Application Note: Replacing Shunts with Danisense Current Transducers for Calibration Systems

Benefits of one Current Transducer to several Shunts of different current ranges for improved current measurement resolution and accuracy

Common-mode Signal Rejection

The current transducer electrically isolates the primary circuit from the measurement circuit to directly avoid interference from the "common-mode" voltage ripple and noise on the primary current. A reasonable assumption is ripple and noise of 50mV peak with a range of frequencies. With a 50mV shunt, the 50mV maximum signal across the shunt will have this common-mode "noise" of approximately +/-50mV superposed on the shunt signal. If the desired resolution is 0.1% of full scale, then the DAQ must reject this common-mode signal to better than 50uV. This specification is typically given for a high performance DAQ as the "common-mode rejection ratio". For this example, the "CMRR" must be better than 1000.

Much higher output signal

The relative contribution from cable pickup and DAQ noise is much lower with a current transducer than a shunt. As an example, using a Danisense DCCT:

DL2000UB-10V	Current Transducer, 1.4kArms/±2kA DC, 7.07Vrms/±10V Signal (5mV/A), DSUB Power, BNC Signal

With a +/-10V output signal at +/-2000A and +/-5mV/A Sensitivity, this Transducer would give a signal of +/-250mV at +/-50A primary current. Even for a +/-50A primary current the signal from the current transducer is 5x the signal from the 50A shunt to give at least 5x better S/N.

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Much Lower Insertion Impedance reduces power dissipation and improves short- and long-term stability

A shunt matched to give 50mV at 1500A primary current has a power dissipation of 75W. For the same shunt with a primary current of 50A and 1.67mV output signal the power dissipation is 0.83W, down by a factor of ~ 100. To achieve high measurement stability and repeatability requires a very low temperature coefficient for the shunt. Even so, the sensitivity in V/A will be different at low current (low power dissipation) than at maximum rated current (maximum power dissipation). The effective insertion impedance of the **DL2000UB-10V** current transducer is <0.5uohm and the effective power dissipation in the primary circuit at 1500A is <1W, down by a factor of 100 from that for the 50mV shunt.

High Signal/Noise even at a primary current of 5A

For a 5A primary current the output signal is 5*5mV/A =25mV, 5x higher than 5mV at 5A from a 50A, 50mV shunt. To resolve this to better than 1A requires a DVM or DAQ with better than 5mV resolution for 10V full scale or 2000ppm digital resolution. A 5 1/2 Digital or better DVM is adequate with the low pass frequency set to <100Hz and a 60Hz notch filter to reduce high frequency and 60Hz pickup. The transducer noise in the frequency range dc to 100Hz is <0.02ppm rms of full-scale or about 0.12ppm p-p, or 1.2uV p-p equivalent to about 0.25mA p-p, much lower than the desired 1A resolution. For a shunt having 5x lower signal than from this current transducer, the demand on the DAQ or DVM for resolution and noise are 5x more stringent to achieve equivalent performance.

Attached:

Standard GMW Calibrations of a +/-1V and +/-10V current transducer.

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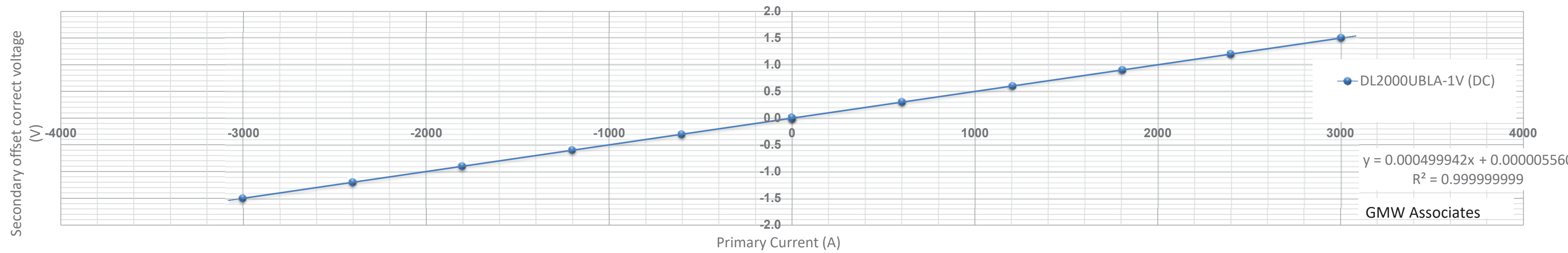
Test Results:

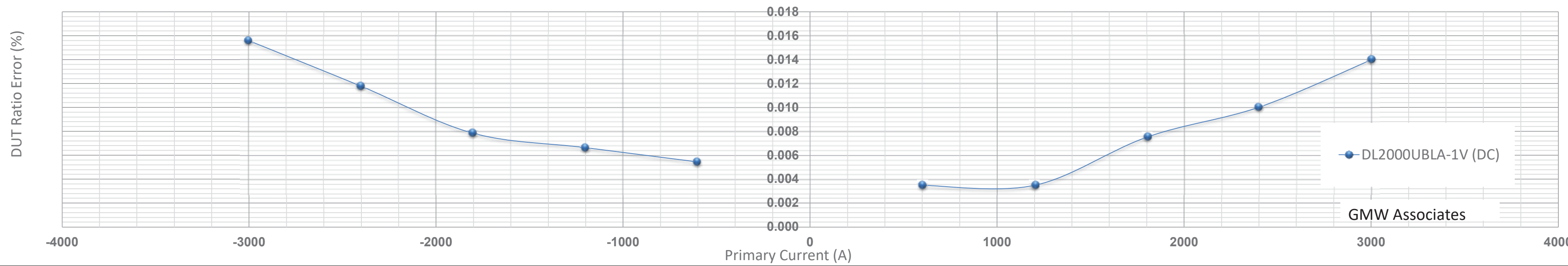
DUT DC zero offset: 4.673E-07 **V**

REF DC zero offset: -1.160E-06 **A**

REF primary current Norminal (A)	REF secondary current (A)	REF primary (*) current (A)	DUT secondary voltage (V)	DUT secondary offset correct voltage (V)	DUT Ratio (A/V)	DUT Ratio Error (%)	DUT Ratio Error Meas Unc (%)
0.000	0.000	-0.001	0.000	0.000			
-600.000	-0.134	-601.813	-0.301	-0.301	2000.11	0.0054	0.11
-1200.000	-0.267	-1200.961	-0.600	-0.600	2000.13	0.0066	0.10
-1800.000	-0.401	-1803.433	-0.902	-0.902	2000.16	0.0079	0.10
-2400.000	-0.534	-2401.144	-1.200	-1.200	2000.24	0.0118	0.10
-3000.000	-0.668	-3004.000	-1.502	-1.502	2000.31	0.0156	0.10
0.000	0.000	-0.021	0.000	0.000			
600.000	0.134	602.183	0.301	0.301	2000.07	0.0035	0.11
1200.000	0.267	1201.241	0.601	0.601	2000.07	0.0035	0.10
1800.000	0.401	1803.665	0.902	0.902	2000.15	0.0075	0.10
2400.000	0.534	2401.220	1.200	1.200	2000.20	0.0100	0.10
3000.000	0.668	3003.920	1.502	1.502	2000.28	0.0140	0.10
0.000	0.000	0.022	0.000	0.000			

Test Frequency DC





Note: All ratio errors are referenced to nominal secondary current & "as left" data is the same as "as found" data.

* with turns if applicable

GMW Associates

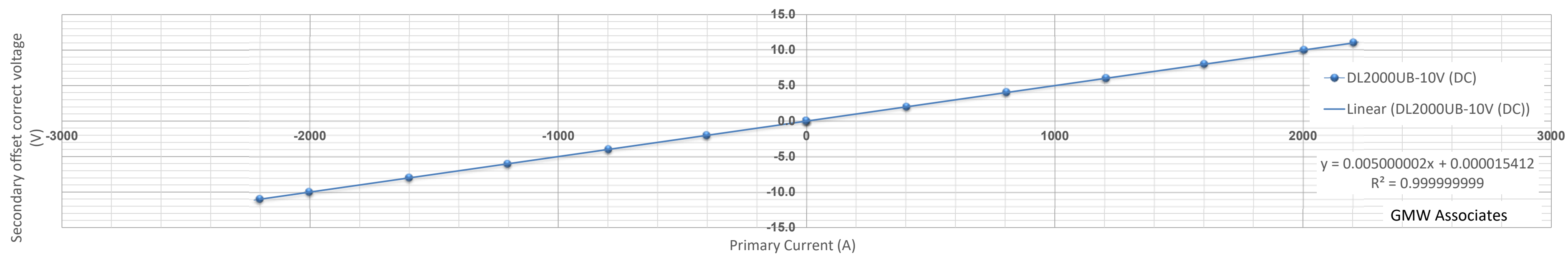
Test Results:

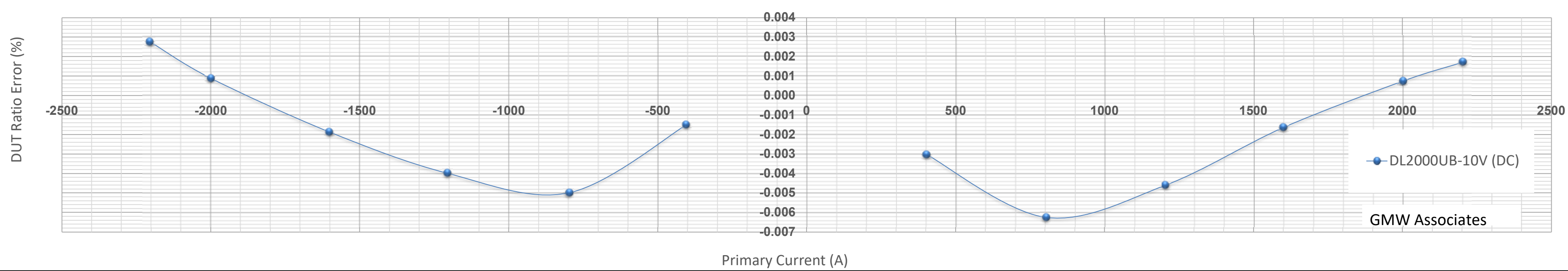
DUT DC zero offset: 4.098E-05 **V**

REF DC zero offset: -1.582E-07 **A**

REF primary current Nominal (A)	REF secondary current (A)	REF primary (*) current (A)	DUT secondary voltage (V)	DUT secondary offset correct voltage (V)	DUT Ratio (A/V)	DUT Ratio Error (%)	DUT Ratio Error Meas Unc (%)
0.000	0.000	-0.001	0.000	0.000			
-400.000	-0.090	-402.963	-2.015	-2.015	200.00	-0.001	0.10
-800.000	-0.178	-798.886	-3.995	-3.995	199.99	-0.005	0.10
-1200.000	-0.268	-1205.690	-6.029	-6.029	199.99	-0.004	0.10
-1600.000	-0.356	-1601.358	-8.007	-8.007	200.00	-0.002	0.10
-2000.000	-0.445	-2001.646	-10.008	-10.008	200.00	0.001	0.10
-2200.000	-0.490	-2203.869	-11.019	-11.019	200.01	0.003	0.10
0.000	0.000	-0.010	0.000	0.000			
400.000	0.090	403.073	2.015	2.015	199.99	-0.003	0.10
800.000	0.179	803.391	4.017	4.017	199.99	-0.006	0.10
1200.000	0.268	1205.527	6.028	6.028	199.99	-0.005	0.10
1600.000	0.356	1601.306	8.007	8.007	200.00	-0.002	0.10
2000.000	0.445	2001.357	10.007	10.007	200.00	0.001	0.10
2200.000	0.490	2203.430	11.017	11.017	200.00	0.002	0.10
0.000	0.000	0.011	0.000	0.000			

Test Frequency DC





Note: All ratio errors are referenced to nominal secondary current & "as left" data is the same as "as found" data.

* with turns if applicable