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Application Note

Improving On-Site Power Reliability with Redundant Communications

Mission critical operations depend heavily on a continuous quality supply of electricity to stay in business. Any power disruption is a huge cost to consumers and can create unsafe situations. When losing power is not an option, mission critical operations need to rely on dependable on-site power that is automated to eliminate delays and operational errors.

A reliable communications network is key to ensuring power security. Modern on-site power systems are managed by advanced digital controllers in a distributed control system. In any given power system, multiple DGC-2020HDs in a network communicate with each other on a peer-to-peer level. This architecture avoids the risk of a total system failure.

When communication is lost to a DGC-2020HD controller, network driven activities supported by that specific controller such as load sharing and generator sequencing may be lost, while the rest of the system continues to function normally. To mitigate against loss of communication, the Basler DGC-2020HD is equipped with redundant Ethernet communications capability.

When style number xxxxDxxxx for dual copper Ethernet is selected, the DGC-2020HD offers two Ethernet ports than can be configured for redundant failover mode. This mode causes the DGC-2020HD to automatically switch between one physical Ethernet port or the other when a port is determined to be unhealthy. Only one Ethernet port on the DGC-2020HD will be active at a time. The DGC-2020HD attempts to switch over in a seamless manner. Each port will share the same IP address, default gateway, and subnet mask. The same MAC address will be provided on each port so as not to interfere with switches or routers. For all intents and purposes, the ports should appear to be identical. The Ethernet Configuration View is shown in Figure 1.

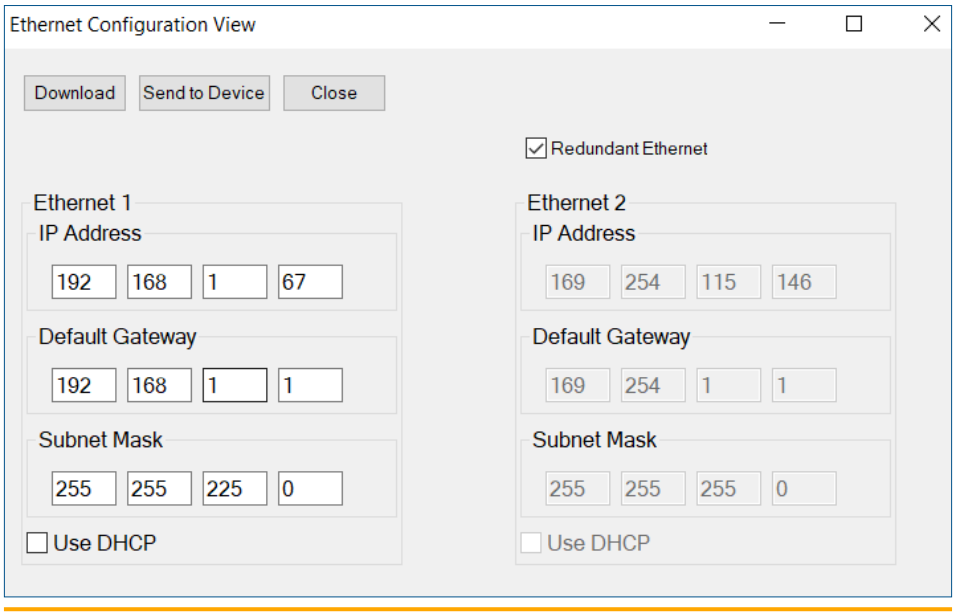

Figure 1 - Ethernet Ports 1 and 2 Share the Same Settings when Redundant Ethernet is Selected

The criterion that causes the DGC-2020HD to switch between ports depends on the Redundant Mode setting. Two modes exist: Link Monitor and ARP Ping. In Link Monitor mode, the DGC-2020HD determines a healthy port simply by the link status on the connected Ethernet port. The link status will be healthy simply when the Ethernet cable is plugged into the DGC-2020HD and the upstream network switch. This is roughly analogous to the Link Status LED found on many Ethernet jacks. Examples where the link may not be healthy include the cable being unplugged, the cable being damaged or cut, or the directly connected network switch being powered off.

In ARP Ping (Address Resolution Protocol) mode, the DGC-2020HD determines a healthy port by sending ARP requests to and receiving ARP replies from the configured devices. Doing so provides better determination of end-to-end connectivity between devices. This can overcome some shortcomings of the Link Monitor with the correct configuration. There are two associated settings in ARP Ping mode: Ping Mode and Ping IP 1-16. The group of Ping IP settings specify addresses of which devices to send ARP requests. If Ping Mode is set to Any, receiving a valid ARP reply from any of the configured devices determines the port to be healthy. If the Ping Mode is All, the port will only be determined to be healthy if receiving replies from all devices. Choosing between All or Any will largely depend on the network topology. The Redundant Ethernet Setup screen is shown in Figure 2.

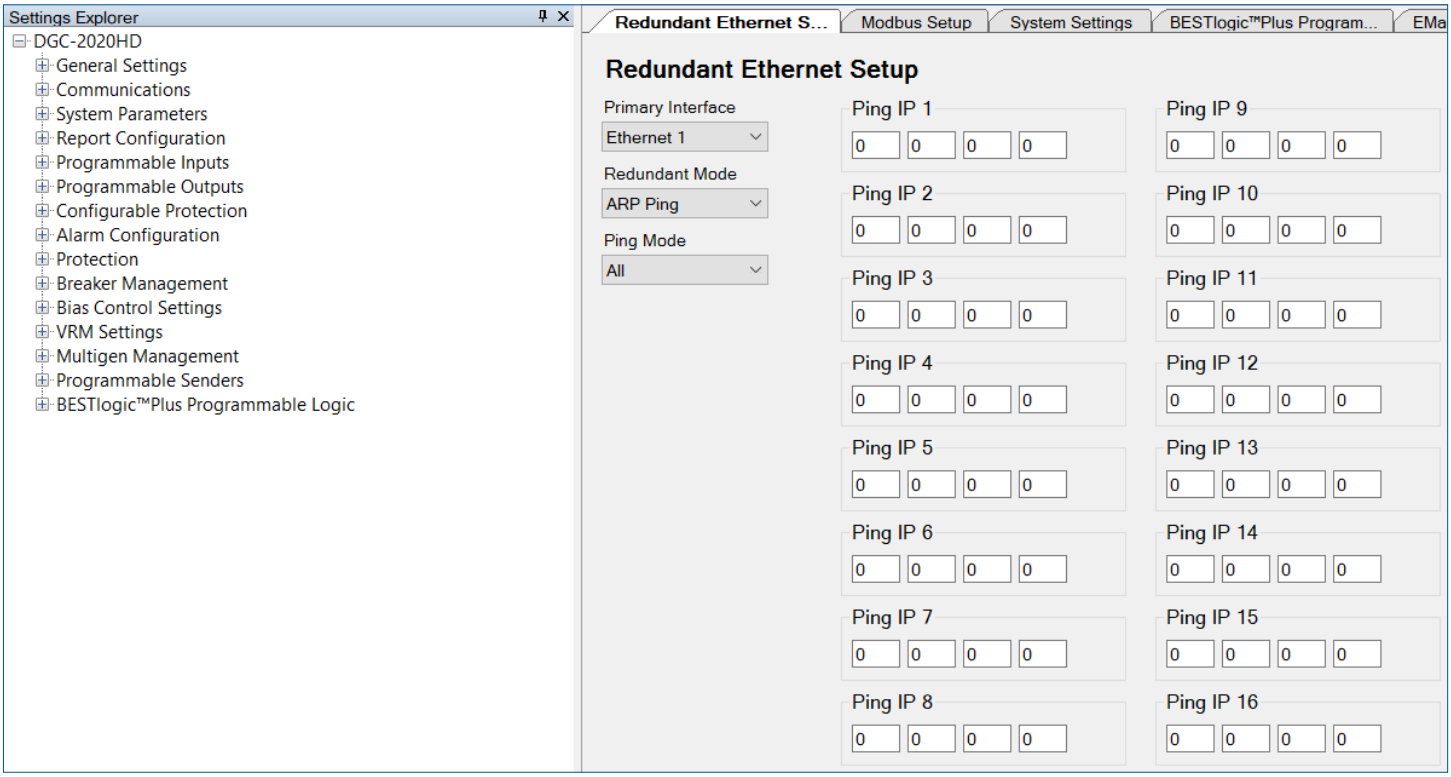

Figure 2 - Redundant Ethernet Setup Screen

The overall reliability of either configuration of the DGC-2020HD depends on the configuration and topology of the network switches. This is beyond the scope of the configuration of the DGC-2020HD. It is important to understand the failure points that a network is designed to tolerate. The below example will go through a simple network configuration and examine some of the types of network failures this could tolerate with correct configuration of the DGC-2020HD controllers. A network with ringed Ethernet switches is shown in Figure 3.

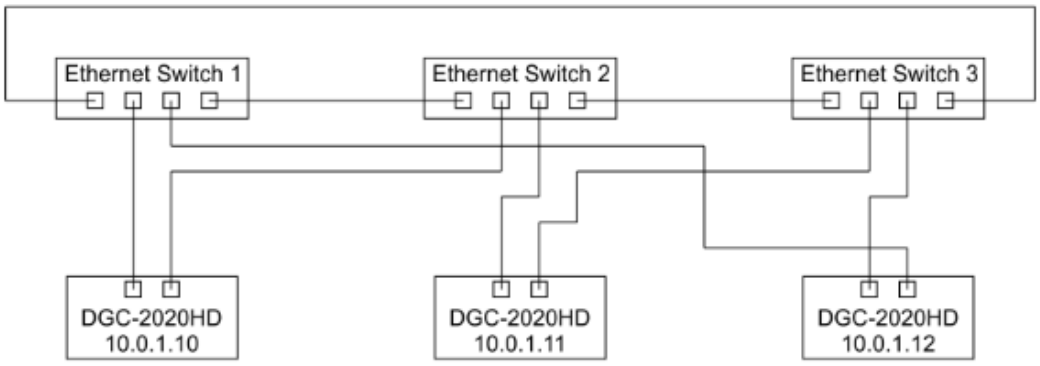

Figure 3 - Network with Ringed Ethernet Switches

The example network in Figure 1 shows a ring network with three DGC-2020HD controllers and three Ethernet switches. Each port on each DGC-2020HD controller is connected to a port on a separate physical Ethernet switch. The Ethernet switches have links between them to form an overall ring between the Ethernet switches. Ethernet switches are not able to act correctly when there is a loop such as this in the network. It is **CRITICAL** that the Ethernet switches support a protocol such as RSTP (Rapid Spanning Tree Protocol) in order to logically break any such switching loop. Connecting an unmanaged Ethernet switch in this manner or failing to enable the RSTP setting in the managed switch may result in complete failure of network communication. RSTP is a standard protocol and is likely to be found on common managed network switches. Some vendors of network switches may offer proprietary improvements or protocols in addition to RSTP. It is up to the network designer to determine if any such protocol is appropriate. RSTP and any other proprietary ring detection protocol will likely have additional configuration settings to tune the protocol for the network. It is up to the network designer to choose appropriate settings for the network design.

This example network can be configured to tolerate several single and some multiple points of failure. The examples below will demonstrate some failure scenarios.

Figure 4 shows several examples of single cable failures that the network design can tolerate. Because of the multiple connections between the DGC-2020HD controllers and the Ethernet switches, any DGC-2020HD controller can tolerate a single cable failure on either port. In addition, the Ethernet switches can tolerate a single cable failure between any connections of the switches. The red X's show a broken or disconnected cable. The highlighted sections show the active network segments in this case. The DGC-2020HD ports will failover due to the redundant capability of the controller. Because of the broken inter-switch link, the RSTP protocol will not disable any switch port and the highlighted inter-switch ports will become active. RSTP is required when the broken inter-switch link is restored under normal operating conditions. RSTP will logically disable one of the inter-switch links to prevent a switching loop according to the RSTP protocol.

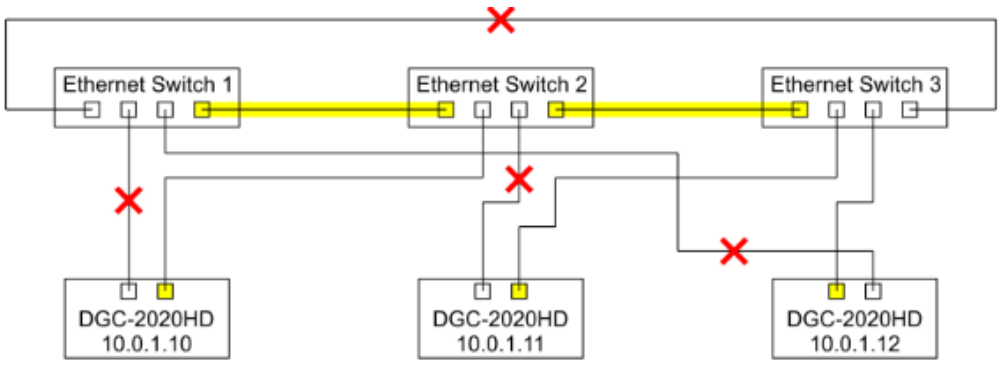

Figure 4 - Single Cable Failures

Figure 5 shows an example of a single entire Ethernet switch failure, e.g. the switch was damaged or power removed. In this case, any DGC-2020HD port connected to the switch will not be active due to the loss of link to the switch. The highlighted ports show the active ports on the DGC-2020HD controllers. Note that the third DGC-2020HD unit can select between either port because both still have valid links to the connected switches.

In the previous two failure scenarios, it did not matter whether the DGC-2020HD was configured in Link Monitor or ARP Ping mode. Figure 6 shows a scenario where ARP Ping may provide better reliability over the Link Monitor mode. In this scenario, the middle inter-switch links are disconnected from the other two switches. In Link Monitor mode, the DGC-2020HD controllers are all free to choose either port to communicate on because they will all have active links to their upstream switches. However, it is clear the DGC-2020HD at address 10.0.1.12 could not communicate to either controller if they happened to choose the link to the middle switch on which to communicate.

To better this situation, the ARP Ping mode could be used. In this example, the Ping Mode should be set to All. Each DGC-2020HD should be configured with the two IP addresses of the other two controllers, e.g. in controller 10.0.1.10, configure Ping IP 1 as 10.0.1.11 and Ping IP 2 as 10.0.1.12, etc. This will cause the links highlighted to become active. The DGC-2020HD controllers' ports connected to the middle switch will not be considered healthy because there is no path to communicate to the DGC-2020HD at 10.0.1.12 through this switch. Note the DGC-2020HD at 10.0.1.12 can use either port because it is not connected to the middle switch. It could even still tolerate an additional single cable failure.

Although this example demonstrated configuration of DGC-2020HD controllers, similar consideration must be given to external equipment such as Modbus PLC masters. The network must be analyzed and understood for the level of failure protection it will provide. Even with the capability of the DGC-2020HD controller, the overall reliability of the network will only be as good as the failures for which it was designed to tolerate.

It is important to note that when one Ethernet port is designated as a redundant failover port, the DGC-2020HD is still able to perform intergenset communications, BESTCOMS*Plus*® Communications, and Modbus® communications on the active Ethernet port. Because the Ethernet port settings are the same on the active and the redundant port, all communications failover to the redundant port seamlessly.

In conclusion, multiple DGC-2020HDs communicate with each other on a peer-to-peer network to provide distributed control for an on-site power system. This is a more reliable network architecture than centralized networks, which incur the risk of a total system failure if the master controller fails. In addition, the DGC2020HD provides further network reliability by allowing one port to be designated as redundant, so that intergenset, BESTCOMS*Plus*®, and Modbus® communications failover seamlessly in various communication failure modes. Overall, a reliable intergenset communications network is vital for building a resilient on-site power system, thus avoiding loss of revenue and safety concerns caused by unplanned power outages.

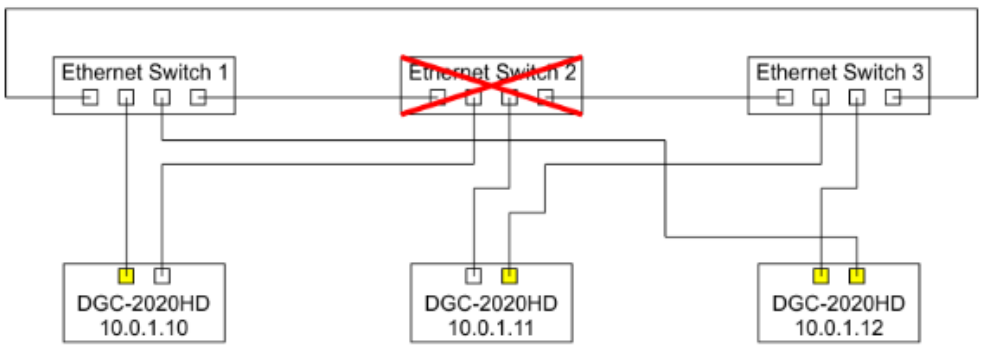

Figure 5 - Single Switch Failure

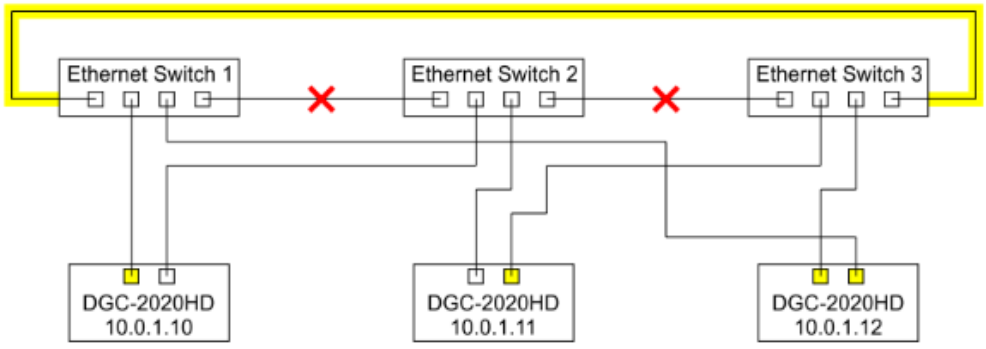

Figure 6 - Inter-Switch Link Failure

For more information

For more information on the DGC-2020 family of genset controllers, download the product bulletins or instruction manuals at www.basler.com. For assistance with product orders or questions, visit www.basler.com/support, contact your Application Engineer, or contact Technical Support at +1 618.654.2341.

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