**1. Introduction**

This document details the design choices and configurations for setting up an efficient communication link via Ethernet network to manage two KUKA KRC2 robots and a hydraulic pump with a PLC.

**2. System Overview**

The system comprises the following key components:

* **Central PLC**: Siemens SIMATIC S7-1500
* **KUKA KRC2 Robots**: 2 units
* **Peripheral Devices**: Includes laser scanners, tool changers, sensor interface plates, load cells, control boxes, pneumatic and fluid solenoid valves, hydraulic valves, pressure switches, a hydraulic pump, a PC workstation, a spindle VFD, and a fixture.
* **Ethernet Cables**
* **Ethernet Switch**
* **Communication Protocol:** EtherNet/IP or Profinet

**3. Design Choices**

**3.1 FieldBus Technology: Ethernet**

**Rationale**:

* **Wide Adoption**: Ethernet is widely used in industrial automation for its robustness and reliability.
* **Scalability & Compatibility**: The KUKA KRC2 robots and other devices support Ethernet, ensuring seamless integration.
* **High Speed Communication & Performance**: Ethernet offers high-speed data communication and real-time capabilities essential for control applications.
* **Remote Access**: Ethernet allows for remote access to the PLC and robot, enabling easier diagnostics, troubleshooting, and monitoring from different locations.

**3.2 Network Topology: Master-Slave Configuration**

**Rationale**:

* **Centralized Control**: Using a central PLC as the master simplifies network management and control logic implementation.
* **Scalability**: Additional devices can be easily added as slaves without significant reconfiguration.
* **Fault Tolerance**: The master-slave configuration helps isolate faults, improving system reliability.

**3.3 Central Controller: Siemens SIMATIC S7-1500**

**Rationale**:

* **Performance**: The S7-1500 series offers high processing power, suitable for complex automation tasks.
* **Integration**: Native support for Ethernet and extensive compatibility with industrial protocols.
* **Diagnostics**: Advanced diagnostic capabilities for easy troubleshooting and maintenance.

**4. Hardware & Network Configuration**

**4.1 Central PLC Configuration**

* **Model**: Siemens SIMATIC S7-1500 (CPU 1511-1 PN)
* **Setup**: Configure network parameters (baud rate, node addresses) using TIA Portal software.
* **Devices Addition**: Add KRC2 robots, I/O modules, and other peripherals to the associated IO Slots for the IO Modules in the PLC project.

**4.2 KRC2 Robot Configuration**

* **Network Setup**: Ensure that both KRC-2 Controllers are wired to the same ethernet switch as the PLC, using Ethernet Cables
* **Addressing**: Set the static IP address and sub net mask for each robot. Make sure it is on the same network as the PLC.
* **Connection**: Ping the KRC-2 Controllers from the PLC to verify there is communication established.

**4.3 Peripheral Device Configuration**

* **Laser Scanners, Tool Changers, Sensor Interface Plates, Load Cells, Control Boxes, Solenoid Valves, Pressure Switches, Hydraulic Pump, Spindle VFD, and Fixture**:
  + For digital signals, wire the digital inputs/outputs to the PLC’s digital input/output modules.
  + For analog signals, connect analog inputs/outputs to the PLC’s analog input/output modules.

**4.4 Programming & IO Mapping**

* **PLC Program:** Develop a PLC program to handle communication with robots. Define tags or variables for data to be exchanged with the KUKA KRC2.
* **KUKA Robot Program:** 
  + Develop KRL programs to handle the data received from the PLC and to send data to the PLC.
  + Ensure proper mapping of PLC variables to KUKA robot I/O points.

**5. Testing and Validation**

* **Network Power-Up**: Ensure all devices are connected and powered correctly.
* **Communication Verification**: Perform a ping test from the PLC to the KUKA KRC2 Controller to ensure network connectivity.
* **Functionality Testing**:
  + Send control commands from the PLC to the KUKA robot and verify responses.
  + Validate the data exchange by monitoring the data being sent and received between the PLC and the KUKA KRC2 robot.

**6. Troubleshooting**

* **Common Issues:**
  + IP addresses conflicts or incorrect subnet settings
  + Physical connection issues such as loose cables or faulty hardware
  + Incorrect configuration settings in the PLC or KUKA KRC2 Controller
* Resolution Steps:
  + Verify and correct IP addresses and subnet settings.
  + Check all physical connections and ensure that the network switch and cables are functioning properly.
  + Review and adjust the configuration settings in both the PLC and KUKA KRC2 Controllers.

**7. Documentation and Maintenance**

* **Documentation:**
  + Maintain detailed records of IP addresses, configuration settings, and program code.
* **Maintenance:**
  + Regularly update the firmware and software for both the PLC and KUKA KRC2 Controller
  + Periodically test the communication link and perform preventive maintenance to ensure continued reliability.

**8. Conclusion**

This design document provides a comprehensive overview of the Ethernet network setup for managing KUKA KRC2 robots and a hydraulic pump.