

Buffer amp is required to convert PWM waveform to a nice steady 0-5 volts. Its a simple unity gain voltage follower

First Stage Amp is a bit tricky. Look at it in two parts, as both an inverting and non-inverting amp. Calculations are:
 Non-Inverting = $V_{offset} \cdot (R4/R3 + 1)$
 Inverting = $-V_{signal} \cdot (R3/R4)$
 $V_{out} = V_{offset} \cdot (R4/R3) - V_{signal} \cdot (R3/R4)$
 With a signal of 0V, V_{out} needs to be about 0.25V lower than loop supply
 As V_{signal} increases, it subtracts from V_{offset}
 Adjust R5 to set 4.0mA with 0v V_{signal}
 Setting R1 affects the offset as well, so you will have to go back and forth between R1 and R5 to get min and max current set properly.

Second stage amp is just a non-inverting voltage follower. It keeps the emitter side of the transistor at the same voltage as the first stage output.

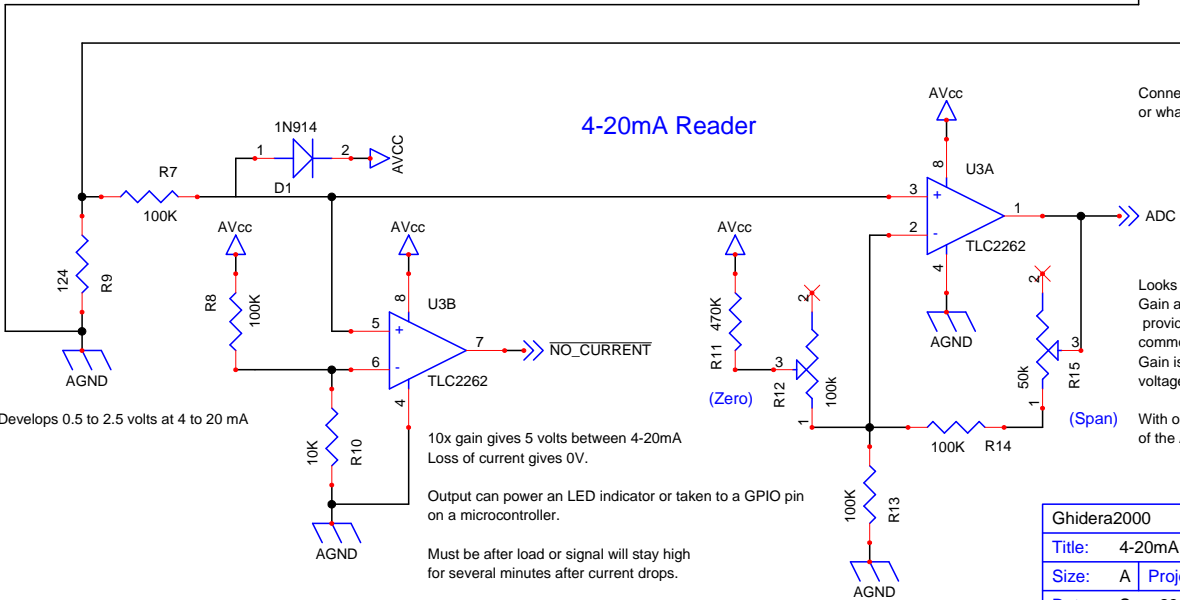
Start with a setting of 62.5 ohms. Needs to drop roughly 0.25V when loop is at 4mA

S1 switches between sending 4-20mA or just reading 4-20mA

Max load ~600 Ohms

J1 15V/.020 mA = 750 ohms
 I figure with all the internal resistance and rail-offsets, 600 is safe.

All opamps are rail-to-rail, though U3B need not be. First and second stage opamps must have min supply capability of 15V or more. Others are fine with 5V.



Connect a DC ammeter to J1 test and calibrate. Alligator clips or whatever your preference for connecting to external loops.

Looks strange but, junction of R12, R13, and R14 gives Gain and 0.5V offset. With an unput of 0.5V (4mA) the junction provides 0.5V as well. Since at this time both inputs are 0.5V, common mode rejection means an output of zero volts. Gain is roughly 2x. 2.5V input = 5V output - it varies over the voltage span due to the offset. e.g. 2v in = about 3.78 out.

With only a 2x gain feedback, output would be 1-5V, losing 20% of the ADCs range.

R10 Develops 0.5 to 2.5 volts at 4 to 20 mA

10x gain gives 5 volts between 4-20mA. Loss of current gives 0V.

Output can power an LED indicator or taken to a GPIO pin on a microcontroller.

Must be after load or signal will stay high for several minutes after current drops.

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|-------------|-----------------------------|-----------|----------|
| Ghidera2000 | | | |
| Title: | 4-20mA Transmitter & Reader | | |
| Size: | A | Project: | 4-20mA |
| | | File: | Root.sch |
| Date: | Sep. 29, 2003 | Sheet: | 1 of 1 |
| | | Revision: | 0.1 |