Digital Electronics 2
Lab 2

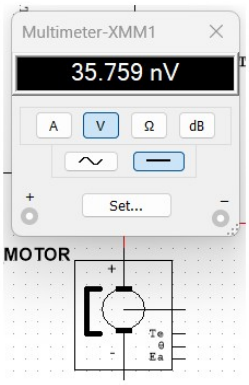
Sequence of Operations

1. User enters their code for validation
2. User presses the validation push button. If the code is not validated, the user cannot proceed. If it is validated, they can proceed.
3. User can press S (start) to start the circuit. They can then also turn it off with R. While the circuit is running, no modification to the entered code or validation logic will disrupt it. The only way to turn it off is with R (reset).
4. At this point, if the circuit is running, the motor will receive a small amount of voltage that is going through three series resistors.
5. The user can activate the G push button to activate relay 1 and skip the first series resistor. The motor now receives ~4V of power.
6. The user can now activate the H push button to then bypass the second series resistor. The motor now receives ~4 more volts of power.
7. The last relay can be activated with the J pushbutton to activate the last relay and bypass the last series resistor, thus delivering the rest of the voltage to the motor to have it running at 12V.

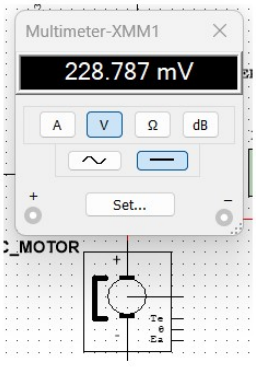
Simulation Results

1) The circuit is not running, so the motor receives a negligible amount of voltage. 2) The circuit is running, but due to the three series resistors the motor still receives small voltage. 3) The first relay is activated and the first series resistor is bypassed, increasing the voltage by ~4V. 4) The second relay is activated, skipping the second resistor and again increasing voltage to the motor by ~4V. 5) The final relay is activated and the final resistor is skipped, so the motor now receives the full 12V.

1



2



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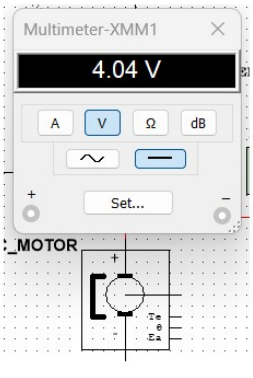

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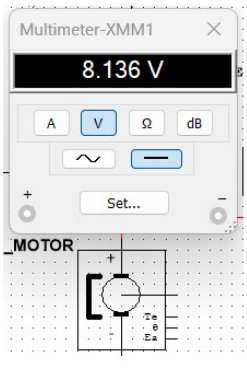
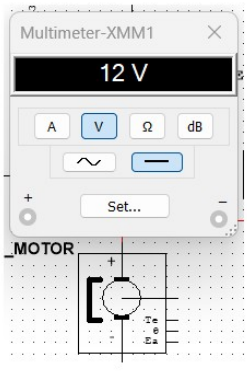
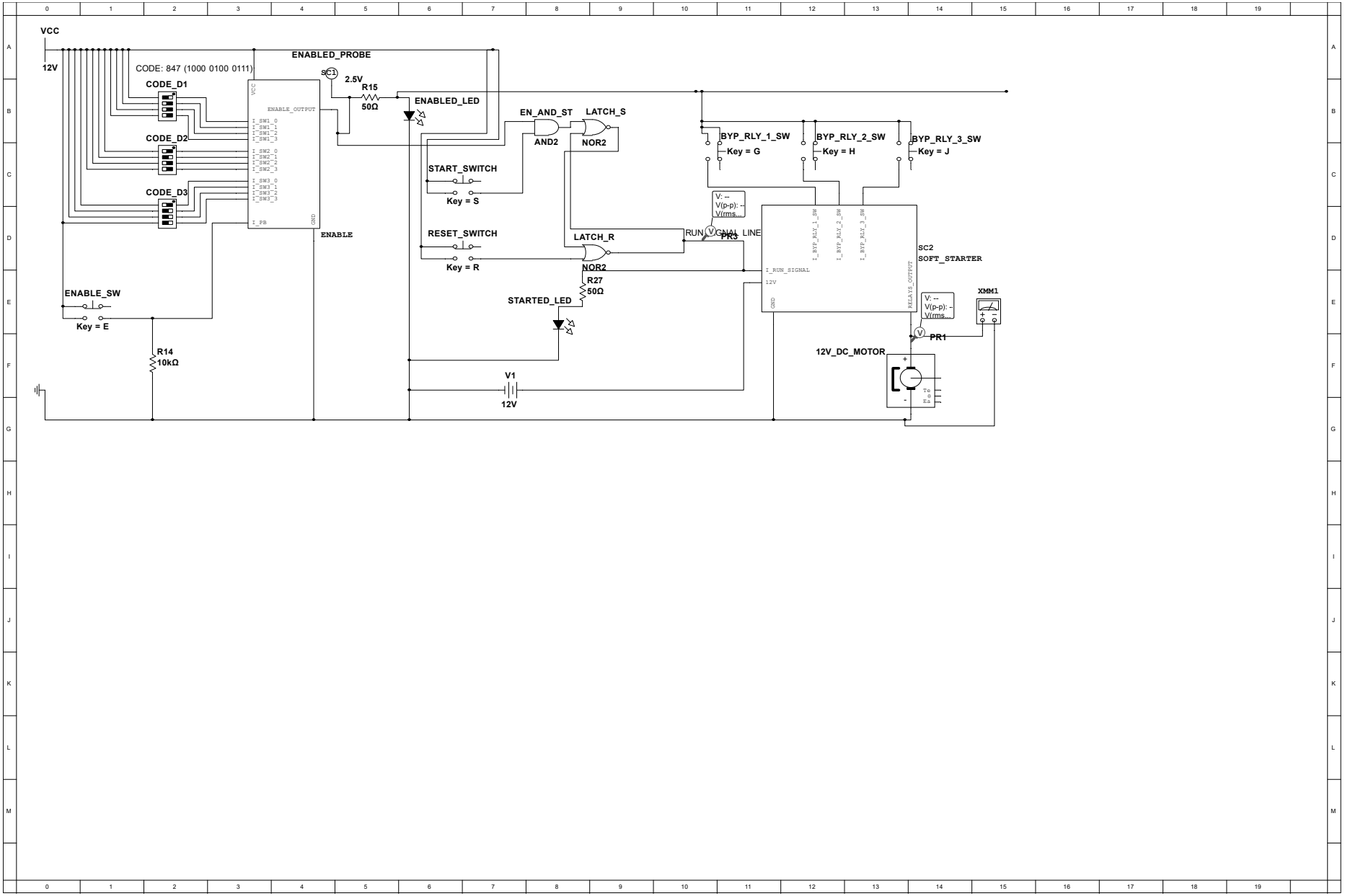


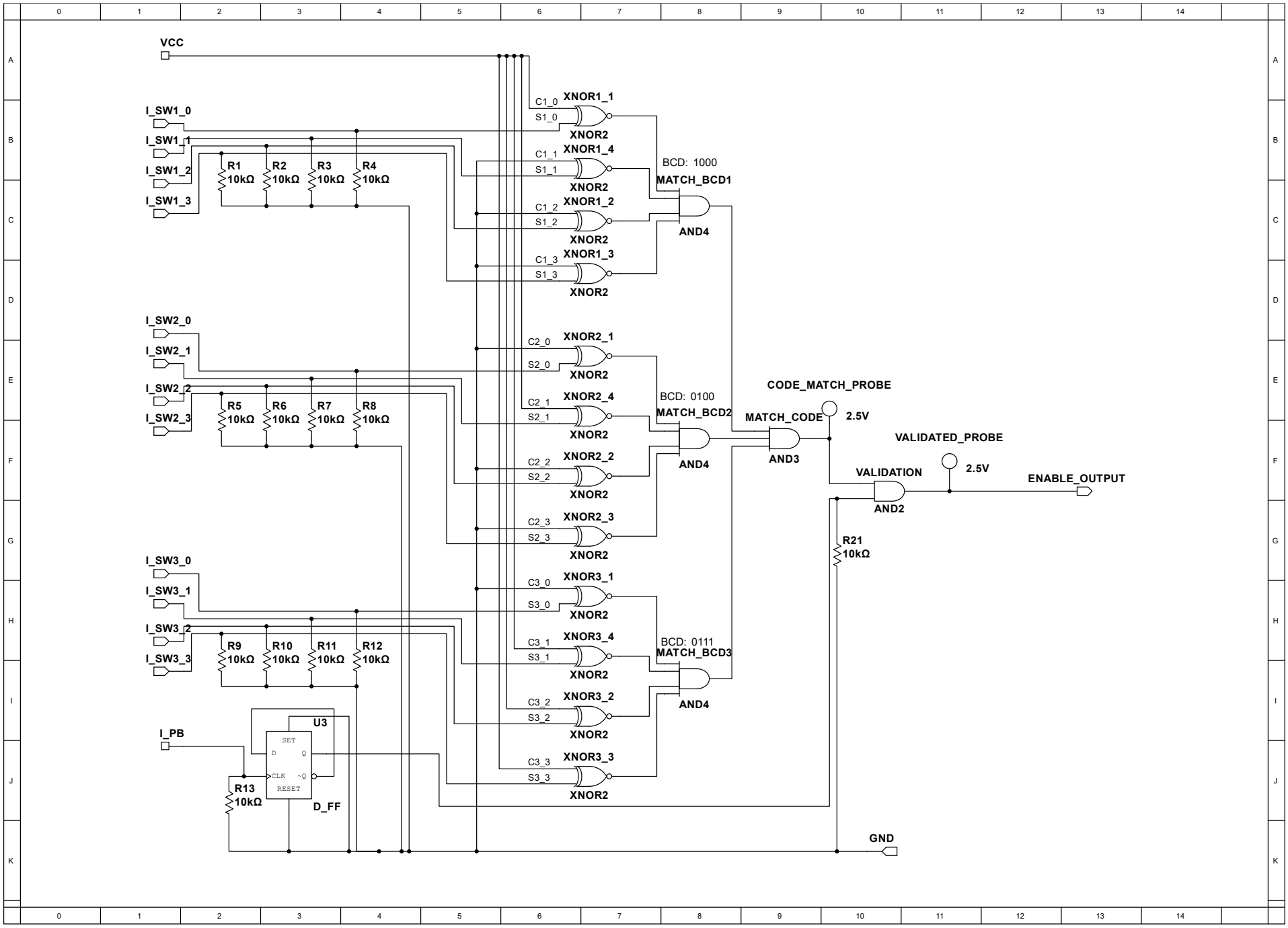
5

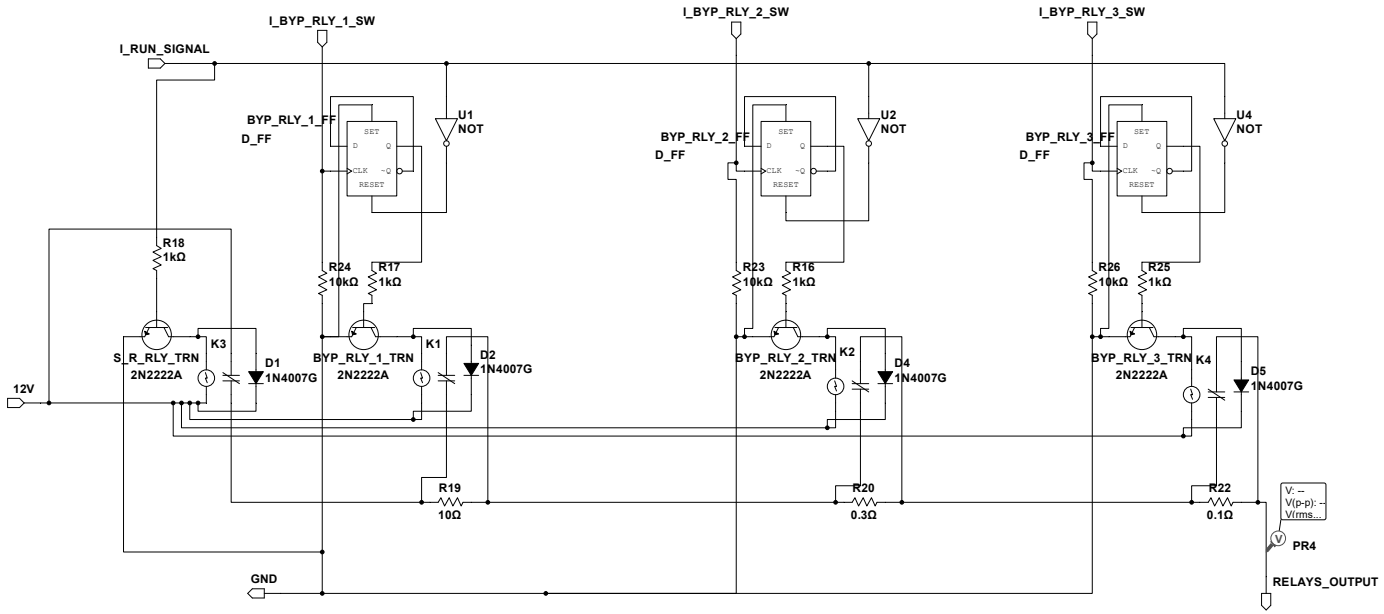


LATCH (Start/ Stop) Truth Table

ENABLE	START	RESET	RUN(next)
0	0	0	Hold
0	0	1	Reset
0	1	0	Hold
0	1	1	Reset
1	0	0	Hold
1	0	1	Reset
1	1	0	Set
1	1	1	Invalid


VCC
12V
CODE: 847 (1000 0100 0111)
CODE_D1
CODE_D2
CODE_D3
ENABLED_PROBE
SC1
2.5V
R15
50Ω
ENABLED_LED
ENABLE_OUTPUT
I_SW1_0
I_SW1_1
I_SW1_2
I_SW1_3
I_SW2_0
I_SW2_1
I_SW2_2
I_SW2_3
I_SW3_0
I_SW3_1
I_SW3_2
I_SW3_3
I_PB
GND
ENABLE
EN_AND_ST
AND2
LATCH_S
NOR2
START_SWITCH
Key = S
RESET_SWITCH
Key = R
LATCH_R
NOR2
R27
50Ω
STARTED_LED
ENABLE_SW
Key = E
R14
10kΩ
V1
12V
BYP_RLY_1_SW
Key = G
BYP_RLY_2_SW
Key = H
BYP_RLY_3_SW
Key = J
V: --
V(p-p): --
V(rms...
RUN_SIGNAL LINE
PR3
I_BYP_RLY_1_SW
I_BYP_RLY_2_SW
I_BYP_RLY_3_SW
I_RUN_SIGNAL
12V
GND
RELAYS_OUTPUT
SC2
SOFT_STARTER
XMM1
PR1
12V_DC_MOTOR


VCC
I_SW1_0
I_SW1_1
I_SW1_2
I_SW1_3
R1 10kΩ
R2 10kΩ
R3 10kΩ
R4 10kΩ
C1_0
S1_0
XNOR1_1
XNOR2
C1_1
S1_1
XNOR1_4
XNOR2
C1_2
S1_2
XNOR1_2
XNOR2
C1_3
S1_3
XNOR1_3
XNOR2
BCD: 1000
MATCH_BCD1
AND4
I_SW2_0
I_SW2_1
I_SW2_2
I_SW2_3
R5 10kΩ
R6 10kΩ
R7 10kΩ
R8 10kΩ
C2_0
S2_0
XNOR2_1
XNOR2
C2_1
S2_1
XNOR2_4
XNOR2
C2_2
S2_2
XNOR2_2
XNOR2
C2_3
S2_3
XNOR2_3
XNOR2
BCD: 0100
MATCH_BCD2
AND4
CODE_MATCH_PROBE
MATCH_CODE
2.5V
AND3
VALIDATED_PROBE
VALIDATION
2.5V
ENABLE_OUTPUT
AND2
R21 10kΩ
I_SW3_0
I_SW3_1
I_SW3_2
I_SW3_3
R9 10kΩ
R10 10kΩ
R11 10kΩ
R12 10kΩ
C3_0
S3_0
XNOR3_1
XNOR2
C3_1
S3_1
XNOR3_4
XNOR2
C3_2
S3_2
XNOR3_2
XNOR2
C3_3
S3_3
XNOR3_3
XNOR2
BCD: 0111
MATCH_BCD3
AND4
I_PB
U3
SET
D
Q
CLK
~Q
RESET
R13 10kΩ
D_FF
GND


I_BYP_RLY_1_SW
I_BYP_RLY_2_SW
I_BYP_RLY_3_SW
I_RUN_SIGNAL
BYP_RLY_1_FF
D_FF
BYP_RLY_2_FF
D_FF
BYP_RLY_3_FF
D_FF
U1
NOT
U2
NOT
U4
NOT
SET
D
Q
CLK
~Q
RESET
R18
1kΩ
R24
10kΩ
R17
1kΩ
R23
10kΩ
R16
1kΩ
R26
10kΩ
R25
1kΩ
S_R_RLY_TRN
2N2222A
K3
D1
1N4007G
BYP_RLY_1_TRN
2N2222A
K1
D2
1N4007G
BYP_RLY_2_TRN
2N2222A
K2
D4
1N4007G
BYP_RLY_3_TRN
2N2222A
K4
D5
1N4007G
12V
R19
10Ω
R20
0.3Ω
R22
0.1Ω
V: --
V(p-p): --
V(rms...
PR4
GND
RELAYS_OUTPUT