# USB PD Demo Board User Guide

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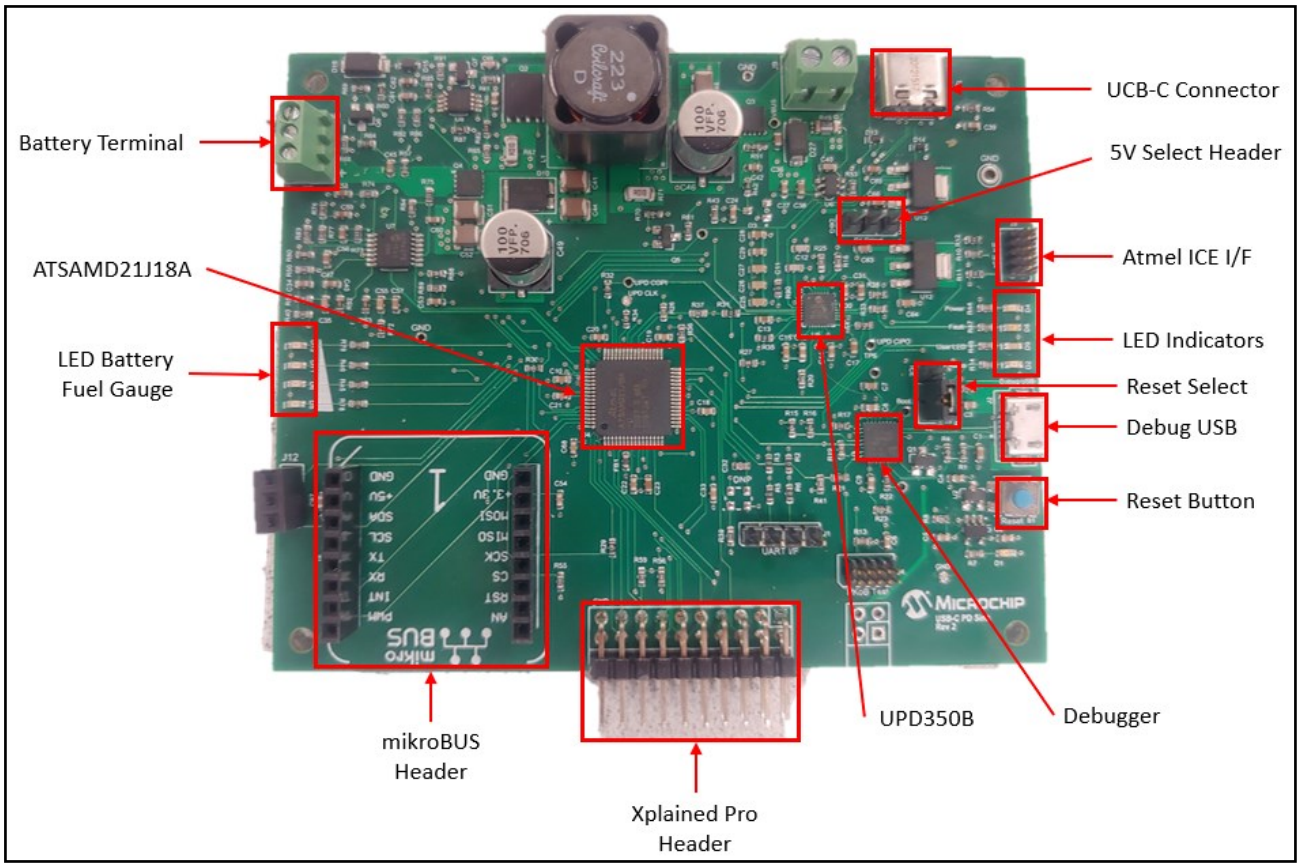



Figure 1, PD Demo Board

# Board Overview

The USB PD Demo Board is a USB power delivery battery charger demo board featuring the ATSAMD21J18A microcontroller. The board includes a PKoB for USB programming/debugging, along with an Atmel ICE interface.

Two types of expansion headers are supported by the board. There is one Xplained Pro I/O header with a 4-pin Xplained Pro power header, and a mikro-BUS click board connector.

The battery charger's SEPIC power supply can support the full 20V/5A 100W USB PD specification.

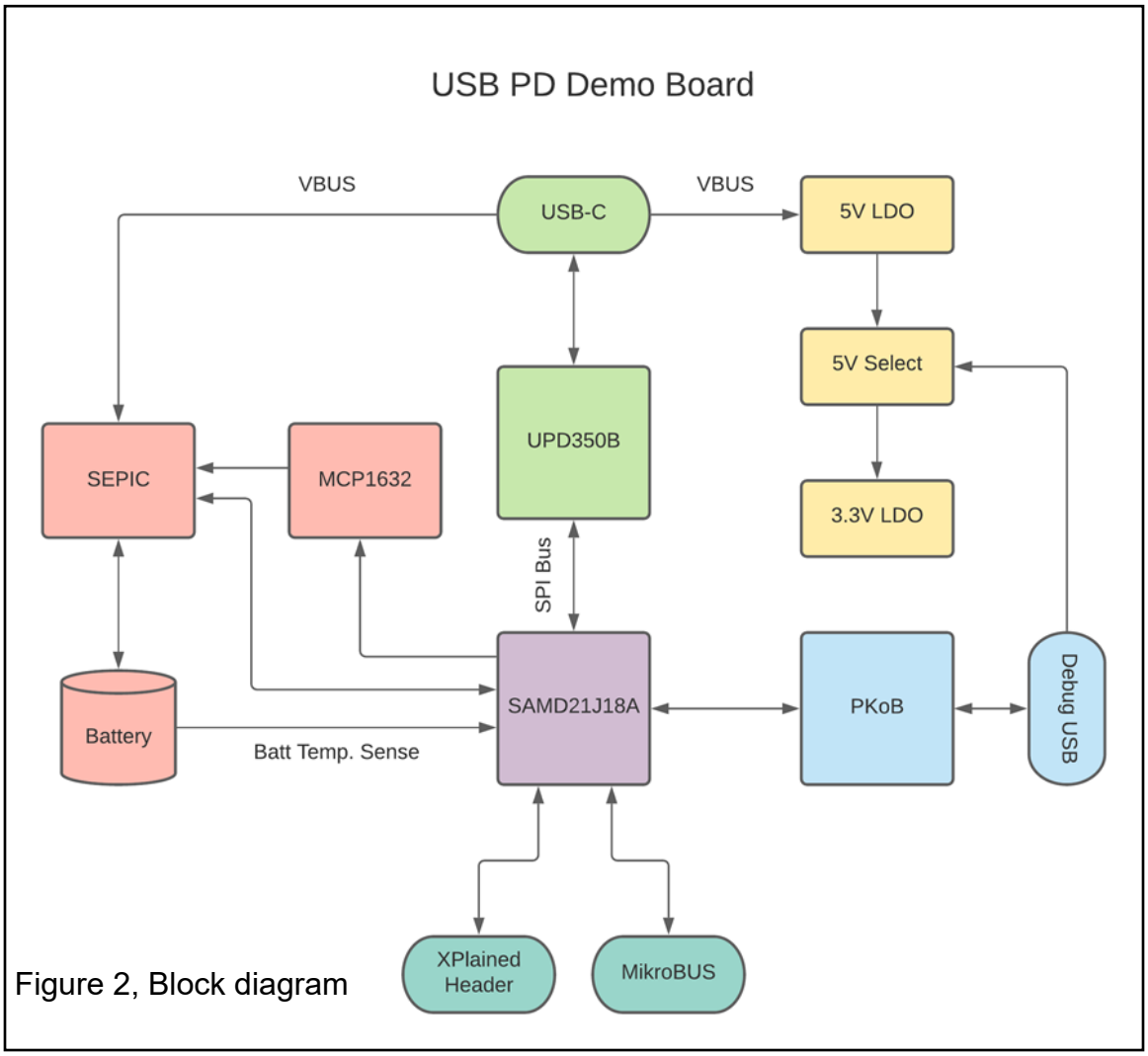
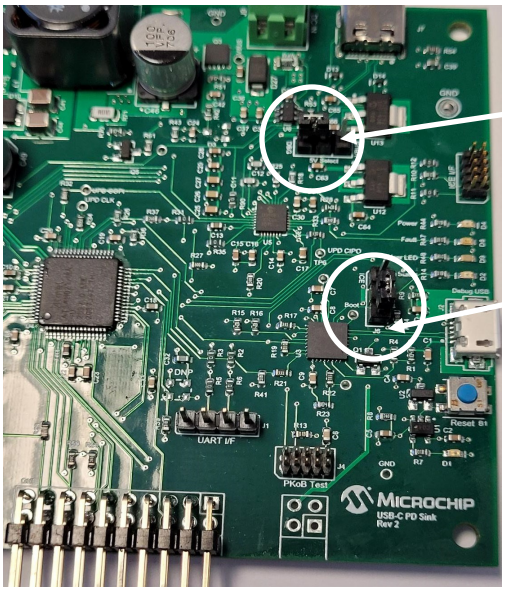



Figure 2, Block diagram

# Getting Started

1. Verify the A) 5V Select Header has a jumper on the DBG side and the B) Reset Select has a jumper on the Boot side as shown below.



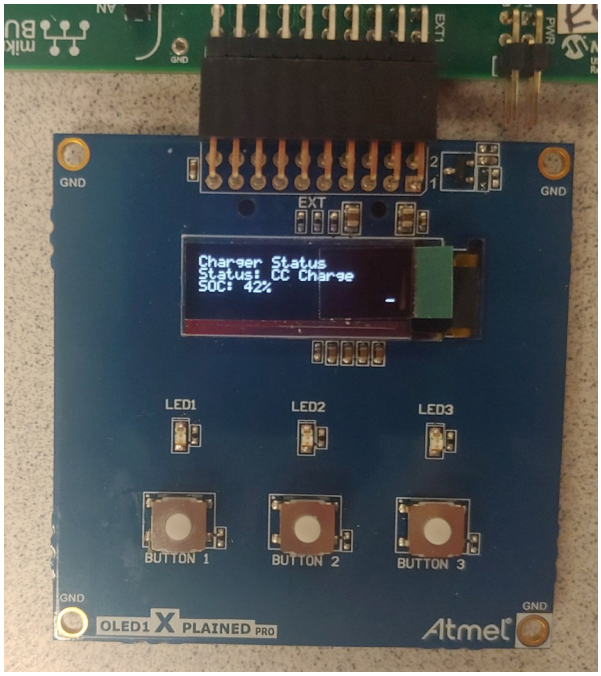

2. Download and launch MPLAB X IDE.
3. Plug the debug USB into your computer and check that MPLAB X recognizes that the kit is connected.
4. If the “Power” LED does not light up, check that the 5V select header is set to the correct source.
5. Download the PSF folder from the GitHub site ( https://github.com/MicrochipTech/PD_Sink_Battery_Charger_Demo ) and unzip the folder.
6. Open MPLAB X and click File > Open Project, then navigate to where you downloaded the file and go to the folder PSF_EVB_Sink> PSF > Demo > PSF_EVB_Sink > firmware and select the project file; PSF_EVB_Sink.x
7. Select the programming tool: USB Type-C Demo Board-SN: XXX
8. Build and program the demo code by pressing the  button located on the toolbar.
9. Connect the positive side of a 12V battery to the battery terminal marked “+” and the negative side of the battery to the terminal marked “-”.
10. Connect any USB PD capable charger to the USB-C connector to begin charging.

# Getting Started

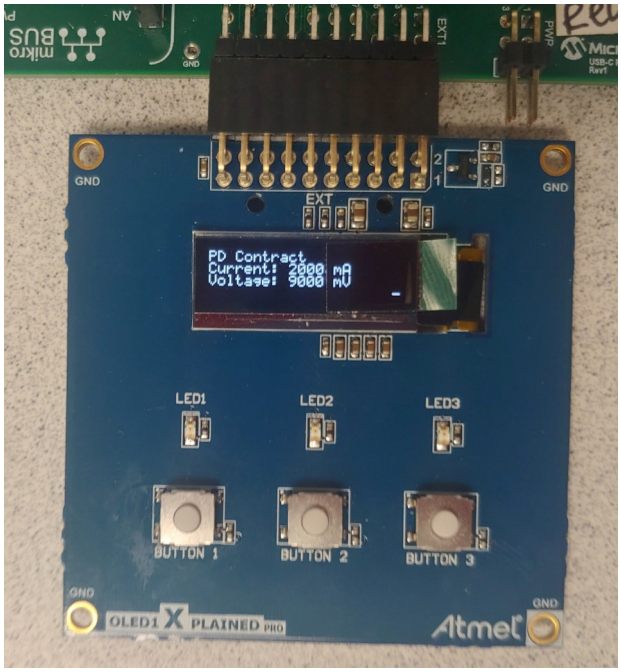
The demo code supports the OLED1 Xplained Pro add-on board on extension header 1. This add-on board is optional but is a useful tool for debugging and charger status monitoring.  The OLED1 Xplained Pro board can be purchased here:  OLED1 Xplained Pro Board.

Button 3 on the OLED1 board is used to switch between two display pages. On the first page, the battery charger status is shown (either Fault, Pre-condition, CC Mode, CV Mode, or Fully Charged). If a fault has occurred, it will display what type of fault it is. If there is no fault, it will display the battery SOC as a percentage. On page 2, the negotiated PD contract is displayed in terms of negotiated voltage and current.

Note: You may have to press the board reset button after plugging in the OLED1 board if the display does not work initially.




OLED1 Add-on Page 1




OLED1 Add-on Page 2

Figure 4, Different pages of OLED1 display board

# Getting Started

Figures 5 and 6 detail the different state and fault codes that are recognized by the charger state machine and will be displayed on the OLED1 board. A brief description of what each code means is given.

| Status Type | Integer Code | Description |
|---|---|---|
| FAULT | 0 | A fault has been detected |
| PRECONDITIONING | 1 | Battery voltage is too low for full current charging |
| CCMODE | 2 | Constant current charge mode |
| CVMODE | 3 | Constant voltage charge mode |
| CHARGED | 4 | Battery is fully charged |
| RECHARGE | 5 | Battery voltage has fallen since being charged |

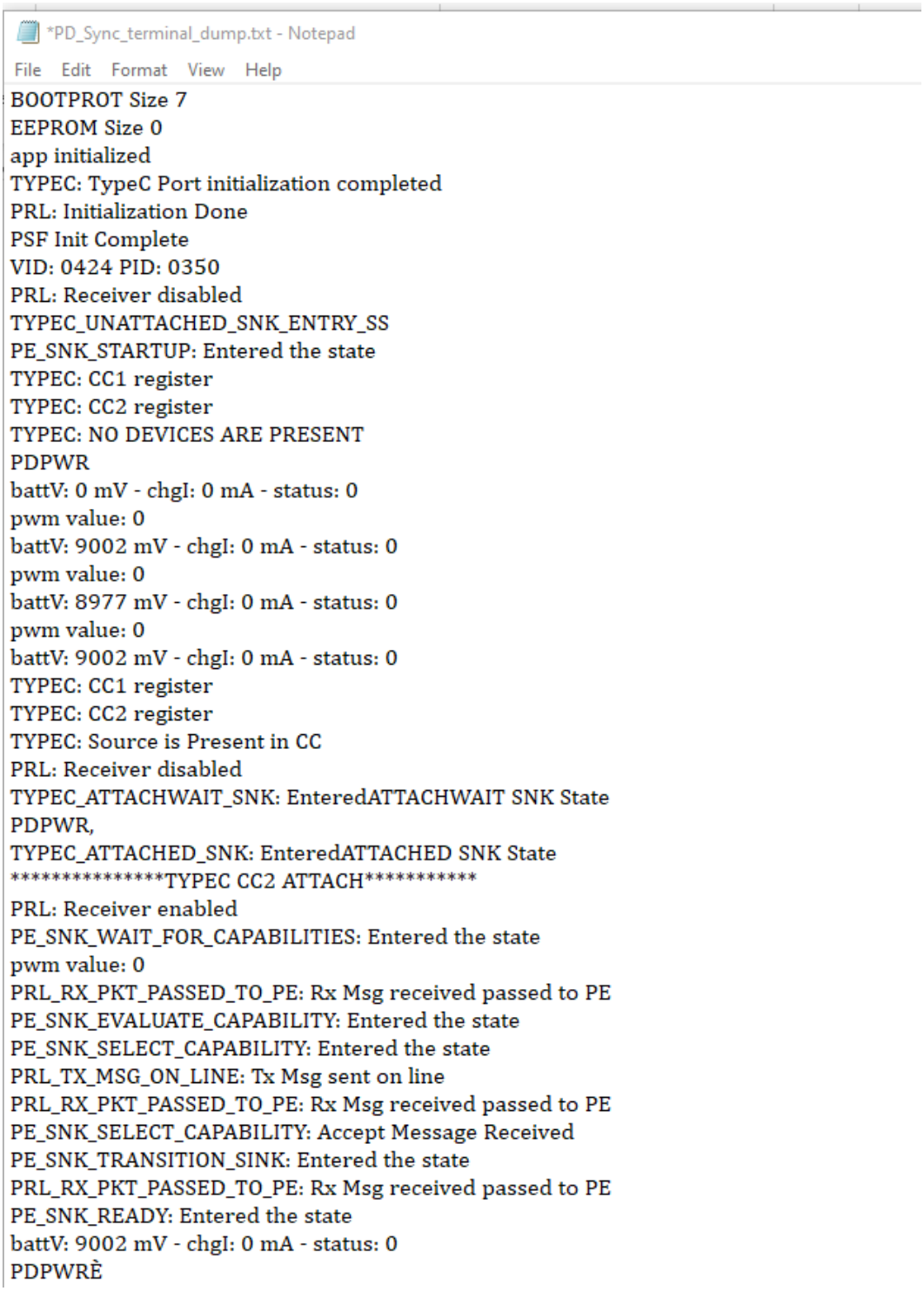
Figure 5, Charger state machine status codes

| Fault Type | Integer Code | Description |
|---|---|---|
| GENERIC | 0 | Unknown fault |
| NOSOURCE | 1 | No PD source is attached |
| UVLO | 2 | Battery terminal voltage is too low |
| OVLO | 3 | Battery terminal voltage is too high |
| OVERTEMP | 4 | Battery temperature is too high |
| UNDERTEMP | 5 | Battery temperature is too low |

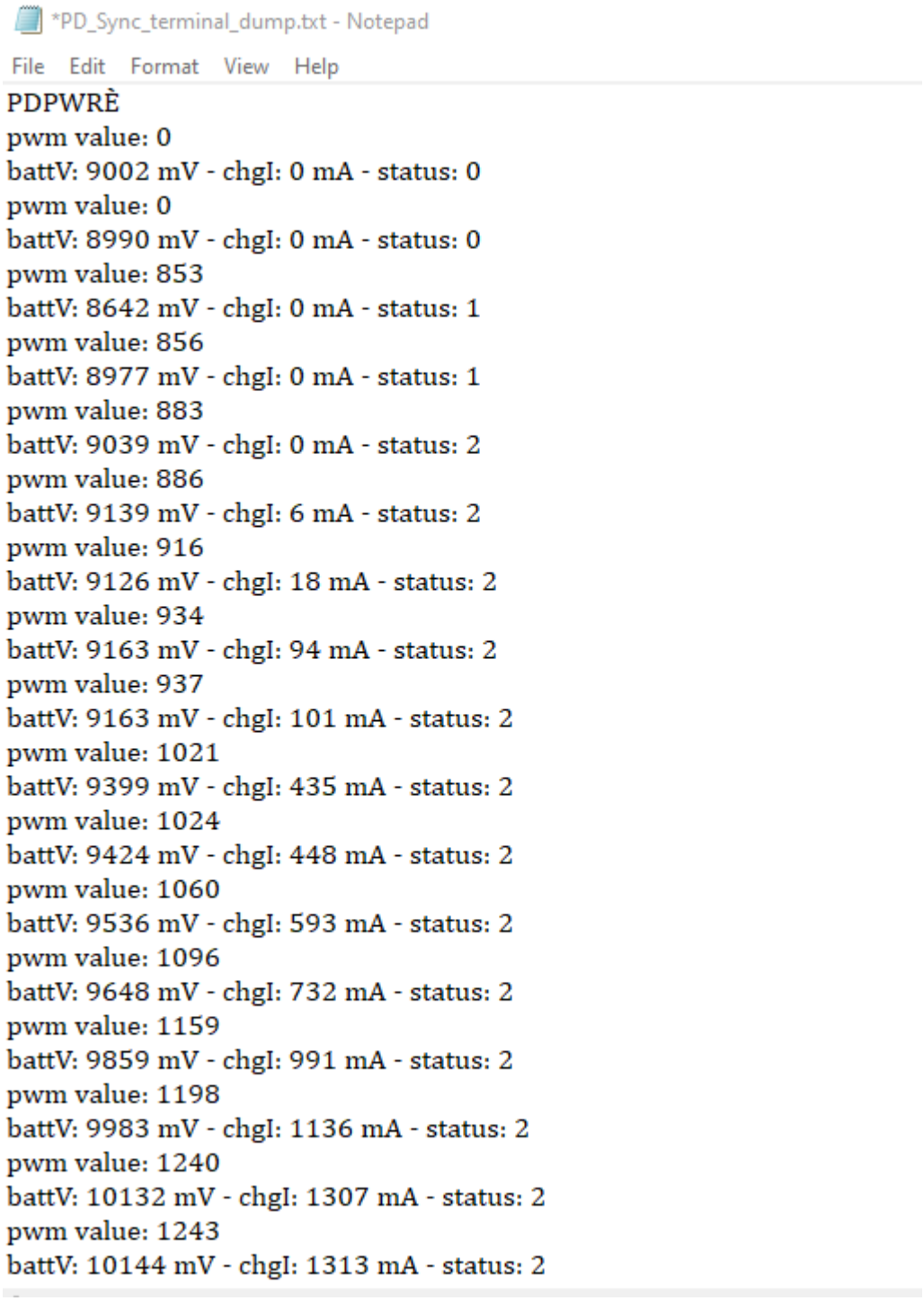
Figure 6, Charger state machine fault codes

# Getting Started—Debug information

Debug information is output to debug com port for the board.  Using a terminal program, Tera Term, set to the correct COM port for the PD EVAL board and 115.2 KBaud, debug information will be printed to the terminal window as shown below.



Debug information shown below of the charging of the battery.



# Calibration Procedure

An optional calibration procedure can be done to improve the accuracy of the charger current sense readings. A multimeter will be required for this process.

Steps to calibrate current readings:

1. Construct the circuit shown in the diagram below.
2. In the code file “SEPIC_CTRL.c” change the CALEN variable to 1 and reprogram the board to enable the calibration.

```
#define CALEN 1    //calibration mode enable, 0 = off, 1 = on
```

3. Plug a PD power source in to the USB-C connector (not depicted below).
4. Using the data visualizer in MPLAB X, enter the current (in mA) displayed on the multimeter. Doing this for two different values will enable us to calculate the necessary calibration parameters.
5. These values are stored in EEPROM and the calibration only needs to be done once. You will have to repeat the calibration if you reprogram the board.

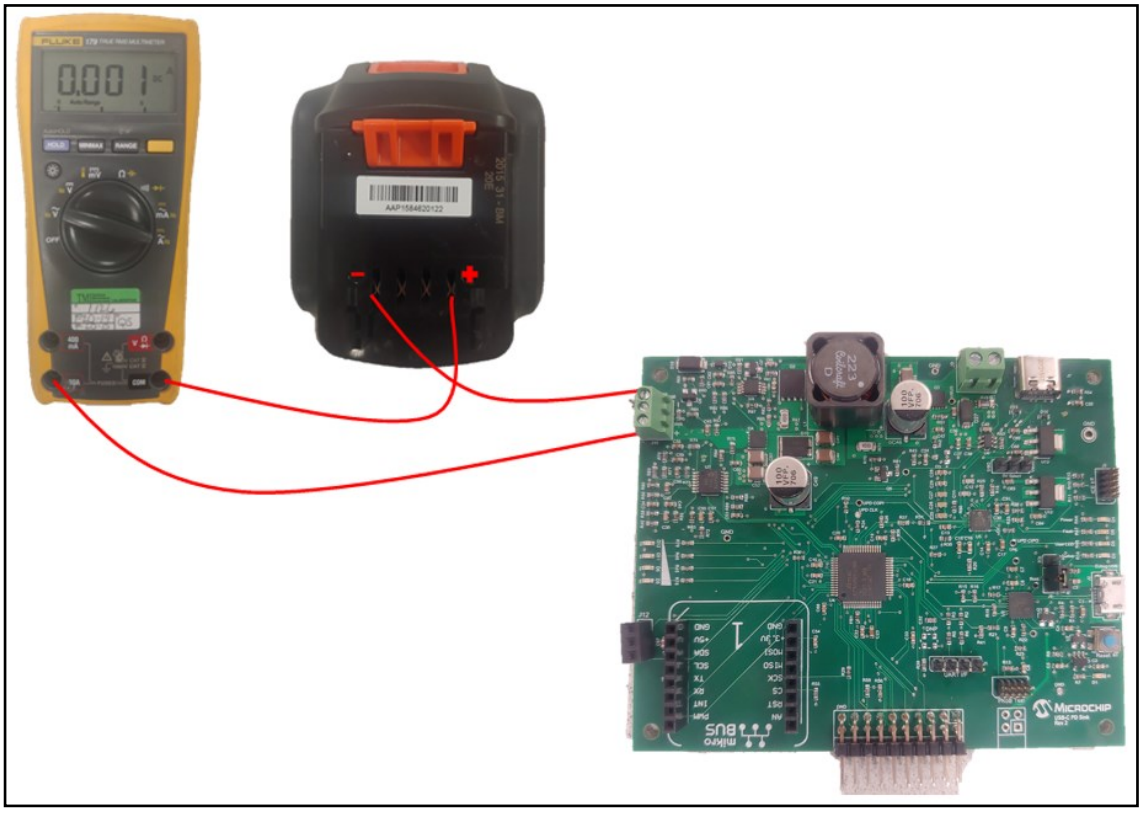


Figure 5, Calibration procedure diagram

# Charger Characteristics

The charger uses a constant current/constant voltage charge algorithm. There are three main states that the charger operates in, pre-condition, constant current charge, and constant voltage charge. The charger will enter pre-condition mode if it detects the battery voltage is too low to safely charge at full current. In this mode, charge current is limited to a few hundred milliamps. Once the charger detects the battery voltage is above the pre-charge cutoff threshold, it will ramp up current to the maximum allowed charge current. This value can be hard-coded by the user or can be set to automatically calculate based on the negotiated PD contract.

The charger will continue to charge at constant current until the battery voltage nears its maximum voltage at which point it will enter constant voltage mode. In this mode, the charger checks the battery voltage every 500ms. If the voltage is above the maximum battery voltage, it will decrement current until it is at or slightly below that voltage threshold. This will maintain the battery voltage at a constant level. This process will continue until the charge current is below a specified cutoff current. At this point the charger will shutoff but will continue monitoring the battery and topping off the charge as needed.

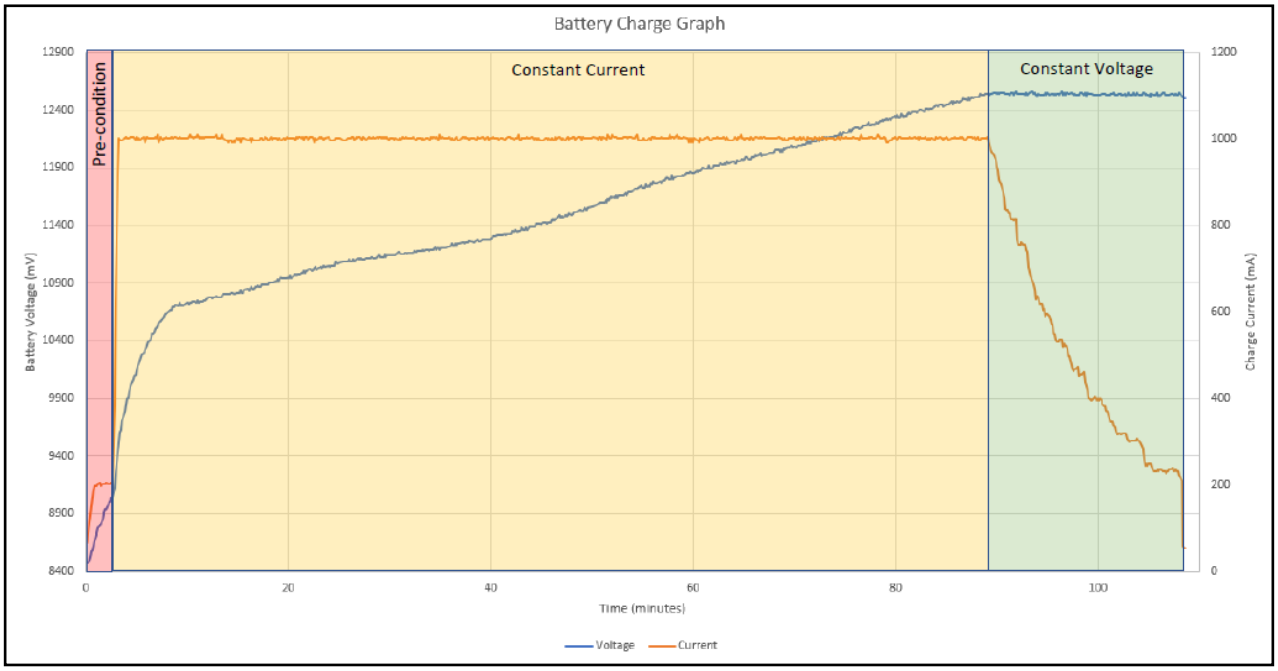



Figure 6, Charger characteristics graph

# Charger Characteristics

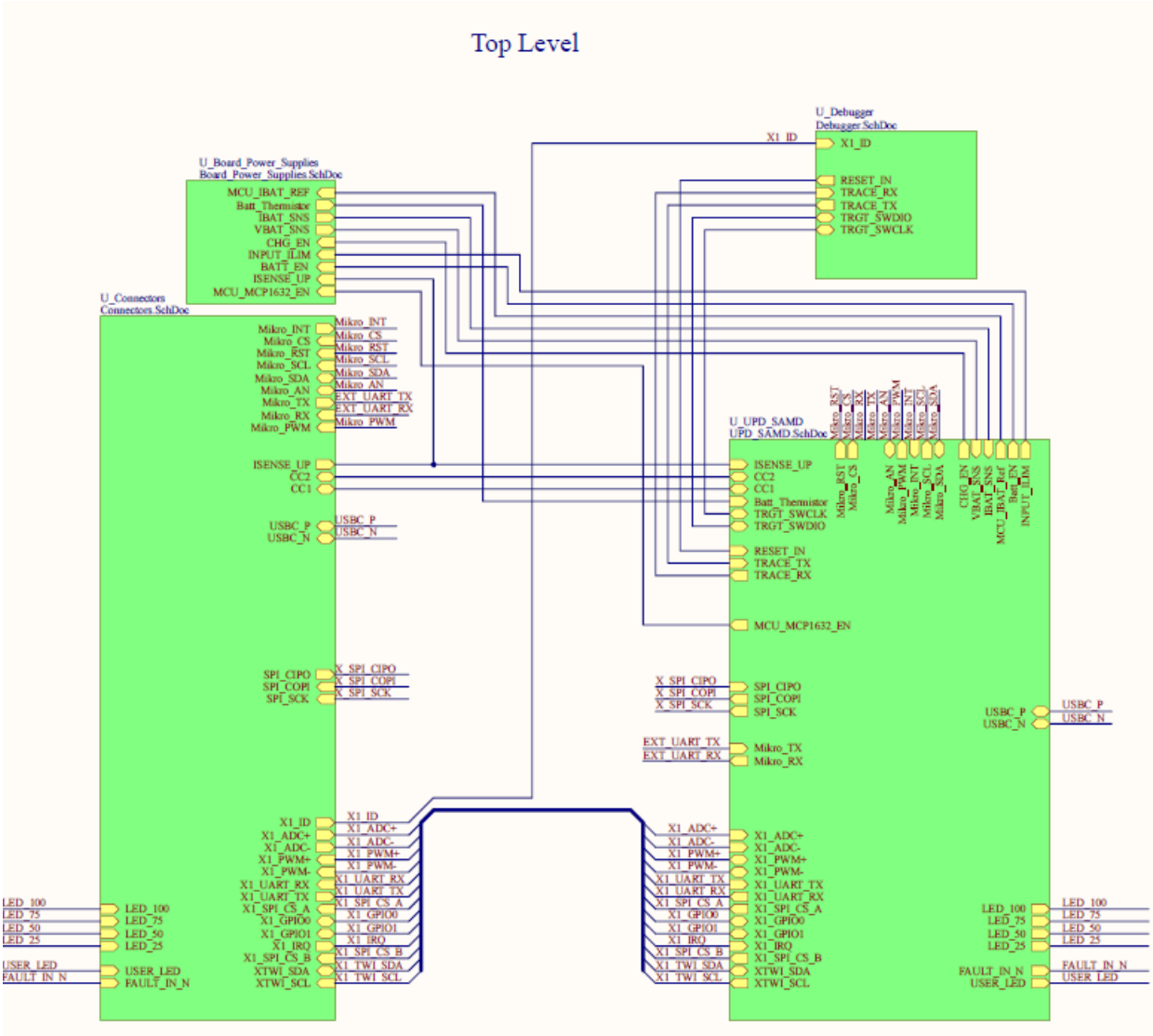
The parameters for charger state thresholds can be tuned in the “SEPIC_CTRL.c” file. Several defines are used to establish battery parameters and desired thresholds/cutoffs.

```
//set battery parameters
#define CELLVMIN 2700 //inidivual cell min voltage in mV
#define CELLVMAX 4200 //inidivual cell max voltage in mV
#define BATTIMAX 3000 //max charge current in mA
#define NUMCELLS 3 //number of series cells
#define UCLO 150 //charge cutoff current in mA
#define BATTVMAX (NUMCELLS * CELLVMAX) //total battery maximum voltage
#define BATTVMIN (NUMCELLS * CELLVMIN) //total battery minimum voltage (UVLO value)
#define RECHARGETHRESH 4100*NUMCELLS //threshold for trickle charge engage
#define MINCCCHARGETHRESH 3000*NUMCELLS //threshold for full speed cc charging
#define CVTHRESH 4180*NUMCELLS //threshold to swtich from CC to CV charge
```

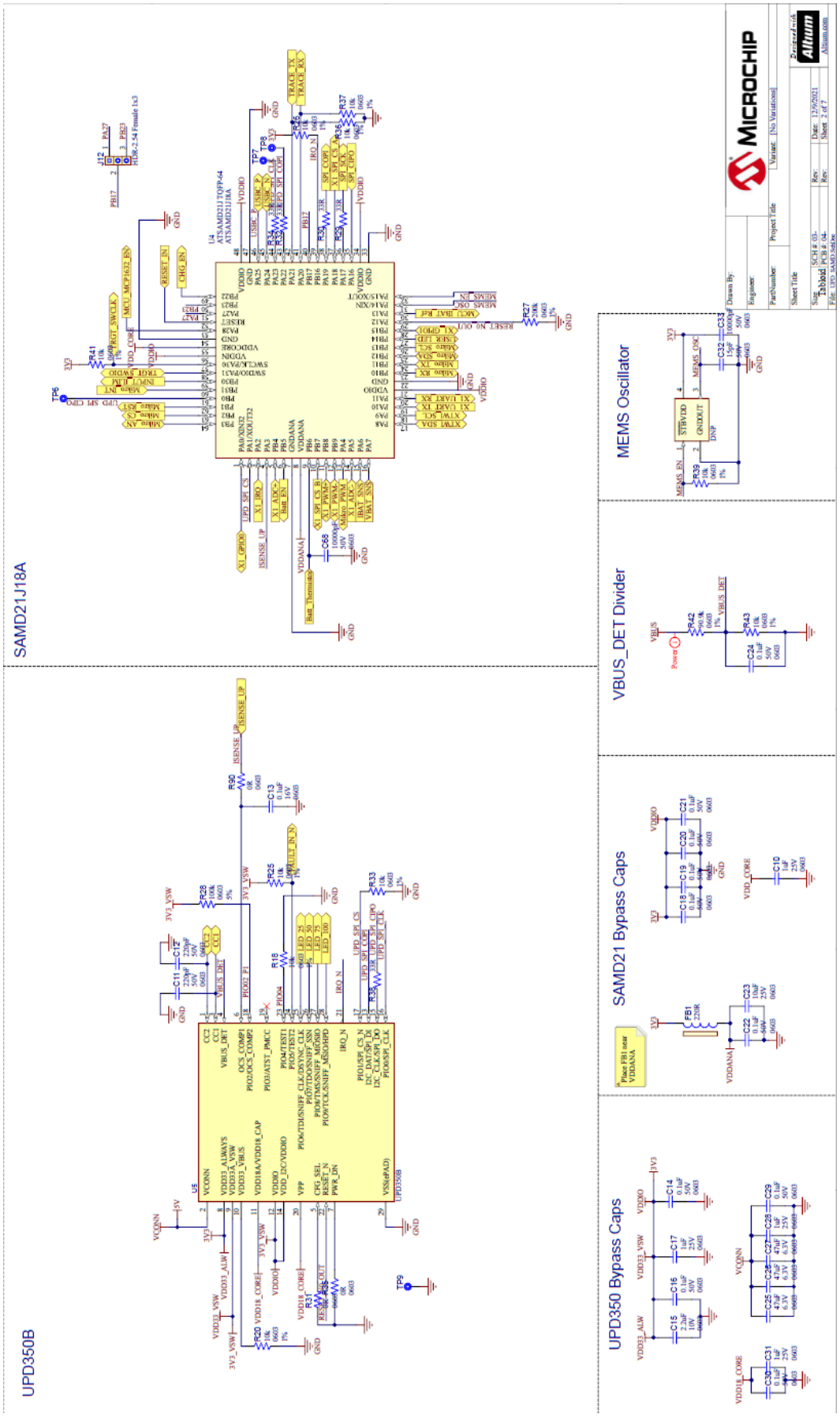
Additionally, the preferred charge current can be manually or automatically determined by modifying the code shown below.

```
320     uint16_t maxcurrent = gasCfgStatusData.sPerPortData[0].ul6NegoCurrentInmA;
321     //set this value for a manual max charge current limit,
322     //otherwise comment this line to use the PD negotiated current
323     maxcurrent = 1000;
```

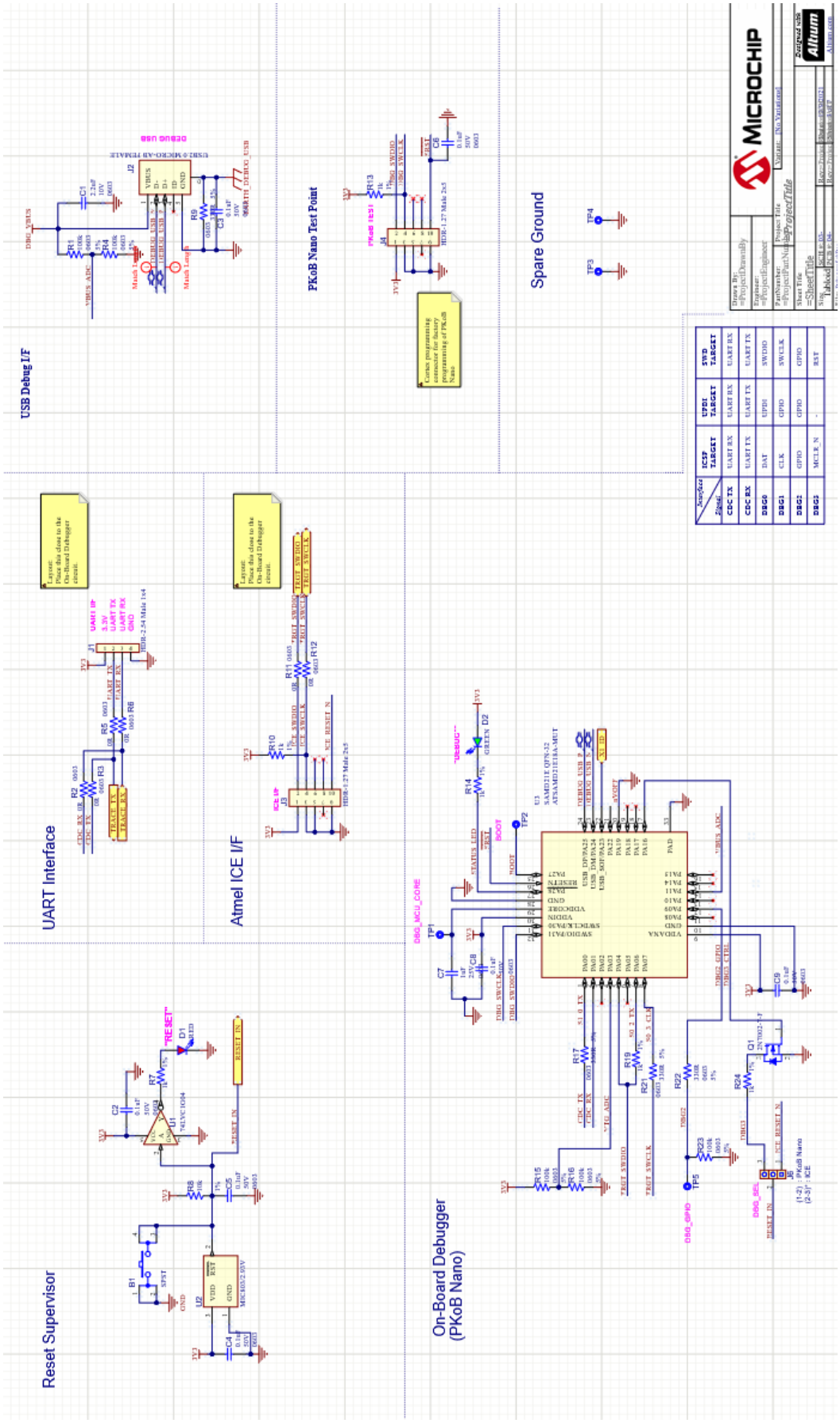
# Schematics


Top Level
U_Debugger
Debugger.SchDoc
X1_ID
RESET_IN
TRACE_RX
TRACE_TX
TRGT_SWDIO
TRGT_SWCLK
U_Board_Power_Supplies
Board_Power_Supplies.SchDoc
MCU_IBAT_REF
Batt_Thermistor
IBAT_SNS
VBAT_SNS
CHG_EN
INPUT_ILIM
BATT_EN
ISENSE_UP
MCU_MCP1632_EN
U_Connectors
Connectors.SchDoc
Mikro_INT
Mikro_CS
Mikro_RST
Mikro_SCL
Mikro_SDA
Mikro_AN
Mikro_TX
Mikro_RX
Mikro_PWM
EXT_UART_TX
EXT_UART_RX
CC2
CC1
USBC_P
USBC_N
SPI_CIPO
SPI_COPI
SPI_SCK
X1_ADC+
X1_ADC-
X1_PWM+
X1_PWM-
X1_UART_RX
X1_UART_TX
X1_SPI_CS_A
X1_GPIO0
X1_GPIO1
X1_IRQ
X1_SPI_CS_B
X1_TWI_SDA
X1_TWI_SCL
XTWI_SDA
XTWI_SCL
LED_100
LED_75
LED_50
LED_25
USER_LED
FAULT_IN_N
U_UPD_SAMD
UPD_SAMD.SchDoc
Batt_Thermistor
TRGT_SWCLK
TRGT_SWDIO
Mikro_TX
Mikro_RX
CHG_EN
VBAT_SNS
IBAT_SNS
MCU_IBAT_Ref
Batt_EN
INPUT_ILIM

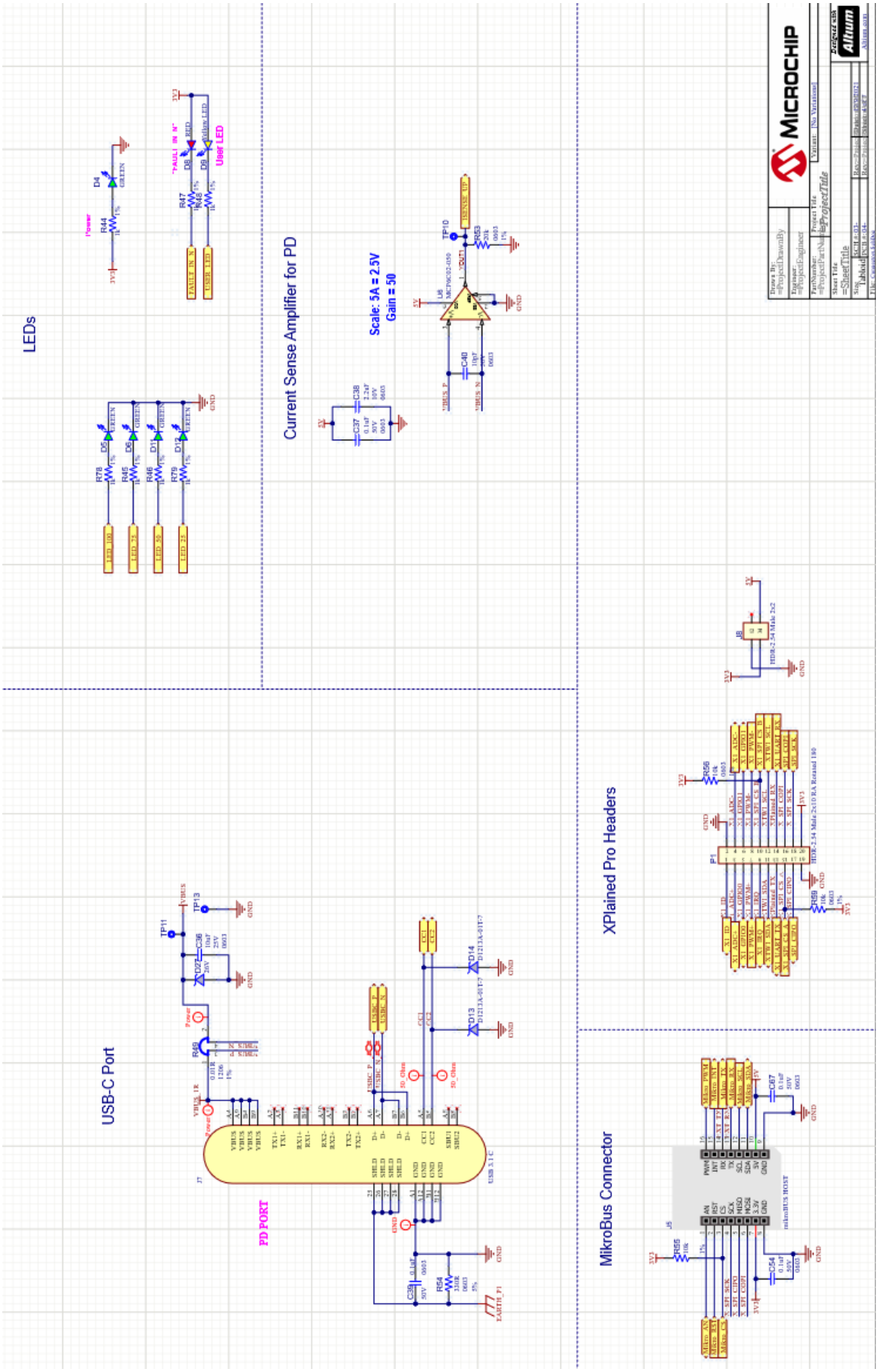
# Schematics


SAMD21J18A
UPD350B
MEMS Oscillator
VBUS_DET Divider
SAMD21 Bypass Caps
UPD350 Bypass Caps
MICROCHIP

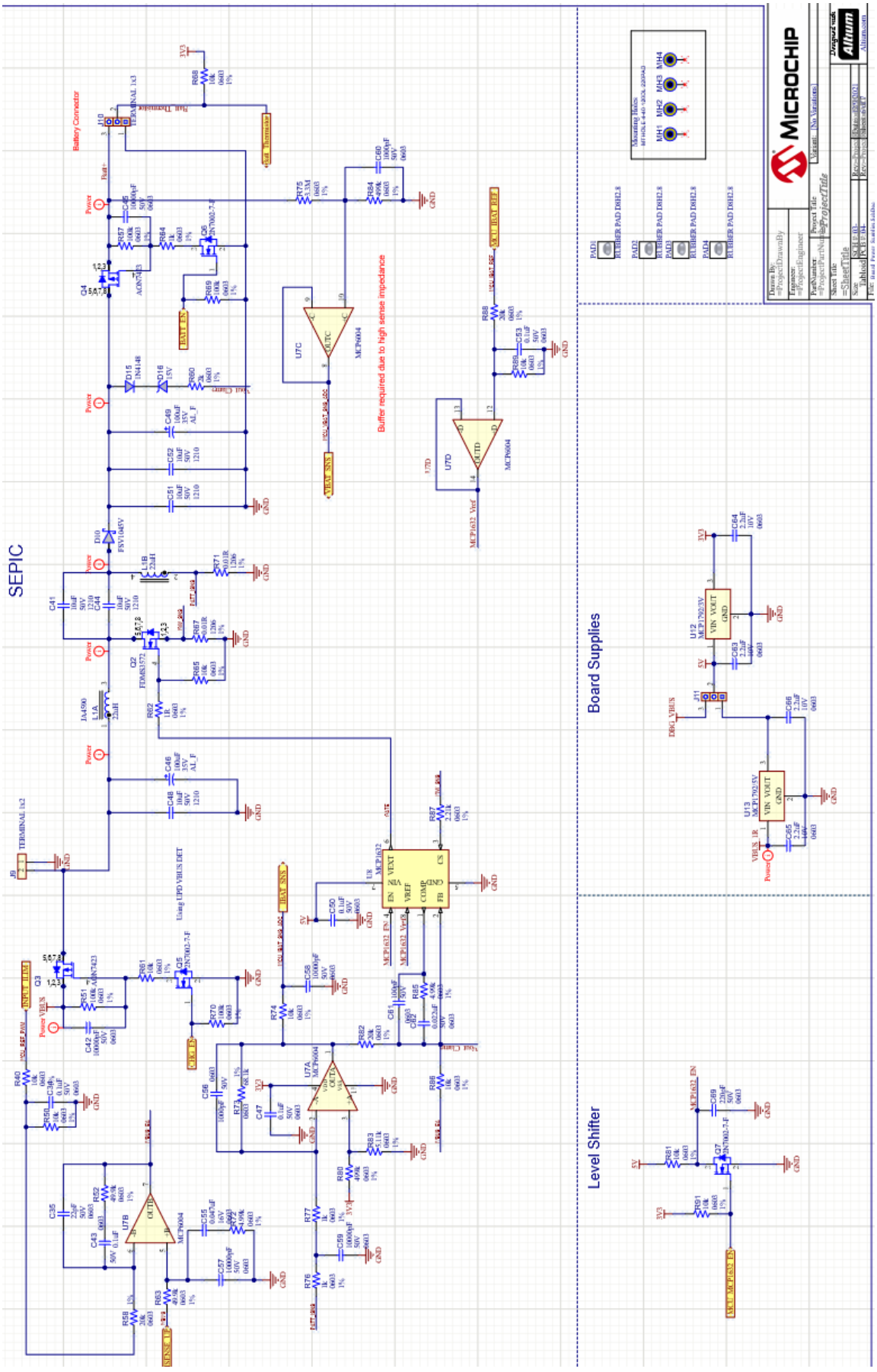
# Schematics


USB Debug I/F
PKoB Nano Test Point
Spare Ground
UART Interface
Atmel ICE I/F
Reset Supervisor
On-Board Debugger (PKoB Nano)
MICROCHIP

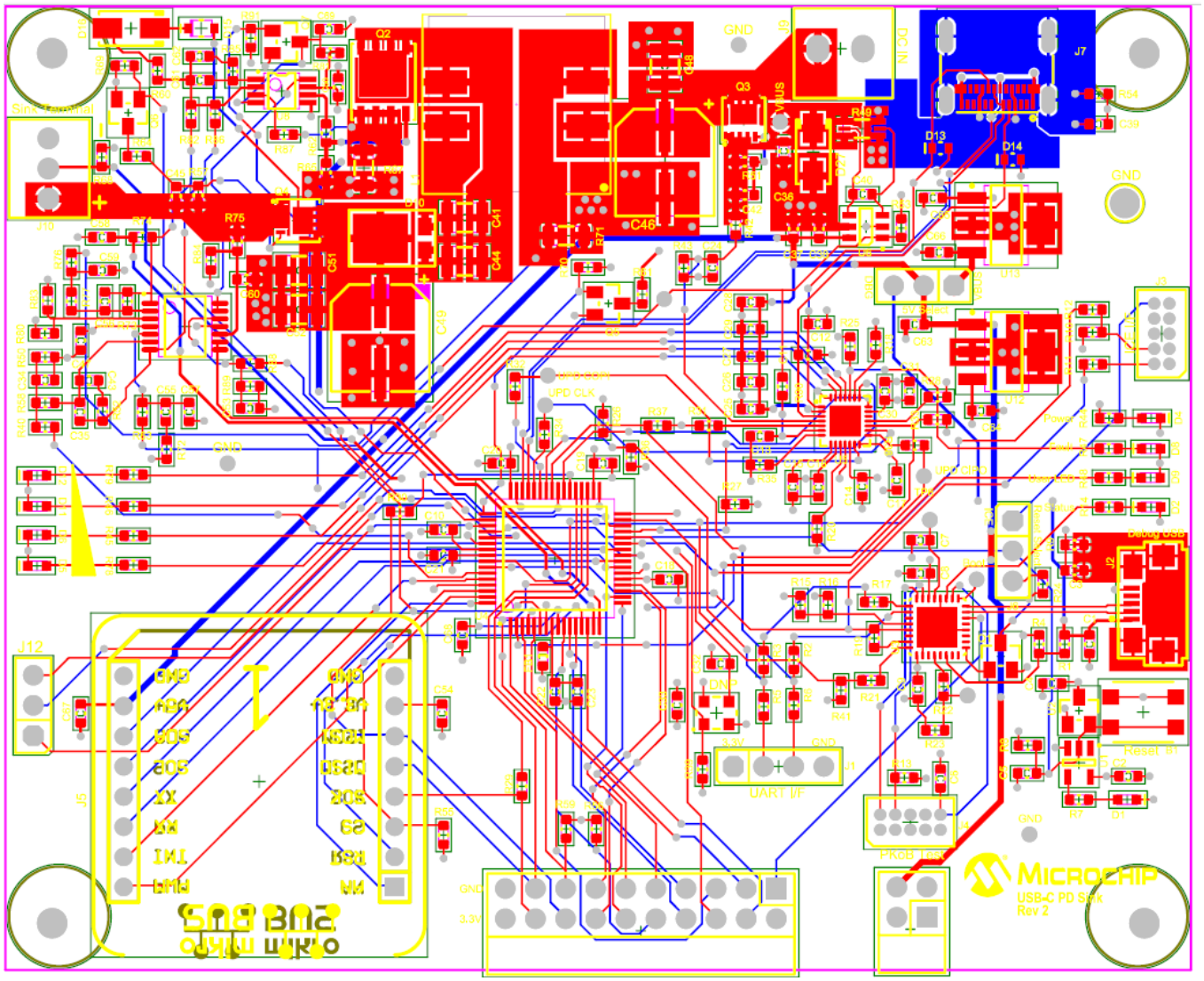
# Schematics


LEDs
Current Sense Amplifier for PD
Scale: 5A = 2.5V
Gain = 50
USB-C Port
PD PORT
XPlained Pro Headers
MikroBus Connector
MICROCHIP

# Schematics


SEPIC
Board Supplies
Level Shifter
Buffer required due to high sense impedance
MICROCHIP

# PCB Print



# Bill of Materials

| Quantity | Designator | Description | Manufacturer 1 | Manufacturer Part Number 1 | Supplier 1 | Supplier Part Number 1 | Supplier Unit Price 1 | Price /1 Board | Populated | Quantity | Quantity Overrid | Status | MCHP-ID |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | B1 | SWITCH TACT SPST 16V 100mA 7914G-1-032E SMD | Bourns | 7914G-1-032E | Digi-Key | 7914G-1-032ECT-ND | $0.8700 | $0.8700 | YES | 1 | 1 | MCL Desi | SWITCH1134 |
| 7 | C1, C15, C36, C63, C64, C65, C66 | CAP CER 2.2uF 10V 20% Y5V SMD 0603 | Murata | GRM188F51A225ZE01D | Digi-Key | 490-1586-1-ND | | $0.0000 | Yes | 7 | 1 | MCL Desi | CAP0367 |
| 26 | C2, C3, C4, C5, C6, C8, C9, C14, C16, C18, C19, C20, C21, C22, C24, C29, C30, C34, C37, C39, C43, C47, C50, C53, C54, C67 | CAP CER 0.1uF 50V 20% Y5V SMD 0603 | Kyocera AVX | 06035G1042ATZA | Digi-Key | 478-3724-1-ND | | $0.0000 | Yes | 26 | 1 | MCL Desi | CAP0455 |
| 6 | C7, C10, C17, C28, C31 | CAP CER 1uF 25V 20% X6R SMD 0603 | Panasonic | ECJ-1V41E105M | Digi-Key | PCC2354CT-ND | $0.1300 | $0.6500 | Yes | 5 | 1 | MCL Desi | CAP0489 |
| 3 | C11, C12, C69 | CAP CER 220pF 50V 5% NP0 SMD 0603 | KEMET | C0603C221J5GACTU | Digi-Key | 399-1066-1-ND | | $0.0000 | Yes | 3 | 1 | MCL Desi | CAP0552 |
| 1 | C13 | CAP CER 0.1uF 16V 10% X7R SMD 0603 | Taiyo Yuden | EMK107B7104KA-T | Digi-Key | 587-1240-1-ND | $0.1000 | $0.1000 | YES | 1 | 1 | MCL Desi | CAP0011 |
| 2 | C23, C36 | CAP CER 10uF 25V 20% X5R SMD 0603 | Murata | GRM188R61E106MA73 | Digi-Key | 490-7202-1-ND | $0.3400 | $0.6800 | YES | 2 | 1 | MCL Desi | CAP1461 |
| 3 | C25, C26, C27 | CAP CER 47uF 6.3V 20% X5R SMD 0603 | Murata | GRM188R60J476ME15D | Digi-Key | 490-13247-1-ND | $0.4900 | $1.4700 | YES | 3 | 1 | MCL Desi | CAP1661 |
| 1 | C32 | CAP CER 15pF 50V 5% NP0 SMD 0603 | Yageo | CC0603JRNP09BN150 | Digi-Key | 311-1060-1-ND | $0.1000 | $0.1000 | Yes | 1 | 1 | MCL Desi | CAP0121 |
| 7 | C33, C42, C45, C57, C58, C59, C68 | CAP CER 10nF 50V 10% X7R SMD 0603 AEC-Q200, CAP CER 10000pF 50V 20% X7R SMD 0603 | Kyocera AVX | 06035C103K4T2A, 0603 | Digi-Key | 478-7927-1-ND, 478-12 | $0.1300 | $0.9100 | YES | 7 | 1 | MCL Desi | CAP2186, CAP |
| 1 | C35 | CAP CER 22pF 50V 5% NP0 SMD 0603 | Cal-Chip | GMC10CG220J50NTLF | Cal-Chip | GMC10CG220J50NTLF | $0.1000 | $0.1000 | Yes | 1 | 1 | MCL Desi | CAP0074 |
| 1 | C40 | CAP CER 10pF 50V 5% NP0 SMD 0603 | KEMET | C0603C100J5GACTU | Digi-Key | 399-1049-2-ND | | $0.0000 | Yes | 1 | 1 | MCL Desi | CAP0142 |
| 5 | C41, C44, C48, C51, C52 | CAP CER 10uF 50V 20% X7R SMD 1210 | TDK | C3225X7R1H106M250AC | Digi-Key | 445-14933-1-ND | $0.9400 | $4.7000 | YES | 5 | 1 | MCL Desi | CAP1298 |
| 2 | C46, C49 | CAP ALU 100uF 35V 20% SMD | Panasonic | EEE-FP1V101AP | Digi-Key | PCE4142CT-ND | $0.9200 | $1.8400 | YES | 2 | 1 | MCL Desi | CAP1322 |
| 1 | C55 | CAP CER 0.047uF 16V 10% X7R SMD 0603 | Murata | GRM188R71C473KA01D | Digi-Key | 490-1529-1-ND | | $0.0000 | YES | 1 | 1 | MCL Desi | CAP1145 |
| 2 | C56, C60 | CAP CER 1000pF 50V 20% X7R SMD 0603 | TDK | C1608X7R2A102K080AA | Digi-Key | 445-1296-1-ND | $0.1000 | $0.2000 | YES | 2 | 1 | MCL Desi | CAP0001 |
| 1 | C61 | CAP CER 100pF 50V 5% NP0 SMD 0603 | Cal-Chip | GMC10CG101J50NTLF | Cal-Chip | GMC10CG101J50NTLF | $0.1000 | $0.1000 | Yes | 1 | 1 | MCL Desi | CAP0035 |
| 1 | C62 | CAP CER 0.022uF 50V 5% X7R SMD 0603 | Kyocera AVX | 06035C223JATZA | Digi-Key | 478-3722-2-ND | | $0.0000 | YES | 1 | 1 | MCL Desi | CAP0625 |
| 2 | D1, D8 | DIO LED RED 2V 30mA 2mcd Clear SMD 0603 | Vishay Lite-On | LTST-C190EKT | Digi-Key | 160-1182-1-ND | $0.2600 | $0.5200 | YES | 2 | 1 | MCL Desi | DIODE1058 |
| 6 | D2, D4, D5, D6, D11, D12 | DIO LED GREEN 2V 30mA 35mcd Clear SMD 0603 | Vishay Lite-On | LTST-C191KGKT | Digi-Key | 160-1446-1-ND | $0.2600 | $1.5600 | YES | 6 | 1 | MCL Desi | DIODE1155 |
| 1 | D9 | LED YELLOW DIFFUSED 1608 SMD | Rohm | SML-D12Y1WT86 | Digi-Key | SML-D12Y1WT86CT-ND | $0.2100 | $0.2100 | YES | 1 | 1 | MCL Desi | DIODE1547 |
| 1 | D10 | | | | | | | $0.0000 | | 1 | | | |
| 2 | D13, D14 | DIO TVS D1213-01 3.3V SMD SOD-523 AEC-Q101 | Diodes | D1213A-01T-7 | Digi-Key | D1213A-01T-7DICT-ND | $0.4000 | $0.8000 | YES | 2 | 1 | MCL Desi | DIODE1502 |
| 1 | D15 | DIO RECT 1N4148 855mV 300mA 75V SOD-323 | Diodes | 1N4148WS-7-F | Digi-Key | 1N4148WS-FDICT-ND | $0.1900 | $0.1900 | Yes | 1 | 1 | MCL Desi | DIODE0096 |
| 1 | D16 | DIO ZENER BZG03C15G 15V 1.5W SMD DO-214AC SMA | ON Semiconductor | BZG03C15G | Digi-Key | BZG03C15GOSCT-ND | $0.4400 | $0.4400 | YES | 1 | 1 | MCL Desi | DIODE1097 |
| 1 | D27 | DIO TVS SMAJ26A 26V 400W DO-214AC, SMA | Littelfuse | SMAJ26A | Digi-Key | SMAJ26ALFCT-ND | $0.3800 | $0.3800 | Yes | 1 | 1 | MCL Desi | DIODE0188 |
| 1 | DNP | MCHP CLOCK OSCILLATOR SINGLE 24 MHz DSC1001CL5-024.0000T L3.2W2.5H0.85 | Microchip | DSC1001CL5-024.0000T | Digi-Key | DSC1001CL5-024.0000T-ND | | $0.0000 | YES | 1 | 1 | MCL Desi | MIC6590 |
| 1 | FB1 | FERRITE 220R@100MHz 500mA SMD 0603 | Murata | BLM18AG221SN1D | Digi-Key | 490-1012-1-ND | $0.1000 | $0.1000 | YES | 1 | 1 | MCL Desi | FB1014 |
| 1 | J1 | CON HDR-2.54 Male 1x4 Gold 5.84MH TH VERT | Wurth Electronics | 61300411121 | Digi-Key | 732-5317-ND | $0.1900 | $0.1900 | Yes | 1 | 1 | MCL Desi | CON0148 |
| 1 | J2 | CON USB2.0 MICRO-AB FEMALE SMD R/A | Hirose | ZX62-AB-5PA(31) | Digi-Key | H125279CT-ND | | $0.0000 | YES | 1 | 1 | MCL Desi | CON0436 |
| 2 | J3, J4 | CON HDR-1.27 Male 2x5 Gold 3.05MH TH VERT | Amphenol ICC / FCI | 20021111-00010T4LF | Digi-Key | 609-3712-ND | $0.7700 | $1.5400 | YES | 2 | 1 | MCL Desi | CON1497 |
| 2 | J5 | SOCKET mikroBUS HOST DIP 16 TH | Sullins | PPTC081LFBN-RC | Digi-Key | S7006-ND | $0.6500 | $1.3000 | YES | 1 | 2 | MCL Desi | SKT1042 |
| 2 | J6, J11 | CON HDR-2.54 Male 1x3 Tin 5.84MH TH VERT | Samtec | TSW-103-07-T-S | Digi-Key | SAM1035-03-ND | $0.2400 | $0.4800 | Yes | 2 | 1 | MCL Desi | CON0465 |
| 1 | J7 | CON USB3.1-C Female SMD R/A | Molex | 105450-0101 | Digi-Key | WM12856CT-ND | $2.1900 | $2.1900 | YES | 1 | 1 | MCL Desi | CON1642 |
| 1 | J8 | CON HDR-2.54 Male 2x2 Gold 6.75MH TH R/A | Molex | 0901220761 | Digi-Key | WM5008-02-ND | $0.4900 | $0.4900 | YES | 1 | 1 | MCL Desi | CON1527 |
| 1 | J9 | CON TERMINAL 3.81mm 1x2 Female 16-24 AWG 10A TH R/A | Amphenol | YO02215000000G | Digi-Key | 609-3918-ND | | $0.0000 | YES | 1 | 1 | MCL Desi | CON1037 |
| 1 | J10 | CON TERMINAL 2.54mm 1x3 Female 20-30 AWG 6A TH R/A | On-Shore Technology | OSTVN03A150 | Digi-Key | ED10562-ND | $1.0900 | $1.0900 | YES | 1 | 1 | MCL Desi | CON1303 |
| 1 | J12 | CON HDR-2.54 Female 1x3 Gold 8.64MH TH VERT | TE Connectivity | 5-534237-1 | Digi-Key | A32904-ND | $1.4700 | $1.4700 | YES | 1 | 1 | MCL Desi | CON1425 |
| 1 | L1 | INDUCTOR DUAL 22uH 2.45A 20% SMD L12.5W12.5H8.5 | Wurth Electronics | 744870220 | Digi-Key | 732-2327-1-ND | $2.9000 | $2.9000 | YES | 1 | 1 | MCL Desi | IND1405 |
| 1 | P1 | CON HDR-2.54 Male 2x10 Rotated 180Degrees Gold TH RT ANGLE | Sullins | PBC10DBAN | Digi-Key | S2111E-10-ND | $1.9300 | $1.9300 | YES | 1 | 1 | MCL Desi | CON1547 |
| 4 | PAD1, PAD2, PAD3, PAD4 | MECH HW RUBBER PAD Cylindrical flat top D8H2.8 Black | 3M | SJ5076 BLACK | Farnell | 1165061 | $4.7800 | $19.1200 | MECH | 4 | 1 | MCL Desi | MECH0087 |
| 4 | Q1, Q5, Q6, Q7 | TRANS FET N-CH 2N7002-7-F 60V 170mA 370mW SOT-23-3 | Diodes | 2N7002-7-F | Digi-Key | 2N7002-FDICT-ND | $0.2100 | $0.8400 | YES | 4 | 1 | MCL Desi | TRA1102 |
| 1 | Q2 | TRANS FET N-CH FDMS3572 80V 22A 2.5W Power56-8 | ON Semiconductor / Fair | FDMS3572 | Digi-Key | FDMS3572TR-ND | | $0.0000 | YES | 1 | 1 | MCL Desi | TRA1019 |
| 2 | Q3, Q4 | TRANS FET P-CH AON7423 20V 28A 6.2W 8-PowerWDFN | Alpha & Omega Semico | AON7423 | Digi-Key | 785-1310-2-ND | | $0.0000 | YES | 2 | 1 | MCL Desi | TRA1060 |
| 10 | R1, R4, R15, R16, R23, R28, R51, R57, R69, R70 | RES TKF 100k 5% 1/10W SMD 0603 (Don't Use, Duplicate, Use RSMT0026), RES TF 100k 1% 1/8W SMD 0603 | Panasonic, Vishay Beyt | ERJ-3GEYJ104V, MCT0 | Digi-Key | P100KGCT-ND, MCT060 | $0.0370 | $0.3700 | Yes | 10 | 1 | MCL Desi | RES1115, RES |
| 9 | R2, R3, R5, R6, R11, R12, R31, R35, R90 | RES TKF 0R 1/10W AEC-Q200 SMD 0603 | Panasonic | ERJ-3GEY0R00V | Digi-Key | P0.0GCT-ND | $0.1000 | $0.9000 | YES | 9 | 1 | MCL Desi | RES2300 |
| 16 | R7, R10, R13, R14, R19, R24, R44, R45, R46, R47, R48, R64, R76, R77, R78, R79 | RES TKF 1k 1% 1/10W AEC-Q200 SMD 0603 | Panasonic | ERJ3EKF1001V | Digi-Key | P1.00KHCT-ND | $0.0360 | $0.6080 | YES | 16 | 1 | MCL Desi | RES2457 |
| 24 | R8, R18, R20, R25, R26, R33, R36, R37, R39, R40, R41, R43, R50, R55, R56, R59, R61, R65, R68, R74, R81, R86, R89, R91 | RES TF 10k 1% 1/16W SMD 0603 | TE Connectivity | 5-1879837-9 | Digi-Key | A102203CT-ND | $0.1680 | $3.9120 | YES | 24 | 1 | MCL Desi | RES1368 |
| 8 | R9, R17, R21, R22, R54 | RES TKF 330R 5% 1/10W SMD 0603 | Rohm | MCR03EZPJ331 | Digi-Key | RHM330GCT-ND | | $0.0000 | Yes | 5 | 1 | MCL Desi | RES0195 |
| 1 | R27 | RES TKF 200k 1% 1/10W SMD 0603 | Vishay | CRCW0603200KFKEA | Digi-Key | 541-200KHCT-ND | | $0.0000 | Yes | 1 | 1 | MCL Desi | RES1140 |
| 5 | R29, R30, R32, R34, R38 | RES TKF 33R 1% 1/10W SMD 0603 | Rohm | MCR03EZPFX33R0 | Digi-Key | RHM33.0HCT-ND | | $0.0000 | Yes | 5 | 1 | MCL Desi | RSMT0701 |
| 1 | R42 | RES TKF 90.9k 1% 1/10W SMD 0603 | Panasonic | ERJ-3EKF9092V | Digi-Key | P90.9KHTR-ND | | $0.0000 | Yes | 1 | 1 | MCL Desi | RSMT0385 |
| 1 | R49 | RES SHUNT 0.01R 1% 1/4W 1206 | Yageo | PF1206FRF070R01L | Digi-Key | 311-0.01AJCT-ND | $0.4700 | $0.4700 | YES | 1 | 1 | MCL Desi | RSMT1231 |
| 2 | R52, R63 | RES TKF 49.9k 1% 1/10W SMD 0603 | Yageo | RC0603FR-0749K9L | Digi-Key | 311-49.9KHRCT-ND | $0.1000 | $0.2000 | YES | 2 | 1 | MCL Desi | RES2498 |
| 4 | R53, R58, R82, R88 | RES TKF 20k 1% 1/10W SMD 0603 | Panasonic | ERJ3EKF2002V | Digi-Key | P20.0KHCT-ND | $0.1000 | $0.4000 | Yes | 4 | 1 | MCL Desi | RSMT0309 |
| 1 | R60 | RES TKF 2k 1% 1/10W SMD 0603 | Panasonic | ERJ-3EKF2001V | Digi-Key | P2.00KHTR-ND | $0.1000 | $0.1000 | YES | 1 | 1 | MCL Desi | RSMT0382 |
| 1 | R62 | RES TKF 1R 1% 1/10W SMD 0603 | Yageo | RC0603FR-071RL | Digi-Key | 311-1.00HRCT-ND | $0.1000 | $0.1000 | YES | 1 | 1 | MCL Desi | RES1369 |
| 2 | R67, R71 | RES SHUNT MF 0.01R 1% 1W SMD 1206 | Bourns | CRF1206-FX-R010ELF | Digi-Key | CRF1206-FX-R010ELFCT-ND | | $0.0000 | YES | 2 | 1 | MCL Desi | RSMT1228 |
| 2 | R72, R85 | RES TKF 4.99k 1% 1/10W SMD 0603 | Panasonic | ERJ-3EKF4991V | Digi-Key | P4.99KHCT-ND | | $0.0000 | Yes | 2 | 1 | MCL Desi | RSMT0185 |
| 1 | R73 | RES TKF 68.1k 1% 1/10W SMD 0603 | Yageo | RC0603FR-0768K1L | Digi-Key | 311-68.1KHRCT-ND | $0.1000 | $0.1000 | Yes | 1 | 1 | MCL Desi | RSMT1041 |
| 1 | R75 | RES TKF 3.3M 1% 1/8W SMD 0603 | Stackpole Electronics | RMCF0603FT3M30 | Digi-Key | RMCF0603FT3M30CT-ND | | $0.0000 | Yes | 1 | 1 | MCL Desi | RES1158 |
| 2 | R80, R84 | RES TKF 499k 1% 1/10W SMD 0603 | Panasonic | ERJ-3EKF4993V | Digi-Key | P499KHCT-ND | $0.1000 | $0.2000 | YES | 2 | 1 | MCL Desi | RES1191 |
| 1 | R83 | RES TKF 5.11k 1% 1/10W SMD 0603 | Yageo | RC0603FR-075K11L | Digi-Key | 311-5.11KHRCT-ND | $0.1000 | $0.1000 | YES | 1 | 1 | MCL Desi | RES1639 |
| 1 | R87 | RES TKF 2.21k 1% 1/10W SMD 0603 AEC-Q200 | Vishay | CRCW06032K21FKEA | Digi-Key | 541-2.21KHCT-ND | $0.1000 | $0.1000 | YES | 1 | 1 | MCL Desi | RES2467 |
| 1 | U1 | IC LOGIC 74LVC1G04 SOT-23-5 | Texas Instruments | SN74LVC1G04DBVR | Digi-Key | 296-11599-1-ND | $0.3400 | $0.3400 | YES | 1 | 1 | MCL Desi | IC00353 |
| 1 | U2 | MCHP ANALOG SUPERVISOR 2.93V MIC803-29D4VM3-TR SOT-23-3 | Microchip | MIC803-29D4VM3-TR | Digi-Key | 576-3806-1-ND | $0.3900 | $0.3900 | YES | 1 | 1 | MCL Desi | MIC7416 |
| 1 | U3 | MCHP MCU 32-BIT 48MHz 256Kb 32Kb ATSAMD21E18A-MUT QFN-32 | Microchip | ATSAMD21E18A-MUT | Digi-Key | ATSAMD21E18A-MUTC | $3.9600 | $3.9600 | YES | 1 | 1 | MCL Desi | MIC8641 |
| 1 | U4 | MCHP MCU 32-BIT 48MHz 256kB 32kB ATSAMD21J18A-AU TQFP-64 | Microchip Technology | ATSAMD21J18A-AU | Microchip Tech | ATSAMD21J18A-AU | | $0.0000 | YES | 1 | 1 | MCL Desi | MIC8796 |
| 1 | U5 | MCHP INTERFACE UPD350B USB Type C PD PORT CONTROLLER, SPI, DB, QFN-28 | Microchip | UPD350B-I/Q8X | Digi-Key | UPD350B-I/Q8X-ND | $1.7400 | $1.7400 | YES | 1 | 1 | MCL Desi | MIC8374 |
| 1 | U6 | MCHP ANALOG CURRENT SENSE AMP MCP6C02T-050E/CHY SOT-23-6 | Microchip | MCP6C02T-050E/CHY | Digi-Key | MCP6C02T-050E/CHYCT-ND | | $0.0000 | YES | 1 | 1 | MCL Desi | MIC7900 |
| 1 | U7 | MCHP ANALOG OPAMP 4-Ch 1MHz MCP6004T-E/ST TSSOP-14 | Microchip | MCP6004T-E/ST | Microchip | MCP6004T-E/ST | | $0.0000 | Yes | 1 | 1 | MCL Desi | MIC2947 |
| 1 | U8 | MCHP ANALOG PWM CONTROLLER 300kHz MCP1632T-AAE/MS MSOP-8 | Microchip | MCP1632T-AAE/MS | Digi-Key | MCP1632T-AAE/MS-ND | | $0.0000 | YES | 1 | 1 | MCL Desi | MIC6117 |
| 1 | U12 | MCHP ANALOG LDO 3V MCP1792 SOT-223-3 | Microchip Technology | MCP1792-3302H/DB | Microchip Tech | MCP1792-3302H/DB | | $0.0000 | YES | 1 | 1 | MCL Desi | MIC8751 |
| 1 | U13 | MCHP ANALOG LDO 5V MCP1792 SOT-223-3 | Microchip Technology | MCP1792-5002H/DB | Microchip Tech | MCP1792-5002H/DB | | $0.0000 | YES | 1 | 1 | MCL Desi | MIC8805 |