Measuring high and low currents with one transducer

1 Application example measuring both high and low currents with the same transducer using a relay and two measuring resistors

When working with controlled high and low currents in, for example battery health monitoring, it is possible to adjust the working output voltage for the desired current range by utilizing a Double Pole, Double Throw (DPDT) high-quality relay.

Using two measuring resistors and coupling the resistors and output voltage with a relay, a switchable current range is possible, while still maintaining very high precision for the full current output range.

It is important to use a high precision resistor e.g. like VPG Z-foil type resistor, for the high current range (Rm1) to maintain the highest precision for the current transducer.

For the lower current range, it is still recommended to use a high precision resistor – but depending on the application requirement, it may be acceptable to use other types of resistors for the Rm2 measuring resistor. It is also recommended to implement a digital low pass filter inside the input measuring system to optimize the Signal to Noise Ratio (SNR). Choosing a cut-off frequency/bandwidth of minimum 10x the desired frequency range is recommended.

It is highly recommended to use a floating or differential input measuring unit for best performance.

Figure 1-1 show a Danisense transducer that is connected to a power supply including a GND connection. The transducer output is coupled through the measurement resistors Rm1 and Rm2 and back to the internal GND point inside the transducer.

Figure 1-2 show a Danisense transducer (like the Danisense MBC4000I) using a 3-terminal power connection scheme. The 3-terminal power connection of such a Danisense Transducer is connected to a power supply without the GND connection returning the current into the Danisense transducer. The transducer output is coupled through the measurement resistors Rm1 and Rm2 and connected to the external Power Supply GND instead, which will thereby return the transducer output current to the power supply.

When the current range of the busbar is controlled, it is possible to use a DPDT relay to control the current range of the transducer. Coupling the relay as Normally Connected (NC) to use the high current range resistor RM1 only – the transducer will be in “high current mode” as standard. When the current in the busbar reaches low current range, controlling the relay will enter the transducer current range in to “low current range” by adding Rm2 in series with Rm1 and at the same time, changing the output voltage to be connected to the correct measuring node. This ensures better resolution of the output voltage at low currents.

During the switching of the relay – the output voltage is undefined – and the input measuring unit must adapt to this. The switch time of the relay is usually documented in the datasheet of the chosen relay.

It is important to choose a high-quality relay that is rated for switching the full secondary current $I_{secondary}$ for position RL1B, but preferably one that is also capable of switching the very low measurement currents in the uA-range for position RL1A. If a single relay cannot do both – it is possible to use two relays with different properties specialized for each switching purpose.

If a high busbar current is applied while in “low current mode” – the Rm2 measuring resistor and input measuring unit may be damaged if not designed for the high current and higher output voltage. Furthermore, the transducer will saturate and enter protection. Current measurements will be incorrect until the high busbar current is removed, and the current transducer has reached normal operation again.

1.1 Calculation example for Danisense MBC4000I current transducer

From the datasheet it can is found that the Primary / Secondary ratio k = 5000. Using this number for the calculations results in the following:

High current output 0A to 4000A:

Using the recommended nominal measuring resistor of 1.25Ω stated in the datasheet.

$V_{out} = I_{secondary}$ x Rm1 = $I_{primary}/k$ x Rm1 = $4000A_{rms}/5000$ x 1.25Ω = $1.0V_{rms}$

Low current output 0A to 50A:

Assuming that the chosen low current range is $I_{primary} = 50A_{rms}$ and the input measuring system has a range of $\pm 5V_{rms}$.

The wish is to utilize most of the input measuring system resolution of $\pm 5V_{rms}$. Finding the highest value resistor for the application can be done by:

$V_{out} = I_{secondary}$ x (Rm1+Rm2)

(Rm1 + Rm2) = $V_{out} / I_{secondary} = V_{out} / (I_{primary}/k) = 5V_{rms} / (50_{Arms} / 5000)$ = 500Ω

This means that Rm2 = 500Ω - Rm1 = 500Ω - 1.25Ω = 498.75Ω

Choosing an Rm2 resistor from the standard E24-value resistor of 470Ω, leads to the best compromise between using the E24-value resistor range and staying within the measuring system $\pm 5V_{rms}$ voltage input range:

$V_{out} = I_{secondary}$ x (Rm1+Rm2) = $(50A_{rms} / 5000)$ x (1.25Ω + 470Ω) = $4.7125V_{rms}$

Note:
When measuring low current range and using a high value resistor Rm2, the transducer bandwidth will be affected.

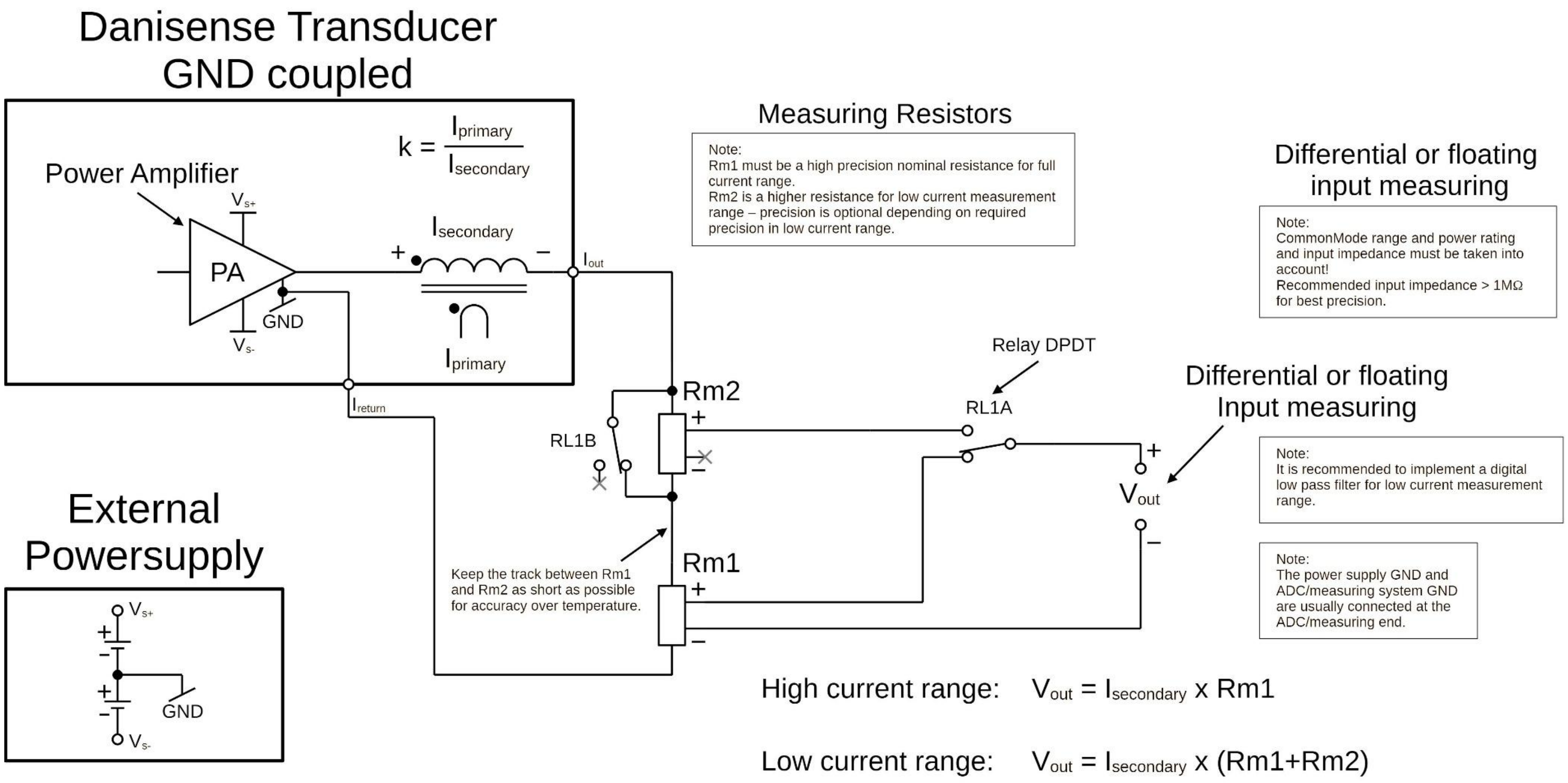

Figure 1-1 High and Low current range using two measuring resistors with a standard GND-coupled Danisense Transducer

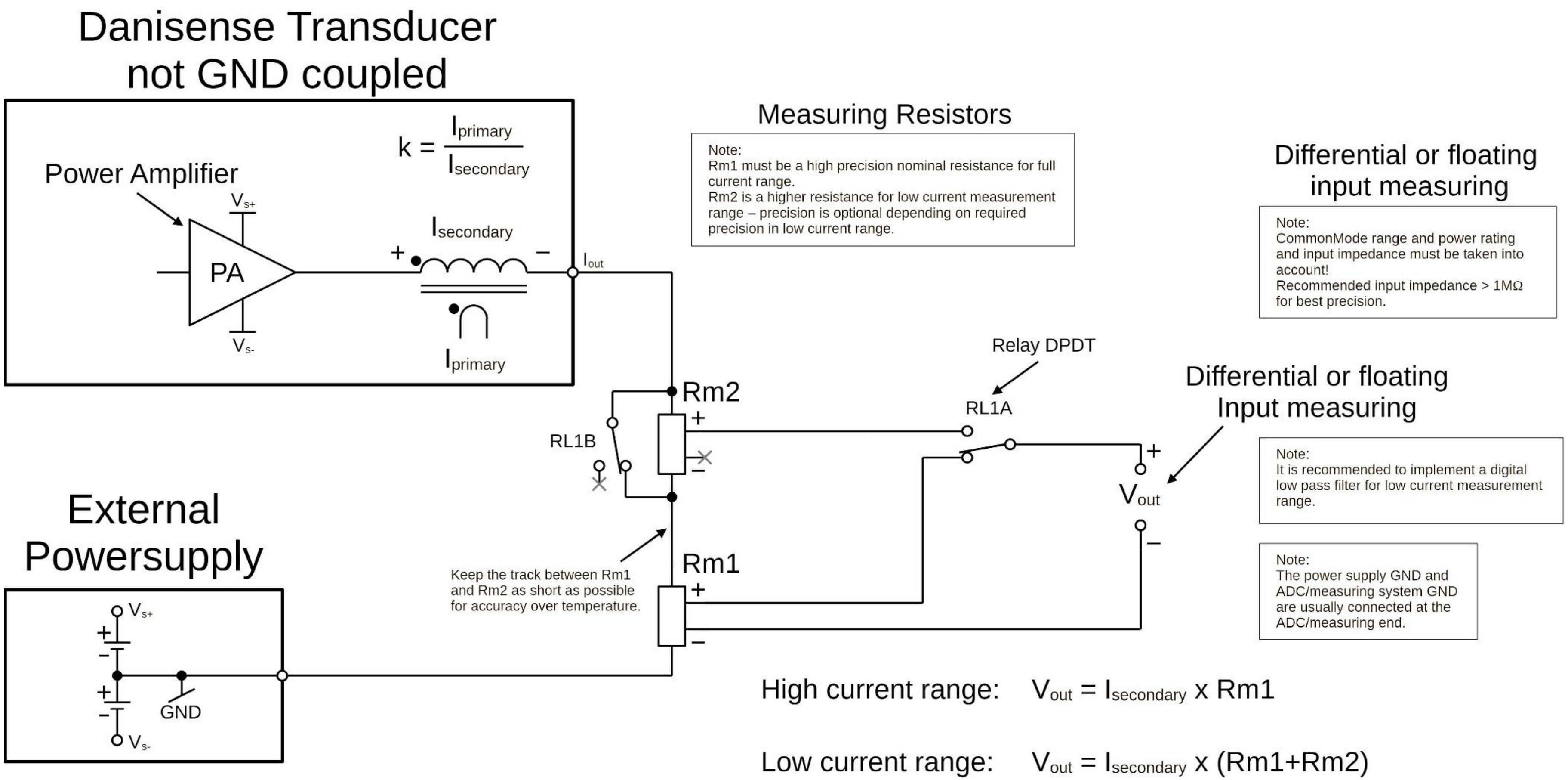

Figure 1-2 High and Low current range using two measuring resistors with a not GND-coupled Danisense Transducer