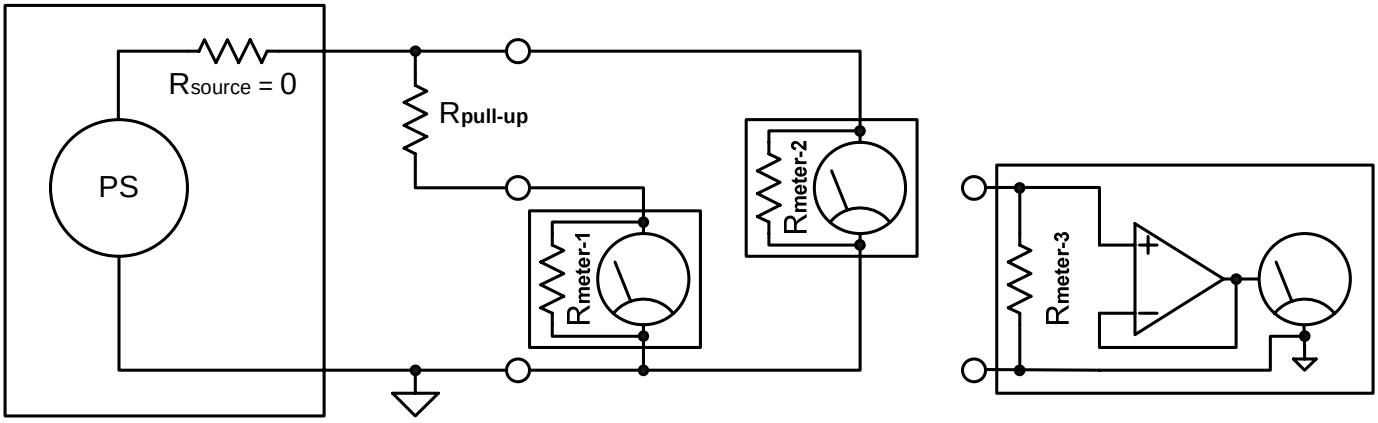
Notes on circuit test - Voltage Measurement



Notes:

1. Rsource is the output impedance of the power source, can be assumed to be nearly 0 ohms for this discussion.
2. Rmeter-1 is the input impedance of a typical measuring device: For a passive oscilloscope probe such as a TEK-P6193A, an HP 34401A bench meter or Fluke handheld DMM, ~10MegOhms is typical.
3. Rmeter-3 is the input impedance of an active probe or an op-amp connected as a voltage follower: Typical values range from 250nAmps max for a bipolar (LM358) to 25fAmps for a FET input type (LMC6482). At 3 volts of bias, the LM358 would be roughly equivalent (Worse case) to the devices in note 2. The input impedance of a FET amp, the type used in an active probe, would be on the order of 100million-MegOhms.

Discussion:

Because the impedance of the device making the measurement forms a voltage divider with the circuit under test, the reading of a voltage may or may not be the same as the actual operating point for that circuit.

A measurement using meters of almost any type at the power source (Rmeter-2) will yield measurements of good accuracy due to the low impedance of the source compared to the meter. This holds true for the output of power supplies, op-amp outputs, logic outputs etc.

For a measurement of a high impedance circuit such as a processor pull up, the input network of an op-amp circuit, a FET gate circuit etc, the input impedance for devices such as those listed in note 2 (Rmeter-1) can cause a significant division of the voltage being measured: For example, where Rpull-up is 1MegOhm and the source is 3.000vdc, the reading would be ~2.730vdc, or a 270mv error.

A FET input active probe or a good op-amp connected as a voltage follower (Rmeter-3) used in the preceding example however would have little loading effect on the circuit under test, errors here coming instead from calibration and input offset types of sources.

The effect of the measuring device on the circuit under test must always be considered and accounted for or the information gleaned from a test will have only limited value in addition to causing a distraction from the real problem. This hold true as well for tests where parasitics of the measuring device will affect the measurement: A good scope probe could be 10pF which at high frequencies could appear as a near short condition (Such as a crystal oscillator for example)!