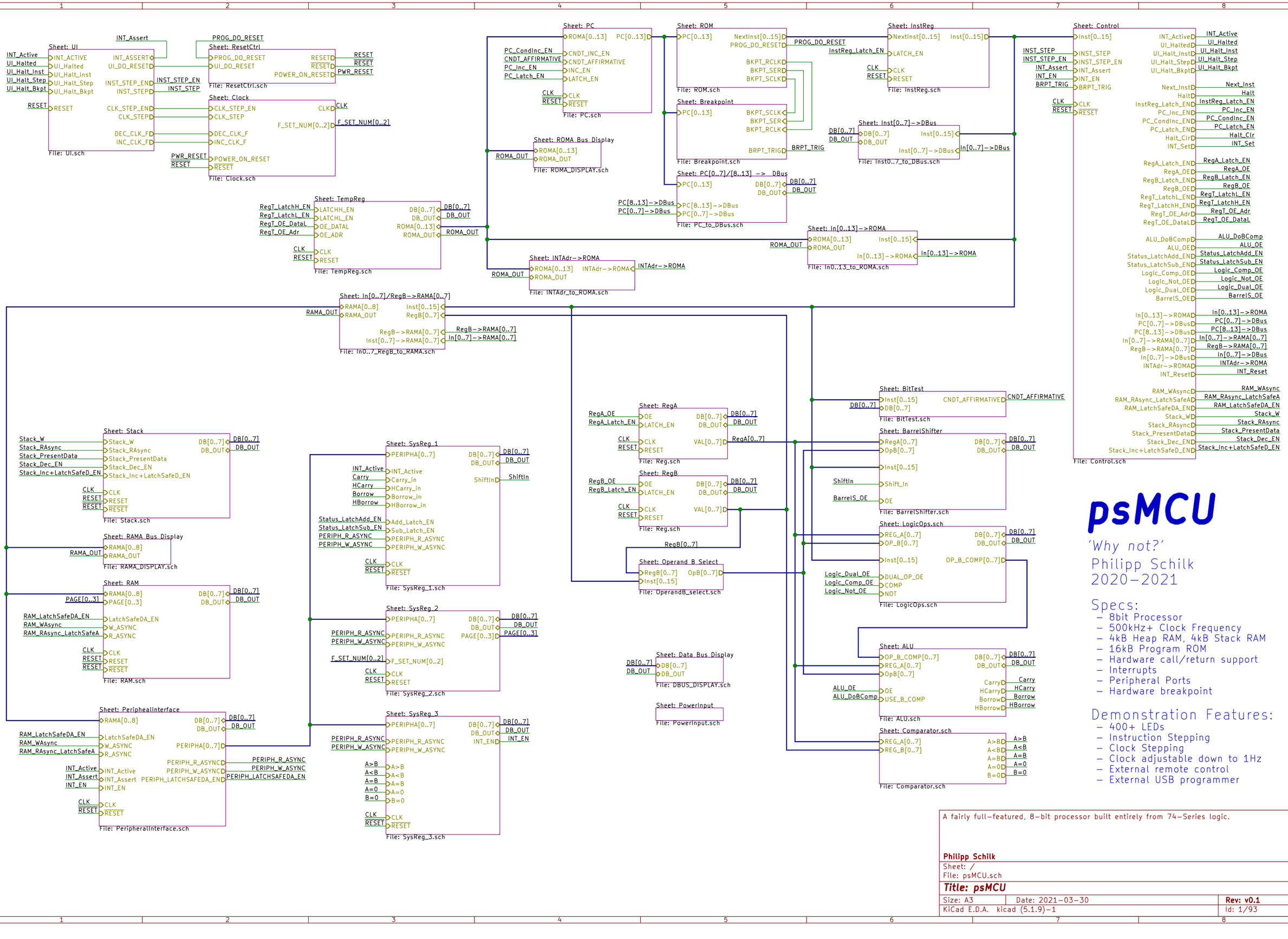
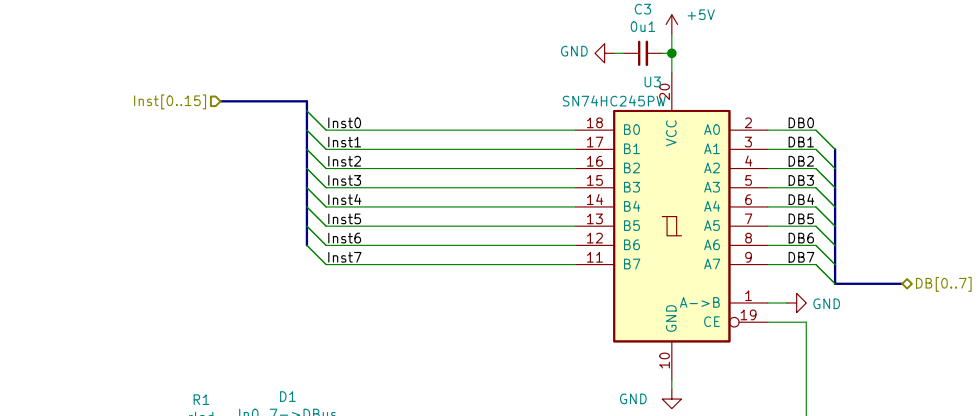

Sheet: UI
File: UI.sch
Sheet: ResetCtrl
File: ResetCtrl.sch
Sheet: Clock
File: Clock.sch
Sheet: PC
File: PC.sch
Sheet: ROM
File: ROM.sch
Sheet: Breakpoint
File: Breakpoint.sch
Sheet: InstReg
File: InstReg.sch
Sheet: Control
File: Control.sch
Sheet: Inst[0..7]->DBus
File: Inst0..7_to_DBus.sch
Sheet: ROMA Bus Display
File: ROMA_DISPLAY.sch
Sheet: PC[0..7]/[8..13] -> DBus
File: PC_to_DBus.sch
Sheet: TempReg
File: TempReg.sch
Sheet: In[0..13]->ROMA
File: In0..13_to_ROMA.sch
Sheet: INTAdr->ROMA
File: INTAdr_to_ROMA.sch
Sheet: In[0..7]/RegB->RAMA[0..7]
File: In0..7_RegB_to_RAMA.sch
Sheet: BitTest
File: BitTest.sch
Sheet: RegA
File: Reg.sch
Sheet: RegB
File: Reg.sch
Sheet: BarrelShifter
File: BarrelShifter.sch
Sheet: Stack
File: Stack.sch
Sheet: SysReg_1
File: SysReg_1.sch
Sheet: RAMA Bus Display
File: RAMA_DISPLAY.sch
Sheet: RAM
File: RAM.sch
Sheet: SysReg_2
File: SysReg_2.sch
Sheet: OperandB_Select
File: OperandB_select.sch
Sheet: LogicOps.sch
File: LogicOps.sch
Sheet: DBUS_DISPLAY
File: DBUS_DISPLAY.sch
Sheet: PeripheralInterface
File: PeripheralInterface.sch
Sheet: SysReg_3
File: SysReg_3.sch
Sheet: PowerInput
File: PowerInput.sch
Sheet: ALU
File: ALU.sch
Sheet: Comparator.sch
File: Comparator.sch
psMCU
'Why not?'
Philipp Schilk
2020–2021
Specs:
– 8bit Processor
– 500kHz+ Clock Frequency
– 4kB Heap RAM, 4kB Stack RAM
– 16kB Program ROM
– Hardware call/return support
– Interrupts
– Peripheral Ports
– Hardware breakpoint
Demonstration Features:
– 400+ LEDs
– Instruction Stepping
– Clock Stepping
– Clock adjustable down to 1Hz
– External remote control
– External USB programmer
A fairly full–featured, 8–bit processor built entirely from 74–Series logic.
Philipp Schilk
Sheet: /
File: psMCU.sch
Title: psMCU
Size: A3
Date: 2021–03–30
Rev: v0.1
KiCad E.D.A. kicad (5.1.9)–1
Id: 1/93



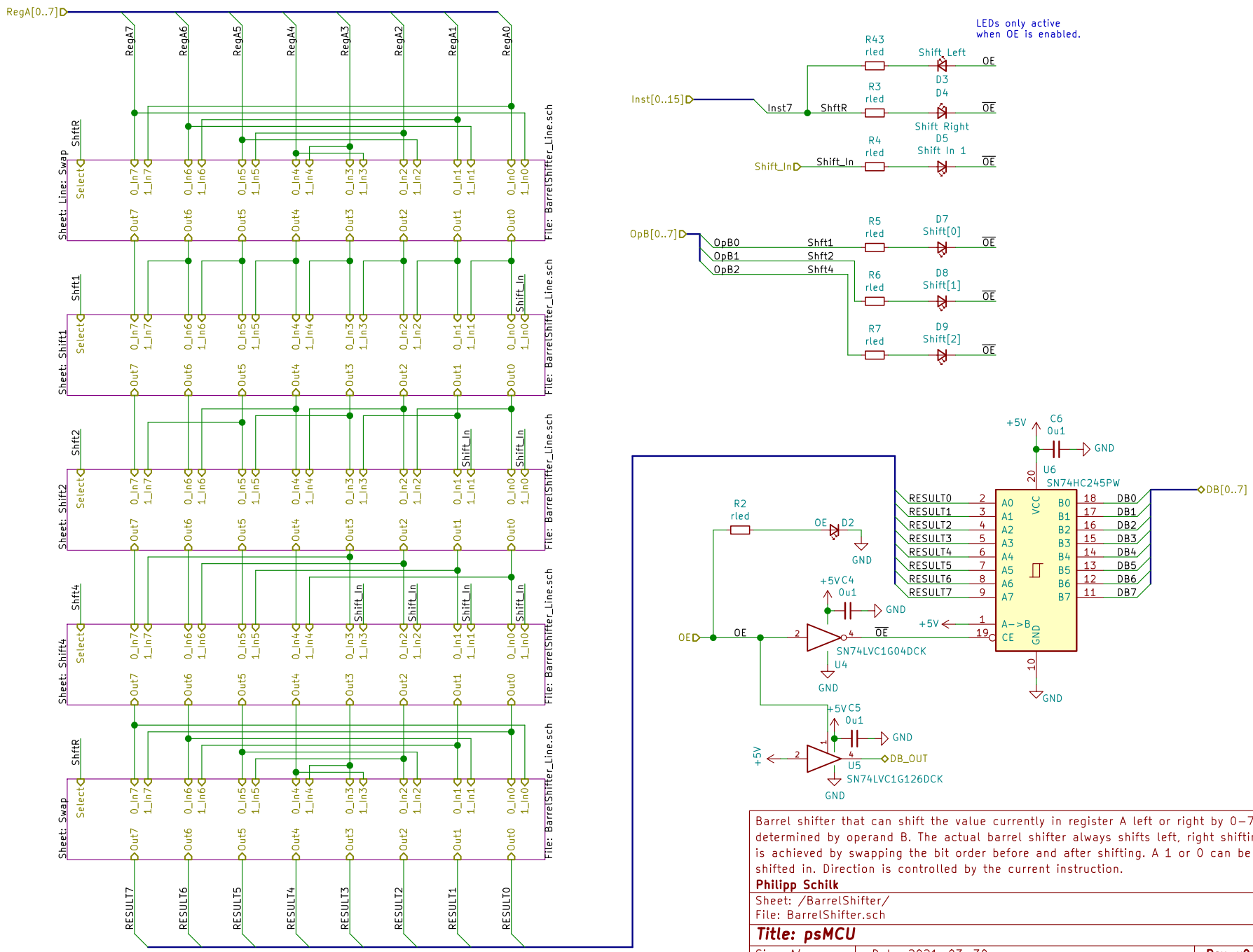
Puts the lowest byte of the current instruction onto the DBus. Used to load literals into registers.

Philipp Schilk

Sheet: /Inst[0..7]->DBus/
File: Inst0..7_to_DBus.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 2/93



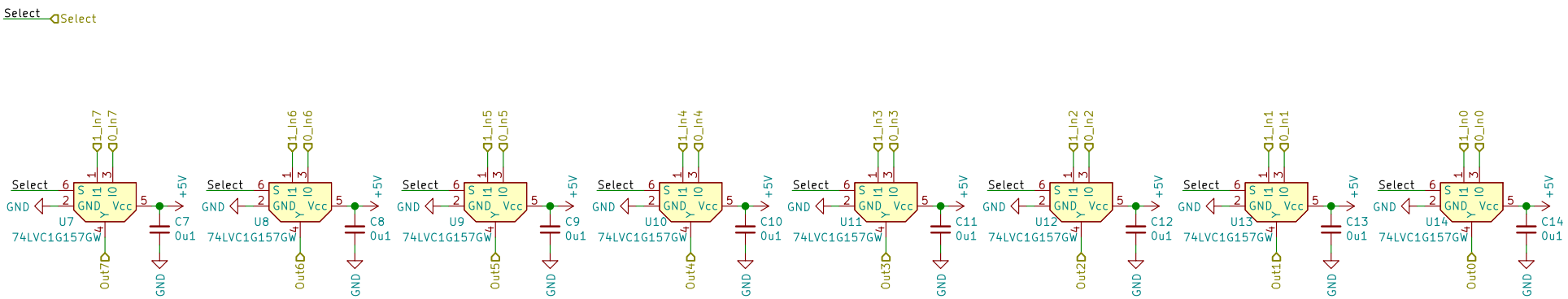
Barrel shifter that can shift the value currently in register A left or right by 0–7, determined by operand B. The actual barrel shifter always shifts left, right shifting is achieved by swapping the bit order before and after shifting. A 1 or 0 can be shifted in. Direction is controlled by the current instruction.

Philipp Schilk

Sheet: /BarrelShifter/
File: BarrelShifter.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 3/93



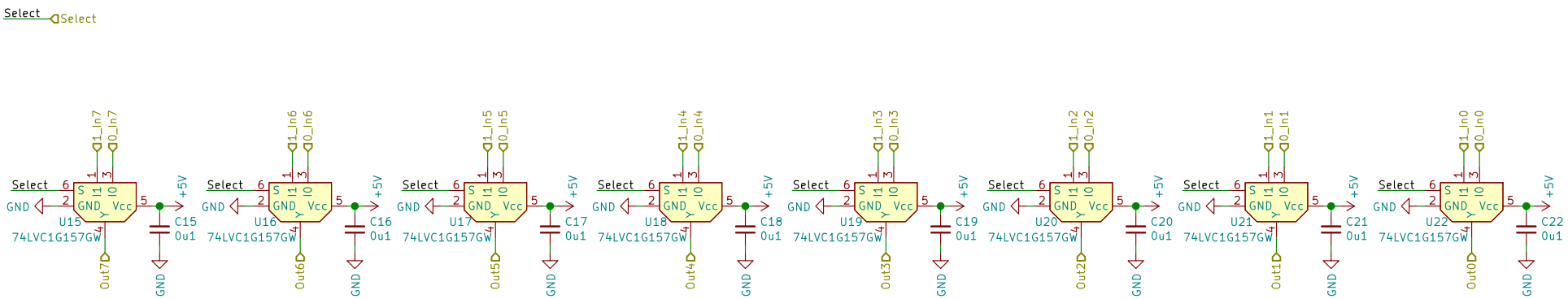
A line of 8 2in-1out multiplexers used multiple times in the barrel shifter.

Philipp Schilk

Sheet: /BarrelShifter/Shift2/
File: BarrelShifter_Line.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 4/93



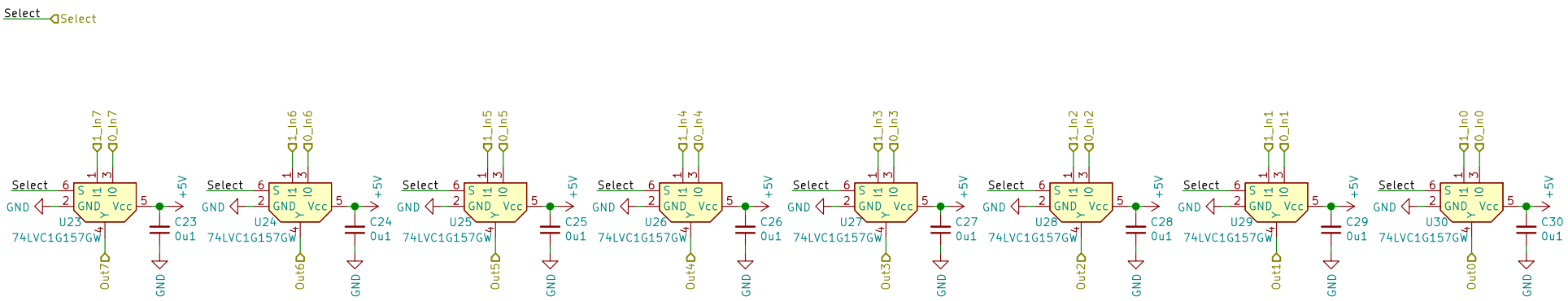
A line of 8 2in-1out multiplexers used multiple times in the barrel shifter.

Philipp Schilk

Sheet: /BarrelShifter/Shift4/
File: BarrelShifter_Line.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 5/93



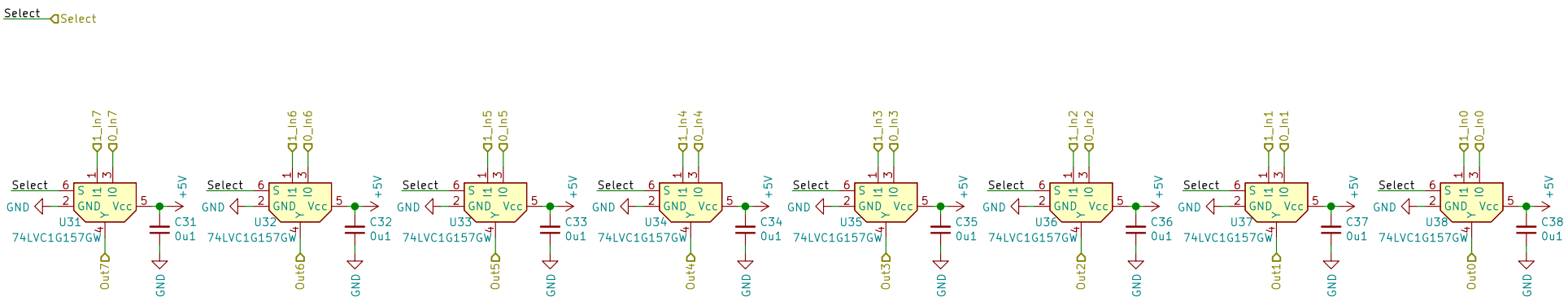
A line of 8 2in-1out multiplexers used multiple times in the barrel shifter.

Philipp Schilk

Sheet: /BarrelShifter/Swap/
File: BarrelShifter_Line.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 6/93



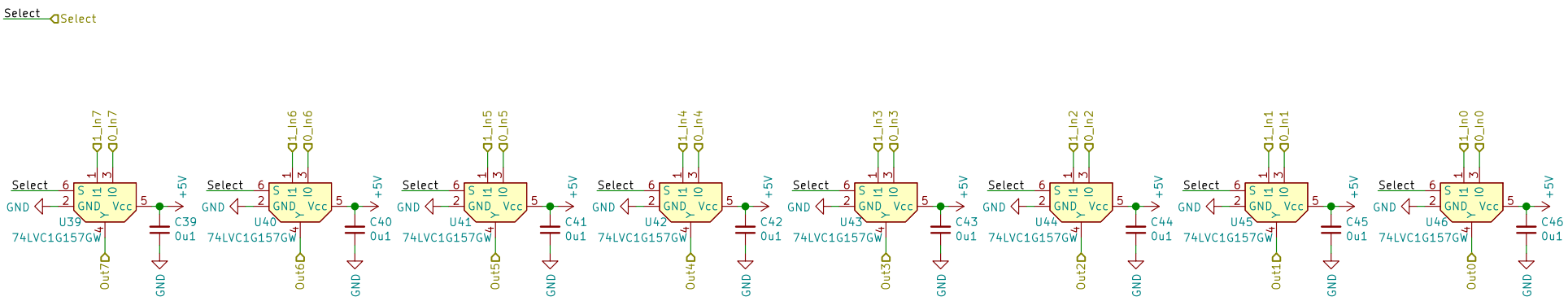
A line of 8 2in-1out multiplexers used multiple times in the barrel shifter.

Philipp Schilk

Sheet: /BarrelShifter/Line: Swap/
File: BarrelShifter_Line.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 7/93



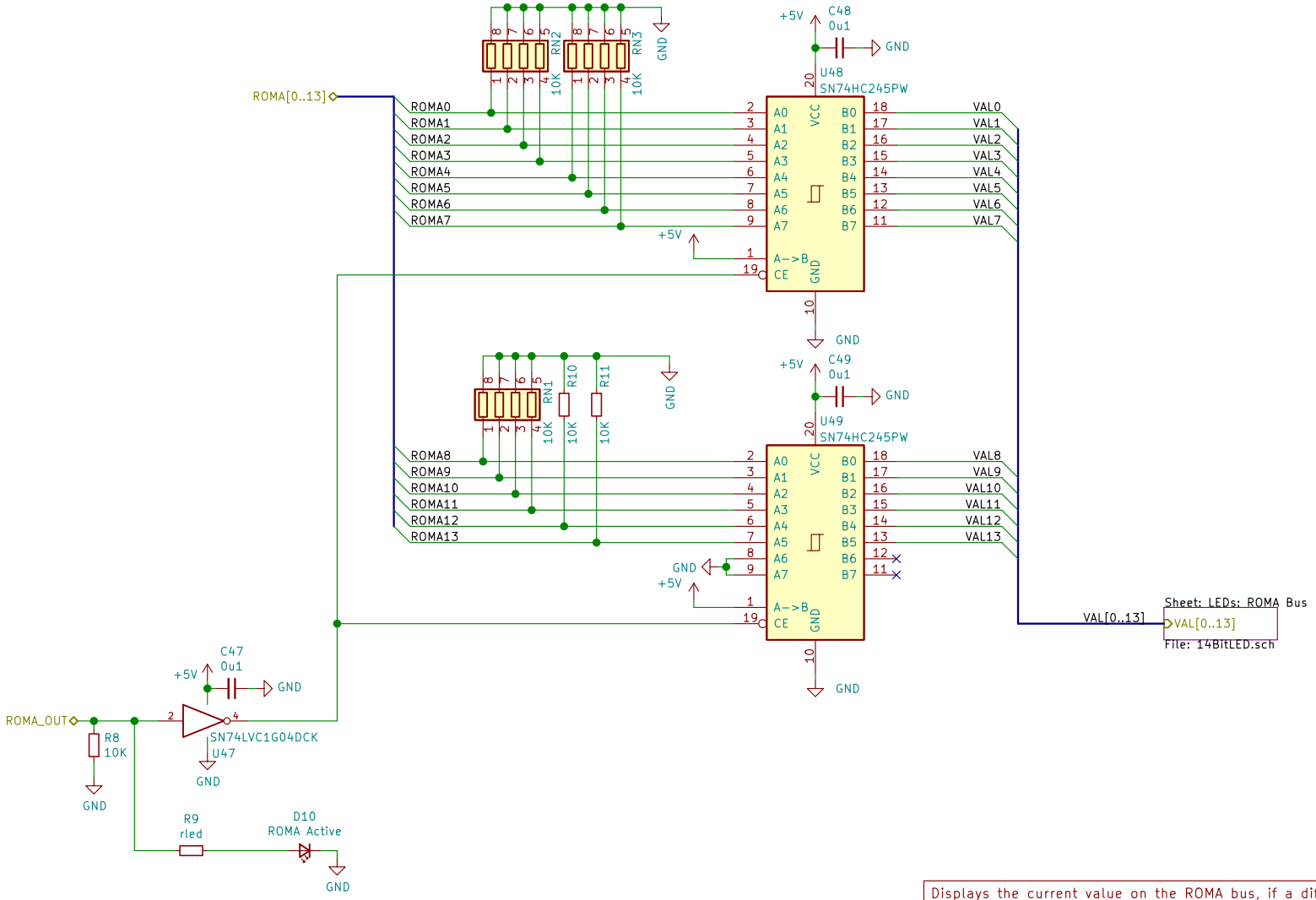
A line of 8 2in-1out multiplexers used multiple times in the barrel shifter.

Philipp Schilk

Sheet: /BarrelShifter/Shift1/
File: BarrelShifter_Line.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 8/93



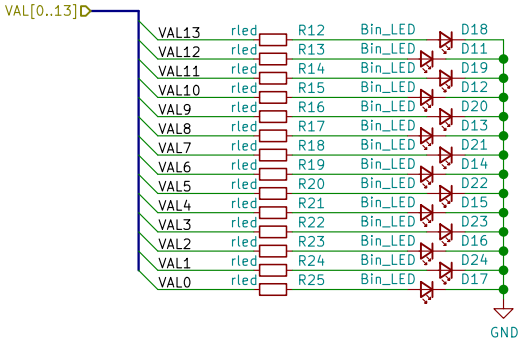
Displays the current value on the ROMA bus, if a different module is providing one (indicated by the ROMA_OUT signal)

Philipp Schilk

Sheet: /ROMA Bus Display/
File: ROMA_DISPLAY.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 9/93



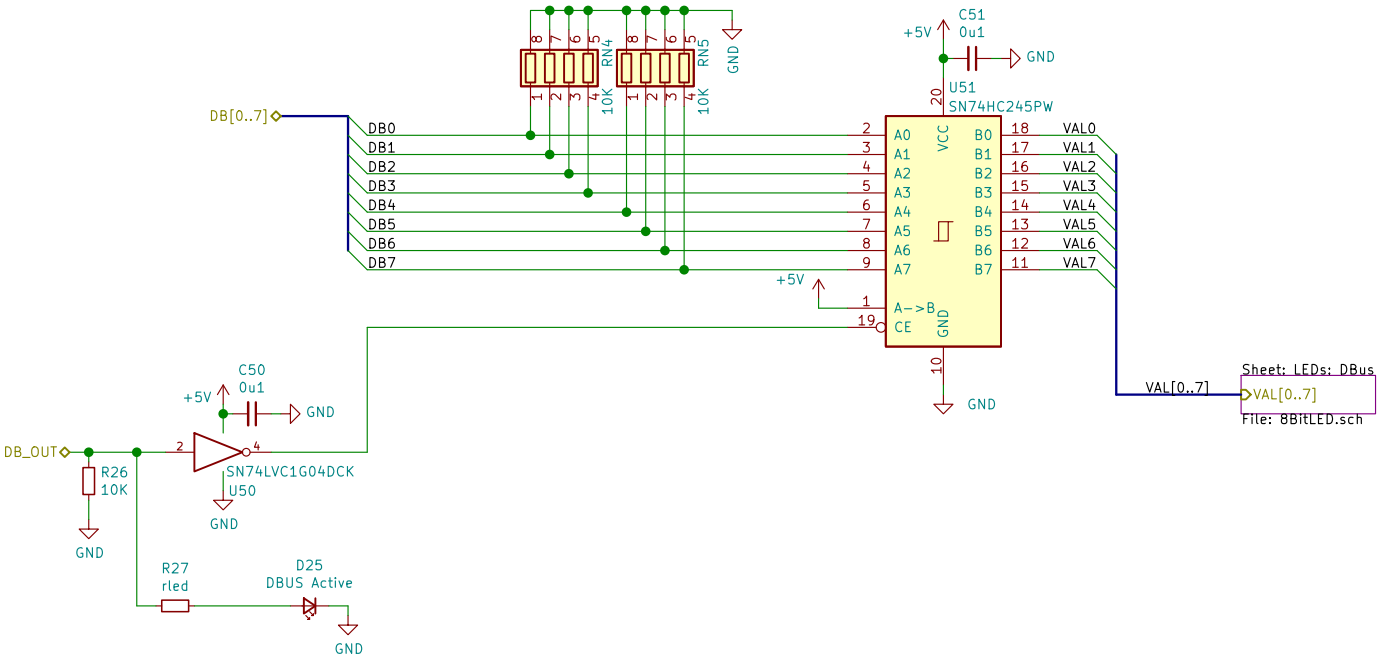
14bit binary LED display.

Philipp Schilk

Sheet: /ROMA Bus Display/LEDs: ROMA Bus/
File: 14BitLED.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 10/93



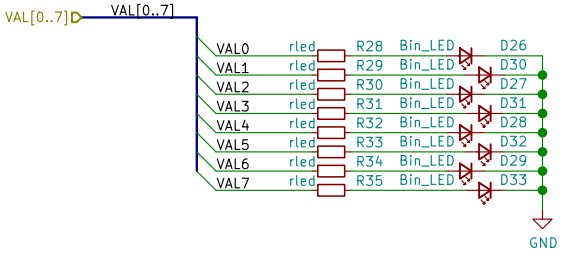
Displays the current value on the DBus, if a different module is providing one (indicated by the DBUS_OUT signal). Features both a binary and 7seg. display.

Philipp Schilk

Sheet: /Data Bus Display/
File: DBUS_DISPLAY.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 11/93



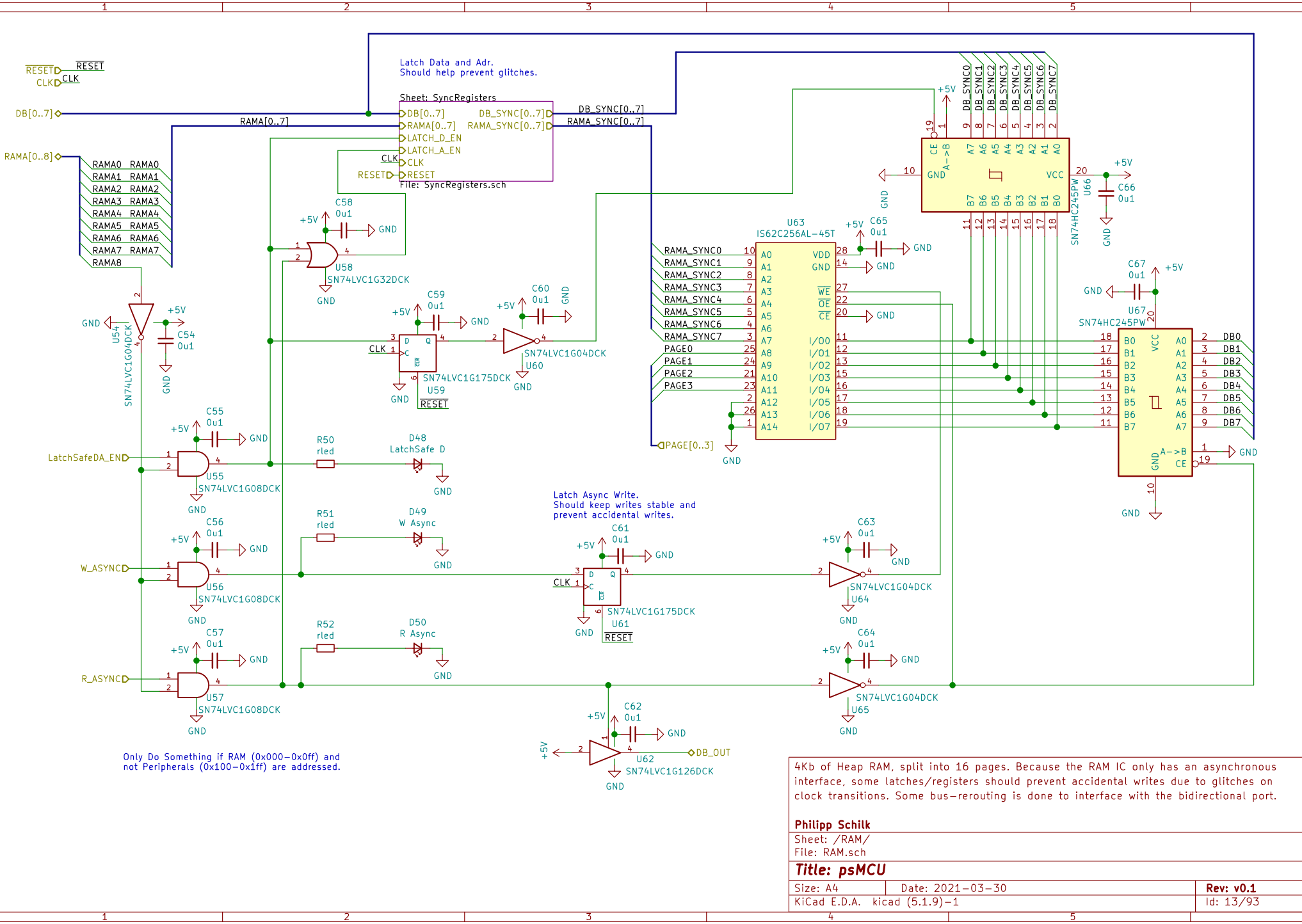
8bit binary LED display.

Philipp Schilk

Sheet: /Data Bus Display/LEDs: DBus /
File: 8BitLED.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 12/93



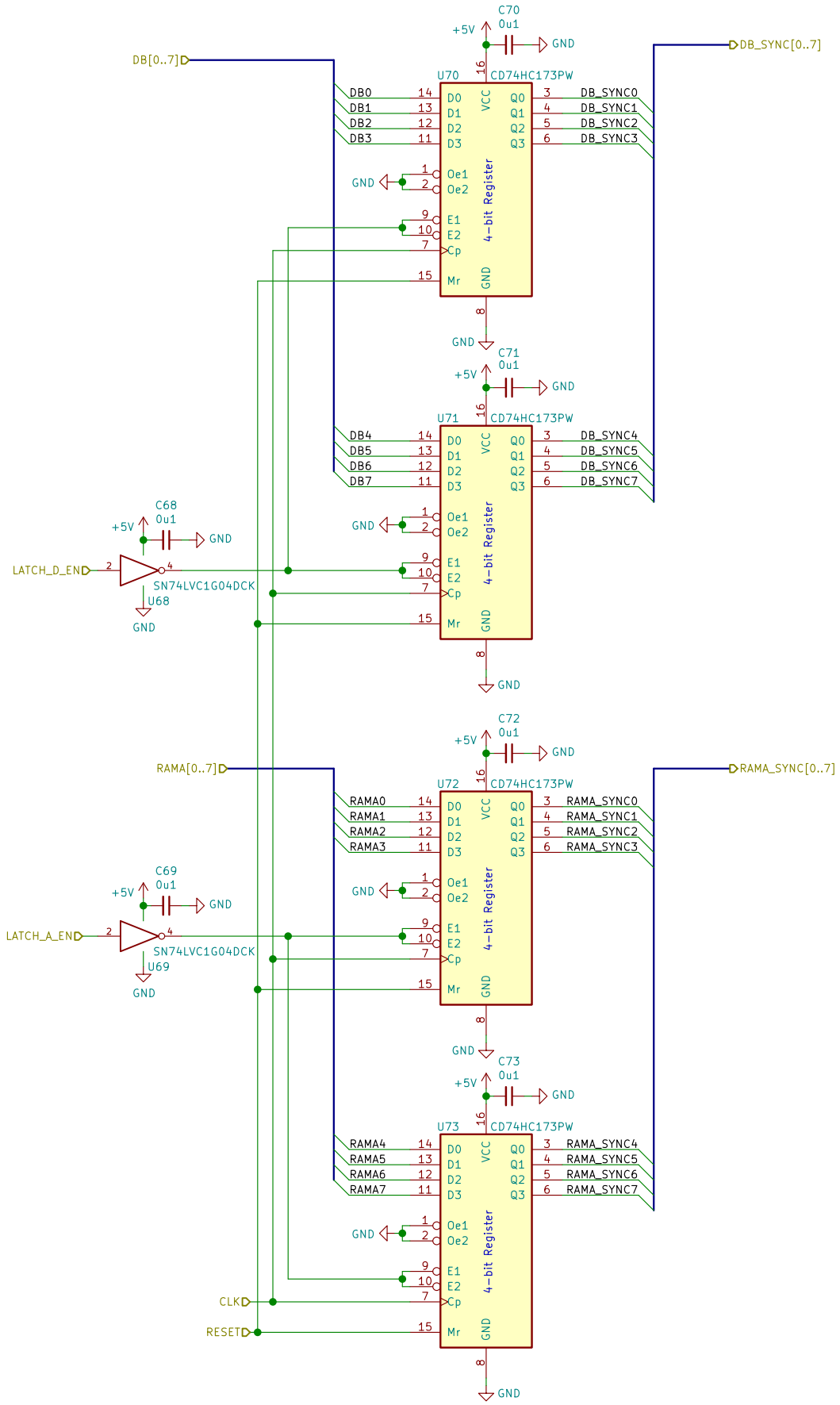
4Kb of Heap RAM, split into 16 pages. Because the RAM IC only has an asynchronous interface, some latches/registers should prevent accidental writes due to glitches on clock transitions. Some bus-rerouting is done to interface with the bidirectional port.

Philipp Schilk

Sheet: /RAM/
File: RAM.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 13/93



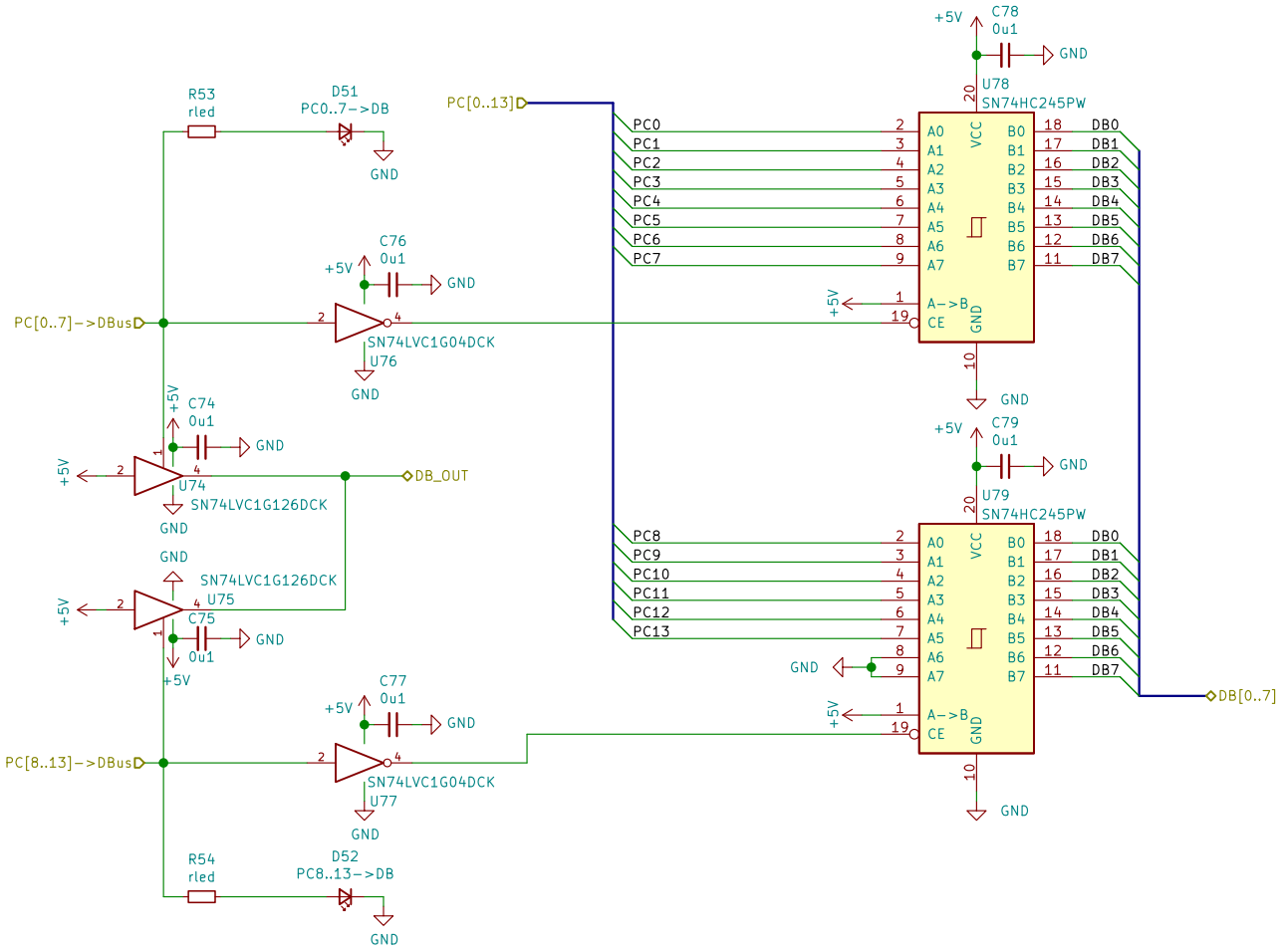
Registers to latch data/adr into, for RAM access.

Philipp Schilk

Sheet: /RAM/SyncRegisters/
File: SyncRegisters.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 14/93



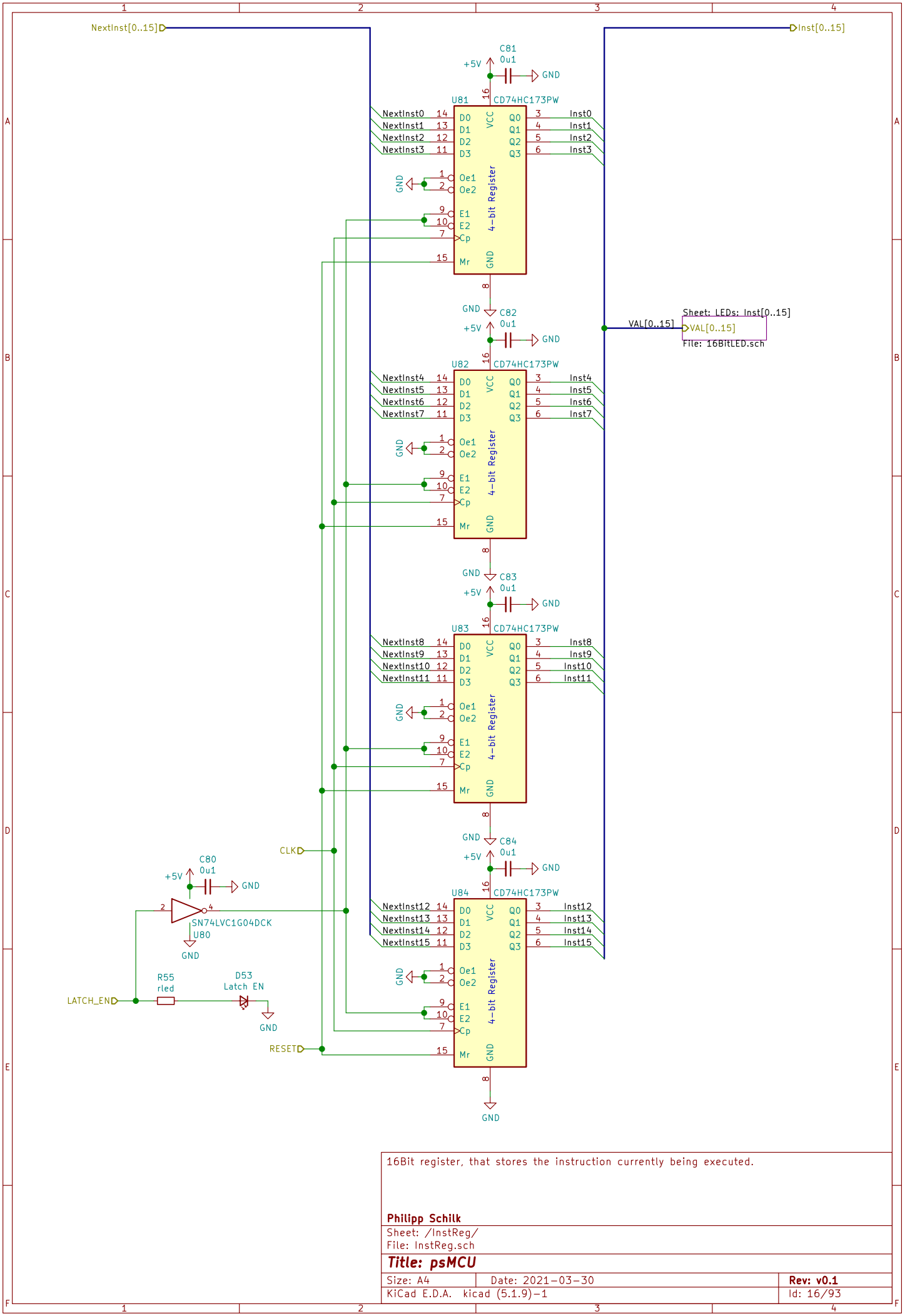
Puts the higher or lower byte of the PC counter onto the DBus. Used to push a return address onto the stack.

Philipp Schilk

Sheet: /PC[0..7]/[8..13] -> DBus/
File: PC_to_DBus.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 15/93



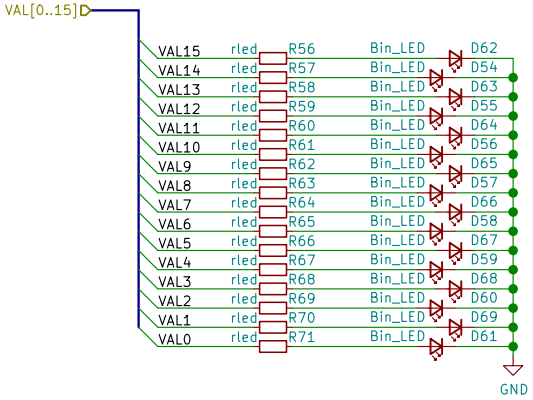
16Bit register, that stores the instruction currently being executed.

Philipp Schilk

Sheet: /InstReg/
File: InstReg.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 16/93



A 16bit binary LED display.

Philipp Schilk

Sheet: /InstReg/LEDs: Inst[0..15]/
File: 16BitLED.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 17/93

Switch between Programmer and Program Counter

Memory

Switch between the 8 program slots.

Serial Address Interface

Serial Data Interface (Reading)

Serial Data Interface (Writing)

Connect Programmer during Programming

Programmer Connector

Grounding pins 6 and 9 should allow the SST39SF010 to be substituted with a higher memory version (020,040) in a pinch.

Extend Shift Registers by 1

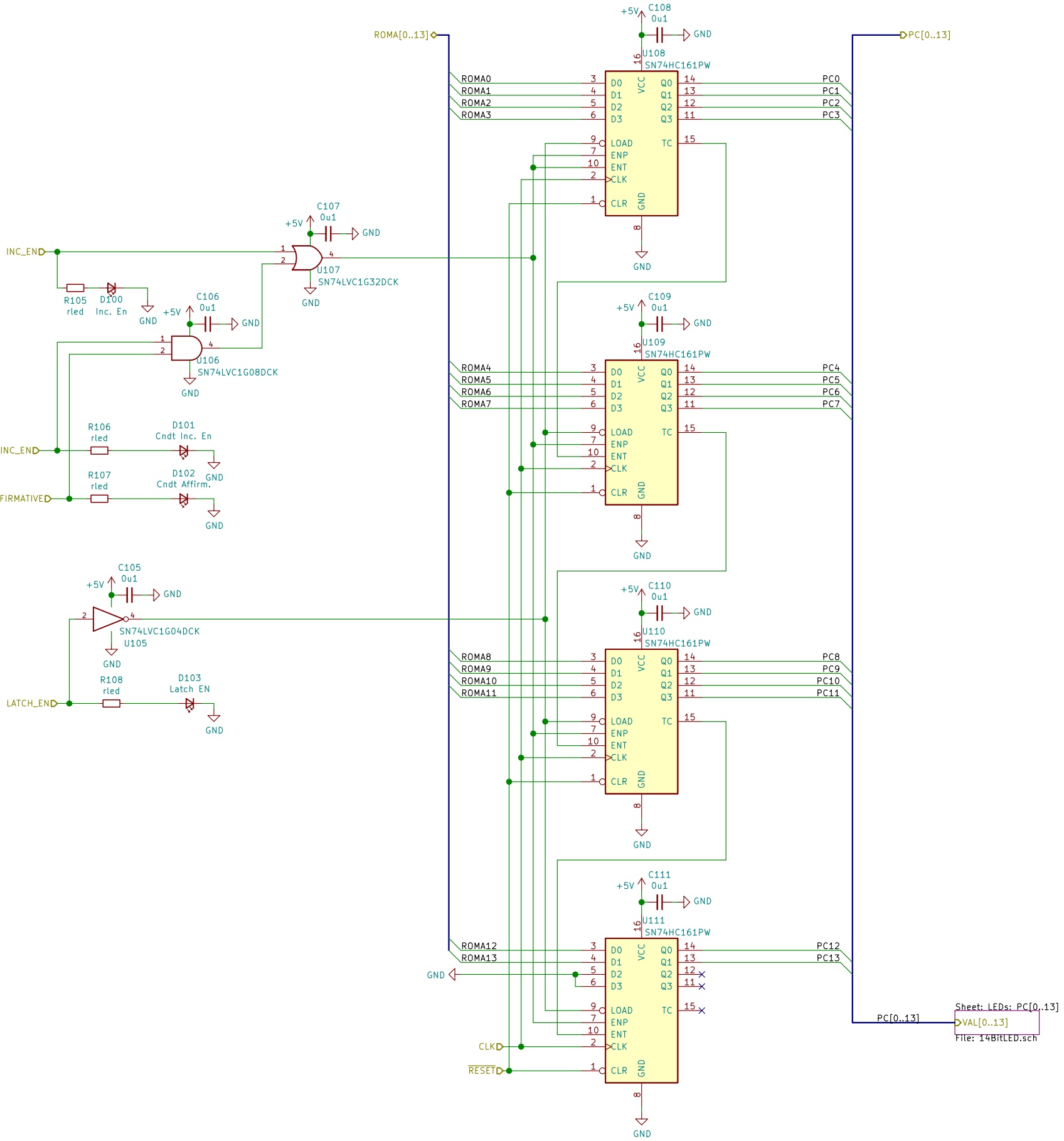
ROM that stores the 16-bit instructions and programming interface. During normal operation, the current instruction is read out based on the program counter. The external programmer can reroute the IO of the ROM ICs to allow writing and reading to memory. To reduce pin count, programming is done serially with shift registers.

Philipp Schilk

Sheet: /ROM/
File: ROM.sch

Title: psMCU

Size: A3	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 18/93



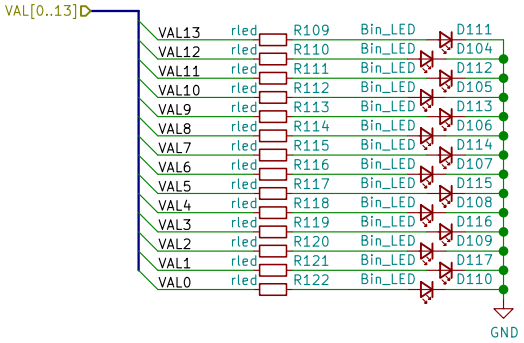
Program Counter. Increment moves to next instruction. Parallel latch enables jumps. Conditional Increment is an increment that is only performed, if the comparator indicates, allowing conditional bit-test instructions.

Philipp Schilk

Sheet: /PC/
File: PC.sch

Title: psMCU

Size: A3	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 19/93



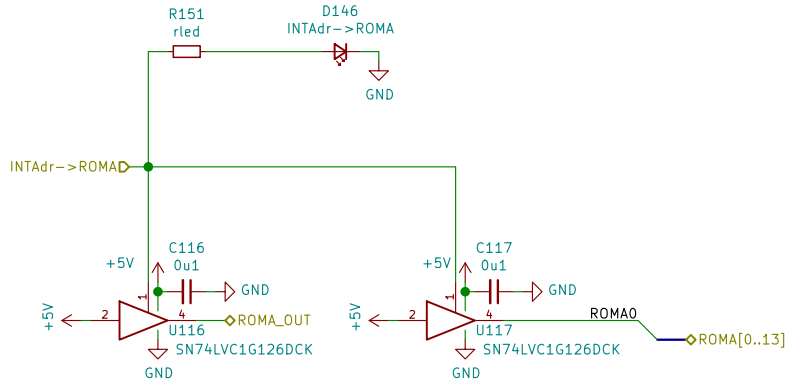
14bit binary LED display.

Philipp Schilk

Sheet: /PC/LEDs: PC[0..13]/
File: 14BitLED.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 20/93



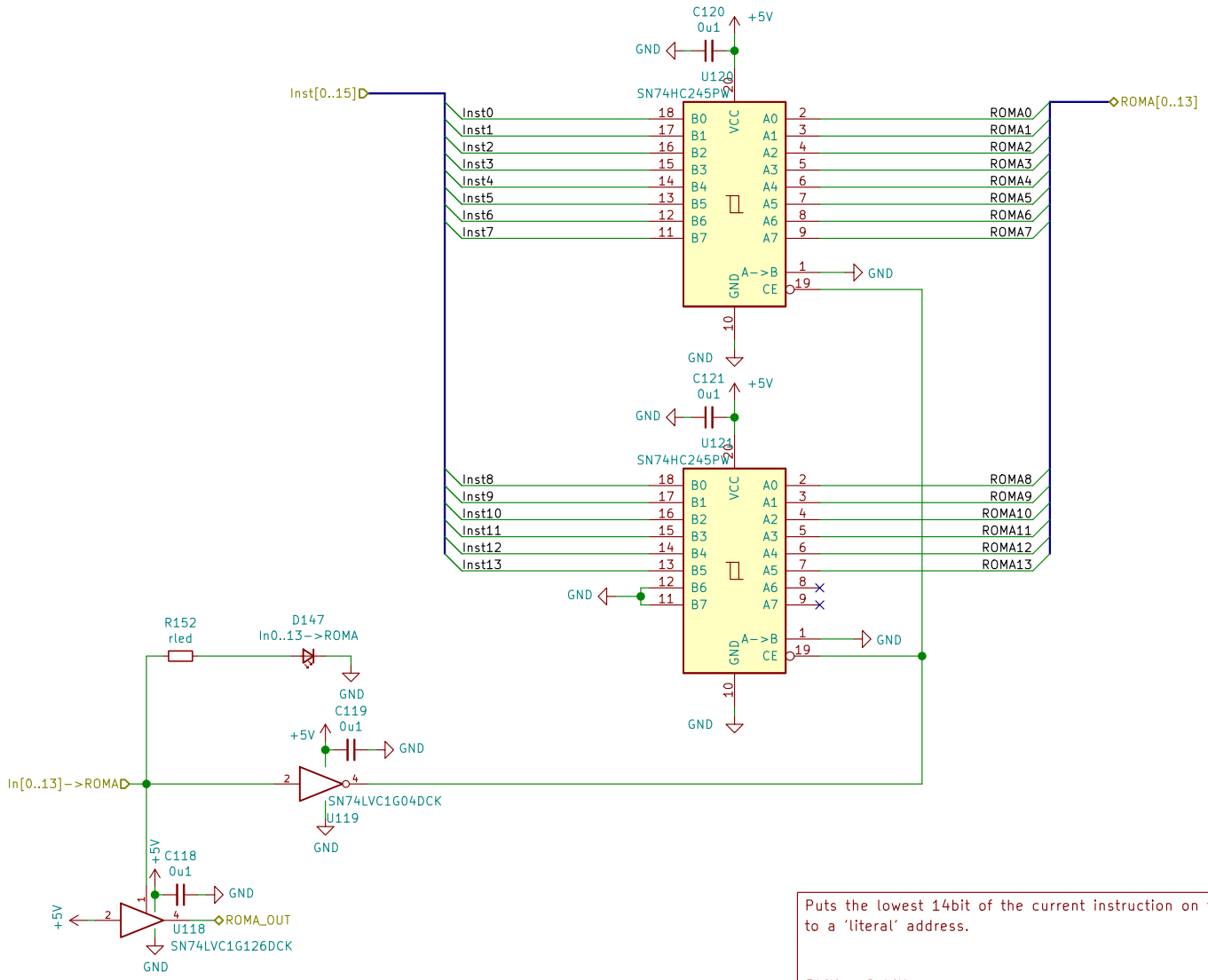
Writes the adr. of the interrupt handler (0x1) to branch to it when an interrupt occurs.

Philipp Schilk

Sheet: /INTAdr->ROMA/
File: INTAdr_to_ROMA.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 21/93



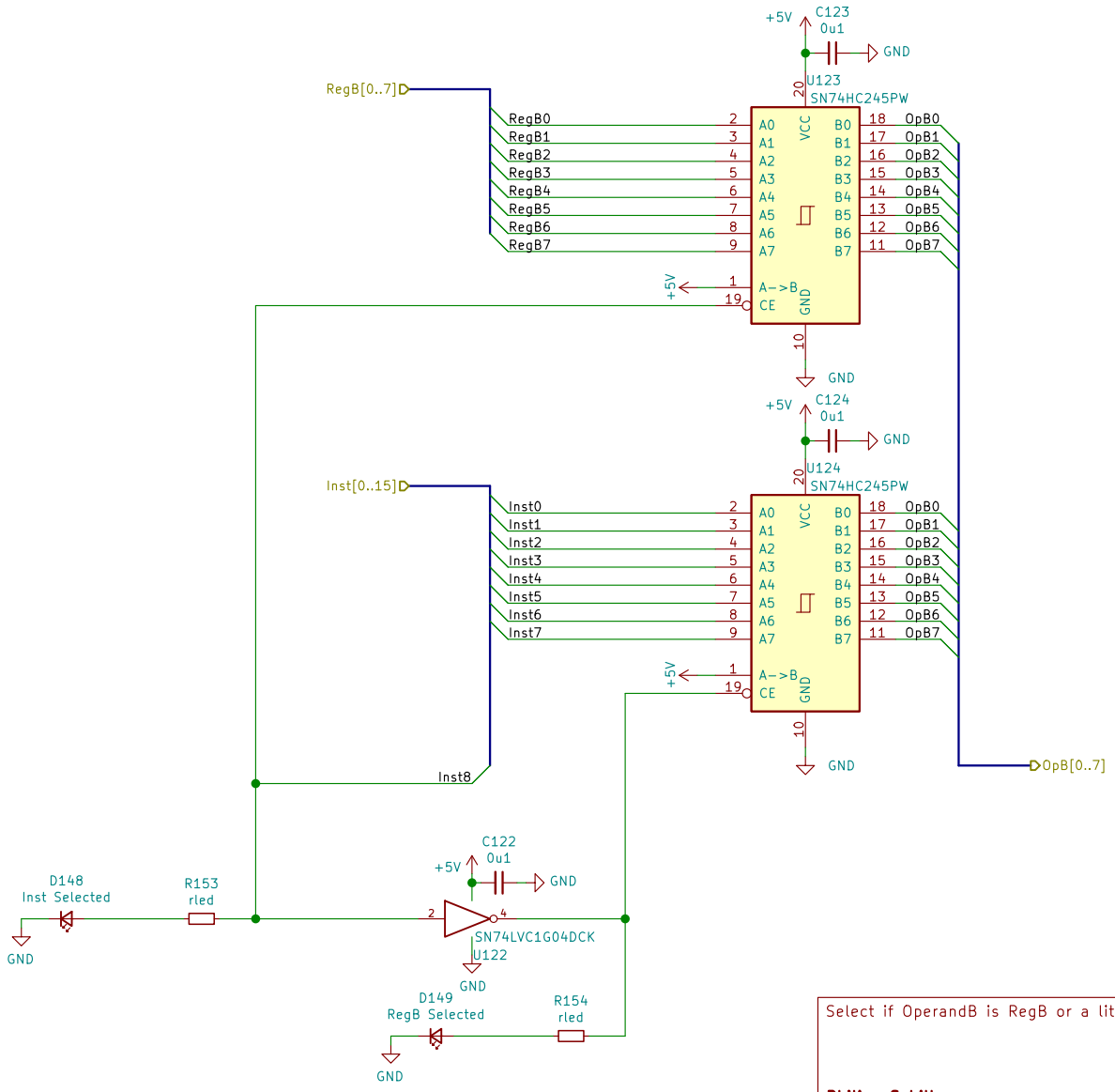
Puts the lowest 14bit of the current instruction on the ROMA bus. Used for branching to a 'literal' address.

Philipp Schilk

Sheet: /In[0..13]->ROMA/
File: In0..13_to_ROMA.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 22/93



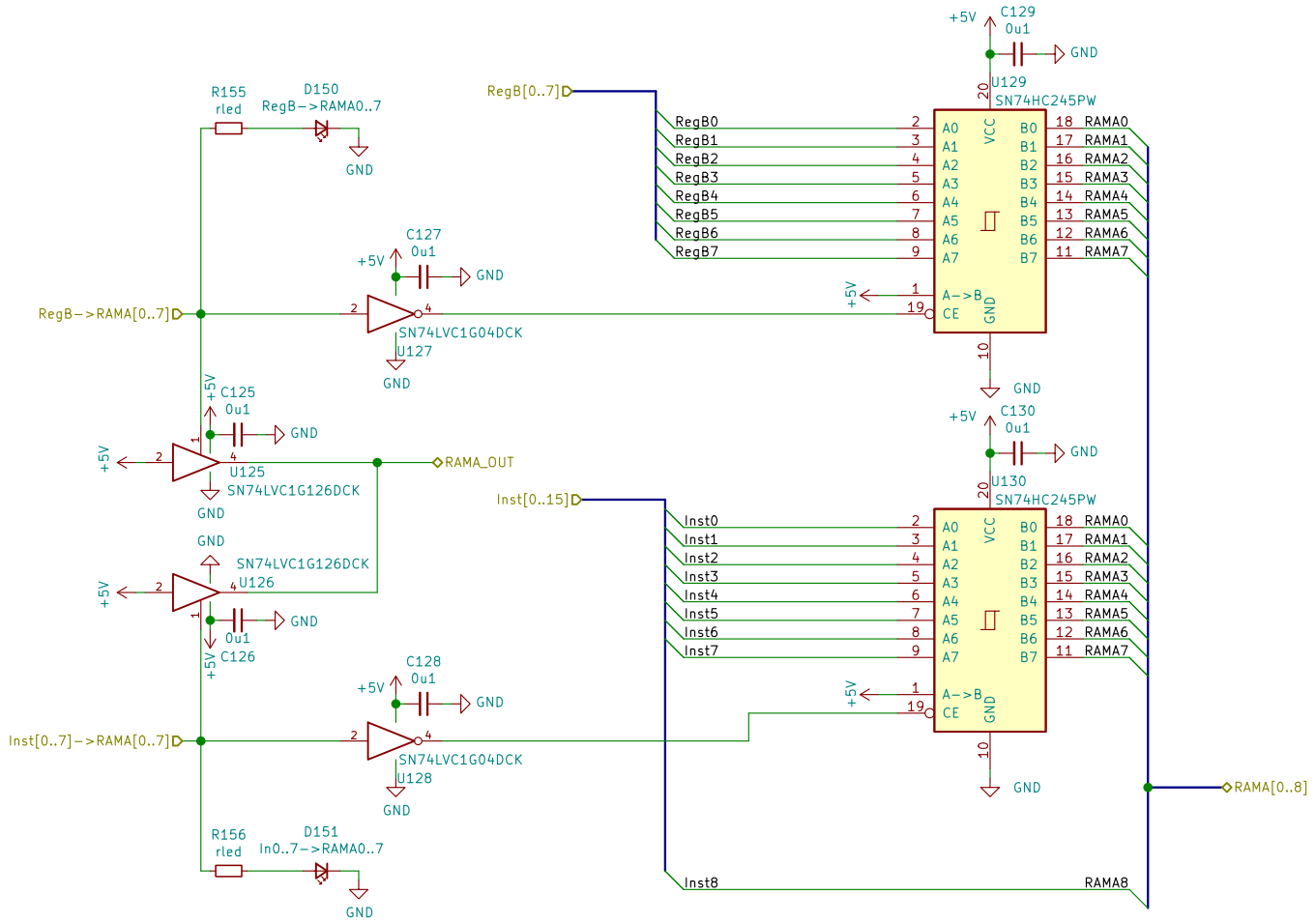
Select if OperandB is RegB or a literal from the current Instruction.

Philipp Schilk

Sheet: /Operand B Select/
File: OperandB_select.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 23/93



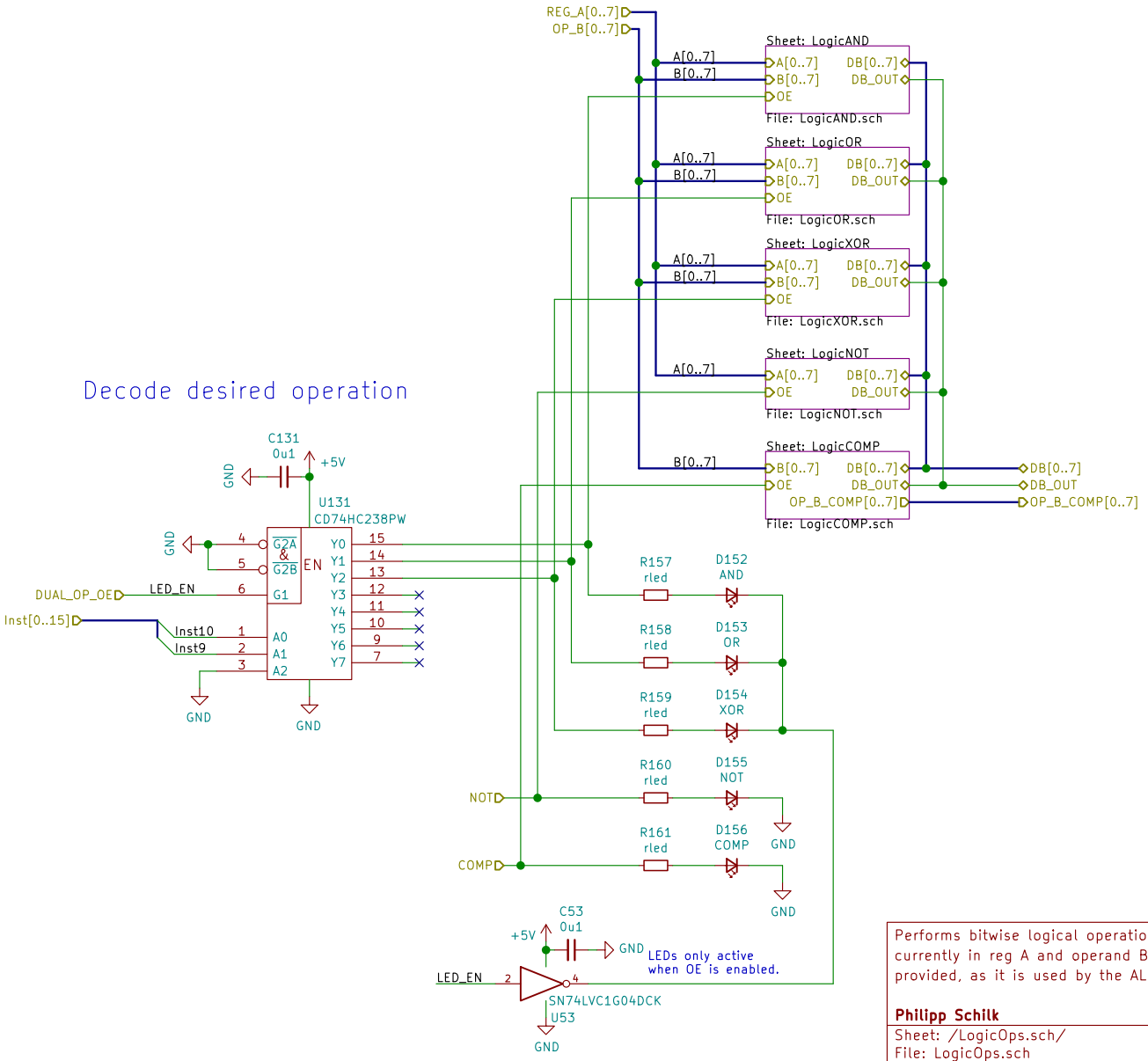
Puts either RegB or the lowest byte of the current instruction on the RAMA bus.
Used to access fixed/dynamic RAM addresses.

Philipp Schilk

Sheet: /In[0..7]/RegB->RAMA[0..7]/
File: In0..7_RegB_to_RAMA.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 24/93



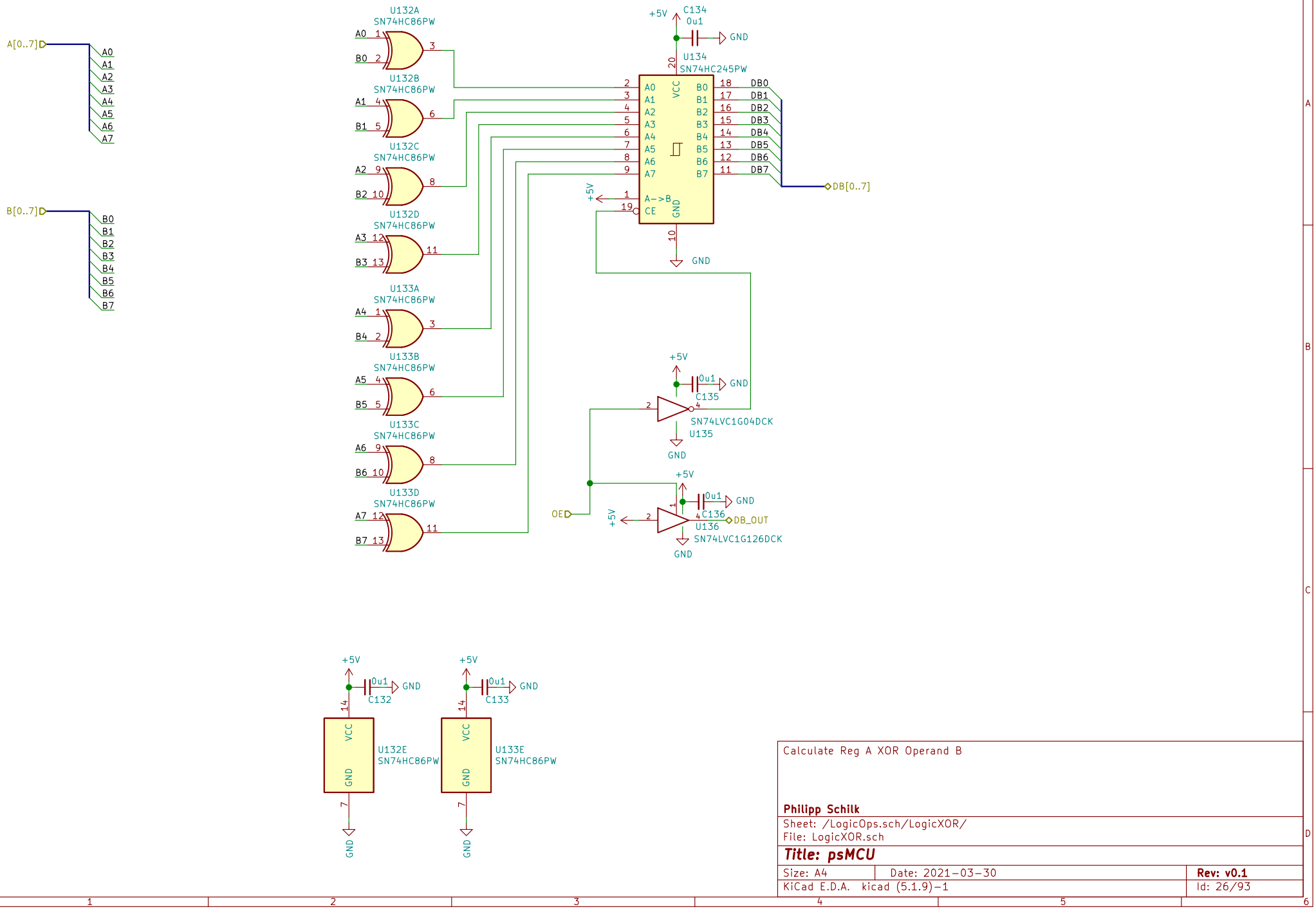
Performs bitwise logical operations (AND, OR, XOR, NOT, 2's complement) on the value currently in reg A and operand B. The 2's complement of operand B is always provided, as it is used by the ALU for subtraction.

Philipp Schilk

Sheet: /LogicOps.sch/
File: LogicOps.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 25/93



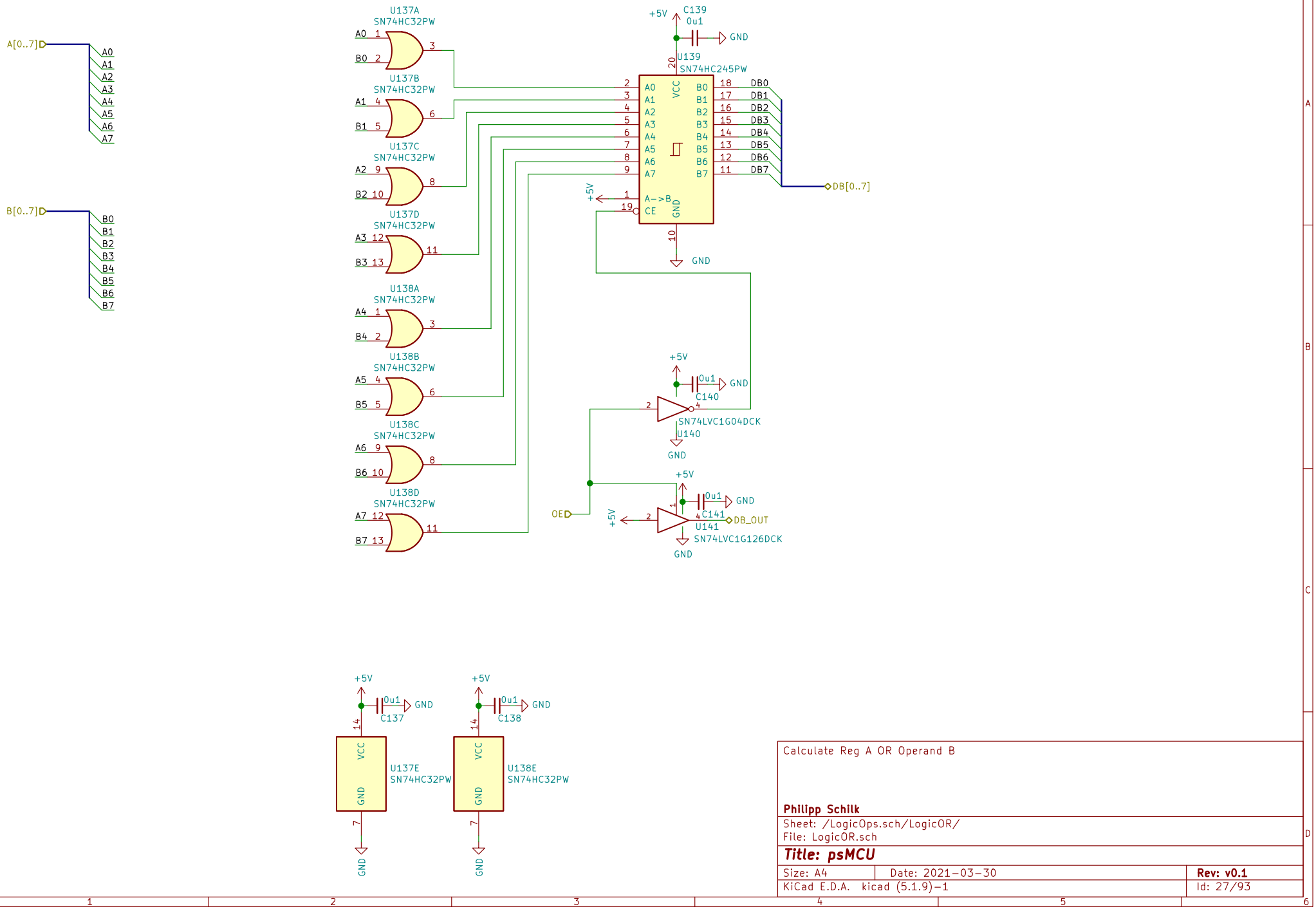
Calculate Reg A XOR Operand B

Philipp Schilk

Sheet: /LogicOps.sch/LogicXOR/
File: LogicXOR.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 26/93



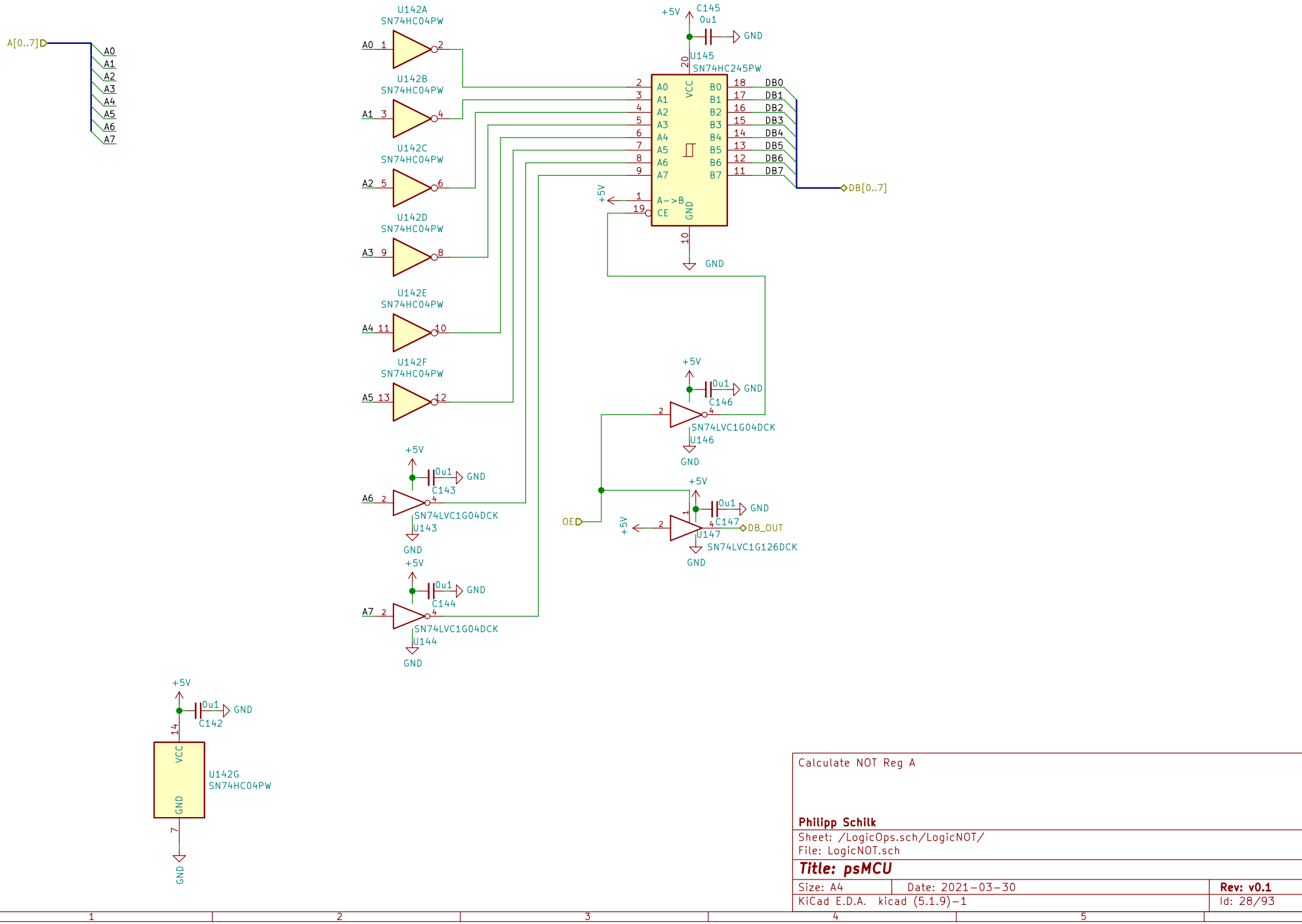
Calculate Reg A OR Operand B

Philipp Schilk

Sheet: /LogicOps.sch/LogicOR/
File: LogicOR.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 27/93



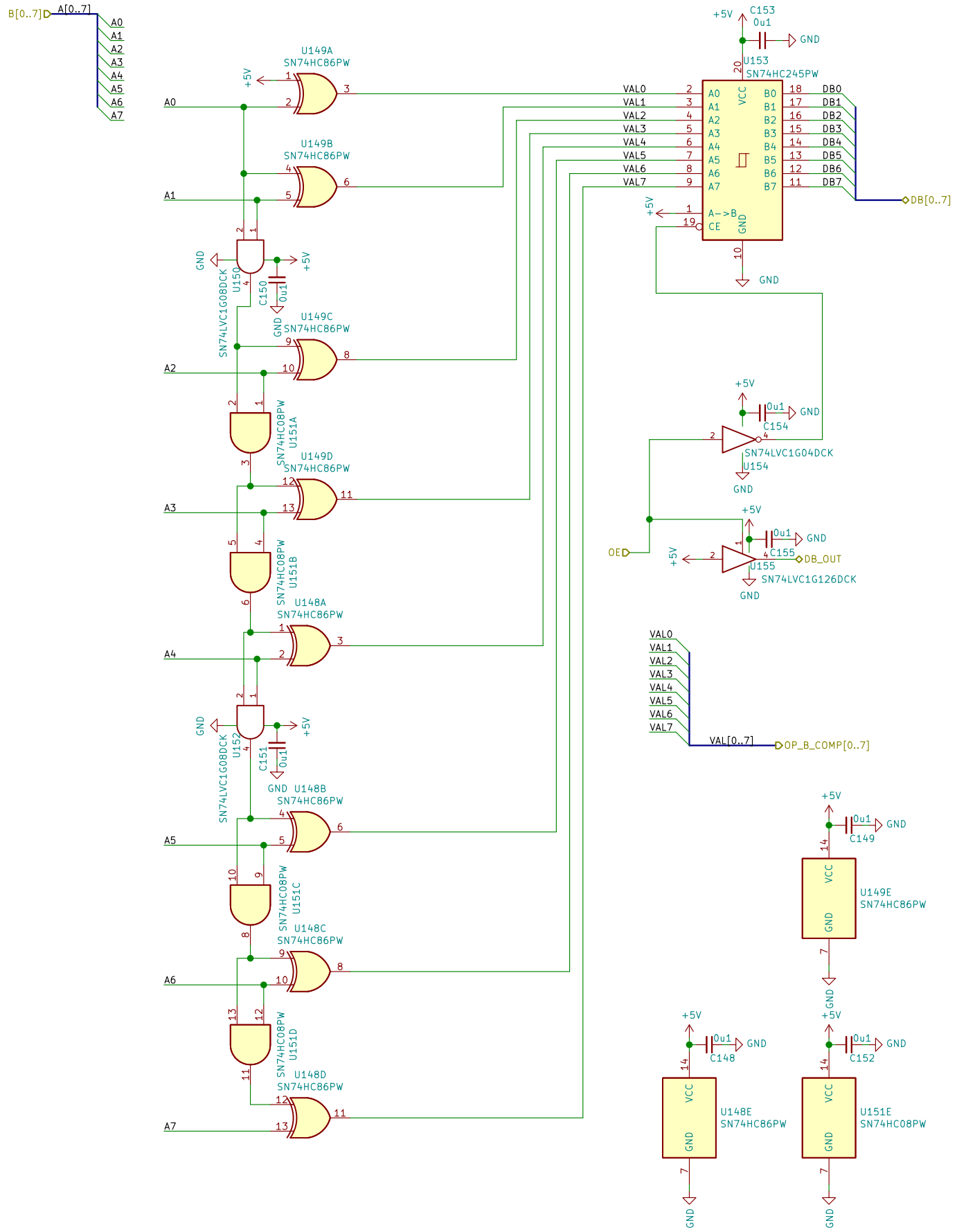
Calculate NOT Reg A

Philipp Schilk

Sheet: /LogicOps.sch/LogicNOT/
File: LogicNOT.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 28/93



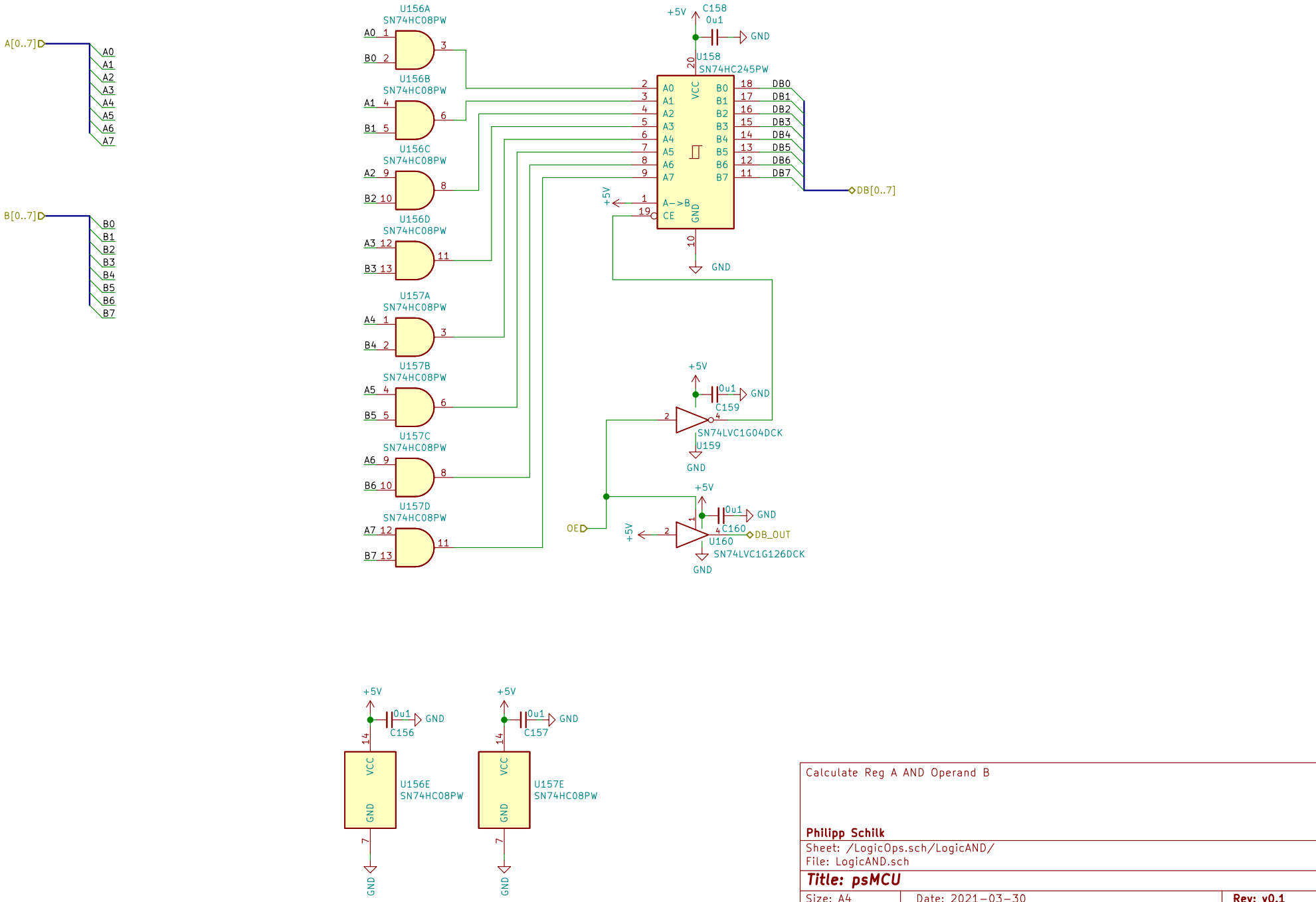
Calculate the 2's complement (*-1) of Operand B

Philipp Schilk

Sheet: /LogicOps.sch/LogicCOMP/
File: LogicCOMP.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 29/93



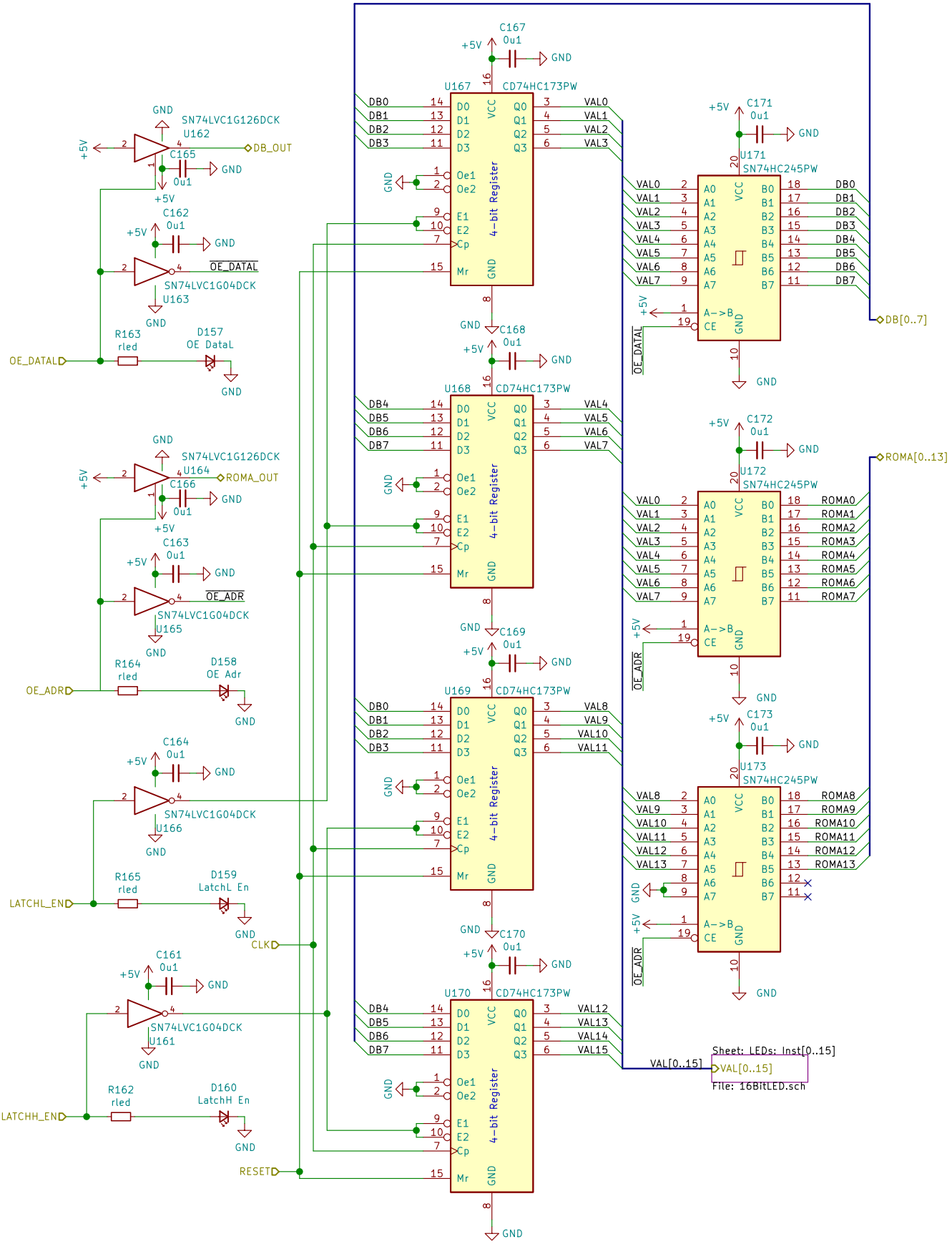
Calculate Reg A AND Operand B

Philipp Schilk

Sheet: /LogicOps.sch/LogicAND/
File: LogicAND.sch

Title: psMCU

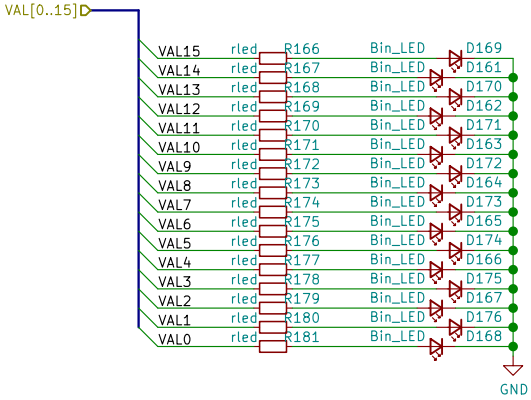
Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 30/93



A 16 bit register used during return instructions, to swap register contents, and during a few other instructions. The DBus can be latched into the higher or lower 8 bits. The current content can be read to the ROMA bus, or the lower 8 bits can be read to the DBus.

Philipp Schilk

Sheet: /TempReg/ File: TempReg.sch		
Title: psMCU		
Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 31/93



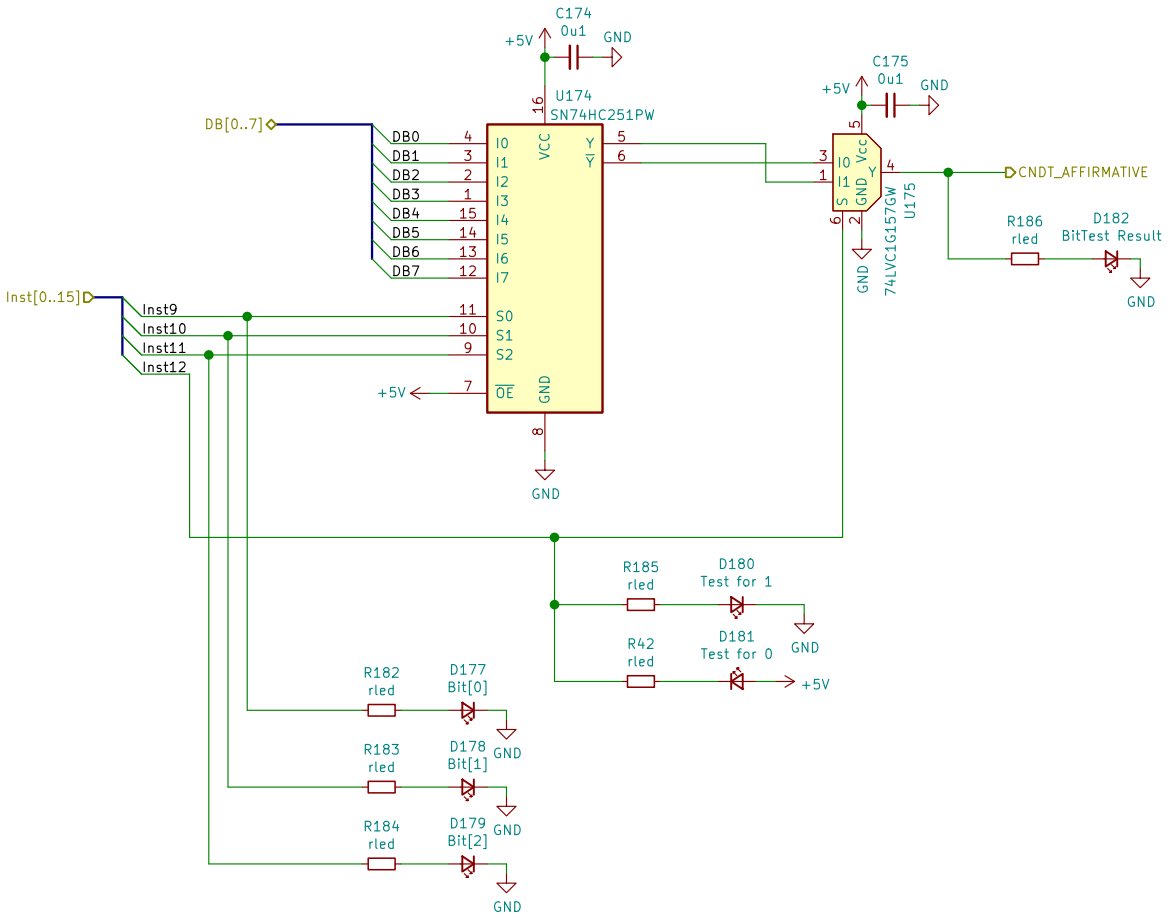
A 16bit binary LED display.

Philipp Schilk

Sheet: /TempReg/LEDs: Inst[0..15]/
File: 16BitLED.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 32/93



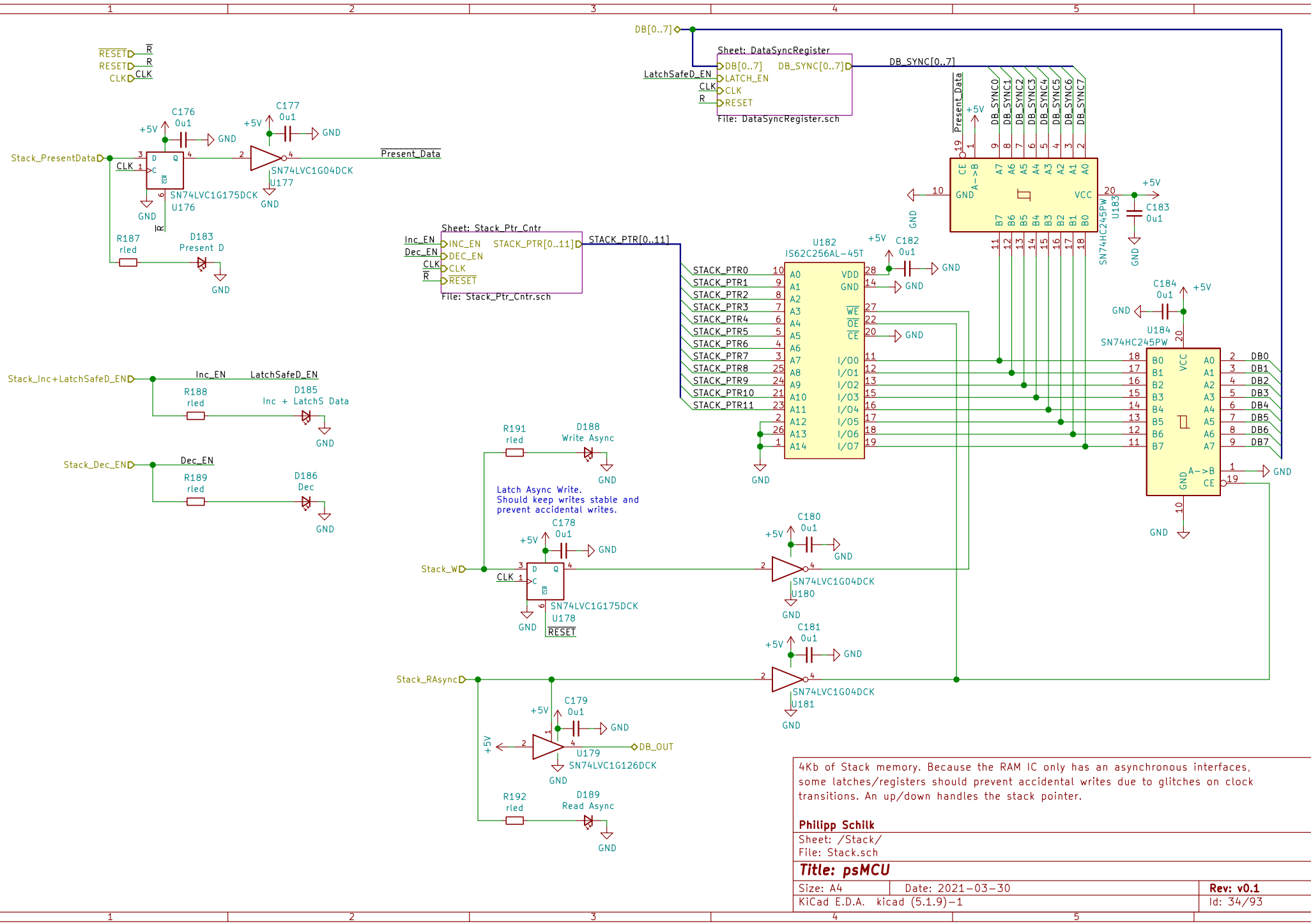
Checks if a given bit of the value currently on the DBus is set/reset. Used for the conditional bit test instructions. Which bit is tested, and if it is being tested for 1/0 is determined by the current instruction.

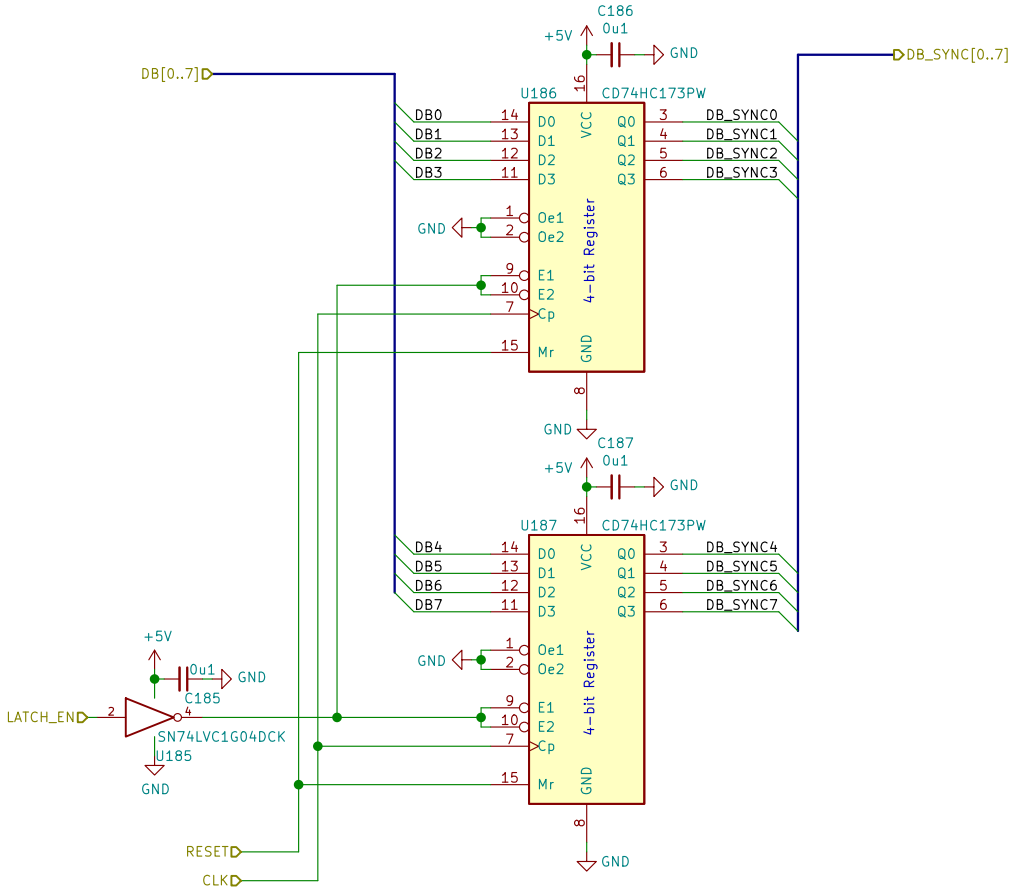
Philipp Schilk

Sheet: /BitTest/
File: BitTest.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 33/93


DB[0..7]
Sheet: DataSyncRegister
LatchSafeD_EN
CLK
R
DB[0..7]
LATCH_EN
CLK
RESET
DB_SYNC[0..7]
File: DataSyncRegister.sch
DB_SYNC[0..7]
Present_Data
DB_SYNC0
DB_SYNC1
DB_SYNC2
DB_SYNC3
DB_SYNC4
DB_SYNC5
DB_SYNC6
DB_SYNC7
SN74HC245PW
U183
C183
0u1
RESET
CLK
Stack_PresentData
C176
0u1
C177
0u1
SN74LVC1G175DCK
U176
SN74LVC1G04DCK
U177
Present_Data
R187
rled
D183
Present D
Sheet: Stack_Ptr_Cntr
Inc_EN
Dec_EN
CLK
R
INC_EN
DEC_EN
CLK
RESET
STACK_PTR[0..11]
File: Stack_Ptr_Cntr.sch
STACK_PTR[0..11]
U182
IS62C256AL-45T
C182
0u1
C184
0u1
U184
SN74HC245PW
DB0
DB1
DB2
DB3
DB4
DB5
DB6
DB7
Stack_Inc+LatchSafeD_EN
Inc_EN
LatchSafeD_EN
R188
rled
D185
Inc + LatchS Data
Stack_Dec_EN
Dec_EN
R189
rled
D186
Dec
R191
rled
D188
Write Async
Latch Async Write.
Should keep writes stable and
prevent accidental writes.
Stack_W
C178
0u1
SN74LVC1G175DCK
U178
RESET
C180
0u1
SN74LVC1G04DCK
U180
C181
0u1
SN74LVC1G04DCK
U181
Stack_RAsync
C179
0u1
SN74LVC1G126DCK
U179
DB_OUT
R192
rled
D189
Read Async
4Kb of Stack memory. Because the RAM IC only has an asynchronous interfaces, some latches/registers should prevent accidental writes due to glitches on clock transitions. An up/down handles the stack pointer.
Philipp Schilk
Sheet: /Stack/
File: Stack.sch
Title: psMCU
Size: A4
Date: 2021-03-30
Rev: v0.1
KiCad E.D.A. kicad (5.1.9)-1
Id: 34/93



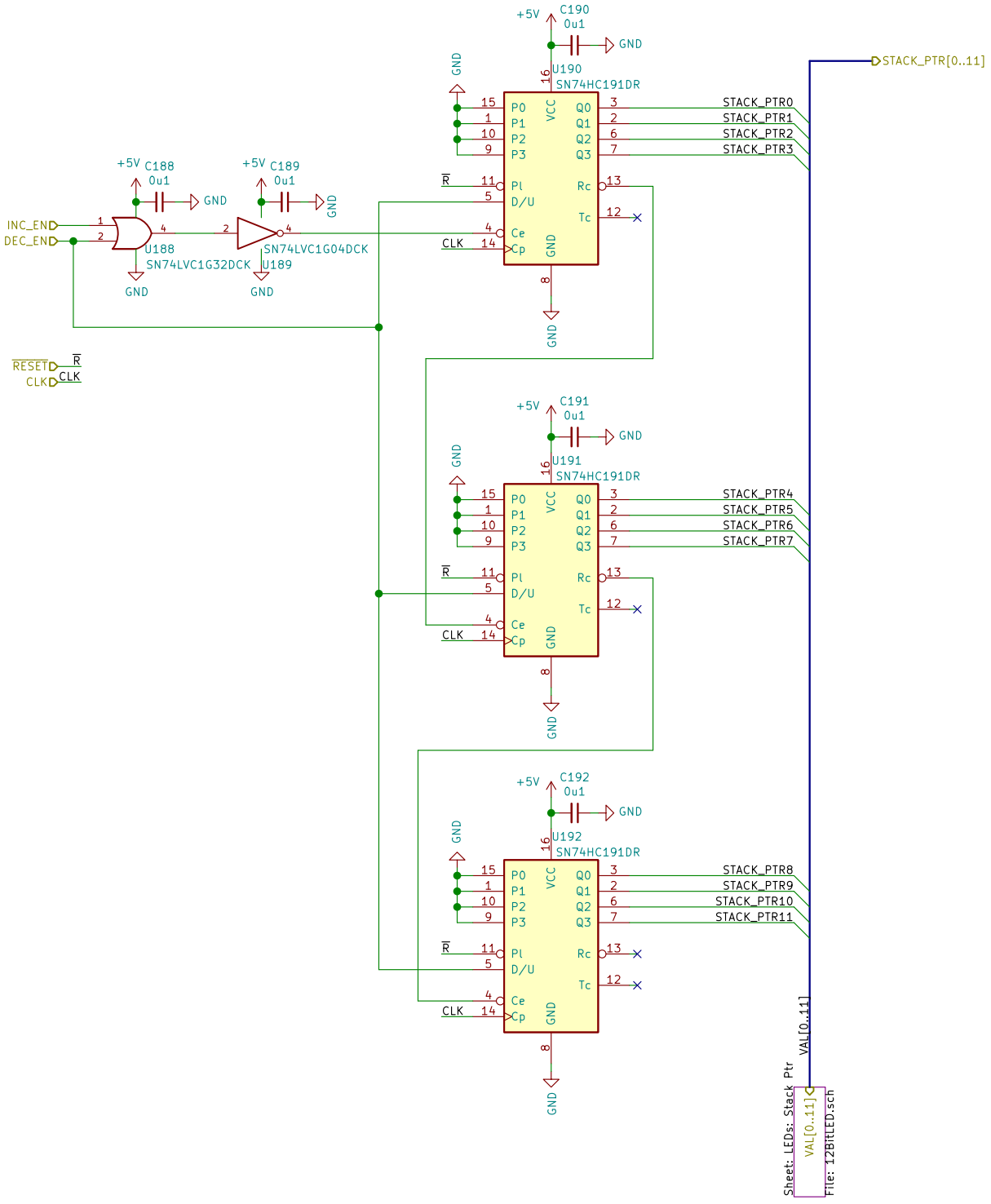
Registers to latch data into, for Stack access.

Philipp Schilk

Sheet: /Stack/DataSyncRegister/
File: DataSyncRegister.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 35/93



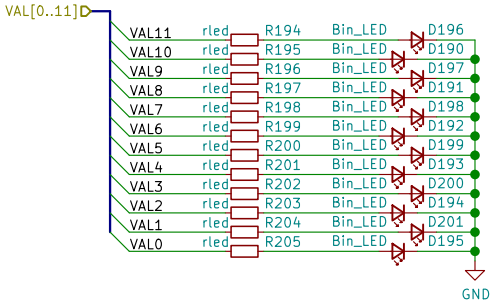
Stack pointer, implemented as an up/down counter.

Philipp Schilk

Sheet: /Stack/Stack_Ptr_Cntr/
File: Stack_Ptr_Cntr.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 36/93



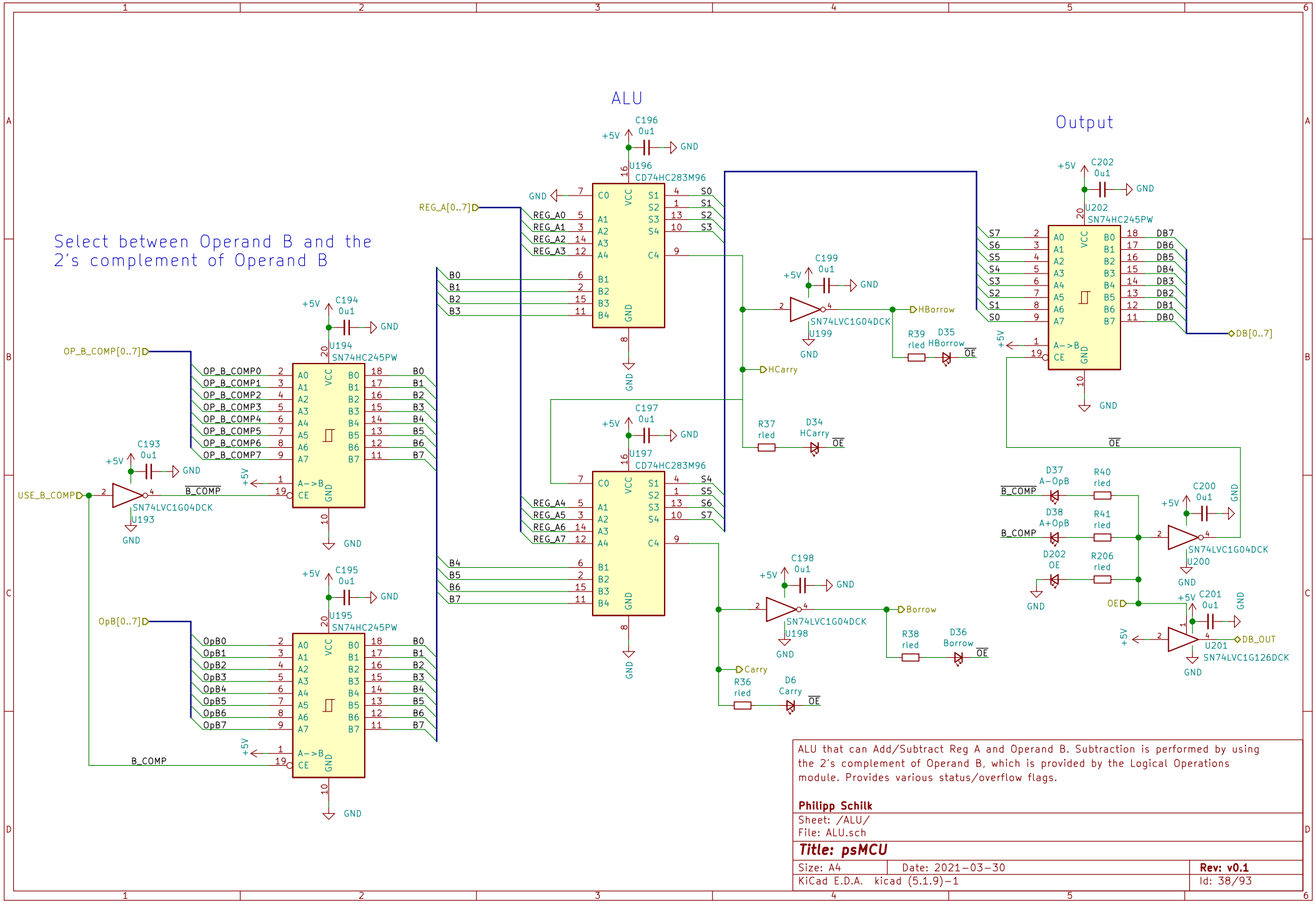
12bit binary LED display.

Philipp Schilk

Sheet: /Stack/Stack_Ptr_Cntr/LEDs: Stack Ptr/
File: 12BitLED.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 37/93



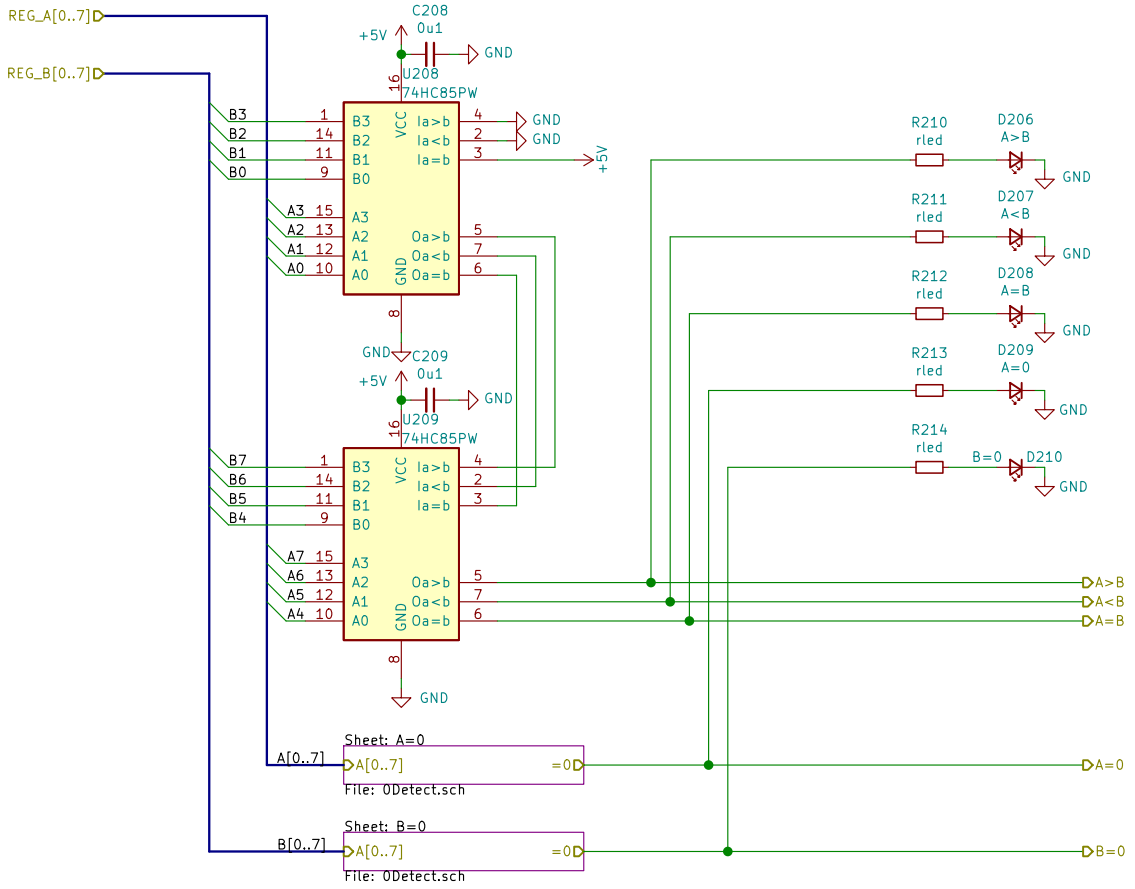
ALU that can Add/Subtract Reg A and Operand B. Subtraction is performed by using the 2's complement of Operand B, which is provided by the Logical Operations module. Provides various status/overflow flags.

Philipp Schilk

Sheet: /ALU/
File: ALU.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 38/93



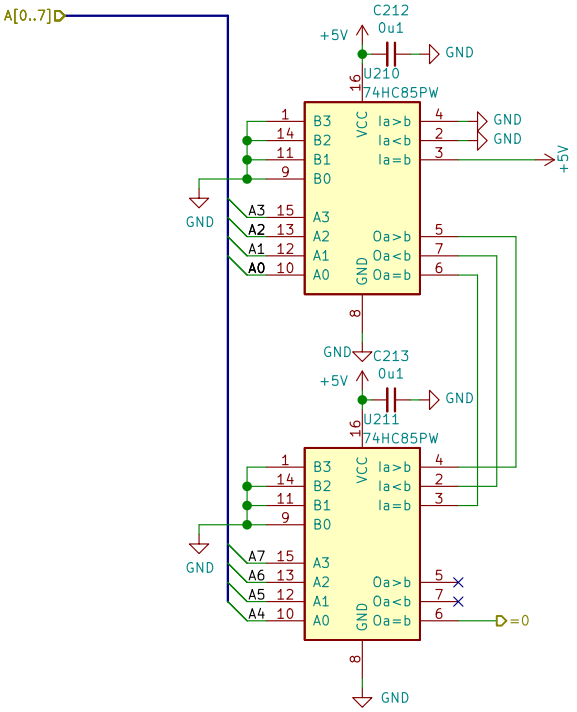
Performs unsigned magnitude comparison of RegA and RegB, also tests for A=0 and B=0.

Philipp Schilk

Sheet: /Comparator.sch/
File: Comparator.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 39/93



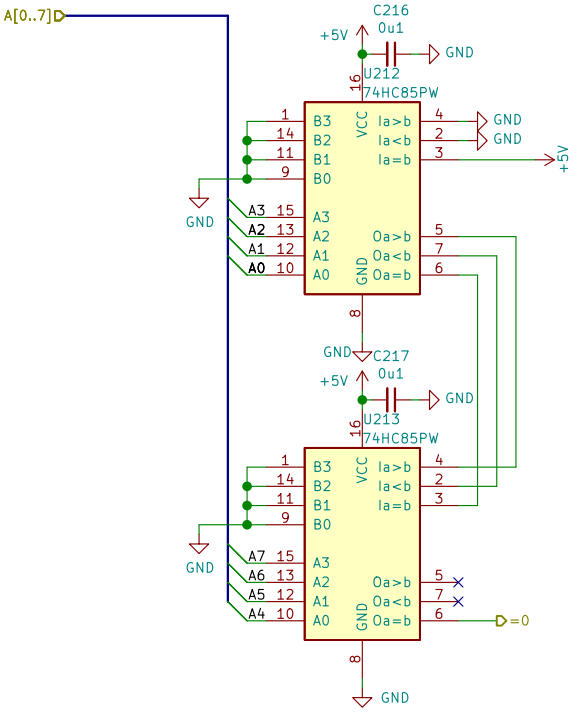
Test if the input value is equal to 0.

Philipp Schilk

Sheet: /Comparator.sch/A=0/
File: 0Detect.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 40/93



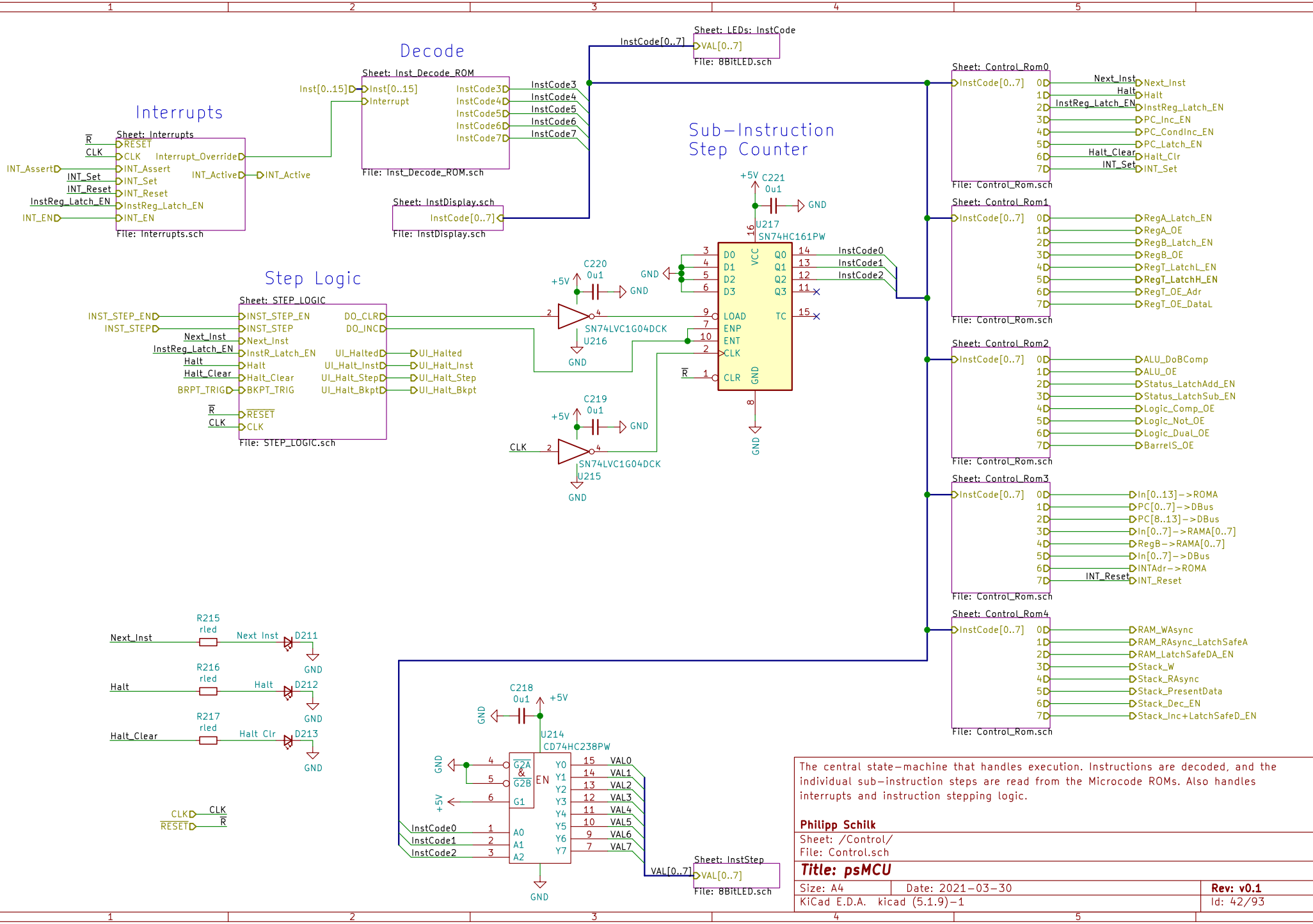
Test if the input value is equal to 0.

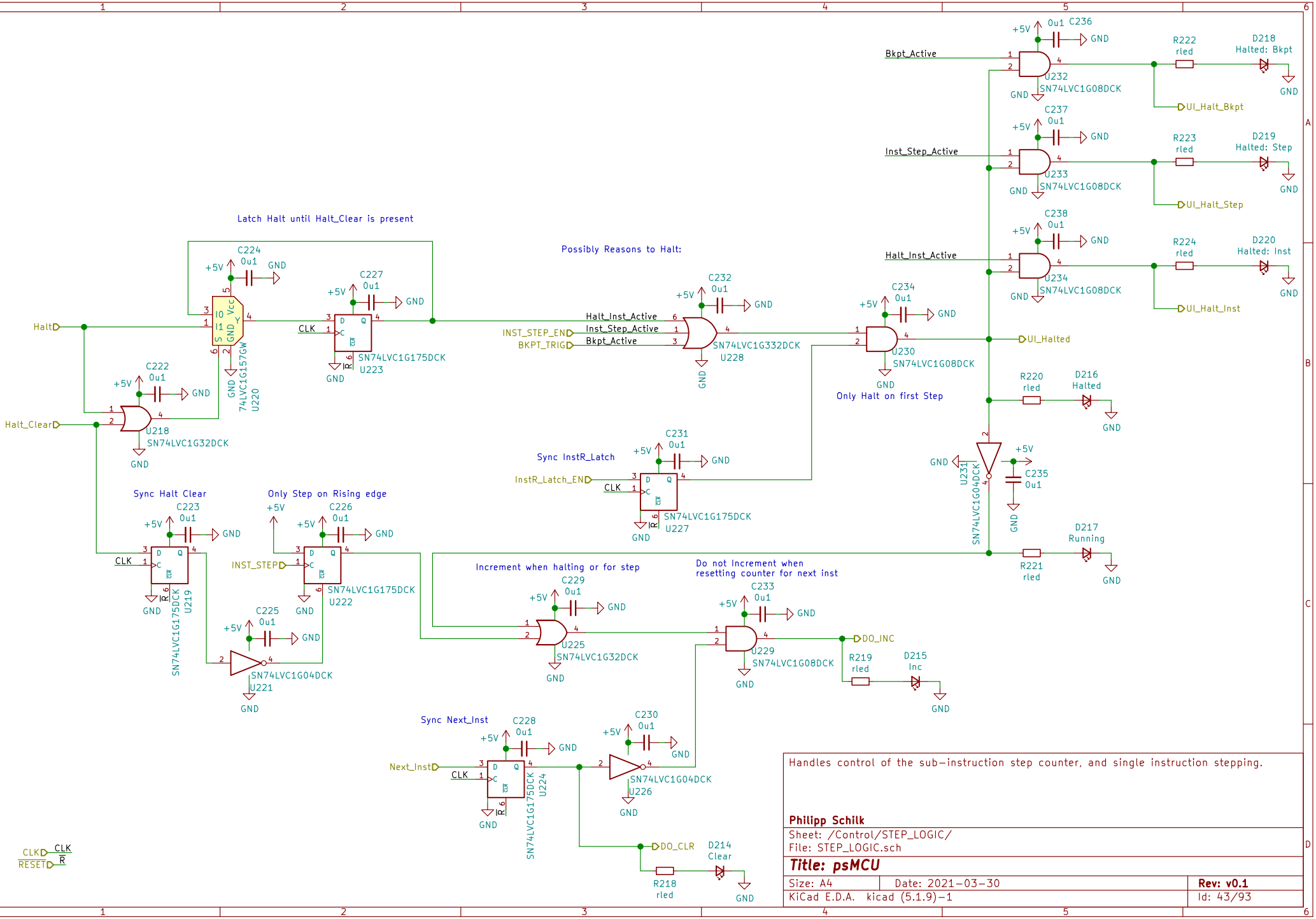
Philipp Schilk

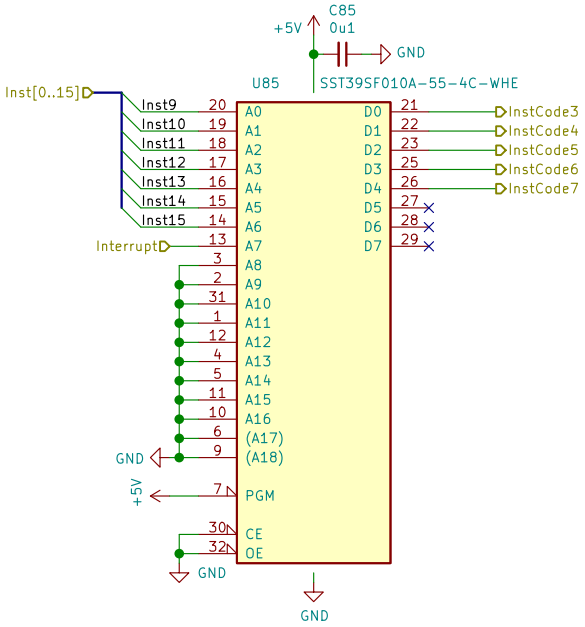
Sheet: /Comparator.sch/B=0/
File: 0Detect.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 41/93


Decode
Interrupts
Sub-Instruction Step Counter
Step Logic
Sheet: Inst_Decode_ROM
File: Inst_Decode_ROM.sch
Sheet: Interrupts
File: Interrupts.sch
Sheet: InstDisplay.sch
File: InstDisplay.sch
Sheet: LEDs: InstCode
File: 8BitLED.sch
Sheet: STEP_LOGIC
File: STEP_LOGIC.sch
U217 SN74HC161PW
U216 SN74LVC1G04DCK
U215 SN74LVC1G04DCK
U214 CD74HC238PW
C220 0u1
C221 0u1
C219 0u1
C218 0u1
Sheet: Control_Rom0
Sheet: Control_Rom1
Sheet: Control_Rom2
Sheet: Control_Rom3
Sheet: Control_Rom4
File: Control_Rom.sch
Sheet: InstStep
File: 8BitLED.sch
R215 rled
R216 rled
R217 rled
D211
D212
D213
The central state-machine that handles execution. Instructions are decoded, and the individual sub-instruction steps are read from the Microcode ROMs. Also handles interrupts and instruction stepping logic.
Philipp Schilk
Sheet: /Control/
File: Control.sch
Title: psMCU
Size: A4
Date: 2021-03-30
Rev: v0.1
KiCad E.D.A. kicad (5.1.9)-1
Id: 42/93


Latch Halt until Halt_Clear is present
Possibly Reasons to Halt:
Only Halt on first Step
Sync Halt Clear
Only Step on Rising edge
Sync InstR_Latch
Increment when halting or for step
Do not Increment when
resetting counter for next inst
Sync Next_Inst
Bkpt_Active
Inst_Step_Active
Halt_Inst_Active
Halt
Halt_Clear
CLK
INST_STEP
INST_STEP_END
BKPT_TRIG
InstR_Latch_EN
Next_Inst
DO_INC
DO_CLR
UI_Halted
UI_Halt_Bkpt
UI_Halt_Step
UI_Halt_Inst
SN74LVC1G175DCK
SN74LVC1G157GW
SN74LVC1G32DCK
SN74LVC1G08DCK
SN74LVC1G04DCK
Halted
Running
Inc
Clear
rled
GND
+5V
0u1
CLK
RESET
Handles control of the sub-instruction step counter, and single instruction stepping.
Philipp Schilk
Sheet: /Control/STEP_LOGIC/
File: STEP_LOGIC.sch
Title: psMCU
Size: A4
Date: 2021-03-30
Rev: v0.1
KiCad E.D.A. kicad (5.1.9)-1
Id: 43/93



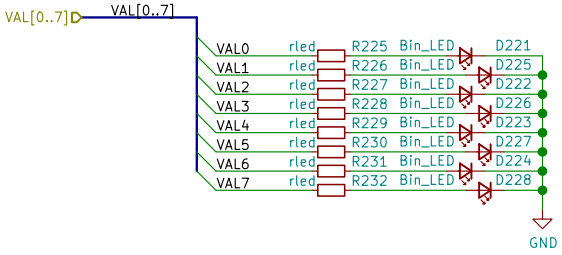
Decodes the MSBs of an instruction into the actual instruction code for microcode lookup.

Philipp Schilk

Sheet: /Control/Inst_Decode_ROM/
File: Inst_Decode_ROM.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 44/93



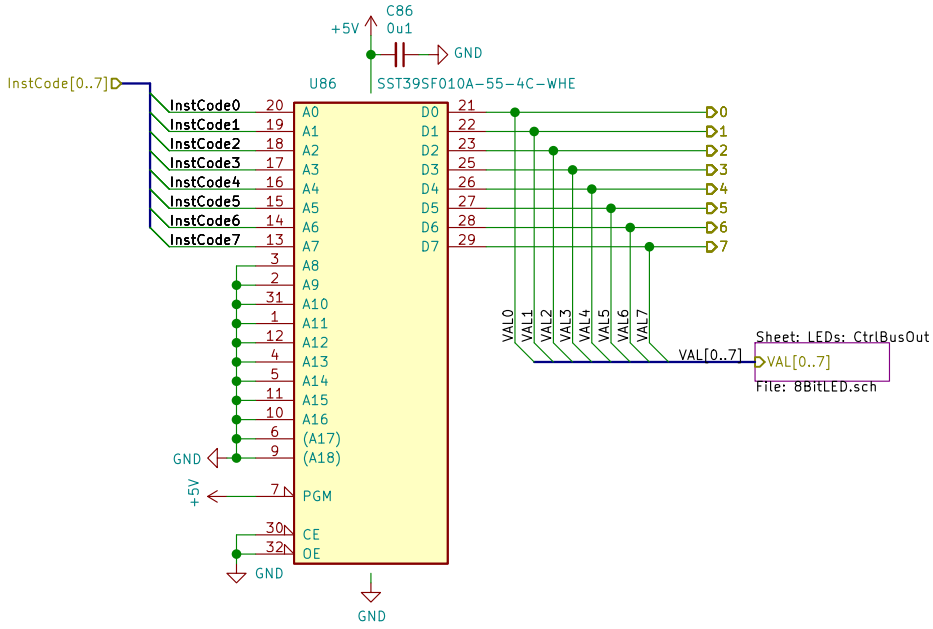
8bit binary LED display.

Philipp Schilk

Sheet: /Control/LEDs: InstCode/
File: 8BitLED.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 45/93



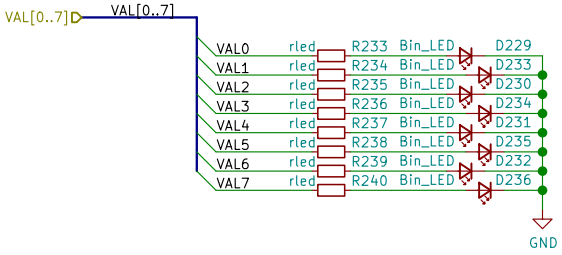
Microcode ROM, stores what control signals are needed for each sub-step of each instruction.

Philipp Schilk

Sheet: /Control/Control_Rom0/
File: Control_Rom.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 46/93



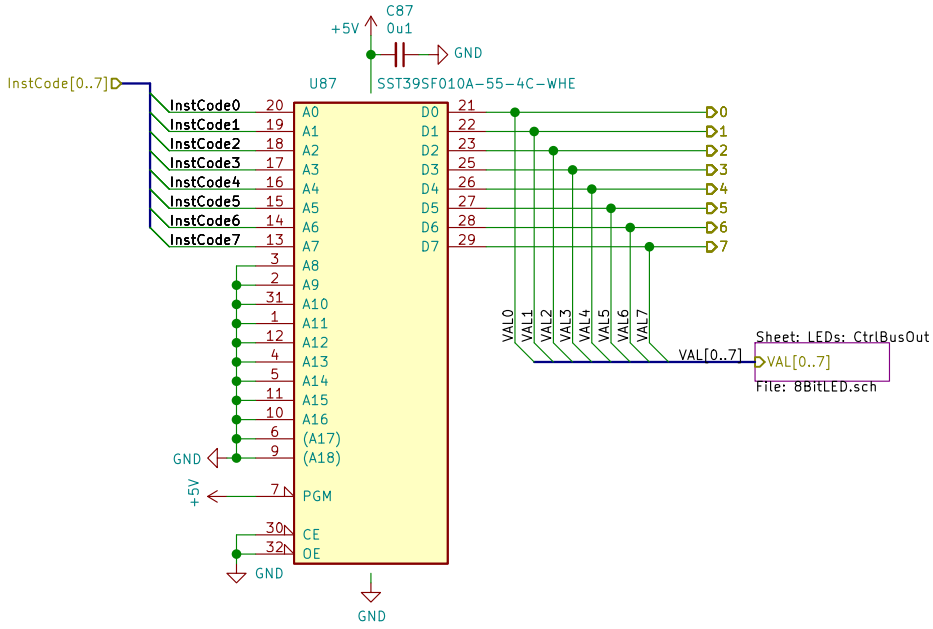
8bit binary LED display.

Philipp Schilk

Sheet: /Control/Control_Rom0/LEDs: CtrlBusOut/
File: 8BitLED.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 47/93



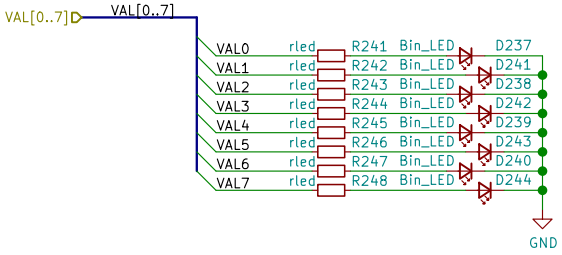
Microcode ROM, stores what control signals are needed for each sub-step of each instruction.

Philipp Schilk

Sheet: /Control/Control_Rom1/
File: Control_Rom.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 48/93



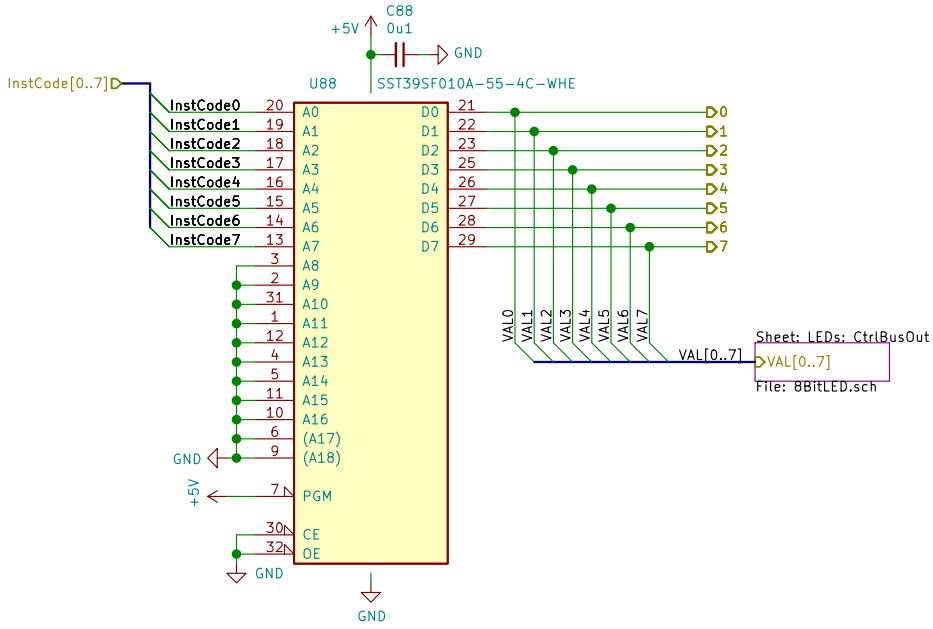
8bit binary LED display.

Philipp Schilk

Sheet: /Control/Control_Rom1/LEDs: CtrlBusOut/
File: 8BitLED.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 49/93



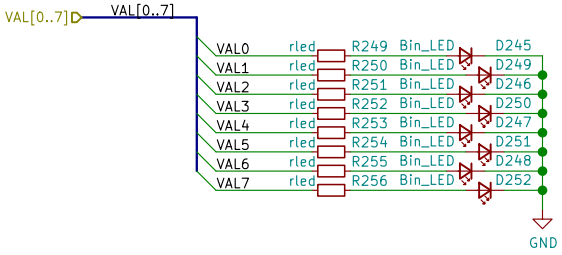
Microcode ROM, stores what control signals are needed for each sub-step of each instruction.

Philipp Schilk

Sheet: /Control/Control_Rom3/
File: Control_Rom.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 50/93



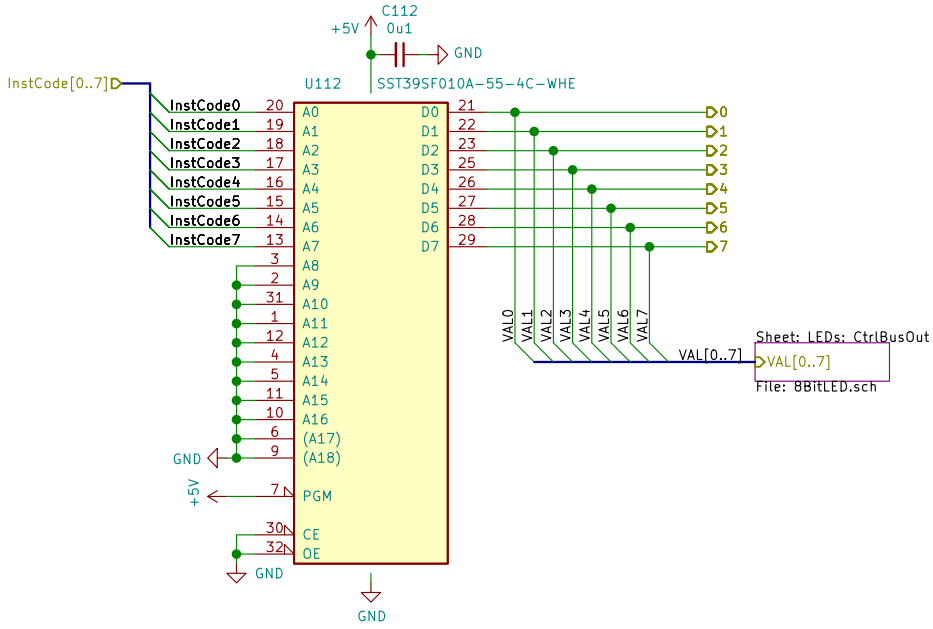
8bit binary LED display.

Philipp Schilk

Sheet: /Control/Control_Rom3/LEDs: CtrlBusOut/
File: 8BitLED.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 51/93



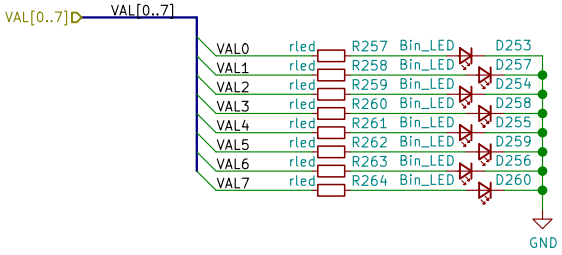
Microcode ROM, stores what control signals are needed for each sub-step of each instruction.

Philipp Schilk

Sheet: /Control/Control_Rom4/
File: Control_Rom.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 52/93



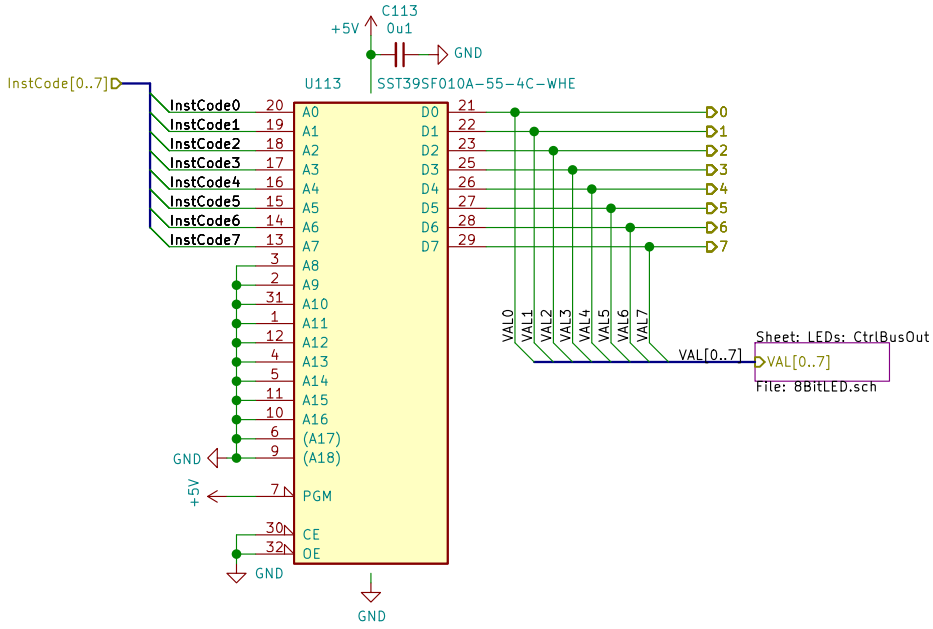
8bit binary LED display.

Philipp Schilk

Sheet: /Control/Control_Rom4/LEDs: CtrlBusOut/
File: 8BitLED.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 53/93



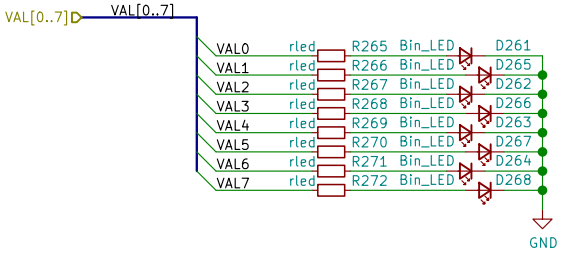
Microcode ROM, stores what control signals are needed for each sub-step of each instruction.

Philipp Schilk

Sheet: /Control/Control_Rom2/
File: Control_Rom.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 54/93



8bit binary LED display.

Philipp Schilk

Sheet: /Control/Control_Rom2/LEDs: CtrlBusOut/
File: 8BitLED.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 55/93

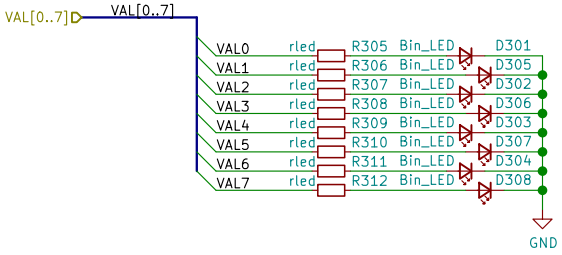
Displays which instruction is currently being executed.

Philipp Schilk

Sheet: /Control/InstDisplay.sch/
File: InstDisplay.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 56/93



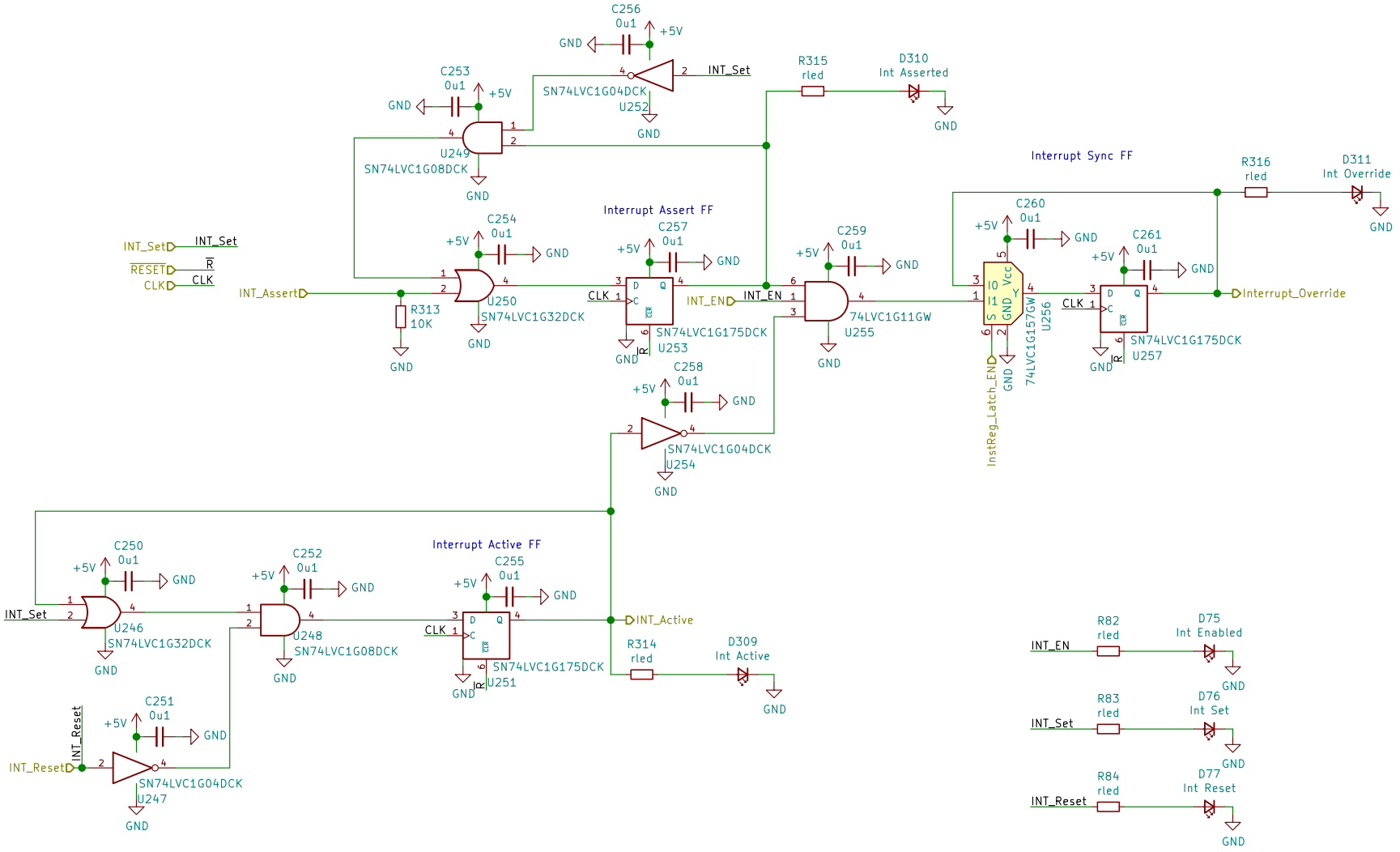
8bit binary LED display.

Philipp Schilk

Sheet: /Control/InstStep/
File: 8BitLED.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 57/93



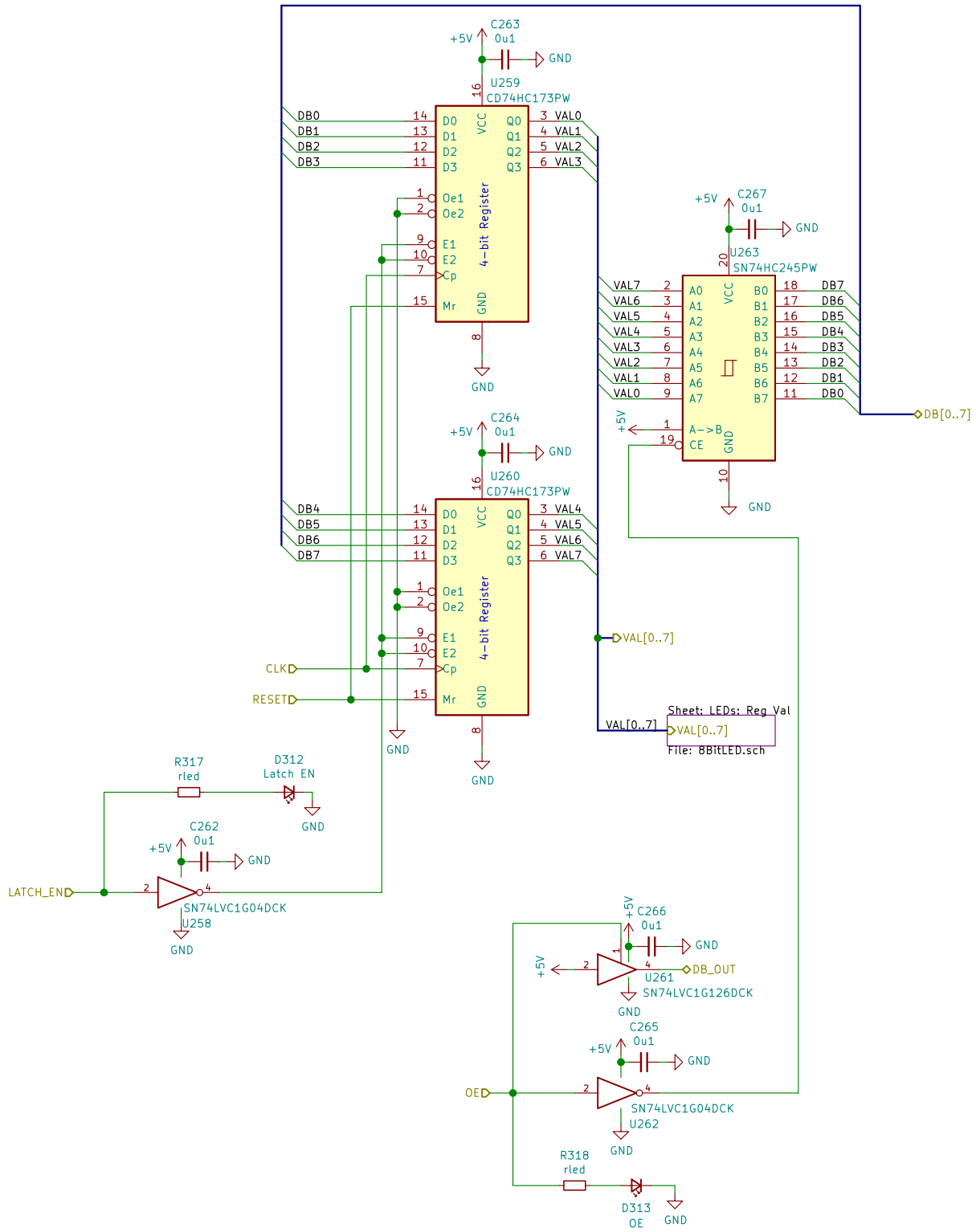
Interrupt logic. Keeps track if an interrupt is currently being served, and forces the state-machine to branch to the interrupt handler if one occurs.

Philipp Schilk

Sheet: /Control/Interrupts/
File: Interrupts.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 58/93



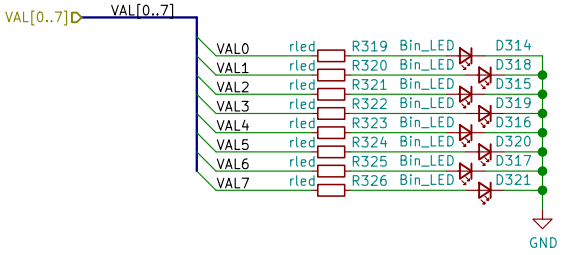
A basic 8-bit register. Interfaces with the DBus, and features a 7 segment display.

Philipp Schilk

Sheet: /RegA/
File: Reg.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 59/93



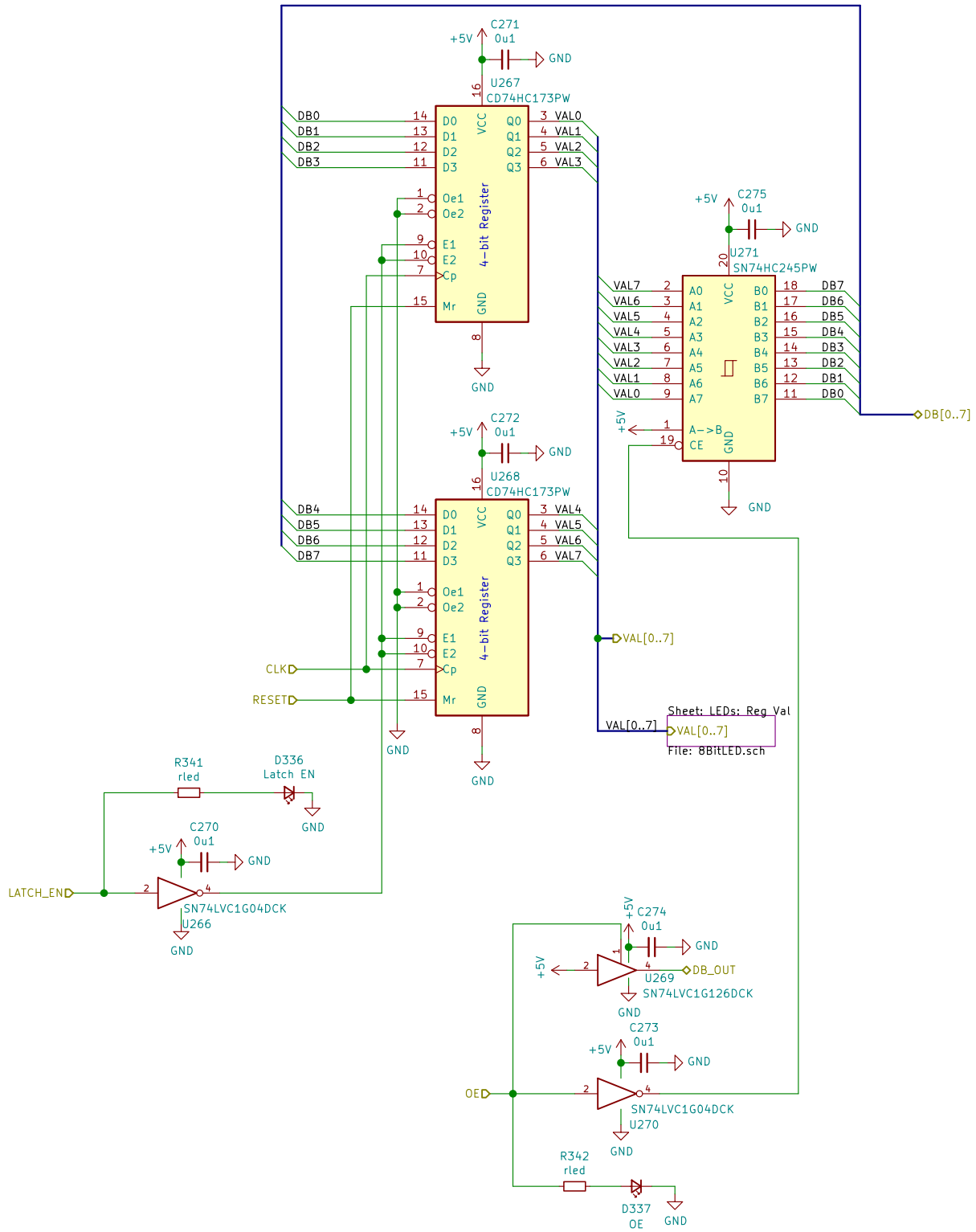
8bit binary LED display.

Philipp Schilk

Sheet: /RegA/LEDs: Reg Val/
File: 8BitLED.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 60/93



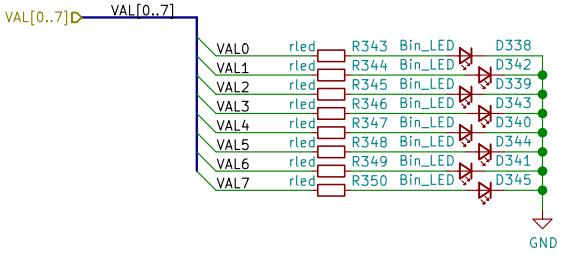
A basic 8-bit register. Interfaces with the DBus, and features a 7 segment display.

Philipp Schilk

Sheet: /RegB/
File: Reg.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 61/93



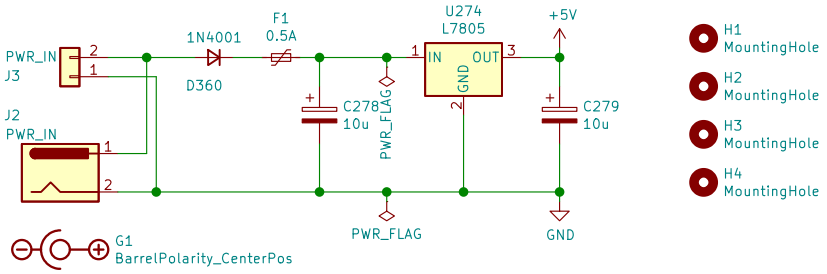
8bit binary LED display.

Philipp Schilk

Sheet: /RegB/LEDs: Reg Val/
File: 8BitLED.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 62/93



Power input connectors, reverse polarity protection, voltage regulation. Also includes the 4 M4 mounting holes.

Philipp Schilk

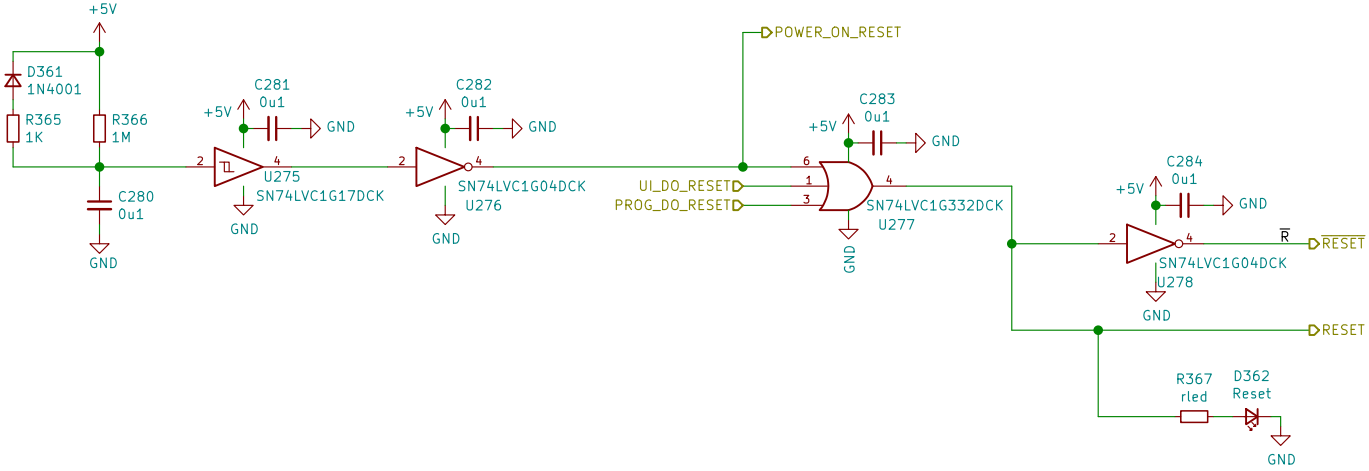
Sheet: /PowerInput/
File: PowerInput.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 63/93

Automatic Reset on Power-on

Generate different Reset signals



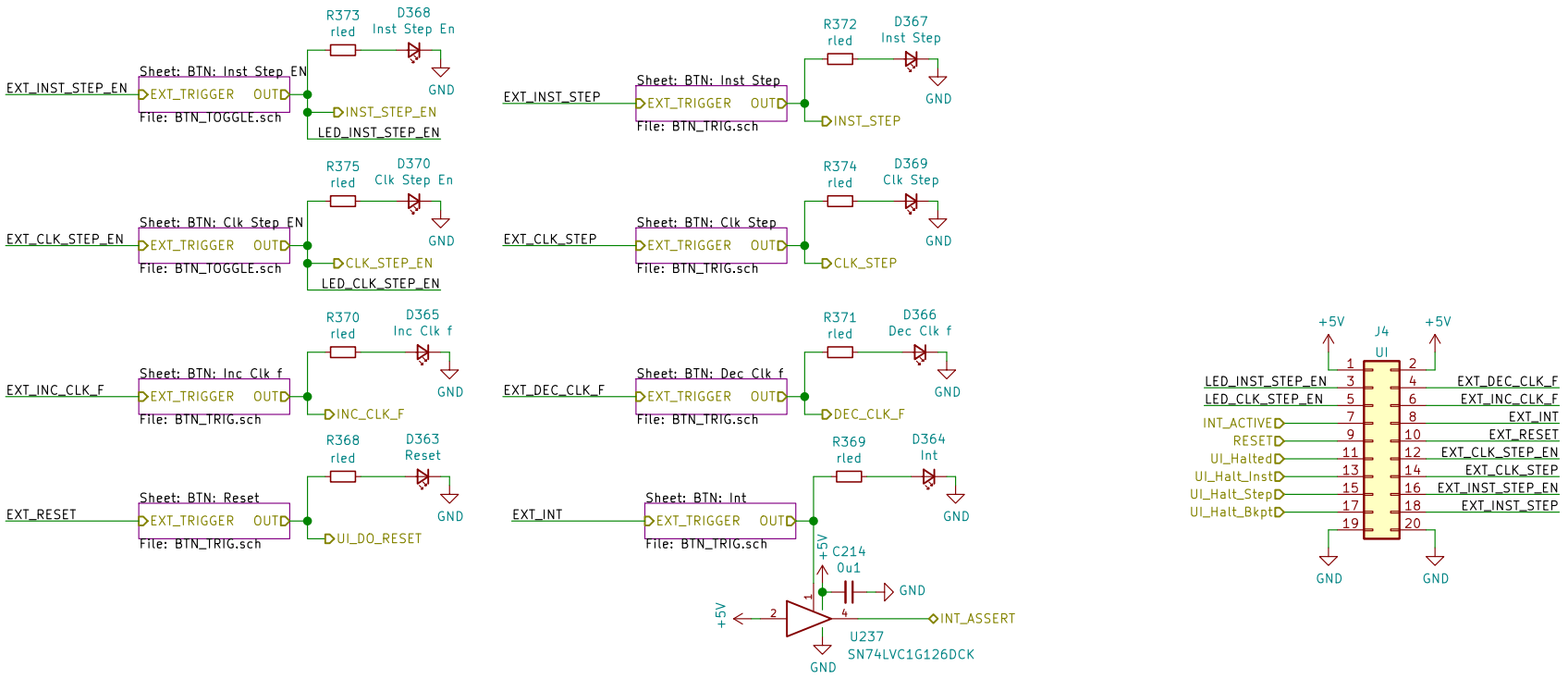
Generates reset during power-on and combines the different reset sources to generate the RESET and $\overline{\text{RESET}}$ signals used globally.

Philipp Schilk

Sheet: /ResetCtrl/
File: ResetCtrl.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 64/93



Contains all buttons needed to control the state/execution flow of the processor and a connector/interface for and external remote control.

Philipp Schilk

Sheet: /UI/
File: UI.sch

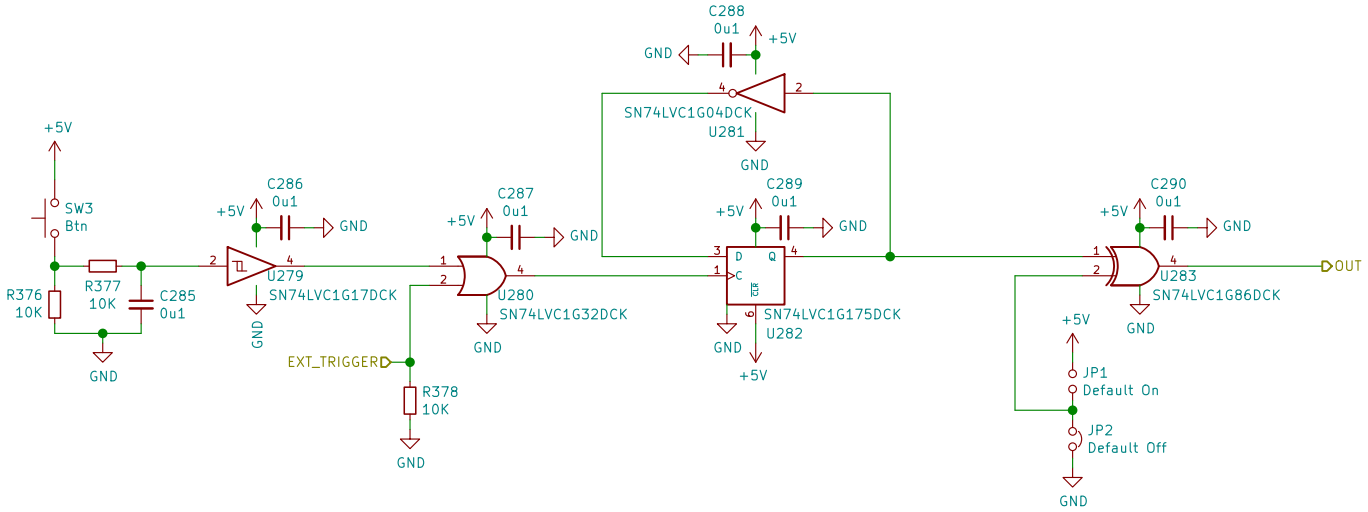
Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 65/93

BTN + Debounce

T-FF

Set default Position



A button that toggles a state on/off. Handles de-bounce and combines the signal from an external remote control. Allows for the default state during power-on to be set by jumpers

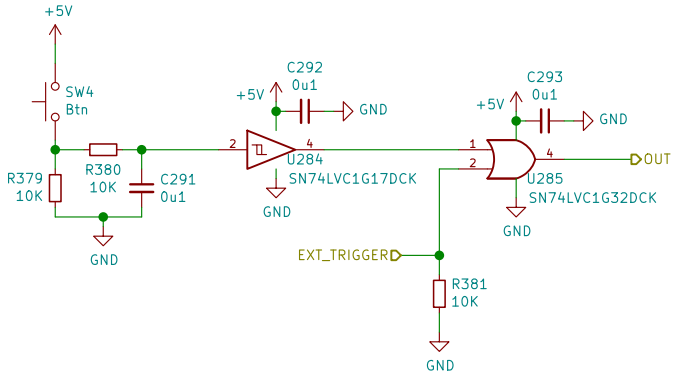
Philipp Schilk

Sheet: /UI/BTN: Inst Step EN/
File: BTN_TOGGLE.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 66/93

BTN + Debounce



A simple single-trigger button. Handles de-bouncing and also combines the signal from an external remote.

Philipp Schilk

Sheet: /UI/BTN: Inst Step/
File: BTN_TRIG.sch

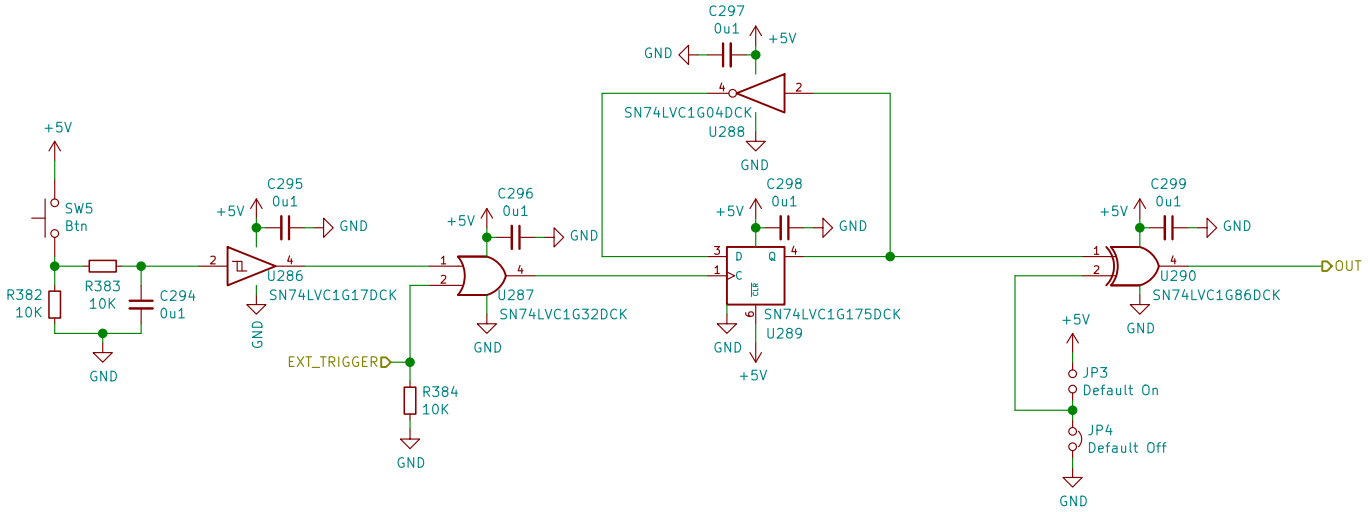
Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 67/93

BTN + Debounce

T-FF

Set default Position



A button that toggles a state on/off. Handles de-bounce and combines the signal from an external remote control. Allows for the default state during power-on to be set by jumpers

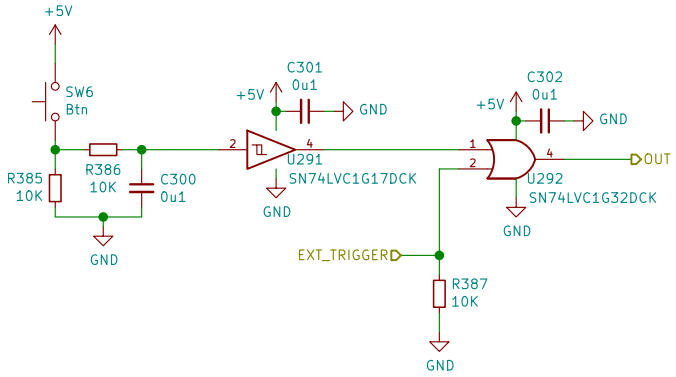
Philipp Schilk

Sheet: /UI/BTN: Clk Step EN/
File: BTN_TOGGLE.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 68/93

BTN + Debounce



A simple single-trigger button. Handles de-bouncing and also combines the signal from an external remote.

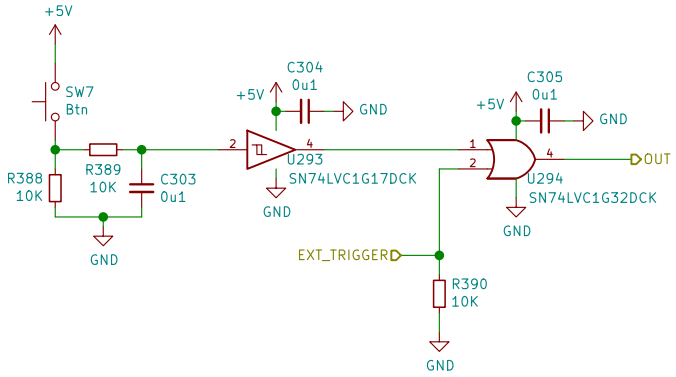
Philipp Schilk

Sheet: /UI/BTN: Clk Step/
File: BTN_TRIG.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 69/93

BTN + Debounce



A simple single-trigger button. Handles de-bouncing and also combines the signal from an external remote.

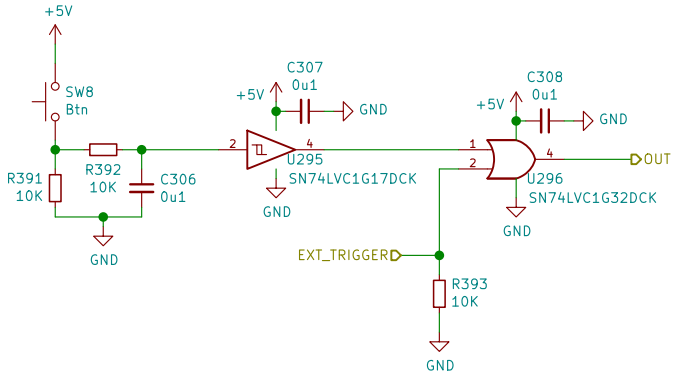
Philipp Schilk

Sheet: /UI/BTN: Reset/
File: BTN_TRIG.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 70/93

BTN + Debounce



A simple single-trigger button. Handles de-bouncing and also combines the signal from an external remote.

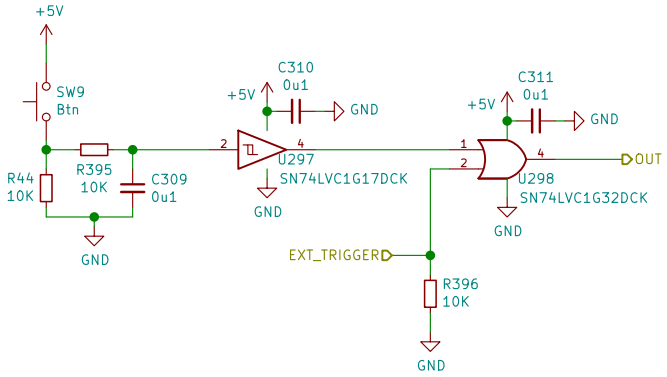
Philipp Schilk

Sheet: /UI/BTN: Int/
File: BTN_TRIG.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 71/93

BTN + Debounce



A simple single-trigger button. Handles de-bouncing and also combines the signal from an external remote.

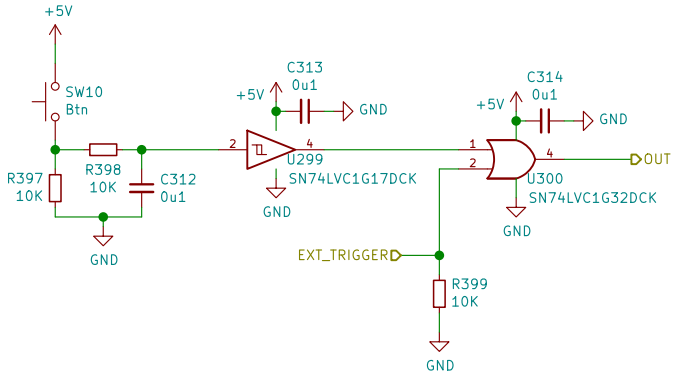
Philipp Schilk

Sheet: /UI/BTN: Inc Clk f/
File: BTN_TRIG.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 72/93

BTN + Debounce



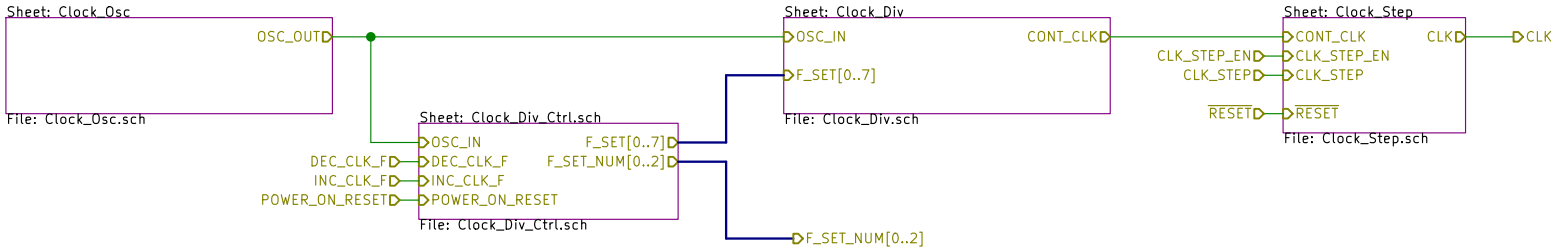
A simple single-trigger button. Handles de-bouncing and also combines the signal from an external remote.

Philipp Schilk

Sheet: /UI/BTN: Dec Clk f/
File: BTN_TRIG.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 73/93



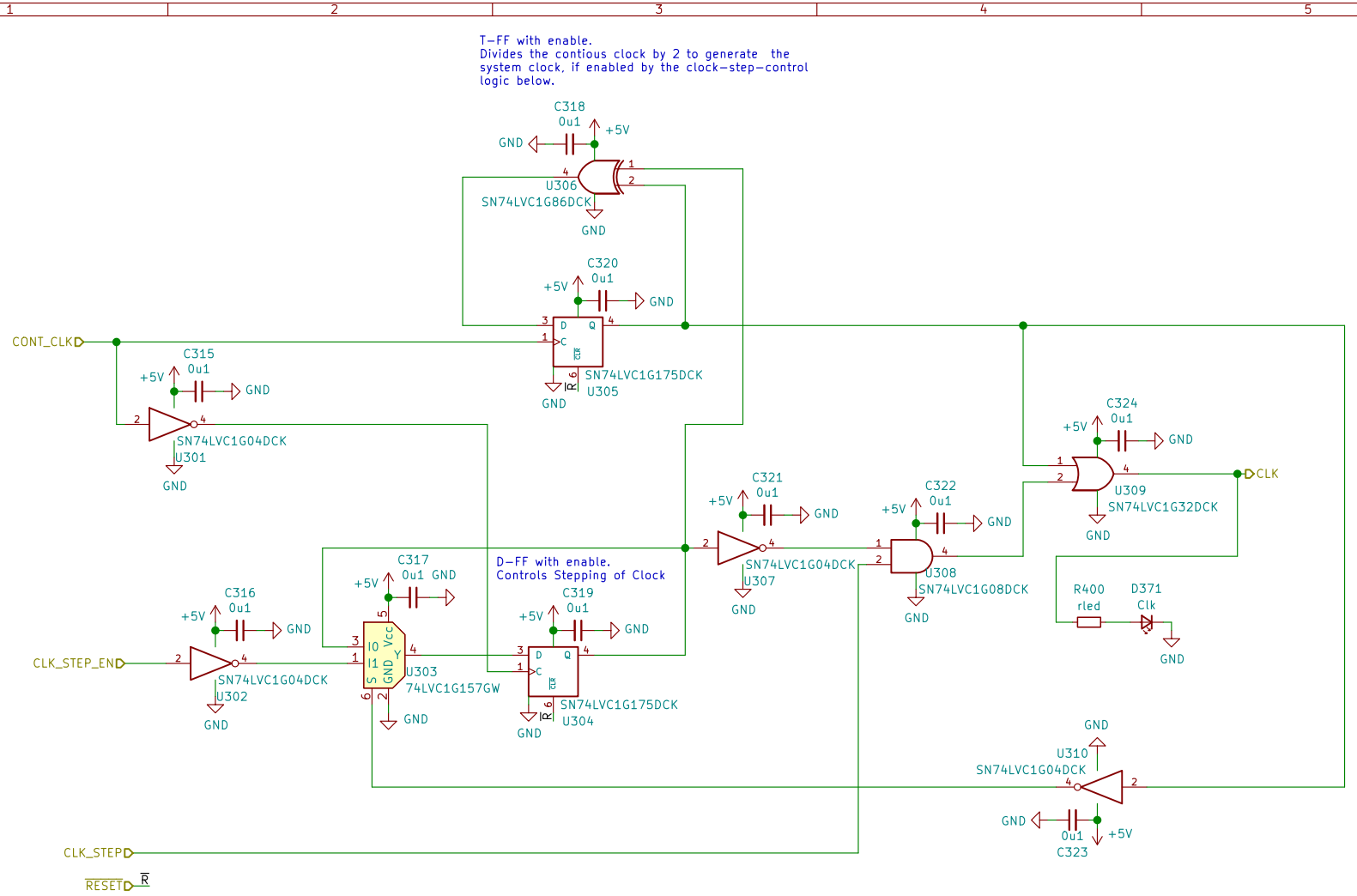
Variable frequency clock generation.

Philipp Schilk

Sheet: /Clock/
File: Clock.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 74/93



Generates the actual system clock. Can pause the clock and allow manual 'clock stepping'. Avoids clock-glitches when changing modes.

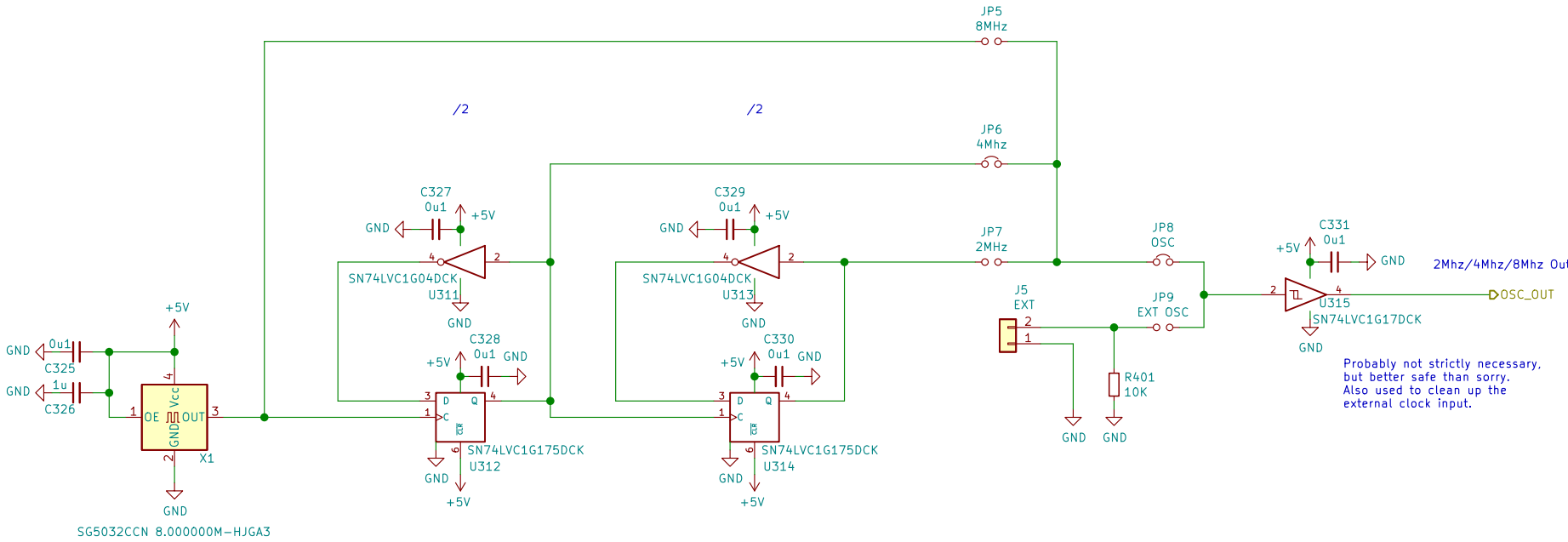
(Black Magic. I don't quite remember how this works!)

Philipp Schilk

Sheet: /Clock/Clock_Step/
File: Clock_Step.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 75/93



The central oscillator. Allows for 2 optional dividers or an external clock source.
Using the internal crystal, this module can generate 2MHz, 4Mhz, or 8MHz

Philipp Schilk

Sheet: /Clock/Clock_Osc/
File: Clock_Osc.sch

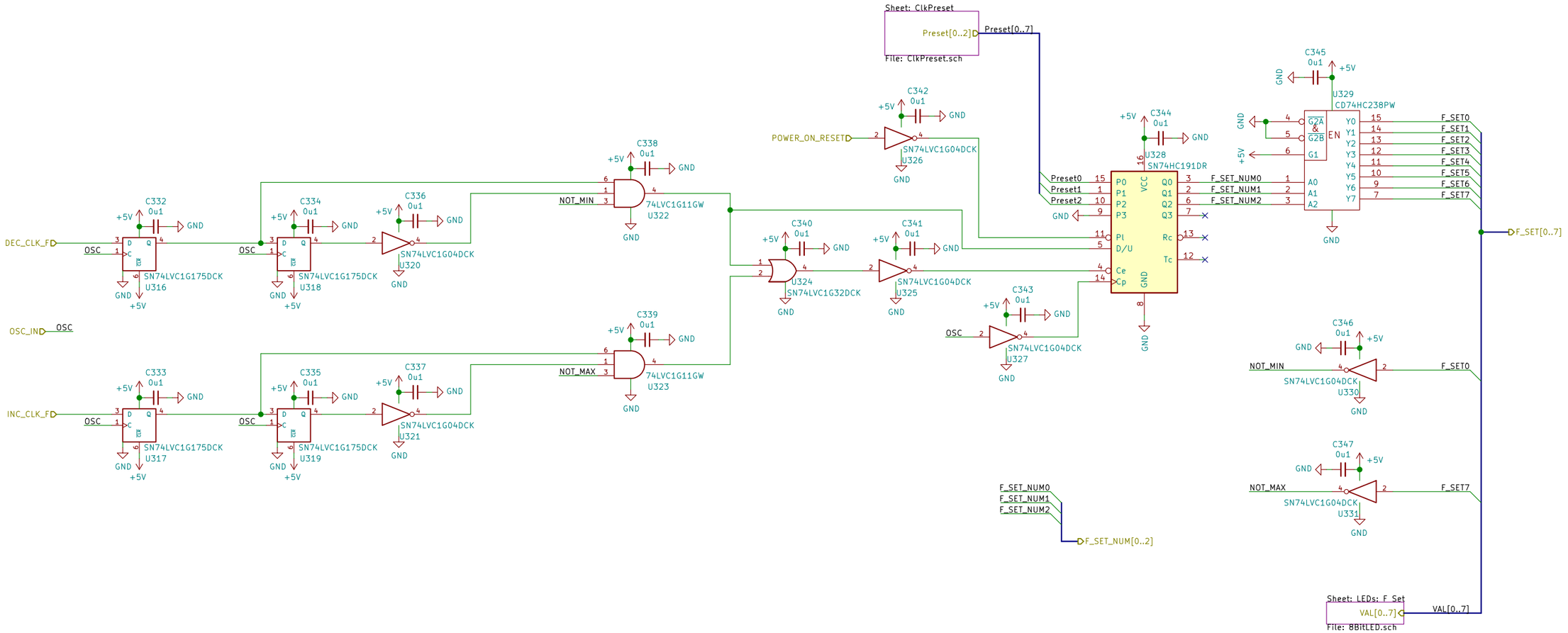
Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 76/93

Input Rising-Edge Detectors

Up/Down Counter

Binary to one-hot converter



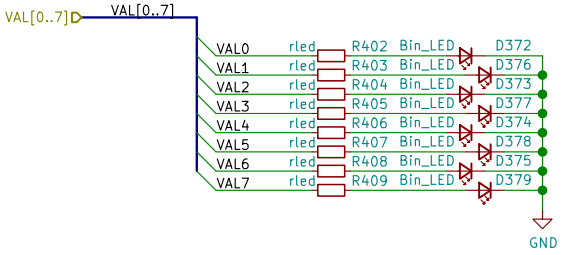
Frequency selection logic/state machine. Allows selection between 8 frequency set-points. Rising-Edge detectors ensure each button press is only counted once. The default clock setting during power-on is configurable with jumpers. Output encoded as 1-of-8/one-hot signal.

Philipp Schilk

Sheet: /Clock/Clock_Div_Ctrl.sch/
File: Clock_Div_Ctrl.sch

Title: psMCU

Size: A3	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 77/93



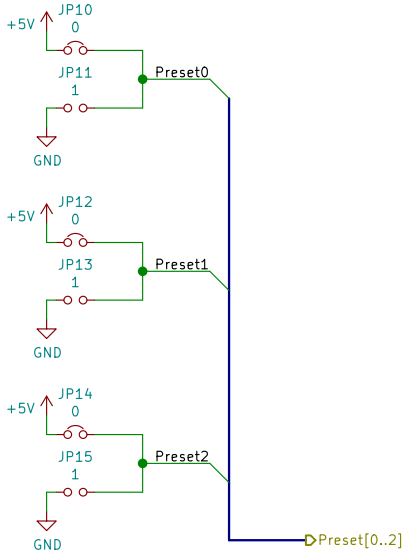
8bit binary LED display.

Philipp Schilk

Sheet: /Clock/Clock_Div_Ctrl.sch/LEDs: F Set/
File: 8BitLED.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 78/93



Jumpers to configure default clock frequency after power-on.

Philipp Schilk

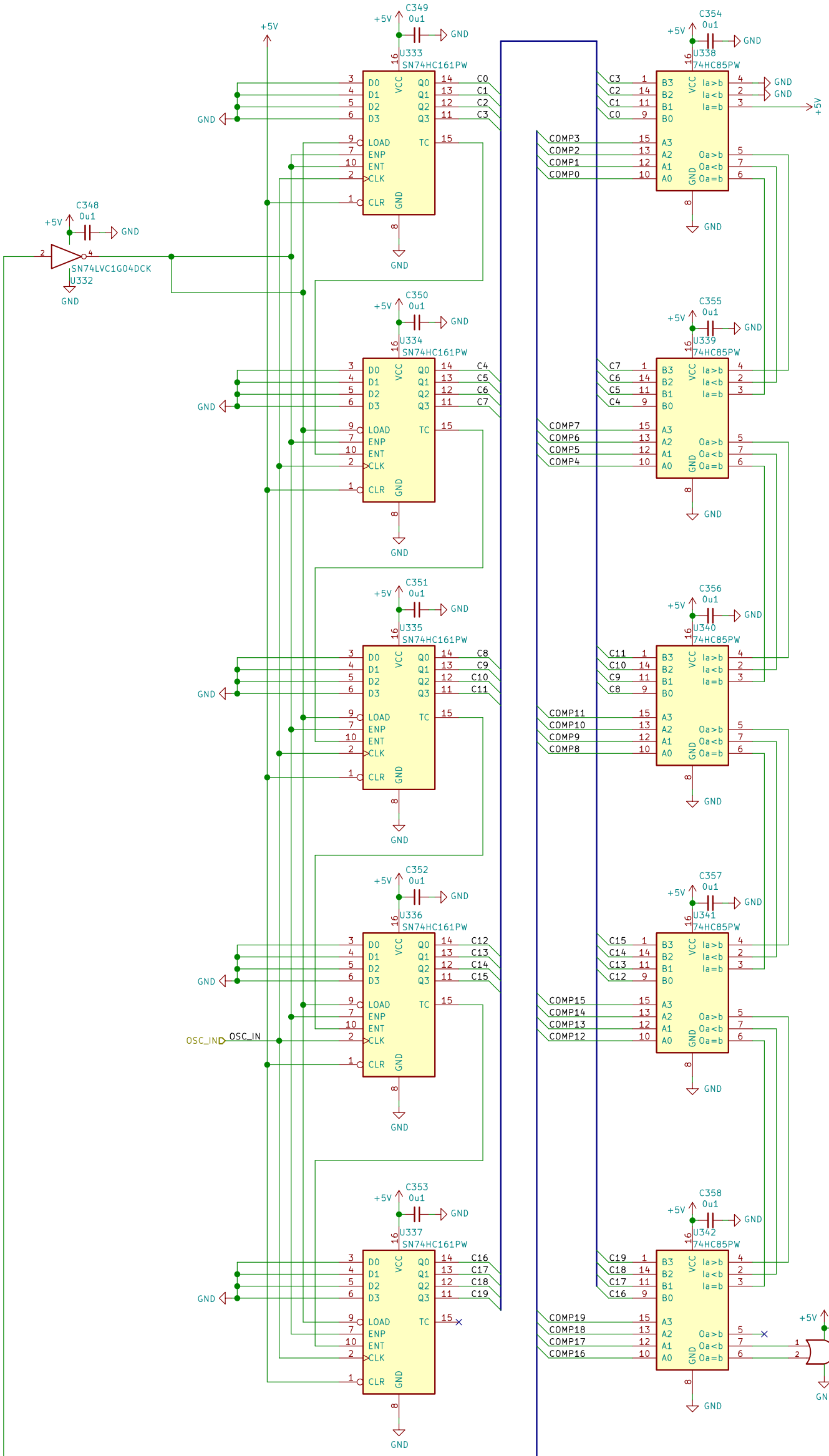
Sheet: /Clock/Clock_Div_Ctrl.sch/ClkPreset/
File: ClkPreset.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 79/93

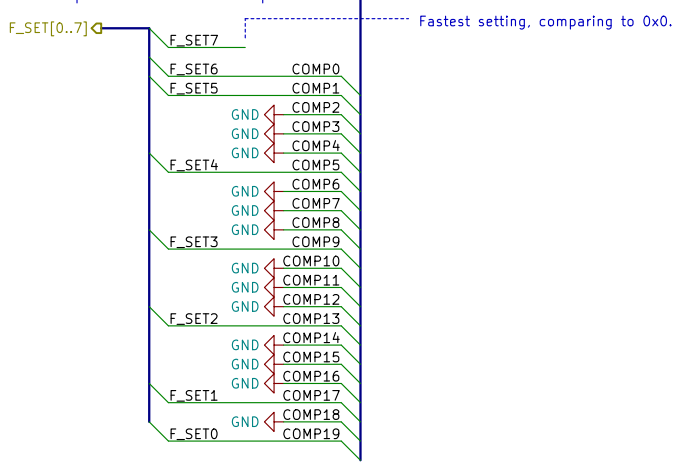
Counter

Comparator



Output T-FF

Convert Frequency Setting to Comparator set-point



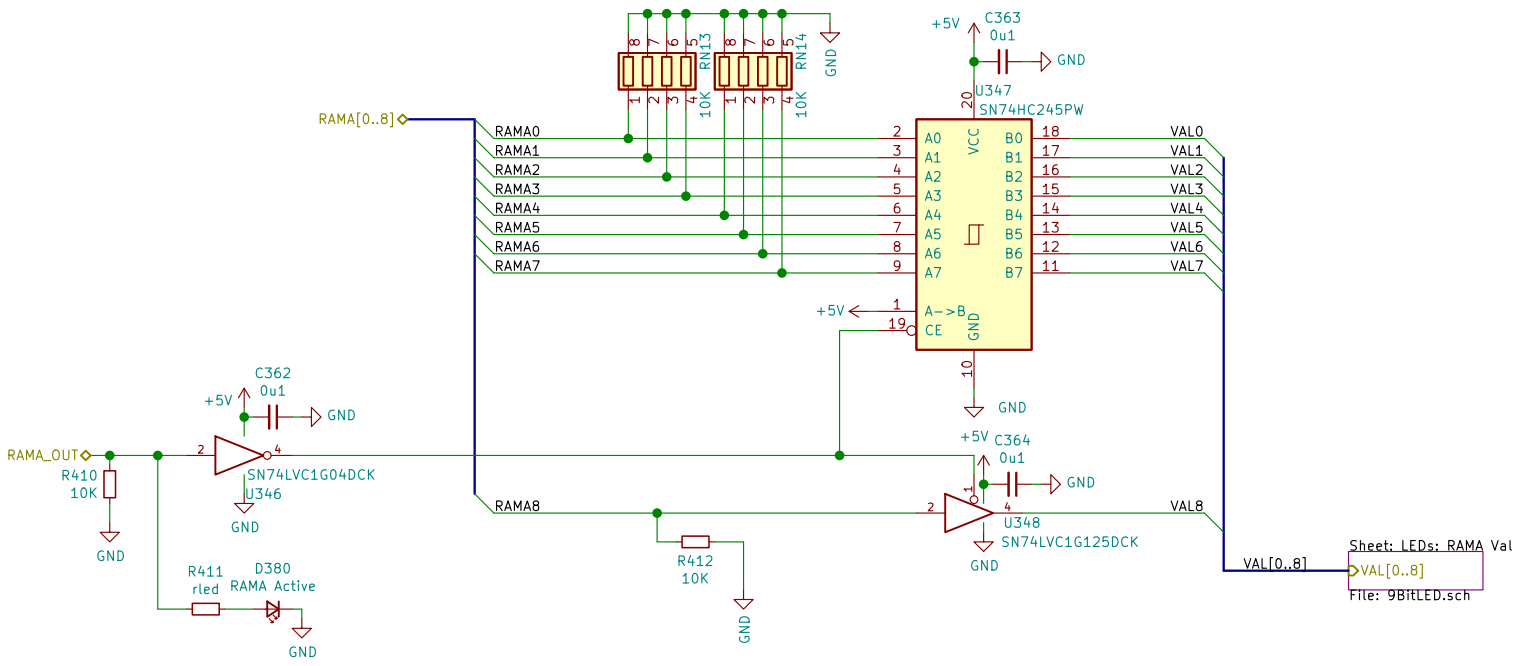
Variable clock divider based on 20-bit binary counter and comparator.
Should switch between frequencies without any clock-glitches.
Minimum division is /2.

Philipp Schilk

Sheet: /Clock/Clock_Div/
File: Clock_Div.sch

Title: psMCU

Size: A3	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 80/93



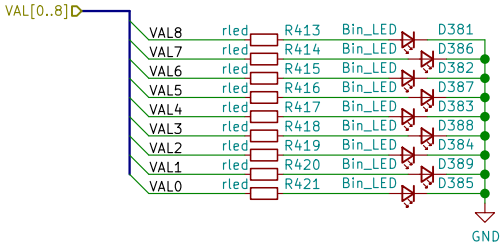
Displays the current value on the RAMA bus, if a different module is providing one (indicated by the RAMA_OUT signal)

Philipp Schilk

Sheet: /RAMA Bus Display/
File: RAMA_DISPLAY.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 81/93



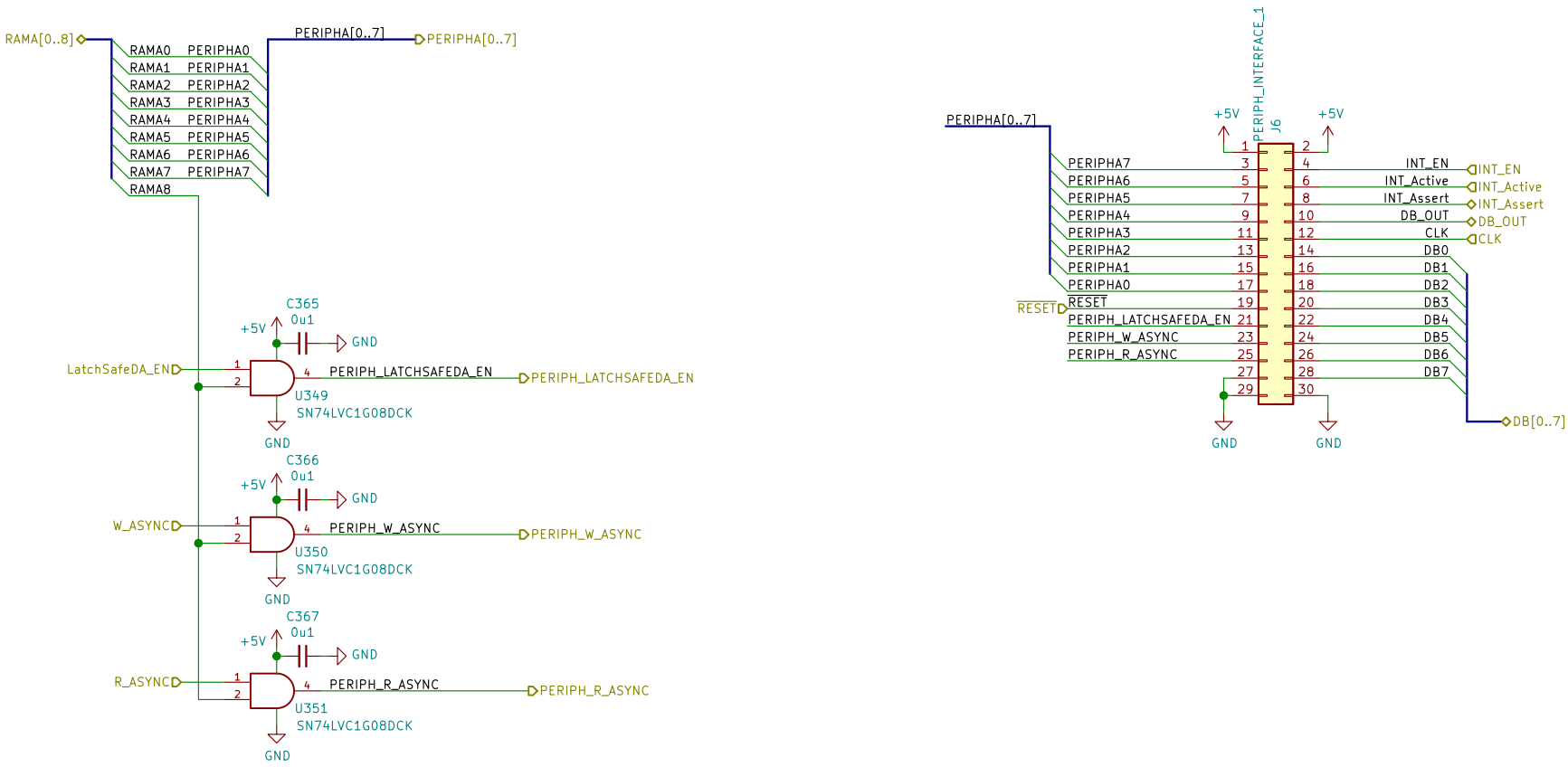
9bit binary LED display.

Philipp Schilk

Sheet: /RAMA Bus Display/LEDs: RAMA Val/
File: 9BitLED.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 82/93



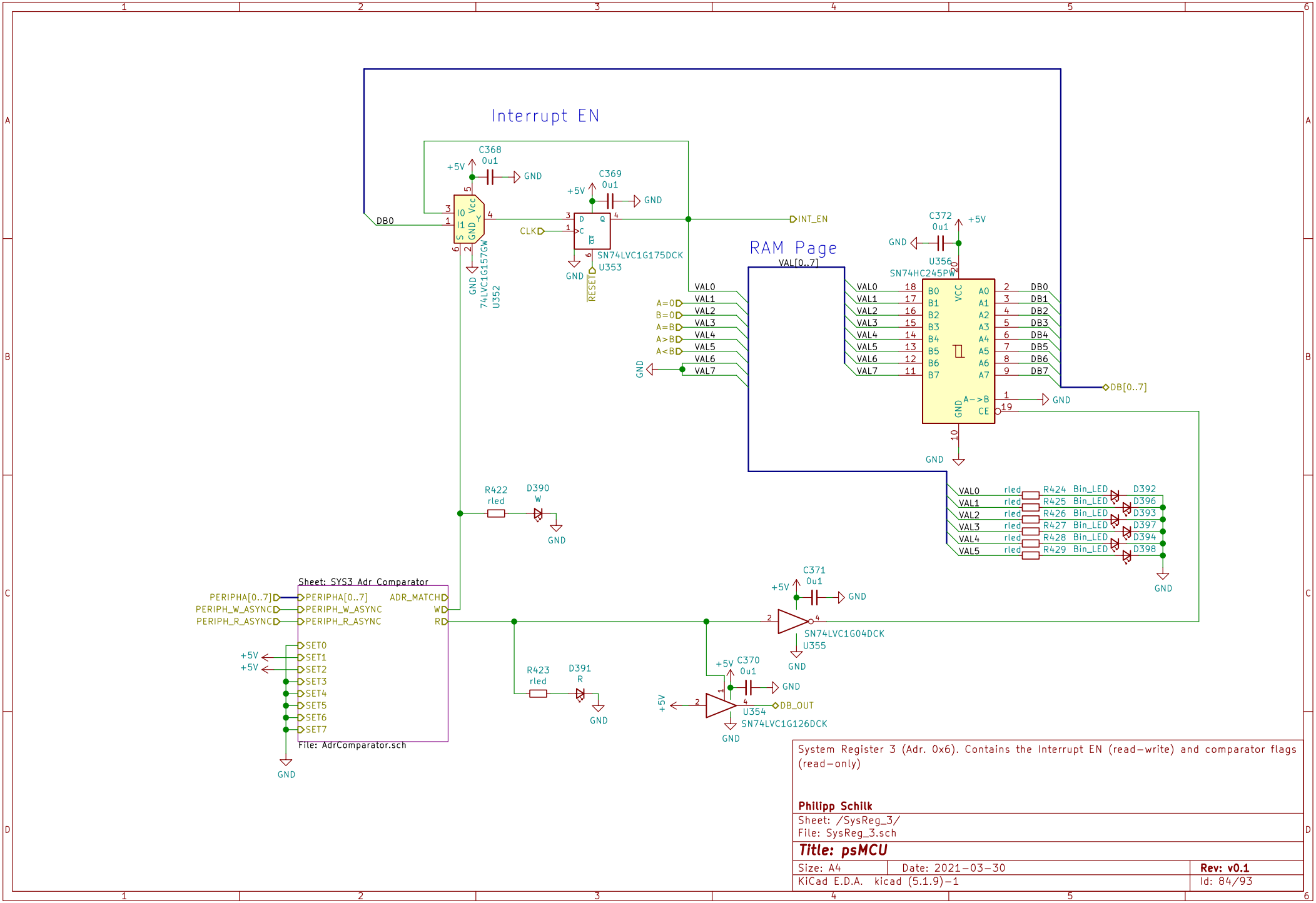
2 Identical Peripheral Connectors. Also pre-filters RAMA addresses for peripherals.

Philipp Schilk

Sheet: /PeripheralInterface/
File: PeripheralInterface.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 83/93



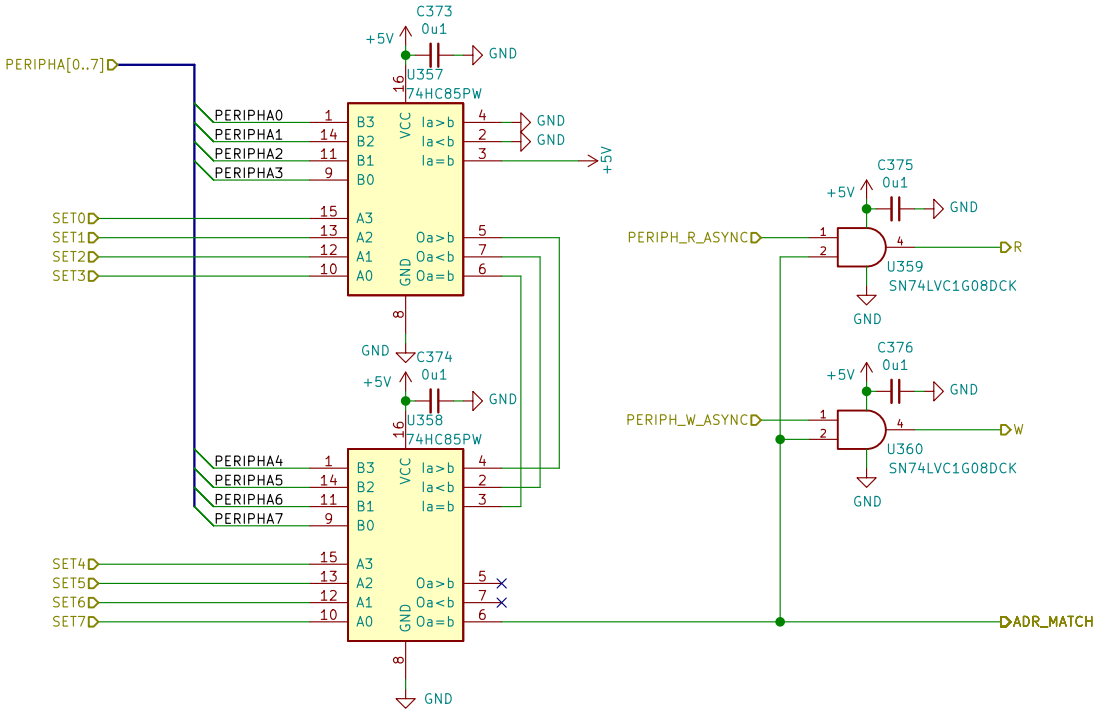
System Register 3 (Adr. 0x6). Contains the Interrupt EN (read-write) and comparator flags (read-only)

Philipp Schilk

Sheet: /SysReg_3/
File: SysReg_3.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 84/93



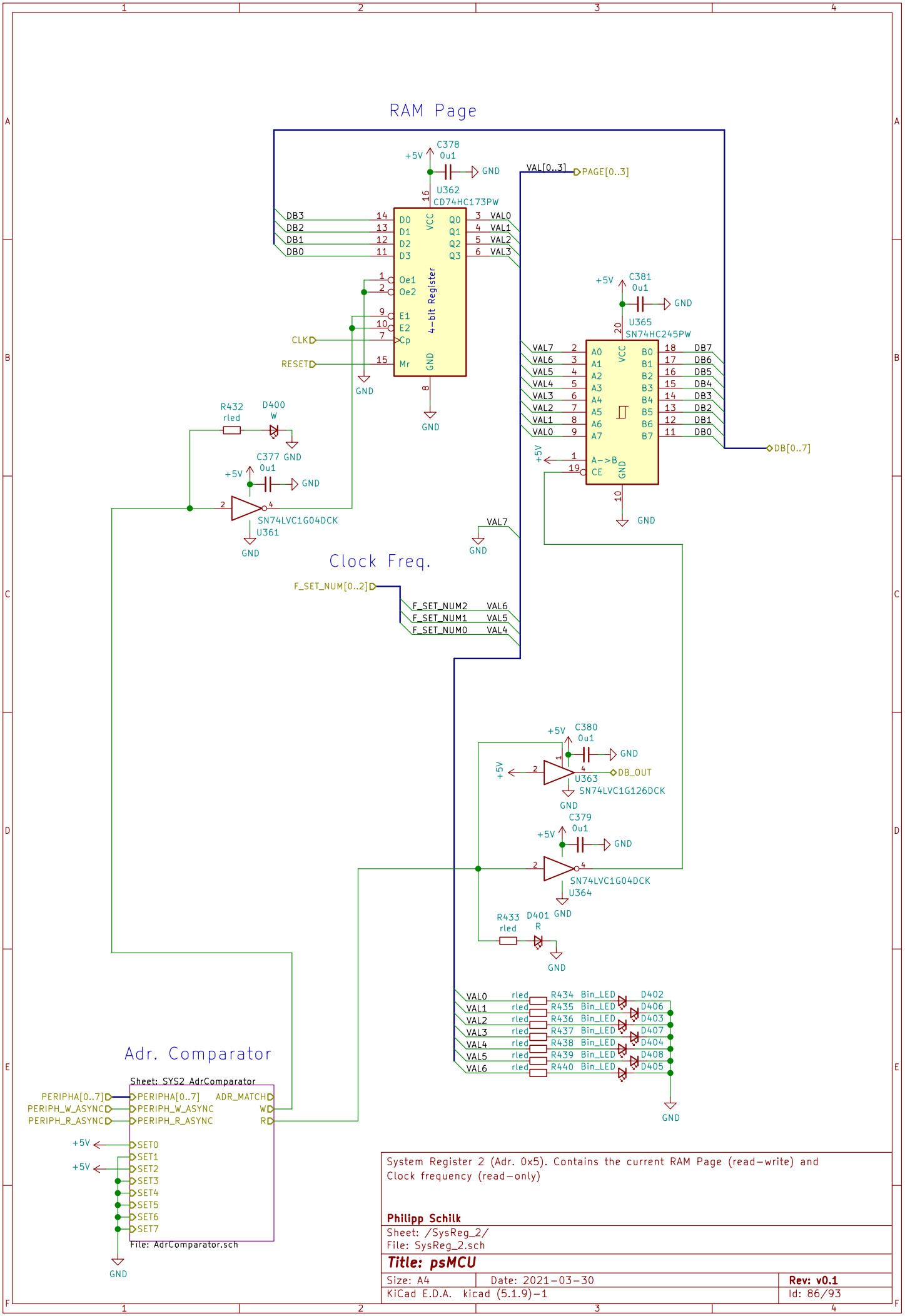
An adr. comparator. Used to check if the address currently on he RAMA bus corresponds to a specific address.

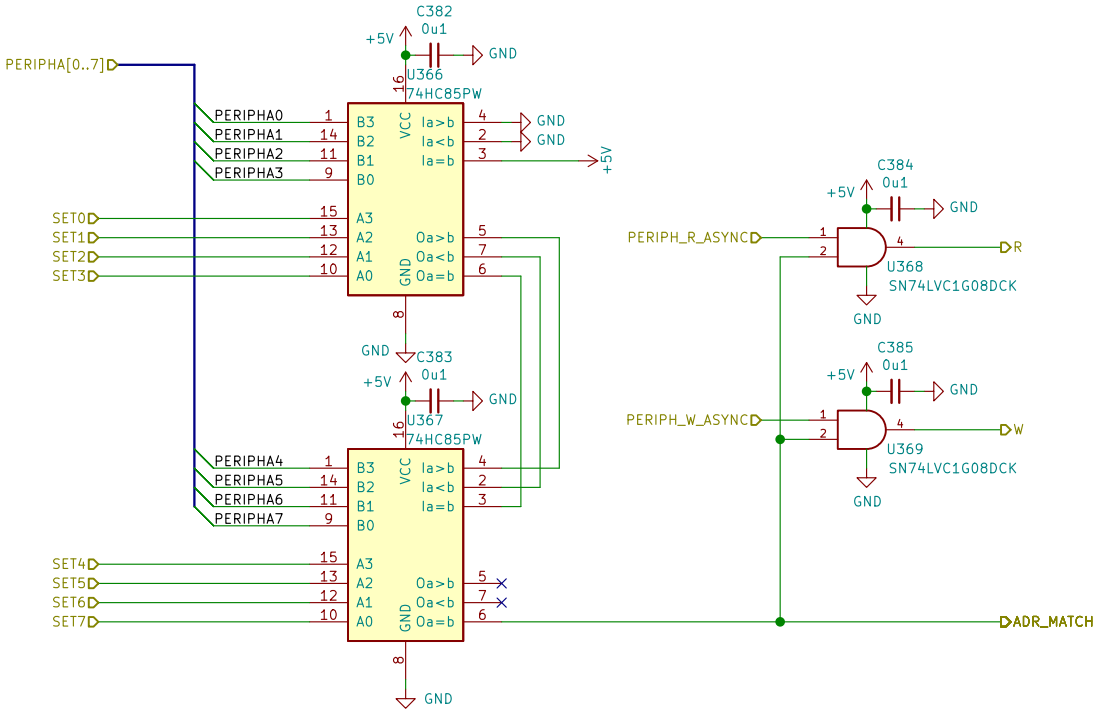
Philipp Schilk

Sheet: /SysReg_3/SYS3 Adr Comparator/
File: AdrComparator.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 85/93


RAM Page
C378
0u1
+5V
GND
VAL[0..3]
PAGE[0..3]
U362
CD74HC173PW
DB3
DB2
DB1
DB0
D0
D1
D2
D3
Q0
Q1
Q2
Q3
VAL0
VAL1
VAL2
VAL3
VCC
Oe1
Oe2
E1
E2
Cp
Mr
4-bit Register
CLK
RESET
C381
U365
SN74HC245PW
A0
A1
A2
A3
A4
A5
A6
A7
B0
B1
B2
B3
B4
B5
B6
B7
A->B
CE
DB7
DB6
DB5
DB4
DB3
DB2
DB1
DB0
DB[0..7]
R432
rled
D400
W
C377
U361
SN74LVC1G04DCK
Clock Freq.
F_SET_NUM[0..2]
F_SET_NUM2
F_SET_NUM1
F_SET_NUM0
C380
U363
SN74LVC1G126DCK
DB_OUT
C379
U364
R433
rled
D401
R
Adr. Comparator
Sheet: SYS2 AdrComparator
PERIPHA[0..7]
PERIPH_W_ASYNC
PERIPH_R_ASYNC
ADR_MATCH
W
R
SET0
SET1
SET2
SET3
SET4
SET5
SET6
SET7
File: AdrComparator.sch
R434
R435
R436
R437
R438
R439
R440
Bin_LED
D402
D406
D403
D407
D404
D408
D405
System Register 2 (Adr. 0x5). Contains the current RAM Page (read-write) and Clock frequency (read-only)
Philipp Schilk
Sheet: /SysReg_2/
File: SysReg_2.sch
Title: psMCU
Size: A4
Date: 2021-03-30
Rev: v0.1
KiCad E.D.A. kicad (5.1.9)-1
Id: 86/93



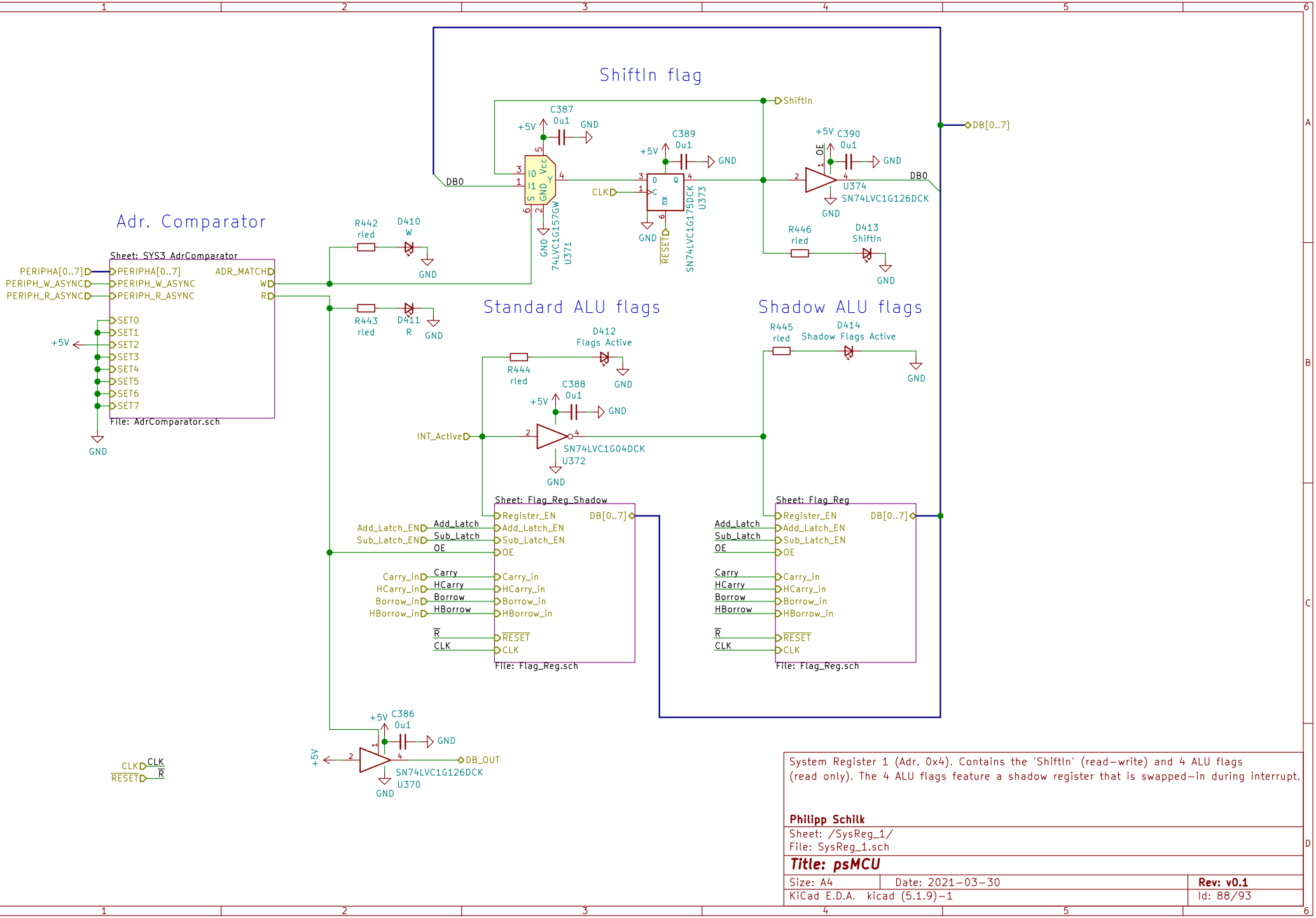
An adr. comparator. Used to check if the address currently on he RAMA bus corresponds to a specific address.

Philipp Schilk

Sheet: /SysReg_2/SYS2 AdrComparator/
File: AdrComparator.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 87/93



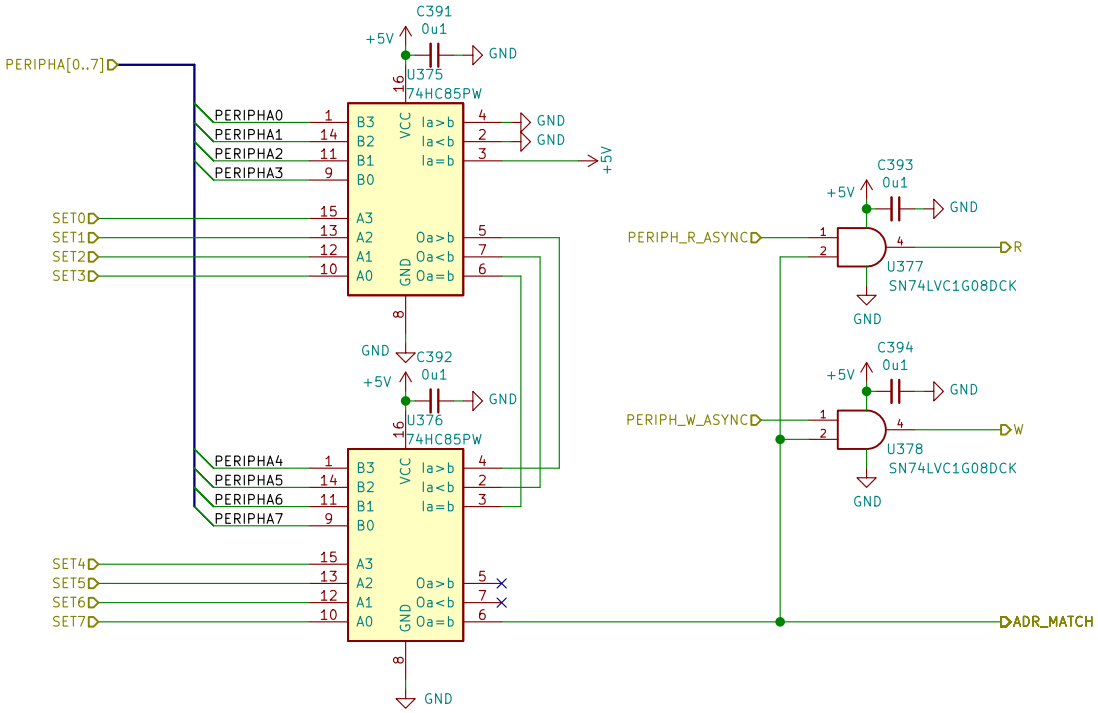
System Register 1 (Adr. 0x4). Contains the 'ShiftIn' (read-write) and 4 ALU flags (read only). The 4 ALU flags feature a shadow register that is swapped-in during interrupt.

Philipp Schilk

Sheet: /SysReg_1/
File: SysReg_1.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 88/93



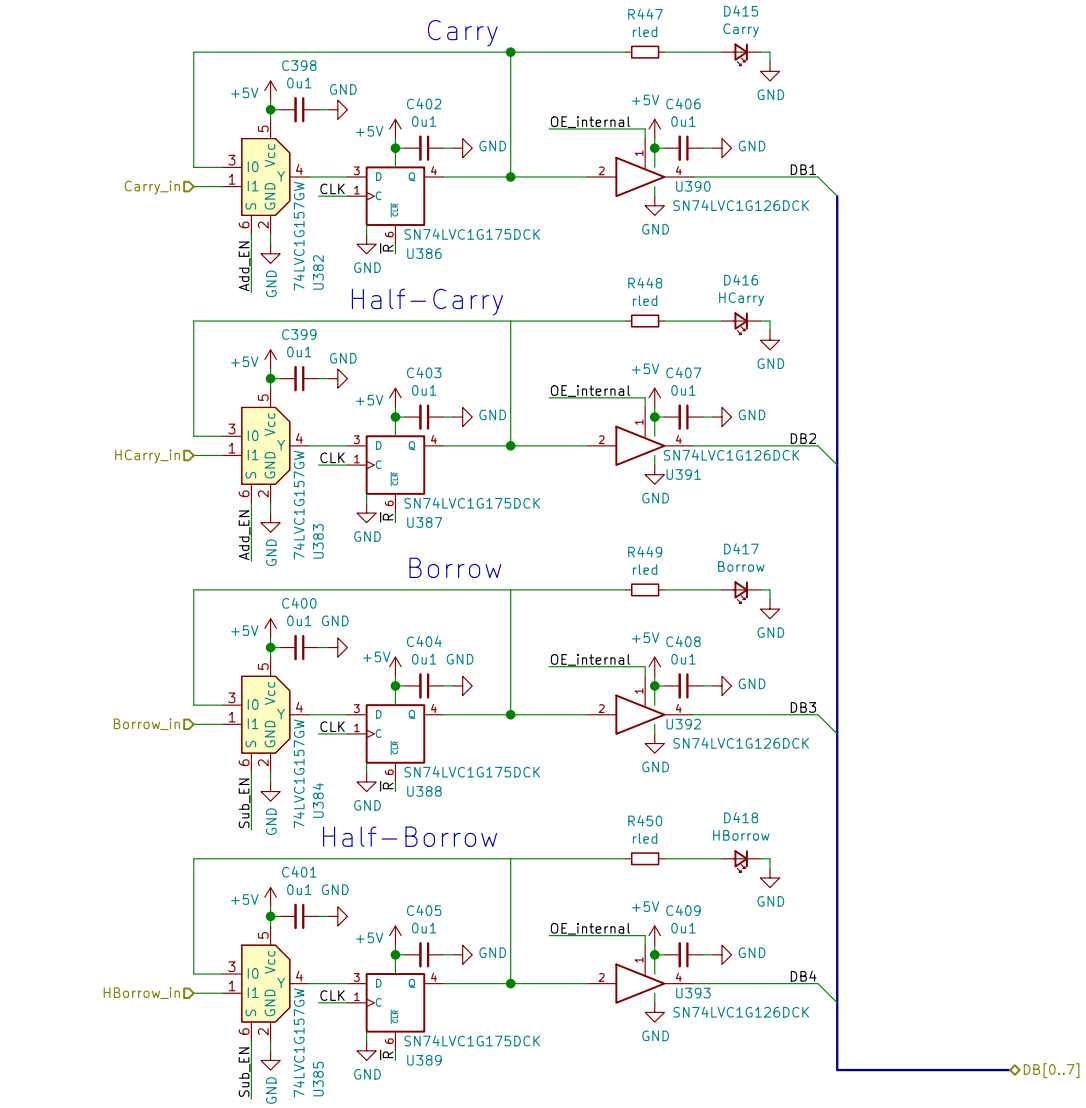
An adr. comparator. Used to check if the address currently on he RAMA bus corresponds to a specific address.

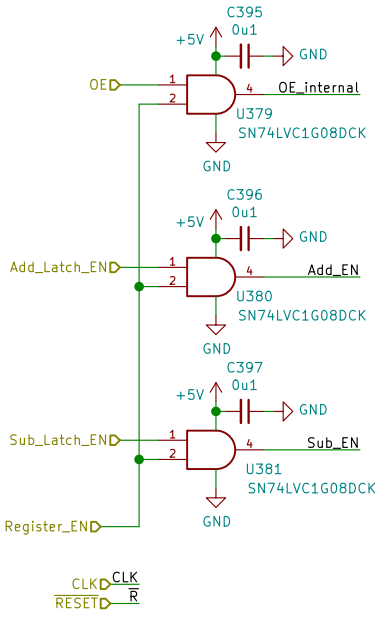
Philipp Schilk

Sheet: /SysReg_1/SYS3 AdrComparator/
File: AdrComparator.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 89/93





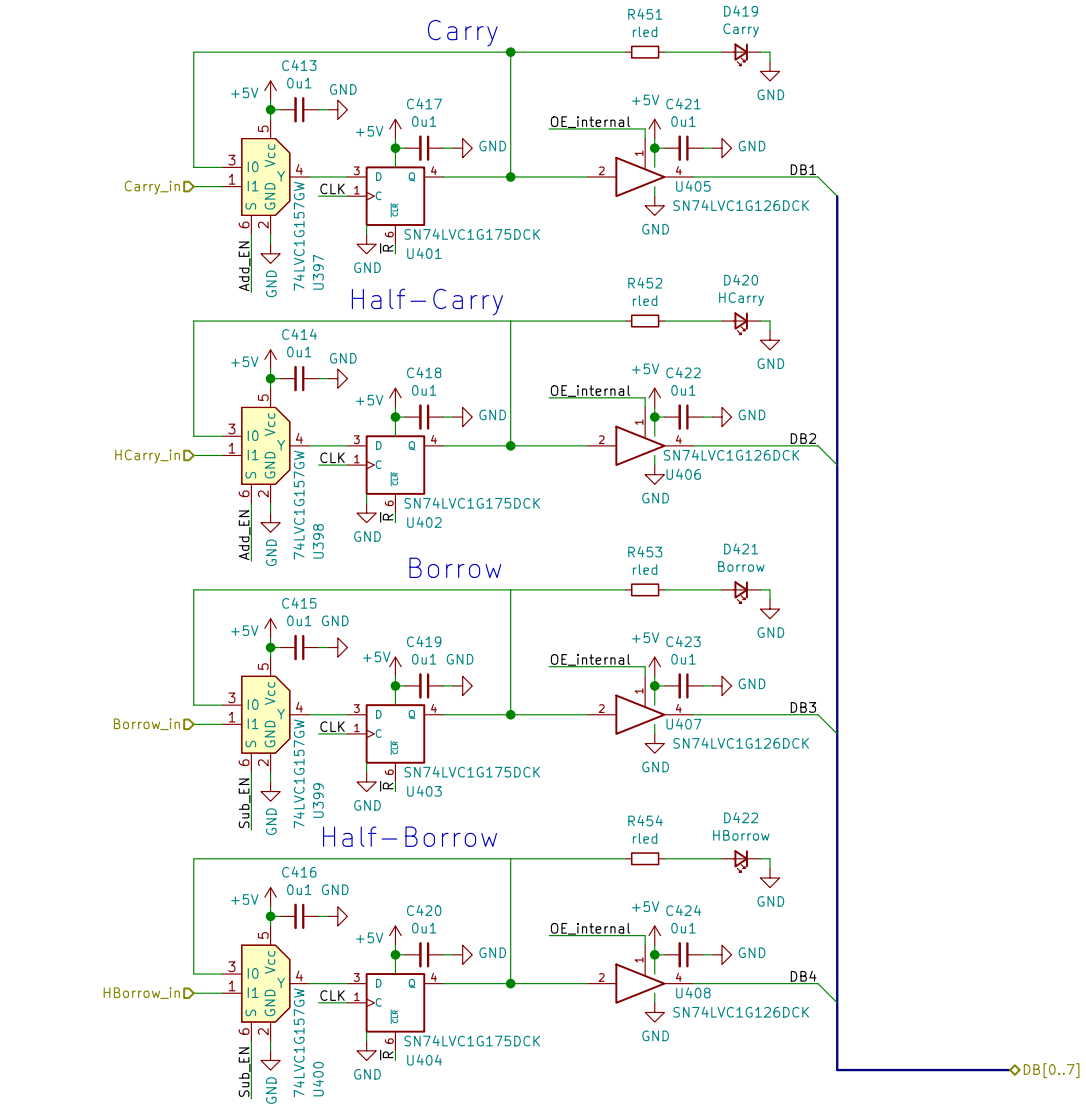
A 4−bit register to store ALU flags.

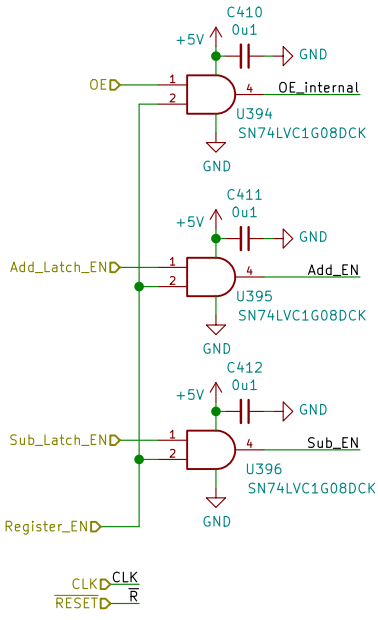
Philipp Schilk

Sheet: /SysReg_1/Flag_Reg_Shadow/
File: Flag_Reg.sch

Title: psMCU

Size: A4	Date: 2021−03−30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)−1		Id: 90/93





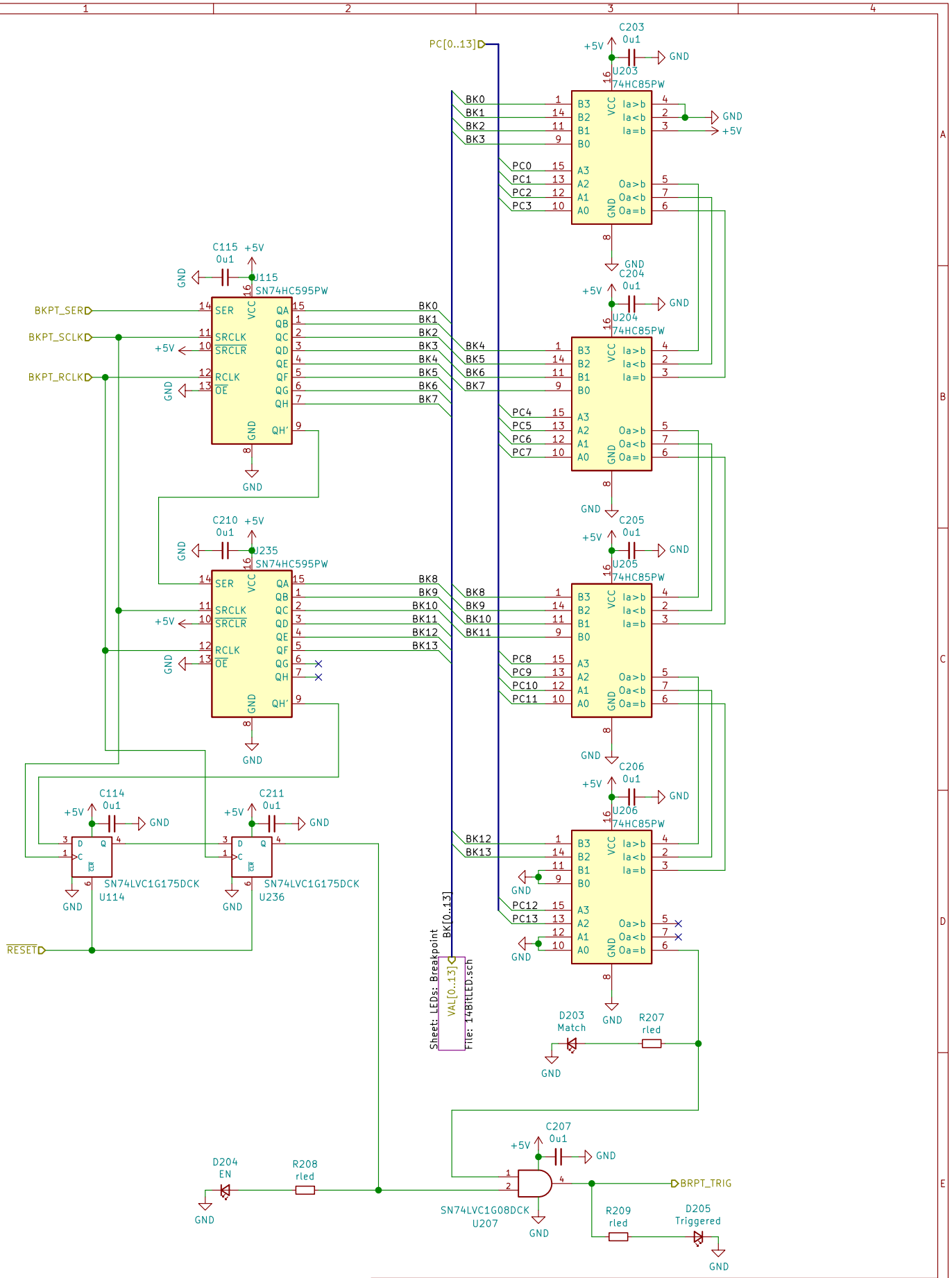
A 4−bit register to store ALU flags.

Philipp Schilk

Sheet: /SysReg_1/Flag_Reg/
File: Flag_Reg.sch

Title: psMCU

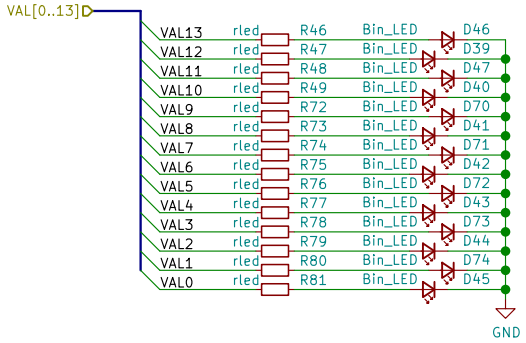
Size: A4	Date: 2021−03−30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)−1		Id: 91/93



Compares current program counter value against a breakpoint-address settable using DIP-switches. Can be enabled/disabled.

Philipp Schilk

Sheet: /Breakpoint/		
File: Breakpoint.sch		
Title: psMCU		
Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 92/93



14bit binary LED display.

Philipp Schilk

Sheet: /Breakpoint/LEDs: Breakpoint/
File: 14BitLED.sch

Title: psMCU

Size: A4	Date: 2021-03-30	**Rev: v0.1**
KiCad E.D.A. kicad (5.1.9)-1		Id: 93/93