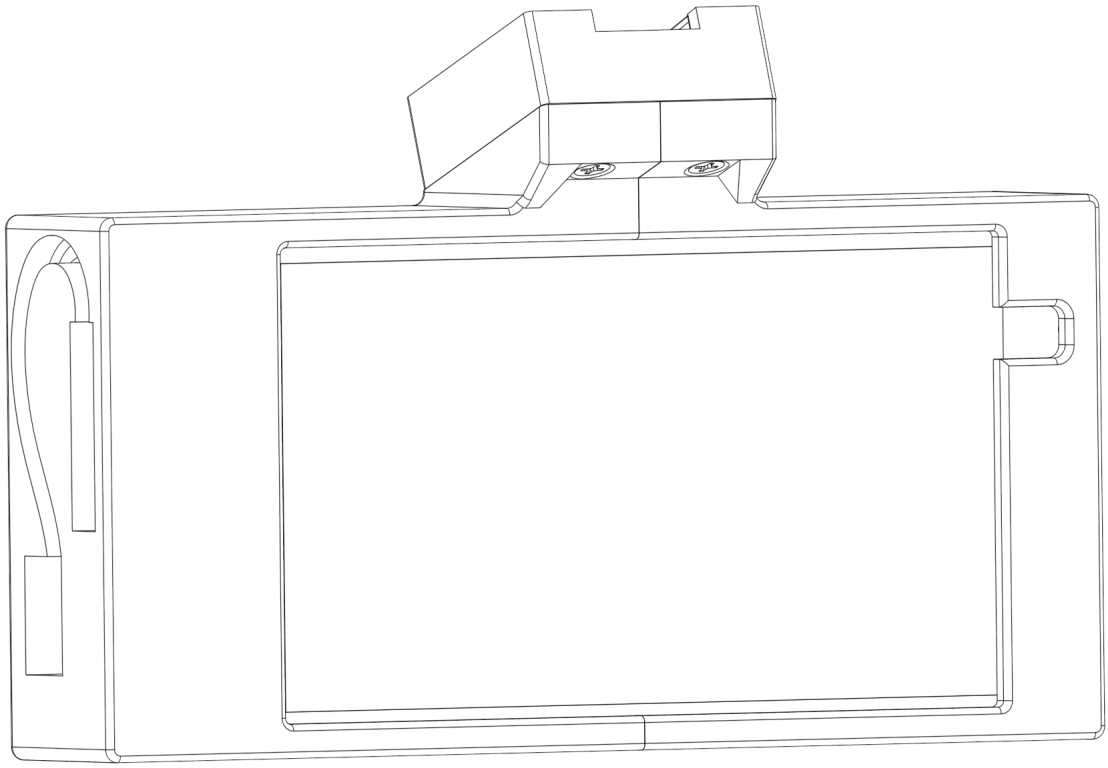
neo

research platform



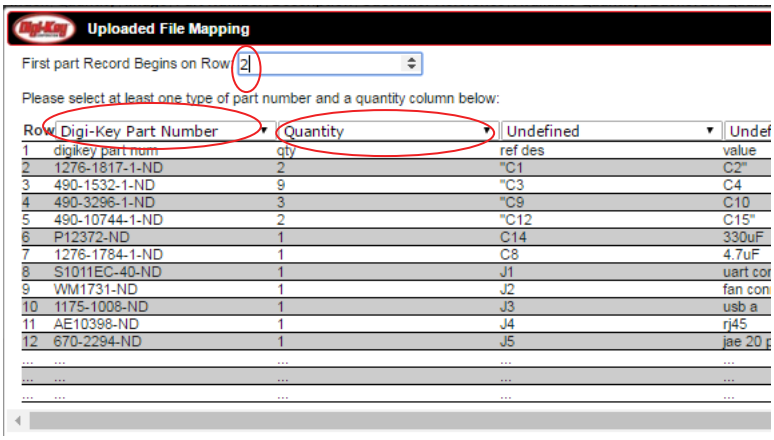
comma.ai

github.com/commaai/neo

suppliers

electronics

1. download digikey.csv
2. go to digikey.com/classic/Ordering and register or log in
3. click Upload to Cart and navigate to the downloaded csv file
4. change the "First part Record Begins on Row" to 2
5. change the first column to "Digi-Key Part Number"
6. change the second column to "Quantity"
7. leave the rest as undefined then click Add to Current Cart
8. this bom includes spares of various components



Row	Digi-Key Part Number	Quantity	Undefined	Undef
1	digikey part num	qty	ref des	value
2	1276-1817-1-ND	2	"C1	C2"
3	490-1532-1-ND	9	"C3	C4
4	490-3296-1-ND	3	"C9	C10
5	490-10744-1-ND	2	"C12	C15"
6	P12372-ND	1	C14	330uF
7	1276-1784-1-ND	1	C8	4.7uF
8	S1011EC-40-ND	1	J1	uart co
9	WM1731-ND	1	J2	fan con
10	1175-1008-ND	1	J3	usb a
11	AE10398-ND	1	J4	rj45
12	670-2294-ND	1	J5	jae 20 p
...	...	...	...	...
...	...	...	...	...
...	...	...	...	...

board

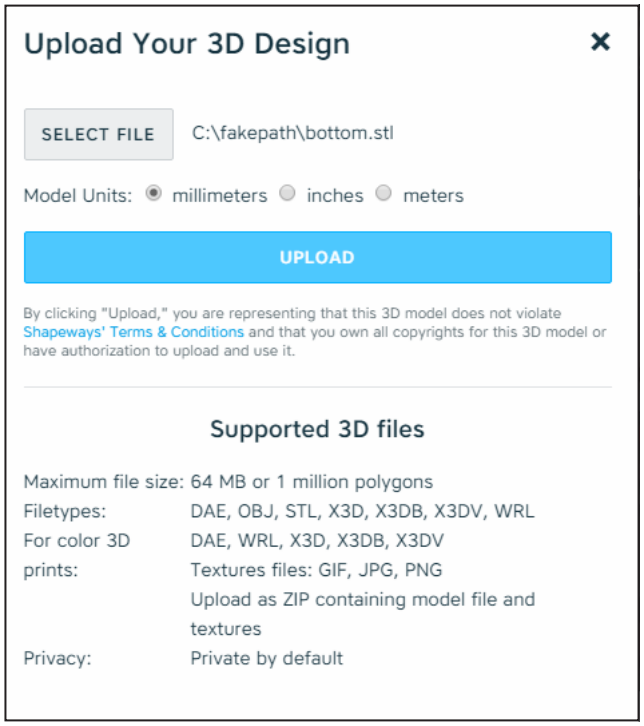
1. download neo.brd
2. go to oshpark.com/uploads/new and drag the downloaded brd file into the window
3. enter your email and click continue
4. scroll to the bottom of the next page and click Approve and Order
5. OSHpark requires a minimum of 3 boards per order

cables

1. order cat6 cable from amazon.com/dp/B00N2VISLW
2. order OTG USB cable from amazon.com/dp/B0194WSKOM
3. *optional: order serial debug cable from sfe.io/p9717*
4. *optional: order 12V 2A power supply from amazon.com/dp/B019Q3U72M*

3d prints

1. download all stl files from github.com/commaai/neo/case
2. go to shapeways.com and login or register
3. click upload in the top right corner
4. select one of the downloaded files (keep units in millimeters) and then click upload

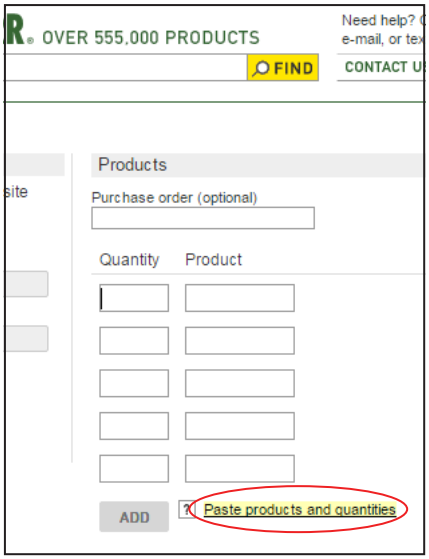


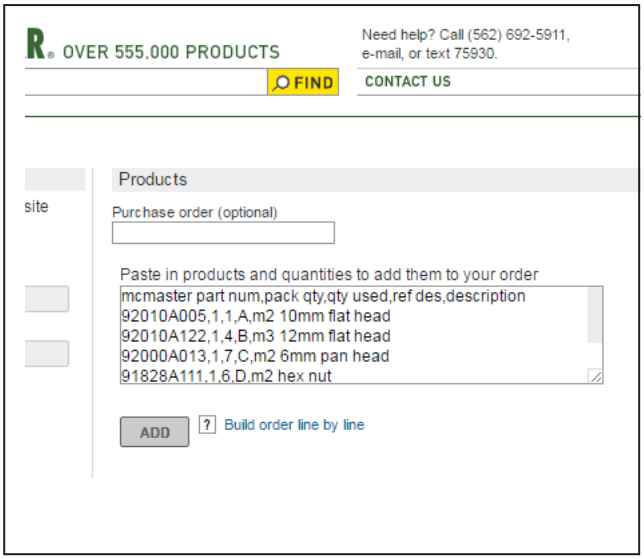
5. repeat for the remaining three files (you can only upload one at a time)

6. hover over "MAKE" on the top menu bar and then click "My Models"
7. select the material and finish of the 4 prints (we recommend "Black Strong & Flexible") and then click "ADD TO CART"

hardware

1. download mcmaster.csv
2. open the file in your favorite text editor and select all
3. go to mcmaster.com and click "BUILD ORDER" in the upper right corner
4. click "Paste products and quantities" then paste the previously copied text

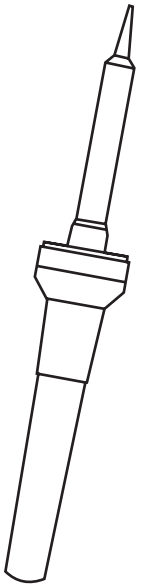




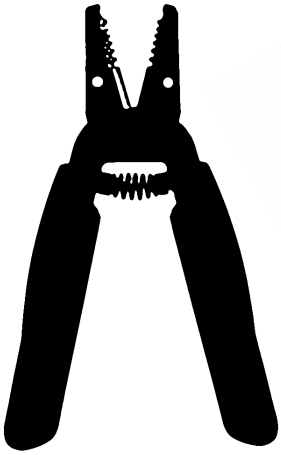
5. click add and all the necessary hardware will be added to your cart

electronics assembly

tools



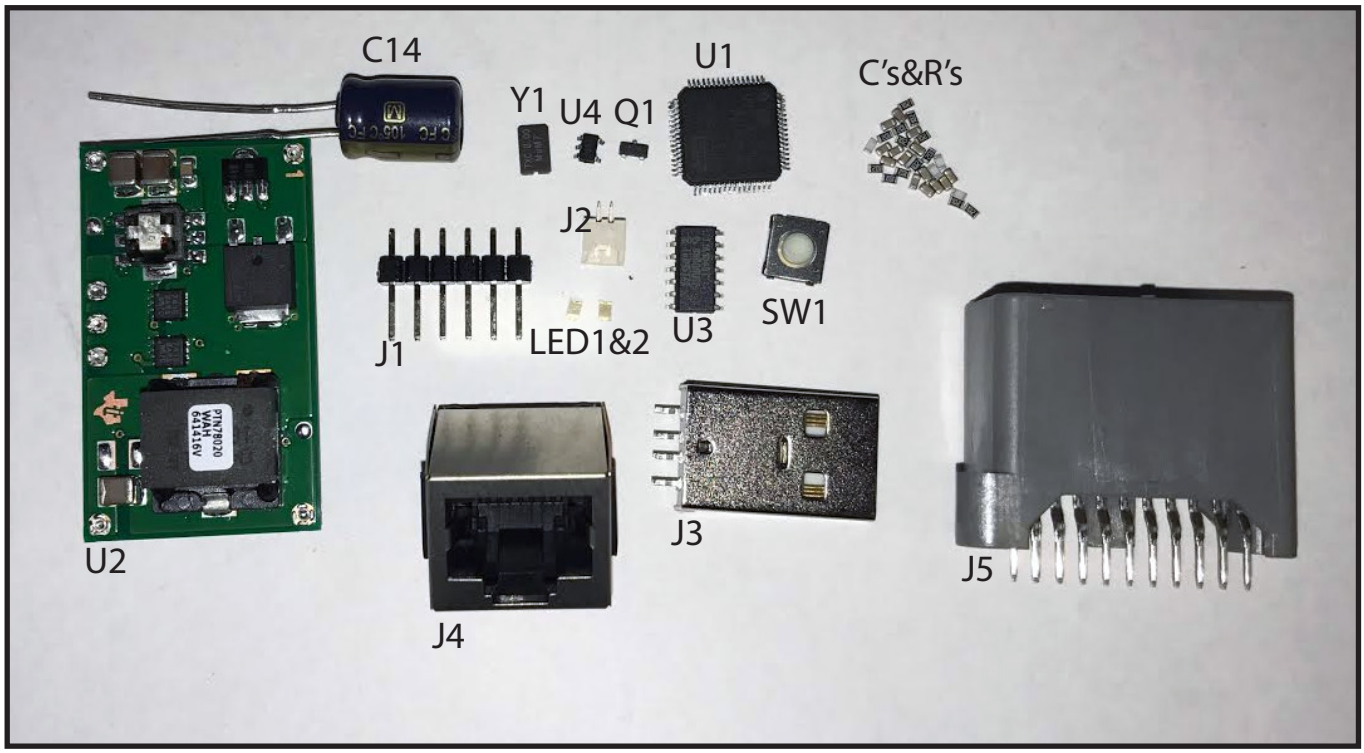
soldering iron



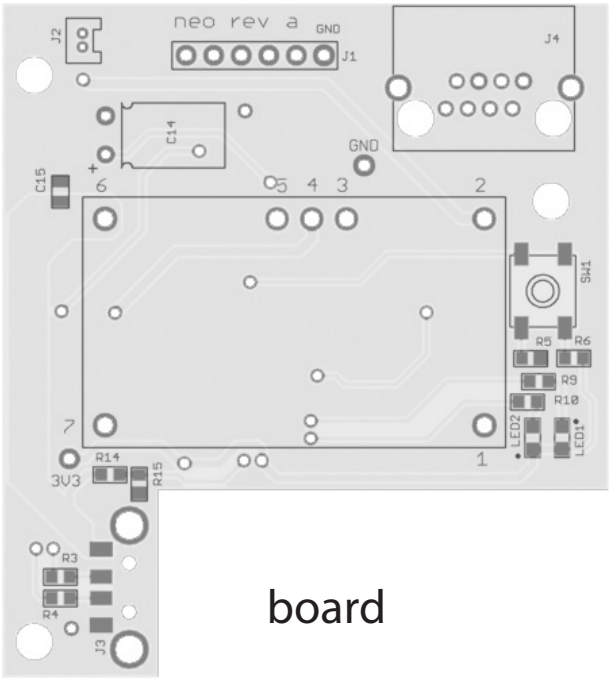
wire strippers

tweezers

parts



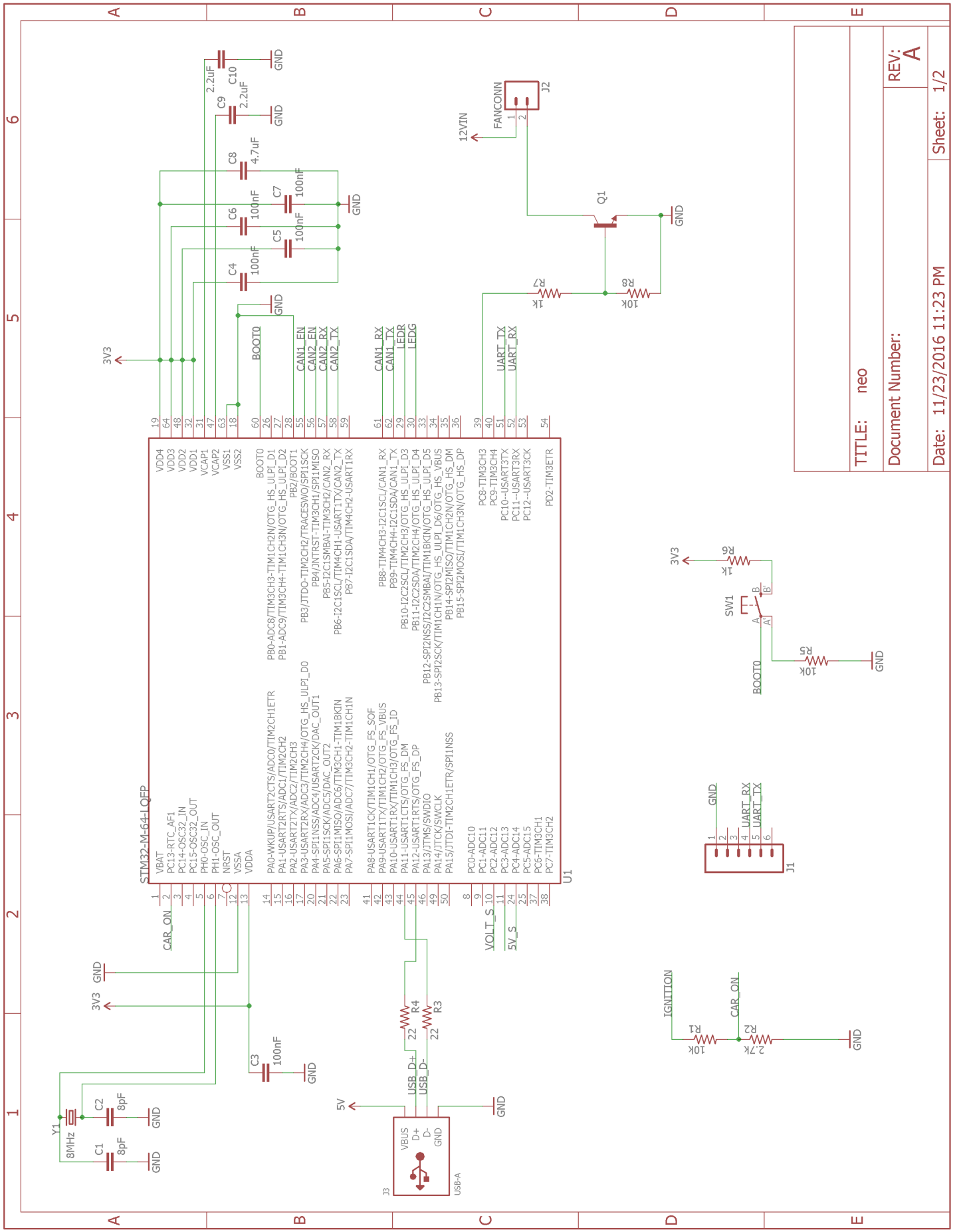
cat6 cable

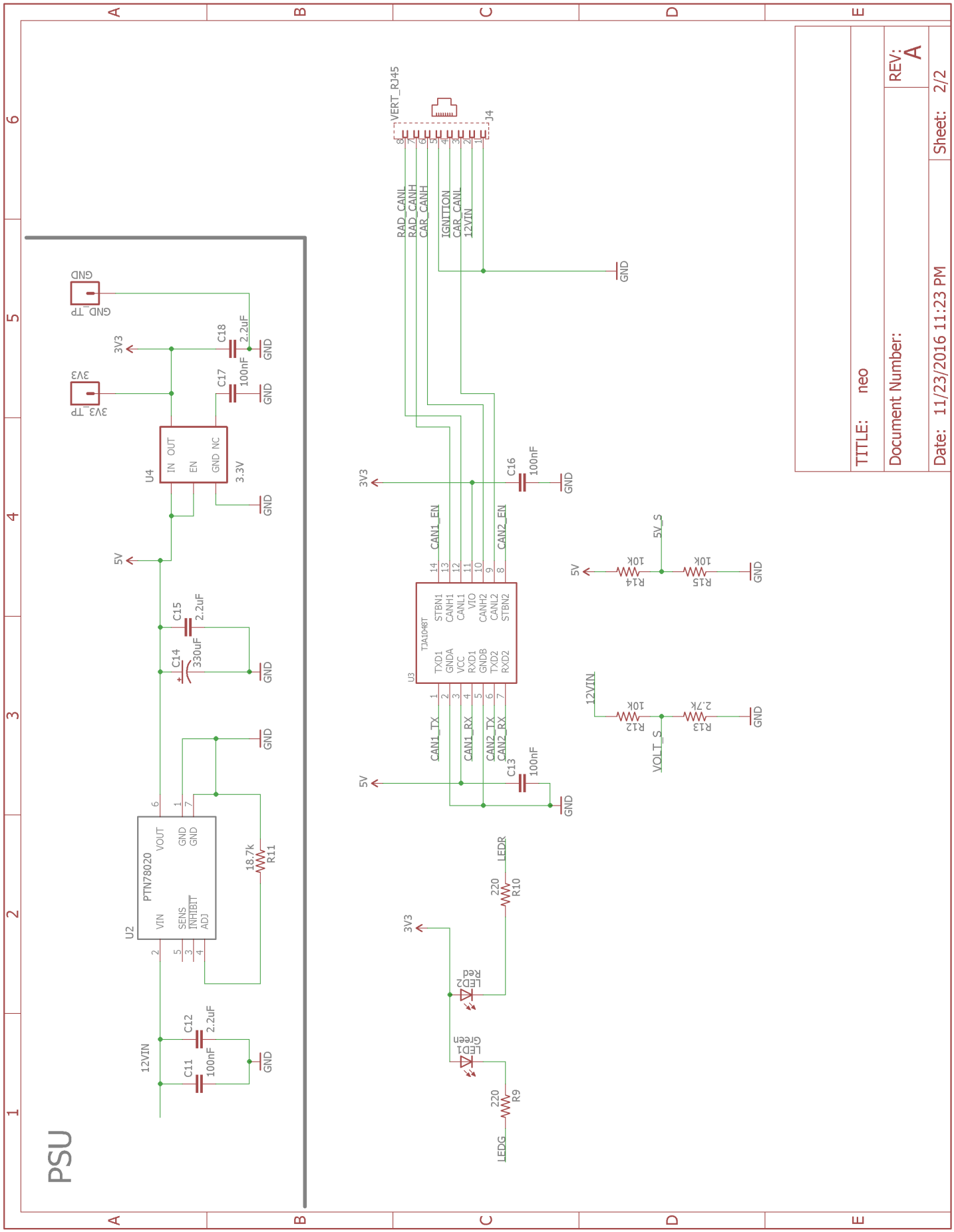


board

bill of materials

digikey part num	qty	ref des	value	footprint
1276-1817-1-ND	2	C1, C2	8pF	0603
490-1532-1-ND	9	C3, C4, C5, C6, C7, C11, C13, C16, C17	100nF	0603
490-3296-1-ND	3	C9, C10, C18	2.2uF	0603
490-10744-1-ND	2	C12, C15	2.2uF	0805
P12372-ND	1	C14	330uF	radial
1276-1784-1-ND	1	C8	4.7uF	0603
S1011EC-40-ND	1	J1	uart connector	thru hole-6
WM1731-ND	1	J2	fan connector	thru hole-2
1175-1008-ND	1	J3	usb a	smd-4
AE10398-ND	1	J4	rj45	thru hole-8
670-2294-ND	1	J5	jae 20 pin	thru hole-20
475-1410-1-ND	1	LED1	green	0805
475-1415-1-ND	1	LED2	red	0805
MMBT2222ALT1GOSCT-ND	1	Q1	mmbt2222a	sot23-3
311-10KGRCT-ND	6	R1, R5, R8, R12, R14, R15	10k	0603
311-18.7KHRCT-ND	1	R11	18.7k	0603
311-1.0KGRCT-ND	2	R6, R7	1k	0603
311-2.7KGRCT-ND	2	R2, R13	2.7k	0603
311-22GRCT-ND	2	R3, R4	22	0603
311-220GRCT-ND	2	R9, R10	220	0603
P12961SCT-ND	1	SW1	spst	smd-4
497-11153-ND	1	U1	stm32f205	lqfp-64
296-20515-ND	1	U2	ptn78020w	thru hole-7
568-8681-1-ND	1	U3	tja1048	so14
296-36844-1-ND	1	U4	3.3v	sot23-5
887-1667-1-ND	1	Y1	8MHz	smd-2
603-1840-ND	1	H1	12V fan	40x10mm
345-1108-ND	4	H2, H3, H4, H5	heatsink	28mm

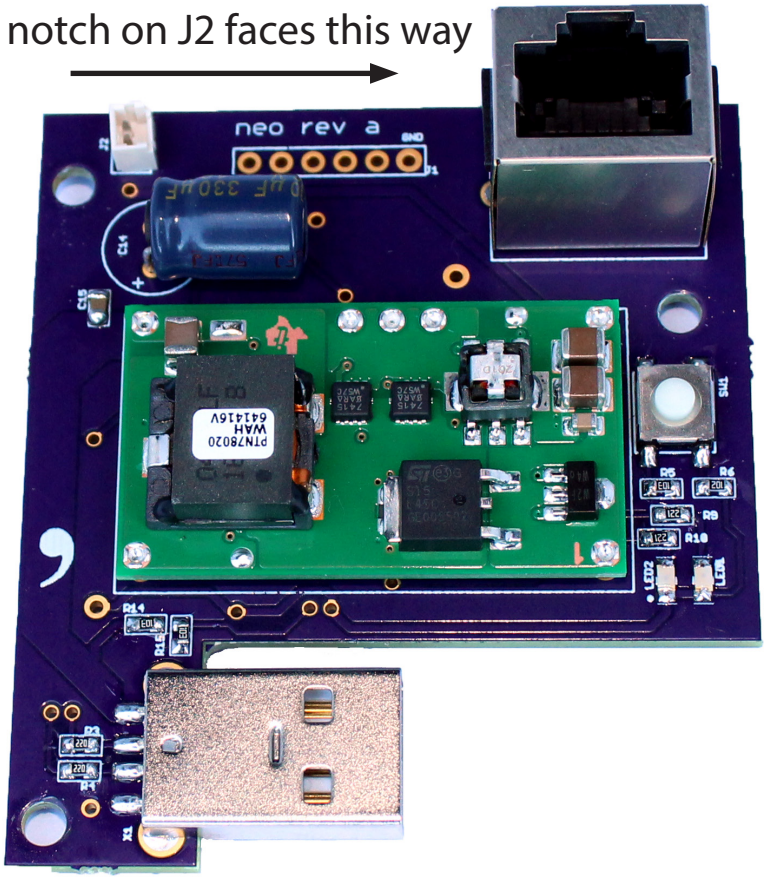

TITLE: neo
Document Number:
REV: A
Date: 11/23/2016 11:23 PM
Sheet: 1/2
STM32-M-64-LQFP
U1
FANCONN
J2
Q1
SW1
J1
J3
USB-A
Y1
8MHz
C1
8pF
C2
8pF
C3
100nF
C4
100nF
C5
100nF
C6
100nF
C7
100nF
C8
4.7uF
C9
2.2uF
C10
2.2uF
R1
10K
R2
2.7K
R3
22
R4
22
R5
10K
R6
1K
R7
1K
R8
10K
12VIN
3V3
5V
GND
IGNITION
CAR_ON
BOOT0
CAN1_EN
CAN2_EN
CAN2_RX
CAN2_TX
CAN1_RX
CAN1_TX
LEDR
LEDG
UART_TX
UART_RX
VOLT_S
5V_S
USB_D+
USB_D-
VBUS
D+
D-
GND

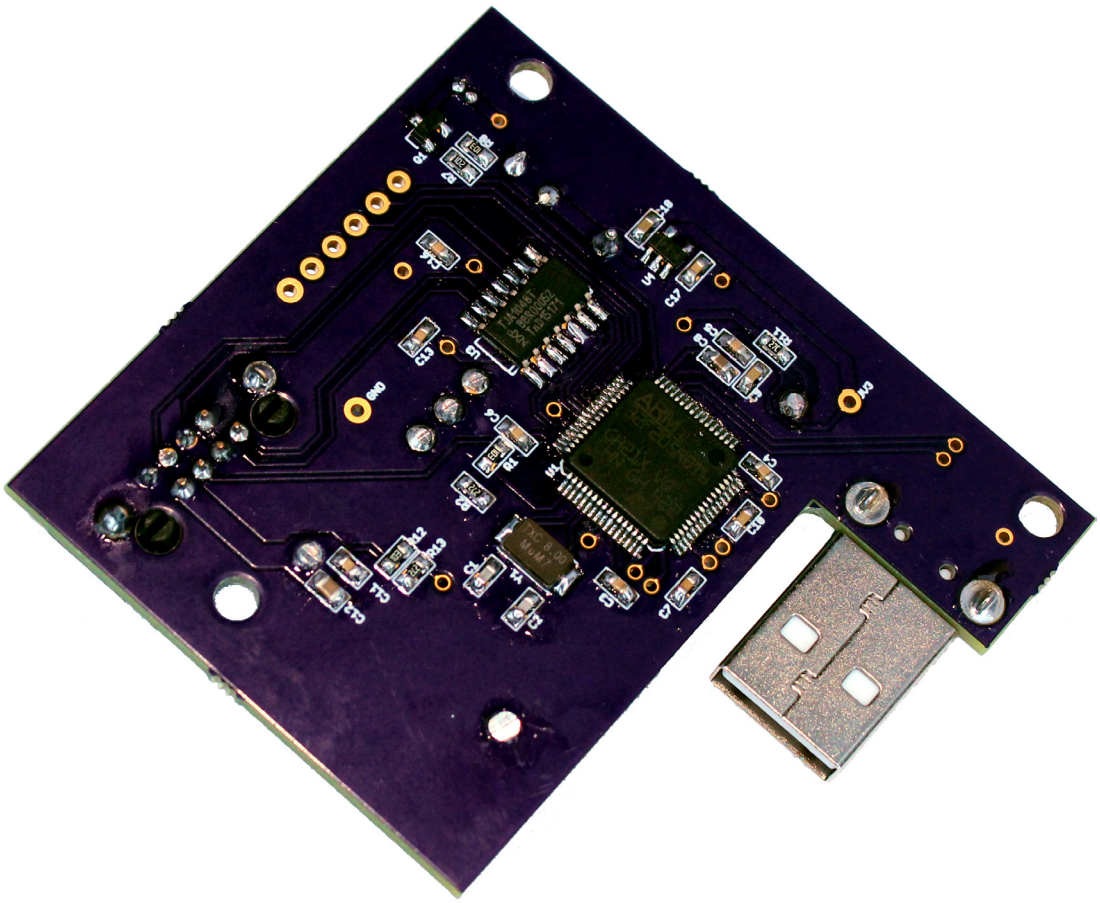

PSU
VERT_RJ45
J4
RAD_CANL
RAD_CANH
CAR_CANH
IGNITION
CAR_CANL
12VIN
GND
3V3
C16
100nF
U3
TJA1048T
CAN1_EN
CAN2_EN
STBN1
CANH1
CANL1
VIO
CANH2
CANL2
STBN2
TXD1
GNDA
VCC
RXD1
GNDB
TXD2
RXD2
CAN1_TX
CAN1_RX
CAN2_TX
CAN2_RX
C13
100nF
5V
5V_S
R14
10K
R15
10K
12VIN
R12
10K
R13
2.7K
VOLT_S
LEDR
220
R10
LEDG
220
R9
LED1
Green
LED2
Red
GND_TP
3V3_TP
C18
2.2uF
C17
100nF
U4
IN
OUT
EN
GND
NC
3.3V
C15
2.2uF
C14
330uF
U2
PTN78020
VIN
VOUT
SENS
INHIBIT
ADJ
GND
18.7k
R11
C12
2.2uF
C11
100nF
TITLE: neo
Document Number:
REV: A
Date: 11/23/2016 11:23 PM
Sheet: 2/2

build notes

1. solder U1 onto the front of the board and check for any shorts between pins, this is the microcontroller that interacts with the OnePlus3
2. solder C1-13 in any order onto the front of the board
3. solder R1, R2, R7, R8, R11-13 onto the front of the board
4. solder Q1 onto the front of the board, this controls the speed of the fan
5. solder U3 onto the front of the board, this is the CAN transceiver
6. solder U4 onto the front of the board, this is the 5V to 3.3V converter
7. solder Y1 onto the front of the board, this is the main crystal resonator
8. optional for uart debug: fashion J1 by breaking away 6 pins from the 40 pin connector then solder onto the back of the board, this is the uart breakout connection
9. solder J2 onto the back of the board with the notch on the right (see image below), this is the connector for the fan
10. solder J3 onto the back of the board, make sure it remains level with the board so that the OTG USB cable will lay flat when connected
11. solder J4 onto the back of the board, make sure the plastic legs are fully snapped into their holes, this is the breakout to the research vehicle
12. J5 is used externally from the board, put it aside for later
13. solder LED1 and LED2 to the back of the board, note that the green and red LEDs do not have the same polarity so if they are mixed up they will not operate properly
14. solder R3-6, R9, R10, R14, R15 onto the back of the board
15. solder SW1 onto the back of the board, this is used to put the microcontroller into DFU mode to flash the initial firmware (should not be required for future firmware flashes)
16. bend pins of C14 before soldering so that the curved surface lays on the back of the board (see image below)
17. solder C15 onto the back of the board
18. solder U2 onto the back of the board, this is the 12V to 5V power supply
19. go to page 14 and build the breakout cable in order to test the board

notch on J2 faces this way





breakout cable

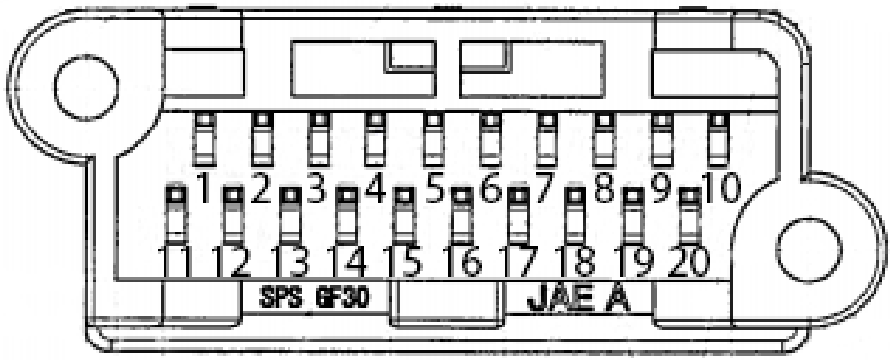
1. cut off ~8" of the cat6 cable and strip the internal wires
2. for a Honda vehicle, make the connections in the JAE column (for all other vehicles make the connections show in the OBDII column)
3. cover the back of the JAE (or OBDII) connector with hot glue in order to prevent any shorts or breaking of wires

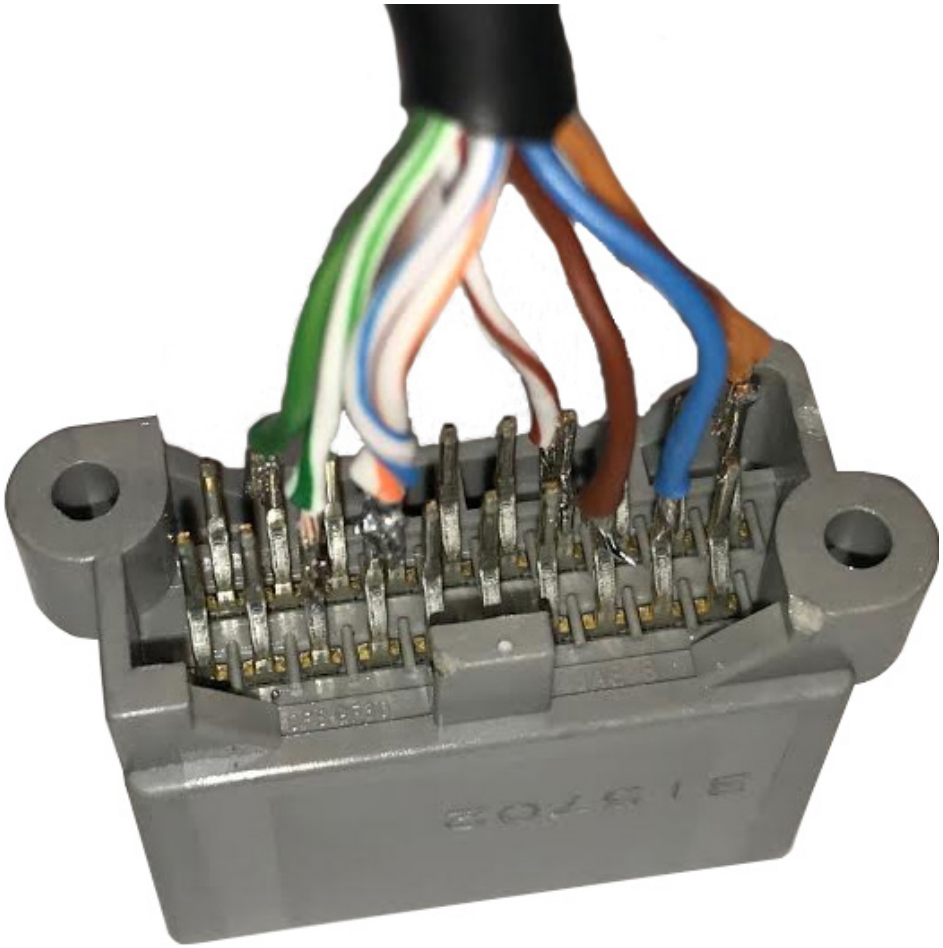
note: *you can build an AC-DC adapter using the 12V power supply mentioned on page 3.*

rj45 pin	**cat5 (t568b) wire**	**signal**	**JAE**	***OBDII***
1	orange stripe	gnd	14	*4*
2	orange	+12V	10	*16*
3	green stripe	car CAN low	13	*14*
4	blue	ignition	19	---
5	blue stripe	gnd	14	*4*
6	green	car CAN high	2	*6*
7	brown stripe	radar CAN high	7	---
8	brown	radar CAN low	18	---

jae connector (J5)

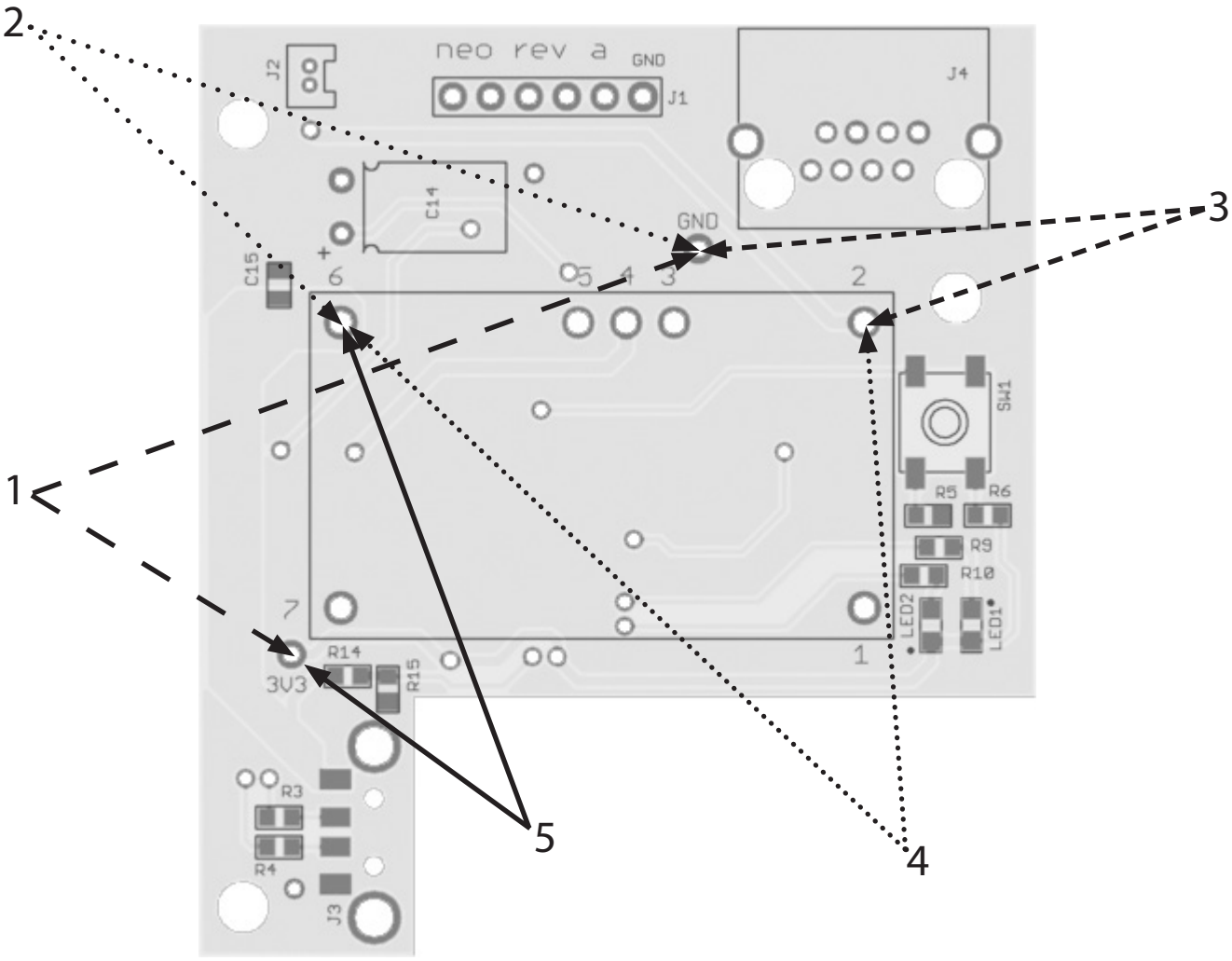
back





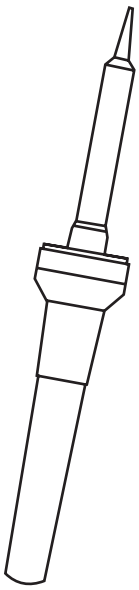
test the board

1. check for any shorts between the pairs of points shown below, fix if any exist
2. setup the OnePlus3 with NEOS by following the instructions at github.com/commaai/neo/releases/tag/swag
3. plug the female end of the OTG USB cable into the board and the USB C connector into the OnePlus3
4. plug the rj45 connector into the board and hold down SW1 while you plug the breakout cable into the vehicle (or 12V adapter), this puts the microcontroller into DFU mode
5. the OnePlus3 will upload the firmware to the microcrontroller, if the red LED on the board begins to flash then your board is working properly
6. if you have any issues or submit an issue request at github.com/commaai/neo/issues

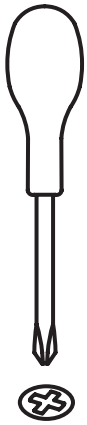


case assembly

tools

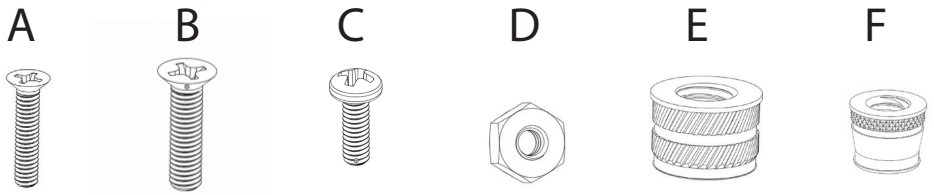


soldering iron



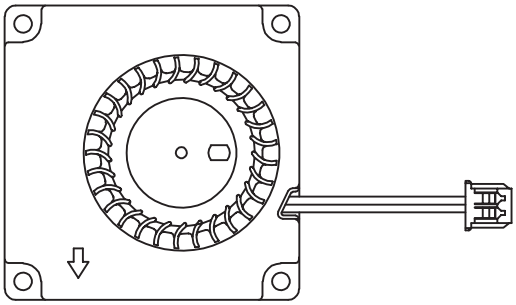
phillips head

parts



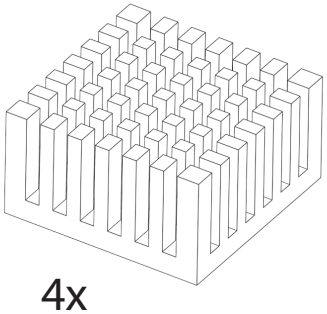
1x 4x 7x 6x 4x 2x

blower fan (H1)



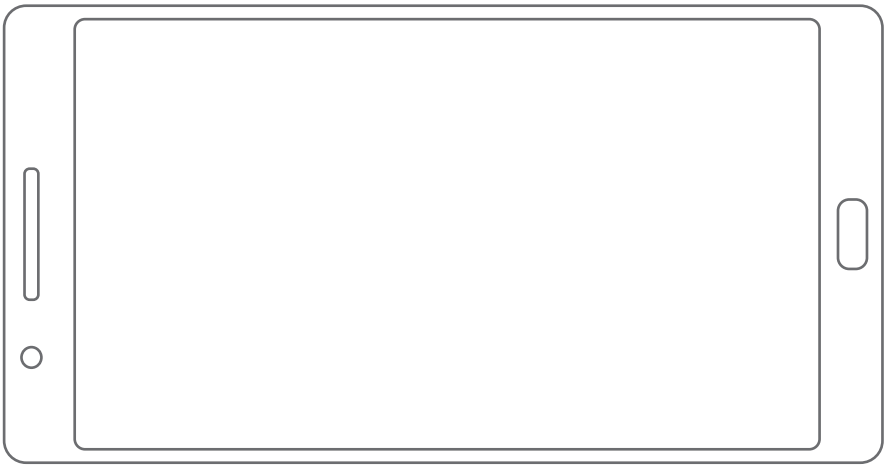
1x

heatsinks (H2-5)



4x

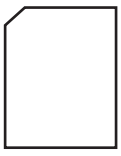
OnePlus3



1x

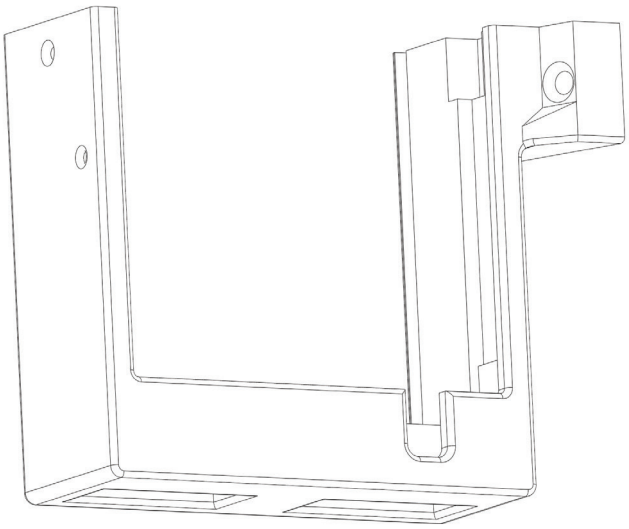
order on oneplus.net

unlimited data SIM



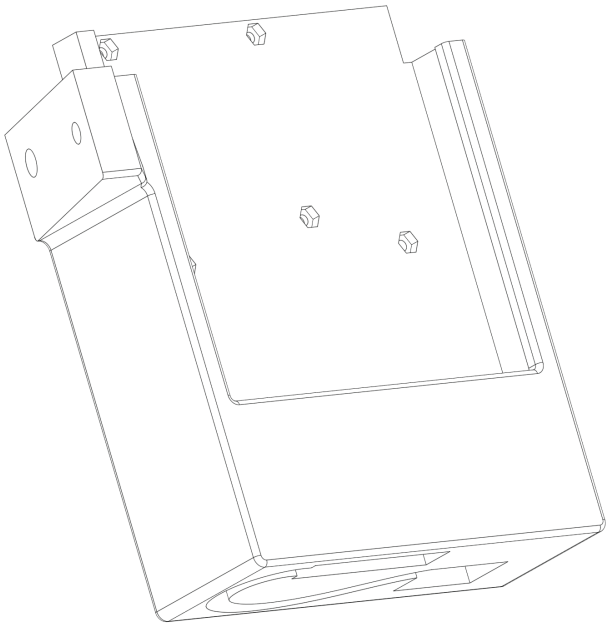
1x

case top



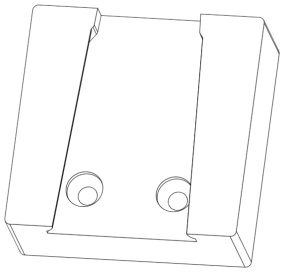
1x

case bottom



1x

mount

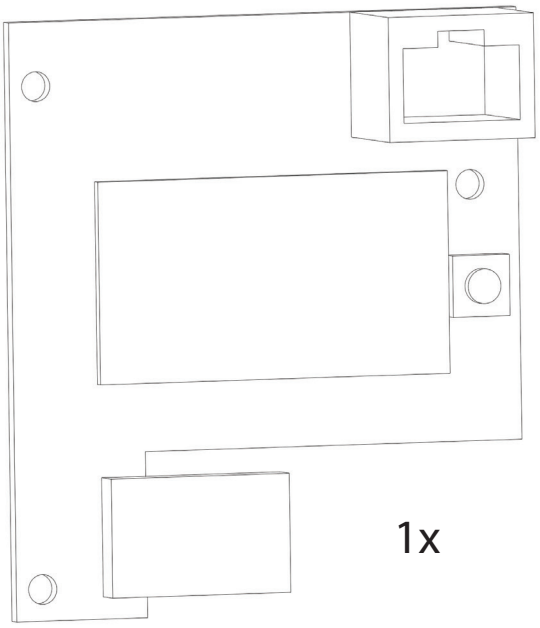


1x

back cover

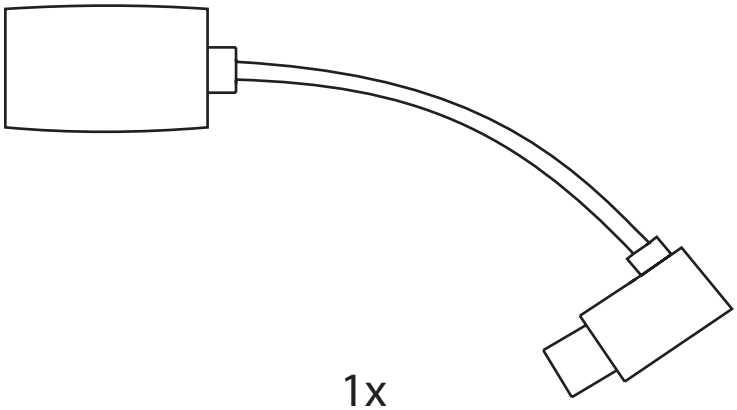
1x

assembled pcb



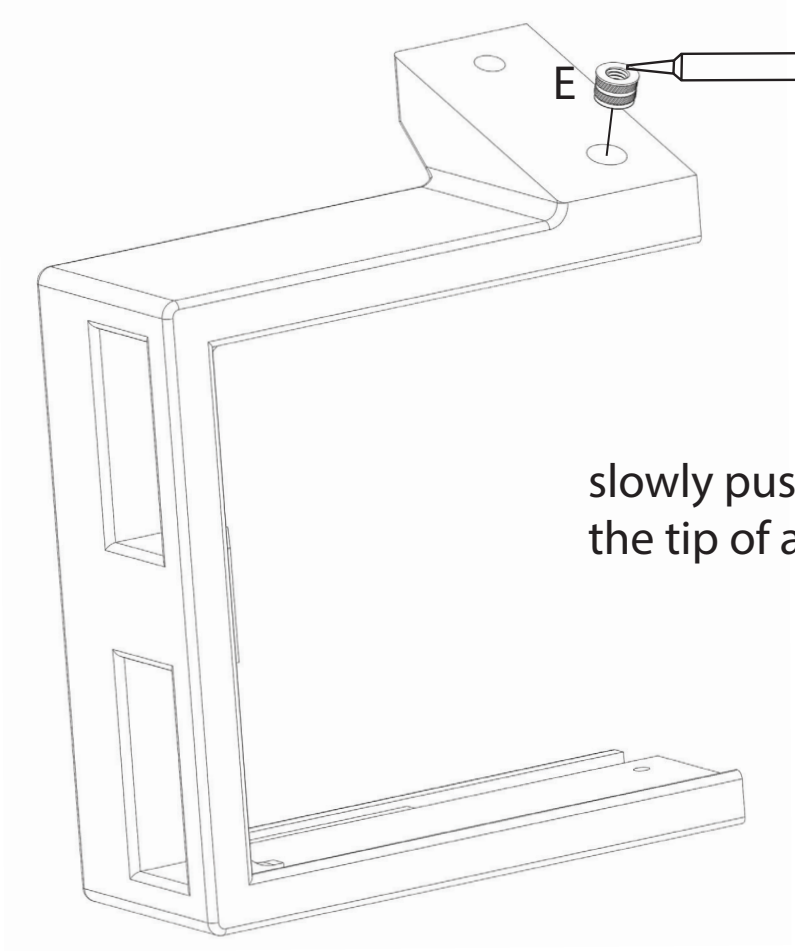
1x

USB OTG cable

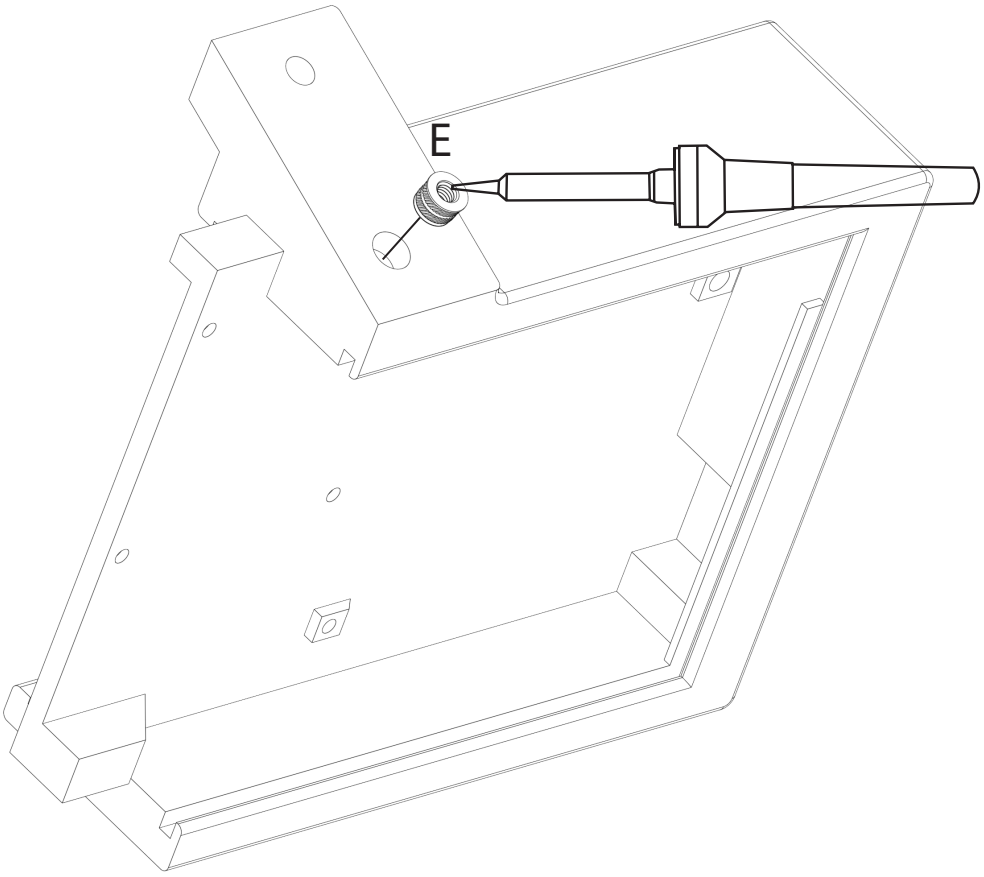


1x

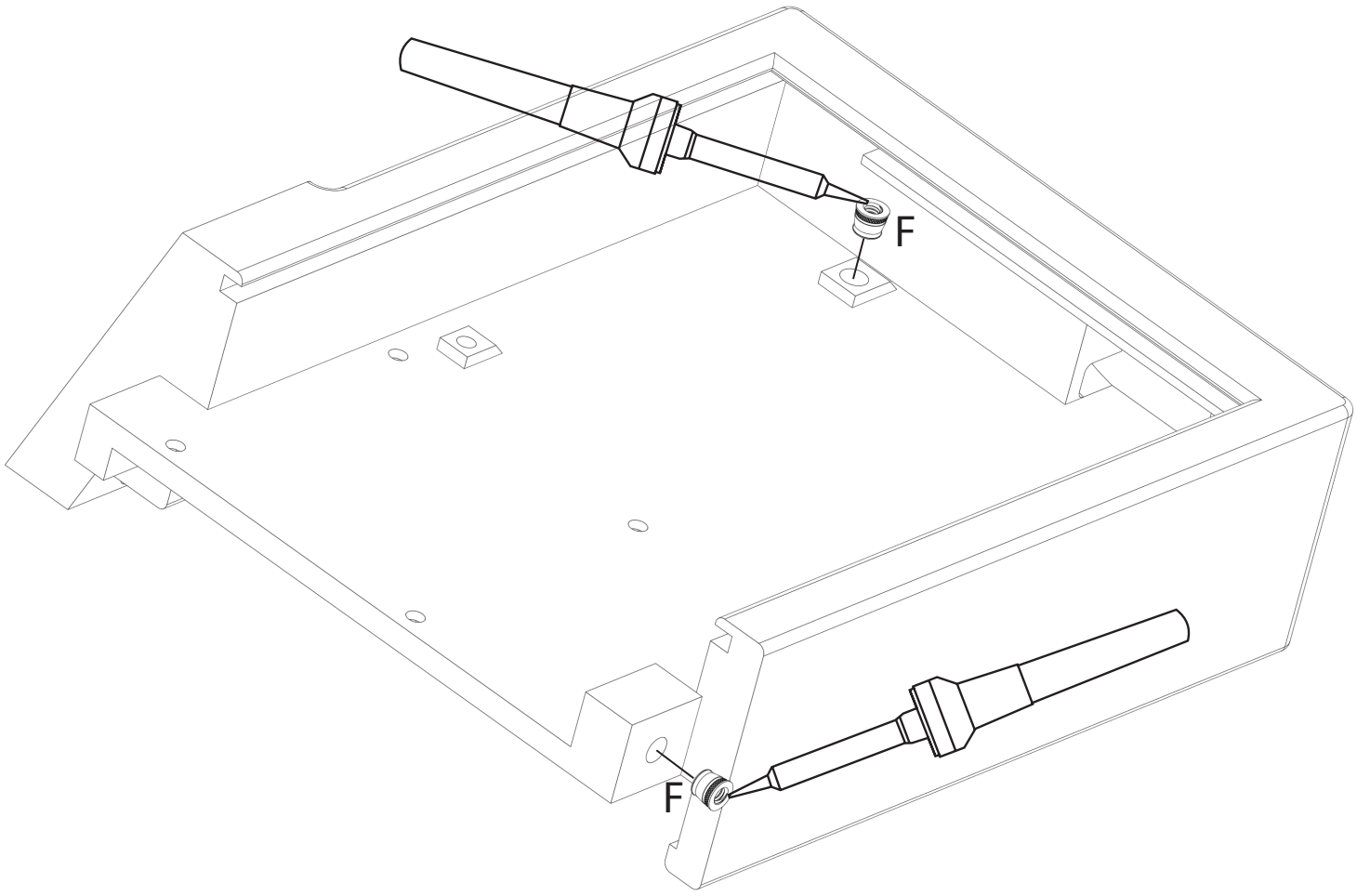
1



slowly push E into the plastic using the tip of a soldering iron

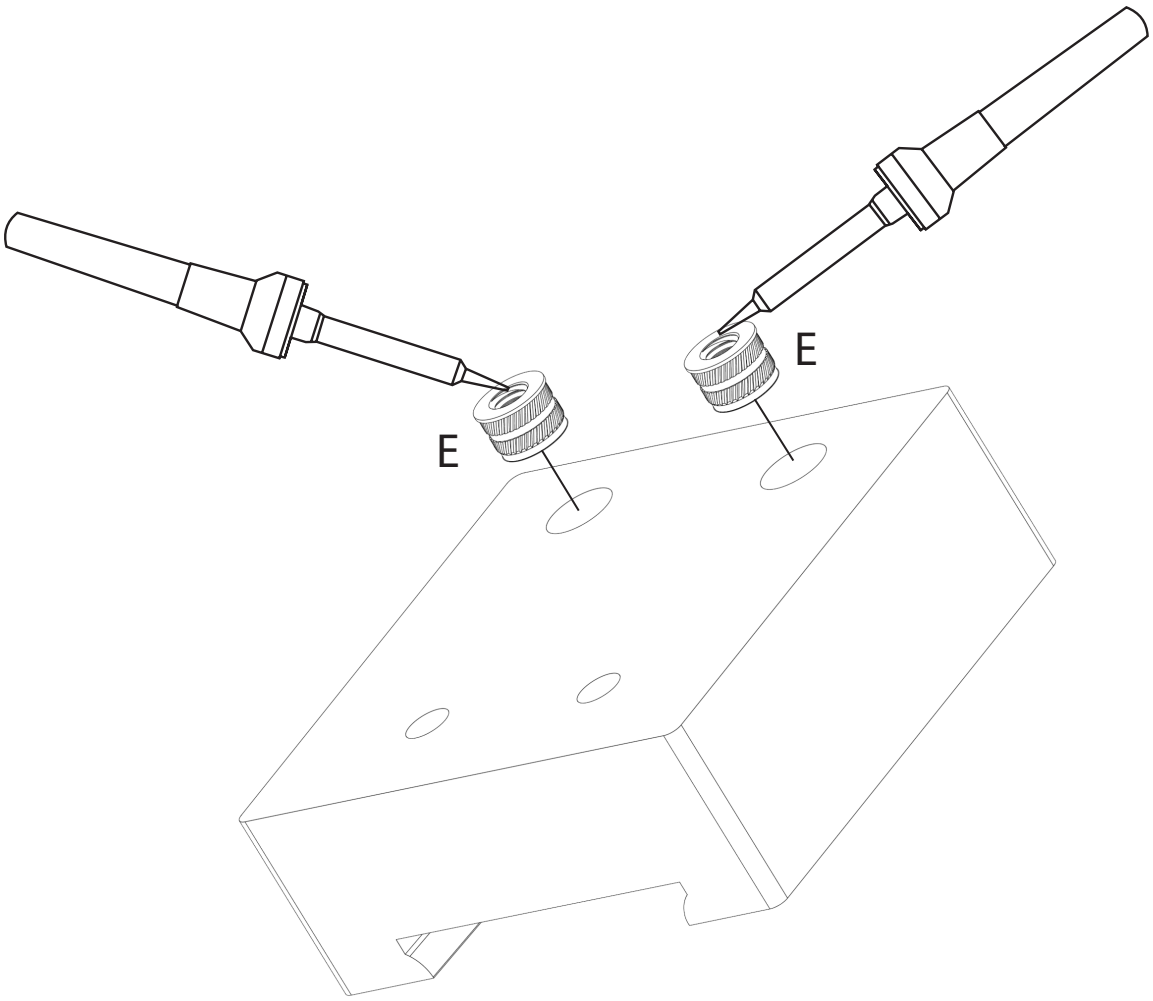


2



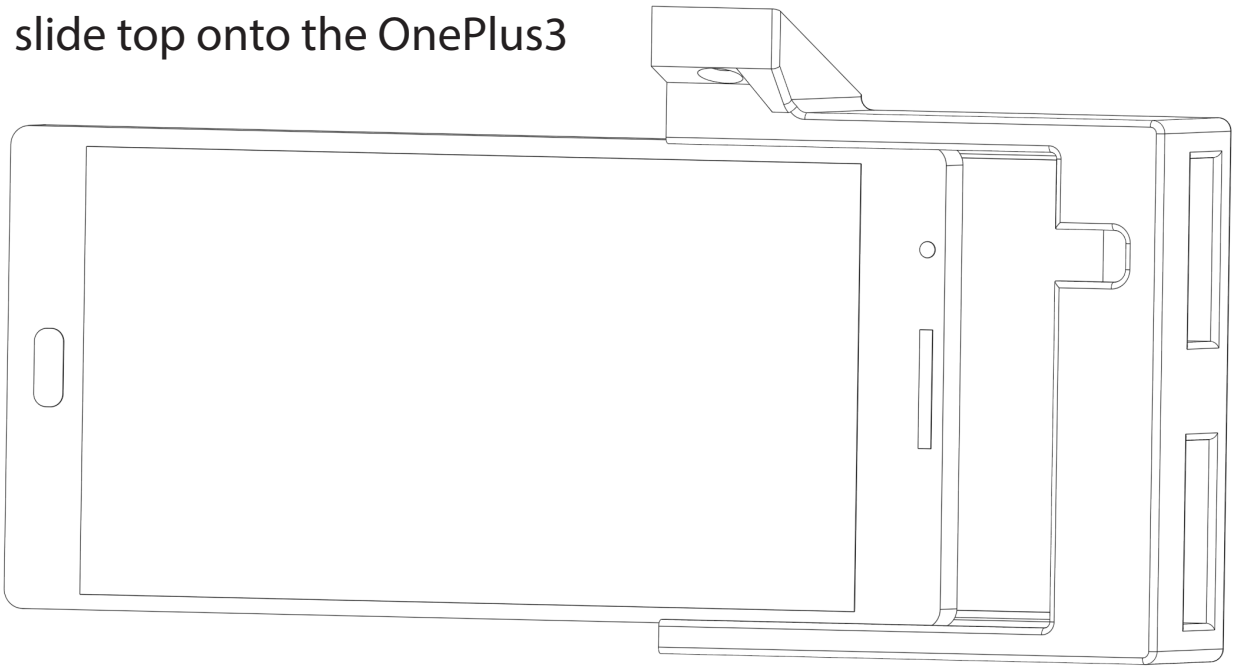
item F will take significantly less
force to insert than item E

3

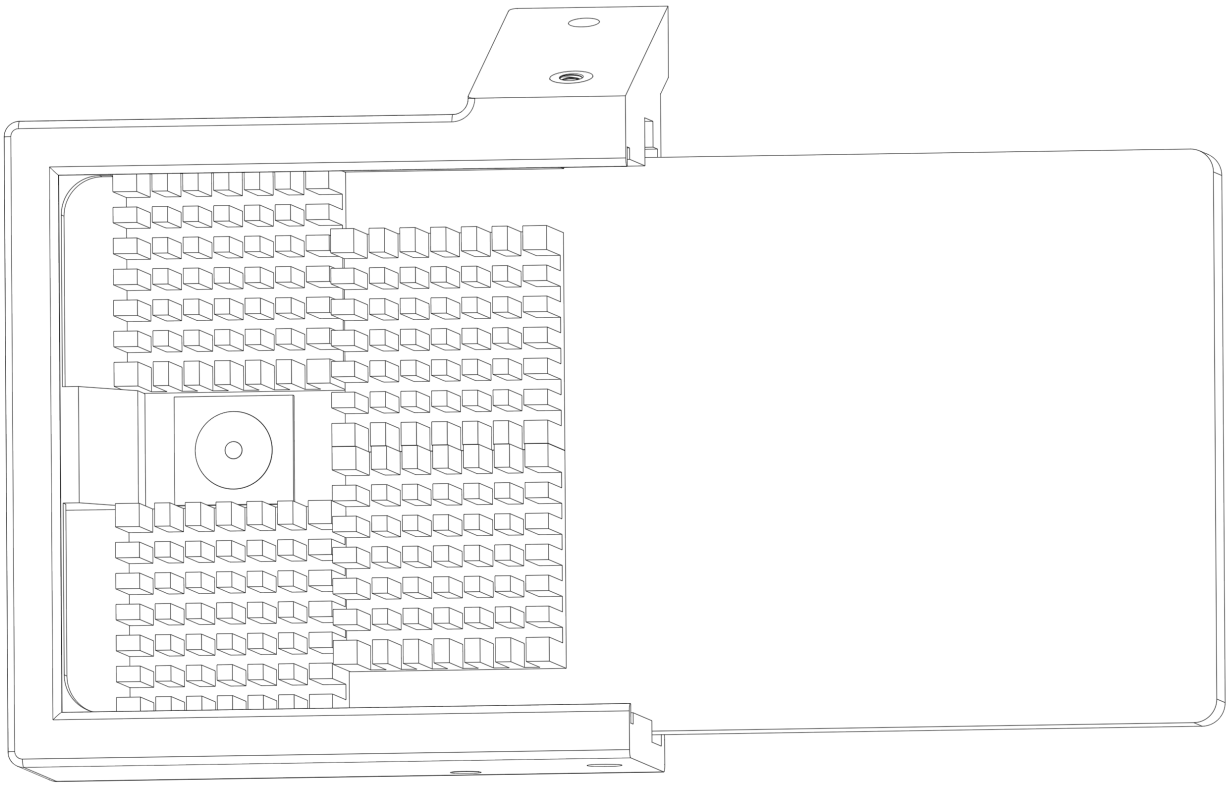


4

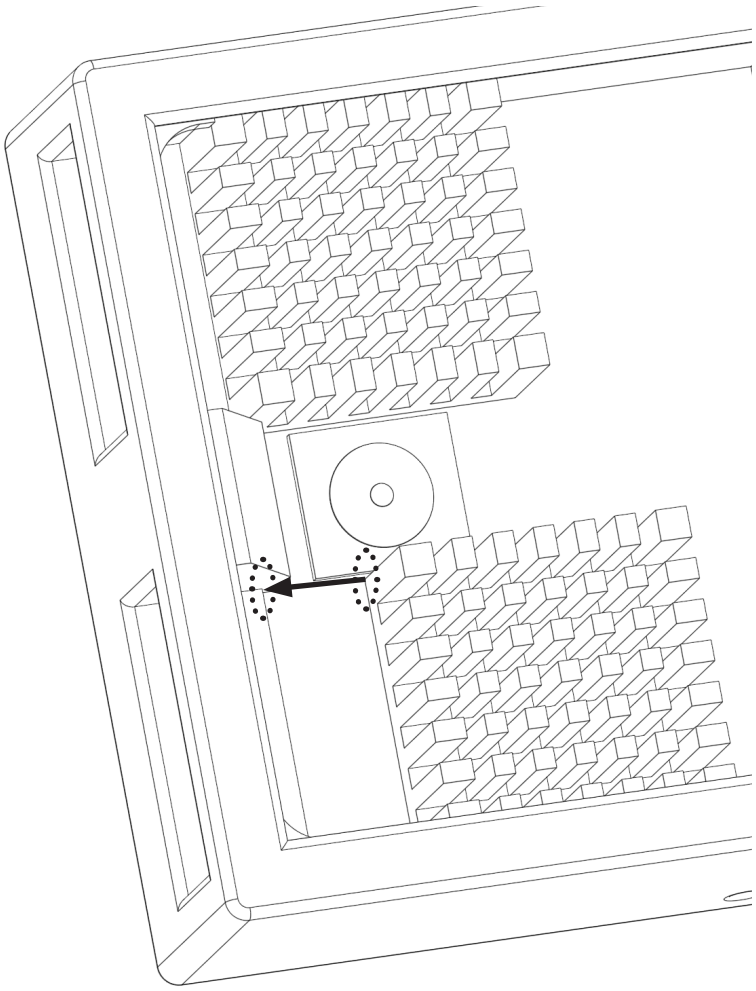
slide top onto the OnePlus3



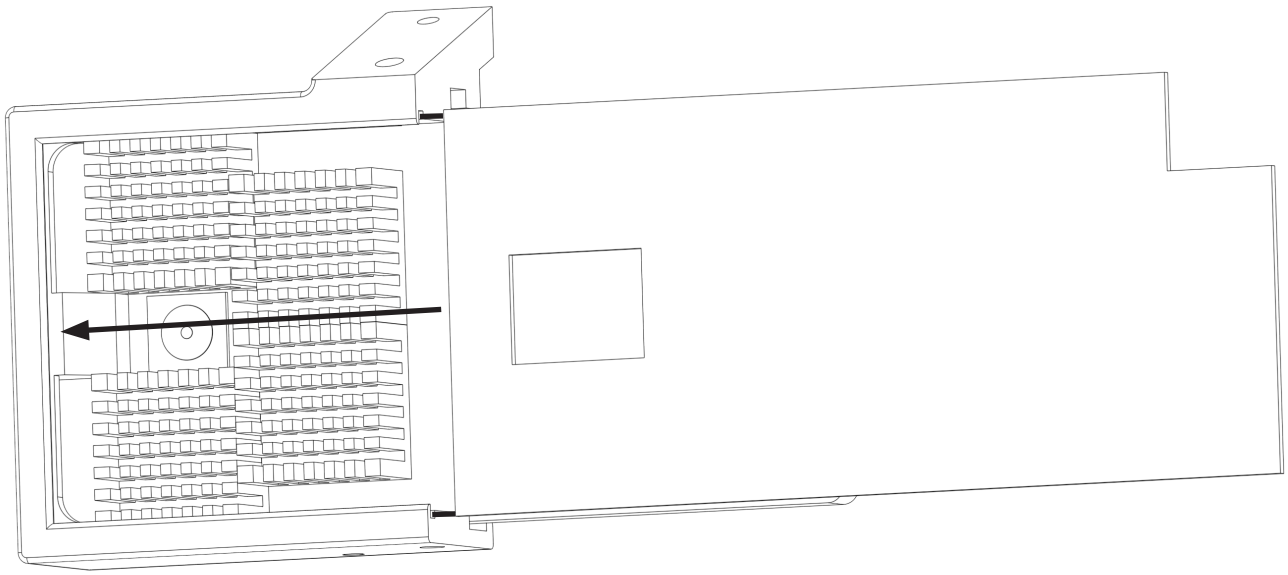
remove paper backing from heatsinks and
stick to the OnePlus3



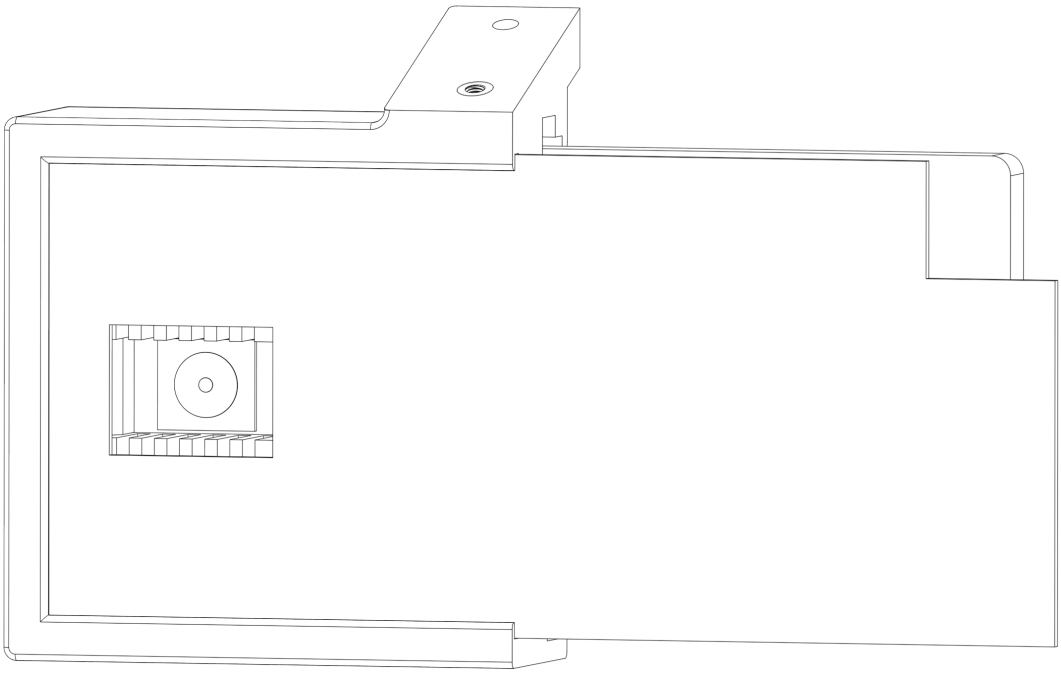
make sure the corners of the top heatsinks
are flush with the corners of the plastic case



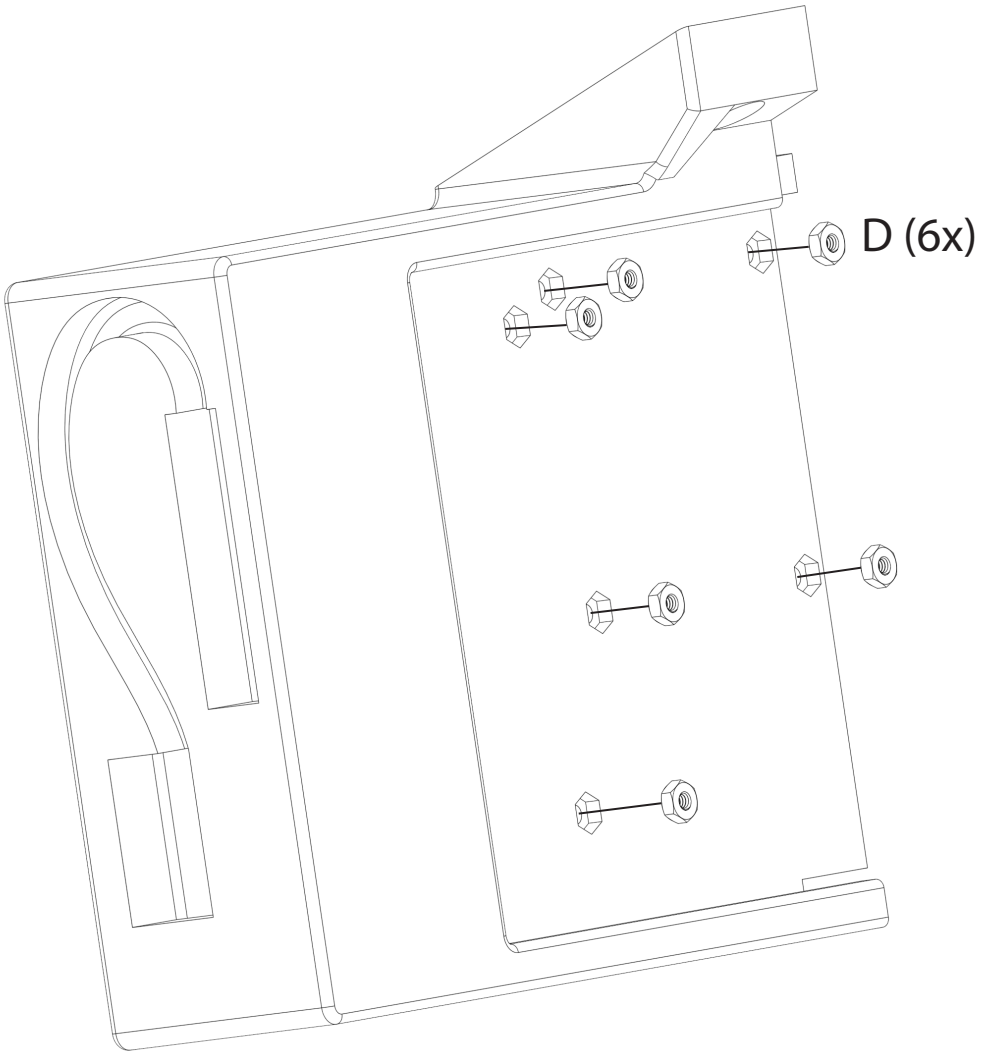
5



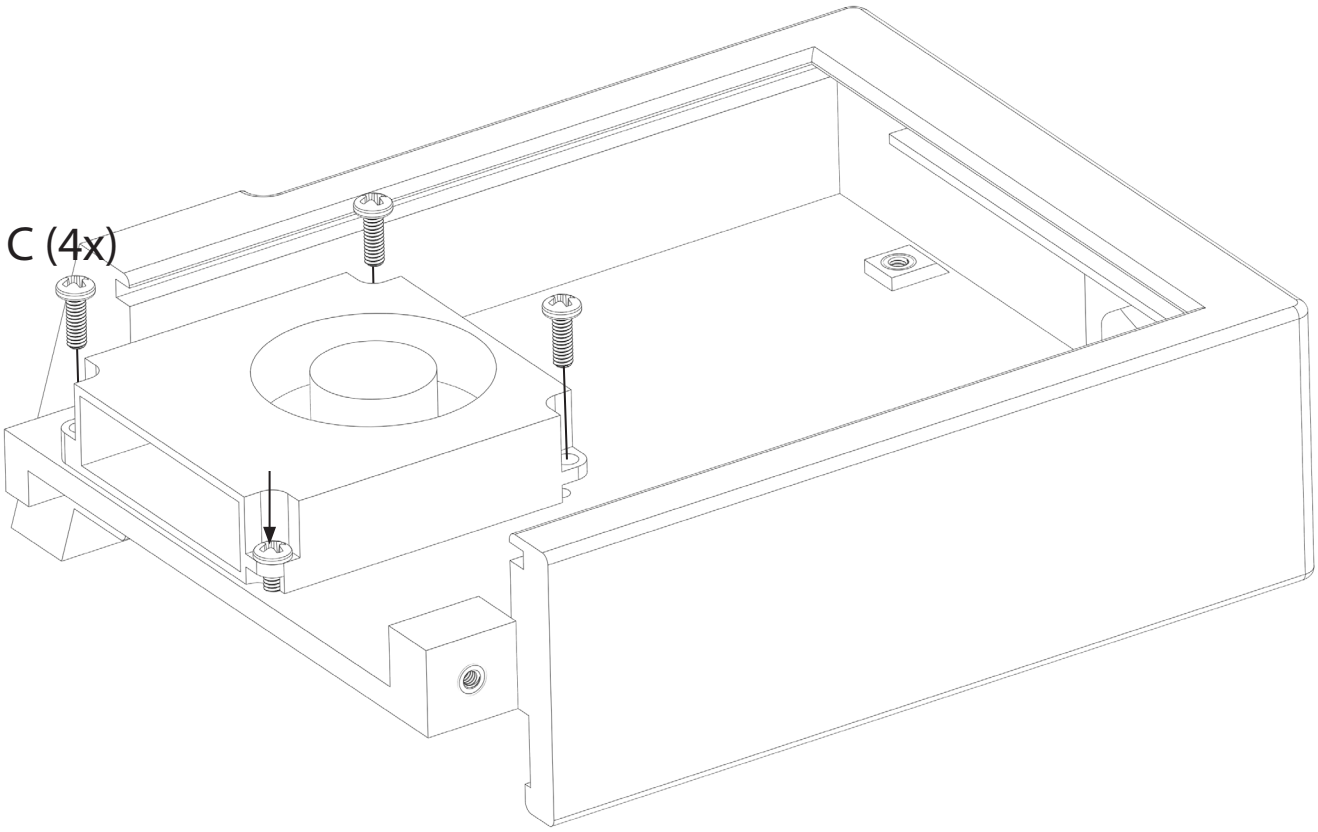
slide the cover into the top part of the case
then set aside to work with the bottom

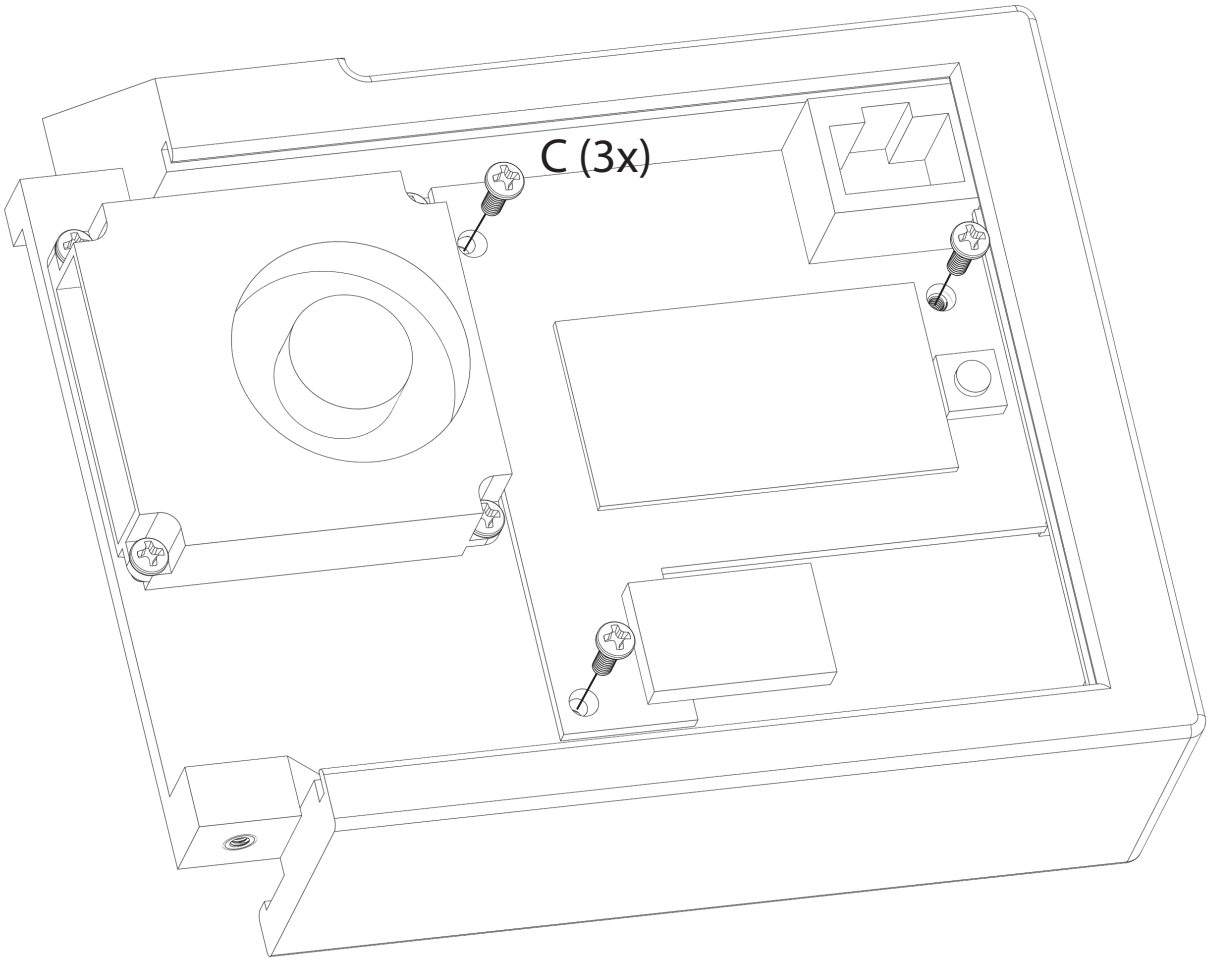


6

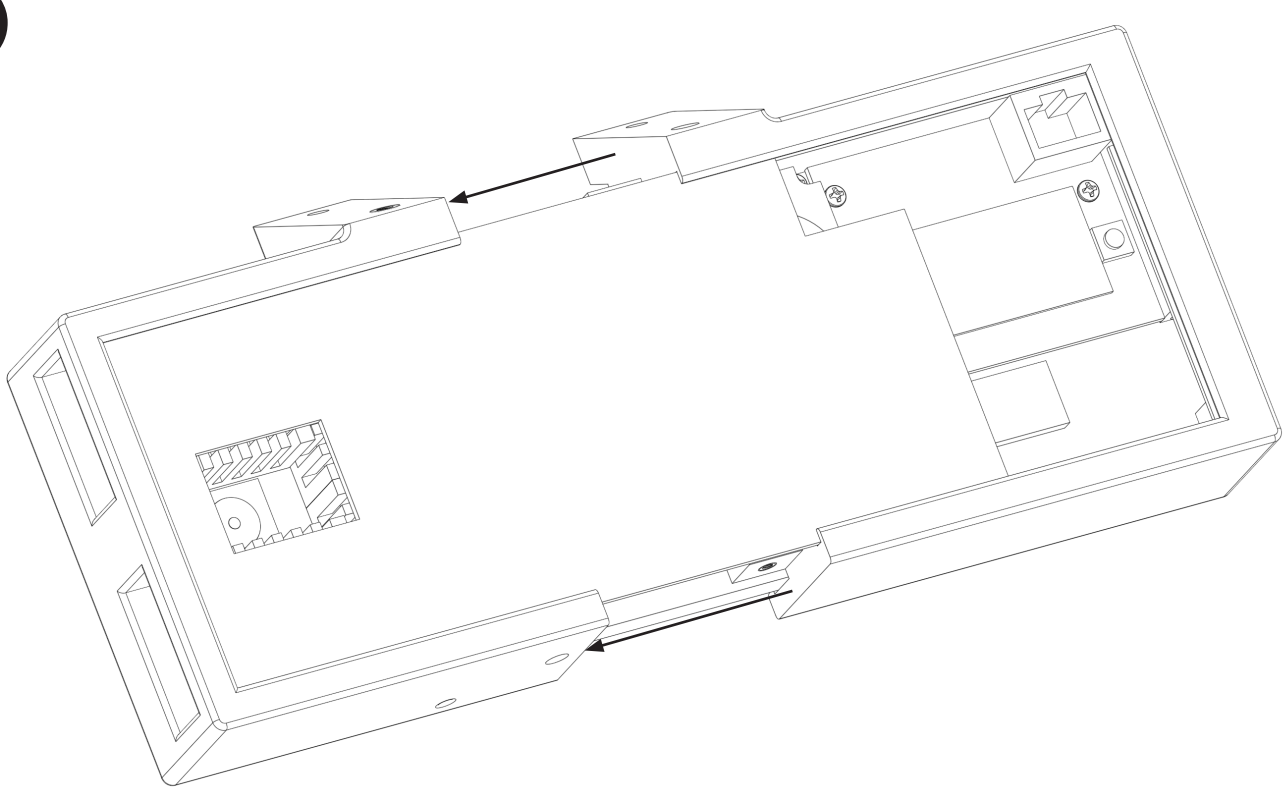


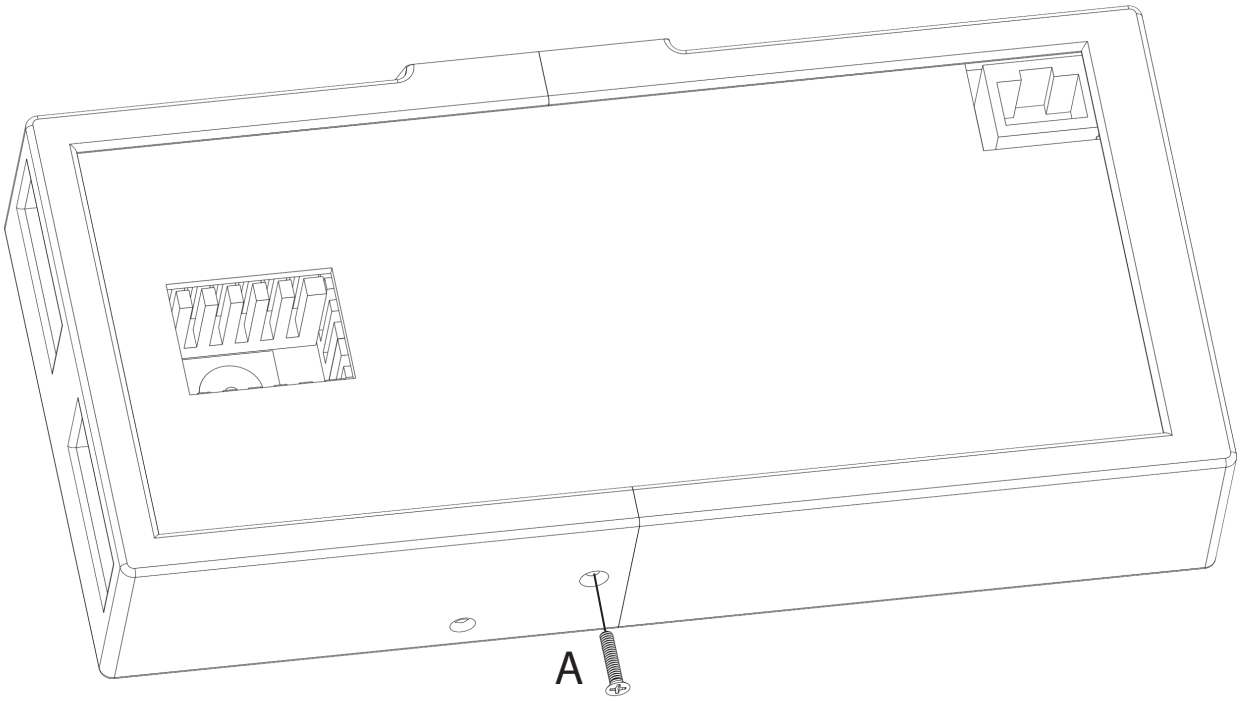
7



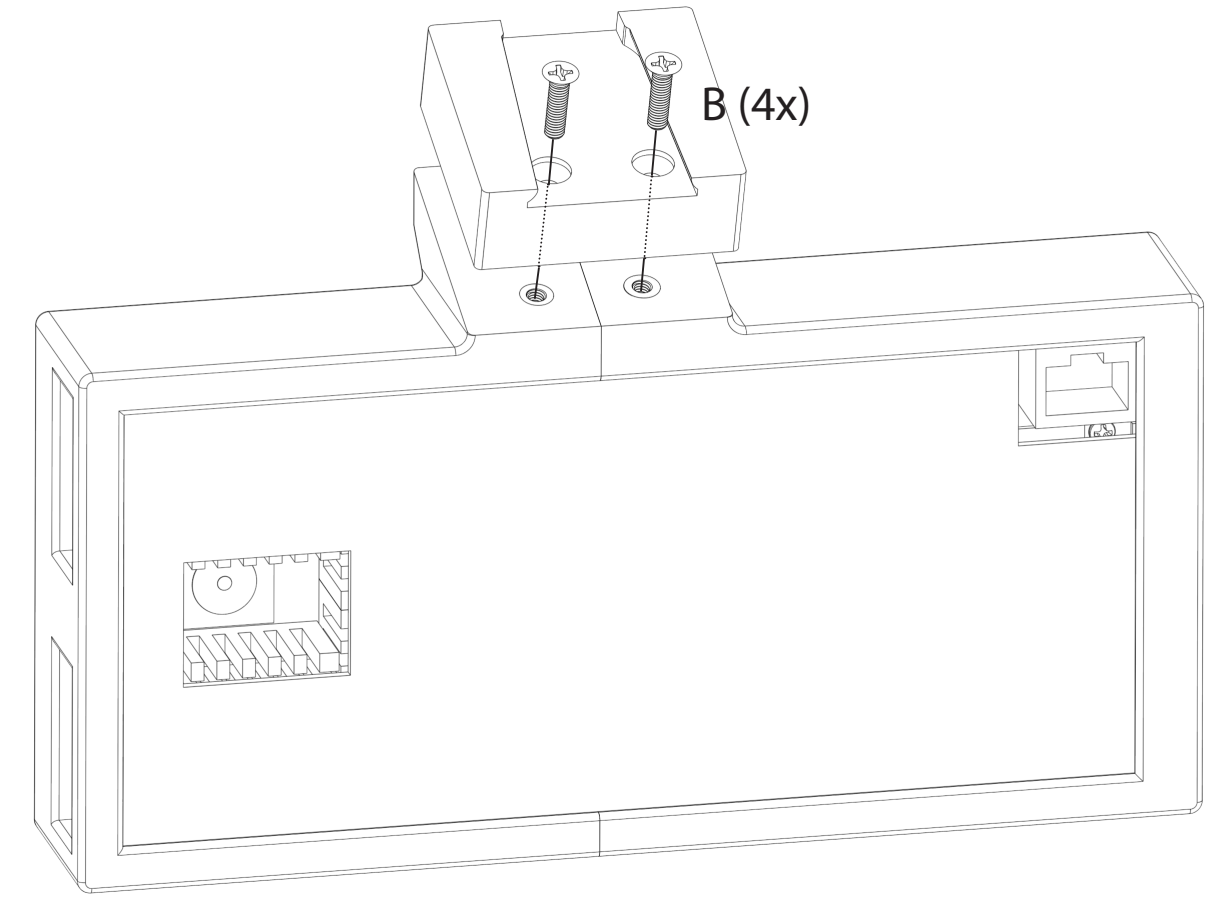


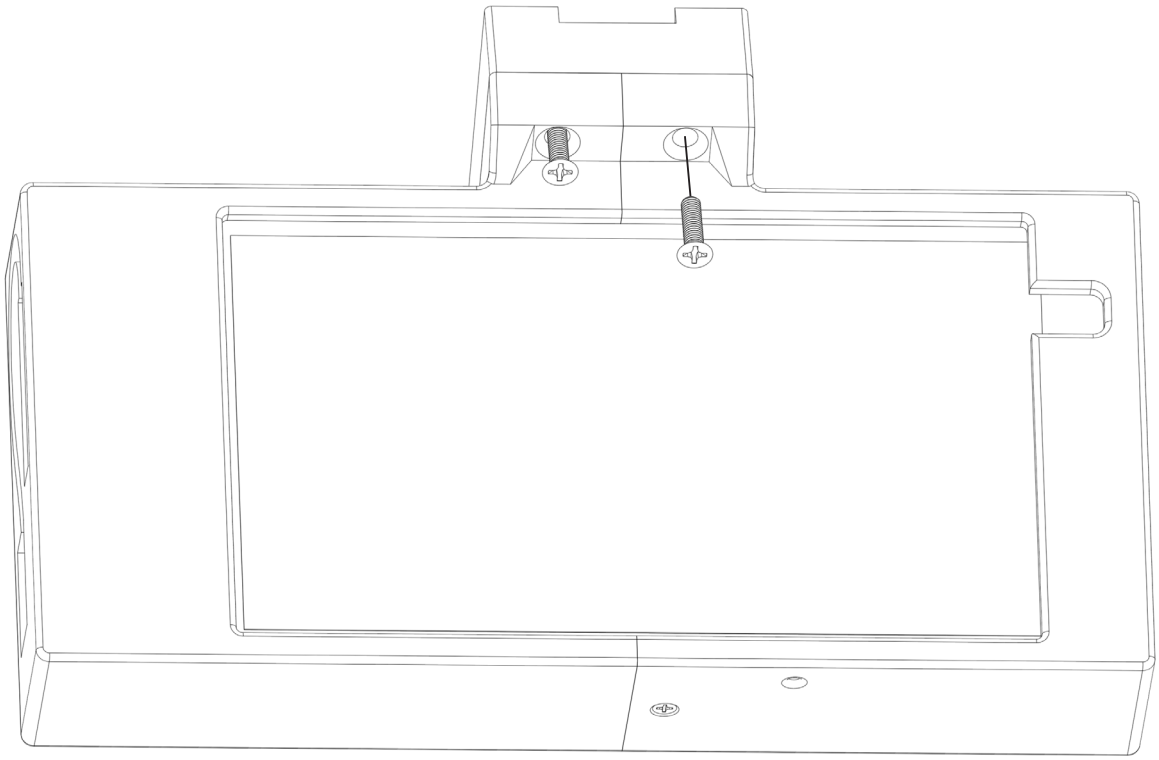
8



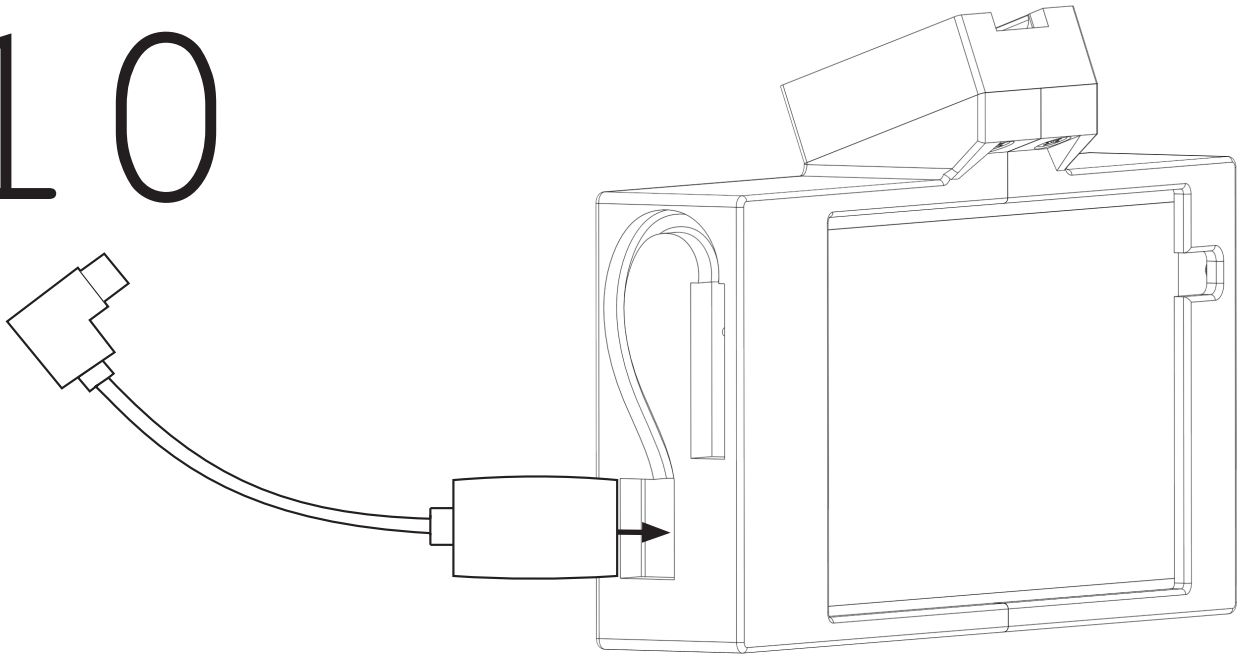


9

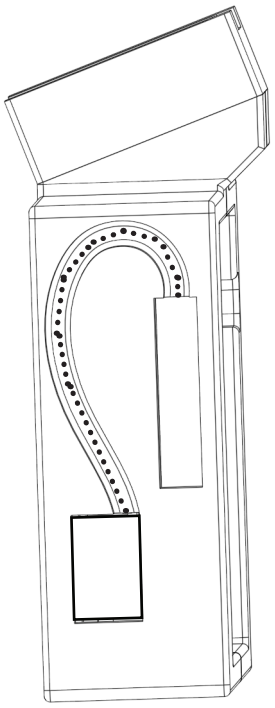




10

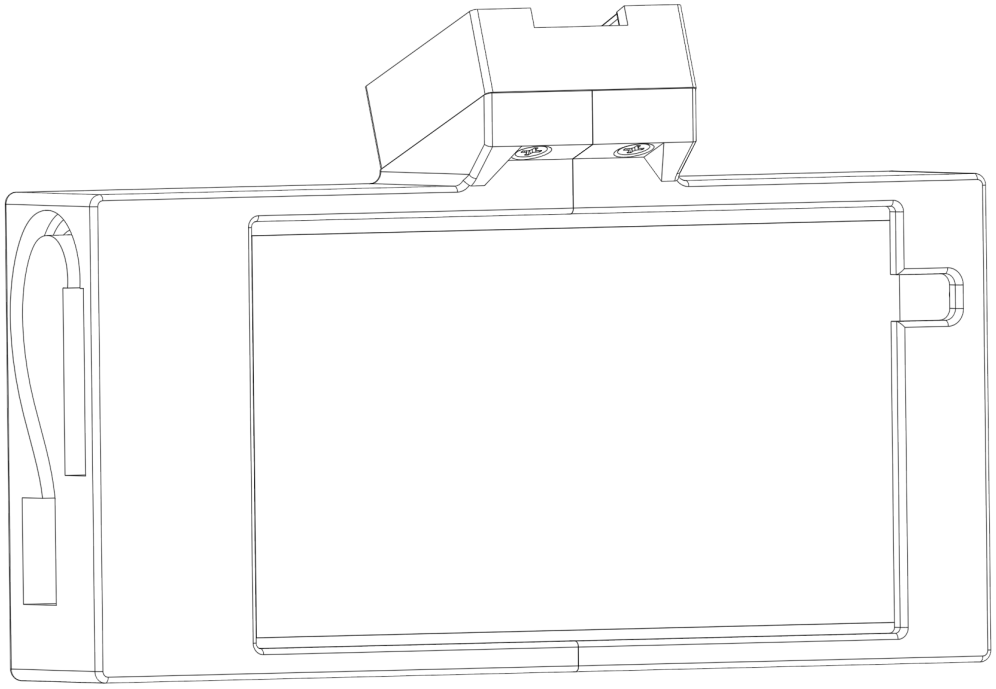


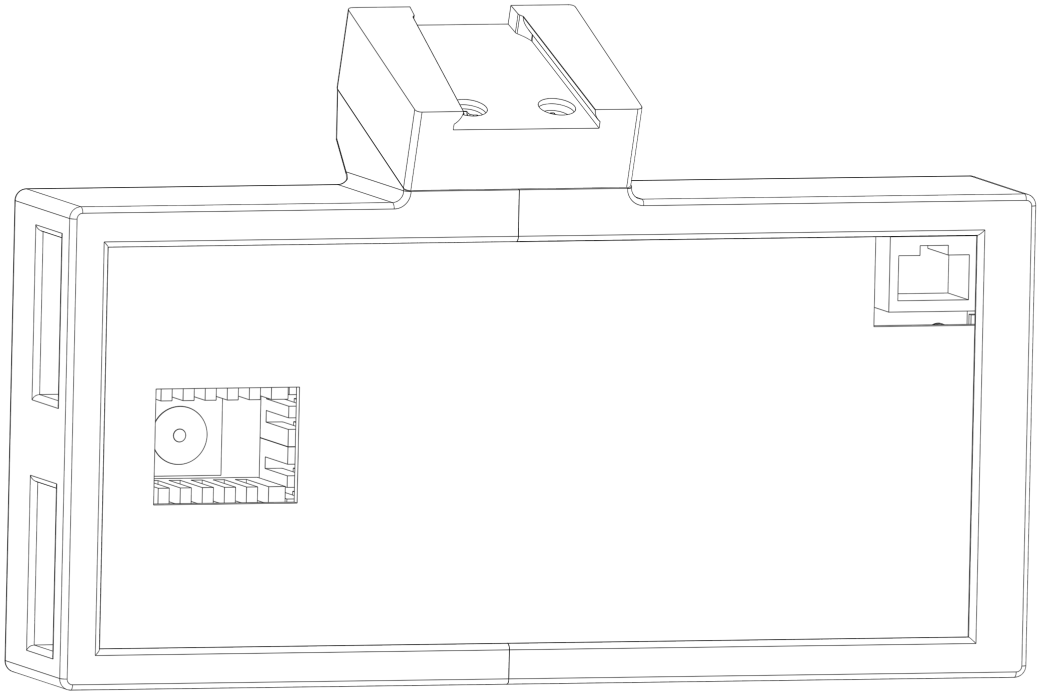
push the cable into the slot on the bottom of the case until it clicks into the interface board



snake the cable through the channel in the bottom of the case and plug the USB C connector into the OnePlus3 (this may take a few tries)

done





Copyright (c) 2016, comma.ai

Permission is hereby granted, free of charge, to any person obtaining a copy of this software and associated documentation files (the "Software"), to deal in the Software without restriction, including without limitation the rights to use, copy, modify, merge, publish, distribute, sublicense, and/or sell copies of the Software, and to permit persons to whom the Software is furnished to do so, subject to the following conditions:

The above copyright notice and this permission notice shall be included in all copies or substantial portions of the Software.

THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM, OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.