

Application Note

Comparison of Network Load Sharing and Cross-Current Compensation

Many applications where generators are tied together on a bus need to be capable of sharing reactive power with each other. Without such a system in place, problems could arise with balancing loads and one generator motoring the other. In the past, the two solutions to this problem were reactive Droop and reactive Cross-Current Compensation (CCC). The DECS-150, DECS-250, DECS-250N, DECS-250E, and DECS-450 improve on the traditional cross-current compensation loop by removing the extra hardware associated with it, such as the burden resistor and wires running between machines. The method that allows for these improvements is known as Network Load Sharing (NLS). NLS uses Ethernet communication and a dedicated communications network instead of traditional wiring. With traditional wiring in CCC, the distance between two units is limited because of wiring impedance, but the distance in an NLS setup is almost unlimited with the use of Ethernet switches and repeaters. This is highly advantageous for marine applications. For example, one generator may be located in the bow of the vessel while the other is in the stern, and that long distance would cause problems for a CCC-type system. In addition to the removal of distance limits, Ethernet can reduce the susceptibility of the system to noise that could be picked up on otherwise unshielded wiring.

NLS was designed to deliver better performance than traditional reactive CCC loops. Tables 1 and 2 compare the two load-sharing methods on 75 kW and 100 kW generators. The results show that NLS generators have superior response and sharing capabilities because NLS is more accurate with the amount of vars on each system. The data shows that the percentages of error attributed to differences in reactive power on each generator are much lower in the NLS setup. The NLS generators can be more precise since they share based on each of the individual machine's ratings and not the CT ratios. By basing calculations on the individual machine ratings, a generator in NLS always takes on the same relative amount of load, whereas generators in CCC adjust excitation based on the voltage seen across the burden resistors. In the case where the CT ratios are not identical,

Table 1. Shared Vars in Cross-Current Compensation

CCC Data					
Reactive/Real Loads at 240 Vac	50/50 Split (w/o losses)	kvar on 100 kW Generator	kvar on 75 kW Generator	Differential	Error
75 kW/25 kvar	9.3875	7.42	10.2	2.78	2.96%
75 kW/50 kvar	18.775	16.5	18.7	2.2	2.3%
75 kW/75 kvar	28.1625	26.1	27.5	1.4	1.49%
100 kW/75 kvar	28.1625	26.15	27.5	1.35	1.4%
35 kW/25 kvar	9.3875	7.5	9.44	1.94	2.0%

Table 2. Shared Vars in Network Load Sharing

NLS Data					
Reactive/Real Loads at 240 Vac	50/50 Split (w/o losses)	kvar on 100 kW Generator	kvar on 75 kW Generator	Differential	Error
75 kW/25 kvar	9.3875	8.2	8.9	0.7	0.74%
75 kW/50 kvar	18.775	17.5	18	0.5	0.53%
75 kW/75 kvar	28.1625	26.5	26.8	0.3	0.32%
100 kW/75 kvar	28.1625	26.5	27.1	0.6	0.64%
35 kW/25 kvar	9.3875	8.2	8.7	0.5	0.5%

Note: The tables show some losses because of line drop between generators and because the load bank is rated for 240 Vac and these machines were operated at 208 Vac.

there is a difference in the burden resistor's voltage proportional to the difference in the ratios, leading to some constant error in the sharing between generators.

A common concern with using communications for load sharing is how a unit will perform if, for example, another unit in the communications circuit fails or communications are lost. If this does happen, the DECS reverts to the programmed NLS Droop until normal communications are restored or until the malfunctioning unit is removed properly (e.g. Unit ID is disabled on the other units). This is essentially the same action that an analog regulator takes if connection of the cross-current loop opens.

NLS also allows users to configure the DECS for unique applications such as ring bus systems or selective island configurations. The settings for NLS are relatively easy to configure, and a typical implementation is as follows. The settings and logic that follow demonstrate ring bus functionality in one of several possible ways. In Figure 1, the majority of the relevant settings for the load sharing capabilities are shown and the remaining logic elements are not shown. Load sharing is enabled by selecting the Enable checkbox and entering settings for the gain and droop percentages. For NLS, the droop setting governs how the DECS reacts during transients while var sharing. The other setting of concern is the gain, which should be adjusted based on the system.

Figure 1: Load Share Settings (Found under Settings Explorer->Operating Settings->Parallel/Line Drop Compensation)

If the gain remains at zero, the unit may not share well, so the gain setting should be corrected before attempting to load share.

When configuring NLS, it is important to ensure that the DECS IP addresses are assigned via BESTCOMSPi^{us}®, by choosing Communication and then Configure.

Then, devices are given a Load Share ID, which can determine which other machines are online and communicating. Then, machines communicate their rated vars and determine how much each unit should carry to maintain an even percentage split across the units.

For instance, if a system has a ring bus setup similar to that shown in Figure 2, the logic in each DECS unit may be configured so that they can be individually enabled or disabled based on the status of the tie and bus breakers.

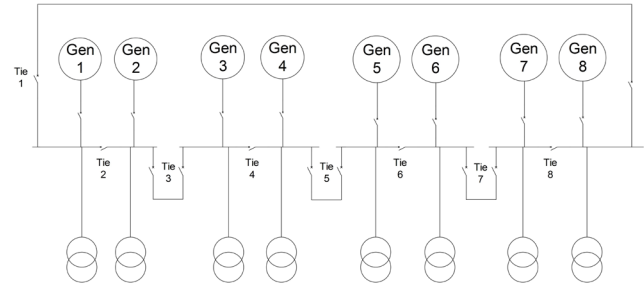


Figure 2: Reconfigurable Bus Example

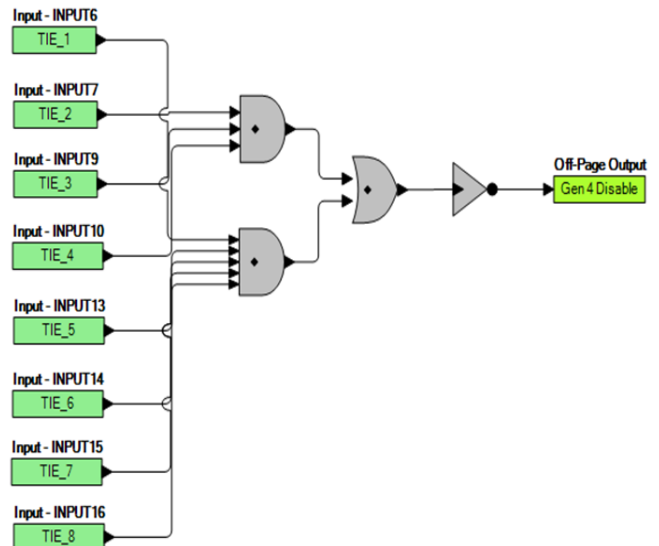
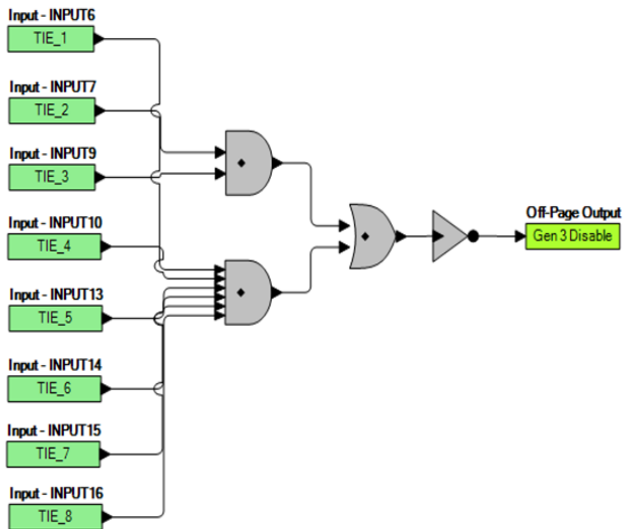
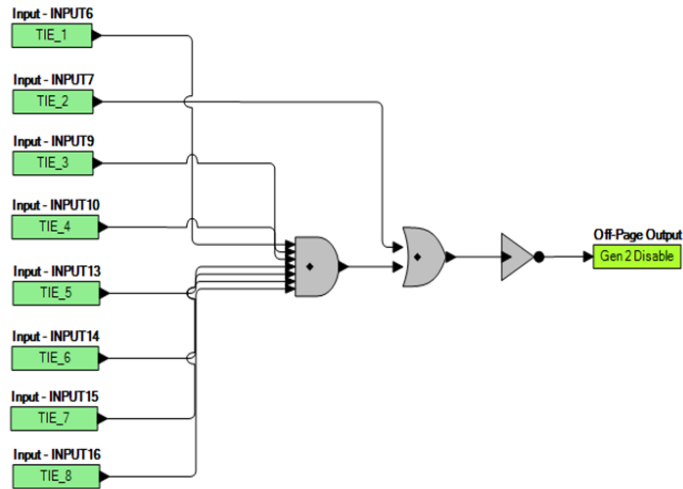
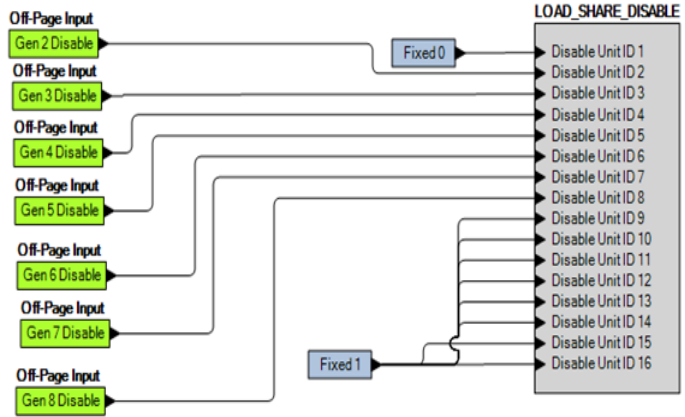
This also allows the system to disconnect single units or groups of generators at a time. If the system needs to disconnect the first bus from the other three, this is achieved by disabling Gen 1 and Gen 2 for the DECS units on Gen 3 through Gen 8, while disabling all of the other generators on Gen 1 and Gen 2. This leaves Gens 1 and 2 sharing on their own system, while Gens 3 through 8 continue to share on theirs. Units can be disabled through Modbus® or through contact inputs, and custom logic in BESTlogic™Plus as illustrated in Figure 3.

In addition to the logic in Figure 3, the DECS can utilize expected IDs. The expected IDs address single-point failures by allowing each DECS to communicate on the network. If the DECS does not see a Unit ID which has not been disabled via settings, logic or Modbus, it continues to share in NLS or reverts to droop depending on how the unit was set. If something occurs, like an Ethernet cable becoming unplugged on Gen 3, all of the other generators will suddenly lose sight of Gen 3 on the network without the Unit ID being disabled. Then, depending on the system's configuration, the other seven generators could continue operating in NLS or revert to droop.

The test results prove that the NLS has a significant advantage over traditional CCC system setups. NLS provides better system response, more accurate load sharing capabilities, and flexibility while eliminating wiring and hardware associated with traditional CCC systems. The results also conclude that the NLS system is robust and will offer secure operation in the event that the communications between DECS units is lost or disrupted.

For more information

Visit Basler Electric's website at www.basler.com, where you will find product information, bulletins, and application notes about the DECS-150, DECS-250, DECS-250N, DECS-250E, and DECS-450.



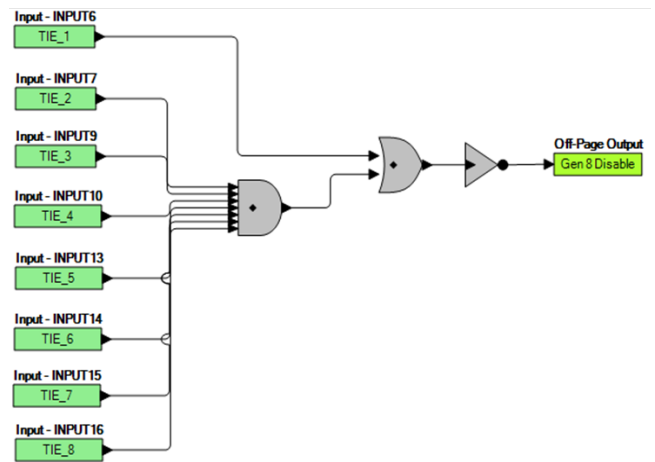
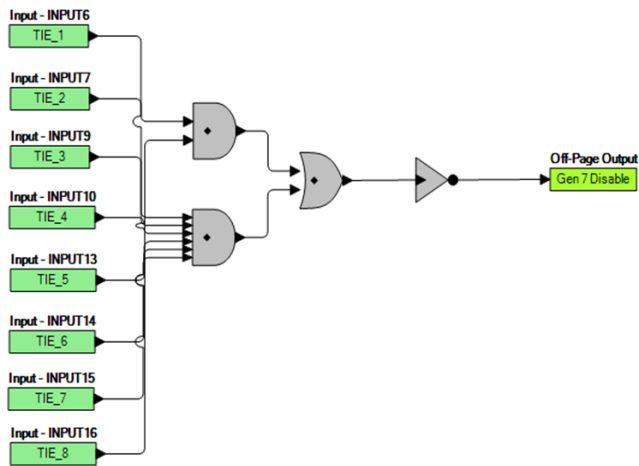
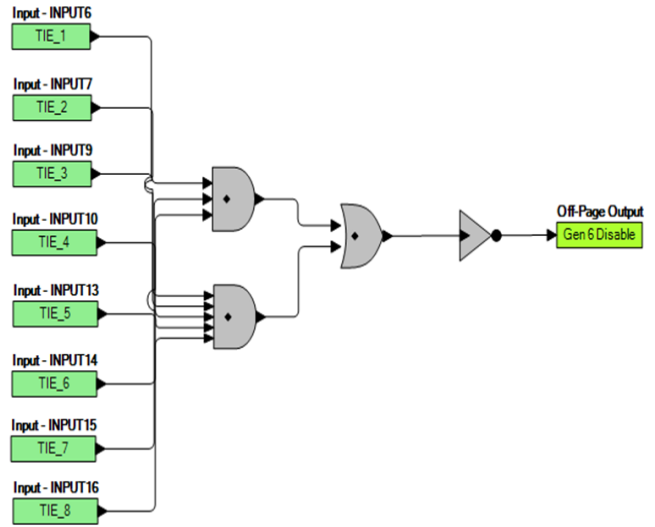
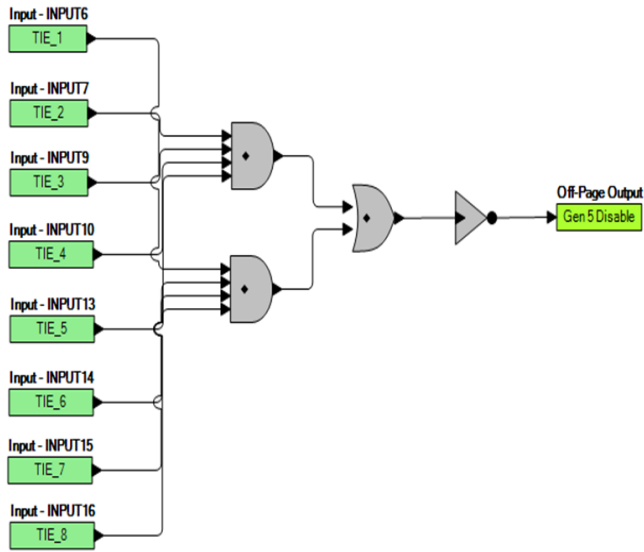


Figure 3: Example logic for Generator 1