Application Highlight

2500 Series®
Programmable Automation Control System

Global Customer Communicates to Injection Molding Machine ~30x Faster Using ACP1 Application Coprocessor for Ethernet Communications

A US-based division of a global manufacturer has successfully implemented a custom Ethernet communications interface to an injection molding machine using the 2500P-ACP1 Application Coprocessor. The project replaced a previous serial communications link and provided the ability to read much more data from the molding machine —resulting in better quality and lot tracking information. In addition, the faster communications interface significantly improved the process cycle time and product yield from this production line.

Summary

When a global customer with more than $1B in sales needed to increase communications speed to a new piece of process equipment, they turned to CTI's 2500P-ACP1 Application Coprocessor and Workbench Integrated Development Environment for IEC-61131.

Customer Issue

The customer, operating an FDA-certified process, replaced two injection molding machines with a single new machine. Previously, separate serial links were used to communicate with the two injection molding machines The serial messages consisted of custom ASCII messages required by the vendor's proprietary protocol. After receiving the ASCII message, substantial PLC logic was still required to extract the parameter data from the protocol packet, convert data

into numerical values, and store values in consecutive memory blocks where they could be transferred and/or accessed as required. This effort took several man-weeks of work to complete and was considered too complex for on-site engineers to make changes.

Because the previous serial data communications was limited to 9600 baud, it took approximately 150 msec to read each parameter value from the machine via the serial link. With at least 40 required parameters per machine, the communications process took ~6.5 seconds to complete even when both machines were accessed simultaneously. When the process was integrated into a single machine, all parameters had to be accessed via a single communications channel. This made the use of a serial interface prohibitively slow.

CTI 2500P-ACP1

The 2500P-ACP1 Application Coprocessor is programmed using CTI Workbench - our integrated development tool for IEC-61131 programming. Among the enhanced features of Workbench are instructions which allow direct access to the Ethernet interface. These functions provide a simplified application programming interface (API) to develop customized Ethernet communications protocols using TCP and/or UDP connections that previously required a communications "driver" created by an experienced programmer.

The ACP1 module supports a full set of functions for management of TCP/IP and UDP sockets for building client or server applications to communicate over Ethernet networks. CTI Workbench provides a simplified interface for these network socket functions that allows ACP1 program logic to open/close Ethernet connections and send/receive Ethernet packets. The application can specify the ASCII data to be transmitted within each Ethernet packet, and can extract/process all data contained in Ethernet packets received from an external device. The ACP1 supports up to 10 separate TCP and/or UDP sockets to be managed simultaneously via these functions.

CTI Solution

CTI Workbench was used to develop a custom Ethernet protocol for our customer to replace the previous serial communications link. The application consisted of the following:

i) TCP Client Driver – This program section is reusable "as-is" for all TCP Client communication projects.

— Creates TCP connection to the machine, sends/receives TCP data packets, detects communication errors, and manages status information to/from PLC.

ii) Protocol Manager – Template and data structure is reusable. Message protocol is unique for each machine.

—Builds data string embedded in the TCP message to send to machine and processes data from received TCP messages.

—Data parameters are inserted from internal string arrays – easily modified by customer when "number of parameters" or "Parameter ID" needs to be changed.

—Converts ASCII parameter values in received messages to REAL numbers and writes to specified PLC memory locations at completion of each "read" cycle.

—Maintains timers to trigger new "read" cycle and track completion time for each cycle.

—Manages data reporting when communication errors occur.

The customer upgraded its existing Siemens 555 controllers to CTI 2500 Series CPUs in order to use the Ethernet-based data transfer between the CPU and ACP1. However, this upgrade was seamless as CTI CPUs are able to run existing TISOFT, Workshop and APT programs without any changes.

Benefits of the ACP1 Solution

Switching from serial communications to Ethernet communications using the 2500P-ACP1 provided the customer several important benefits:

1) **Communications speed ~30x faster** — The communications "time per transaction" decreased from ~150msec per parameter to ~5msec per parameter. The improvement is so dramatic that this function is no longer the "critical path" in the production area.

2) **Customer can access far more data** — The customer is now able to collect additional parameters due to the increased speed of communications. The improved communications rate now permits the customer to read not only the FDA-required parameters but also additional parameters that provide operational data points to assist in optimizing the process to improve product quality and maximize production yield.

   Old serial line interface: ~6.5 seconds to read 40+ parameters
   New ACP1 Ethernet interface: ~800 msec to read 160+ parameters

3) **Asynchronous operations result in faster cycle times** — Because the ACP1 performs all operational functions as an independent coprocessor, communications and data processing are executed asynchronously to the PLC scan. In addition to machine communications, the ACP1 performs all data handling—extraction of parameter data, conversion to numbers, building data arrays, and data transfer to PLC without any PLC programming required.

4) **Solution was cost effective** — Upgrading to the ACP1 solution did not require any reprogramming of PLC logic or change in existing I/O. The customer upgraded existing Siemens 555 PLCs to CTI 2500-C400 CPUs and bought one ACP1.

5) **Changes to the communications protocol are fast and easy to make** — Whereas previous changes to the communications protocol between the molding machines and the PLC required contractor involvement, changes to the ACP1 protocol are much simpler and can be done quickly by on-site personnel.

6) **Initial implementation exceedingly fast** — CTI was able to use the CTI Workbench simulator to test the communications interface on a Windows PC without the customer having to install any new equipment in the plant. As a result, CTI was able to develop the ACP1 program based on product specification and email it to the customer. The customer then used the simulator to verify communications with the new

machine. The “proof of concept” phase lasted 2-3 days to fully implement and test the communications protocol. After successful “proof of concept” testing at the plant, the entire project was completed with only 2-3 additional days on site working with the customer. Most of this effort included finalizing data formats, status information, and error reporting.

7) **Ability to re-use programs in future projects—**Workbench’s IEC61131 languages allow for “bottom-up” program development where sections of logic are encapsulated in “Program Organizational Units” (POUs) and then reused as necessary. Because CTI was able to re-use program structure and existing POUs, a second communications interface was created (from scratch) on site and a successful in-plant test was performed in less than 24 hours.

Global Deployment of the New Solution

This project exemplifies CTI’s commitment to work in partnership with our customers to provide solutions that exceed expectations, are cost effective, and have minimal impact on operations. The success of the project has generated several additional projects to speed communications with printers, barcode readers, and vision systems and to enhance data collection for lot tracking.

Additionally, while they had previously contemplated replacing the line with all new process control equipment in order to achieve the same quality and yield as on other lines in the plant, the customer is now so satisfied with this cost-effective and minimally disruptive solution that the same solution is being propagated to similar lines in other facilities around the world. With minimal investment in equipment and almost no downtime or reprogramming, the customer has modernized its existing line and achieved a significant throughput increase. The line is now equal to or faster than other “more modern” lines, and the customer has also gained valuable new operational data to enable continued improvement in the quality and yield of the process. As an example, the customer is able to collect 60% more data in one-third the time when compared to a Controllogix processor communicating to the same model injection molding machine on their newest production line. More data and more production, in less time, at a lower cost, and with minimal disruption. **At CTI, that’s what we call Smart Modernization.™**

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