

Application Note

DECS-250: Using Line Drop Compensation

In most generator applications, the unit is interconnected through a step-up transformer to the system inertia. Because of its internal impedance, the generator step-up transformer provides the system with an inherent droop characteristic. These transformers introduce a voltage drop into the system which increases proportionally to an increase in reactive current. Because of this, these systems can be set up with little or no droop. However, in some cases, this voltage drop may be greater than desired and may be exacerbated by further deviations in reactive load. Using a digital regulator, the system can adjust using line-drop compensation. Line drop compensation works by regulating to a point other than the generator's output, and usually somewhere into the generator step-up transformer. Equation 1 illustrates the formula for calculating the line drop value.

$$V_{LD} = \sqrt{(V_{avg} - (LD * I_{avg} * \cos(\angle I_b)))^2 + (LD * I_{avg} * \sin(\angle I_b))^2}$$

Equation 1: Line Drop Compensation Calculation

- V_{LD} is the per-unit value of the line drop compensated voltage
- V_{avg} is the per-unit metered voltage
- LD is the line drop scalar, which is the line drop setting divided by 100
- I_{avg} is the per-unit metered current
- I_b is the B-phase current angle in degrees

In some applications, there may be more concern about maintaining the line voltage and eliminating most of the impedance. In other applications, there may be concern about the load and maintaining maximum reactive power support for voltage weak systems. For the example below, maintaining the reactive power is desired, so the system is set up to remove only a small percentage of the transformer's impedance. In Figure 1, the transformer has a typical impedance of 10% with a 30 MVA rating and the generator has a rating of 20 MVA. The first step is to calculate the impedance as seen from the generator. This is shown in Equation 2.

$$Z_{Transformer} = (20 \text{ MVA} / 30 \text{ MVA}) * 10\% = 6.66\% \text{ on the generator}$$

Equation 2: Impedance Transformation Calculation

If the digital voltage regulator (DECS-250) has too much line drop compensation, the advantage of utilizing the step-up transformer is lost and the system may exhibit poor sharing, and the reactive power would drift over time. However, depending upon the application, the opposite may be true where reactive power support is strong but the system has too much terminal voltage deviation, leading to a different type of instability. When following the guidelines provided here, it is important to recognize that the results obtained will be dependent upon the system application and connections. A good approximation is to

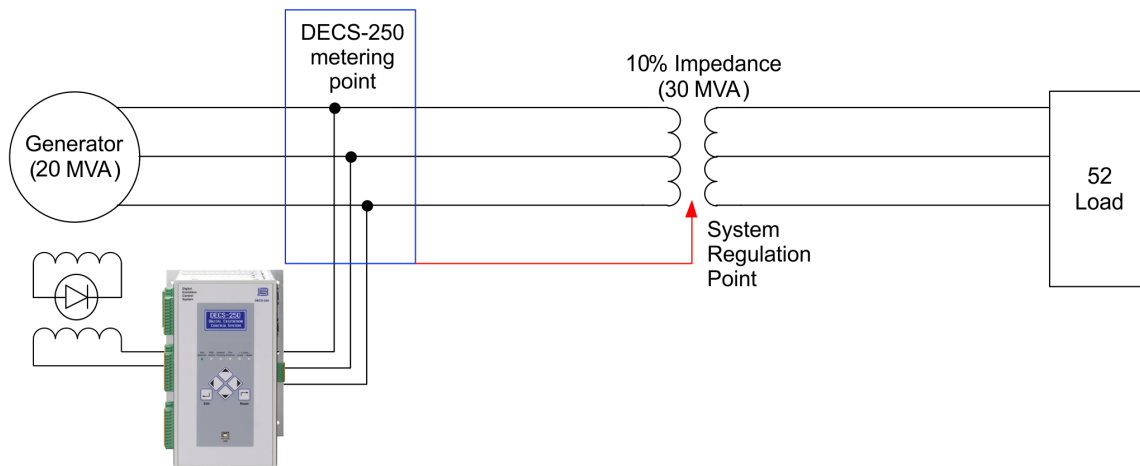


Figure 2 - Line Drop Compensation Setting

use half of the impedance seen by the generator as the line drop compensation setpoint while having the proper precautions and protections in place. So from Equation 2, the line drop compensation setpoint would be 3.33%. In this example, we would use a more conservative setting of 3% (Figure 2), or slightly less than half of the observed generator-side impedance.

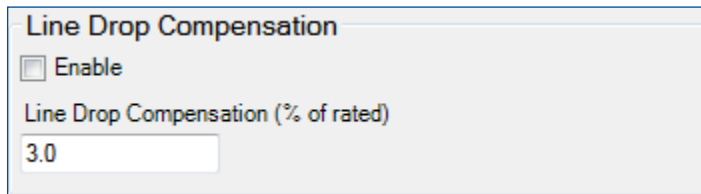


Figure 2: Line Drop Compensation Setting

By utilizing a 3% line drop compensation setting, Equation 1, and the assumption that the system is at unity

power factor, the new per-unit voltage setpoint can be calculated. This is achieved by plugging the variables into the equation which results in a setpoint of 1.00045. Then, the setpoint needs to be converted to primary units. The generator's nominal voltage is 13,800 Vac; therefore, the compensated setpoint in the DECS-250 would be 13,806 Vac. This would also allow the system to retain around a 3.66% droop characteristic. While any given application may be different, this note provides basic guidelines for applying line drop compensation.

For more information

For additional information on DECS-250 Digital Excitation Control System, including more application notes, product bulletins and instruction manuals, go to www.basler.com, contact your Application Engineer, or contact Technical Support at +1 618.654.2341.