# Systems Engineering

## Arduino Board

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iTIC http://itic.cat

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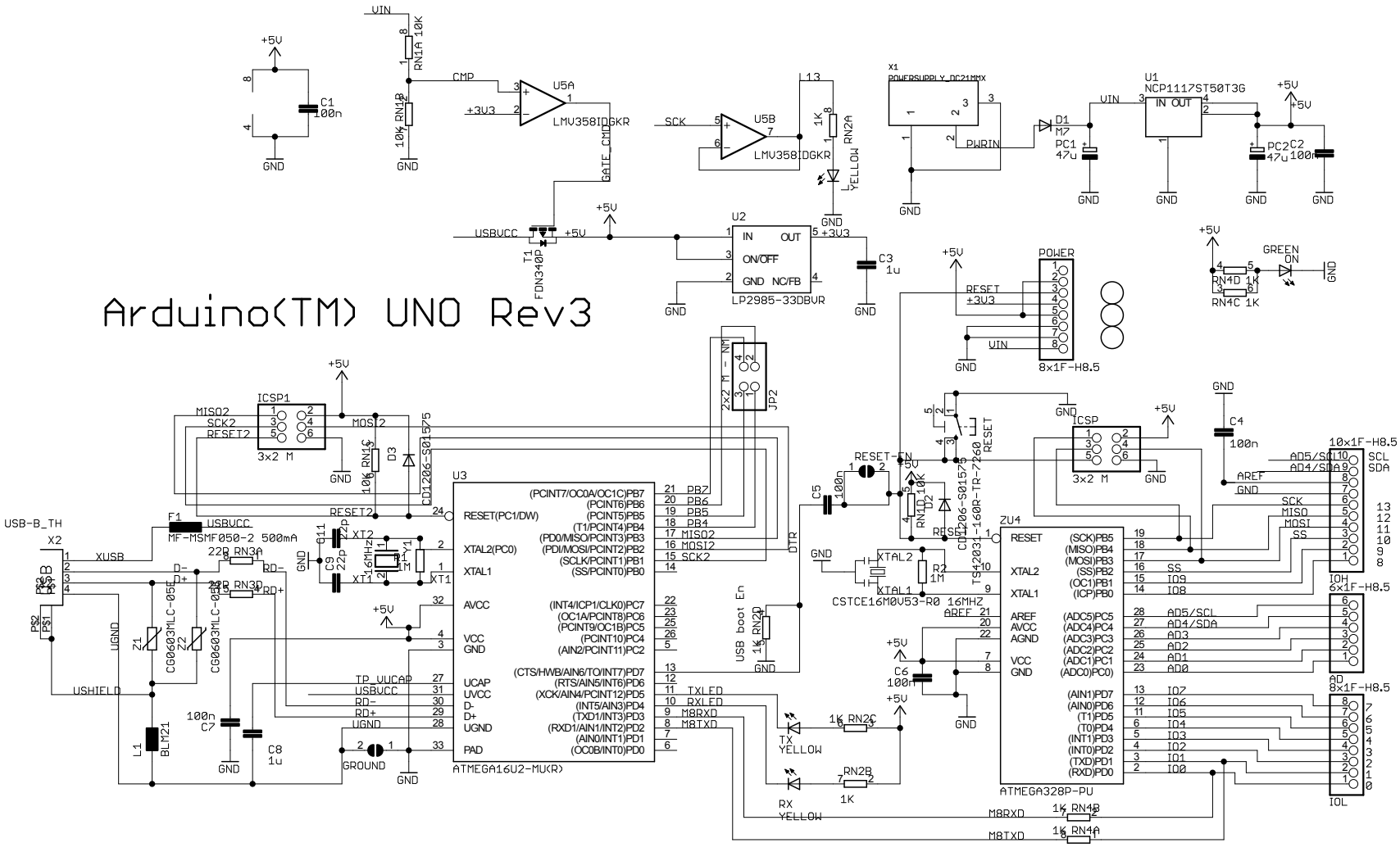
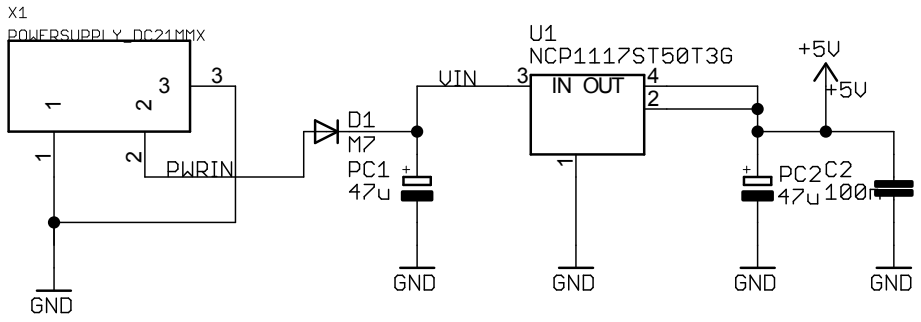
Sources: A good discussion on the Arduino board is available at

https://rheingoldheavy.com/category/education/fundamentals/arduino-from-scratch-series/

# Arduino Schematic

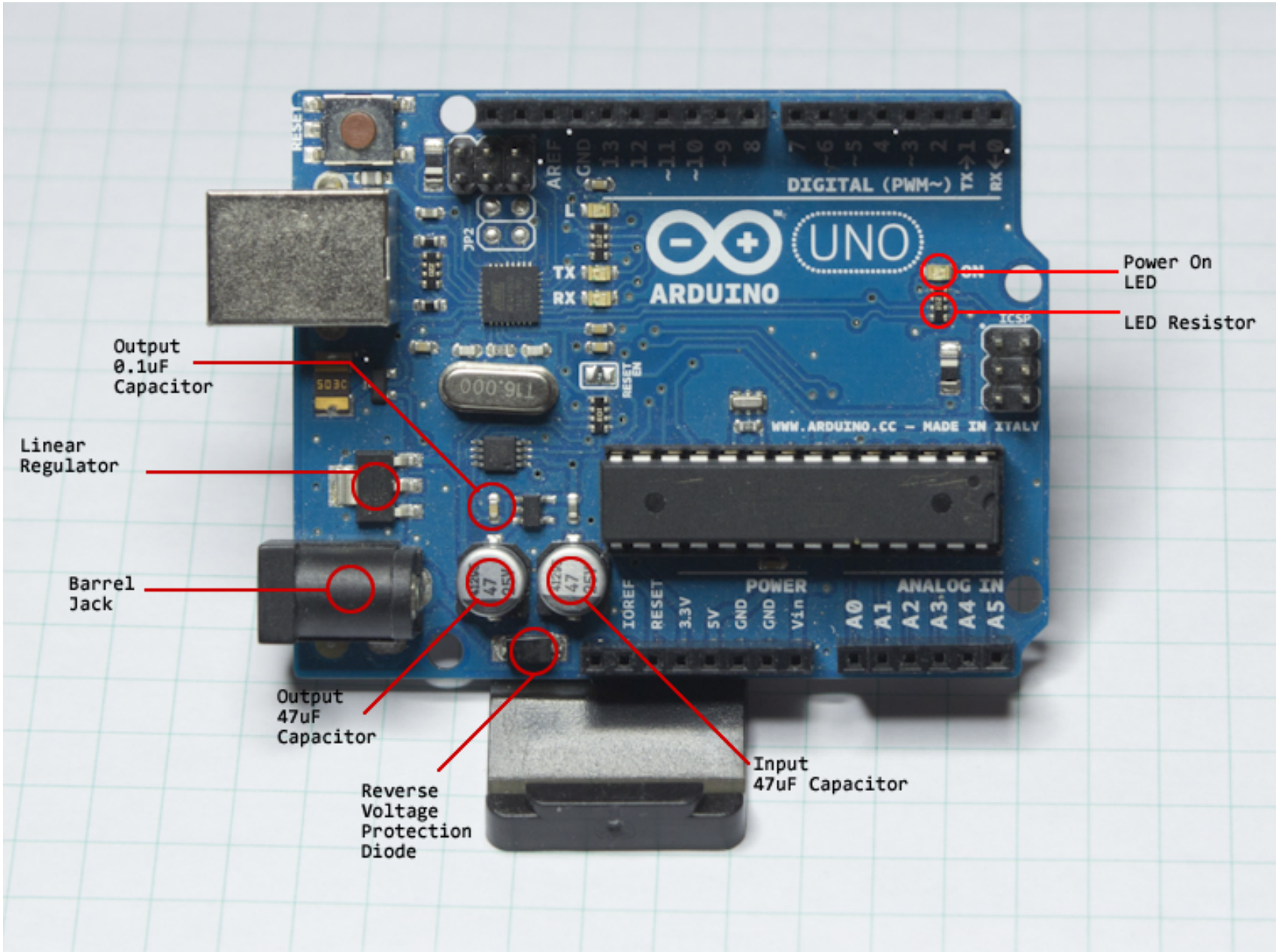


# External DC: Schematic

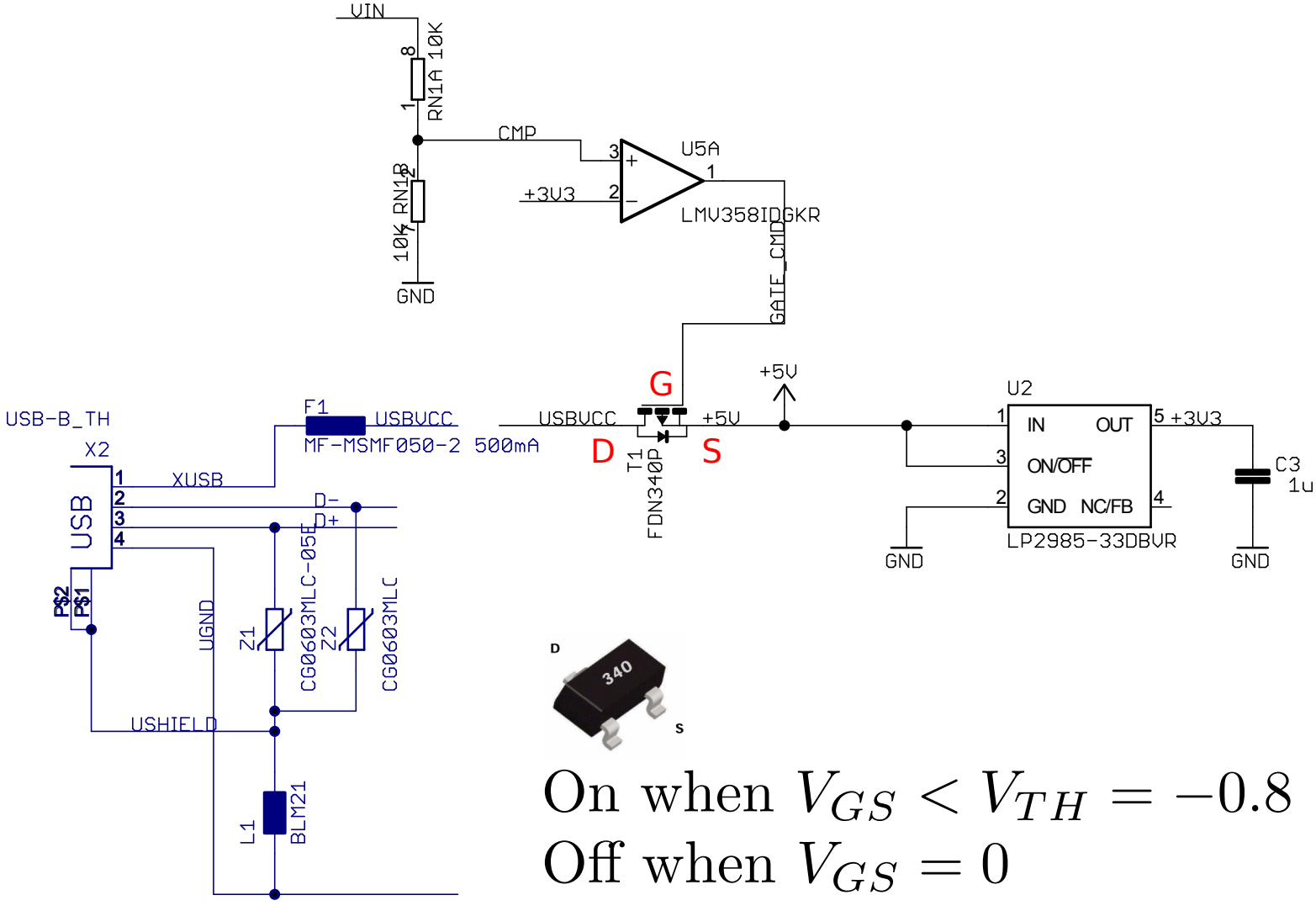



- Connector
- Reverse connection protection
- NCP1117
  - Capacitors
  - Heatsinking

# External DC: Image



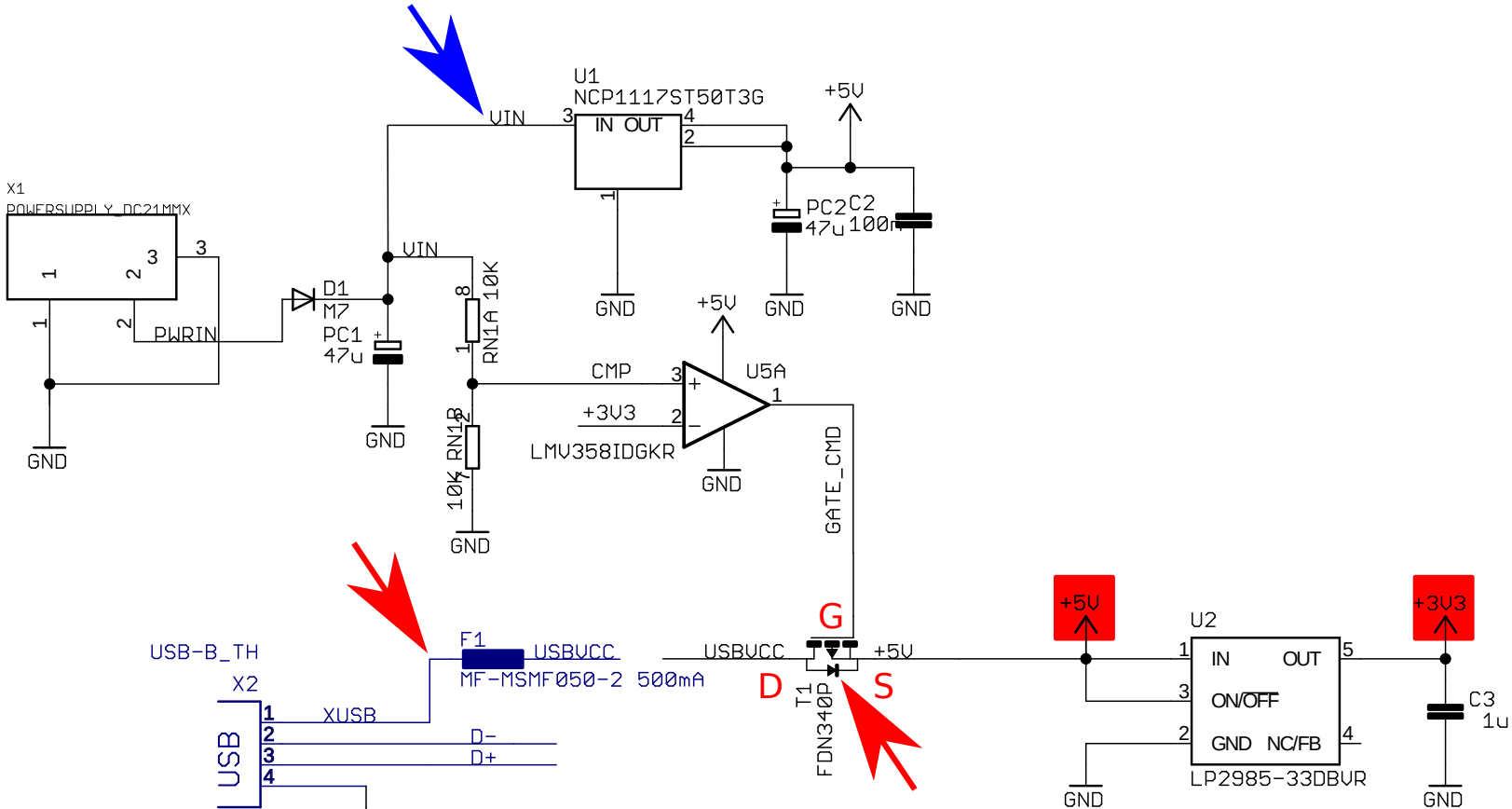
# Power Supply Selection: Schematic

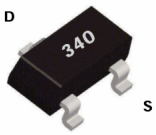



On when $V_{GS} < V_{TH} = -0.8$

Off when $V_{GS} = 0$

# Full Power Schematic: USB power is ON



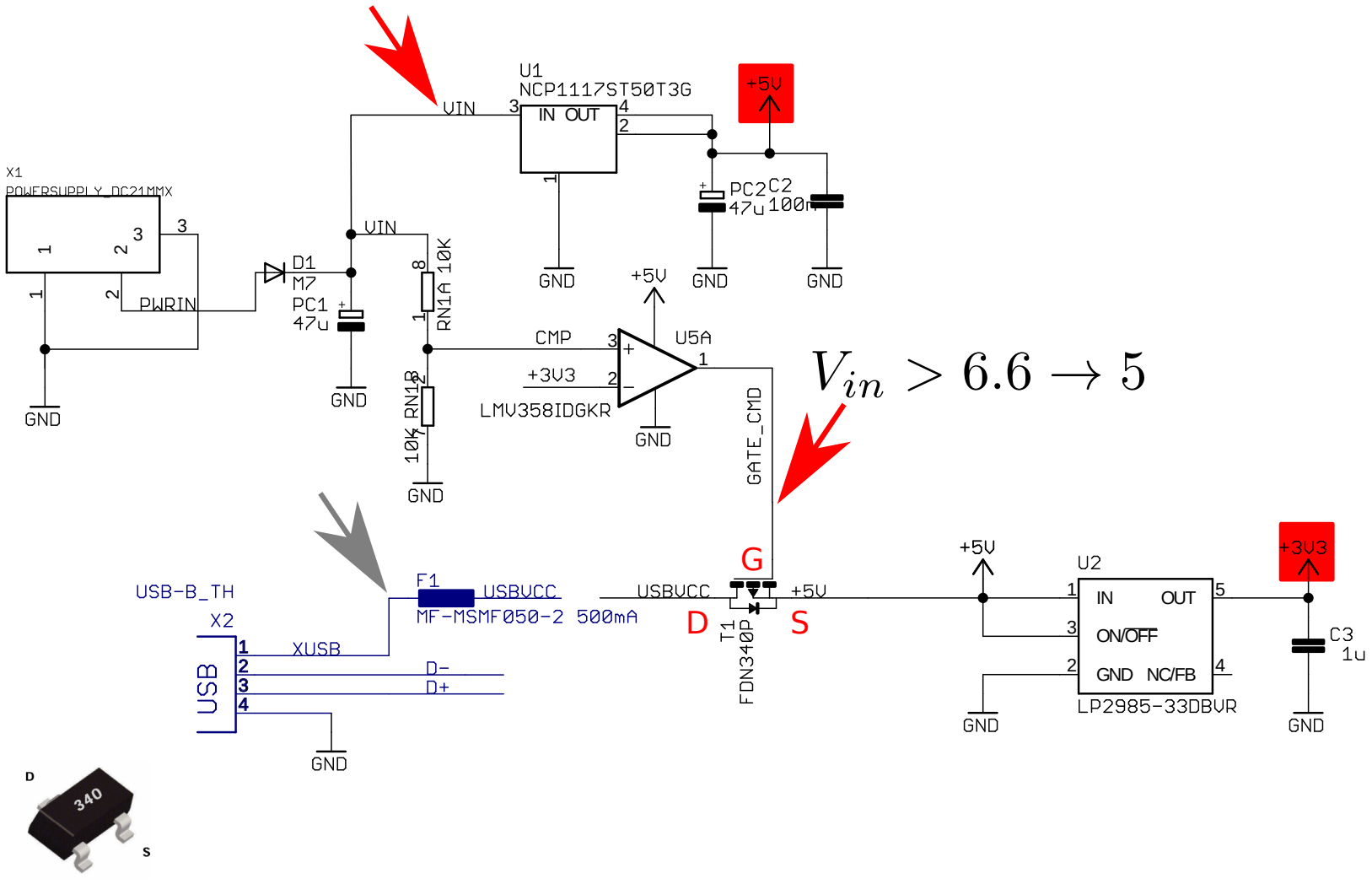

Diode conducts initially

$V_{GS} < -0.8 \rightarrow$ON

On when $V_{GS} < V_{TH} = -0.8$

Off when $V_{GS} = 0$

# Full Power Schematic: External power is ON



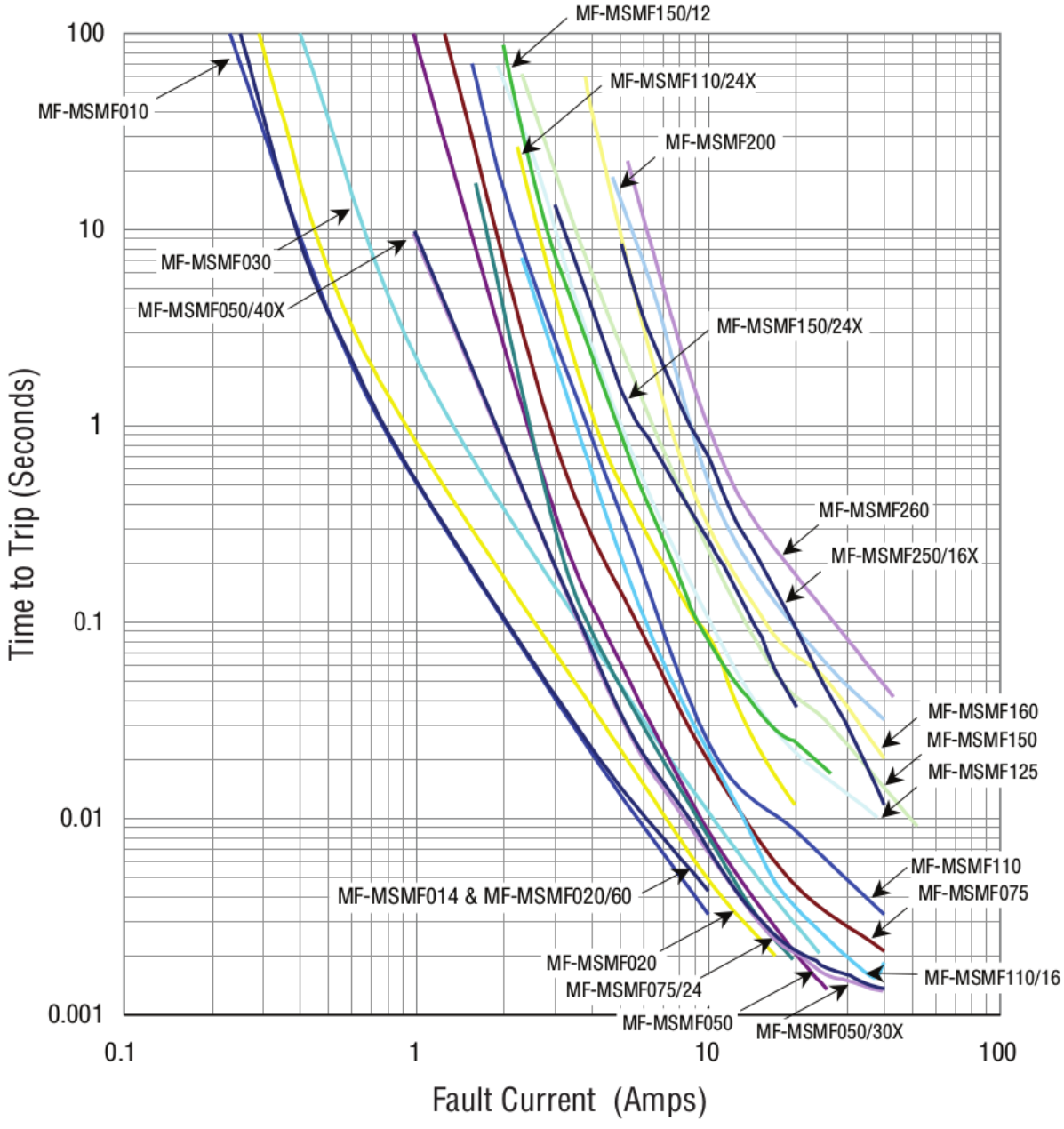




On when $V_{GS} < V_{TH} = -0.8$

Off when $V_{GS} = 0$

# USB: Resettable Fuse MF-MSMF050 (polyswitch)



# USB: CG0603MLC-05E Varistors

## General Information

The Bourns® ChipGuard® Automotive MLC Series is a sub-1 pF protector designed specifically for use in automotive circuits requiring ESD protection. In addition to its very low capacitance, this protector exhibits extremely fast response times to ESD events, making it ideal for protecting a wide array of high speed digitial electronic applications.

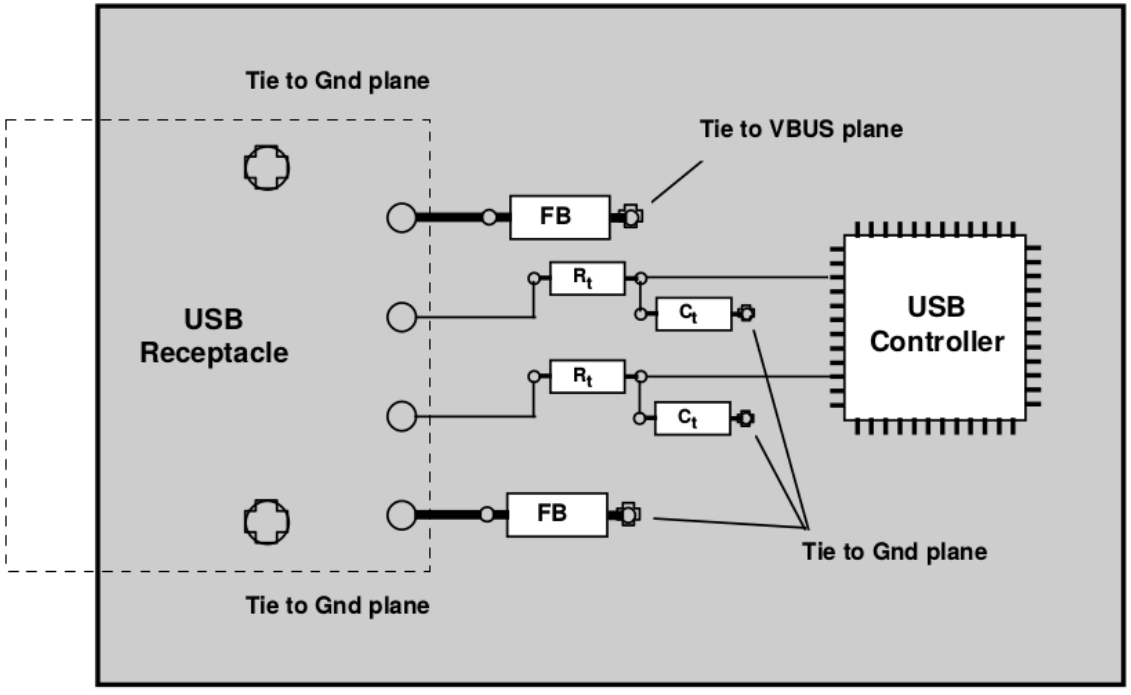
The ChipGuard® Automotive MLC Series is fully AEC-Q200 qualified and supported.

## Electrical Characteristics @ 25 °C (unless otherwise noted)

| Parameter | Symbol | CG0603MLC-05E | CG0603MLC-12E | Unit |
|---|---|---|---|---|
| DC Working Voltage | $V_W(DC)$ | ≤5 | ≤12 | V |
| Maximum Leakage Current @ Max. $V_W(DC)$ | $I_L$ | <0.01 | | µA |
| Typical Clamping Voltage (Note 1) | $V_C$ | 30 | | V |
| Typical Trigger Voltage (Note 1) | $V_T$ | 300 | | V |
| Typical Peak Voltage (Note 2) | $V_P$ | 300 | | V |
| Typical Capacitance @ 1 MHz, 1 Vrms | $C_O$ | 0.2 | | pF |
| Response Time | $R_T$ | <1 | | ns |
| ESD Protection:<br>Per IEC 61000-4-2 Level 4<br>Min. Contact Discharge<br>Min. Air Discharge<br>Typical ESD Withstand | | <br><br>±8<br>±15 (Note 3)<br>1000 | | <br><br>kV<br>kV<br>Pulses |
| Operating Temperature | $T_{OPR}$ | -55 to +125 | | °C |
| Storage Temperature | $T_{STG}$ | -55 to +125 | | °C |

Notes: 1. $V_T$ and $V_C$ measured using TLP (Transmission Line Pulse) method.
2. Peak voltage measured under ESD Test Conditions: IEC61000-4-2, 8 kV contact discharge.
3. IEC 61000-4-2 ESD Performance will meet minimum 1000 reps without degradation in performance.

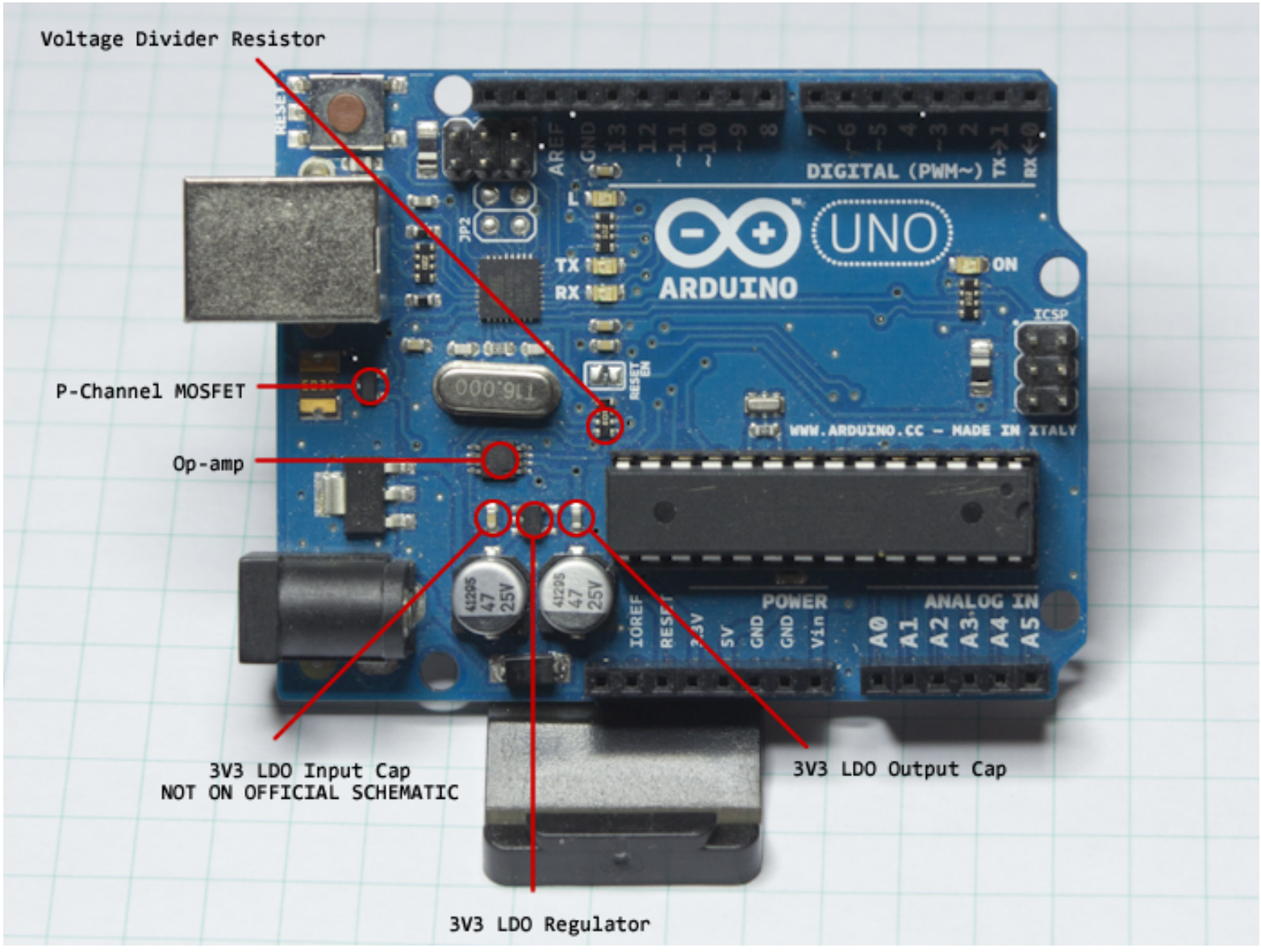
# USB: Guidelines



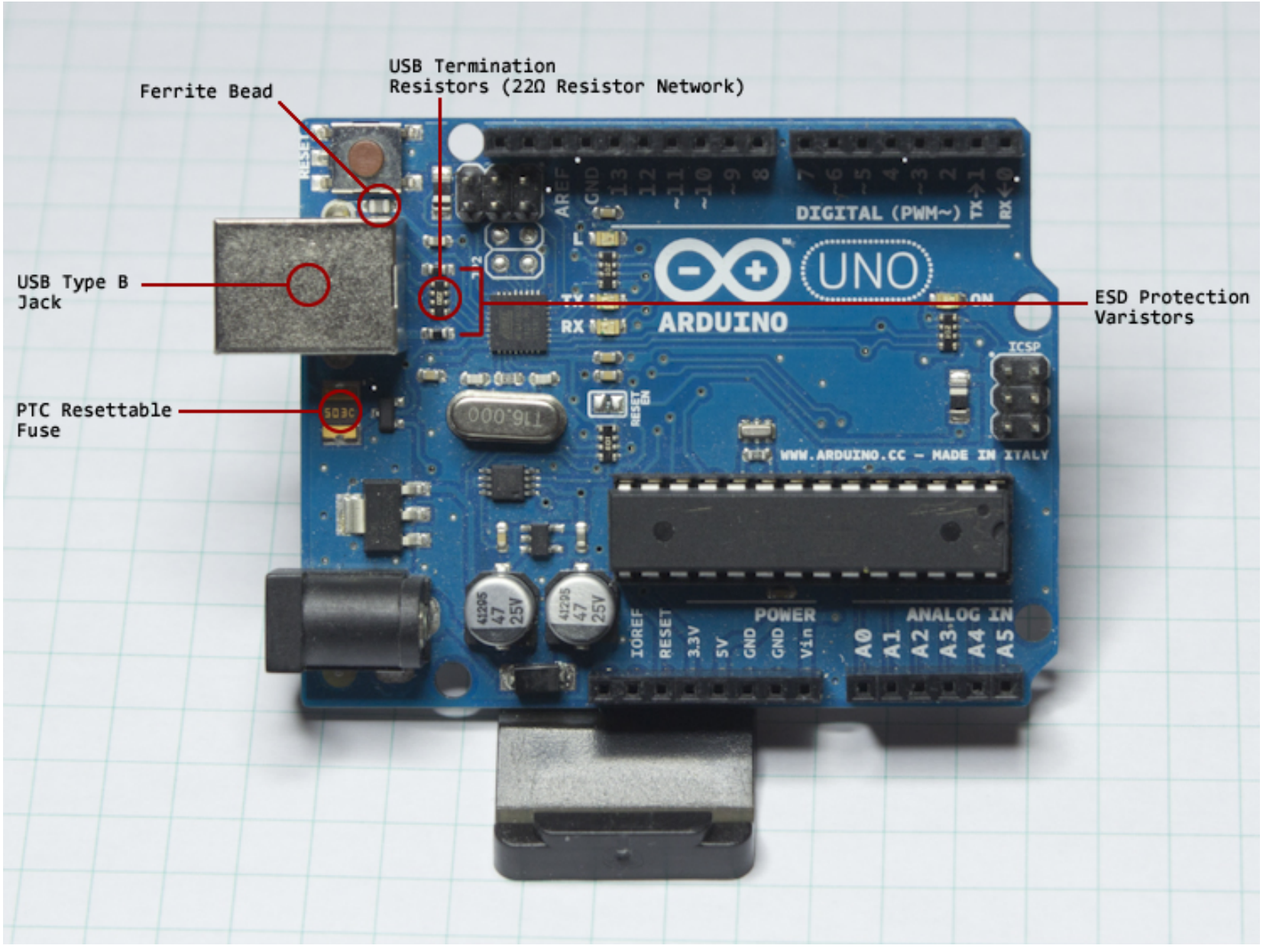

- Ferrite Beads to Vbus and GND
- Termination resistances
- Termination capacitors

Sources:EMI Design Guidelines for USB Components

# Power Supply Selection: Comparator



# Power Supply Selection: USB Connection



# Power Supply Selection: PMOS

ON Semiconductor®

## FDN340P

### Single P-Channel, Logic Level, PowerTrench® MOSFET

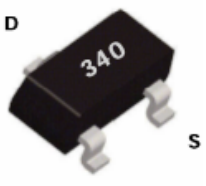
#### General Description

This P-Channel Logic Level MOSFET is produced using Fairchild Semiconductor advanced Power Trench process that has been especially tailored to minimize the on-state resistance and yet maintain low gate charge for superior switching performance.

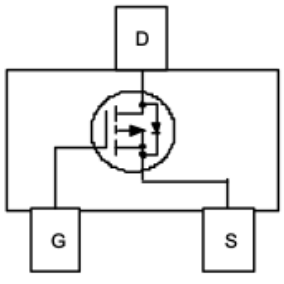
These devices are well suited for portable electronics applications: load switching and power management, battery charging circuits, and DC/DC conversion.

#### Features

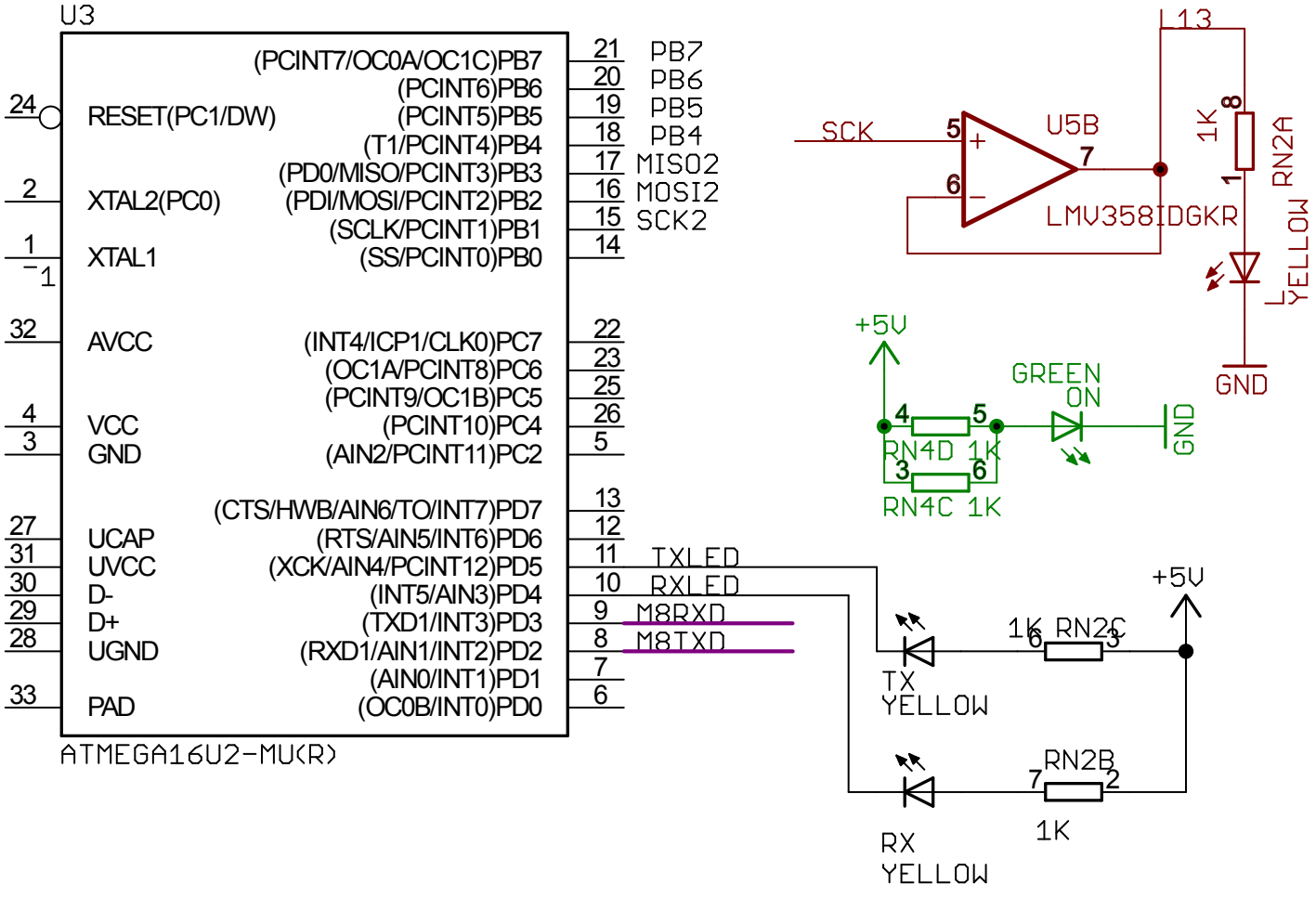
- –2A, 20 V $R_{DS(ON)}$ = 70 mΩ @ $V_{GS}$ = –4.5 V
  $R_{DS(ON)}$ = 110 mΩ @ $V_{GS}$ = –2.5 V
- Low gate charge (7.2 nC typical).
- High performance trench technology for extremely low $R_{DS(ON)}$ .
- High power version of industry Standard SOT-23 package. Identical pin-out to SOT-23 with 30% higher power handling capability.



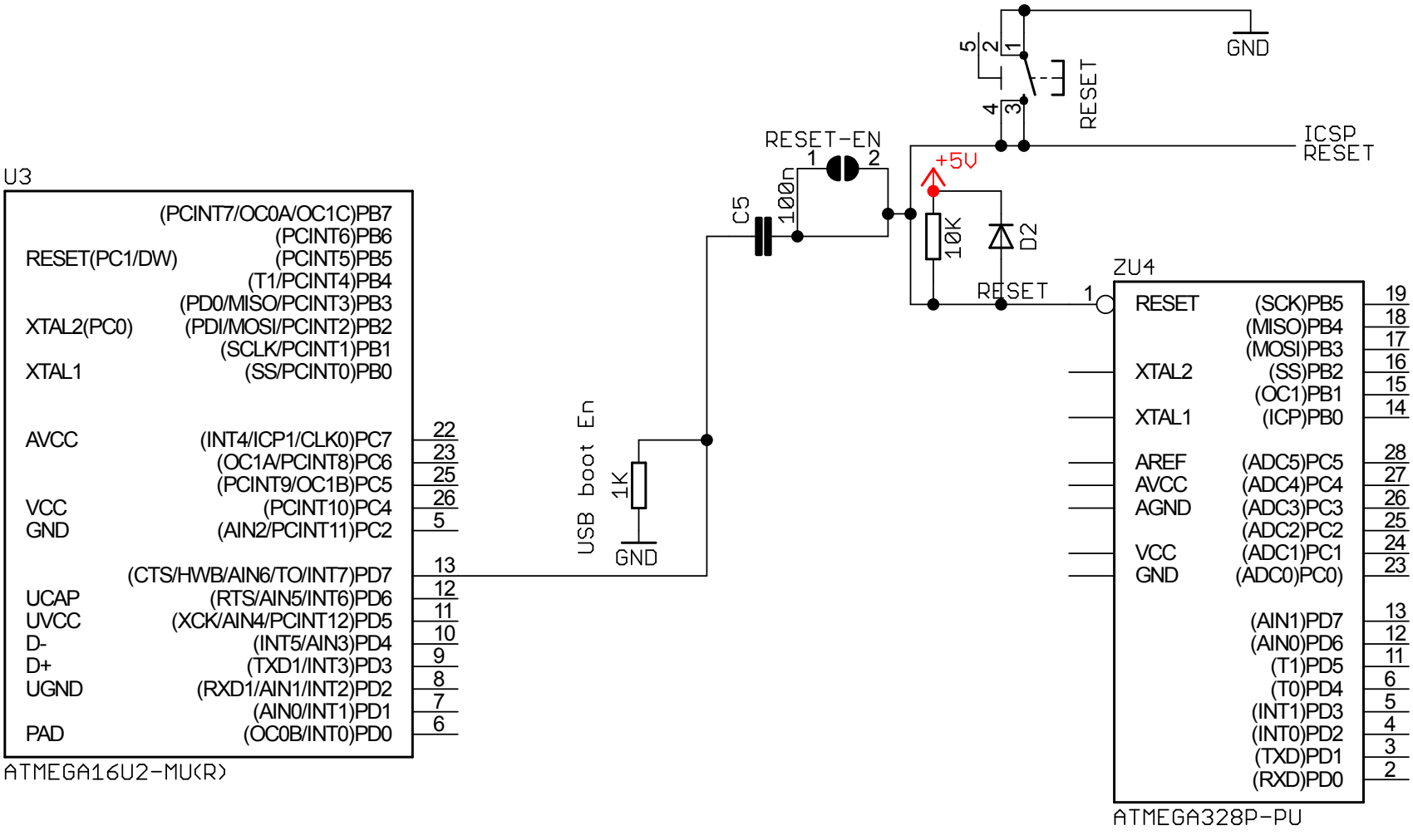

SuperSOT™-3



# The LEDs


U3
(PCINT7/OC0A/OC1C)PB7
(PCINT6)PB6
(PCINT5)PB5
(T1/PCINT4)PB4
(PD0/MISO/PCINT3)PB3
(PDI/MOSI/PCINT2)PB2
(SCLK/PCINT1)PB1
(SS/PCINT0)PB0
(INT4/ICP1/CLK0)PC7
(OC1A/PCINT8)PC6
(PCINT9/OC1B)PC5
(PCINT10)PC4
(AIN2/PCINT11)PC2
(CTS/HWB/AIN6/TO/INT7)PD7
(RTS/AIN5/INT6)PD6
(XCK/AIN4/PCINT12)PD5
(INT5/AIN3)PD4
(TXD1/INT3)PD3
(RXD1/AIN1/INT2)PD2
(AIN0/INT1)PD1
(OC0B/INT0)PD0
RESET(PC1/DW)
XTAL2(PC0)
XTAL1
AVCC
VCC
GND
UCAP
UVCC
D-
D+
UGND
PAD
ATMEGA16U2-MU(R)
PB7
PB6
PB5
PB4
MISO2
MOSI2
SCK2
TXLED
RXLED
M8RXD
M8TXD
SCK
U5B
LMV358IDGKR
13
1K
RN2A
YELLOW
GND
+5V
GREEN
ON
RN4D 1K
RN4C 1K
TX
YELLOW
RX
YELLOW
RN2C
RN2B
1K

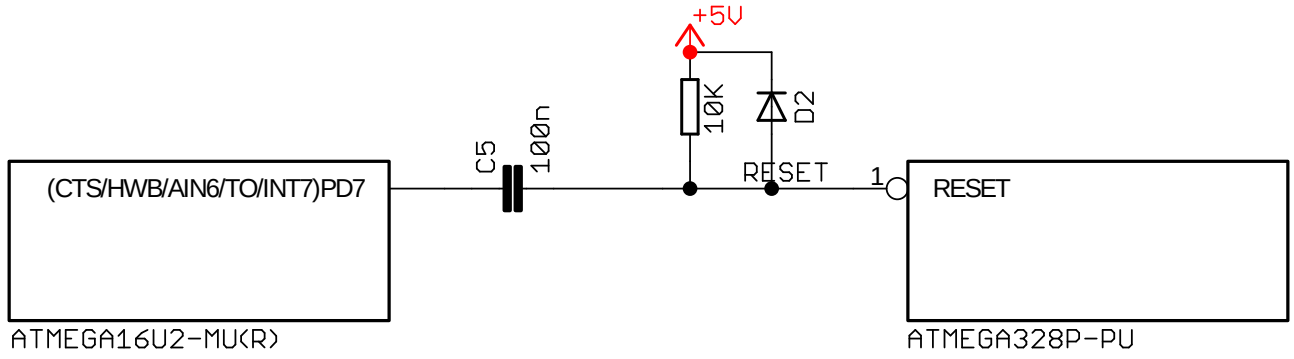
# Reset Circuitry



# 3 Reset Sources

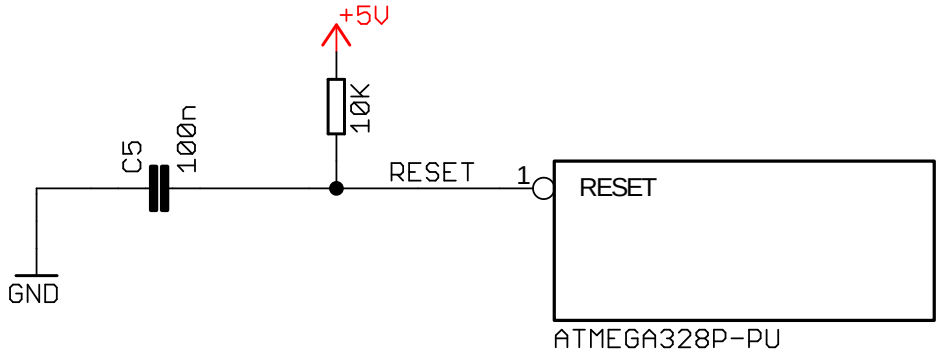
- Manual Reset
- Reset by USB port
- Reset by ICSP reset
- Have to coexist

# Reset by USB port



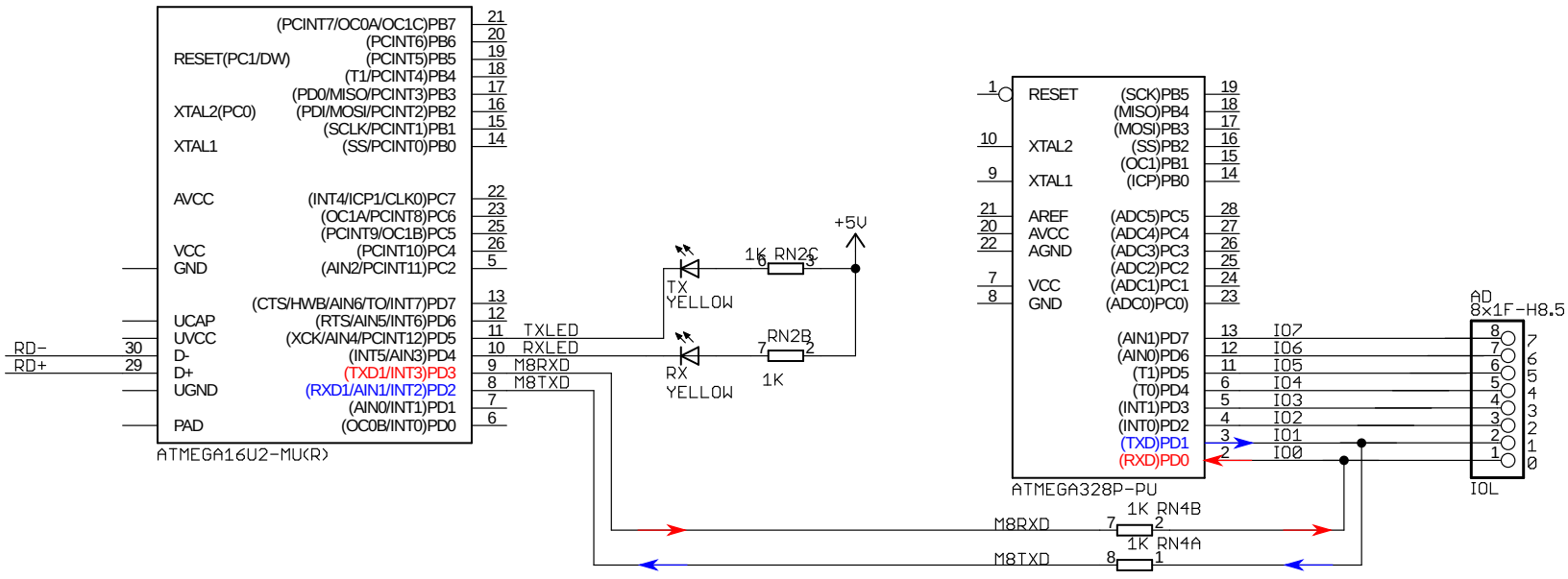

- Ignore D2
- PD7 transition 0 to 1
- PD7 transition 1 to 0
- Time constant 100nF $\times$ 10K

# Power ON Reset



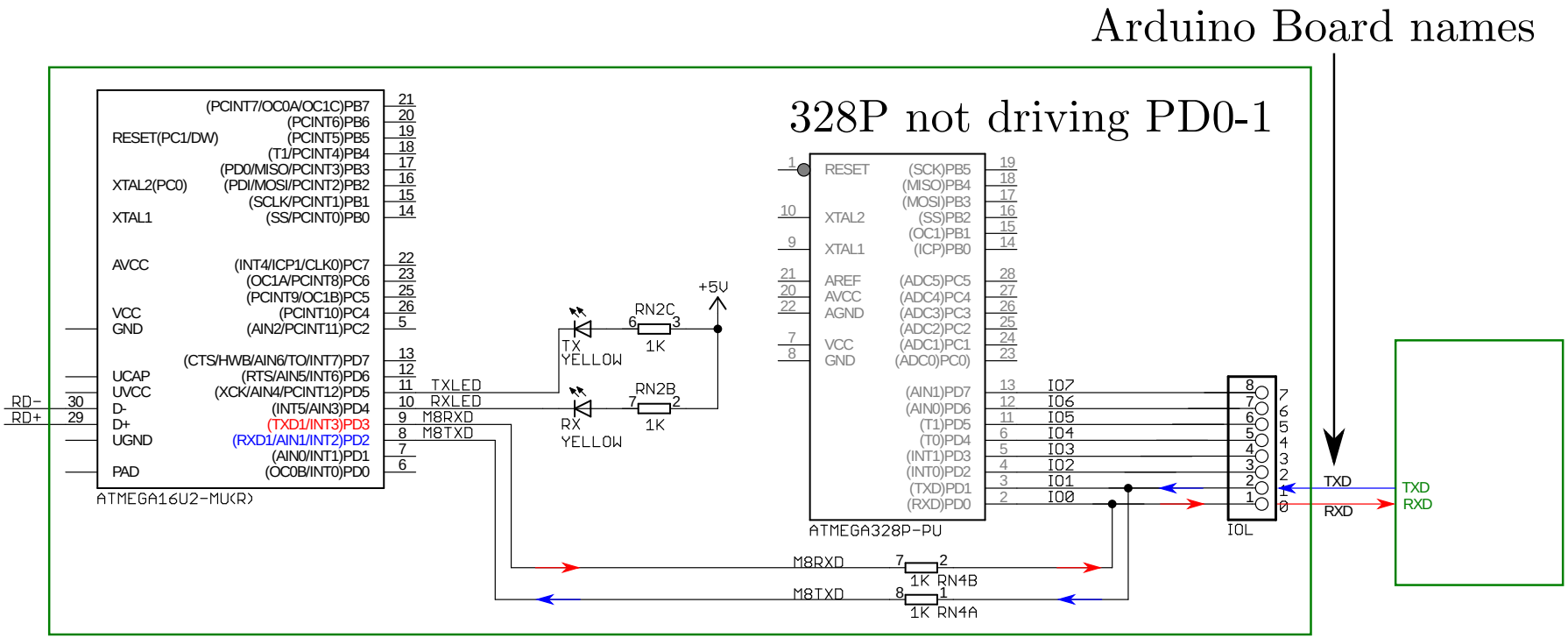

- C5 holds RESET low during some time constants

# Serial Port




- ATMEGA16U2 Makes USB to Serial translation
- See: Arduino USB-Serial

# Bridge to External Serial Port




- Arduino board: 5V
- External board: ?