Application Note:
DCCT with calibration windings

ULTRA-STABLE HIGH PRECISION CURRENT TRANSDUCERS

- INTEGRATED BODY: DS, DM and DL SERIES

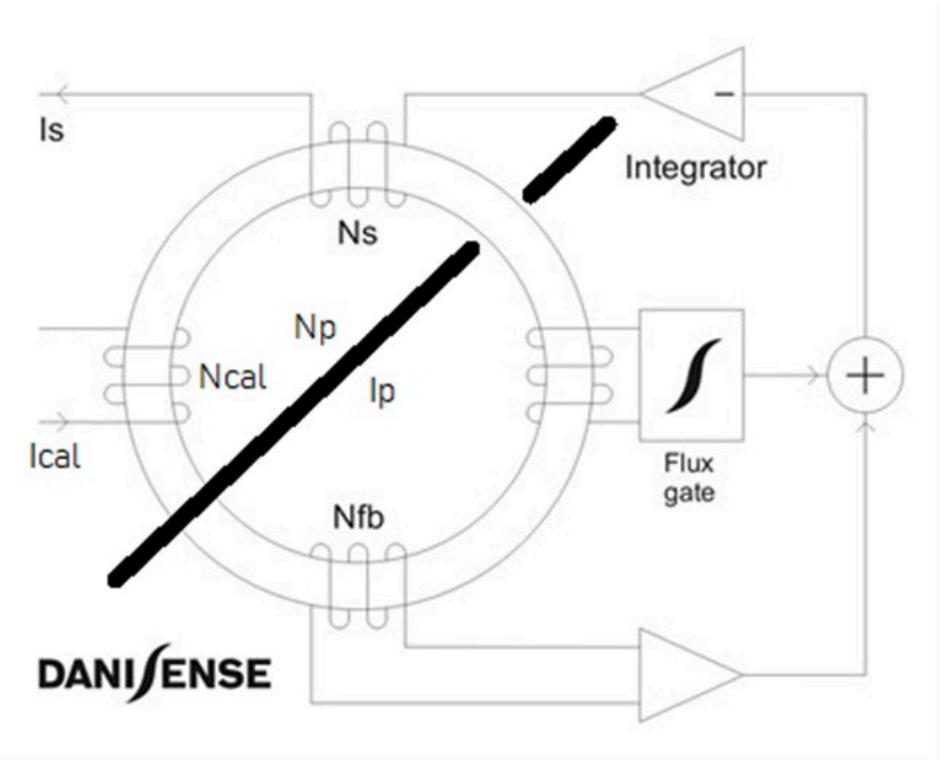
Version 1.1

Precision - Innovation

Introduction

At Danisense we are designing and manufacturing high-precision DCCT current transducers based on the Flux-gate principle, used for measuring wide range of DC and AC currents in demanding applications.

The high level of accuracy is achieved by closed-loop operation as shown on the diagram below, where advanced electronics feeds a secondary current Is through the compensation winding Ns to compensate for the magnetic flux of the measured current Ip flowing through the primary busbar Np in order to achieve zero-flux operation. The secondary current Is is therefore representative of the primary current Ip scaled-down by the ratio of the number of turns in the primary busbar and the secondary winding (Is=Ip*Np/Ns).



There are certain current measurement applications where it is important to check the proper functioning of the DCCT without applying any primary current, due to e.g. safety concerns, system control issues, necessity of performing system selftest before energizing the plant etc. Another range of applications demands extremely high accuracy so that re-calibration of the DCCT is required before performing every single test / experiment without removing the transducer from the test setup and without the ability of applying accurately known full-scale primary current. In both situations the problem can be solved by introducing a so called “calibration winding” Ncal, where a well known and low calibration current Ical can be injected to create magnetic flux that accurately resembles the magnetic flux created by the primary Ampere-turns Ip*Np and generates secondary current Is=Ical*Ncal/Ns.

In the following chapters we are going to discuss all the application details and our recommendations when using DCCTs with calibration winding.

Description

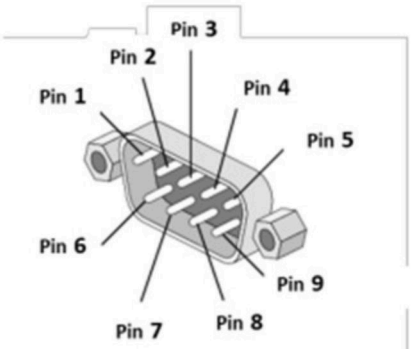
A calibration winding is a primary winding that can be useful for testing and calibration of a current transducer without applying nominal primary current. This is because the calibration current is much smaller than the busbar current.

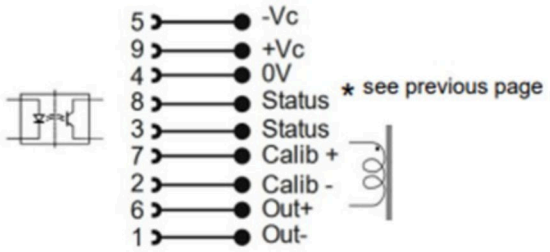
The number of turns in the calibration winding is typically in the range of 100 to 3000. The calibration current is calculated as the desired primary current divided by the number of turns in the calibration winding. The transducer can be tested and calibrated without dismounting it from the test and measurement setup.

DCCT versions with calibration winding are also described in Danisense Product Manual (https://www.danisense.com/documentation/application-notes) in chapter 2.3.2.1.2, which is presented in its entirety below:

2.3.2.1.2 Version with calibration winding

For some applications, it's preferable to perform a prior functional / accuracy check of the device at full scale or a fraction of full scale before apllying the power. For that purpose, a primary winding, most commonly of 100 turns or 1000 turns is added. The terminals of this winding are available at pin 2 and 7 of the DSUB9 connector (e.g. DS200ID-CD1000) as shown below





It's also possible to have the terminal of the calibration winding on a separate BNC connector (e.g. DS200ID-CB1000). For this version, the electrical connection is similar to the volage output model in the following section.

Thin wire are used for the test winding due to space restriction. Please observe the current limit for the test winding, specified in the relevant datasheet to avoid damage to the wire.

Handling advices for DCCTs with built-in Calibration winding

1. Driving source

The driving source must be a constant current generator with a high output impedance, not only at DC but also at higher frequencies. When loaded with a low resistance, the calibration winding will react as a magnetic shorting of the transducer head which can lead to oscillations. The problem gets worse with increased numbers of turns.

If the current source itself does not have sufficient impedance, a resistor and / or an inductor can be put in series with the output. The resistor should typically be in the range of 10 to 100 ohm. An inductor must have the same impedance at approx. 1kHz. Values must be determined for different applications. The driving source must be able to handle high inductive loads.

After calibration both terminations of the calibration winding must be disconnected, leaving the winding floating. This is to avoid any disturbances that can influence the transducers precision during normal operation. It also protects the driving source from being disturbed or destroyed from potential voltage spikes originating from the calibration winding.

2. Limited bandwidth of transducer

Users of transducers with calibration windings must be aware that they have a reduced bandwidth compared to the same type of transducer without calibration windings. This is because of the stray capacitances between windings, even with open ends and these capacitors lead to false currents that disturb the frequency response. The higher number of turns, the lower bandwidth. Examples:

The DS200-CD100 has a bandwidth of a bit more than 1 MHz, almost the same as a DS200ID

The DS200-CD600 has a bandwidth of approx. 100 kHz

The DM1200-CD3000 has a bandwidth of approx. 10 kHz where the DM1200ID has 400 kHz

The figures are only indicative and very dependent on how precise the windings are made.

See last page for Frequency Response examples of various transducers with calibration windings.

3. Calibration without removing DCCT from the busbar

A big advantage with using calibration windings is that the transducer can be calibrated on site, meaning it does not have to be dismounted, which can be very troublesome and time consuming in some cases.

Make sure that no current is running in the primary busbar during this on-site calibration process. Some power supplies have certain leakage current, even when they are shut down.

4. Loading the transducer

Since the calibration winding is an extra winding that consumes the same amount of power as the secondary winding, the transducer will be warmer during calibration than during normal operation.

This may result in a slightly worse linearity error than if the primary current came from the busbar.

Opposite to that, the linearity error can be lower by using the calibration winding if the busbar is not ideally placed in the center hole.

Existing range of Danisense DCCTs with calibration winding

Danisense offers a range of transducers with calibration winding available in the DSUB connector and used with DSSIU-6-1U. The range consist of the following products:

• DS200ID-CD100
  100 turns, 400mA continuous current - Equivalent primary current +/- 40A

• DS200ID-CD1000
  1000 turns, 300mA continuous current - Equivalent primary current +/- 300A

• DS600ID-CD100
  100 turns, 400mA continuous current - Equivalent primary current +/- 40A

• DM1200ID-CD3000
  3000 turns, 500mA continuous current - Equivalent primary current +/- 1500A

• DL2000ID-CD100
  100 turns, 400mA continuous current - Equivalent primary current +/- 40A

Note: The DM1200ID-CD3000 should not be used for applications where AC currents with higher frequency than 1kHz need to be measured accurately, due to limited measurement bandwidth.

All transducers marked with red text can be full scale calibrated.

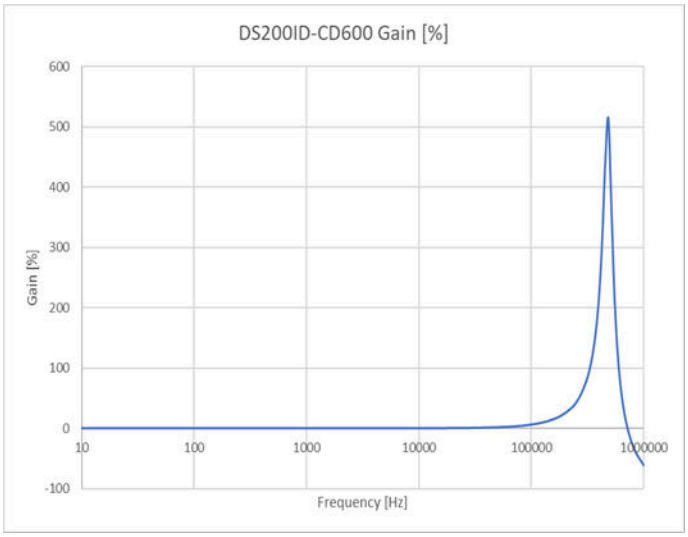
All above transducers do work with the DSSIU-6-1U, and the calibration current can be individually applied via the yellow 4mm banana plugs on the rear side. By putting the windings in series, up to six DCCT's can be calibrated at the same time with the same current.

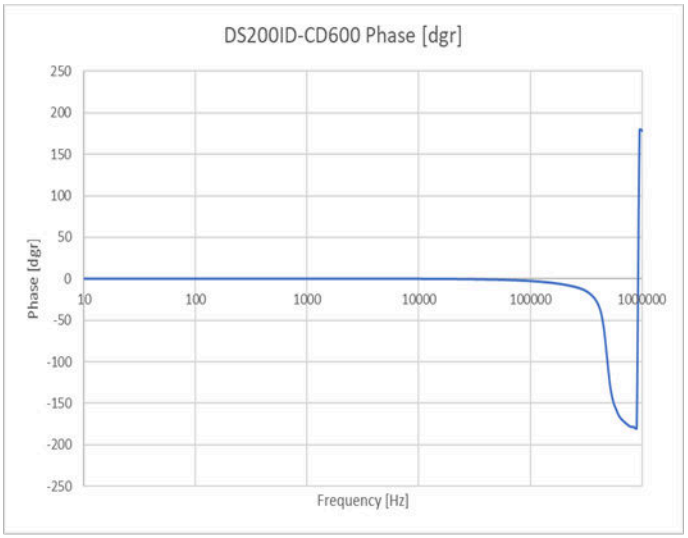
In addition to the list of transducers with calibration winding available in the DSUB connector, the following one has the calibration winding available in a BNC plug:

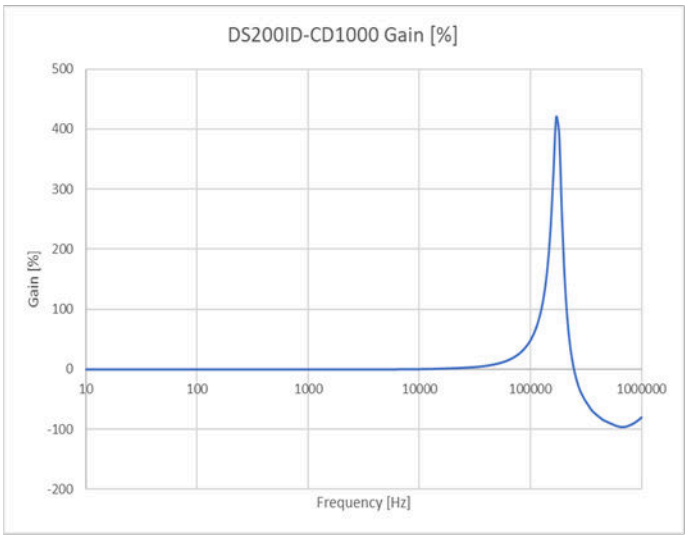
• DL2000ID-CB100

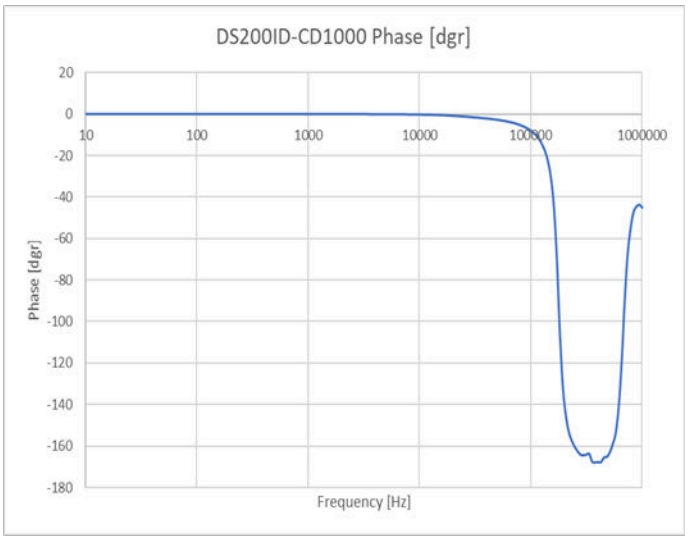
100 turns, 400mA continuous current - Equivalent primary current +/- 40A

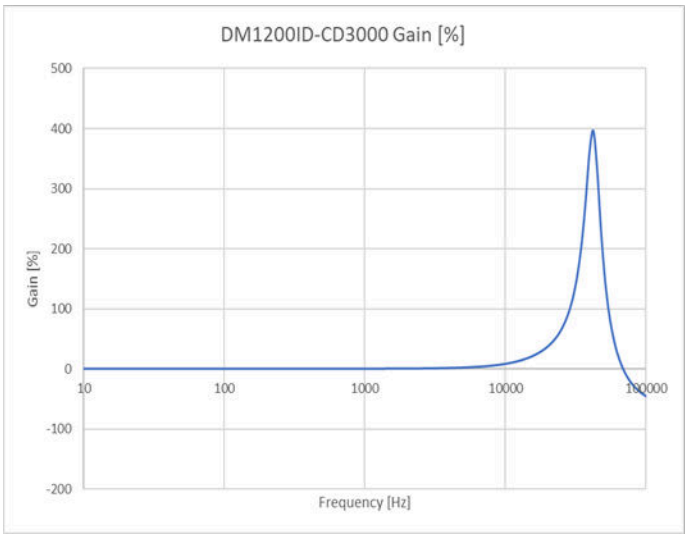
Frequency Response examples for various transducers with calibration windings

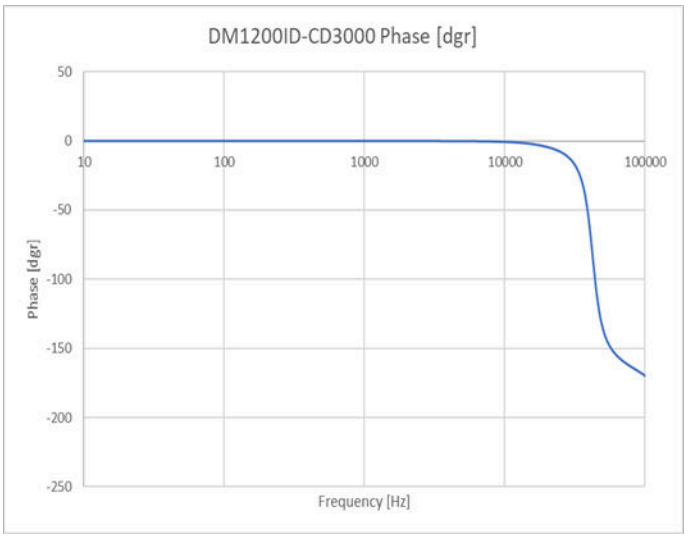












Malervej 10 DK-2630
Taastrup Denmark
Tel: +45 3510 2373
Email: info@danisense.com