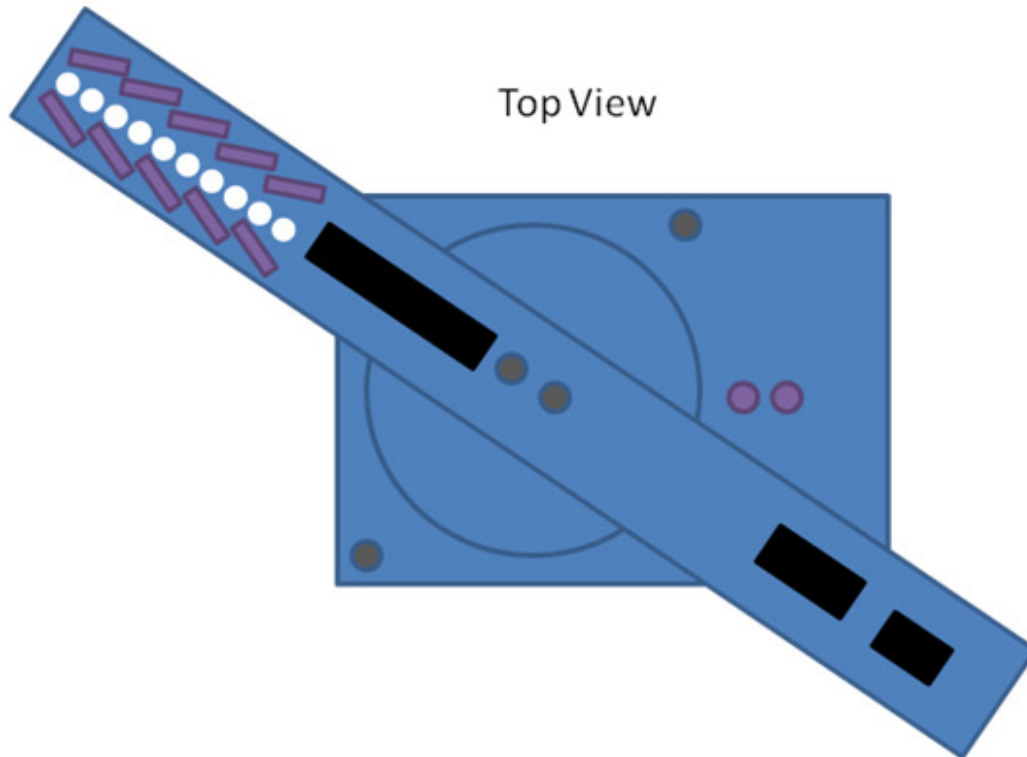


10 LED POV DISPLAY

SKU PCB-0020

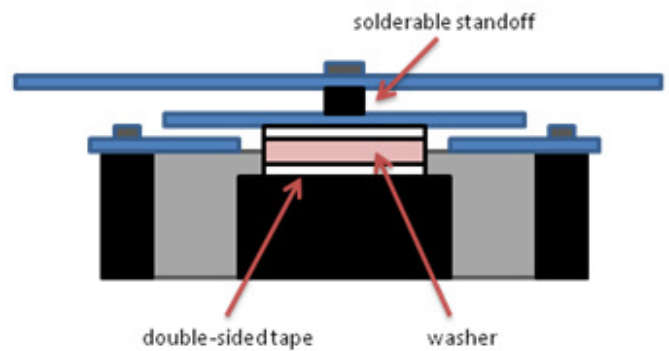
The kit consists of 3 PCBs assembled as shown in the following diagrams.



Side View



Side View Close Up



POV DISPLAY BASE

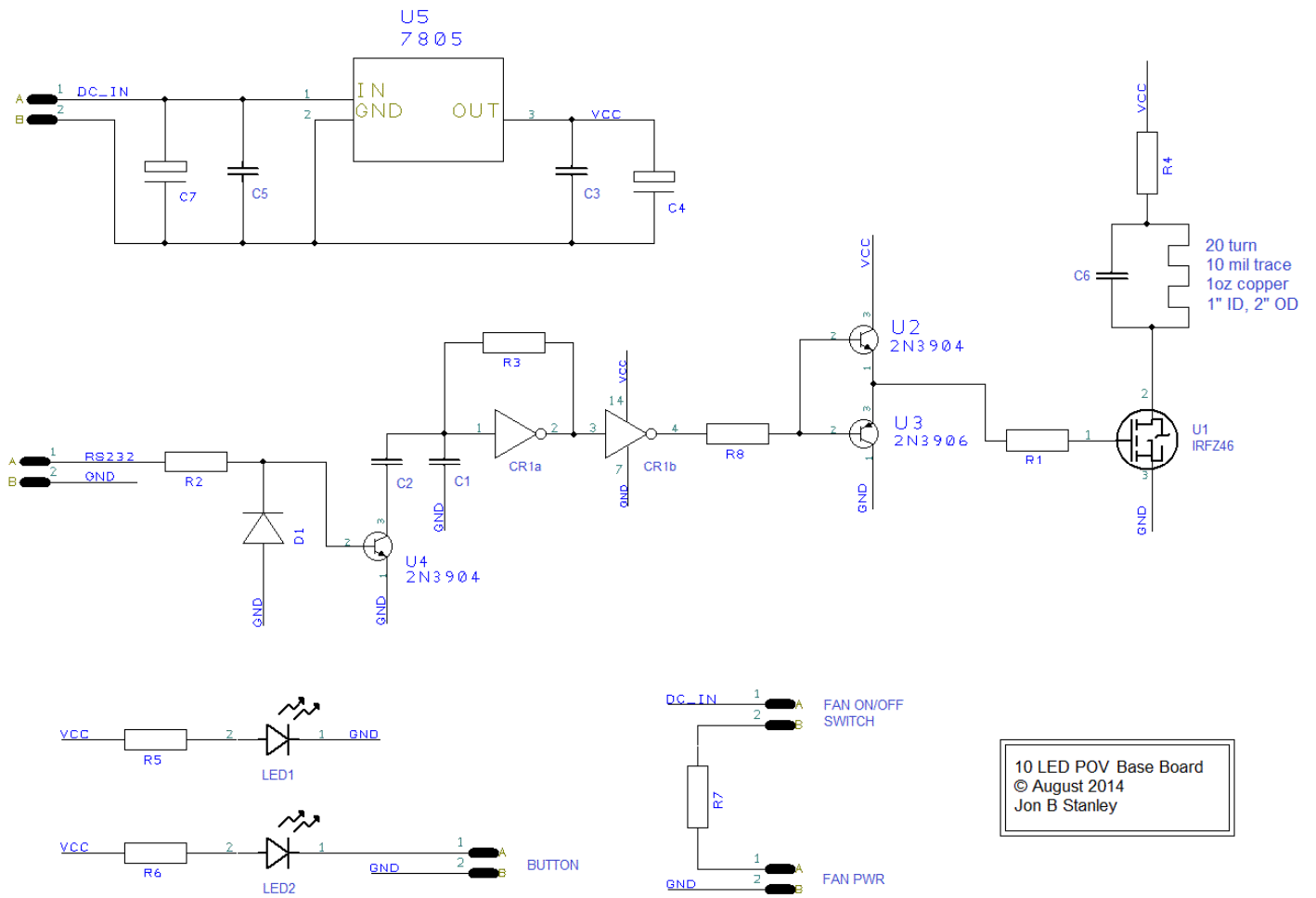
PCB COMPONENT LIST (INCLUDED IN COM-0020 KIT)

Part	Value	Description	Suggested Part Number
C1	0.001uF	Ceramic disc capacitor, 5% tol, 2.5mm spacing	Digikey 490-8633-ND
C2	0.001uF	Ceramic disc capacitor, 5% tol, 2.5mm spacing	Digikey 490-8633-ND
C3	0.1uF	Ceramic disc capacitor, 2.5mm spacing	Digikey 478-5741-ND
C4	100uF	Electrolytic capacitor, 16V, 2.5mm spacing	Digikey 338-1692-ND
C5	0.1uF	Ceramic disc capacitor, 2.5mm spacing	Digikey 478-5741-ND
C6	0.001uF	Ceramic disc capacitor, 2.5mm spacing	Digikey 490-8633-ND
C7	100uF	Electrolytic capacitor, 16V, 2.5mm spacing	Digikey 338-1692-ND
R1	10 ohm	1/4 watt resistor	
R2	4.7K ohm	1/4 watt resistor	
R3	4.7K ohm	1/4 watt resistor (SEE NOTE)	
R4	0 (wire)	1/4 watt resistor	
R5	4.7K ohm	1/4 watt resistor	
R6	4.7K ohm	1/4 watt resistor	
R7	0 (wire)	1/4 watt resistor for fan speed adjustment	
R8	4.7K ohm	1/4 watt resistor	
U1	IRFZ46	N-Channel Power MOSFET	Digikey IRFZ46NPBF-ND
U2	2N3904	General purpose NPN	Digikey 2N3904FS-ND
U3	2N3906	General purpose PNP	Digikey 2N3906FS-ND
U4	2N3904	General purpose NPN	Digikey 2N3904FS-ND
U5	LM7805	5V 1A voltage regulator	IC: Digikey LM7805CT-ND Heatsink: Digikey HS112-ND
CR1	74HCT14	Hex Schmitt inverters	Digikey 296-2093-5-ND
D1	1N4148	General purpose signal diode	Digikey 1N4148TACT-ND
LED1	XTNI30W	3mm T-1 IR LED 940nm	Digikey 1497-1063-ND
LED2	XTNI30W	3mm T-1 IR LED 940nm	Digikey 1497-1063-ND

EXTERNAL COMPONENT LIST

Part	Description	Suggested Part Number
SCREW/NUTS	6-32 x 3/8" screws and nuts for mounting to fan	4 included with PCB-0020 kit
FAN	60x60mm (50x50mm mount hole spacing) 5VDC 1000-5000RPM PC fan	2500RPM: Digikey Q620-ND 3500RPM: Digikey Q621-ND 4500RPM: Digikey Q622-ND
DC SUPPLY	9-12VDC >0.6A power supply	Digikey 237-1450-ND
DC JACK	DC power barrel jack	Digikey CP-024B-ND
SWITCH	Toggle switch for fan motor on/off	Digikey 360-3288-ND
BUTTON	Pushbutton for time set	Digikey SW629-ND
SERIAL	RS232 9-pin DB9 connector or FTDI adapter	DB9 male: Digikey AE10972-ND DB9 female: Digikey AE10926-ND FTDI adapter: Sparkfun DEV-09716

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10 LED POV Base Board
 © August 2014
 Jon B Stanley

POV DISPLAY LED BOARD

PCB COMPONENT LIST (INCLUDED IN COM-0020 KIT)

Part	Value	Description	Suggested Part Number
Photo1	WP3DP3BT	3mm phototransistor 940nm (SEE NOTES)	Digikey 754-1468-ND
Photo2	WP3DP3BT	3mm phototransistor 940nm (SEE NOTES)	Digikey 754-1468-ND
U1	ATMega328	Arduino Uno (bootloader)	IC: Digikey 1050-1019-ND Socket: Digikey ED3050-5-ND
U3	CD4013	Dual D-type Flip-Flop	IC: Digikey 296-2033-5-ND
U4	2N3904	General purpose NPN	Digikey 2N3904FS-ND
U5	2N3906	General purpose PNP	Digikey 2N3906FS-ND
U6	TL082	General purpose op-amp	IC: Digikey 296-1781-5-ND
U7	MCP1700	+3.3V 250mA regulator (SEE NOTES)	Digikey MCP1700-3302E/TO-ND
R1	470 ohm	1/4 watt resistor for LED current limiting	
R2	470 ohm	1/4 watt resistor for LED current limiting	
R3	470 ohm	1/4 watt resistor for LED current limiting	
R4	470 ohm	1/4 watt resistor for LED current limiting	
R5	470 ohm	1/4 watt resistor for LED current limiting	
R6	470 ohm	1/4 watt resistor for LED current limiting	
R7	470 ohm	1/4 watt resistor for LED current limiting	
R8	470 ohm	1/4 watt resistor for LED current limiting	
R9	470 ohm	1/4 watt resistor for LED current limiting	
R10	470 ohm	1/4 watt resistor for LED current limiting	
R11	470 ohm	1/4 watt resistor	
R12	10K ohm	1/4 watt resistor	
R13	470 ohm	1/4 watt resistor	
R14	10K ohm	1/4 watt resistor	
R15	10K ohm	1/4 watt resistor	
R16	10K ohm	1/4 watt resistor	
R17	10K ohm	1/4 watt resistor	
R18	10K ohm	1/4 watt resistor	
R19	1K ohm	1/4 watt resistor (SEE NOTES)	
R20	3.3K ohm	1/4 watt resistor (SEE NOTES)	
R21	2.2K ohm	1/4 watt resistor	
R22	1K ohm	1/4 watt resistor	
C1	100uF	Electrolytic capacitor, 16V, 2.5mm spacing	Digikey 338-1692-ND
C2	100uF	Electrolytic capacitor, 16V, 2.5mm spacing	Digikey 338-1692-ND
C4	0.1uF	Ceramic disc capacitor, 2.5mm spacing	Digikey 478-5741-ND
C5	0.001uF	Ceramic disc capacitor, 2.5mm spacing	Digikey 490-8633-ND
C6	18pF	Ceramic disc capacitor, 2.5mm spacing	Digikey 445-4762-ND
C7	18pF	Ceramic disc capacitor, 2.5mm spacing	Digikey 445-4762-ND
C8	0.1uF	Ceramic disc capacitor, 2.5mm spacing	Digikey 478-5741-ND
C9	0.1uF	Ceramic disc capacitor, 2.5mm spacing	Digikey 478-5741-ND
C10	0.01uF	Ceramic disc capacitor, 5% tol, 2.5mm spacing	Digikey 445-8384-ND
C11	0.1uF	Ceramic disc capacitor, 2.5mm spacing	Digikey 478-5741-ND
C12	0.1uF	Ceramic disc capacitor, 2.5mm spacing	Digikey 478-5741-ND

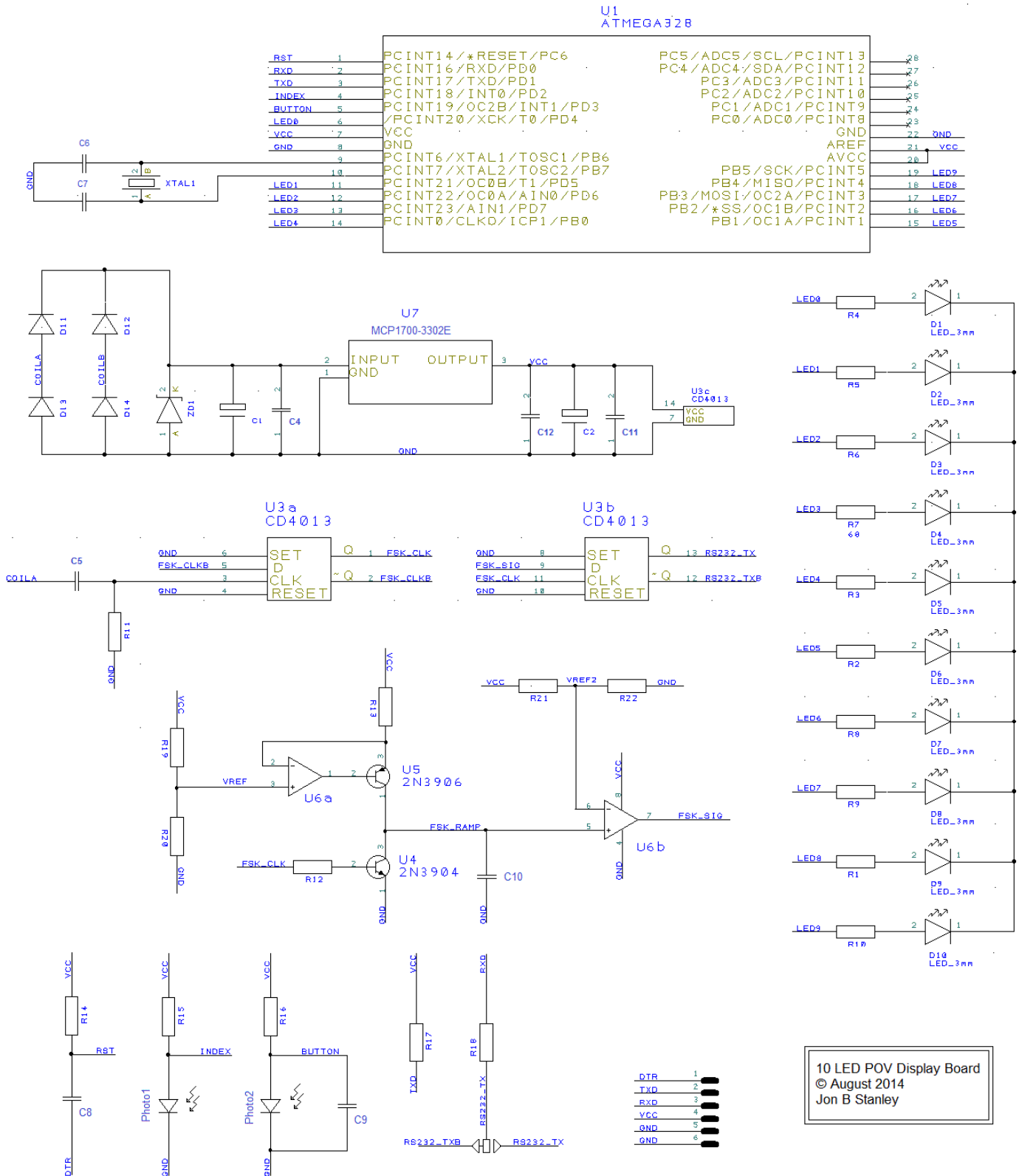
PCB COMPONENT LIST (CONTINUED)

Part	Value	Description	Suggested Part Number
XTAL1	ATS16B-E	16MHz crystal (SEE NOTES)	Digikey CTX1085-ND
ZD1	1N4733	5.1V 1W zener	Digikey 568-1362-1-ND
D1	LED	3mm T-1 >6000mcd LED	White: Digikey 365-1467-ND
D2	LED	3mm T-1 >6000mcd LED	White: Digikey 365-1467-ND
D3	LED	3mm T-1 >6000mcd LED	White: Digikey 365-1467-ND
D4	LED	3mm T-1 >6000mcd LED	White: Digikey 365-1467-ND
D5	LED	3mm T-1 >6000mcd LED	White: Digikey 365-1467-ND
D6	LED	3mm T-1 >6000mcd LED	White: Digikey 365-1467-ND
D7	LED	3mm T-1 >6000mcd LED	White: Digikey 365-1467-ND
D8	LED	3mm T-1 >6000mcd LED	White: Digikey 365-1467-ND
D9	LED	3mm T-1 >6000mcd LED	White: Digikey 365-1467-ND
D10	LED	3mm T-1 >6000mcd LED	White: Digikey 365-1467-ND
D11	SD103A	Schottky diode 200mA	Digikey SD103AVSCT-ND
D12	SD103A	Schottky diode 200mA	Digikey SD103AVSCT-ND
D13	SD103A	Schottky diode 200mA	Digikey SD103AVSCT-ND
D14	SD103A	Schottky diode 200mA	Digikey SD103AVSCT-ND
DEBUG	Header	6-pin debug header 0.1" pitch	Digikey 952-2270-ND

EXTERNAL COMPONENT LIST

Part	Description	Suggested Part Number
SCREW/NUT	6-32 x 3/8" screws and nut for counterbalance	1 included with PCB-0020 kit
ARDUINO PROGRAMMER	FTDI serial programmer with 5VDC signals or Arduino board with 5V/TXD/RXD/GND	Sparkfun DEV-09716

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POV DISPLAY TRANSFORMER SECONDARY

EXTERNAL COMPONENT LIST

Part	Description	Suggested Part Number
STANDOFFS	Hex standoffs M3 8mm male-female	2 included with PCB-0020 kit
NUTS	M3 nuts	2 included with PCB-0020 kit
SPACER	Acrylic washer 7/8" diameter 1/8" thick	1 included with PCB-0020 kit
ADHESIVE DOT	Round 7/8" adhesive dots	2 included with PCB-0020 kit

ASSEMBLY NOTES

Base PCB

1. The 74HCT14 has wide input threshold variation so the FSK output frequency can vary from component to component. The value of R3 establishes a nominal logic low FSK frequency of 300KHz (3.3 us period) and logic high FSK frequency of 150KHz (6.6 us period). For FSK demodulation to function with the suggested resistor values, an oscilloscope is required to verify that the logic low FSK frequency is > 270KHz (> 3.7 us period) and the logic high frequency is < 165KHz (< 6.0 us period). If the frequency is off then the values of R3, C1 and C2 could be replaced with slightly different values.
2. When there is a logic low at the RS232 connection feeding into the base of transistor U4, the capacitor C2 is not grounded so the oscillator frequency is determined by R3 and C1. A logic high turns on transistor U4 to ground C2, which changes the FSK frequency to be dependent on C1+C2 in parallel.
3. Standard RS232 (logic low < 3V, logic high > 3V) or TTL RS232 (logic low = 0V, logic high = 3.3-5V) can be fed into the connection. However, standard RS232 and TTL RS232 are inverses of each other so the POV Display PCB has a PCB trace selection that by default selects standard RS232. If TTL RS232 is used then the polarity on the POV Display PCB should be cut and the other routing selection bridged with some solder.
4. The RS232 circuitry consisting of D1, R2, and U4 is optional and not required to be populated if the POV display Arduino firmware doesn't require data from a computer, i.e. used as a clock.
5. The MOT PWR pins on the PCB provide power to the fan. However, the MOT PWR + pin ties to the DC input jack in case you prefer to use a 12V or higher voltage fan. If the recommended 5V fan is used then the + (red) side of the fan wire should be soldered directly to the 5V output pin of the 7805 regulator (this pin is nearest U1) rather than at the MOT PWR + connection.
6. Be sure to install the IRFZ46 (U1) with the metal tab facing inward towards the PCB, and the 7805 (U5) with the metal side facing outward away from the PCB.

For kits purchased before May 2016

1. The RS232 connection has no signal or ground marking on the PCB. The signal is the pin nearest the transistor U4.
2. The silkscreen markings on the top side indicate LED K A, but it should be A K to match the LED silkscreen direction on the other side of the PCB.

Transformer Secondary PCB

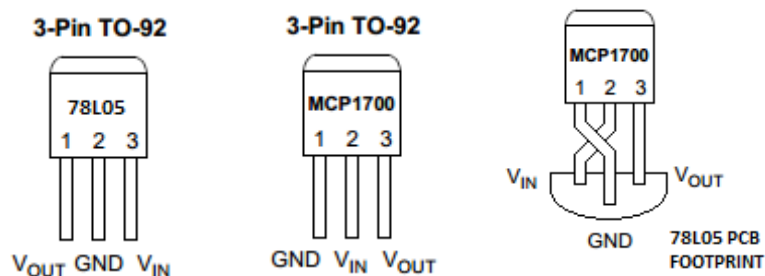
1. The hex standoff posts are solderable. It is recommended to apply some solder to the sides of the standoff first before attempting to place and solder the standoffs on the transformer PCB. Try to minimize the amount of soldering time and heating on the transformer PCB pads for the standoff to avoid damage. If desired, glue could be applied for strength but is not necessary. Be sure to test fit the POV Display PCB before soldering the second hex standoff to ensure the placement will work.
2. The adhesive dot and spacer should be placed as centered as possible on the fan and the secondary PCB. Ensure the spacer is not rubbing against the base PCB. The more centered the transformer secondary is to the fan, the better balanced the POV Display PCB will be when it is spinning resulting in minimal vibration.
3. If using a different fan from what is recommended, it is possible for the gap between the transformer secondary PCB to the base PCB to vary when using the provided spacer and adhesive dots. If the gap is too large then there may be double pulses seen on the junction of C5 and R11 feeding into the clock input of the 4013 (U3a pin 3) resulting in its Q output not resembling a clean clock and thus cause FSK demodulation to either be unreliable or fail. To fix this, insert small washers between the fan and the base PCB if necessary, and verify with an oscilloscope that the clock output of the 4013 is a clean square wave.

POV Display PCB

1. The phototransistors mount at the bottom of the PCB. Ensure that the flat side of the phototransistor is pointing towards the center of the PCB. It is essentially inserted in reverse compared to a LED because the collector is at the flat side that normally is the cathode side of a LED.
2. The recommended LEDs are white in color. You are free to choose LEDs of different colors, but it is strongly recommended to use only high brightness > 6000mcd LEDs so less current is required for a visible display. The recommended LEDs currently operate at approximately 1.5mA each for a total of 15mA for the entire 10 LED column. Exceeding ~20-25mA draw for the entire board could cause 3.3V regulation problems because the PCB transformer does not provide much power. A consequence of 3.3V losing regulation is the Arduino and/or the FSK slope detector that relies on stable voltage references will fail to function correctly.
3. R19 and R20 establish the FSK demodulator slope detector reference level to distinguish between a logic low or a logic high. Depending on the tolerance and variation of the other components, either one of the resistors may need to be adjusted slightly for FSK to work correctly. In the case that debugging is required, it is recommended that you have an oscilloscope and a function generator capable of producing square waves up to 20KHz. Refer to www.electronixandmore.com/projects/propclk/index.html for diagrams and detailed theory of operation. Note that the POV display board by default expects standard RS232 to be fed into the base PCB. If TTL RS232 is used instead then the trace at the output of the 4013 needs to be cut and routed to the opposite polarity output.
4. A screw and nut should be placed in the hole between the Arduino and the LEDs to balance the PCB.
5. The 2 holes in the center for mounting on the standoffs soldered on the transformer secondary PCB are intentionally larger than the screw terminals on the standoffs to allow for some margin of error in assembly of the standoffs and also to allow some play for moving the PCB back and forth a little bit to adjust the weight distribution for fine tuning of balance.

For kits purchased before March 2017

1. U7 was originally designed for a 78L05 +5V 100mA regulator, but a MCP1700-3302E +3.3V 250mA LDO regulator is recommended. The pinout of the MCP1700 is not the same as the 78L05 so the pins will need to be separated and routed to the correct corresponding pins of the 78L05 footprint on the PCB. It is recommended to install the MCP1700 backwards relative to the 78L05 footprint and swap the pin 1-2 routing to the PCB as shown in the illustration on the right.



2. The XTAL1 footprint in the PCB is smaller than the recommended part. The crystal will need to be installed slightly above capacitors C6 and C7 as shown in the following illustration.

