Fieldbus Design Document  
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For this project, the primary fieldbus chosen was EtherCAT, due to its inherent flexibility. The KR C2 controller is an older design without native EtherCAT support, so in order to support communications with the cell controller, an Ethernet/IP communication module is specified for both the robot controller as well as the EtherCAT-based cell controller. This also allows the laser scanners to communicate with either the robot or cell controllers, as it too was specified with an Ethernet/IP communications module.

The remainder of the communications utilizes one of two methods: Ethernet (TCP) for the load cell, workstation, and cell controller communications; and EtherCAT for all standard and safety IO (both discrete and analog). The Beckhoff controller can handle any translation necessary between the various buses. A managed ethernet switch was specified to ensure that the various buses could be properly segmented from each other.

A few assumptions had to be made. First, the VFD was assumed to be 480VAC powered and utilizing a 4-20mA speed reference. Next, it is assumed that the Keyence laser scanner listed in the device list includes the read head, head cable, and controller. Next, the KR C2 is assumed to be edition 05, as that appears to be the latest version and was the only manual to be found online. Finally, the hydraulic pump specified does not appear to have a return line built in (single acting), though since the return is relatively low pressure it is assumed that the return from the valves could just be plumbed back to the reservoir.

The cell controller is specified with a safety control card, and safety I/O to interface with cell controls such as E-stops, perimeter sensors, and door locks as well as the KR C2 controller. It was assumed these external devices exist in some form. If the safety interlocks are simple enough, they could instead be wired directly to the ESC card on the robot controller, however, this precludes the cell controller from being able to execute any higher-level safety control (such as time delaying door locks to allow time for motion to stop, or stopping hydraulic controls when the cell is open, etc.)

Design documents included are a block diagram showing a simplified arrangement of the components and how they connect, a marked up version of the devices list including additional information, and a specified device list which includes information about all of the components I selected.