Sheet: Power

File: TNC3_Power.sch

Sheet: Audio

File: TNC3_Audio.sch

Sheet: Bluetooth

File: TNC3_Bluetooth.sch

W4 BOOT

W5 LSCO

W6 SW_POWER

W7 USB_D+

W8 USB_D-

W9 SDA

W10 SCL

W32 VDDA

W33 GND

ST/Link SWD connector. This is implemented as through-hole pads for pogo pins on the PCB.

P2 CONN_01X06

RN1 R_Pack04

U1 STM32L433CCUx

PH3/BOOT0

VBAT

PH0/RCC_OSC_IN

PH1/RCC_OSC_OUT

PB0/ADC1_IN15

PB1/COMP1_INM/ADC1_IN16

PB2/COMP1_INP

PB3/COMP2_INM/SYS_JTDO-TRACESWO

PB4/COMP2_INP/SYS_NJTRST

PB5

PB6/COMP2_INP

PB7/COMP2_INM/PVD_IN

PB8

PB9

PB10

PB11

PB12

PB13

PB14

PB15

NRST

PC13/RTC_OUT/RTC_TAMP1/RTC_TS/SYS_WKUP2

PC14/RCC_OSC32_IN

PC15/RCC_OSC32_OUT

OPAMP1_VINP/COMP1_INM/ADC1_IN5/RTC_TAMP2/SYS_WKUP1/PA0

ADC1_IN6/COMP1_INP/OPAMP1_VINM/PA1

LSCO/SYS_WKUP4/ADC1_IN7/COMP2_INM/PA2

ADC1_IN8/COMP2_INP/OPAMP1_VOUT/PA3

COMP1_INM/COMP2_INM/ADC1_IN9/DAC1_OUT1/PA4

COMP1_INM/COMP2_INM/ACD1_IN10/DAC1_OUT2/PA5

ADC1_IN11/PA6

ADC1_IN12/PA7

PA8

PA9

USB_CRS_SYNC/PA10

USB_DM/PA11

USB_DP/PA12

SYS_JTMS-SWDIO/PA13

SYS_JTCK-SWCLK/PA14

SYS_JTDI/PA15

VDDUSB VDD VDD VDDA

VSS VSS VSS VSS VSSA

SW1 SW_PUSH

SW2 SW_PUSH

SW3 SW_PUSH

Y1 Crystal

The LED_BT test point can also be used for MCO (master clock output) from the MCU in diagnostic mode to verify the accuracy of the various MCU clocks.

This forms a voltage divider with the pull-down resistor on PH0. The purpose of this is to bring the voltage at PH0 within the required range to ensure USB connection and disconnection events are detected. This merits discussion because when the USB cable is disconnected, there is still residual voltage on the +5V line because of the pull-up resistor on D+ leaking through the TVS diodes (U7), which no longer have a +5V bias. With the 30K resistor (partially chosen because one already exists on the BOM), we ensure the voltage is below the threshold for logical 0 when the pulldown resistor is enabled and the USB cable is disconnected. (All digital logic is analog!)

The EEPROM is used to store the system settings since the MCU has only a single bank of flash memory.

A slower I2C interface is fine since it is read and written rarely, and only during initial boot or when updatging the TNC configuration.

U2 M24C32-FMC6TG

SMLP34RGB2W3 D1C

SMLP34RGB2W3 D1B

SMLP34RGB2W3 D1A

RGB LED control. Red it used as a TX indicator. Green is used to show DCD status. And Blue is used for I/O status (Bluetooth and/or USB connection).

Note that the LEDs are connected to GPIO pins on the MCU that can do PWM to provide fading, dimming and other effects. The timer required to do this consumes a little power, so there are power and programming complexity trade-off required for this.

BM78 BT/BLE Module
STM32L433CCU6
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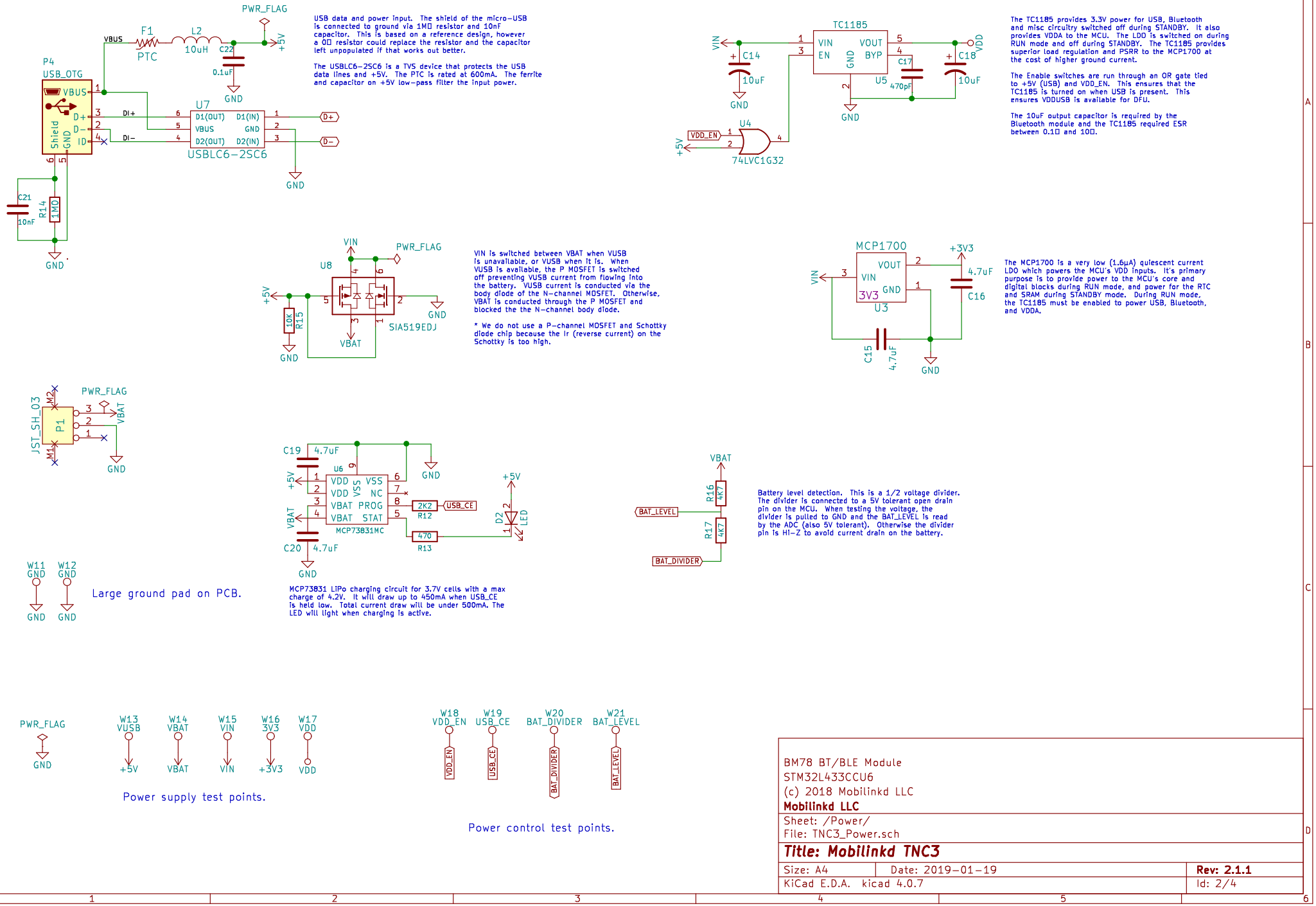
Size: A4	Date: 2019-01-19	**Rev: 2.1.1**
KiCad E.D.A. kicad 4.0.7		Id: 1/4


USB data and power input. The shield of the micro-USB is connected to ground via 1MΩ resistor and 10nF capacitor. This is based on a reference design, however a 0Ω resistor could replace the resistor and the capacitor left unpopulated if that works out better.
The USBLC6-2SC6 is a TVS device that protects the USB data lines and +5V. The PTC is rated at 600mA. The ferrite and capacitor on +5V low-pass filter the input power.
P4
USB_OTG
VBUS
D+
D-
ID
Shield
GND
F1
PTC
L2
10uH
C22
0.1uF
PWR_FLAG
+5V
GND
U7
USBLC6-2SC6
D1(OUT)
D1(IN)
VBUS
GND
D2(OUT)
D2(IN)
C21
10nF
R14
1MΩ
The TC1185 provides 3.3V power for USB, Bluetooth and misc circuitry switched off during STANDBY. It also provides VDDA to the MCU. The LDO is switched on during RUN mode and off during STANDBY. The TC1185 provides superior load regulation and PSRR to the MCP1700 at the cost of higher ground current.
The Enable switches are run through an OR gate tied to +5V (USB) and VDD_EN. This ensures that the TC1185 is turned on when USB is present. This ensures VDDUSB is available for DFU.
The 10uF output capacitor is required by the Bluetooth module and the TC1185 required ESR between 0.1Ω and 10Ω.
TC1185
VIN
VOUT
EN
GND
BYP
C14
10uF
C17
470pF
C18
10uF
VDD
U5
U4
74LVC1G32
VDD_EN
VIN is switched between VBAT when VUSB is unavailable, or VUSB when it is. When VUSB is available, the P MOSFET is switched off preventing VUSB current from flowing into the battery. VUSB current is conducted via the body diode of the N-channel MOSFET. Otherwise, VBAT is conducted through the P MOSFET and blocked the the N-channel body diode.
* We do not use a P-channel MOSFET and Schottky diode chip because the Ir (reverse current) on the Schottky is too high.
U8
SIA519EDJ
R15
10K
VBAT
The MCP1700 is a very low (1.6μA) quiescent current LDO which powers the MCU's VDD inputs. It's primary purpose is to provide power to the MCU's core and digital blocks during RUN mode, and power for the RTC and SRAM during STANDBY mode. During RUN mode, the TC1185 must be enabled to power USB, Bluetooth, and VDDA.
MCP1700
+3V3
3V3
U3
C16
4.7uF
C15
4.7uF
JST_SH_03
P1
M1
M2
VBAT
C19
4.7uF
C20
4.7uF
U6
MCP73831MC
VDD
VSS
NC
VBAT
PROG
STAT
2K2
R12
USB_CE
470
R13
D2
LED
Battery level detection. This is a 1/2 voltage divider. The divider is connected to a 5V tolerant open drain pin on the MCU. When testing the voltage, the divider is pulled to GND and the BAT_LEVEL is read by the ADC (also 5V tolerant). Otherwise the divider pin is HI-Z to avoid current drain on the battery.
R16
4K7
R17
4K7
BAT_LEVEL
BAT_DIVIDER
W11
W12
GND
Large ground pad on PCB.
MCP73831 LiPo charging circuit for 3.7V cells with a max charge of 4.2V. It will draw up to 450mA when USB_CE is held low. Total current draw will be under 500mA. The LED will light when charging is active.
PWR_FLAG
W13
VUSB
W14
VBAT
W15
VIN
W16
3V3
W17
VDD
Power supply test points.
W18
VDD_EN
W19
USB_CE
W20
BAT_DIVIDER
W21
BAT_LEVEL
Power control test points.
BM78 BT/BLE Module
STM32L433CCU6
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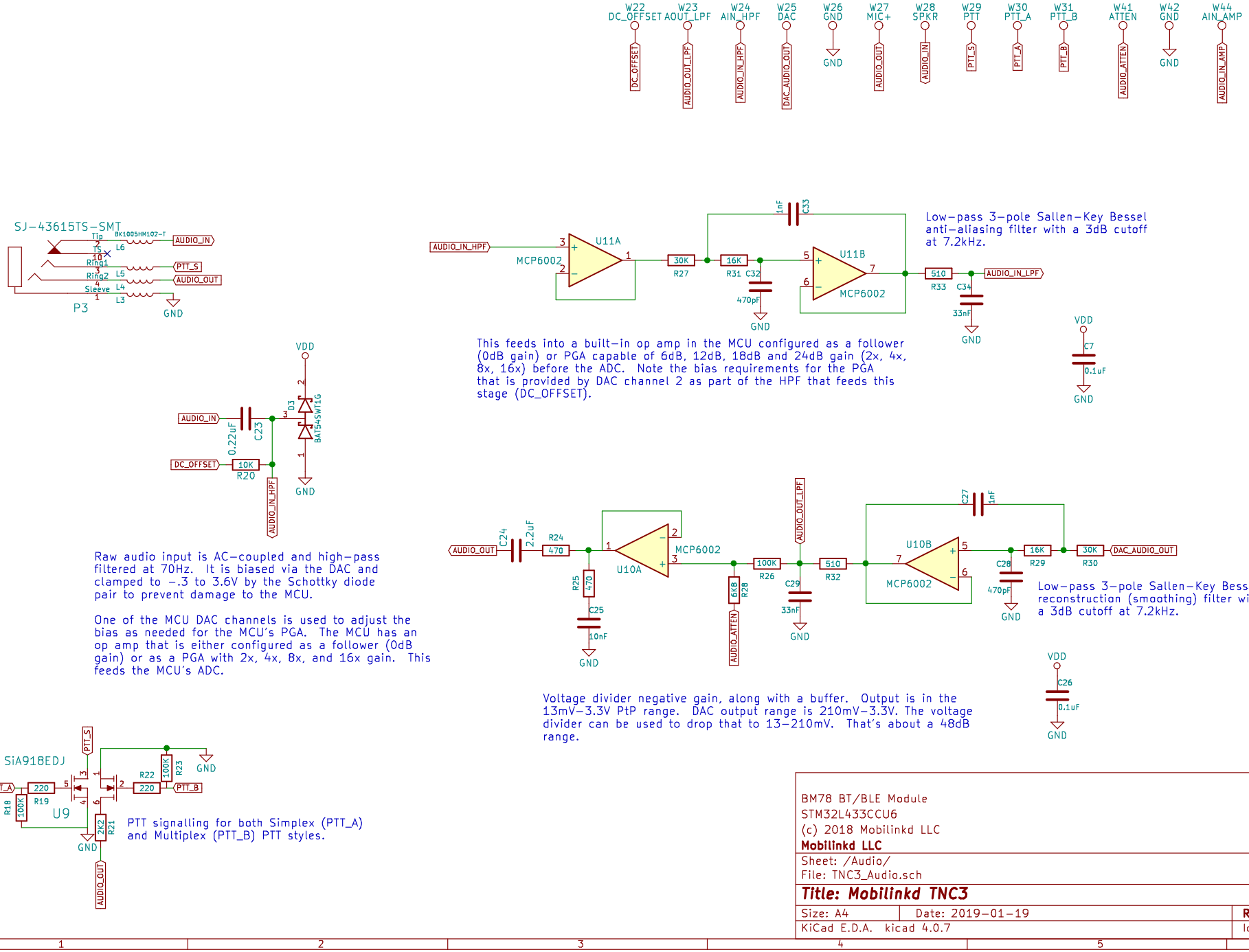
Id: 2/4



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The BM78 is a dual-mode, Bluetooth & BLE module that is certified in most regions of the developed world. The module used on the TNC3 is not re-programmable. It does have an EEPROM for configuration of the Bluetooth and BLE services. It provides transparent data service.

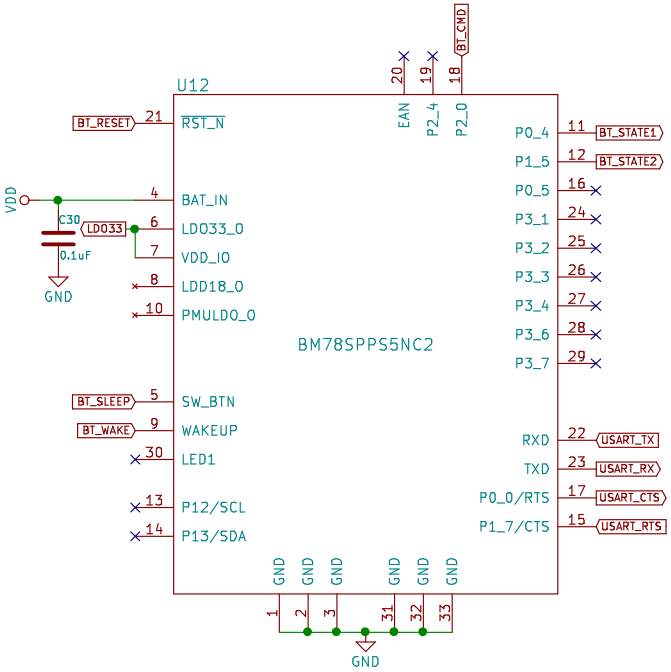
The BM78 can essentially be powered on by brining BT_SLEEP (SW_BTN) high, and powered off by bringing BT_SLEEP low. This is used when a USB connectionis established. Otherwise, the TNC powers down the entire VDD domain when the TNC is turned off (STOP2).

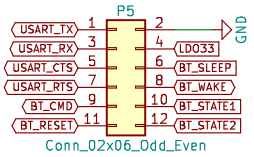
BT_WAKE can be used to wake up the device from deep sleep (for discovery, for example). However, this is currently not used.

The two STATE indicators are used to determine connection state and whether the TNC is discoverable. BT_STATE2 is the more important of the two as it goes low when a connection is established.

The BM78 operates in two modes: EEPROM Programming and Transparent Data Service. EEPROM Progamming is done once during the initial boot sequence (and after a "full system reset") by pulling BT_CMD low and powering on the device (via BT_SLEEP). The full EEPROM is written using the UART (115200, 8N1, no flow control). This sets the name, TX power, service and GATT UUIDs, enables UART flow control in TDS mode, etc.

In transparent data service (TDS) mode, the TNC requires that the device be paired before a connection is established. The module will accept either Bluetooth or BLE connections.





BM78 BT/BLE Module
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Sheet: /Bluetooth/
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Size: A4	Date: 2019-01-19	**Rev: 2.1.1**
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