CASE STUDY

Denver Light Rail Transit System—Denver, Colorado

Remote I/O Modules Enable DC Substation Transfer Trip for Expanding Denver Light Rail System

SEL-2505 Remote I/O Module provides an economical solution for transfer-trip scheme with reliable, robust communications, compact design, and reduced dc ground exposure.

Denver, CO—Cities throughout the world are increasingly concerned about traffic congestion and related costs in fuel, extended commuting time, highway construction and maintenance costs, and the ability to attract new residents and businesses.

One metropolitan area that is aggressively attacking the traffic problem is Greater Denver, Colorado, which according to the Texas Transportation Institute has the third worst traffic congestion of any major city in the United States. To relieve this problem, Denver has expanded its FasTracks Initiative to add rail and bus system availability to area residents looking for a workable alternative to driving their cars to work.

A significant part of the FasTracks $4.7 billion expansion will come through the added service coverage of the Light Rail Transit (LRT) system. Begun in the mid 1990s, the LRT has captured public attention, with ridership increasing each year. Operated by the Regional Transportation District (RTD), the LRT system services downtown Denver and the southwest corridor areas via approximately 80 miles of track. The RTD will soon extend LRT access by adding about 40 miles of track.

LRT system vehicles are powered by 900 volts direct current (Vdc) electricity. The Traction Electrification System provides power via a traction power system and overhead contact system. The power system consists of traction power substations and the traction power feeder system. The feeder system includes both positive and negative feeder cables and respective conduits.

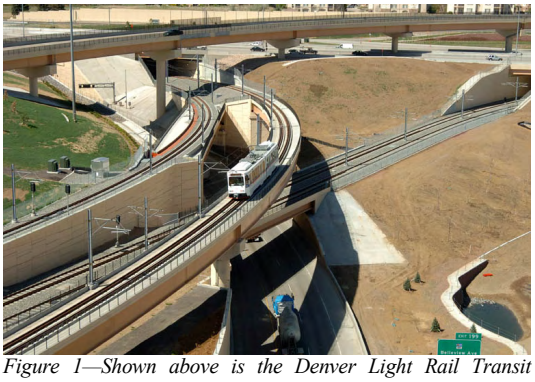

Figure 1—Shown above is the Denver Light Rail Transit System passenger train on the I-25/I-225 interchange. It has a light frame and small body that enable it to operate along crowded city streets and within tight urban corridors with frequent stops. Light rail was introduced to the region in 1994.

Traction power substations are located along the LRT line and receive primary power from the local power utility company. The substations include all the equipment necessary to transform and rectify the primary ac three-phase power to dc traction power. As part of the overall FasTracks program, the RTD recently upgraded the switchgear at the existing substations. The prime electrical contractor on the switchgear project was Interstate Electrical Contractors (Wheat Ridge, Colorado). Interstate contracted with NEI Electric Power Engineering (Arvada, Colorado) to add dc breakers built by Traction Power Systems

(North Canton, Ohio). NEI also worked with IMPulse NC, INC. (Mt. Olive, North Carolina), one of the leading specialists in traction power electrification.

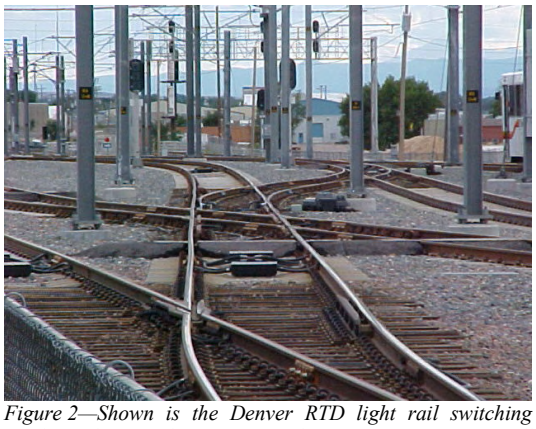

Figure 2—Shown is the Denver RTD light rail switching tracks at the Broadway Station. The Denver LRT system will have a total of 120 miles of track once the project is complete in 2016.

Phase One of the project includes six substations. A 13.8-kV utility feeder supplies power to the substations and transformers, and rectifiers convert the voltage to 900 Vdc. Four circuit breakers distribute the dc power to the overhead catenaries. Negative feeders return through the tracks.

"The main goal of the project is flexibility," explains Donn Morris, senior engineer at NEI. "LRT substations are set up to support two tracks going north and south from the substation. There were two breakers installed, one that feeds the A Track and one that feeds the B Track. But there is an isolation break at the substation. The breaker feeding the A Track feeds track that goes both north and south of the substation. So, if that breaker trips, they lose two segments of track—both the northbound and southbound."

To avoid losing power on both the northbound and southbound tracks, the RTD decided to add four circuit breakers: one circuit breaker feeds the south A Track; one for the north A Track; and, similarly, one each for the north and south B Tracks. "This gives them more flexibility. They can isolate a fault to one segment of track now, which means both ends (either north or south) do not lose power from a single fault," says Morris.

NEI needed a solution for providing state-of-the-art digital communications for transfer tripping the new circuit breakers. NEI replaced a complex set of gear with the SEL-2505 Remote I/O Module from Schweitzer Engineering Laboratories, Inc. (Pullman, Washington). The SEL-2505 transfers protection and control information between devices at protection speeds (typically 11 ms). The SEL-2505 converts logic I/O into MIRRORED BITS® communications messages and creates advanced, secure, and fast bus protection. MIRRORED BITS communications is an innovative, low-cost, device-to-device communications technology that sends internal logic status, encoded in a digital message, from one device to another.

"I proposed the SEL-2505 because it offers a more robust communications design," Morris explains. "People in the industry like it because it is a utility-grade device. Yet the SEL-2505 is also a more compact design and offers better reliability and better communications. These devices can talk to each other and handle the transfer trip signals for the breakers. Cost wise, it was a better deal, too."

The SEL-2505 works with all protection equipment, including relays and circuit breakers. You can install the SEL-2505 in a relay cabinet or transformer enclosure, and use fiber-optic communications running back to another I/O module or a substation relay, such as the SEL-351 Directional Overcurrent and Reclosing Relay, to monitor points and send trip and close signals out to the circuit breaker. "At each of the six substations I've installed two SEL-2505 I/O Modules—one at each end of the track—that are talking to each other. The cabinets containing the SEL-2505 [Modules] go right inside the IMPulse control buildings. It has all the relaying that we need to handle the transfer-trip signals."

The substations were originally equipped with Weed Instrument Company, Inc., fiber-

optic transceivers. Weed says RTD wanted to reuse those transceivers to maintain a consistency of spare parts. Unfortunately, the Weed product had been discontinued and was no longer available. "However, Weed makes a little DIN-rail fiber optics setup that would do the job," says Morris. The Weed system was lower optical power, however, and conversions to copper-delivered signals decreased reliability.

Figure 3—The flexibility of the SEL-2505 Remote I/O Module allows engineers to upgrade the design of the electrical system transfer-tripping scheme using a utility-grade device with improved reliability, compact design, and improved communications. Using MIRRORED BITS communications between devices, data are typically transferred at a rate of 11 ms. Another advantage is the ability to replace control wiring to outside cabinets with fiber-optic cable to reduce dc ground exposure.

"The previous system was made by another company and it did the job," says Ken Moss, RTD systems engineer and project manager. "The Schweitzer system is possibly more reliable because it has a lot of optical power. So, we haven't had any problem with line loss over fiber-optic between the two. The transfer-trip signal is all carried over fiber-optic, which is a tremendous advantage over a copper system because of the electrical isolation that the fiber-optic provides between two substations. Also, the fiber optics provide substantial electrical insulation, so you don't have to worry about any ground potential rise due to a fault current."

Morris says that NEI specified SEL products because of broad industry acceptance and the broadest choice of microprocessor-based relays.

"From our standpoint, SEL gives us the most flexibility in setting the relays," Morris explains. "Plus, the SEL relay's features allow us to do more than some of the other relays. While SEL is not known for products that are designed for dc applications, the SEL-2505 application was exactly perfect for this one."

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About RTD's FasTracks

FasTracks is RTD's 12-year comprehensive plan to build and operate high-speed rail lines and expand and improve bus service and park-n-rides throughout the region. FasTracks includes: 119 miles of new light rail and commuter rail; 18 miles of bus rapid transit service; 21,000 new parking spaces at rail and bus stations; and expanded bus service in all areas. For more information, contact Regional Transportation District, 1600 Blake Street, Denver, CO 80202; phone: (303) 628-9000; or visit the website: www.rtd-denver.com

About NEI Electric Power Engineering

NEI Electric Power Engineering is an ideal resource for assistance in the development and completion of a vast range of power engineering projects—from basic projects all the way up to power plant and substation design. NEI services include consulting, startup, commissioning, and turnkey projects. Since 1982, NEI has provided state-of-the-art service and expertise to REAs and co-ops, municipal utilities, investor-owned electric utilities, large chemical and process plants, privately-owned power producers, heavy industry, commercial facilities, and many others. NEI provides professional expertise and design engineering services for all aspects of power system engineering. For more information, contact NEI Electric

Power Engineering, P.O. Box 1265, Arvada, CO 80001; phone: (303) 431-7895; fax (303) 431-1836; or visit the web site: www.neiengineering.com

About SEL

Schweitzer Engineering Laboratories, Inc. (SEL) has been making electric power safer, more reliable, and more economical since 1984. This ISO 9001:2000-certified company serves the electric power industry worldwide through the design, manufacture, supply, and support of products and services for power system protection, control, and monitoring. For more information, contact SEL, 2350 NE Hopkins Court, Pullman, WA 99163-5603; phone: (509) 332-1890; fax: (509) 332-7990; email: info@selinc.com; website: www.selinc.com.

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