INCOM Lighting and Energy Management System

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Introduction

To meet the need for energy management, Westinghouse offers the INCOM 2000 Lighting and Energy Management System which uses advanced microprocessor-based control technology. The INCOM System is a cost effective alternative to the highly complex and expensive building automation systems or the low cost, but inefficient time clock for lighting and energy management control.

The INCOM System is a distributed control system designed for commercial, industrial and institutional facilities. It provides unequalled reliability, flexibility and cost effectiveness for lighting control and other energy management functions.

System Description

The INCOM System utilizes a personal computer (PC) as a master to control as many as 128 remotes, with each remote containing up to 42 relay outputs, or 5376 controllable loads in a single system. A custom card within the PC called CONI (Computer Network Interface) contains the Westinghouse-developed INCOM (INtegrated COMmunications) chip which provides two-way communications between the PC and the remotes. Each remote also contains an INCOM② chip which functions as an addressable "slave" to the CONI "master". Either control or data information can be passed from the master to the slave or slave to master by means of the INCOM network.

The communications network may be twisted-pair wire, coaxial cable①, powerlines①, fiber optics① or any combination of the four. The INCOM chip transmits and receives 33 bit binary data messages on the network in any asynchronous format. Each message begins with 2 start bits and ends with 1 stop bit. The binary messages may be one of three speeds; 300, 1200 or 38.4K bits per second (baud). A 300 baud rate is intended for powerline networks. The 1200 baud rate, intended for less noisy environments is used with twisted-pair. The 38.4K baud rate is intended for high speed networks consisting of fiber optics or coaxial cable. In all cases the INCOM chip is pin configured to handle all three baud rates.

The carrier is coupled onto the network by means of a small coupling transformer. This transformer, in combination with 2 filter capacitors, forms a tuned coupling network② which makes the network extremely selective and immune to noise. Another coupler is used to couple the signal onto the powerline①.

① Refer to Westinghouse for availability.
② Patent Pending

Westinghouse designed the INCOM System with the modularity and flexibility needed to meet the changing requirements of most buildings. It's expandable, so, as your control functions and/or controllable loads increase, additional solid state circuit boards and remote units can be added.

The INCOM System is listed under the UL916 Standard for Energy Management Equipment and has FCC approval.

System Hardware

Master Control Unit

The Master Control Unit is comprised of a personal computer, monitor screen, keyboard, a communications interface card, a clock/calendar with battery back-up and "user-friendly" software.

The personal computer is the monitor and the director of information which must be shared throughout the system. Control strategies, program scheduling, control from the monitor screen, and communication to and from the remote units are all orchestrated at the Master Control Unit. An optional printer can be used for data logging and report generation.

The system programs available at the Master Control Unit include: time and event scheduling, demand limiting, optimum start/stop, temperature compensated duty cycle, unoccupied cycle, dial-up load control, remote system access, remote unit hardware diagnostics, and data logging and report generation.

The INCOM System is essentially self-supervising once placed into operation. The System is, initially, configured to building requirements by entering time and event schedules according to preplanned control strategies. This program is stored in non-volatile diskette memory which can be quickly retrieved in the event of a power failure.

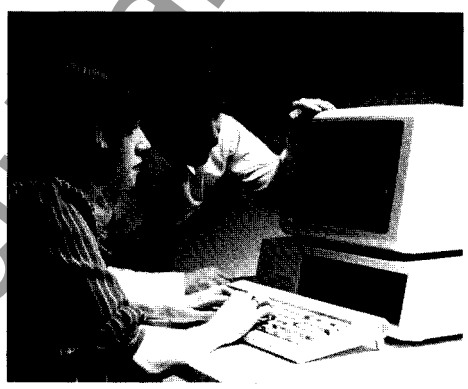
Remote Unit

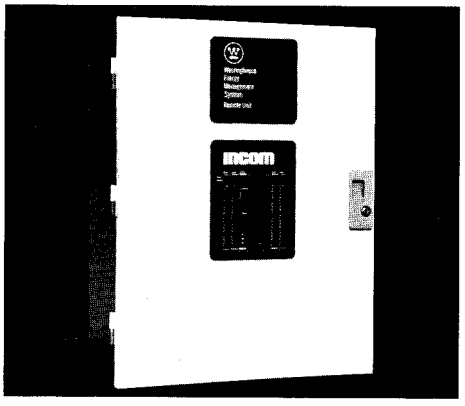
The Remote Unit is the key to providing local control and status indication of each relay in the system. Localized and discrete lighting and load control are obtained through individually programmed control points. The program configurations are downloaded into the Remote Unit from the Master Control Unit. Once downloaded, the Remotes retain their switch configuration map in non-volatile memory to provide local lighting control even in the unlikely event of a Master Control Unit failure.

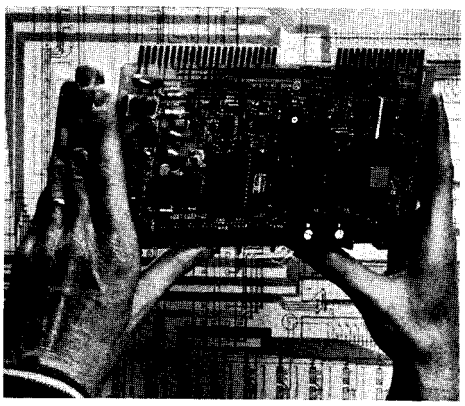
The Remote Unit contains its own power supply with breaker and fuse protection in addition to relays that directly turn loads on or off. The actual relay quantity is determined by the area covered, the number of zones/loads controlled and the number of lighting levels required.

With the addition of software at the Master and plug-in cards at the Remote, the System's capability can be expanded to include other energy management functions, such as, optimum start/stop, unoccupied cycle, temperature compensated duty cycling, or demand limiting.

Each Remote Unit contains a mother board which can hold as many as 8 daughter boards, of which there are 5 types (Figure No. 1).







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1. **Controller Board** – This card includes the INCOM chip and coupling network as well as a microprocessor which provides the intelligence for the Remote. The microprocessor also serves as an interface between the INCOM chip, the personal computer, and the other daughter boards. The Controller Board also provides a +5 volt power supply for the RR7 and RSI boards.

2. **Relay Boards** – Two different types of relay output boards are available: RR7 and RSB. Each remote unit can accept 2 relay output boards.

   The RR7 and RSB boards each provide the on/off control pulses for 21 latching relays. A status-indicating LED is provided for each relay output.

3. **Switch Input Board (RSI)** – Each of two such boards provides 21 switch inputs. The inputs can be used to provide either a local override for a relay within the Remote or sent to the Master for "SOFTPATCHING" to control relays in other Remotes as would be desired with a photocell input. Each switch can be programmed as maintained, momentary, alarm or global. A description of each input type is provided later in this Descriptive Bulletin under the ***Softpatch*** heading. The mode of each switch input is determined by the Master which downloads information to each Remote. Once configured, the Remotes will remember this information, even during a power outage.

4. **KW Demand Board (RKW)** – This board which contains a microprocessor and its own +5V power supply, accepts KW pulses from as many as 4 watt-hour meters. The INCOM System can accept up to 4 RKW boards to monitor up to 16 watt-hour meters. Two or three-wire meters can be read by a KW Demand Board. Meter constants (KW per pulse) for each meter and demand window width are sent from the Master to the Remote KW board. The pulses from all meters are totalized and used to generate both predicted and actual KW demand values. These values are sent to the Master for purposes of demand limiting by load shedding.

5. **Temperature Input Board (RTD)** – This board accepts eleven (11) temperature sensing 10,000 Ohm at 26°C resistive inputs. The INCOM System can accept up to 10 RTD boards for a total of 110 temperature inputs. Sensors can be used to sense indoor and outdoor temperature for optimum start/stop, unoccupied cycle or temperature compensated duty cycling.

   Each remote unit door contains a diagnostic window through which LED status may be viewed to verify proper baord operation, or to pinpoint problem areas.

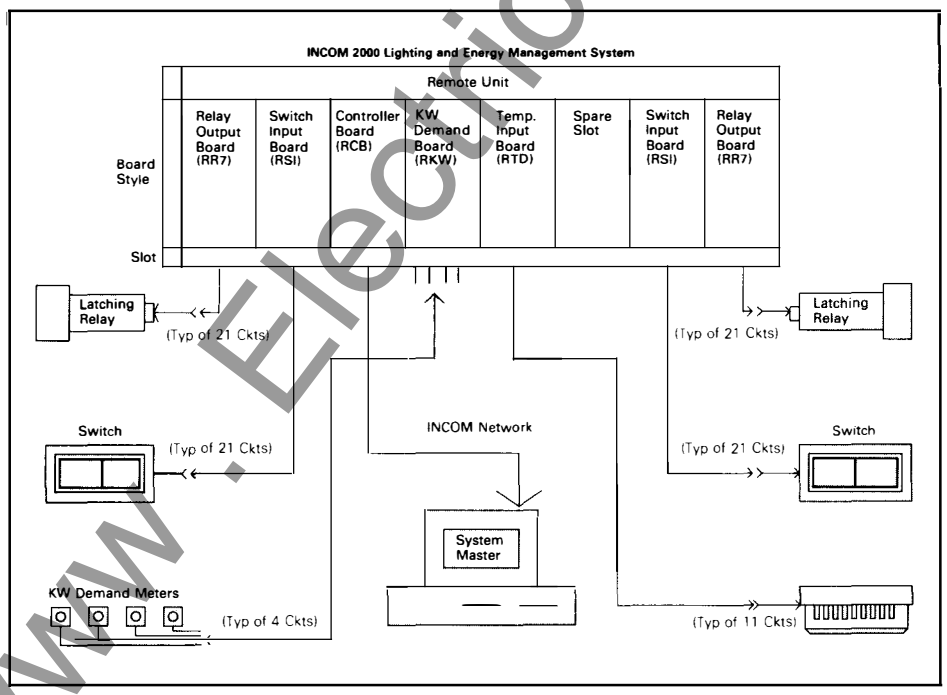

Figure 1

System Programs

Time and Event Schedules

Each load in the system may be controlled on a time basis, with up to 4 "on" times and 4 "off" times assignable per discrete load per day. The time schedules cover 7 days a week, 365 days per year with automatic leap year and Daylight Savings Time adjustments. Provisions are made for 3 unique "special day" schedules which may be assigned in place of the normal daily schedules. Each "special day" can run for 14 consecutive calendar days.

Softpatch

Local switch inputs can be programmed to one or more outputs in the system through the ***Softpatch*** function. The INCOM System can accept up to 5376 inputs. Switch inputs can be programmed to either a momentary, maintained, alarm or global mode.

Momentary inputs "toggle" 1 or 2 loads off and on with alternate pulses. Examples of momentary switches would be low voltage wall switches used for local overrides.

Maintained inputs are "status" indicators. If the switch is in the on (off) position, the load is in the on (off) position unless overridden by the Master Control Unit. Maintained inputs control 1 or 2 loads. Examples of maintained contacts are limit switches, wall switches or thermostats.

Alarm inputs are used to notify the Master that an input has been initiated. The alarm is then annunciated at the Master until acknowledged. Additionally, the alarm input's time and identification is logged into the alarm status file.

Global inputs are used when multiple loads are controlled from one input or when the switch input signals only one condition, "On" or "Off". Global inputs are maintained type inputs. For instance, photocells could be used as a global input to control interior, perimeter or exterior lighting.

① Refer to Westinghouse for availability.

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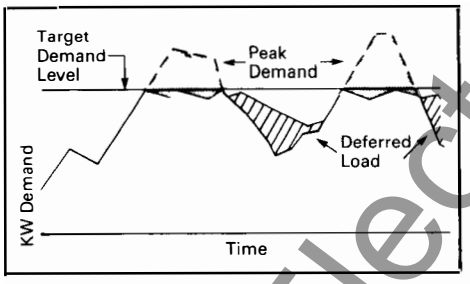
Temperature Dependent Demand Limiting
Most large facilities are billed for their peak electrical demand usage (kW) in addition to the amount of electrical energy consumed (kWh). Peak demand is the maximum electrical demand (kW) for a specific period of time during the month (usually 15 or 30 minutes). This peak demand can substantially increase your electric bill for the month. Where "ratchet" rates are in effect, the demand penalty may affect electrical bills for as many as 11 additional months.

To limit peak demand, the INCOM System utilizes a 15 or 30 minute sliding window method to continually monitor actual electrical power consumption. It then calculates a predicted level of usage (kW) and begins shedding up to 100 pre-determined loads to keep the actual demand usage below user defined limits. With the Temperature Dependent feature, loads will be shed or restored while user-defined comfort levels are maintained.

The System will support up to 4 RKW cards of which each can read 4 meters. The INCOM System also allows demand controlled loads to be set with minimum ON and OFF times. This feature helps to assure that equipment is not damaged due to short on-off cycles. Another unique feature of the demand limiting function is the rotatable load option. This feature will rotate only those loads assigned as "rotatable" so that the priority changes each 15 minute interval and the same loads are not consistently the first ones dropped in the demand limiting function.



Demand Limiting

HVAC Control
The INCOM Lighting and Energy Management System performs many of the functions offered by more expensive building automation systems. The INCOM System is ideally suited to control unitary, packaged and rooftop HVAC systems. The INCOM System interfaces with the HVAC system in the control circuit and enables and disenables the system given the temperature inputs received from RTD type sensors as illustrated in Figure No. 2. This is particularly attractive for retrofit applications where minimal expense is incurred by adding more sophisticated energy management strategies to the existing HVAC system.

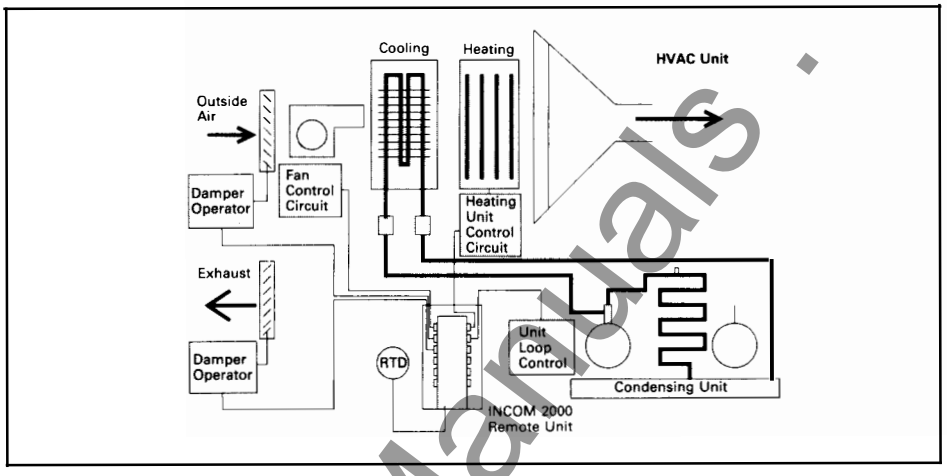


Figure 2

Many office complexes, industrial plants, warehouses, large retail stores and hotels use dispersed rooftop or unitary HVAC units which are easily controlled by our distributed "smart" Remotes. The INCOM System provides a combination of discrete lighting control, demand control, and HVAC energy management strategies which allow you to optimize your energy savings. The energy management strategies available are:

1. Adaptive Optimum Start/Stop
Time clocks used in starting and stopping the operation of the building's mechanical system are inefficient most of the year. Many mechanical systems are started one to two hours prior to occupancy and are left running far after the majority of people are gone.

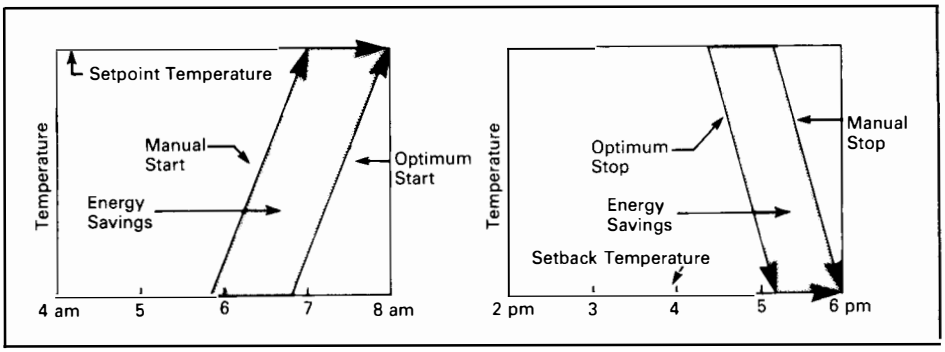
The INCOM System's Optimum Start/Stop program monitors the inside and outside temperatures and calculates how long it takes the mechanical equipment to prepare the building for occupancy. Mechanical equipment is started "optimally" to utilize only the necessary energy required to prepare the building for occupancy.

Optimum Start/Stop shortens occupancy preparation time on mild or typical days, thereby reducing energy cost. On extreme hot or cold days the preparation time is lengthened to assure the occupants' comfort upon arrival. Toward the end of the day the program determines how soon the mechanical equipment can operate at unoccupied levels, thereby allowing the inside air temperature to coast within comfort levels for the remaining occupancy time.

The Optimum Start/Stop program actually learns from history the heat transfer coefficient of the building. If the temperature does not reach the desired comfort level by occupancy time it starts the mechanical equipment earlier the next day. If comfort levels are reached prior to desired times the equipment will be started later the next day.

As a result a minimum amount of energy is used in preparing the building for occupancy.

The INCOM System provides up to 100 different Optimum Start/Stop programs. Each program has its own comfort levels and temperature input requirements. The System is ideal for applications with many diverse mechanical loads such as multiple heat pumps, unit heaters, or multiple packaged HVAC equipment.



Optimum Start/Stop

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2. Temperature Compensated Duty Cycling
Once the INCOM System has prepared the building for occupancy, Temperature Compensated Duty Cycling can be used to reduce energy usage throughout the work day. Temperature Compensated Duty Cycling consists of shutting down up to 100 loads for short periods of time during normal working hours without sacrificing the comfort of the building occupants. The INCOM System constantly monitors the outside temperature and space temperature within the building and calculates how long it can keep each piece of equipment off before comfort levels are affected. Periodic cycling of various energy consuming loads can result in significant energy savings. To insure that equipment is not over stressed each load can be assigned minimum on/off times and a maximum off time.

Many engineers feel that duty cycling may damage motors, but other studies suggest that duty cycling may not cause problems when the motors being cycled are relatively small – 50 Hp or less. Still other studies suggest no damage will occur when the motor is no larger than 250 Hp. "Soft start" could make this application more feasible for large motors. Check the motor manufacturer to determine the proper parameters for duty cycling.

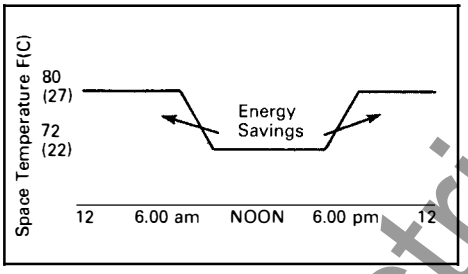
3. Unoccupied Cycle
Most buildings do not require stringent temperature controls 24 hours a day or on weekends. After hours the INCOM System can relax temperature controls for the building. For instance, during unoccupied periods the INCOM System can setup the space temperature in the building at 80°F in the summer months or setback the temperature at 55°F in the winter.

Allowing the INCOM System to automatically control the temperature settings is more reliable and timely than assigning the responsibility to an individual. Combining the unoccupied cycle feature with optimum start/stop will help maximize energy savings for your facility. Overrides can be provided to allow people to work after normal working hours. In addition the unoccupied cycle serves to protect the building by maintaining minimum safe temperature conditions.

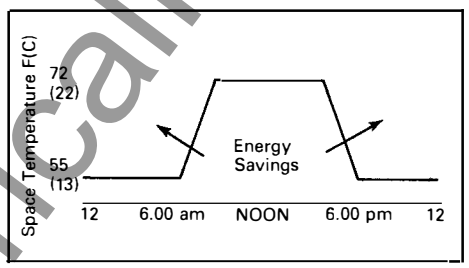
Remote System Access
Through standard telephone lines and additional modems, the INCOM 2000 system may be accessed from a remote controller. This allows all monitoring, control and editing features normally performed at the Master Control Unit to be done from different locations. This feature is especially useful for off-site monitoring and control during unoccupied periods, or for access to several systems from a central location.

Remote Unit Diagnostics
A Remote Unit diagnostic program is also available to trouble-shoot problems. This program, accessed through the Master Control Unit, identifies which remote unit(s) in the system is malfunctioning and will also denote which board(s) within the Remote Unit is not responding properly. This can reduce system downtime and also save time and money on service calls.

Data Logging and Report Generation
These special functions provide timely information which allows the building owner or manager to more effectively operate their buildings, by logging such parameters as electrical energy usage, demand, temperature, etc.



Summer Setup



Winter Setback

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Lighting Strategies
Depending upon the facility, lighting can account for 25 to 50 percent or more of a commercial or industrial building's total energy load. The INCOM Lighting and Energy Management System offers a reliable, flexible and yet economical control system which can help you manage your lighting usage.

The INCOM System provides both central and local lighting control. The Master Control Unit can control up to 5376 loads by time or event scheduling or an operator can dynamically monitor and control loads from the Master Control Unit. Locally, binary switch inputs can be used for local switching and overrides. (See Figure 3).

The INCOM System can be programmed to determine the exact period that certain zones are to be illuminated and to what degree each zone is to be illuminated. For example, after working hours all lighting can be turned off and lighting levels can be reduced to one-third in the zones currently occupied by cleaning crews. The cleaning crew can literally be paced through the building, by turning zones on at predetermined times, to minimize energy costs in addition to improving productivity.

Light level control is achieved through the use of 3 or 4 lamp fixtures providing 2 or 3 level lighting selections (see Figure 4). Different lighting levels can be used for office hours, cleaning crews, and security personnel.

Dial-up Load Control
With Dial-up Load Control, the INCOM System is accessed by an ordinary touch-tone telephone and upon receiving up to 5 numerical digits via the telephone's keypad, the INCOM System will control selected loads independently of the event schedule. For example, a user could control lights in his area by inputting his phone number, if that number was programmed as the load I.D. This feature permits even greater flexibility in the INCOM System installations.

Sales and Service

The Westinghouse network of over 100 sales and service offices can provide you with expert assistance at any point during the design, installation or operation of the INCOM 2000 System. Preventive maintenance and training programs are also available.

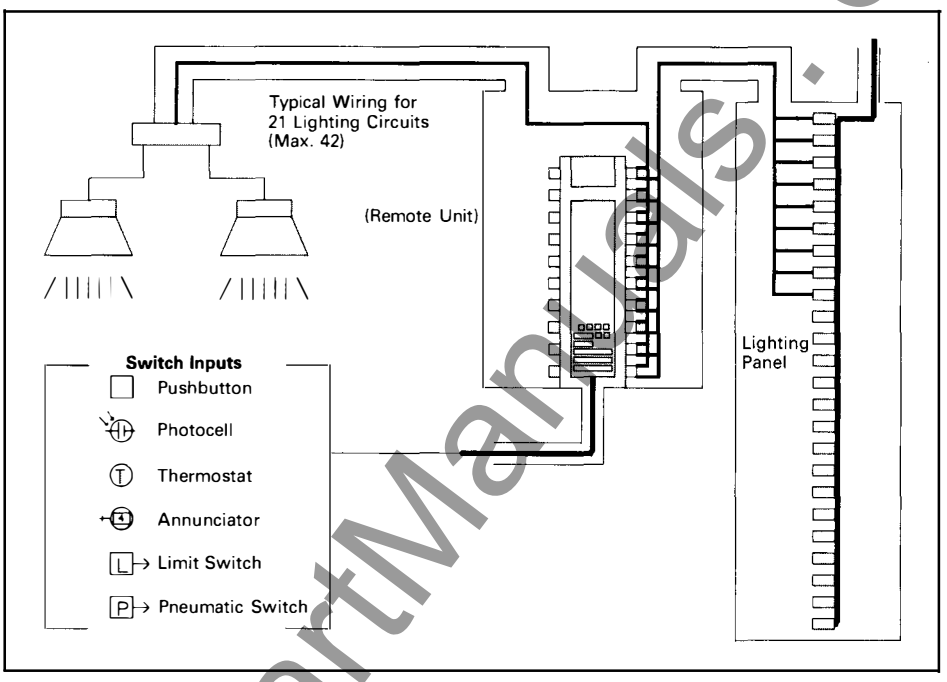

Figure 3

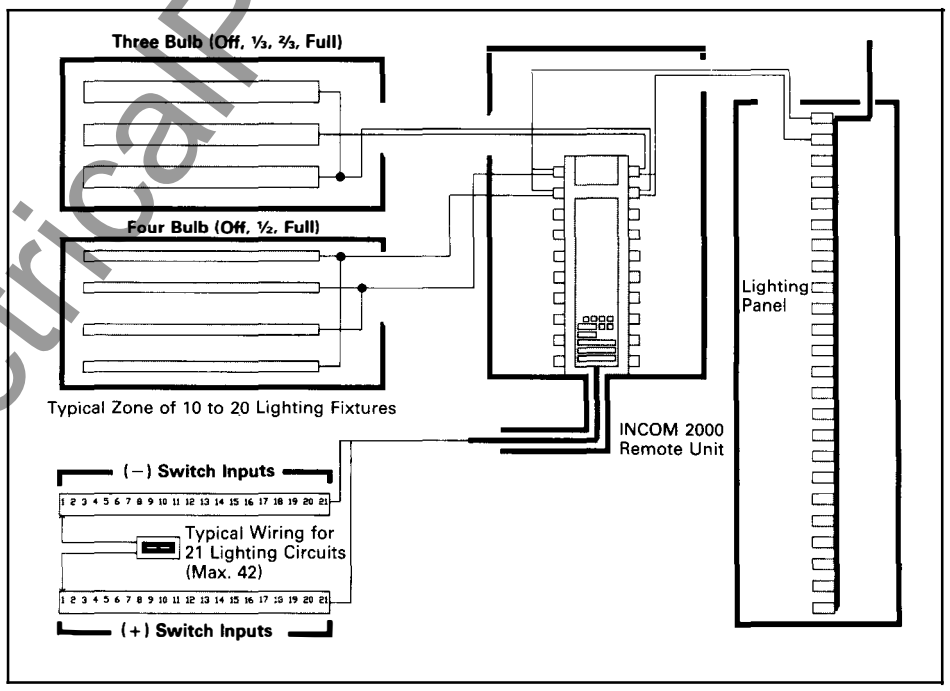

Figure 4

INCOM Lighting and Energy Management System

INCOM System Features and Benefits

Features	Benefits
INCOM integrated communication chip	Reliable, low cost two-way system communications
All printed circuit boards environmentally tested	Increases system reliability and reduces downtime
Error-detection system	Reduces potential for invalid commands
Built-in diagnostic aids	Reduces time and cost of installation, operation, and maintenance
Factory wired, low voltage connections	Lowers installation cost and increases reliability
Modular construction and design	Easy and economical installation allowing system to expand with building needs
Remote unit combines control and power voltage connections in same enclosure	Eliminates the need for additional hardware and installation
Compatible with building electrical distribution and HVAC systems	Provides discrete control of lighting and other loads to maximize energy savings
Four-level access codes	System security
User-friendly	Requires no technical expertise to operate
Telephone override	Control selected loads independent of event schedule
Modem Interface	Remote system monitoring, diagnostics and programming
On-line full-screen editor	Minimizes start-up and provides real-time system monitoring
Disk Copying/formatting capability	Economy and ease of operation
Listed under UL916 Standard for Energy Management Equipment	Personnel safety
FCC approved	Does not interfere with other building electronic equipment
Softpatch	Maximum flexibility of control points without costly hardwire changes

Specification Guidelines

General

1. The Lighting and Energy Management System shall utilize a personal computer as a Master Unit to control as many as 128 Remotes and up to 5,376 discrete outputs.
2. The Lighting and Energy Management System shall be capable of accepting up to 5,376 inputs. These inputs shall be programmable to several modes for system and application flexibility — Momentary, Maintained, Alarm, Global, and Demand Reset.
3. A communications card within the personal computer shall contain a transmitter/receiver chip which provides two-way communication interface between the Master and the Remotes.
4. In order to provide reliable communications between the Master and the Remote, a selective frequency tuned carrier with a narrow bandwidth of less than 1% of the rated carrier frequency shall be used.
5. Communication lines may be extended over 5,000 feet without repeaters. Communication lines shall be immune to ground shorts and noise due to its selective frequency and transmission characteristics.
6. The Lighting and Energy Management System shall be listed under the UL 916 Standards for Energy Management Equipment and comply with FCC Class "A" requirements.
7. All electronic components and boards must be tested as an assembly prior to shipment to the job site.
8. The lighting and energy management system manufacturer shall have a local service office which can assist in installation start-up, servicing, and training.
9. Installation start-up and training shall be provided by the lighting and energy management system manufacturer. Provide 1 day of engineering start-up service for every 6 remotes in the system. For every 5 personnel requiring training provide 1 day of training.

INCOM Lighting and Energy Management System

Specification Guidelines, *Continued*

Master Control Unit

1. The Master Control Unit shall be a minimum 320K personal computer with the following accessories:

   a. Full size monochrome screen
   b. Full size keyboard
   c. Communication network interface card
   d. Real-time clock with battery back-up

   Dual diskette drive personal computers shall be used for controlling 32 Remotes or less. For the control of more than 32 Remotes, a personal computer with 1 diskette drive and 1 – 10 megabyte hard disk drive shall be used.

2. Software shall be user-friendly and menu driven with the following features:

   a. Event and Time-of-Day Scheduling
   b. [Demand Limiting]
   c. [Temperature Compensated Duty Cycling]
   d. [Adaptive Optimum Start/Stop]
   e. [Unoccupied Cycle]
   f. [Dial-up Load Control]
   g. [Remote System Access]
   h. [Remote Unit Diagnostics]
   i. [Data Logging]

      i. [Thirty-five Day Demand and kWh Consumption]
      ii. [Temperature]
      iii. [Alarms]
      iv. [Load Status]
      v. [Load Activity]
      vi. [Tenant Billing – future]
      vii. [Remote Unit Diagnostics]

   [ ] – Indicates Optional Programs

3. Master Control Unit shall have an option to accept a parallel printer.

4. Master Control Unit shall have an option for Dial-up Load Control board with (one/two/three) telephone lines inputs.

5. Master Control Unit shall have an RS-232-C port option for remote monitoring through a modem.

6. System security shall be provided through 4 user defined passwords establishing 4 levels of system entry:

   a. Operator (System Monitoring)
   b. Programmer (System Editing)
   c. Engineer (System Editing and Configuration)
   d. Manager (All functions & Security Code Assignment)

7. Master Control Unit shall have auto-reboot capabilities to bring system back online after a power failure.

8. The Master Control Unit's dimensions shall not exceed 24'' x 20'' x 20''.

Remote Unit

1. The Remote Unit enclosure shall be surface-mounted of NEMA Class 1 construction, 14 gauge cold, rolled steel with baked enamel finish.

2. Two levels of hardware access shall be provided for personnel safety. A keylock for the door and, with the door open or removed, personnel shall not be exposed to any voltage over 60 volts for safety. A shield plate shall be provided to protect personnel from voltages in excess of 60 volts.

3. Each Remote Unit shall contain its own power supply, with input power of 120 or 277 volts as noted in the schedule.

4. Transformer power supply shall be protected by a fuse. Transformer power supply shall not exceed 48 VA per remote.

5. The Remote Unit shall be modularly constructed and capable of being shipped in sub-assemblies to coincide with the construction and installation schedules.

6. Each Remote Unit shall be capable of handling from 1 to 42 mechanically latched relays with contacts rated 20a – 277 VAC ballast, .5HP – 125 VAC. Relay output requirements for each Remote are noted in the schedule.

7. Each Remote Unit shall have On/Off/Restore Bypass capabilities for trouble shooting and emergency operations.

8. Each Remote Unit shall have built-in diagnostic aid for trouble shooting and ease of start-up. A diagnostic window shall be provided so that personnel can determine printed circuit boards status without entering the Remote Unit.

9. The Mother Board shall be a passive device containing no active electronic components. All electronic components shall be contained on the optional Daughter Boards to facilitate diagnostics and trouble shooting.

10. Daughter Boards shall be provided to meet specific applications. Reference schedules for quantities required. The Daughter Boards shall include:

    a. Controller Board (Standard) – This board shall provide the communications between the Remote and the Master. A Remote shall accept one controller board. Diagnostic LED's shall be provided.

    b. Relay Output Boards – Each of 2 relay output boards drives 21 outputs for a maximum of 42 outputs per remote. Diagnostic LED's shall be provided.

    c. Switch Input Boards – Each of 2 switch input boards provides for 21 inputs for a maximum of 42 inputs per remote. Diagnostic LED's shall be provided.

    d. KW Demand Board – A Remote Unit shall accept 1 demand board. Each demand board shall be capable of reading 4 kW meters for demand limiting applications or monitoring. A total of 4 demand boards can be used in a single system to read a maximum 16 kW meters. Diagnostic LED's shall be provided.

    e. Temperature Input Board – A Remote Unit shall accept 1 temperature input board. Each board accepts up to 11 temperature sensors for energy management functions. A total of 10 temperature boards can be used to read a total of 110 temperature inputs system wide.

11. To minimize damage to the Remote Unit's electronics, the power supply shall have a combination breaker/switch on the low voltage (less than 60 volts) side. Additionally, each Daughter Board shall have on-board overload protection in the form of Pico fuses.

12. The Remote Unit power supply and low voltage relay connections shall be shipped prewired to minimize installation time and wiring errors.

13. The Remote Unit shall be operated in an ambient temperature range of 0 to 50 degrees Celsius. The ambient humidity rating shall be 90% relative humidity at 32 degrees Celsius.

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