The Versatile SEL-2505 Remote I/O Module

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ROBUST I/O SOLVES COMMUNICATIONS PROBLEMS

In 1999 SEL introduced the SEL-2505 Remote I/O Module. This easy-to-use device has solved many problems and found its way into scores of interesting applications around the world. SEL first conceived of the SEL-2505 to replace numerous multiconductor cables with a couple of optical fibers. A pair of SEL-2505s can be connected back to back with a length of fiber, as shown in Figure 1.

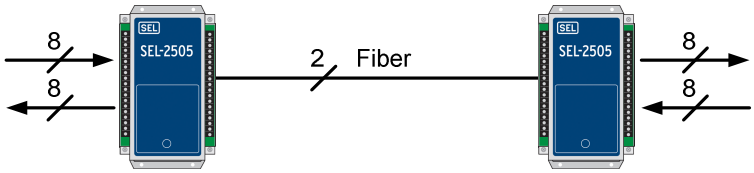

Figure 1 Eight Inputs Drive Eight Outputs Bidirectionally Over a Fiber Pair

Eight contact inputs on the left are mirrored onto eight contact outputs on the right. Conversely, eight contact inputs on the right drive eight contact outputs on the left.

Figure 2 dramatically illustrates the savings in copper provided by this simple and reliable device. It's fast too. A contact output closes at one end just eight milliseconds after the contact input was energized at the other end. This simple system also includes self-monitoring. Each SEL-2505 comes with a communications monitor, an internal self-check, and an alarm output. If the communications channel is disrupted, as would occur if someone were to dig into the cable, then the alarm contact signals the trouble within milliseconds. Not only do we realize environmental, economic, and installation-time savings by using a little fiber instead of a lot of copper, but there are other advantages. The fiber is much more corrosion resistant, it provides electrical isolation between sending and receiving areas, and it improves safety by eliminating ground potential rise hazards on the cable.

Figure 2 All These Copper Conductors Were Replaced With a Handful of Fiber-Optic Cables

The two devices communicate using the SEL MIRRORED BITS® protocol. This simple and unique protocol guarantees the communications integrity needed for critical applications, such as tripping and closing circuit breakers, and starting and stopping large motors. The integrity of MIRRORED BITS communications is also ideal for critical alarm circuits, including those found in government and military facilities and critical industrial processes.

The bidirectional nature of this robust communications system means we can send a command such as the tripping of a security alarm to a central station, and then the central station can signal back that the alarm has been received and acknowledged. Closing a security gate is another example. One of the eight inputs would receive the **CLOSE** command from a pushbutton and send it to a contact that tells the gate-operating mechanism to close the gate. When the gate reaches its closed position, a limit switch on the gate signals an SEL-2505 input that ties to an output near the pushbutton so the person closing the gate knows indeed that the gate actually closed all the way. And, because MIRRORED BITS communications continuously monitors the communications, you know right away if anything fails—not when you go to open the gate!

CONFIGURATIONS

Encrypted Connections

Figure 3 shows a system like the one in Figure 1, except now the communications have been secured using the SEL-3021 Serial Encrypting Transceiver. Note that you use an SEL-2505 with an EIA-232 port here, instead of fiber.

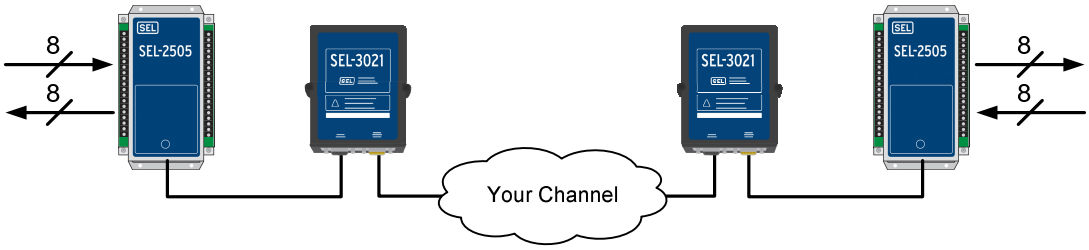

Figure 3 I/O Communications Including Secure Signal Encryption

The SEL-2505 serial port connects to the encryptor by a short cable. The secure side of the encryptor communicates to the remote end via fiber-optic transceivers, modems, or other channels. The security provided by the SEL-3021 is certified to the Federal Information Processing Standard (FIPS) 140-2 and recognized by the National Security Agency (NSA). Its 128-bit AES data encryption and SHA-1 session authentication are secure and authenticate the communications to prevent eavesdropping, man-in-the middle attacks, and replay attacks. Again, any break in the communications produces an alarm.

Fast, Secure Radio Transmissions

Figure 4 shows a similar solution where the SEL-2505s share eight points bidirectionally over a radio channel.

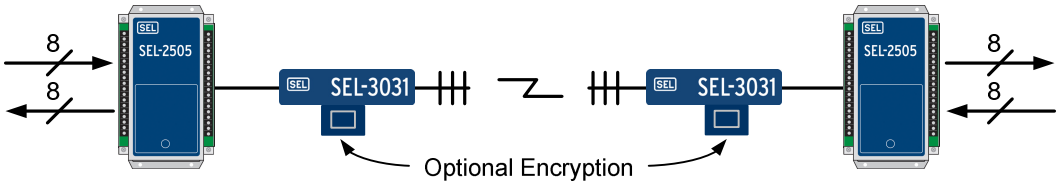

Figure 4 I/O Communications Using an Unlicensed Radio Link

The radio channel is provided by the SEL-3031 900 MHz unlicensed radio. This radio has an optional encryption card to secure and authenticate the radio communications. Even with the radio and encryption of Figure 4, the time from an input assertion on one end to a contact closure on the other end is 25 milliseconds or less. Any disruption of the channel is not only detected by the SEL-3031 radio itself and signaled by its alarm contact, but disruptions are also detected by the alarm logic in the SEL-2505s at both ends.

The SEL-3031 radio provides three serial data links. Figure 5 shows how you can communicate a total of 24 inputs at one end to 24 outputs at the other end and vice versa, using a set of three SEL-2505s at each end but only one radio, one antenna, one lightning arrestor, and one RF path.

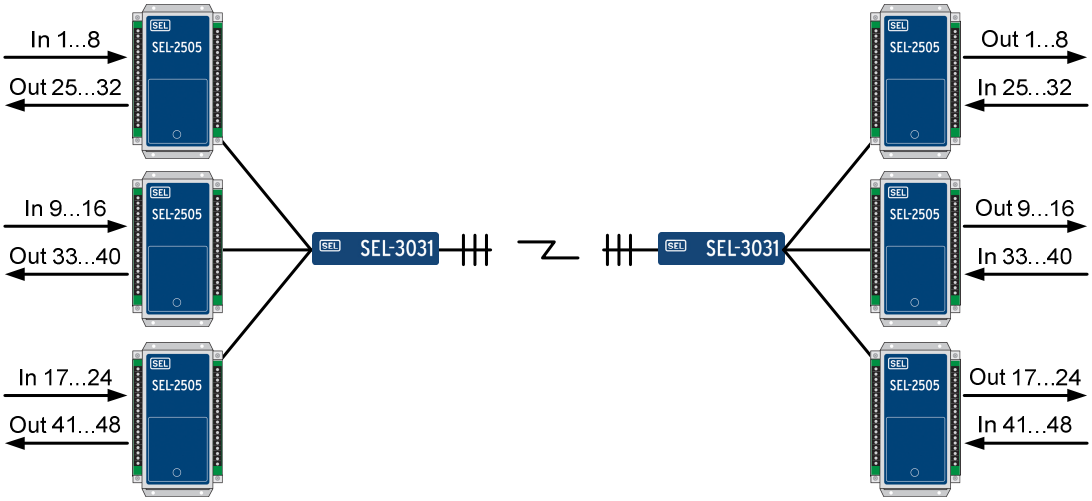

Figure 5 Three Serial Links of Information Can Transmit on a Single Radio

All of these devices are available in models that run from 12, 24, 48, 125, and 250 Vdc, and 48, 125, and 250 Vac. This broad range of power supply choices means you can run these devices from a 12 V battery, a “wall wart” plugged into the 120 Vac, and the 48, 125, and 250 Vdc batteries found in telecommunications and utility systems and elsewhere. The simple SEL-2505 starts up and shuts down in a very controlled way. There is no need to worry about false assertions of outputs due to channel or power interruptions. Furthermore, after power is applied, the SEL-2505 channel starts up and communicates in under a second.

Annunciator Solutions

SEL has a wide variety of solutions that speak MIRRORED BITS communications, including the SEL-2523 Annunciator Panel. This versatile annunciator not only responds to MIRRORED BITS communications but a variety of other protocols, as well as contact inputs. Figure 6 shows three SEL-2505s connected to the annunciator via three MIRRORED BITS communications channels.

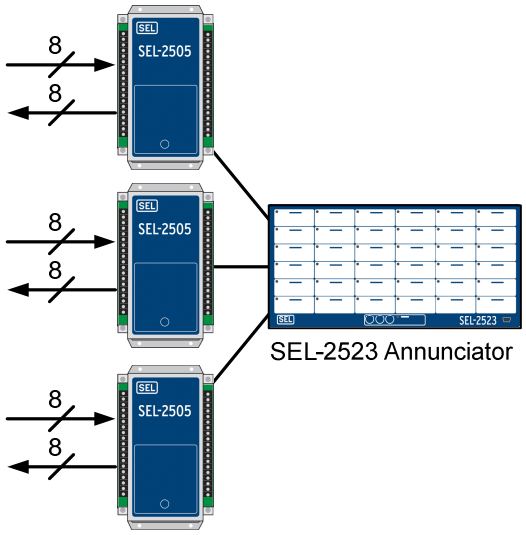

Figure 6 Bring in Remote I/O for Indication, Alarms, and Logic-Driven Remedial Actions

24 of the 36 annunciator windows can respond immediately to the 24 contact inputs of the SEL-2505s. That leaves 12 more windows on the annunciator that can respond to any programmable combinations of the other inputs from the SEL-2505s and the SEL-2505 alarm status. Alarms can also be driven by the contact inputs of the annunciator itself.

Figure 7 shows a variation on the theme of Figure 6. Three SEL-2505s transmit their data over a single radio channel to an SEL-3031 at an annunciator where two of the three channels drive the annunciator. The third channel drives another SEL-2505, and the third annunciator channel picks up data over a fiber-optic link to another SEL-2505. The combinations are limitless, so let your imagination and application be your guide.

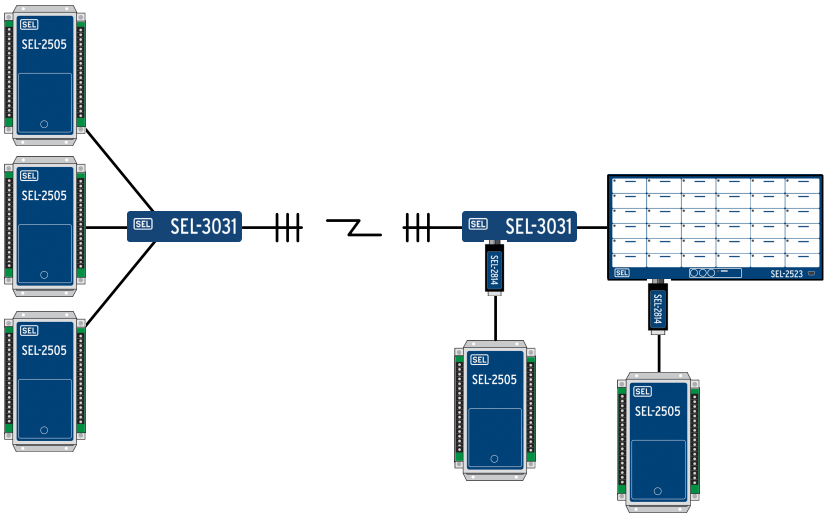

Figure 7 Radio Connection Provides Links to Contact I/O up to 20 Miles Away

The annunciator has several alarm contact outputs. We can send these alarms back to the remote SEL-2505s so that the monitoring devices can alert operators or processes when the annunciator is out of service.

Figure 8 shows a system that provides identical alarming at two remote sites. This arrangement provides both backup indication and identical alarm status at both sites. Operators at each location are aware of problems and status at both ends and are working from the same information. This improves safety and switching coordination, as well as minimizes mistakes.

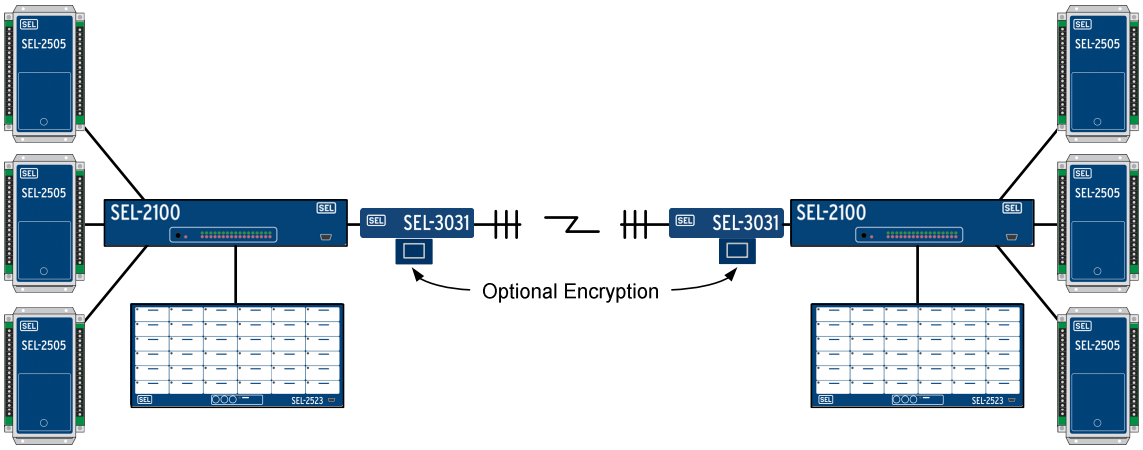

Figure 8 Mirrored Alarming at Remote Locations Provides Critical Information at Multiple Sites

Note that the SEL-2523 is equipped with a powerful logic engine. Thus, the systems in Figures 6 through 8 also function as programmable automation controllers with local and/or remote I/O provided by the SEL-2505s.

CONCLUSION

These simple, reliable, low-cost systems can control and monitor fire and security systems, access controls to buildings, shopping centers, and parking lots, lighting controls, traffic controls, gated communities, airports, electric power systems, water filtration plants and pumping stations, transportation systems, wind farms, dams, photovoltaic systems, backup generating plants, and more.

It is impossible to cover all of the variations on the themes shown in the figures above. It suffices to say, the versatile SEL-2505 can communicate over fiber, radio, and copper channels, can be secured with our encryption technology, and is dependable. So, whenever you need to move contact information from Point A to Point B, or whenever you need to control and monitor remote equipment, think about how the versatile SEL-2505 can help you get the job done safely, reliably, and economically.

BIOGRAPHY

Dr. Edmund O. Schweitzer, III is recognized as a pioneer in digital protection and holds the grade of Fellow of the IEEE, a title bestowed on less than one percent of IEEE members. In 2002, he was elected a member of the National Academy of Engineering. He is the recipient of the Graduate Alumni Achievement Award from Washington State University and the Purdue University Outstanding Electrical and Computer Engineer Award. In September 2005, he was awarded an honorary doctorate from Universidad Autónoma de Nuevo León in Monterrey, Mexico, for his contribution to the development of electric power systems worldwide. He has written dozens of technical papers in the areas of digital relay design and reliability and holds more than 30 patents pertaining to electric power system protection, metering, monitoring, and control. Dr. Schweitzer received his Bachelor's and Master's degrees in electrical engineering from Purdue University, and his PhD from Washington State University. He served on the electrical engineering faculties of Ohio University and Washington State University, and in 1982 he founded Schweitzer Engineering Laboratories, Inc. to develop and manufacture digital protective relays and related products and services. Today SEL is an employee-owned company, which serves the electric power industry worldwide, and is certified to the international quality standard ISO-9001. SEL equipment is in service at voltages from 5 kV through 500 kV, to protect feeders, motors, transformers, capacitor banks, transmission lines, and other power apparatus.

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