RPC-4000 Replica

Preliminary Building Instructions
Draft 0.1, 18. August 2019
For board revision 03-2018

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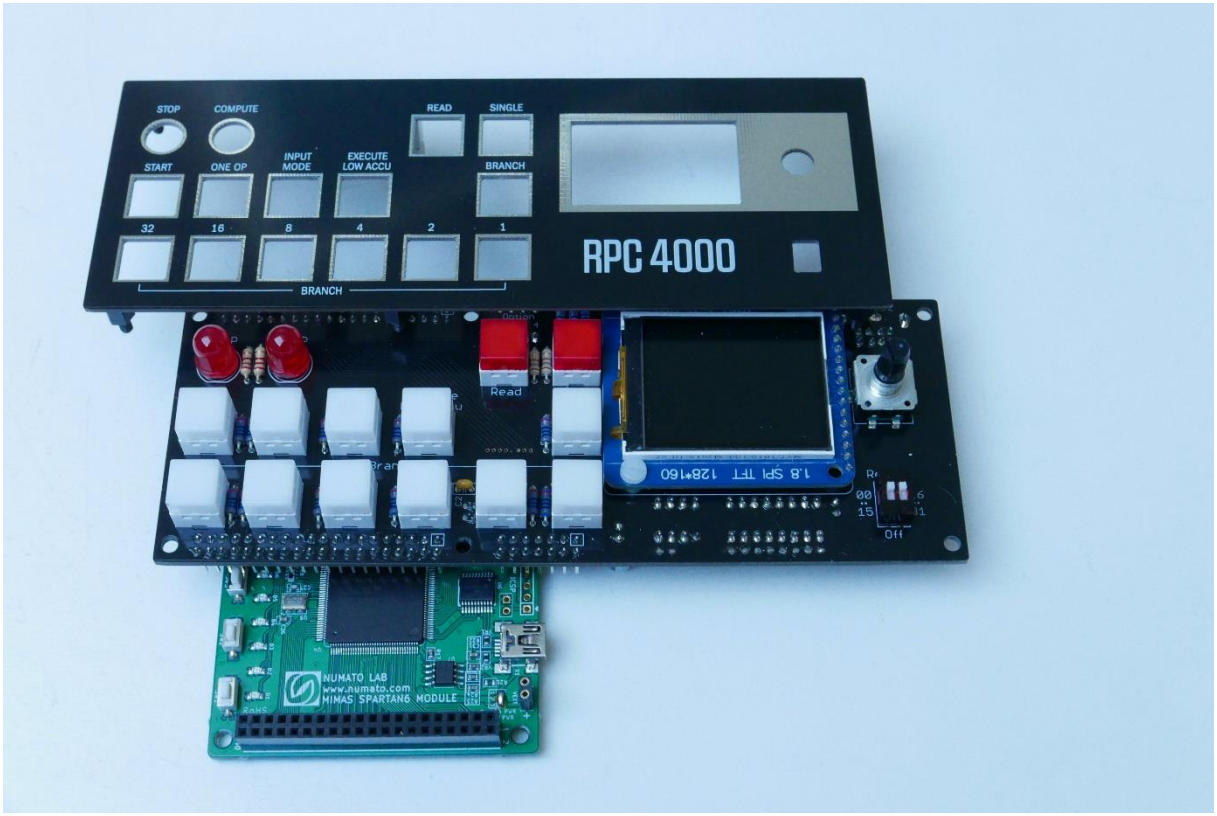
Please see www.e-basteln.de/rpc4000 for more information.

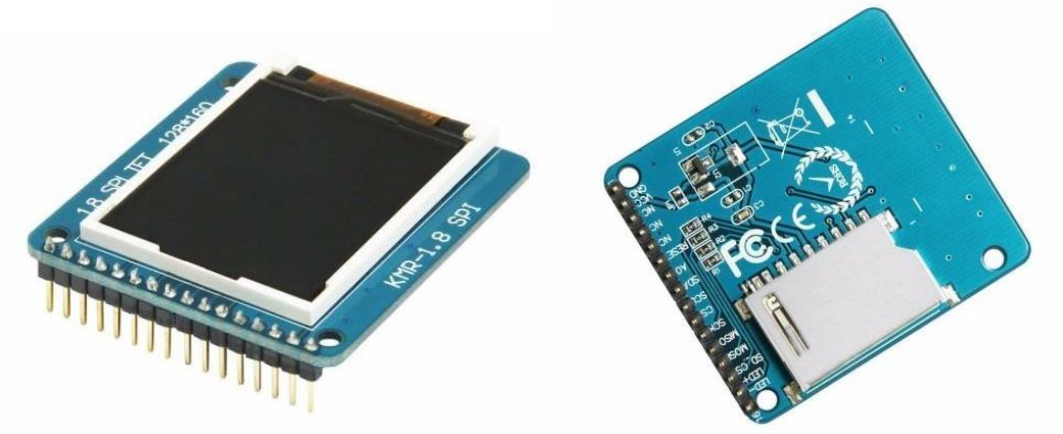
Contents



Building Notes

Parts

- All required components are listed in the BOM (appendix of this document), except for mechanical mounting parts. See the "Mounting" section below for comments on mounting hardware.
- All parts are available from standard distributors like Mouser, except for the FPGA and display modules.
- The Numato Mimas (Spartan 6) FPGA module is available directly from the manufacturer, Numato.com. Shipment from India via DHL has worked smoothly for me several times. I have not tried the resellers on Amazon and ebay.
- The display KMR-1.8 SPI, 128*160 pixels, comes in slightly different versions. Be sure to get the version with SPI interface and a single row of pins, as pictured here.



PCB Assembly

Assembly of the RPC-4000 PCB is mostly straightforward. Just a few notes:

- Prepare the LCD display.
  - It will be powered by 5V, so its on-board 3.3V regulator needs to be active. Jumper JP1, near the GND and VCC terminals on the pin header, needs to be **open**.
  - I removed the SD card slot from the bottom of the LCD, for the lowest mounting profile. If you do not have a hot air soldering station, this can be done destructively with a conventional soldering iron: Unsolder the two tabs at the SD card cage's front edge; slightly bend up the sheet metal enclosure; unsolder the two tabs at the back; repeatedly bend up further to break off all the signal connections; unsolder the left-behind pins from their pads to clean up.
- The LCD, encoder, and 2x DIP switch are mounted on top of the PCB, and will jointly determine the height of the front panel. A test fit of these components, the OMRON switches, and the spacers you intend to use between the PCB and the front panel, is highly recommended!
- I recommend soldering in the LCD without a socket, to keep its profile low.
- **Before** soldering in the LCD, be sure to install the components which sit below it on the bottom: HDMI and USB jack, and the passive components associated with the HDMI port. Inspect the solder joints carefully, especially the closely space HDMI pads, since they will be inaccessible under the LCD.

- Depending on the front panel height you settle on, the two large LEDs (compute/stop indicators) may need to sit slightly above the PCB in order to look good. Test fit and install them towards the end of the build. The front panel will support the LEDs laterally, so they can simply be spaced away from the PCB a bit without further support.

Mounting

- There is a single mounting hole to provide additional support for the LCD, opposite the LCD's pin header. Using a Nylon screw and nut is recommended. The required spacer between the PCB and LCD will most likely be of a non-standard height; use trimmed-down plastic spacers, nuts or washers to taste…
- The Mimas board should be mounted to the PCB with four PCB spacers. 12mm spacers work well. (You can also rely on the friction of the two 2*20 pin headers alone.)
- The front panel should be mounted to the PCB and Mimas board by six PCB spacers. 6mm spacers were slightly to short for my LCD and encoder package, so I added a plastic washer to each of them.
- The front panel does not have pre-drilled holes, but has the six spacer positions marked on the bottom, matching the PCB's holes. I prefer to glue the spacers to the bottom of the front panel, to keep the look of the panel clean. Hot glue or epoxy should work.
- Alternatively, you can drill holes using the markings on the bottom of the front panel and use screws from the top. Note that one of the holes and screws will interrupt the lettering below the breakpoint switches.

One possible mounting scheme: Black 6mm spacers at the top and bottom, with additional Nylon washers at the top. 12mm spacers between Numato Mimas and switch PCB. The black 6mm spacers have one female and one male thread, the silver 12mm spacers two female threads.

- The LCDs come mounted to their adapter PCBs with some tolerance. If your LCD is tilted or off-center vs. the cutout in the front panel, you can carefully lift it off with a knife and reposition the LCD – it is simply attached with double-sided adhesive tape. Be careful not to damage the flat cable.

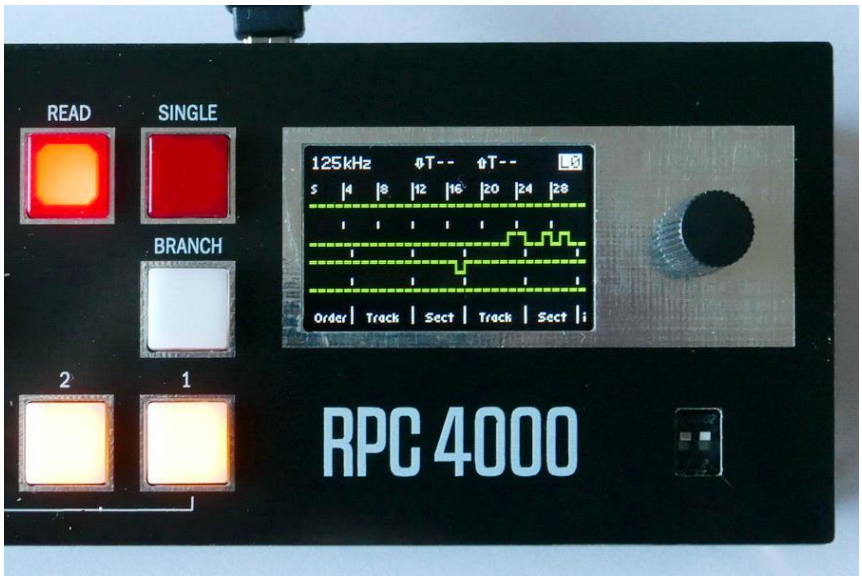
Usage Notes

These are very preliminary – without any software, there is not much to be done with the RPC-4000 yet. Just a few hints for first function testing:

- The USB port provides power supply and the main terminal connection.
- The USB device will appear on your computer as a composite device with *two* serial CDC devices. Since the RPC-4000 can address its Flexowriter and paper tape punch/reader independently, two terminal connections via USB are used to simulate these devices.
- The CDC devices should work without further driver installation under Windows 10 and Linux. Earlier Windows versions will require an INF file which is not available so far.

- Like on the LittleGP-30, The rotary encoder has multiple functions:
  - Pushing and releasing the button will cycle through
    accumulator selection (original RPC-4000 function),
    clock rate selection,
    horizontal scrolling of HDMI drum display.
  - At any time, rotting the encoder while holding the button down will scroll the HDMI display vertically. (The RPC-4000 has twice the number of drum tracks vs. the LGP-30 – too much to fit on the screen at once. Being able to shift up and down without permanent mode change seems helpful.)

- The LCD mainly shows the original RPC 4000's oscilloscope traces (in green) and the printed scale overlay (in white). In addition the top line shows
  - Current clock rate (inverted when controlled by the encoder),
  - Active input and output devices (this replaces the separate control unit of the original RPC-4000; details below),
  - Accumulator currently selected for display (inverted when controlled by the encoder). This replaces the position indicator on the "hard" rotary selector in the original RPC-4000.



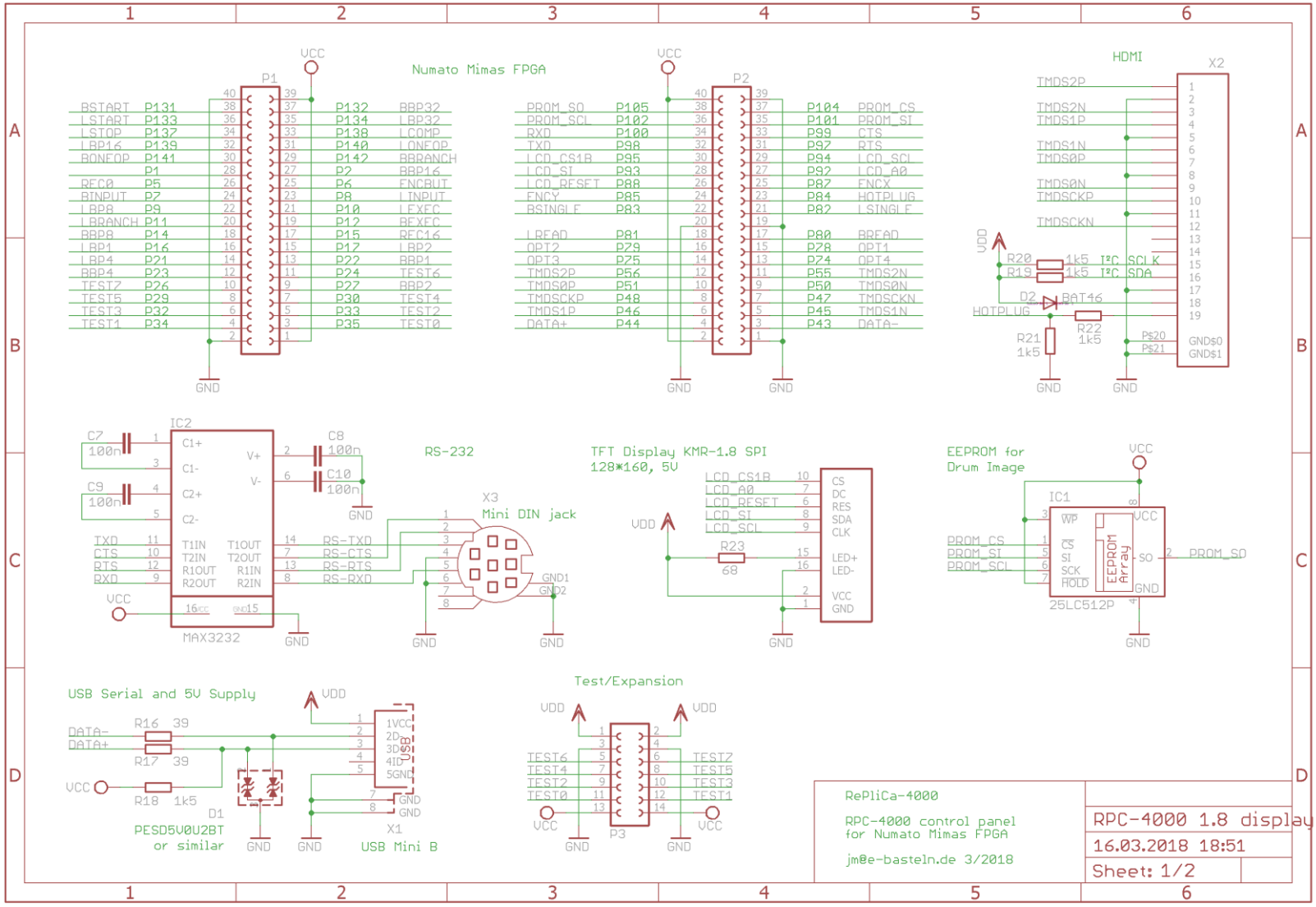
- Controlling the Input and Output devices:
  - In the original RPC-4000, this is done via a separate control panel on the tape punch/reader unit. The replica uses the top line of the display and “overloaded” breakpoint buttons instead.
  - Active Input devices are shown behind the ⇓ symbol in the display.
    T = Terminal, R = tape Reader, X = auXiliary device.
    These are controlled by long presses of breakpoint buttons 32, 16, and 8.
    Only one device can be active at any time, so these behave as “radio buttons”.
  - Active Output devices are shown behind the ⇑ symbol in the display.
    T = Terminal, P = tape Punch, X = auXiliary device.
    These are controlled by long presses of breakpoint buttons 4, 2, and 1.
    Multiple devices can be active in parallel, so pressing each button repeatedly toggles its device on and off.

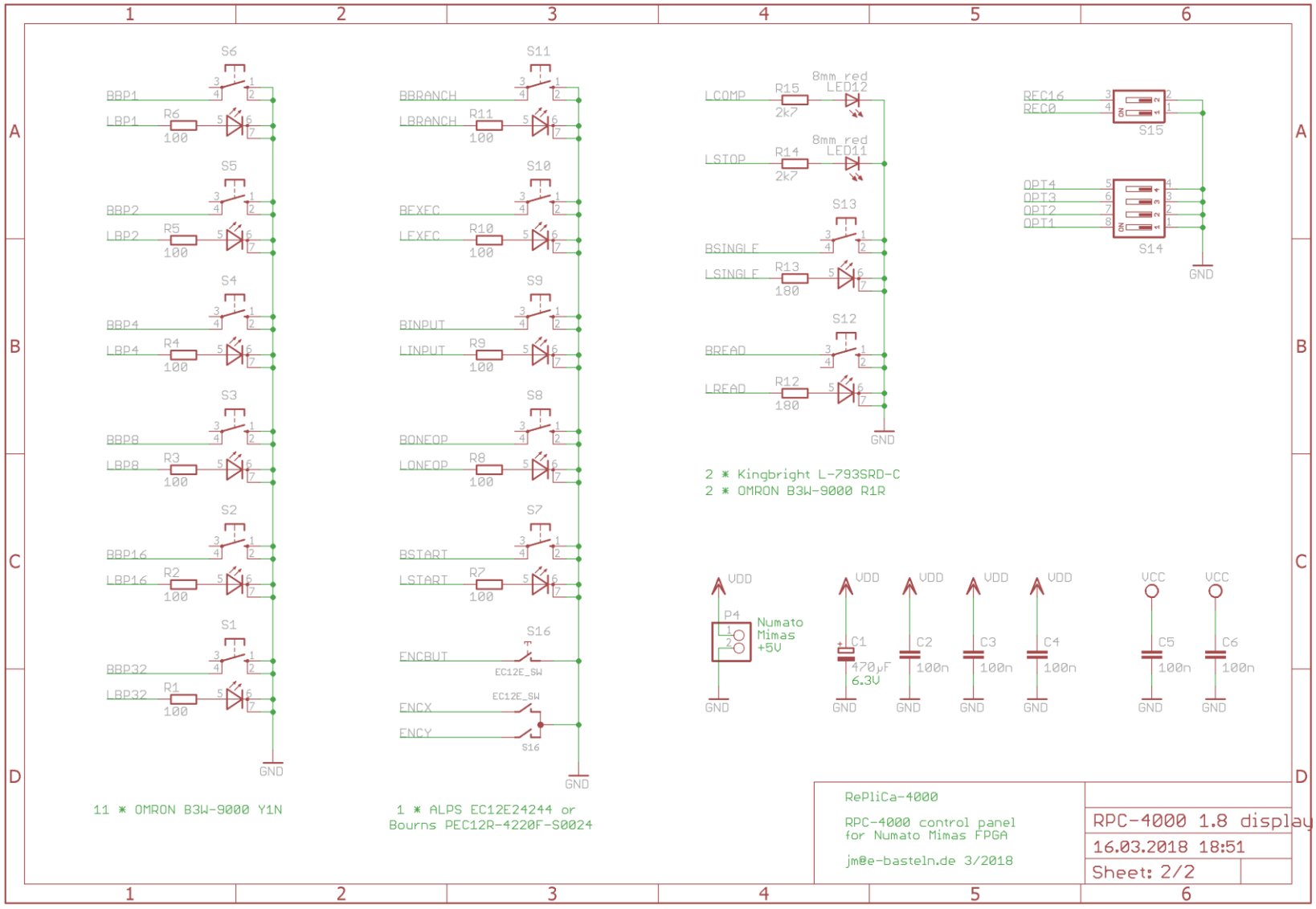
- RS-232 interface:
  - The RS-232 connection can either provide a third peripheral device (e.g. to simulate an optional high-speed paper tape punch and reader), or can operate in parallel with one of the USB devices in order to connect a real, physical terminal. This is controlled via switches 1 and 1 of the 4-position DIP switch:
  - "xx00" UART not used
    "xx01" UART serves as auX device
    "xx10" UART duplicates Typewriter device
    "xx11" UART duplicates Punch/Reader device
  - The UART currently operates at a fixed speed or 19200 baud. DIP switches 3 and 4 are meant to support baud rate selection, but this is not implemented yet.

Bill of Materials

Part	Quant	Value	Mouser part number	Comment
Semiconductors				
D1	1	PESD5V0U2BT (NXP) or similar	771-PESD5V0U2BTT/R	Dual TVS diode SOT-23, optional
D2	1	BAT46	511-BAT46	Schottky UF = 0.25V, 150 mA.
IC1	1	25LC512P, DIP-8		Serial EEPROM for drum storage
IC2	1	MAX3232, DIP-16		RS-232 level converter, 3.3V
LED11, LED12	2	Kingbright L-793SRD-C, 8mm		Dark red, matches OMRON light color
Passives				
R1 - R11	11	100		all resistors 0.5W, through-hole
R12 - R13	2	180		
R14 - R15	2	2k7		
R16 - R17	2	39	594-MBB02070C3906FCT	series resistors USB
R18 - R22	5	1k5	603-MF0207FTE52-1K5	
R23	1	68		
C1	1	470µF, 6.3V	667-ECA-0JM471	electrolytic, radial, 2.54mm pitch
C2 - C10	9	100n	810-FG26C0G2A104JRT6	2.54mm pitch
Switches				
S1 - S11	11	OMRON B3W-9000 Y1N	653-B3W-9000-Y1N	10mm, 1 yellow LED, white cap. B3W-9002 also ok (higher force)
S12, S13	2	OMRON B3W-9000 R1R	653-B3W-9000-R1R	10mm, 1 red LED, red cap. B3W-9002 also ok (higher force)
S14	1	DIP switch 4x		
S15	1	DIP switch 2x		height must not exceed display and encoder!
S16	1	Rotary enoder with push-button	652-PEC12R-4220F-S24	ALPS EC12E24244 or Bourns PEC12R-4220F-S0024
(none)	1	Knob for 6mm flattened axis	450-AA150 + 450-CP156	knob for encoder
Connectors				
P1, P2	2	Pin header 2*20, 2.54mm pitch		I/O connection to Mimas PCB
P3	1	Pin header 2*7, 2.54mm pitch		expansion/test port
P4	1	Pin header, 1 pin		single pin, 5V from Mimas PCB
X1	1	USB jack Mini-B	538-54819-0519	angled, through-hole
X2	1	HDMI jack through-hole		3 rows, 7+6+6 pins, 1.5mm pitch
X3	1	Mini-DIN jack, 8 pins		e.g. Assmann A-DIO-FS08, Lumberg TM 0508 A/8
(none)	1	Pin socket, 2 pins, 2.54mm pitch		populate on Mimas board!
Modules				
(none)	1	TFT KMR-1.8 SPI, 128*160, 5V	(ebay)	Different variants sold! Photo in building instructions.
(none)	1	Numato Mimas FPGA module	(numato.com, Amazon)	Spartan 6. Not Mimas V2!

Schematics


Numato Mimas FPGA
P1
P2
HDMI
X2
RS-232
MAX3232
X3
Mini DIN jack
TFT Display KMR-1.8 SPI
128*160, 5V
EEPROM for
Drum Image
25LC512P
USB Serial and 5V Supply
PESD5V0U2BT
or similar
USB Mini B
Test/Expansion
P3
RePliCa-4000
RPC-4000 control panel
for Numato Mimas FPGA
jm@e-basteln.de 3/2018
RPC-4000 1.8 display hotplug
16.03.2018 18:51
Sheet: 1/2


S6
BBP1
LBP1
R6
100
S5
BBP2
LBP2
R5
100
S4
BBP4
LBP4
R4
100
S3
BBP8
LBP8
R3
100
S2
BBP16
LBP16
R2
100
S1
BBP32
LBP32
R1
100
GND
11 * OMRON B3W-9000 Y1N
S11
BBRANCH
LBRANCH
R11
100
S10
BEXEC
LEXEC
R10
100
S9
BINPUT
LINPUT
R9
100
S8
BONEOP
LONEOP
R8
100
S7
BSTART
LSTART
R7
100
S16
ENCBUT
EC12E_SW
ENCX
ENCY
S16
GND
1 * ALPS EC12E24244 or
Bourns PEC12R-4220F-S0024
LCOMP
R15
2k7
8mm_red
LED12
LSTOP
R14
2k7
8mm_red
LED11
S13
BSINGLE
LSINGLE
R13
180
S12
BREAD
LREAD
R12
180
GND
2 * Kingbright L-793SRD-C
2 * OMRON B3W-9000 R1R
REC16
REC0
S15
OPT4
OPT3
OPT2
OPT1
S14
GND
VDD
P4
Numato
Mimas
+5V
GND
C1
470µF
6.3V
C2
100n
C3
100n
C4
100n
C5
100n
C6
100n
VCC
RePliCa-4000
RPC-4000 control panel
for Numato Mimas FPGA
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Sheet: 2/2