I1
P_I2
P_I3

nFAULT

R31
10k

VCC

TODO: PROTECTION CIRCUIT

CAN_TX
CAN_RX

Title				
Size	Number			Revision
A4				
Date:	3.11.2018		Sheet	of
File:	A:\Documents\ev\BESC\besc sch.SchDoc		Drawn By:	

Bill of Materials

Bill of Materials For Project [besc proj.PrjPcb] (No PCB Document Selected)

Source Data From: **besc proj.PrjPcb**
Project: **besc proj.PrjPcb**
Variant: **None**

Creation Date: 3.11.2018   14:45:40
Print Date: 43407   43407,61512

Footprint	Comment	LibRef	Designator	Description	Quantity
CAP 2220/5650 3.3MM	4.7u 200V	cap	C1_HB1, C1_HB2, C1_HB3, C2_HB1, C2_HB2, C2_HB3, C3_HB1, C3_HB2, C3_HB3, C4_HB1, C4_HB2, C4_HB3, C37_HB1, C37_HB2, C37_HB3, C38_HB1, C38_HB2, C38_HB3	Capacitor	18
0805	22u	cap	C5_HB1, C5_HB2, C5_HB3	Capacitor	3
ELKO_18x40_90deg	560uf 200V	Cap Pol1	C6_HB1, C6_HB2, C6_HB3, C12_HB1, C12_HB2, C12_HB3	Polarized Capacitor (Radial)	6
0603	100n	cap	C7_HB1, C7_HB2, C7_HB3, C19, C26, C27, C28, C34, C39	Capacitor	9
0603	220n	cap	C8_HB1, C8_HB2, C8_HB3, C18, C22	Capacitor	5
0603	100p	cap	C9_HB1, C9_HB2, C9_HB3	Capacitor	3
0402	220p	cap	C10_HB1, C10_HB2, C10_HB3	Capacitor	3
0603	220p	cap	C11_HB1, C11_HB2, C11_HB3	Capacitor	3
0805	10u	Cap	C13, C14, C15, C16	Capacitor	4
0603	2.2u	Cap	C17, C23, C24	Capacitor	3
0603	15p	cap	C20, C21	Capacitor	2
0603	4.7u	cap	C25	Capacitor	1
0603	10n	cap	C29, C30, C31, C32, C35	Capacitor	5
0603	1u	cap	C33	Capacitor	1
0603	1n	cap	C36	Capacitor	1
DO-214AC	6A	Diode 1N4148	D1_HB1, D1_HB2, D1_HB3	High Conductance Fast Diode	3
0805-diode	LED BLUE	LED0	D2	Typical INFRARED GaAs LED	1
0805-diode	LED GREEN	LED0	D3	Typical INFRARED GaAs LED	1
0805-diode	LED RED	LED0	D4	Typical INFRARED GaAs LED	1
SOIC14_M	UCC27714	UCC27714	DRV1_HB1, DRV1_HB2, DRV1_HB3		3
ACS758	ACS773ECB-200B-PFF-T	ACS758	IC1_HB1, IC1_HB2, IC1_HB3		3
SOT223_M	NCP1117ST50T3	VOLTREG_LD1117S33	IC2		1
SOT223_M	NCP1117ST33T3	VOLTREG_LD1117S33	IC3		1
MOLEX - 47346-0001 - MICRO USB TYPE B, RECEPTACLE, BOTTOM	USB Micro	USB Mini AB	J1	SOCKET, USB MINI-AB THRU HOLE	1
NETTIE12mil	Net tie	Net tie	NT1		1
JST SM02B-PASS-TB	12V IN	Header 2	P1	JST SM02B-PASS-TB	1
JST SM08B-PASS-TB	COMM	Header 8	P2	JST SM08B-PASS-TB	1
JST SM06B-PASS-TB	HALL/ENCODER	Header 6	P3	JST SM06B-PASS-TB	1
Header 1x5 male	SWD	Header 5	P4	Header, 5-Pin	1
JST SM03B-PASS-TB	Header 3	Header 3	P5	Header, 3-Pin	1
Dpak-7	IPB044N15N5	NMOS-2	Q1_HB1, Q1_HB2, Q1_HB3, Q2_HB1, Q2_HB2, Q2_HB3, Q3_HB1, Q3_HB2, Q3_HB3, Q4_HB1, Q4_HB2, Q4_HB3	N-Channel Power MOSFET	12
0603	3R01	Res2	R1_HB1, R1_HB2, R1_HB3, R3_HB1, R3_HB2, R3_HB3, R10_HB1, R10_HB2, R10_HB3, R12_HB1, R12_HB2, R12_HB3	Resistor	12
0603	10k	Res2	R2_HB1, R2_HB2, R2_HB3, R4_HB1, R4_HB2, R4_HB3, R11_HB1, R11_HB2, R11_HB3, R13_HB1, R13_HB2, R13_HB3, R20, R21, R29, R30, R31	Resistor	17
1210	2.2E	Res2	R5_HB1, R5_HB2, R5_HB3	Resistor	3
0603	5E	Res2	R6_HB1, R6_HB2, R6_HB3	Resistor	3
0603	51E	Res2	R7_HB1, R7_HB2, R7_HB3	Resistor	3
0603	4k7	Res2	R8_HB1, R8_HB2, R8_HB3	Resistor	3
0402	51E	Res2	R9_HB1, R9_HB2, R9_HB3	Resistor	3
0603	68k	Res2	R14_HB1, R14_HB2, R14_HB3, R25	Resistor	4
0603	1k5	Res2	R15_HB1, R15_HB2, R15_HB3, R26	Resistor	4
0603	100E	Res2	R16, R27, R28	Resistor	3
0603	2k2	Res2	R17, R18, R19, R24	Resistor	4
0603	22E	Res2	R22, R23	Resistor	2
0603	10k NTC	Res Thermal	RT1	Thermistor	1
WP-SHFU-M6	PHASE SCREW	En_pin	S1_HB1, S1_HB2, S1_HB3	7461098	3
WP-SHFU-M6	INPUT + SCREW	En_pin	S2	7461098	1
WP-SHFU-M6	INPUT - SCREW	En_pin	S3	7461098	1
SOT23127P600-8N	USBLC6-2P6	USBLC6-2P6	TVS1		1
STM-LQFP64_N	STM32F405RGT7	STM32F405RGT7	U1	ARM Cortex-M4 32-bit MCU+FPU, 210 DMIPS, 1024 kB Flash, 192 kB Internal RAM, 51 I/Os, 64-pin LQFP, -40 to 105 degC, Tray	1
XTAL 5 x 3.2 mm	XTAL	XTAL	Y1	Crystal Oscillator	1
					170

Approved	Notes