# Protective Relays and Trip Units

The term switchgear is used to describe coordinated devices used for control and protection of equipment such as generators, transformers, capacitor banks, motors, and distribution lines. SIPROTEC 7SJ61, 62, and 63 are microprocessor-based protective relays designed to provide protective relay functions, metering, and control associated with switchgear circuit breaker installations.
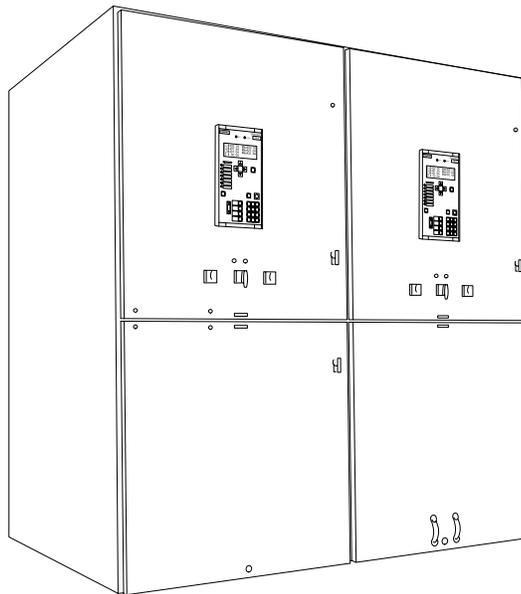
Type GM MV Switchgear

**SIPROTEC**

SIPROTEC is a trade name used by Siemens to identify a group of Siemens multifunction protection relays, such as the 7SJ61, 7SJ62, and 7SJ63. Multifunction protection relays provide the basic protection required in power systems, such as phase and ground overcurrent protection on feeder circuits, motors, and transformers. However, since they are microprocessor based, they can also communicate what is happening to the equipment they are protecting.

Examples of information they can communicate to the ACCESS power monitoring system include: protective element status, trip diagnostics, and integrated metering of the power at its input. SIPROTEC relay features are integrated into the ACCESS single-line animation, waveform support, and alarm handling.

SIPROTEC relays have integrated PLC logic and support multiple protocols. DIGSI is a software package available for SIPROTEC which supports documentation, archiving of relay data, and advanced diagnostics.
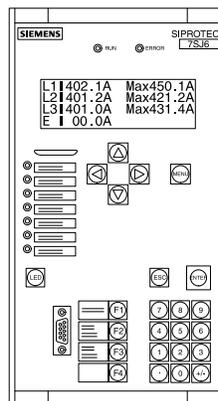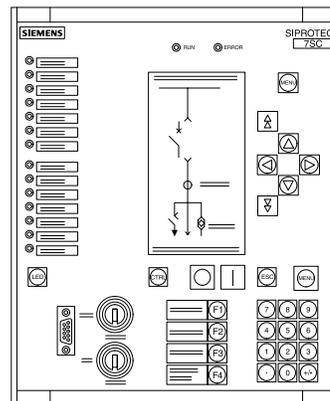


7SJ61                                7SJ63

# Circuit Breaker Trip Units

The following sections describe low voltage insulated case (ICCB), molded case (MCCB) circuit breakers, and Type RL circuit breakers with Static Trip III™ available for use with the ACCESS system.

**ICCB**

Siemens Sentron® ICCB circuit breakers are available in ratings from 800 to 5000 amps and are designed to supply high short time withstand and high interrupting ratings. Two types of interchangeable trip units are available for use with the ICCB and ACCESS system; the basic type TL trip unit and the high performance System Breaker Energy Communicating trip unit (SB-EC). Both trip units use a microprocessor to execute the numerous functions programmed in the unit.
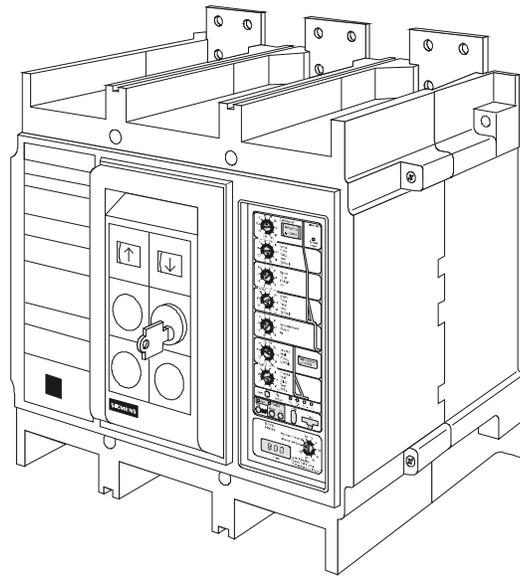
The TL trip unit features a full range of industry standard protective settings. The high-performance Systems Breaker Energy Communicating trip unit (SB-EC Trip Unit) offers advanced metering, protective relaying, time-stamped logs, and power quality monitoring functions. An LCD graphical display provides real-time voltage and current waveforms.
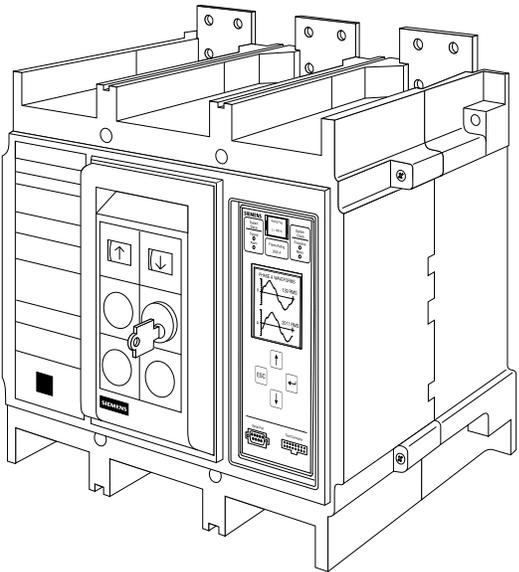
**MCCB**

Siemens Sentron MCCB circuit breakers are available in a digital version, referred to as Sensitrip® III. Sensitrip III circuit breakers utilize a microcomputer which makes it possible to customize overcurrent protection to match the loads of an electrical system. In addition, the Sensitrip III trip unit has communications capability when provided with an expansion plug and connected to a Multiplexer Translator. Sensitrip III can measure and communicate RMS phase current, pickup status, and communications status.
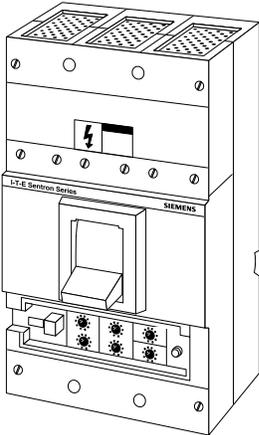
Sensitrip III MCCB
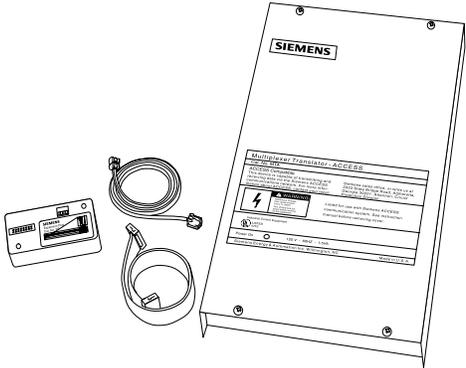
Muliplexer Translator Module
with Cables and Expansion Plug

**Type RL Circuit Breaker**

Siemens RL series low voltage power circuit breakers are used in Siemens low voltage switchgear. RL series circuit breakers are designed for up to 600 volt service with current capacities up to 5000 amps. The RL circuit breaker in the following illustration is shown with a Static Trip III™ trip unit.



Trip Unit

BDU
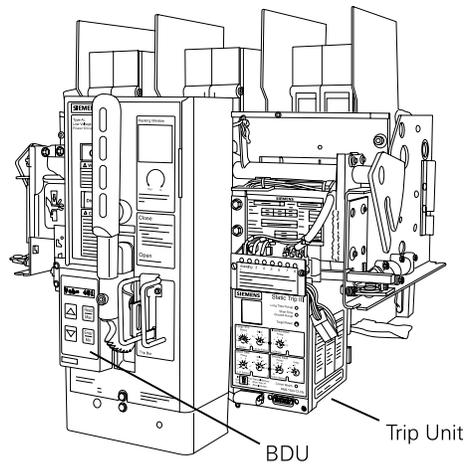
**Static Trip III**

Static Trip III™ units are microprocessor controlled, overcurrent protective devices for use on Type RL low-voltage power circuit breakers. An optional Breaker Display Unit (BDU) can be added to communicating trip units. The BDU displays real-time measurements, trip log, event log, and min/max values.
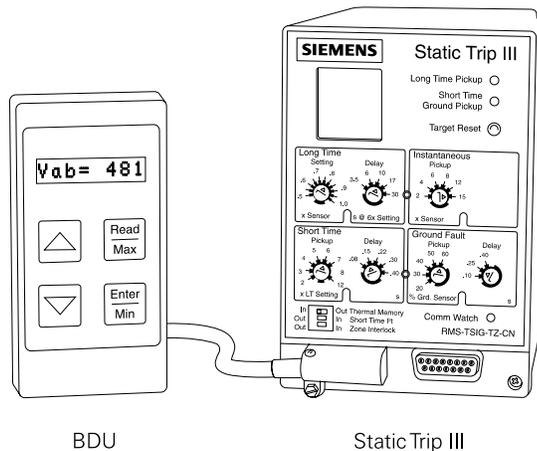


BDU                    Static Trip III

The Static Trip III consists of four models:

| Static Trip Family | |
|---|---|
| III | Basic Overcurrent Protection |
| IIIC | Added Communications and Current Metering |
| IIICP | Added Power Metering |
| IIICPX | Extended Protective Relaying |

A standard feature of the Static Trip IIIC, IIICP, and IIICPX trip units is an alarm output. Any measured parameter can be set to activate the alarm based on threshold and time delay set points. These units also include several logging functions for recording trip events, pickup conditions, alarm activity, and min/max measured values.

Static Trip IIIC, IIICP, and IIICPX trip units have added communication ability. Metered parameters can be displayed and configured locally on the BDU or remotely via the RS-485 communications port through the ACCESS system.

| Measured Value | STIIIC | STIIICP/CPX | Accuracy |
|---|---|---|---|
| Phase Current | ▓ | ▓ | 1.00% |
| Average Current | ▓ | ▓ | 1.00% |
| Ground Current | ▓ | ▓ | 1.00% |
| Phase Line-to-Neutral Voltage | | ▓ | 1.00% |
| Average Line-to-Neutral Voltage | | ▓ | 1.00% |
| Line-to-Line Voltage for all Phases | | ▓ | 1.00% |
| Average Line-to-Line Voltage | | ▓ | 2.00% |
| kW Total for all Phases | | ▓ | 2.00% |
| kWh Total for all Phases | | ▓ | 2.00% |
| kW Reverse | | ▓ | 2.00% |
| kW Demand | | ▓ | 2.00% |
| kVA | | ▓ | 2.00% |
| kVAR | | ▓ | 2.00% |
| kVARh Total for all Phases | | ▓ | 2.00% |
| Power Factor | | ▓ | 4.00% |
| Frequency | | ▓ | 0.25% |

# SAMMS

The Siemens Advanced Motor Master System (SAMMS™) is a microprocessor-based motor control and protection device. SAMMS LV units provides all motor starting functions and thermal protection. SAMMS is a compact system with programmable control logic that replaces timers, control relays, push-buttons, selector switches, pilot devices, and associated wiring.

Some of the more powerful features of the SAMMS unit include: motor run time hours, number of motor starts, number of motor trips, set point alarms, and ground fault protection.
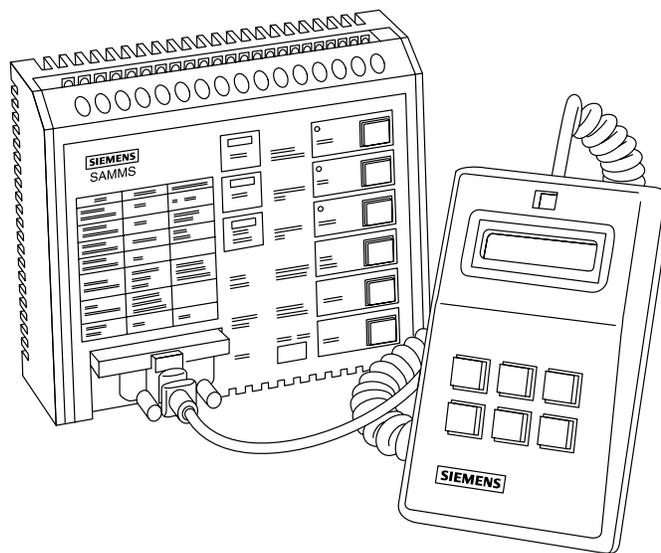
**ACCESS Communication**

SAMMS connects to SEABus through an optional SAMMS Communication Module (CM-1). The CM-1 provides an RS-485 interface to communicate with the ACCESS system.

Pins 5 and 6

1    16

SIEMENS

Two-Wire Cable

To 15 VDC

SAMMS Device

Ribbon Cable

RS-485 Cable

Data +
Shield
Data -

SIEMENS

CM-1
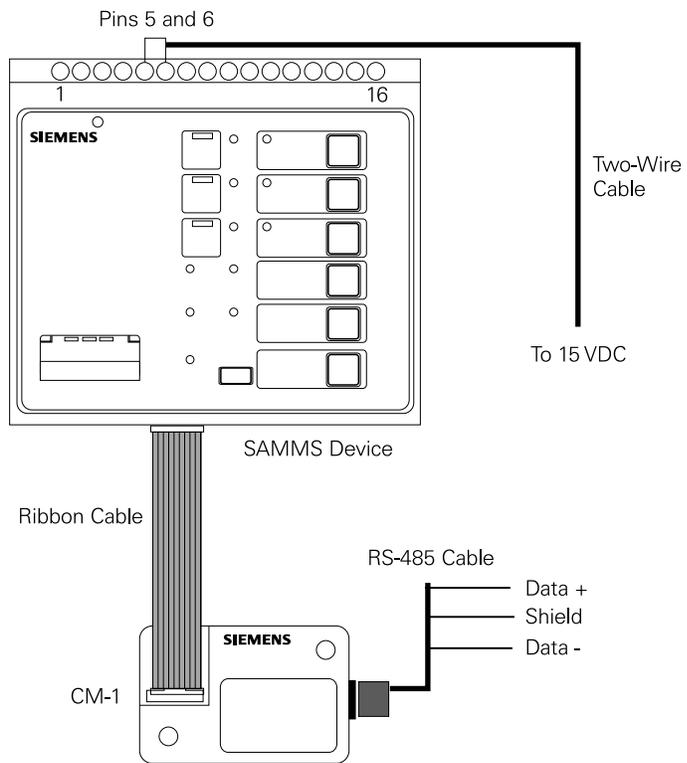
# S7 I/O Device

The S7 I/O™ device is an addressable modular input/output (I/O) device that links power system components to the ACCESS system. This device is a programmable logic controller (PLC), customized to communicate using SEABus.
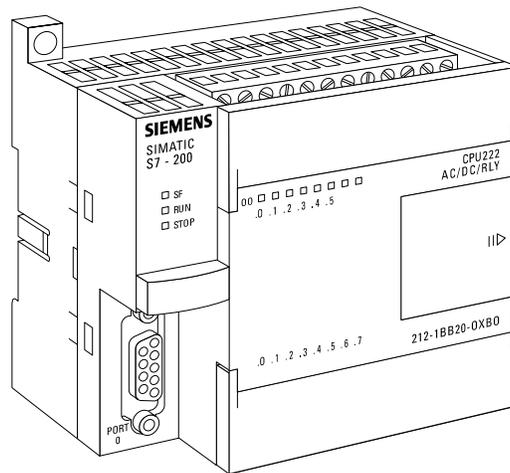


PLCs consist of input modules or points, a central processing unit (CPU), and output modules or points. An input to a PLC may come from a variety of digital or analog signals from various field devices. The PLC converts the input signal into a logic signal that can be used by the CPU. Output modules convert control signals from the CPU into a digital or analog signal that can be used to control various field devices.
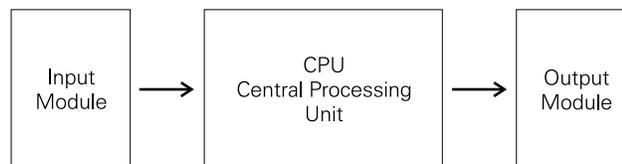
The S7-I/O device provides the capability to monitor and control power system elements that are not specifically designed for ACCESS. Remote monitoring of any device equipped with an auxiliary contact is possible. Inputs such as the temperature relay of a motor or transformer can be input into the I/O device. Status of any circuit breaker with auxiliary contacts can also be monitored. This is especially useful to monitor MCCB status when metering functionality is not required.

The outputs can be used to close contactors, trip circuit breakers, and provide remote indication. In combination with a power meter analog values such as current and voltage can be monitored.

Status of the input and output states, counter data, and event log data is communicated to other components of the ACCESS system through an RS-485 serial link.



Status Indication
(Digital)

Power Meter
(Analog)

Motor or
Transformer
Temperature
Relay
(Digital)

Communicate to
ACCESS via RS-485

Circuit Breaker
Status On/Off/Tripped
(Digital)

Voltage or Current
(Analog)
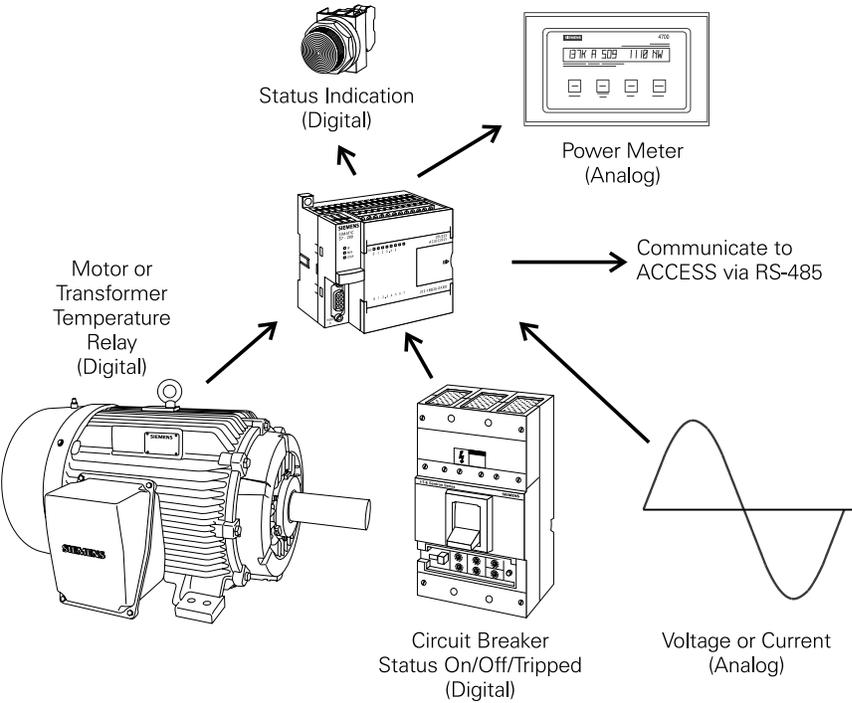
# Lighting Control System

Lighting accounts for a large percentage of commercial and industrial power consumption. With a lighting control system, interior and exterior lights can be controlled via override switches, photocells, motion sensors, and a time clock. This will significantly cut energy costs as well as offer a safe and user-friendly environment for occupants.

New energy codes are requiring lighting control on a state-by-state basis. ASHRAE 90.1 – 1999 calls for motion sensors, override switches and time clocks for commercial applications. These codes apply to buildings larger than 5000 square feet, non-24 hour operation, and non-emergency operation. California and Wisconsin have already adopted ASHRAE 90.1-1999 and several other states are expected to follow.
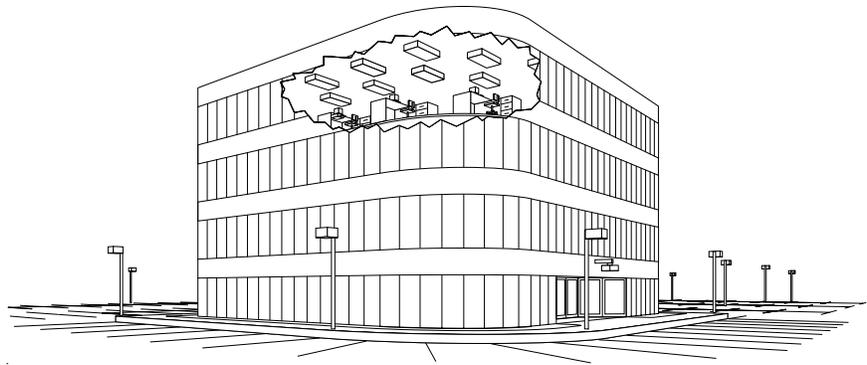
**LCP Products**

The LCP (Lighting Control Panel) family of lighting control systems is perfect for commercial applications such as schools, recreation centers, fast food, office buildings, prisons, and a variety of other applications. Depending on the specific LCP product, a lighting control panel can have up to 32 inputs and outputs. Four models are available: LCP 500, LCP 1000, LCP 1500, and LCP 2000. The LCP comes fully assembled with all specified relays in a NEMA 1 enclosure.

**LCP 500**
4 Inputs
4 Outputs

**LCP 1000 & LCP 1500**
8 Inputs
8 Outputs

**LCP 2000**
32 Inputs
Up to 32 Outputs
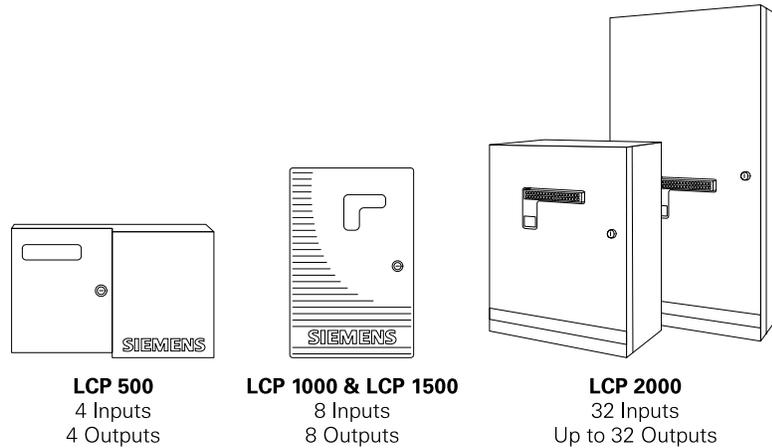
**Time Clock and Keypad**

The Siemens LCP also includes an astronomical clock for controlling timed events. Self-prompting instructions on an LCD screen make programming easy. A keypad is used to enter instructions for lighting circuit control. Optional EZ CONFIG software allows programming of a single cabinet or an entire lighting control network locally or via modem.

SWITCH1   TURNS
ON &  OFF  RELAYS
SHOWN BELOW:   --
01,  02,  04,  06, --
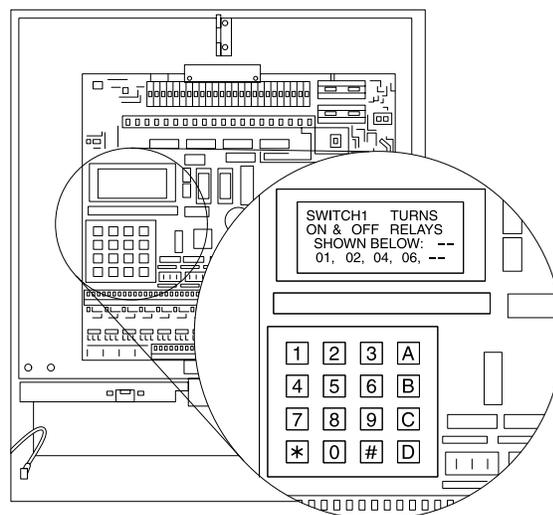
**System Accessories**

Several accessories are available to enhance the operation of LCP products. A photocell can be used to control lights based on the amount of ambient light in an area. Touch-tone phone control (LCP TIM) allows you to use any phone to override the lighting. The LCP 2000 seamlessly integrates with HVAC and building management systems via the ModBus gateway. This integration allows control by other systems of each individual LCP relay or group of relays from a single RS-485 connection. Up to 127 LCP's can be on a single network.



Phone Line

LCP TIM

PC with EZ CONFIG Software                          LCP 2000s
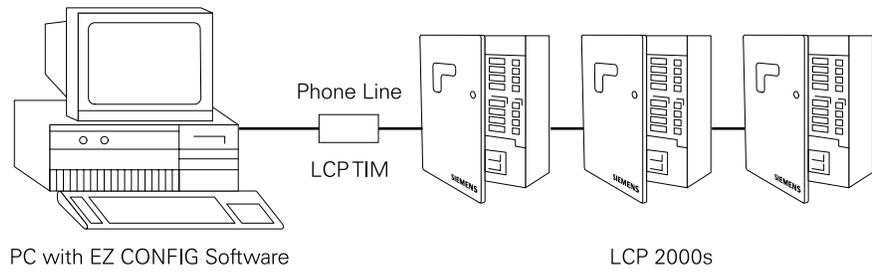
**VISION TOUCH**

VISION TOUCH software, working in conjunction with LCP PC programming software, provides a graphical interface of a lighting system. Once panels have been programmed, VISION TOUCH graphics offer real-time lighting management. Simply touch the area that you wish to control or use a mouse to select one of the preset buttons. Common applications include schools, stadiums, and prisons.

In the following example an LCP is used to control lighting of a gym with three basketball courts, a running track, and various exercise areas. VISION TOUCH is available only for the LCP 2000.



| Court 1 | Court 2 | Court 3 | Exercise Area | Running Track | Court Perimeter | Climbing Wall | Lobby | Lobby |
|---|---|---|---|---|---|---|---|---|
| Court 1-2 Curtain | Court 2-3 Curtain | Aerobics Curtain | Hoist Crt 1 North | Hoist Crt 1 South | Hoist Crt 2 North | Hoist Crt 2 South | Hoist Crt 2 North | Hoist Crt 2 South |
| | | | | | | | | |
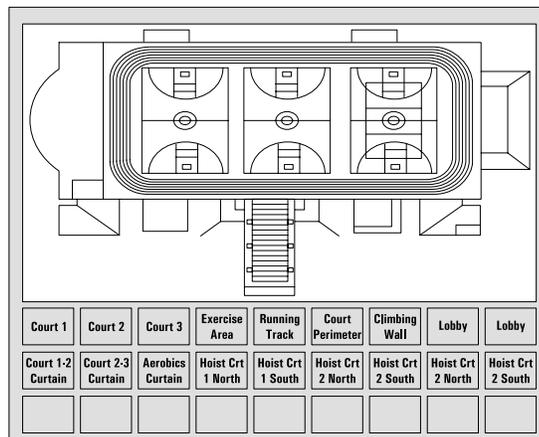
# ACCESS System Application Example

The following illustration shows an example of Siemens ACCESS system including hardware, software, and field devices. In this example Siemens power meters are located throughout the distribution system. Siemens software, WinPM and SIEServe, are used to record voltage, current, power, and harmonic events for use in other parts of the system. Several other components that make up the ACCESS system such as circuit breakers, SIPROTEC series relays, SAMMS, ethernet converters, and isolated multi-drop converters are also utilized.

ACCESS components are installed in Siemens switchboards, switchgear, and motor control centers. Siemens ACCESS devices are also installed in a retrofit application which could have been provided by another manufacturer.



Siemens Sentron™ LV Switchboard
Power Meter        Molded Case Circuit Breaker
SB Breaker and SB-EC Trip Unit
RS-485
MTA Multiplexer Translator
Ethernet Converter
Siemens Type GM MV Switchgear
SIPROTEC Relay    Siemens Type R LV Switchgear
Industrial Computer
DTU3005
Ethernet Converter
PLC
Isolated Multi-Drop Converter
SIEServe
WinPM
TCP/IP Network    RS-232
SAMMS-LV
Static Trip III CP
S7-I/O
Modem
RS-232
Siemens Series 81000™ MVC        Retrofit Application        Siemens Motor Control Center

1. _____ is a trade name used by Siemens to identify a group of multifunction protection relays.

2. Siemens Sentron ICCB circuit breakers are available in ratings from 800 to _____ amps.

3. Static Trip III overcurrent protective devices for use on Type _____ low-voltage power circuit breakers.

4. Static Trip _____ features extended protective relaying.

   a. III
   b. IIIC
   c. IIICP
   d. IIICPX

5. _____ is microprocessor-based motor control and protection device.

6. VisionTouch software is available for use with the _____ .

   a. LCP 500
   b. LCP 1000
   c. LCP 1500
   d. LCP 2000

7. The LCP 2000 can have up to _____ inputs and _____ outputs.

# Review Answers

**Review 1**          1) f; 2) 60; 3) current; 4) a

**Review 2**          1) c; 2) 1200; 3) 562.9; 4) b; 5) 1.41; 6) b

**Review 3**          1) 120; 2) 5; 3) c; 4) K factor; 5) a; 6) Apparent; 7) Power factor; 8) a; 9) d

**Review 4**          1) a; 2) b; 3) SEABus, SEABus; 4) node; 5) Ethernet converters; 6) 50; 7) 4000; 8) 32

**Review 5**          1) key; 2) 9300, 9330; 3) 15th; 4) GPS; 5; 9500

**Review 6**          1) SIPROTEC; 2) 5000; 4) RL; 4) d; 5) SAMMS; 6) d; 7) 32, 32

# Final Exam

The final exam is intended to be a learning tool. The book may be used during the exam. A tear-out answer sheet is provided. After completing the test, mail the answer sheet in for grading. A grade of 70% or better is passing. Upon successful completion of the test a certificate will be issued.

**Questions**

1.  Which of the following is a supervisory device?

    a.   9500 Power Meter   b.   WinPM
    c.   SIEServe           d.   LCP

2.  Which of the following is an example of a linear load?

    a.   Incandescent lighting
    b.   Ballested lighting
    c.   Variable speed drives
    d.   Computers

3.  The crest factor of a pure sinusoidal waveform is

    _____ .

    a.   0.707              b.   0.9
    c.   1.41               d.   2

4.  A _____ is when there is an increase or decrease in normal line voltage within the normal rated tolerance of the electronic equipment. These are usually short in duration and do not affect equipment performance.

    a.   Voltage Swell
    b.   Undervoltage
    c.   Outage
    d.   Voltage Fluctuation

5.      Type _____ disturbances last up to 0.5 Hz.

     a.     Type I               b.     Type II
     c.     Type III            d.     Type IV

6.      The _____ harmonic is a positive sequence harmonic.

     a.     1st                b.     2nd
     c.     3rd                d.     4th

7.      To help reduce the effects of harmonics it may be necessary to install _____ .

     a.     power factor correction capacitors
     b.     a UPS system
     c.     K-rated transformers
     d.     a voltage regulator

8.      The _____ meter has a high resolution graphical display.

     a.     9230            b.     4300
     c.     4720            d.     9500

9.      The _____ meter includes a front optical data port for accessibility by a portable PC.

     a.     4720            b.     9240
     c.     9300            d.     4700

10.     An advantage to loop topology over straight-line topology is the ability to _____ .

     a.     communicate with each device in the event of a break in the communication cable
     b.     reduce the amount of communication wire required
     c.     connect additional field devices
     d.     have longer runs

11. The rules that govern the communication of the ACCESS system are known collectively as _____ .

    a.    DNP 3.0        b.    SEABus
    c.    ModBus        d.    Profibus DP

12. A LAN can be arranged with nodes in a _____ configuration.

    a.    bus        b.    star
    c.    combination        d.    all of the above

13. _____ developed RS-232 and RS-485 standards.

    a.    CBEMA
    b.    Electronic Industries Association
    c.    Institute of Electrical and Electronic Engineers
    d.    U.S. Department of Commerce

14. _____ software provides a graphical interface of a lighting system when used with an LCP 2000.

    a.    SIEBus
    b.    VISION TOUCH
    c.    WinPM
    d.    SIEServe

15. One Isolated Multi-Drop Converter can handle up to _____ field devices.

    a.    4        b.    32
    c.    128        d.    232

16. _____ protective relays are designed to provide protective relay functions, metering, and control associated with switchgear circuit breaker operation.

    a.    SIPROTEC        b.    LCP 2000
    c.    S7/IO        d.    SAMMS

17. The Static Trip _____ provides basic overcurrent protection, metering, and extended protective relaying.

   a.  III                    b.  IIIC
   c.  IIICP                  d.  IIICPX

18. _____ is a motor control protection device

   a.  SAMMS                  b.  SIPROTEC
   c.  Static Trip III        d.  Sensitrip

19. Which of the following meters does not feature harmonic analysis?

   a.  9300                   b.  4700
   c.  9230                   d.  9500

20. Which of the following meters features GPS time synch?

   a.  9230                   b.  9500
   c.  9330                   d.  4720

# Notes

# Notes

# Notes