Ormerod differential IR sensor board circuit description

Refer to the schematic. The board provides the following functions:

1. Illumination (U2 D1 D2 D3). U2 provides constant current drive to LEDs D1 D2 D3. The current can be increased above the default 20mA by fitting a resistor at position R23. Refer to the BCR402U datasheet for details. The +12V and 0V pads allow alternative lighting to be connected.
2. Heater on indication (B1 D7 R8). Bridge rectifier B1 allows correct operation irrespective of the polarity of the heater drive voltage. R8 limits the LED current to 20mA or less for heater voltages of up to 14V.
3. Fan control (U1 Q1 D4 R6 R7). Microcontroller U1 monitors the hot end thermistor voltage via R6. It turns the fan on via R7 and Q1 if either the temperature exceeds about 40C or the thermistor appears to be not connected. If R24 is not fitted then the firmware senses a high on pin PA4 and assumes that the Duet board uses a 1K thermistor series resistor. If R24 is fitted with a low value resistor (e.g. 1K) or a wire link, then the firmware senses a low on pin PA4 and assumes that a 4.7K series resistor is used. Series resistor R6 is included so that if either the 3.3V or the ground connection provided through connector X4 is broken, the effect on the temperature read by the Duet will be less severe and unlikely to result in serious overheating. Flyback diode D4 is included in case the fan presents an inductive load. A 0 ohm resistor or wire link can be added at position R22 if continuous operation of the fan is required.
4. Differential LED height sensor (D5 D6 D8 Q2 C1 C3 R1 R2 R3 R4 R5 R9). Microcontroller U1 measures the output from phototransistor Q2 with D6 and D5 both off, with D6 (the 'far' LED) on, and with D5 (the 'near' LED) on. Resistor R3 driving the near LED has a higher value than resistor R2 driving the far LED, to compensate for the shorter path taken by light reaching the phototransistor from the near LED. The firmware subtracts the reading with both LEDs off from each of the readings with one LED on in order to compensate for ambient IR, to provide a “far reading” and a “near reading”.

   Pin PA0 on U1 determines the operating mode. The internal pullup resistor on pin PA0 is enabled, so that the pin is high if the 4th sensor wire from the Duet is not connected. When PA0 is high, the firmware operates in differential mode. When the far reading is substantially lower than the near reading, or the far reading is below a threshold, pins PA2 and PA7 are both driven low, so that the output on X4 pin 1 is 0V and the Duet sees a Z-probe reading close to zero. When the near reading is slightly below the far LED reading and the far LED reading is above threshold, PA2 is drive high and PA7 is driven low. This gives a z-probe reading of about 465. When the near reading is higher than the far reading and the far reading is above threshold, PA2 is driven low and PA7 high, resulting in a Z-probe reading of about 535. If either the near reading or the far reading is high enough to indicate that the phototransistor is saturated or approaching saturation, then both PA2 and PA7 are driven high, giving a Z probe reading close to 1023.

   C3 serves not only to smooth out the supply voltage fluctuations due to the LEDs being turned on and off, but also to physically block the direct light path between the phototransistor and the photodiodes.

   Resistor R9 and LED D8 provide an indication when the Z probe threshold has been reached.

If the control signal from the Duet on X4 pin 1 is driven low, then the sensor operates in simple modulated IR mode. In this mode, U1 pin PA7 is driven high if the near reading exceeds a fixed threshold. Pin PA2 remains low unless the phototransistor is saturated or approaching saturation, in which case both PA2 and PA7 are driven high to provide a Z probe reading of about 1023.

5. L1, C2 and C3 provide decoupling for U1. The ICSP pads allow U1 to be programmed.
6. Pads PAD1 through PAD7 and the pads for resistors R20 R21 are provided to facilitate modification and experimentation.

Version 1 by D Crocker, 2014-07-04.