High-Side vs Low-Side Current Sense

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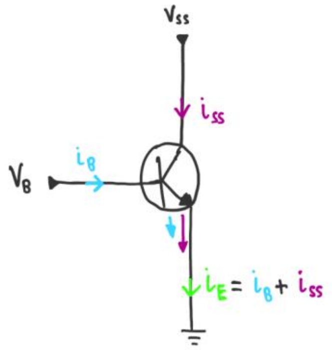
<td>
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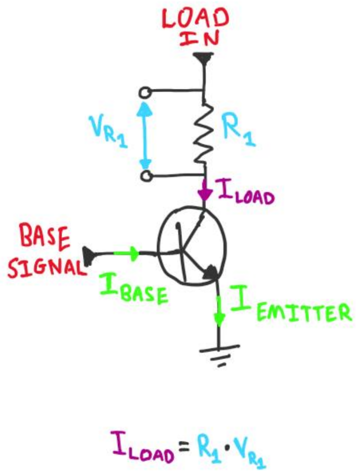
<td>
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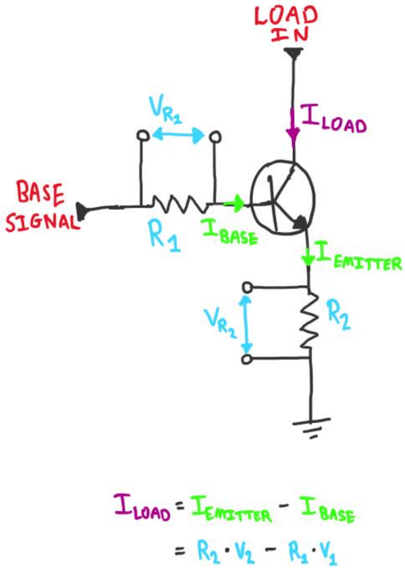
<td>
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<td>Figure 1</td>
<td>Figure 2.1
(High-side current sense)</td>
<td>Figure 2.2 (Low-side current sense)</td>
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Figure 1 is a drastically simplified diagram of the power transistors which are used to dissipate all the power in my programmable load. In my design I am planning to use **8** of these power transistors in parallel. This means that in theory they can all be treated as a single transistor, as represented by **Figure 1**. For my programmable load, it is imperative that I accurately measure the current that is coming in through V_{SS} however there is a potential problem that may need to be addressed.

Figure 1 shows the root of the problem I am referencing. If "i_{SS}" is the current that we need to measure, we need to be careful about which points we measure the current from. If a shunt is placed on the high-side between V_{SS} and the collector (**R1** in **Figure 2.1**) this shunt will measure the exact current we want with no issues. However, if a shunt was placed on the low-side between the emitter and ground (**R2** in **Figure 2.2**), the current that it measures will not be the true current flowing through i_{SS}, but will instead be $i_{SS} + i_B$. Therefore, the current is offset by the base current.

To compensate for the above problem, **Figure 2.2** demonstrates a method which involves taking current measurements from both the base and emitter of the transistor, and simply subtracting the base current from the emitter current ($i_E - i_B = i_C \equiv i_{SS}$) to get a value for the collector current, i_{SS}.

If high-side current sense is used like in **Figure 2.1**, the voltages present at the terminals of the shunt resistor will potentially reach the maximum input voltage of the load (up to 250V). This is a massive complication as it means that any differential amplifier used for the shunt will need to have a common mode voltage range larger than this maximum voltage of 250V. These differential amplifiers are extremely expensive, which is why using more complicated low-side current sense, like in **Figure 2.2**, is enticing.