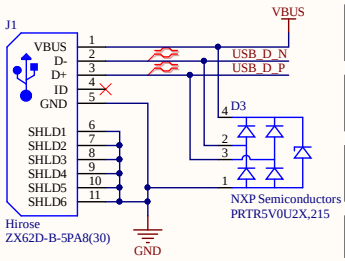
USB connector



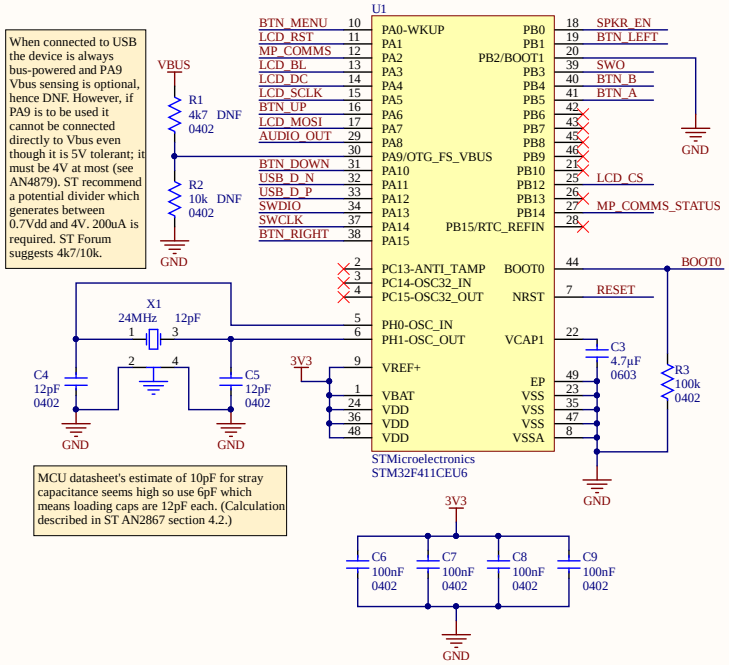
External series resistors on the data lines not required because MCU contains impedance matching (see AN4879).

STM32F401 and F411 have embedded pull-up resistor on USB_D+ line so no need for external pull-up.

Fit ESD protection close to USB connector. Also fit TVS on Vbus. D3 provides both functions.

USB shield and GND connected together following ST dev board designs.

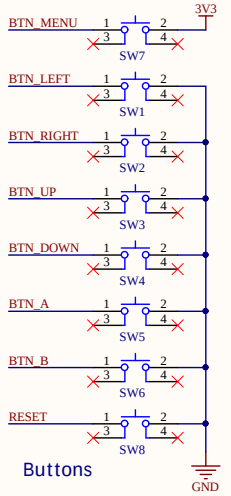
MCU



When connected to USB the device is always bus-powered and PA9 Vbus sensing is optional, hence DNF. However, if PA9 is to be used it cannot be connected directly to Vbus even though it is 5V tolerant; it must be 4V at most (see AN4879). ST recommend a potential divider which generates between 0.7Vdd and 4V. 200uA is required. ST Forum suggests 4k7/10k.

MCU datasheet's estimate of 10pF for stray capacitance seems high so use 6pF which means loading caps are 12pF each. (Calculation described in ST AN2867 section 4.2.)

Clearly mark SW5-SW8 with the labels 'A', 'B', 'Menu' and 'Reset' on the silkscreen.

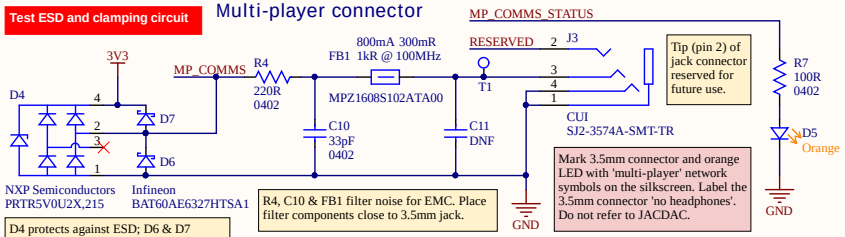


Buttons

Physically arrange SW1-SW4 in a 'D-pad' configuration on the board left-hand side . Put SW5 & SW6 on the right-hand side of the board with SW5 above and to the right of SW6. Locate SW7 & SW8 as preferred.

Multi-player connector

Test ESD and clamping circuit



Tip (pin 2) of jack connector reserved for future use.

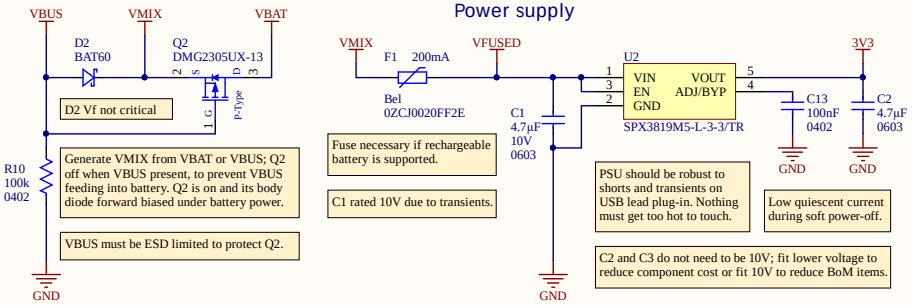
Mark 3.5mm connector and orange LED with 'multi-player' network symbols on the silkscreen. Label the 3.5mm connector 'no headphones'. Do not refer to JACDAC.

R4, C10 & FB1 filter noise for EMC. Place filter components close to 3.5mm jack.

D4 protects against ESD; D6 & D7 protect against DC under- and over-voltage. D6 must be <0.3V Vf at 23mA.

ESD protection via D4, clamping via D6/7.

Power supply



D2 Vf not critical

Generate VMIX from VBAT or VBUS; Q2 off when VBUS present, to prevent VBUS feeding into battery. Q2 is on and its body diode forward biased under battery power.

VBUS must be ESD limited to protect Q2.

Fuse necessary if rechargeable battery is supported.

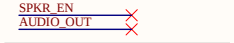
C1 rated 10V due to transients.

PSU should be robust to shorts and transients on USB lead plug-in. Nothing must get too hot to touch.

Low quiescent current during soft power-off.

C2 and C3 do not need to be 10V; fit lower voltage to reduce component cost or fit 10V to reduce BoM items.

Audio

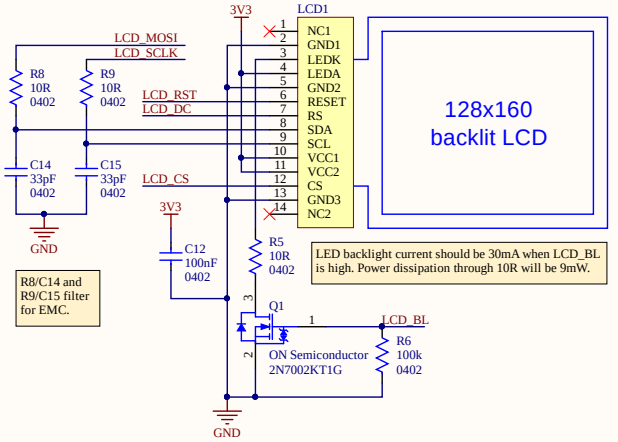


Fit an audio fillter, amplifier and speaker which can be driven from a 300kHz digital PWM output from the MCU.

Provide test points for audio if required.

Audio circuit not yet implemented

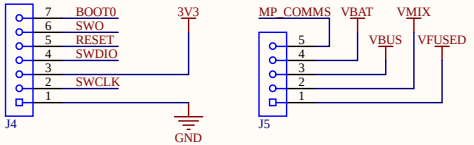
Display



R8/C14 and R9/C15 filter for EMC.

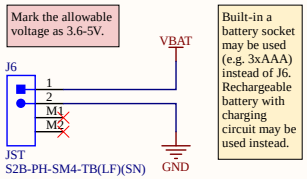
LED backlight current should be 30mA when LCD_BL is high. Power dissipation through 10R will be 9mW.

Programming, debug & test connector footprints



Connector footprints which support a manufacturing jig and also allow a header to be used to support ad-hoc and low volume testing. Place footprint so that hole centres are exactly 0.1" from board edge.

External battery connector



Mark the allowable voltage as 3.6-5V.

Built-in a battery socket may be used (e.g. 3xAAA) instead of J6. Rechargeable battery with charging circuit may be used instead.

Style and polartiy matches Adafruit circuit playground express.

Include the URL 'arcade.makecode.com' on the board silkscreen.

See second schematic sheet for suggested alternative components.

For more information see https://arcade.makecode.com/hardware/adding.

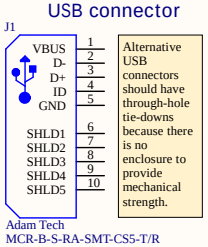
Manufacturing flashing and testing requires connection to test points/hack-connect, USB and multi-player connectors.

Key: **TO-DO** | Silkscreen notes | Design notes

Microsoft	PROJECT DESCRIPTION: MakeCode Arcade reference design for STM32F4				SHEET DESCRIPTION: complete design	
SHEET FILENAME: ArcadeMVD-STM 01-1.5 complete design.SchDoc	PROJECT FILENAME: ArcadeMVD-STM 01-1.5.PrjPCB	PROJECT CODENAME: MS-ArcadeMVD-STM	LICENCE: Attribution 4.0 International (CC BY 4.0)	LAST MODIFIED: 30/08/2019	PAGE: 1 OF 2	DRAWN BY: Steve Hodges	REVISION: 1.5	PCB ID: 01-1.5

Disable compile mask before BoM generation to include alternative parts, enable before forward annotation.

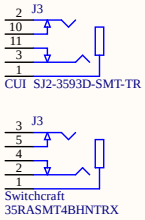
USB connector



Alternative USB connectors should have through-hole tie-downs because there is no enclosure to provide mechanical strength.

Adam Tech
MCR-B-S-RA-SMT-CS5-T/R

Multi-player connector



CUI SJ2-3593D-SMT-TR

Switchcraft
35RASMT4BHNTRX

Multi-player connector can be either 3-way or 4-way 3.5mm audio jack socket; contact switching is not required. Many alternative connectors exist.

CUI SJ2-3593A/B/C/D are all suitable and share similar footprint to SwitchCraft 35RASMT4BHNTRX.

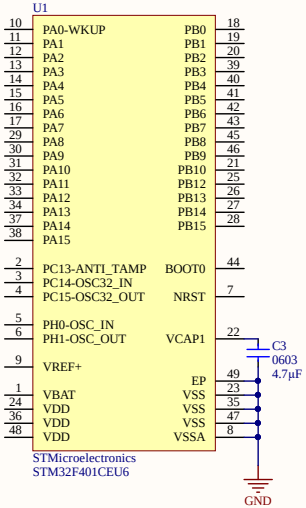
CUI SJ2-3574A (4-way) or SJ2-3573A (3-way) or SJ2-3573A2 (3-way) are suitable; Chinese PJ-320D-X connector shares a similar footprint. If using a 4-way connector, short together the shaft and the adjacent ring on PCB.

Do NOT use PJ-320D-4A or PJ-328, in testing these occasionally short the GND to the tip which could be a problem in the future.

This schematic page contains suggested alternative components, alternative circuits and notes about alternatives. Reference designators are duplicated. Do NOT compile this page into the design, use the compile mask (top left) to hide it before compiling.

MCU

Several alternative MCUs in STM32F4 series are possible; min spec is 96k RAM, 512k flash, 84MHz, 48 pins. Examples include STM32F401CEU6, STM32F411CEU6, STM32F401RET6, STM32F411RET6. Also possible are F412 and F413 parts which meet the spec.

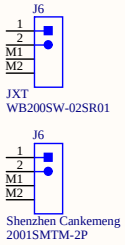


STMicroelectronics
STM32F401CEU6

C2 and C3 do not need to be 10V; fit lower voltage to reduce component cost or fit 10V to reduce BoM items.

External battery connector

Many alternative JST PH series compatible connectors are available.



JXT
WB200SW-02SR01

Shenzhen Cankemeng
2001SMTM-2P

Display

Q1 can be a FET or BJT, adjust passives to suit.

Buttons

Any tact button may be used.

Audio

Many alternative audio amps and speakers/sounders are possible.

Crystal

Any 8, 16 or 24MHz crystal is fine.

Crystals with 20pF capacitance require 20-28pF; crystals with 18pF capacitance which requires 16-24pF loading caps. In theory a crystal with 10pF capacitance may require no external loading caps but datasheet estimate of PCB parasitics of 5pF seems high.

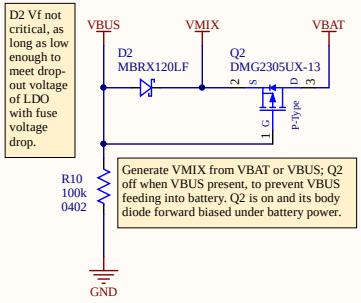
8MHz
20pF

Power supply

If using a rechargeable battery, provide adequate physical protection to prevent damage to the battery by kids and provide adequate electronic protection to ensure short-circuits on the board do not draw levels of current which could result in danger for the user, e.g. by overheating.

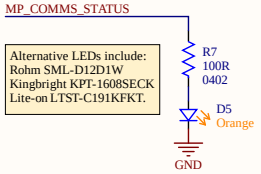
Many alternative LDOs possible, check max current and power dissapation. Quiescent current below 200uA is recommended due to soft power-off feature.

D2 Vf not critical, as long as low enough to meet drop-out voltage of LDO with fuse voltage drop.



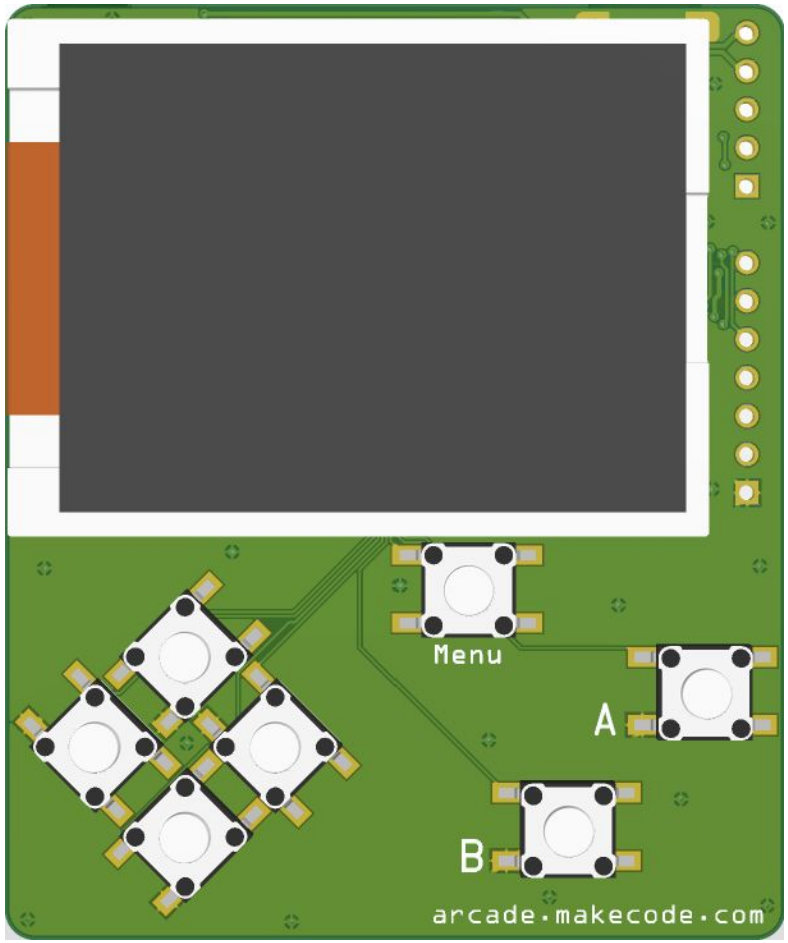
Generate VMIX from VBAT or VBUS; Q2 off when VBUS present, to prevent VBUS feeding into battery. Q2 is on and its body diode forward biased under battery power.

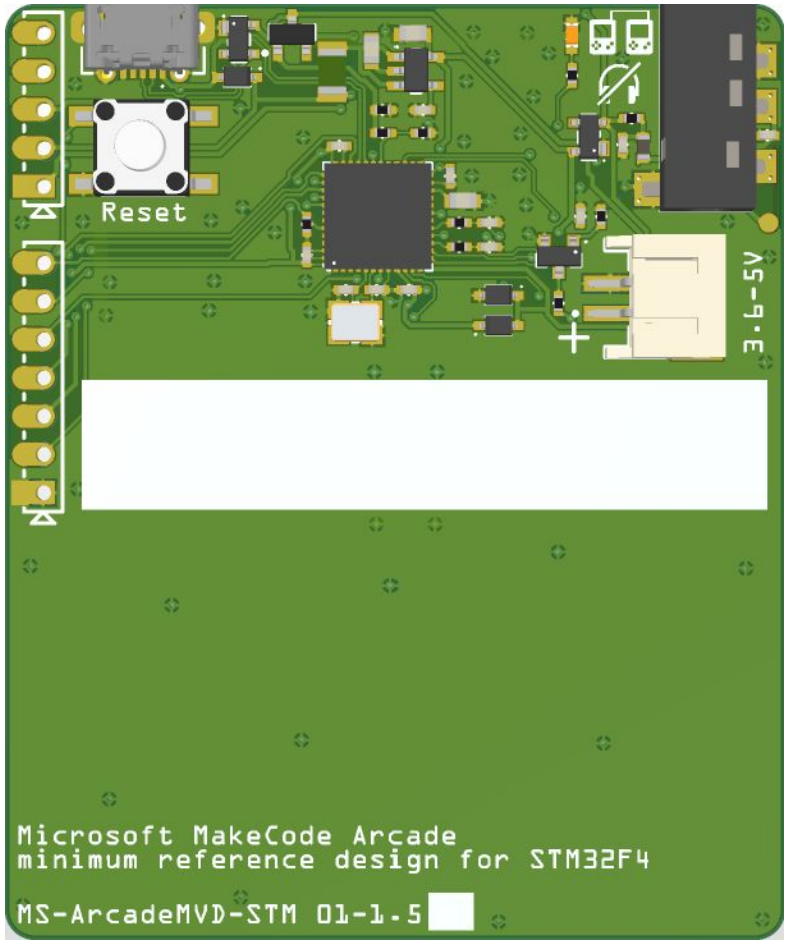
Multi-player connector

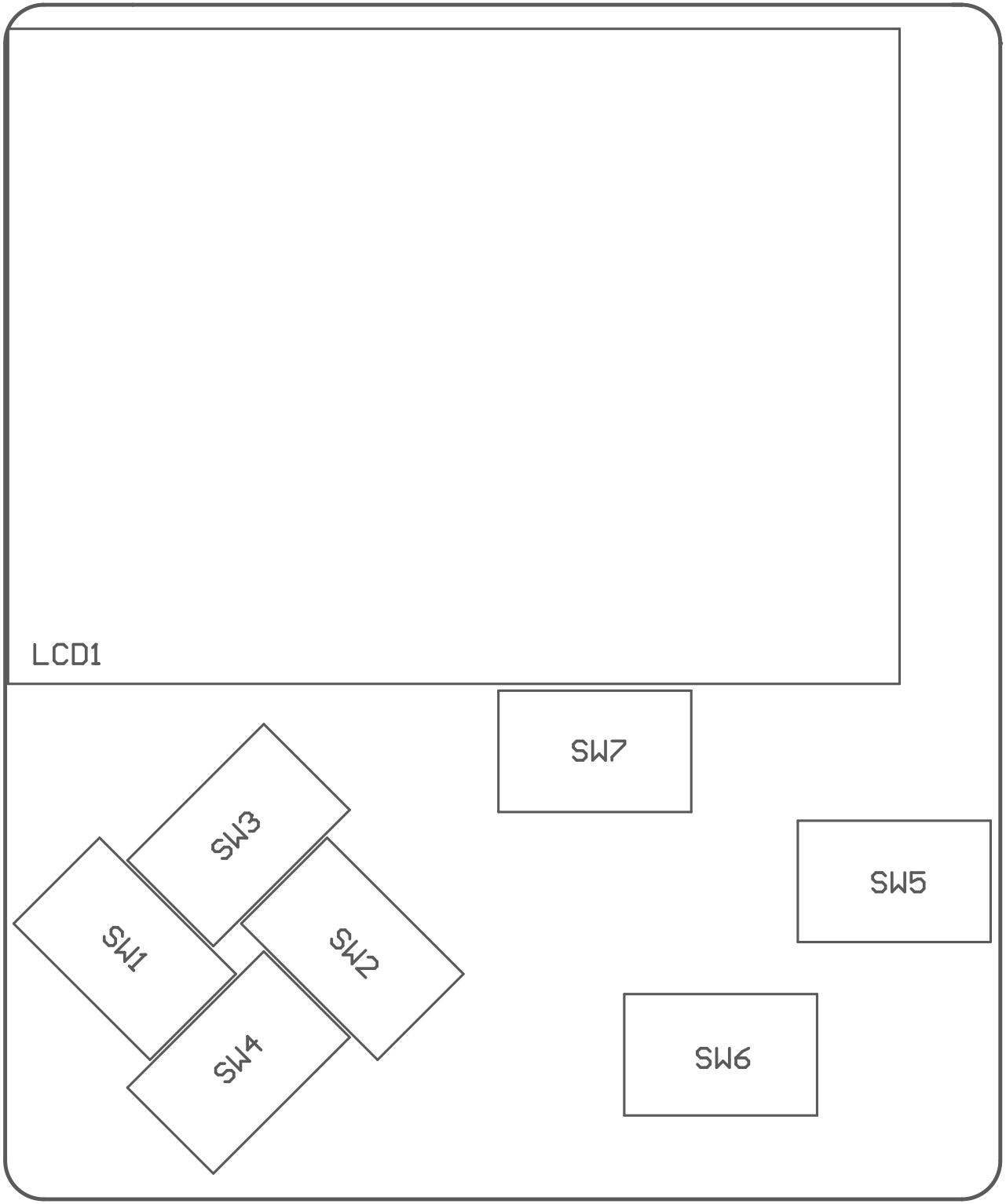


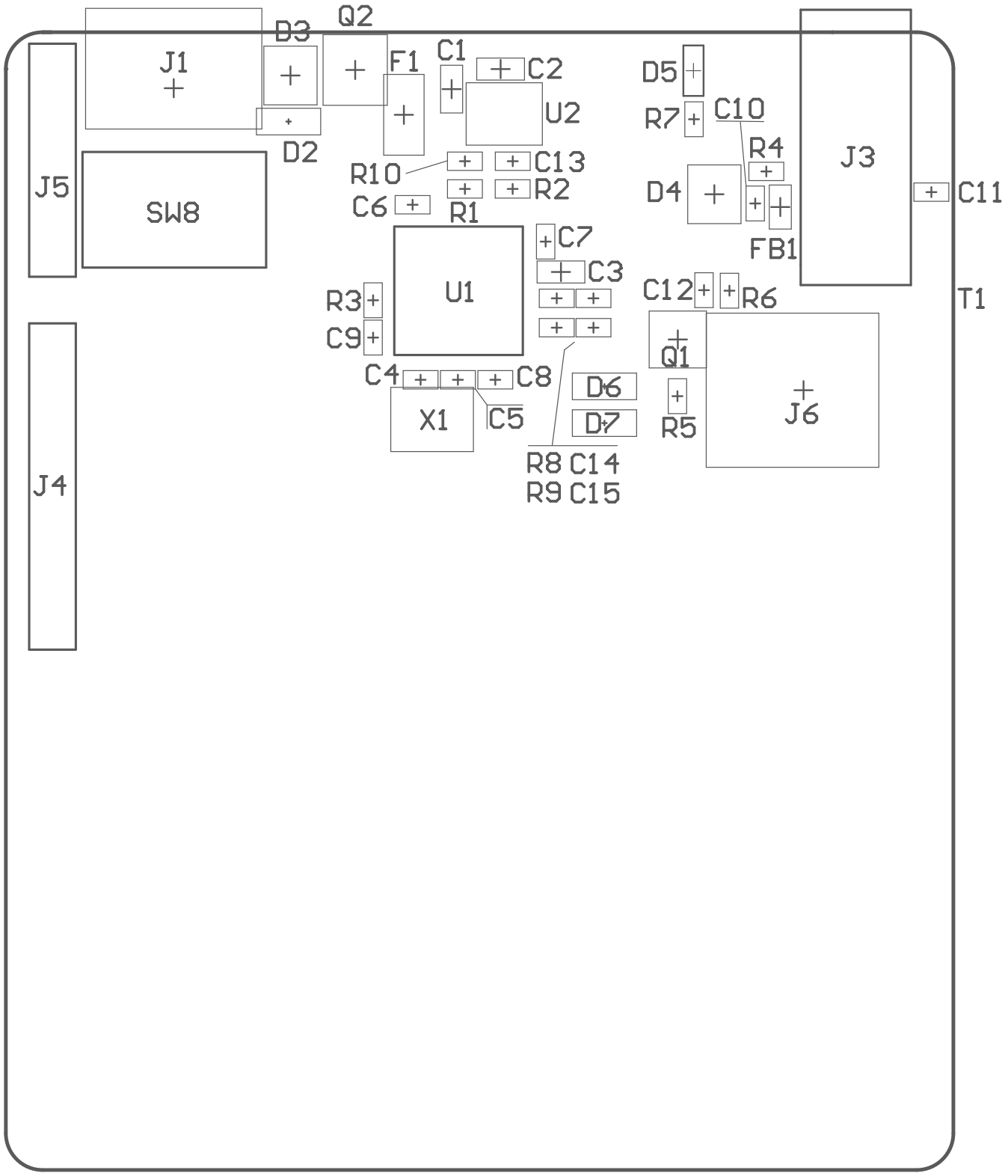
Alternative LEDs include:
Rohm SML-D12D1W
Kingbright KPT-1608SECK
Lite-on LTST-C191KFKT.

Microsoft	PROJECT DESCRIPTION: MakeCode Arcade reference design for STM32F4					SHEET DESCRIPTION: alternative parts	
SHEET FILENAME: ArcadeMVD-STM 01-1.5 alternative parts.SchDoc	PROJECT FILENAME: ArcadeMVD-STM 01-1.5.PrjPCB	PROJECT CODENAME: MS-ArcadeMVD-STM	LICENCE: Attribution 4.0 International (CC BY 4.0)	LAST MODIFIED: 30/08/2019	PAGE: 2 OF 2	DRAWN BY: Steve Hodges	REVISION: 1.5 PCB ID: 01-1.5


Menu
A
B
arcade.makecode.com


Reset
3.6-5V
Microsoft MakeCode Arcade
minimum reference design for STM32F4
MS-ArcadeMVD-STM 01-1.5


LCD1
SW7
SW3
SW1
SW2
SW4
SW5
SW6


J1
D3
Q2
F1
C1
C2
U2
D5
R7
C10
R4
J3
C11
T1
D2
R10
C13
R2
D4
FB1
J5
SW8
C6
R1
C7
C3
U1
C12
R6
R3
C9
Q1
J6
C4
C8
D6
X1
C5
D7
R5
R8
C14
R9
C15
J4