
Intellitec

## Custom Tailored
## Vehicle Electrical System

## Users Manual

# PROGRAMMABLE MULTIPLEX CONTROL

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# The PMC System

## *INTRODUCTION*

The Intellitec Programmable Multiplex Control is a communications and switching system designed to be used primarily on specialty vehicles to make the design and manufacture of the those vehicles easier and less expensive. Flexible in its implementation allows it to be easily used for most signaling and switching functions on the vehicle.

PMC brings a completely new approach to vehicle design. It is not like designing a vehicle harness, or a printed circuit distribution board, where every "i" must be dotted and every "t" must be crossed before installation begins. As long as all the switch and sensor inputs and all the loads you wish to control are connected to a module somewhere in the system, the rest is a simple matter of using the Windows™ based program setup. All the relationships between inputs and outputs are changeable. If the system does not work right the first time you wire it, it does not mean a complete redesign. All you do is plug the computer into the vehicle and modify the setup. If a new switch or load is added, the entire harness does not need to be changed. Just connect the device to the nearest available output module, change the program setup, and you are on your way.

The PMC system uses 160 channels to transmit data throughout the vehicle. The function of each of these channels can be defined by the designer to be an input, or an output function. The data on that channel is then available on the multiplex bus for use throughout the system. The definition of each channel is done by the selection of the modules, which will be explained later. The relationships of these inputs and outputs are then defined by the designer through a Windows™ based program using simple Boolean algebra. If you are not familiar with Boolean algebra, the following chapters will help you understand it.

A principle advantage of the PMC system is the flexibility it offers the user, both at the point of design and later in the field when the vehicle needs functional updates. Since most electrical functions of the vehicle are available on the multiplex bus, nearly unlimited numbers of interactions can be accomplished simply through the programming of the system.

The modules of the system "communicate" with each other using Intellitec's proprietary multiplex scheme (U.S. Patent No. 4,907,222 and other Pat. Pend.). A detailed explanation of this system is available in this manual. A multiplex system is one that allows the transmission of multiple "bits" of information down a single wire. This can save significant amounts of wire and connections, lowering costs, weight, and improving reliability. There are many different methods of multiplexing. It is not a new idea, but has been in use for more than fifty years. Multiplexing is used in everything from aircraft to the desk-top computer. The advent of low cost, solid-state electronics and the demand for control of more electrical and electronic loads, has made it become attractive for more and more applications. It is now the practical solution for the increasing wiring problems in today's modern vehicles.

Intellitec's system is a time division scheme in which time is divided into a given number of segments, each representing a unique bit of information. In the case of the PMC system, the number of time slots is 160. At any given time, one of these bits of information is placed on the "bus" and is available for any of the transceivers to use as needed. Each of these time slots is 250 microseconds long (.000250 seconds). A complete set of 160 channels requires only 40 milliseconds (.040 seconds) to be sent on the "bus". This means that each input and output channel is checked for its proper status every 40 milliseconds.

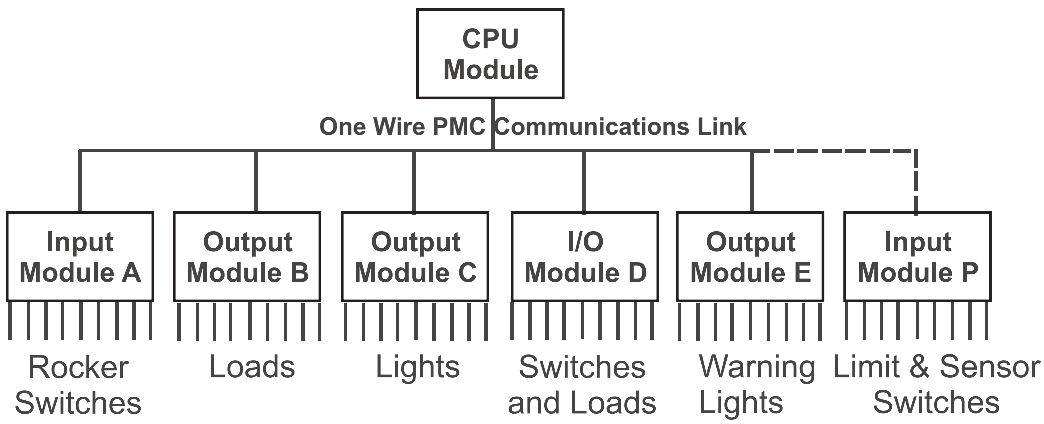
# The PMC System

The PMC system consists of a Master CPU Module and a series of remote Input/Output modules. The CPU module is the "traffic cop", setting up the time slots. It also contains the vehicle specific setup program that determines the relationships between the signals on the bus. The I/O modules provide access to the system, both inputs and outputs. They are generalized units designed for flexibility in the vehicle application.

There can be up to sixteen unique addresses for I/O modules. Each module can include up to ten channels. Each channel represents a switch input, or output to operate a load. The address of the I/O modules is identified by jumpers on each module with an address of A through P (1 - 16). Then, each channel of the module will have a unique address, controllable by the CPU.

When a system is assembled, it will look like this:

### *16 MODULES WITH 160 INPUTS OR OUTPUTS*




***PC INTERFACE*** Windows 95™ based Graphical User Interface is utilized to simply point and click to identify relationships between inputs and outputs.

***TIMERS*** There are ten software timers that can be used to create timed functions such as flashers or delayed turn off's, eliminating the need for separate timer modules.

***CHANNEL IDENTIFICATION*** Each channel has the capability of being named by the OEM. This allows easier programming. The names are also stored in the CPU for future diagnostics.

***DIAGNOSTICS*** Although 99% of the PMC system can be diagnosed with just a commonly available Volt Meter. A diagnostic system is incorporated in the Windows software. Other diagnostic test equipment is also available.

***SLEEP MODE*** If sleep mode is enabled, all loads are automatically turned off , and the CPU and I/O modules draw less than 40 ma., significantly reducing battery drain.

***HIGH SPEED CHANNELS*** Four such channels are available to control time critical functions such as brake lights.

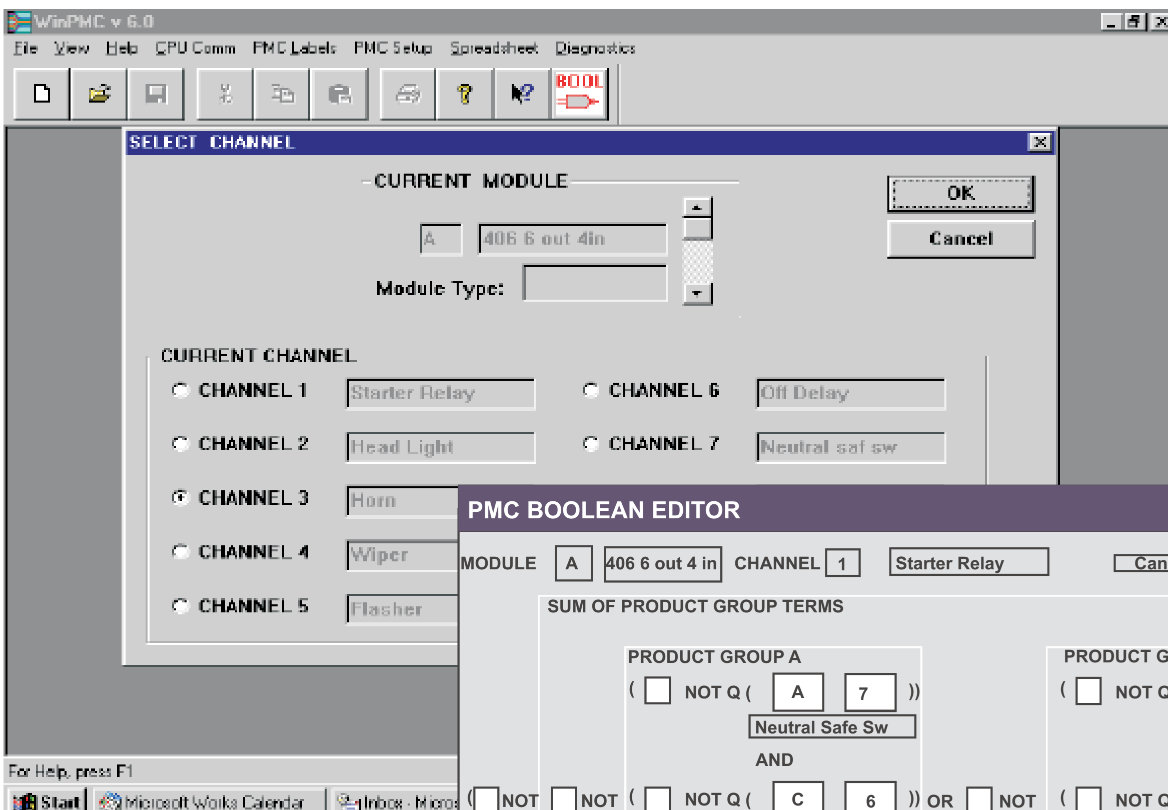
***VIRTUAL MODULES*** The virtual modules exist in memory on the CPU and are used to expand Input to Output relationships. With this extra memory, system programming capabilities can be expanded to meet complex vehicle logic requirements.

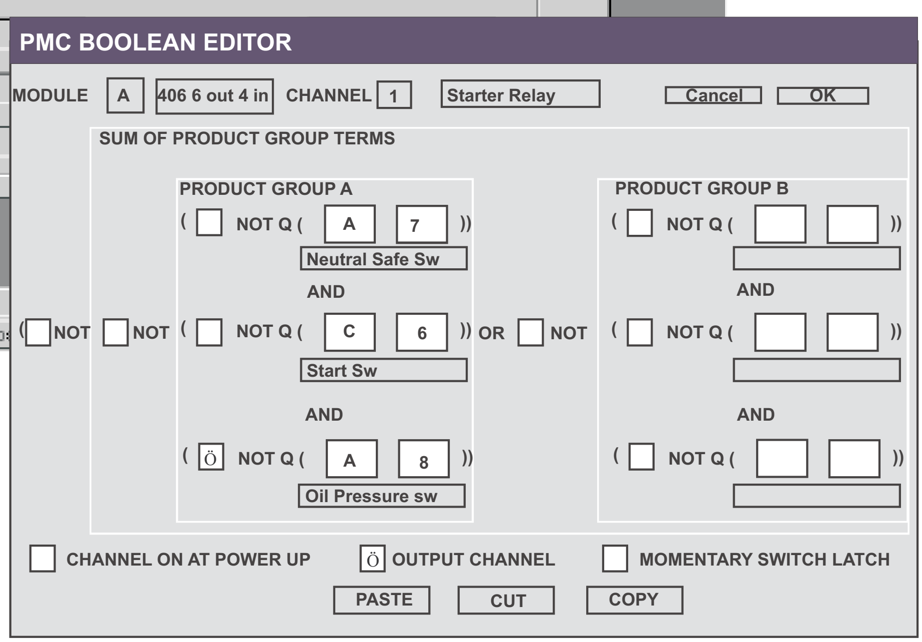
# Set-Up Example

Set up using Boolean Algebra may sound complicated, but is really very simple. The picture below on the left is a representation of one of the graphical user interfaces that are used in the PMC Windows based software. The software allows you to label each of the modules and their inputs and outputs. This makes them all easily recognizable and programming the vehicle less confusing.

The screen to the right is used to define how a particular output is turned on. In this case channel A1, the starter relay, is turned on when the neutral safety switch, the start switch and the low oil pressure switch are all in the "on" position. Changing the relationship is as simple as a few mouse clicks. Any switch that is connected as an input anywhere in the system can be used to control an output as many times as you like. For example, you may wish to use the neutral safety switch, as shown here, and then use it again to act as an interlock for another output.

As you can see in the diagram, items listed vertically produce an "AND" relationship and those listed horizontally produce an "OR" relationship. Although it may appear that the number of AND and OR's are limited, you will see in further chapters that the number of ANDs and ORs are almost unlimited. Additional information will be provided in later chapters.




The starter relay equals the neutral safe switch and the start switch and not the oil pressure switch.

# Chapter 2
# Data Sheets
# PMC Modules

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# PMC Family Specifications

| | |
|---|---|
| **Ambient Temperature Range** | **-40 C to +85 C (-40 F to +185 F)** |
| **Vehicle System Voltage Range 12 Volt System** | **10 to 18 Volts** |
| **Vehicle System Voltage Range 24 Volt System** | **20 to 36 Volts** |
| **CPU only Voltage Range** | **10 to 36 Volts** |
| **Short Term over voltage protection** | **52 Volts** |
| **Positive voltage spike protection** | **+150 Volts** |
| **Negative Voltage protection (continuous)** | **-300 Volts** |
| **Input voltage threshold** | **+ 6 Volts** |
| **System operating current (CPU + 16 modules)** | |
| **PMC sleep mode current (CPU + 16 modules)** | |

Note: PMC operating and sleep mode currents include only the operating current of the PMC modules. Specifications do not include items such as warning lamps, switch backlighting, etc.

Items with * are proposed or in development.
Check with Intellitec for availability

| Page | Part No. | Description | | |
|---|---|---|---|---|
| **Central Processing Units** | | | | |
| 2-5 | 00-00620-021 | 160 Channel Central Processing Unit | +12/24V | |
| 2-7 | 00-00800-022 | 320 Channel Central Processing Unit | +12/24V | |
| **Output Modules** | | | | |
| 2-9 | 00-00621-406 | 4 point DC Input / 6 point Relay Out | +24V | 10 Amp Fused, Relay Output |
| | 00-00621-416 | 4 point DC Input / 6 point Relay Out | +12V | 10 Amp Fused, Relay Output |
| | 00-00621-426 | 4 point DC Input / 6 point Relay Out | +12V | 10 Amp Fused, Relay Output |
| | Same as 406 module, except 12 volt Communications and 24 volt I/O | | | |
| 2-11 | 00-00838-000 | 10 Channel Latching Relay outputs | +12 | 10/20 Amp Fused, Relay Outputs |
| | 00-00838-410 | 10 Channel Relay Outputs | +12 | 10/20 Amp Fused, Relay Outputs |
| 2-13 | 00-00844-500 | 10 solid-state outputs with lamp dimmer control | | 10 Amp Fused, Solid-State Output |
| | 00-00844-510 | 10 solid-state outputs with lamp dimmer control | | 10 Amp Fused, Solid-State Output |
| 2-15 | 00-00846-506 | 4 point DC Input / 6 point FET Out | +24V | 20/10 Amp Fused, Solid-State Output |
| | 00-00846-516 | 4 point DC Input / 6 point FET Out | +12V | 20/10 Amp Fused, Solid-State Output |
| 2-17 | 00-00846-606 | 4 point DC Input / 6 point FET Out | +24V | 20/10 Amp self protected, Solid-State Output |
| | 00-00846-616 | 4 point DC Input / 6 point FET Out | +12V | 20/10 Amp self protected, Solid-State Output |
| | 00-00720-506 | 4 point DC Input / 6 point FET Out | +24V | 20 Amp Fused, Solid-State Output |
| | 00-00720-516 | 4 point DC Input / 6 point FET Out | +12V | 20 Amp Fused, Solid-State Output |
| | 00-00720-606 | 4 point DC Input / 6 point FET Out | +24V | 10 Amp self protected, Solid-State Output |
| | 00-00720-616 | 4 point DC Input / 6 point FET Out | +12V | 10 Amp self protected, Solid-State Output |
| 2-19 | 00-00802-600 | 10 solid-state outputs | +24V | 10 Amp self protected, Solid-State Output |
| | 00-00802-616 | 10 solid-state outputs | +12V | 10 Amp self protected, Solid-State Output |
| 2-21 | 00-00888-600 | 10 sealed Solid-State Outputs | +24V | 10 Amp self protected, Solid-State Outputs |
| | 00-00888-610 | 10 sealed Solid-State Outputs | +12V | 10 Amp self protected, Solid-State Outputs |
| | 00-00888-604 | 10 sealed dim-able Solid-State Outputs | +24V | 10 Amp self protected, Solid-State Outputs |
| | 00-00888-614 | 10 sealed dim-able Solid-State Outputs | +12V | 10 Amp self protected, Solid-State Outputs |
| 2-25 | 00-00702-320 | 10 Channel Low Watt Output Module | +24V | 0.5A Output, 5 Low side Solid-State Outputs |
| | 00-00702-330 | 10 Channel Low Watt Output Module | +12V | 0.5A Output, 5 Low side Solid-State Outputs |
| **Warning Lamp Direct Plug-in Adapters** | | | | |
| 2-27 | 00-00644-806 | 6 Warning Lamp Adapter (Sprague) | +24V | Plugs to 3 by 2 Panel |
| | 00-00644-816 | 6 Warning Lamp Adapter | +12V | Plugs to 3 by 2 Panel |

| Page | Part No. | | Description | |
|---|---|---|---|---|
| **Rocker Switch Direct Plug-in Adapters** | | | | |
| 2-29 | 00-00656-909 | 9 Rocker Switch Adapter | +24V | 9 rocker switches, 10 channels |
| | 00-00656-919 | 9 Rocker Switch Adapter | +12V | 9 rocker switches, 10 channels |
| | | | (Use standard ITT, Sprague or Britax switches) | |
| 2-31 | 00-00643-906 | 6 Rocker Switch Adapter | +24V | 6 rocker switches |
| | 00-00643-916 | 6 Rocker Switch Adapter | +12V | 6 rocker switches |
| | | | (Use standard ITT, Sprague or Britax switches) | |
| 2-33 | 00-00842-024 | 5 Stackable Rocker Switch Adapter | +24V | 5 Carling switches with programmable lights |
| | 00-00842-012 | 5 Stackable Rocker Switch Adapter | +12V | 5 Carling switches with programmable lights |
| | | | (Use standard Carling Contura Series switches) | |
| **Programmable Lighted Key pads** | | | | |
| 2-35 | Various | 4, 6 and 10 button lighted, programmable key pads *(See pages 35-40 for part numbers)* | | |
| 2-39 | 00-00759-000 | 6 button programmable, lighted keypad | | |
| **Input Modules Pages** | | | | |
| 2-41 | 00-00622-100 | 10 point DC Input | +24V | 10 DC Pos or Neg |
| | 00-00622-110 | 10 point DC Input | +12V | 10 DC Pos or Neg |
| 2-43 | 00-00645-700 | 10 Rocker Switch Module | +24V | Inputs for Remote Switches w/backlight |
| | 00-00645-710 | 10 Rocker Switch Module | +12V | Inputs for Remote Switches w/backlight |
| | | | | (Use any switch of your choice) |
| 10 channel water proof sealed input module is under development (12/03) | | | | |
| **Load Manager Voltage input module** | | | | |
| 2-45 | 00-00809-240 | Inputs 4 voltage thresholds | +24 V | |
| | 00-00809-120 | Inputs 4 voltage thresholds | +12 V | |
| **Diagnostic Test Equipment 2-47 through 2-48** | | | | |
| | 00-00738-120 | PMC System Status Monitor | +12V | view status of all PMC channels |
| | 00-00738-240 | PMC System Status Monitor | +24V | view status of all PMC channels |
| 2-47 | 00-00739-120 | PMC Module Simulator | 12V/24V | Emulate any module in the system |
| | | | | Force outputs on, Simulate inputs, See channel status |
| **Sensors** | | | | |
| 2-49 | 00-00741-120 | Bulb Out Input Sensor | +12V | Use to detect burned out lamps |
| | 00-00741-240 | Bulb Out Input Sensor | +24V | and provide input signal to PMC |

The number of modules available for use with the PMC system continues to grow as needs are identified. These modules are designed to offer maximum flexibility to the vehicle designer. The output modules provide high current solid-state, or relay outputs with built in circuit protection. There are modules that have only inputs, or outputs and modules that have both inputs and outputs. Inputs can be set as high side, or low side (+ BAT or GND).

As additional modules are developed, they can be added to this section of your book. The following pages describe each of the modules, along with their performance and specifications. Check with Intellitec, as new modules continue to be developed.

Intellitec will develop custom product for your specific requirement. Custom product includes switch panels and switch adapters, which can be used to make your product unique. If there is an electrical or electronic product that you need to resolve your specific problem; let our engineers propose a solution for you.

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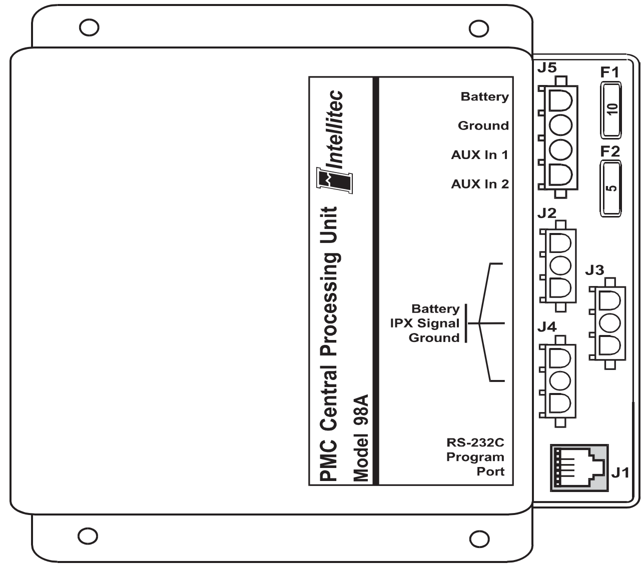
# 160 Channel PMC CPU

## 00-00620-021 Central Processing Unit




The PMC CPU is the main component of Intellitec's Programmable Multiplex Control family. It controls remote I/O modules through Intellitec's multiplex communications system (Pat. No. 4,907,222 and 6,011,997). This multiplex system allows the CPU, I/O Modules and switch panels to be wired together with two wires.

The CPU has three, 3-pin, Amp Mate-N-Lok connectors which are used to communicate to the Input/Output modules. One pin is the multiplex signal, another multiplex Ground, and the third is fused power to operate remote switch panel backlighting.

Multiple modules can be wired to a single connector. All input, or switch information is gathered through the remote modules and directly communicated to the CPU. The CPU then interprets the inputs, determines the states of all outputs and communicates that information to the remote modules via the PMC communications link.

The CPU can communicate with up to 16 modules. Each module can have a combination of up to 10 inputs or outputs, with a single CPU controlling up to 160 inputs/outputs. If your system requires more than 160 I/O points, CPU 00-00800-021 can be used.

The CPU also has 10 timers built-in, which are setup by the Windows software. These timers can function as on/delay, off/delay, and interval timers. PMC can replace flasher modules, mirror heat timers, wiper delays, or any other timer function.

The CPU RS-232C communications ports is used to setup, or program the vehicle specific requirements. The port can also be used to perform system diagnostics; *however*, 99% of the diagnostics can be easily performed on the multiplex communication wires with the use of a commonly available Volt Meter.

The PMC system communicates continually at a relatively slow rate of 4 kHz. Each input/output is updated every .040 seconds. The multiplex signal, which communicates to the output modules, switches all the way from ground to the battery voltage. This slow communications rate and large signal voltage change makes the PMC system extremely resistant to interference from EMI and RFI. Because of the low communications frequency and large signal change, communication can take place without fear of interference over any economical wire and eliminates the need for special cables and connectors. Four high speed channels are available to control elements requiring a higher speed.

The CPU includes a sleep mode. The sleep mode reduces the overall system operating current, allowing the system to be constantly live with insignificant drain on the vehicle battery.

Through the use of Intellitec's PMC Windows based software program and the connection of a PC to the RS-232C port, the user can easily set up the relationships between the switch inputs, timers and outputs. If desired, Intellitec can ship CPU modules to the OEM with their program already loaded.

If your customer needs a modification, a CPU can be programmed at your desk and shipped overnight. The plugs are designed so that the CPU can only be plugged in one way. The CPU may also be reprogrammed over and over again. In the PMC system, the only module that needs programming is the CPU.

All the harnesses are connected with AMP Mate-N-Lok connectors to reduce installation time and errors. Combine the Programmable Multiplex Control Central Processing Unit with the Intellitec standard, semi-custom or custom modules, and you can create the exact system configuration that you want, from basic to all encompassing. The approximate module dimensions are 6.375" X 6.250" X 1.875" (16.2mm X 15.9mm X 4.8mm). *The module should be installed in a protected environment inside of the vehicle.*

# 160 Channel PMC CPU

## 00-00620-021 Central Processing Unit

| SPECIFICATIONS | |
|---|---|
| Part Number | 00-00620-021 |
| Nominal Vehicle Voltage | +12 Volt or +24 Volt system |
| Voltage Range | +10 Volts to 36 Volts |

| SYSTEM CAPACITY | | COMMUNICATIONS | |
|---|---|---|---|
| Program Memory | EPROM | CPU/Module | PMC two wire 4KHZ |
| User Memory | Non Volatile flash | EMI/RFI | High Immunity |
| Module Capacity | 16 | User PC Program | RS-232C |
| I/O per Module | 10 | | |
| Total I/O Control | 160 | | |
| Virtual Channels | 10 | | |
| Timer Channels | 10 | | |

### CONNECTOR PIN DESIGNATIONS

| | | | |
|---|---|---|---|
| J1 | RS-232C | PC Communications *(Note 1)* | |
| J2-J4 | PMC Communications | (All three connectors identical) | |
| Pin 1 | Fused Power for remote backlighting | Fuse F2 5 Amps Max. | |
| Pin 2 | Multiplex Signal | 16 awg Min. *(see Chapter 3 of the Users Guide)* | |
| Pin 3 | Multiplex Ground | 14 awg Min. *(see Chapter 3 of the Users Guide)* | |
| J5-1 | Battery | Fuse F1 10 Amps Max. | |
| J5-2 | Ground | | |
| J5-3 | Aux In 1 (+12V disables sleep mode) | Sleep Mode | 4.7K Input Impedance |
| J5-4 | Aux In 2 (+12V disables sleep mode) | Sleep Mode | 4.7K Input Impedance |

### MATING CONNECTIONS

| Designator | Function | Connector | Mating Part # | Contact, Typical |
|---|---|---|---|---|
| J1 | RS-232C | | RJ11 | (Note 1) |
| J2 | PMC Com | 3 Pin Amp Mate-N-Lok | 1-480700-0 | 350919-3 for 14-18 AWG |
| J3 | PMC Com | 3 Pin Amp Mate-N-Lok | 1-480700-0 | 350919-3 for 14-18 AWG |
| J4 | PMC Com | 3 Pin Amp Mate-N-Lok | 1-480700-0 | 350919-3 for 14-18 AWG |
| J5 | Power | 4 Pin Amp Mate-N-Lok | 1-480702-0 | 350919-3 for 14-18 AWG |

Note 1: Communications to PC is accomplished via Cable and Program Key, included in the programming kit.

# 320 Channel PMC CPU

## 00-00800-021 Central Processing Unit

The PMC CPU is the main component of Intellitec's Programmable Multiplex Control family. It controls remote I/O modules through Intellitec's multiplex communications system (Pat. No. 4,907,222 and 6,011,997). This multiplex system allows the CPU, I/O Modules and switch panels to be wired together with two wires.

This CPU has two identical, 4-pin, Amp Mate-N-Lok connectors. Pin 1 provides a fused 12 volt power source to power things like switch back lighting. Pins 2 and 3 are the multiplex signals (two loops of 160 channels each) which communicate instructions to and from each of the I/O modules, Pin 4 is multiplex communication ground.

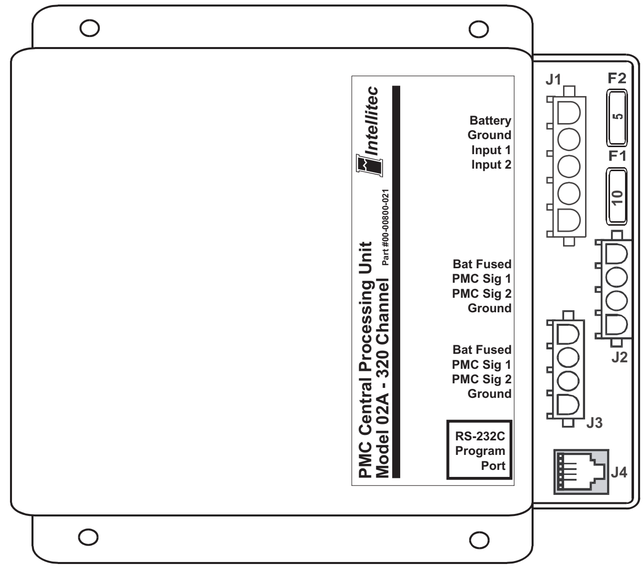
A system can be as small as one CPU and one I/O module, or it can communicate with up to 32 I/O modules. Each module can have a combination of up to 10 inputs, or outputs.

Multiple modules can be wired to a single connector. All input, or switch information is gathered through the remote modules and directly communicated to the CPU. The CPU then interprets the inputs, determines the states of all outputs and communicates that information to the remote modules via the PMC communications link (pins 2 and 3).

This CPU also has 160 timer channels built-in. The timers are setup by the Windows software. These timers can function as on/delay, off/delay, flasher and interval timers. PMC eliminates the need for special flasher modules, mirror heat timers, wiper delays, load managers, etc. In addition there are also 160 virtual channels which provide the capability to write very complex logic relationships between the channels.

The CPU RS-232C communications port and Windows software is used to setup or program the vehicle specific requirements. The port can also be used to perform system diagnostics. If a lap top isn't available most diagnostics can be performed with a volt meter.

The PMC system communicates continually at a relatively slow rate of 4 kHz. Each input/output is updated every .040 seconds. The multiplex signal, communicates to the output modules with a large change in signal voltage. This slow communications rate and large signal voltage change makes the PMC system extremely resistant to interference from EMI and RFI. Because of the low communications frequency and large signal change, communication can take place without fear of interference over any economical wire and eliminates the need for special cables and connectors. Four high speed channels are available to control elements requiring a higher speed.




The CPU includes a sleep mode. The sleep mode reduces the overall system operating current, allowing the system to be constantly live with insignificant drain on the vehicle battery.

Through the use of Intellitec's WinPMC II Windows based software program and the connection of a PC to the RS-232C port, the user can easily set up the relationships between the switch inputs, timers and outputs. If desired, Intellitec can ship CPU modules to the OEM with their program already loaded.

If your customer needs a modification, a CPU can be programmed at your desk and shipped overnight. The plugs are designed so that the CPU can only be plugged in one way. The CPU may also be reprogrammed over and over again. In the PMC system, the only module that needs programming is the CPU. This program resides in non-volitile memory and is retained when power is removed from the CPU.

All the harnesses are connected with AMP, Mate-N-Lok connectors to reduce installation time and errors. Combine the Programmable Multiplex Control Central Processing Unit with the Intellitec standard, semi-custom or custom modules, and you can create the exact system configuration that you want, from basic to all encompassing. The approximate module dimensions are 6.375" X 6.250" X 1.875" (16.2mm X 15.9mm X 4.8mm). The module should be installed in a protected environment inside of the vehicle.

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# 320 Channel PMC CPU

## 00-00800-021 Central Processing Unit

| SPECIFICATIONS | |
|---|---|
| Part Number | 00-00800-021 |
| Nominal Vehicle Voltage | +12 Volt or +24 Volt system |
| Voltage Range | +10 Volts to 36 Volts |

| SYSTEM CAPACITY | | COMMUNICATIONS | |
|---|---|---|---|
| Program Memory | EPROM | CPU/Module | PMC two wire 4KHZ |
| User Memory | Non Volatile | EMI/RFI | High Immunity |
| Module Capacity | 32 | User PC Program | WinPMC II |
| I/O per Module | 10 | | |
| Total I/O Control | 320 | | |
| Virtual Channels | 160 | | |
| Timer Channels | 160 | | |

### CONNECTOR PIN DESIGNATIONS

| | | | |
|---|---|---|---|
| J4 | RS-232C | PC Communications *(Note 1)* | |
| J2-J3 | PMC Communications | (All three connectors identical) | |
| Pin 1 | Fused Power for remote backlighting | 16 awg Min. Fuse F2 5 Amps Max. | |
| Pin 2 | Multiplex Signal Blue Loop | 16 awg Min. *(see Chapter 3 of the Users Guide)* | |
| Pin 3 | Multiplex Ground Yellow Loop | 16 awg Min. *(see Chapter 3 of the Users Guide)* | |
| Pin 4 | Communications Ground | 14 awg Min. *(Make no other connections)* | |
| J1-1 | Battery | Fuse F1 10 Amps Max. | |
| J1-2 | Ground | | |
| J1-3 | Aux In 1 (+12V disables sleep mode) | Sleep Mode | 4.7K Input Impedance |
| J1-4 | Aux In 2 (+12V disables sleep mode) | Sleep Mode | 4.7K Input Impedance |

### MATING CONNECTIONS

| Designator | Function | Connector | Mating Part # | Contact, Typical |
|---|---|---|---|---|
| J1 | CPU Power | 5 Pin Amp Mate-N-Lok | 1-480763-0 | 350919-3 for 14-18 AWG |
| J2 | PMC Com | 4 Pin Amp Mate-N-Lok | 1-480702-0 | 350919-3 for 14-18 AWG |
| J3 | PMC Com | 4 Pin Amp Mate-N-Lok | 1-480702-0 | 350919-3 for 14-18 AWG |
| J4 | RS-232C | | RJ11 | *(Note 1)* |

Note 1: Communications to PC is accomplished via an RS232 Cable and Program Key, included in the programming kit. If your lap top does not have a RS232 port a USB/Serial Adapter may be used. Intellitec has found IOGEAR Model GUC232A, USB PDA/Serial Adapter to work for this purpose.

# 4 Channel DC Input / 6 Channel Relay Output

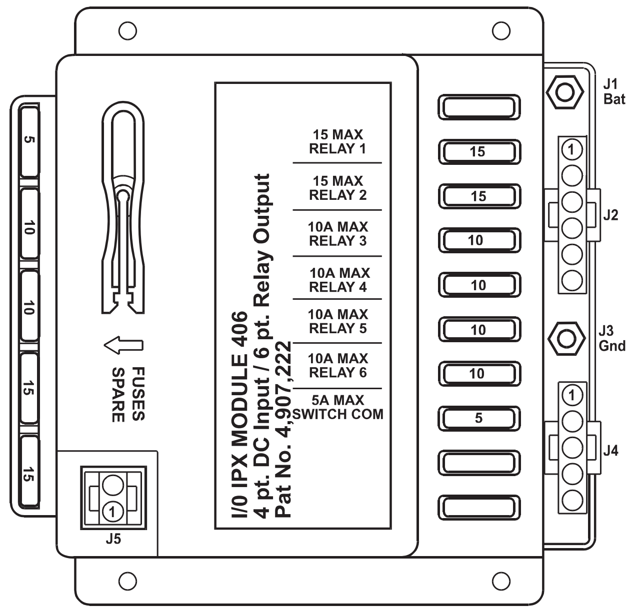
## 00-00621-406/416 PMC I/O Module

The PMC I/O Module 406/416 is a member of Intellitec's Programmable Multiplex Control family. It works in combination with the PMC CPU and other standard, semi-custom, or custom I/O modules.

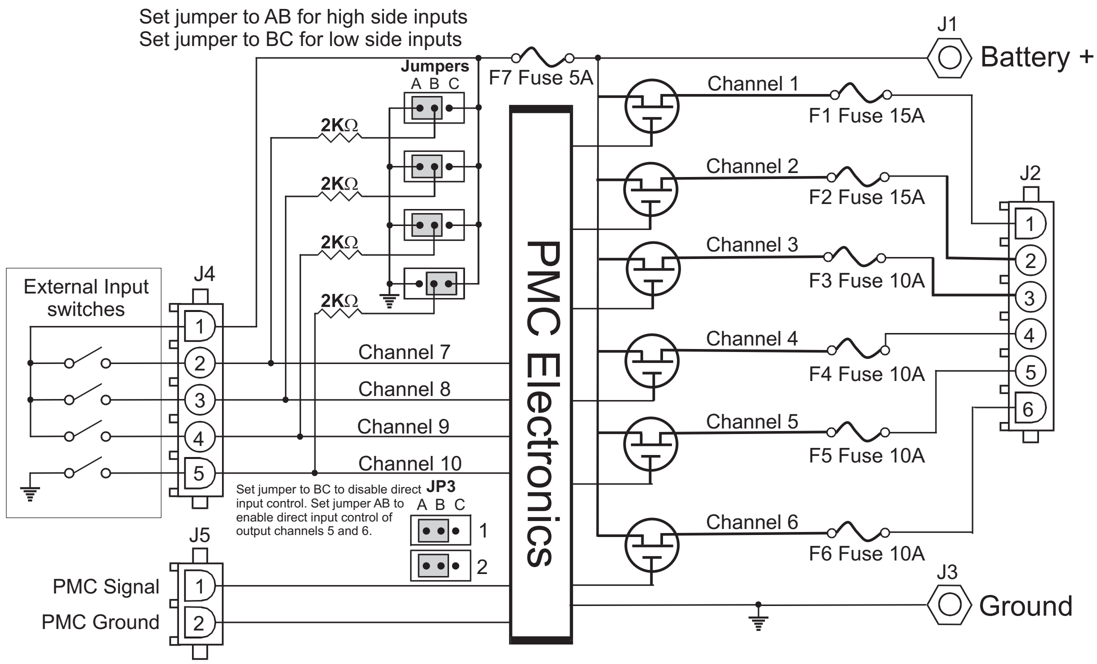
The 406/416 provides power fusing, switching, and distribution in one module. It has two, 15 amp SPST relays and four, 10 Amp SPST relays for switching loads to the battery. Each fuse position can be filled with a fuse, or circuit breaker. The total module current should not exceed 50 Amps.

There are four input connections for rocker, limit, or sensor switches. Each individual input can be configured as either a low side switch to ground, or a high side switch to battery. Input information is directly communicated to the CPU and the relays are controlled by the CPU via the PMC communications link. All of the output harnesses are connected with AMP Mate-N-Lok connectors to reduce installation time and errors.

The approximate module dimensions are 6.375" X 6.250" X 1.875" (16.2mm X 15.9mm X 4.8mm). *It should be installed in a protected environment, inside the vehicle*.




PAT NO. 4,907,222 & 6,011,997




### DIRECT CONTROL

Jumper block Jp3 provides for direct input control of output channels 5 and 6, for this module only. If the jumper JP3-1 is moved from the BC position to the AB position, output channel 5 will be controlled directly from input channel 7 on this module. Booleans written for this channel will have no effect. If jumper JP3-2 is moved to the AB position, output channel 6 will be controlled directly from input channel 8 of this module. This function eliminates the CPU's processing time for the channel involved.

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# 4 Channel DC Input / 6 Channel Relay Output

## 00-00621-406/416 PMC I/O Module

### SPECIFICATIONS

| General Connections | | | 00-00621-416 | 00-00621-406 |
|---|---|---|---|---|
| Nominal Vehicle Voltage | | | 12V | 24V |
| J1 | + 12 Volts | Module Current | 50 Amps Max | 50 Amps Max |
| J3 | Ground | | | |
| J4-1 | Fuse #7 Power for Positive switched inputs | | 3 Amps Max | 3 Amps Max |
| J5-1 | PMC Signal | | 18 awg Min | 18 awg Min |
| J5-2 | PMC Ground | | 14 awg Min | 14 awg Min |

### CHANNEL DESIGNATIONS

| Channel | Connection | Type | Name | Rating |
|---|---|---|---|---|
| 1 | J2-1 | Relay Output, Form A (SPST),(1) | Relay 1 Fuse 1 | 15 Amp Max |
| 2 | J2-2 | Relay Output, Form A (SPST),(1) | Relay 2 Fuse 2 | 15 Amp Max |
| 3 | J2-3 | Relay Output, Form A (SPST),(1) | Relay 3 Fuse 3 | 10 Amp Max |
| 4 | J2-4 | Relay Output, Form A (SPST),(1) | Relay 4 Fuse 4 | 10 Amp Max |
| 5 | J2-5 | Relay Output, Form A (SPST),(1) | Relay 5 Fuse 5 | 10 Amp Max |
| 6 | J2-6 | Relay Output, Form A (SPST),(1) | Relay 6 Fuse 6 | 10 Amp Max |
| 7 | J4-2 | Input, Positive or Negative | Switch 1 | 2K Input Resistance |
| 8 | J4-3 | Input, Positive or Negative | Switch 2 | 2K Input Resistance |
| 9 | J4-4 | Input, Positive or Negative | Switch 3 | 2K Input Resistance |
| 10 | J4-5 | Input, Positive or Negative | Switch 4 | 2K Input Resistance |

Note 1: Relay provides a fused source of voltage to the Load from the Battery.

### MATING CONNECTIONS

| Designator | Function | Connector | Mating Part # | Contact, Typical for 14-18 AWG | for 10-12 AWG |
|---|---|---|---|---|---|
| J1 | Battery | #10/32 Ring Term | | | |
| J2 | Outputs | 6 Pin Amp Mate-N-Lok | 640585-1 | 350919-3 | 640310-3 |
| J3 | Ground | #10/32 Ring Term | | | |
| J4 | Inputs | 5 Pin Amp Mate-N-Lok | 1-480763-0 | 350919-3 | 640310-3 |
| J5 | PMC/Com | 2 Pin Amp Mate-N-Lok | 1-480698-0 | 350919-3 | 640310-3 |

### MODULE SETTINGS

Module can be set for 1 of 16 address. Set four jumpers on jumper block JP2 per table to the right. X = Jumper is out.

| JUMPERS 4 3 2 1 | MODULE Address | JUMPERS 4 3 2 1 | MODULE Address |
|---|---|---|---|
| 0 0 0 0 | A | X 0 0 0 | I |
| 0 0 0 X | B | X 0 0 X | J |
| 0 0 X 0 | C | X 0 X 0 | K |
| 0 0 X X | D | X 0 X X | L |
| 0 X 0 0 | E | X X 0 0 | M |
| 0 X 0 X | F | X X 0 X | N |
| 0 X X 0 | G | X X X 0 | O |
| 0 X X X | H | X X X X | P |

Four inputs labeled Switch 1 - 4 can be individually set for either positive (high-side) switched to the battery, or negative (low-side) switched to ground. Setting a jumper to short pins AB selects positive switch. Setting a jumper to short pins BC selects negative switch.

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The PMC Output Modules 00-00838-000 and 00-00838-410 are members of Intellitec's Programmable Multiplex Control family, as well as the 160 Channel Multipoint Switching System. They works in combination with the PMC CPU or the 160 Channel IPX Master and other standard, semi-custom, or custom I/O modules.

The modules provide power fusing, switching, and distribution . They have five 20 Amp SPST relays and five 10 amp SPST relays for switching loads to the battery. Each fuse position can be filled with a fuse or circuit breaker. *The total module current should not exceed 70 Amps.*

All of the output harness connections are made with AMP Mate-N-Lok connectors to reduce installation time and errors.

The approximate module dimensions are 7.0" X 6.250" X 1.875" (16.2mm X 15.9mm X 4.8mm). *It should be installed in a protected environment inside the vehicle.*

The 838-000 and 838-410 can be set for module addresses of A - P. This allows each output of the module to be addressed for any one of 160 channels in groups of 10. *Using the chart on the next page, set the dip switch to address the module.*

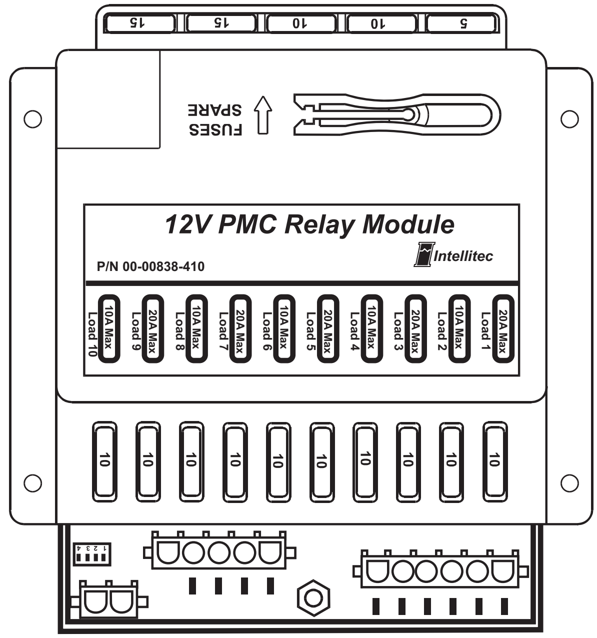
### *LATCHING VS NON-LATCHING*

The 838-000 is a latching module, which means that an output will turn on and latch on when it sees that it's channel has been turned on momentarily. Once the output is on, the output will turn off when it sees it's channel turn on momentarily again.

No program is necessary when used with either a PMC Central Processing Unit or the 160 Channel IPX Master.

An output can be turned on by providing a momentary input on the same channel address. Another momentary input turns the output off.

*Example:* Intellitec's 10 button keypad has a button set for address B1 and a Latching Output Module 838-000 has an output set for address B1 while both are connected to an IPX Master, or PMC CPU. If push button B1 is pressed momentarily, output B1 of the output module will latch on. Pushing the button again will latch the output off. If a push button is set for BL/MR, pressing and holding the button for 3 seconds will cause all outputs that are latched on, to turn off.




When using this module with PMC *you should neither check the latched switch box in the Windows set up software for the pushbutton nor should a Boolean be written to operate the output.* Channel P10 for 3 seconds will unlatch all latched outputs.

The 838-410 is a non-latching module, which means the output will turn on when it sees it's address but will not latch and *should only be used with the PMC system.* In this case, if the channel is turned on momentarily, the output will only be on while the channel is on, but will not latch. This module will respond to programming in the same fashion as any other PMC output module. To keep the output on, the channel must be kept on.

### *DIAGNOSTIC LED INDICATORS*

Next to each Mate-N-Lok output connection you will find an LED. If the output is on, the LED will be on. Should the output be on and a fuse is blown, the LED will not illuminate.

Next to pin J1-2, you will find an LED which illuminates RED and indicates that the multiplex communication signal is not normal.

## *SPECIFICATIONS*

| ***Modules*** | **00-00838-000** | **00-00838-410** |
|---|---|---|
| Nominal Vehicle Voltage | 12V | 12V |
| Outputs | Latching Outputs | Non-Latching Outputs |
| Module Current | 70 Amps Max total | |

### *General Connections*

| | | |
|---|---|---|
| J1-1 | Communications Signal (from Master or CPU) | 18 Awg Min. |
| J1-2 | Communications Ground (from Master or CPU) | 14 Awg Min. |

## *CHANNEL DESIGNATIONS*

| Channel | Connection | Type | Name | Rating |
|---|---|---|---|---|
| 1 | J2-1 | Relay Output, Form A (SPST),(1) | Relay 1 Fuse 1 | 20 Amp Max |
| 2 | J2-2 | Relay Output, Form A (SPST),(1) | Relay 2 Fuse 2 | 10 Amp Max |
| 3 | J2-3 | Relay Output, Form A (SPST),(1) | Relay 3 Fuse 3 | 20 Amp Max |
| 4 | J2-4 | Relay Output, Form A (SPST),(1) | Relay 4 Fuse 4 | 10 Amp Max |
| 5 | J2-5 | Relay Output, Form A (SPST),(1) | Relay 5 Fuse 5 | 20 Amp Max |
| 6 | J2-6 | Relay Output, Form A (SPST),(1) | Relay 6 Fuse 6 | 10 Amp Max |
| 7 | J3-1 | Relay Output, Form A (SPST),(1) | Relay 7 Fuse 7 | 20 Amp Max |
| 8 | J3-2 | Relay Output, Form A (SPST),(1) | Relay 8 Fuse 8 | 10 Amp Max |
| 9 | J3-3 | Relay Output, Form A (SPST),(1) | Relay 9 Fuse 9 | 20 Amp Max |
| 10 | J3-4 | Relay Output, Form A (SPST),(1) | Relay 10 Fuse 10 | 10 Amp Max |

*Note 1:* Relay provides a fused source of voltage to the Load from the Battery.

J3-5 Power Ground

***NOTE: Total Module current not to exceed 70 Amps***

## *MATING CONNECTIONS*

| Designator | Function | Connector | Mating Part # | Contact,Typical *for 14-18 AWG* | *for 10-12 AWG* |
|---|---|---|---|---|---|
| J4 | Battery | #10/32 Ring Term | | | |
| J3 | Communication | 2 Pin Amp Mate-N-Lok | 1-480698-0 | 350919-3 | 640310-3 |
| J2 | Outputs | 6 Pin Amp Mate-N-Lok | 640585-1 | 350919-3 | 640310-3 |
| J1 | Outputs | 5 Pin Amp Mate-N-Lok | 1-480763-0 | 350919-3 | 640310-3 |

## *MODULE SETTINGS*

Module can be set for 1 of 16 address, A-P. Set four dip switches per table on right.

X = Switch OFF

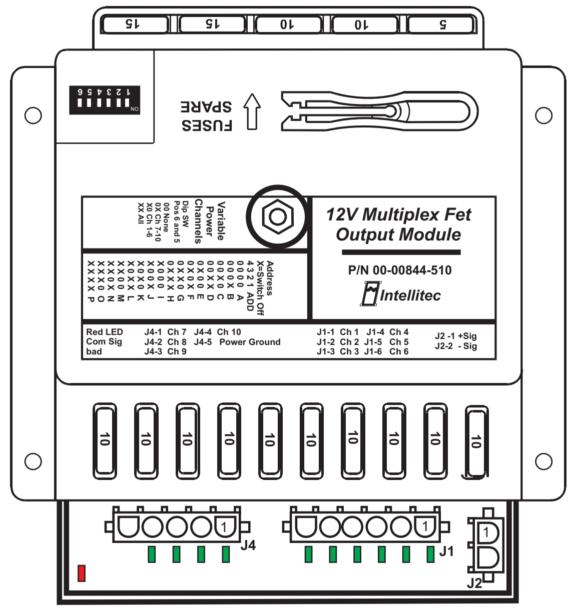
| ***SWITCH 4 3 2 1*** | ***MODULE Address*** | ***SWITCH 4 3 2 1*** | ***MODULE Address*** |
|---|---|---|---|
| 0 0 0 0 | A | X 0 0 0 | I |
| 0 0 0 X | B | X 0 0 X | J |
| 0 0 X 0 | C | X 0 X 0 | K |
| 0 0 X X | D | X 0 X X | L |
| 0 X 0 0 | E | X X 0 0 | M |
| 0 X 0 X | F | X X 0 X | N |
| 0 X X 0 | G | X X X 0 | O |
| 0 X X X | H | X X X X | P |

The PMC Output Modules 00-00844 are members of Intellitec's Programmable Multiplex Control family as well as the 160 Channel Multipoint Switching System. They work in combination with the PMC CPU or the 160 channel IPX master and other standard, semi-custom, or custom I/O modules. These modules provide solid-state outputs with the capability of dimming lights.

The modules provide power fusing, switching, and distribution. Switching is accomplished via long life, field effect transistors instead of relays. Each output will handle 10 Amps. The total module current is limited by the *"I squared rule"* on the following page.

The approximate module dimensions are 7.0" X 6.250" X 1.875" (16.2mm X 15.9mm X 4.8mm). *It should be installed in a protected environment, inside the vehicle.*

The 844 module can be set for module addresses, A-P. *Using the chart on the next page, set the dip switches 1-4 to address the module.*




### PWM PROVIDES VARIABLE POWER (PULSE WIDTH MODULATION)

The 844 modules provide the ability to dim lights from any Intellitec multiplex keypad. With the PMC system, a momentary push button can be used if it is connected to a PMC input. These modules come in two versions. The 00-00844-120 works with the 160 Channel Multipoint Switching System. The 00-00844-500 and 00-00844-510 work with the PMC system.

This module dims the lights using pulse width modulation or PWM. Variable power is applied to the load by quickly turning the power on and off. By varying the duty cycle we can vary the intensity of the lamp.

By adjusting the dip switch, it is possible to select the channels that will operate to dim lights. *See the chart on the next page for dip switch settings.*

### PMC VERSION 00-00844-500 AND 510

When set as a non-dimmable output, the outputs will operate as any other PMC output. To keep the output on, it's channel must be on. If the output is set to be a dimmable output, the output will latch on at the output module. To turn the output on, all that is required is that it's channel be turned on momentarily. When the channel comes on, the output turns on and latches. When the channel turns off, the output remains latched until the channel turns on again, at which time the output turns off.

### OPERATING EXAMPLE FOR A PMC DIMMABLE OUTPUT

If the lighting output channel is B3 and a momentary push button is placed at D5 you could write a boolean such as B3=D5. When momentary button D5 is pressed and released output B3 will turn on at 100% intensity and remain on even though switch channel D5 is off. When D5 is pressed and released a second time, output B3 will turn off.

This happens because we latch the output on and off at the module. When button D5 is pressed and held, the output will begin to ramp up, increasing the lamp intensity. When the button is let go, the lamp will remain at that intensity. Pressing and holding the button a second time will cause the intensity to begin ramping down. When the button is released, the lamp will remain at that intensity. Pressing and releasing the button quickly will cause the output to toggle off. If power has been maintained at the module, the output will remember it's last intensity setting.

### MULTIPOINT SWITCHING VERSION 00-00844-120

This module works with the non-programmable Multipoint Master. This module works in a similar fashion to the 844-500 and 510, except that when it's outputs are not set for dimming they will latch on and off just as the dimmer outputs do. With the Multipoint Master and Intellitec programmable momentary push button switches 00-00841-XXX, a switch is set for the same channel as the output. When the switch turns the channel on, the output latches on. When the switch turns the channel on again, the output latches off. Using the GUI and setting a switch for BL/MR (back light/Master Reset), instructs the switch to turn all 10 outputs off when the switch is held for 3 seconds.

### LED DIAGNOSTIC INDICATORS

Next to each Mate-N-Lok connection you will find green LEDs. If the output is on, the LED will be on. There is also one red LED. This will illuminate if multiplex communications fail. In this case check the connections at J2.

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www.intellitec.com

# PMC and Multipoint Switching System
## 00-00844-120/500/510 Lamp Dimmer Control Output Modules

### SPECIFICATIONS

| **Modules** | **00-00844-120** | **00-00844-500** | **00-00844-510** |
|---|---|---|---|
| Nominal Vehicle Voltage | 12V | 24V | 12V |
| **NOTES:** | *Output latches On/Off When channel turns on momentarily* | *For use with PMC ONLY. Outputs set for dimming latch; others do not latch. Use PMC Channel P10 to unlatch all dimmer module outputs or turn channel on momentarily to unlatch.* | |

### General Connections

| | | |
|---|---|---|
| J1-1 | Communications Signal (from Master or CPU) | 16 Awg Min. |
| J1-2 | Communications Ground (from Master or CPU) | 14 Awg Min. |

### CHANNEL DESIGNATIONS

| Channel | Connection | Type | Rating |
|---|---|---|---|
| 1 | J1-1 | FET Output | 10 Amp Max ** |
| 2 | J1-2 | FET Output | 10 Amp Max ** |
| 3 | J1-3 | FET Output | 10 Amp Max ** |
| 4 | J1-4 | FET Output | 10 Amp Max ** |
| 5 | J1-5 | FET Output | 10 Amp Max ** |
| 6 | J1-6 | FET Output | 10 Amp Max ** |
| 7 | J4-1 | FET Output | 10 Amp Max ** |
| 8 | J4-2 | FET Output | 10 Amp Max ** |
| 9 | J4-3 | FET Output | 10 Amp Max ** |
| 10 | J4-4 | FET Output | 10 Amp Max ** |
| | J4-5 | Power Ground | |

**"I SQUARED RULE"**

** Total module current is limited by the following. The sum of the current squared for each output may not exceed 350.

$$I1^2+I2^2+I3^2+I4^2+I5^2+I6^2+I7^2+I8^2+I9^2+I10^2<350$$

***Failure to follow this rule may cause module failure.***

### MATING CONNECTIONS

| Designator | Function | Connector | Mating Part # | Contact,Typical *for 14-18 AWG* | *for 10-12 AWG* |
|---|---|---|---|---|---|
| | Battery | #10/32 Ring Term | | | |
| J2 | Communication | 2 Pin Amp Mate-N-Lok | 1-480698-0 | 350919-3 | 640310-3 |
| J1 | Outputs | 6 Pin Amp Mate-N-Lok | 640585-1 | 350919-3 | 640310-3 |
| J4 | Outputs | 5 Pin Amp Mate-N-Lok | 1-480763-0 | 350919-3 | 640310-3 |

### MODULE SETTINGS

Module can be set for 1 of 16 address, A-P. Outputs can be set as dimmer or ON/OFF. Set six dip switches per table on right.

X = Switch is OFF

| SWITCH 6 5 4 3 2 1 | MODULE Address | SWITCH 6 5 4 3 2 1 | MODULE Address |
|---|---|---|---|
| 0 0 0 0 | A | X 0 0 0 | I |
| 0 0 0 X | B | X 0 0 X | J |
| 0 0 X 0 | C | X 0 X 0 | K |
| 0 0 X X | D | X 0 X X | L |
| 0 X 0 0 | E | X X 0 0 | M |
| 0 X 0 X | F | X X 0 X | N |
| 0 X X 0 | G | X X X 0 | O |
| 0 X X X | H | X X X X | P |

0 0 No Dimmers
0 X 1 thru 6 are Dimmers
X 0 7 thru 10 are Dimmers
X X All are Dimmers

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# 4 Channel DC Input / 6 Channel Solid-State Output

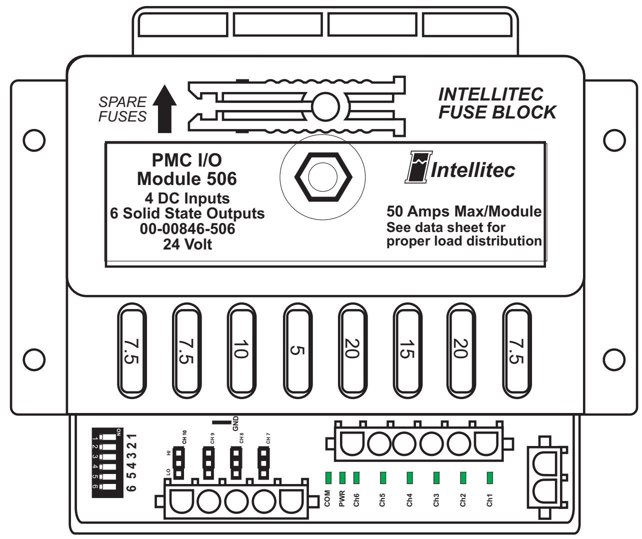
## 00-00846-506/516 PMC Solid State I/O Module

The PMC I/O Module 846-506/516 is a member of Intellitec's Programmable Multiplex Control family. It works in combination with the PMC CPU and other standard, semi-custom, or custom I/O modules.

The 506/516 provides power-fusing, switching, and distribution in one module. With it's six, solid-state, high-side outputs it is capable of controlling a total of 50 Amps. *Please refer to the tables in this brochure for proper load distribution.* The outputs are controlled by field effect transistors and are ideal for high use applications, such as flashing warning lights, turn signals and brake lights.

There are four input connections for rocker, limit, or sensor switches. Each individual input can be configured as either a low-side switch to ground, or a high-side switch to battery. Input information is directly communicated to the CPU via the PMC communications link. All of the input/output harnesses are connected with AMP Mate-N-Lok connectors to reduce installation time and errors.

*This module should be installed in a protected environment, inside a vehicle.*




Dimensions 5-3/4 X 5 inches
Pat. No. 4,907,222 & 6,011,997

### *DIRECT CONNECT OUTPUTS 5 AND 6*

Direct Connection between inputs 7 and 8 and outputs 5 and 6 can be accomplished by setting dip switch 5 and 6 to the on position. When set for direct connect, the respective output will turn on within 1ms of receiving an input at 7 or 8. The purpose of the direct connect outputs is to eliminate the delay caused by communication with the CPU. This setting bypasses any boolean that may be written for these channels. Inputs at 7 and 8 may be high or low-side inputs.

### *DIAGNOSTICS AND LED INDICATORS*

Next to each Mate-N-Lok output connection you will find a green LED. If the output is on, the LED will illuminate. If a fuse is blown and the output should be on, the LED will not illuminate.

A Red LED Illuminates when power is applied. When multiplex communications are present and correct, the COM LED will Illuminate.

If the module's circuit board exceeds temperature of $100^0$ C, all outputs will turn off protecting the module. The COM LED will flash indicating that an over temperature condition exists. After cool down and the power is removed and reapplied, the module will return to normal function. The module will record the number of times overheating has occurred and upon initial power up the LED will flash the number of times the module has been overheated.

### *LOAD DISTRIBUTION*

Max load current per module 50 Amps
Max load current output One 20 Amps
Max load current outputs two through six 10 amps

I = the current in amps
$II1^2/2+I2^2+I3^2+I4^2+I5^2+I6^2=<350$

(Notice that for output one, the current squared is divided by two)

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# 4 Channel DC Input / 6 Channel Solid-State Output

## 00-00846-506/516 PMC Solid State I/O Module

### SPECIFICATIONS

| **General Connections** | | **00-00846-516** | **00-00846-506** |
|---|---|---|---|
| Nominal Vehicle Voltage | | 12V | 24V |
| Maximum Operating Temperature | | $65^0$ C | $65^0$ C |
| Module Current | | 50 Amps Max | 50 Amps Max |
| J1-1 | Output Channel 1 20A | | |
| J1-2 | thru J1-6 Output Channels 2-6 10A | | |
| J2-1 | Communication Signal (from CPU) 16 awg Min. | | |
| J2-2 | Communication Ground (from CPU) 14awg Min. | | |
| J3 | Power Stud +12V size wire to support module load current | | |
| J4-1 | Fused 12V out for positive switched inputs | 3 Amps Max. | 3 Amps Max |
| J4-2-5 | Input Channels 7-10 | 18 awg Min. | 18 awg Min. |
| J5 | Module Ground | 16 awg Min. | 16 awg Min. |

### CHANNEL DESIGNATIONS

| Channel | Connection | Type | Rating |
|---|---|---|---|
| 1 | J1-1 | FET Output | 20 Amps Max @$65^0$ C Ambient |
| 2-6 | J1-2 thru J1-6 | FET Output | 10 Amps Max @$65^0$ C Ambient<br>Use Channel 1 for highest amperage output. Do not exceed 50 Amps total or 350 per below.<br>$I1^2/2+I2^2+I3^2+I4^2+I5^2+I6^2=<350$ |
| 7-10 | J4-2 thru J4-5 | Input, Positive or Negative | |

*Contact Intellitec for assistance determining of your particular load distribution will provide for a reliable design.*

### MATING CONNECTIONS

| Designator | Function | Connector | Mating Part # | Contact, Typical For 14-18 AWG | Contact, Typical for 10-12 AWG |
|---|---|---|---|---|---|
| J1 | Outputs | 6 Pin Amp Mate-N-Lok | 640585-1 | 350919-3 | 640310-3 |
| J2 | PMC/Com | 2 Pin Amp Mate-N-Lok | 1-480698-0 | 350919-3 | 640310-3 |
| J3 | Ground | .250 Tab Terminal | | | |
| J4 | Inputs | 5 Pin Amp Mate-N-Lok | 1-480763-0 | 350919-3 | 640310-3 |

### MODULE SETTINGS

Module can be set for 1 of 16 address, A-P.
Set six dip switches per table on right.

X = Switch is OFF

| SWITCH 6 5 4 3 2 1 | Address | SWITCH 6 5 4 3 2 1 | Address |
|---|---|---|---|
| 0 0 0 0 | A | X 0 0 0 | I |
| 0 0 0 X | B | X 0 0 X | J |
| 0 0 X 0 | C | X 0 X 0 | K |
| 0 0 X X | D | X 0 X X | L |
| 0 X 0 0 | E | X X 0 0 | M |
| 0 X 0 X | F | X X 0 X | N |
| 0 X X 0 | G | X X X 0 | O |
| 0 X X X | H | X X X X | P |

Turning switch 5 on causes Output Ch 5 to be operated directly from Input Ch 7 (Acts like a relay)
Turning switch 6 on causes Output Ch 6 to be operated directly from Input Ch 8 (Acts like a relay)

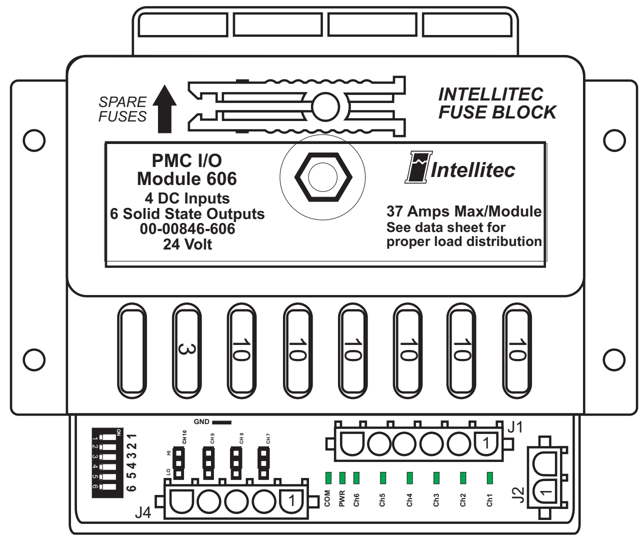
Four inputs Channel 7-10 can be individually set for either positive (high-side)
Switched to the battery, or negative (low-side) switched to ground.

The PMC I/O Module 846-606/616 is a member of Intellitec's Programmable Multiplex Control family. It works in combination with the PMC CPU and other standard, semi-custom, or custom I/O modules.

The *606/616* provides power-fusing, switching, and distribution in one module. With it's six, solid-state, high-side outputs it is capable of controlling a total of 50 Amps. *Please refer to the tables in this brochure for proper load distribution.* The outputs are controlled by field effect transistors and are ideal for high use applications; such as flashing warning lights, turn signals and brake lights.

There are four input connections for rocker, limit, or sensor switches. Each individual input can be configured as either a low-side switch to ground, or a high-side switch to battery. Input information is directly communicated to the CPU via the PMC communications link. All of the input/output harnesses are connected with AMP Mate-N-Lok connectors to reduce installation time and errors.

*This module should be installed in a protected environment inside a vehicle.*




Short circuit protected FETs shut off in the event of a shorted load. Fuses or circuit breakers provide redundant protection.

Dimensions 5-3/4 X 5 inches

### *DIRECT CONNECT OUTPUTS 5 AND 6*

Direct Connection between inputs 7 and 8 and outputs 5 and 6 can be accomplished by setting dip switch 5 and 6 to the on position. When set for direct connect, the respective output will turn on within 1ms of receiving an input at 7 or 8. The purpose of the direct connect outputs is to eliminate the delay caused by communication with the CPU. This setting bypasses any boolean that may be written for these channels. Inputs at 7 and 8 may be High or Low side inputs.

### *DIAGNOSTICS AND LED INDICATORS*

Next to each output connection you will find a green LED. If the output is on, the LED will illuminate. If a fuse is blown and the output should be on, the LED will not illuminate.

A Red LED Illuminates when power is applied. When multiplex communications are present and correct, the COM LED will Illuminate.

If the module's circuit board exceeds $100^0$ C, all outputs will turn off protecting the module. The COM LED will flash indicating that an over temperature condition exists. After cool down, and after power is removed and reapplied the module will return to normal function. The module will record the number of times overheating has occurred and upon initial power up the LED will flash the number of times the module has been overheated.

### *LOAD DISTRIBUTION*

Max load current per module 37 Amps
Max load current per output one through six, 10 amps

I = the current in amps
$I1^2/2+I2^2+I3^2+I4^2+I5^2+I6^2_6=<200$

*(Notice that for output one, the current squared is divided by two)*

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# *Protected FET 4 Channel DC Input / 6 Channel Solid-State Output*
# *00-00846-606/616 PMC Solid State I/O Module*

## *SPECIFICATIONS*

| **General Connections** | | **00-00846-616** | **00-00846-606** |
|---|---|---|---|
| Nominal Vehicle Voltage | | 12V | 24V |
| Maximum Operating Temperature | | $65^0$ C | $65^0$ C |
| Module Current | | 37 Amps Total Max | 37 Amps Total Max |
| J1-1 | Output Channel 1 20A | | |
| J1-2 | thru J1-6 Output Channels 2-6 10A | | |
| J2-1 | Communication Signal (from CPU) 16 awg Min. | | |
| J2-2 | Communication Ground (from CPU) 14 awg Min. | | |
| J3 | Power Stud +12V size wire to support module load current | | |
| J4-1 | Fused 12V out for positive switched inputs | 3 Amps Max. | 3 Amps Max |
| J4-2-5 | Input Channels 7-10 | 18 awg Min. | 18 awg Min. |
| J5 | Module Ground | 16 awg Min. | 16 awg Min. |

## *CHANNEL DESIGNATIONS*

| **Channel** | **Connection** | **Type** | **Rating** |
|---|---|---|---|
| 1-6 | J1-1 thru J1-6 | FET Output | Ch 1 15Amps Max, Ch 2-6 10 Amps Max @$65^0$C Ambient. Use Channel 1 for highest amperage output. Do not exceed 37 Amps total or 200 per below. $I1^2/2+I2^2+I3^2+I4^2+I5^2+I6^2=<200$ |
| 7-10 | J4-2 thru J4-5 | Input, Positive or Negative | |

Contact Intellitec for assistance determining of your particular load distribution will provide for a reliable design.

## *MATING CONNECTIONS*

| **Designator** | **Function** | **Connector** | **Mating Part #** | **Contact, Typical** *for 14-18 AWG* | *for 10-12 AWG* |
|---|---|---|---|---|---|
| J1 | Outputs | 6 Pin Amp Mate-N-Lok | 640585-1 | 350919-3 | 640310-3 |
| J2 | PMC/Com | 2 Pin Amp Mate-N-Lok | 1-480698-0 | 350919-3 | 640310-3 |
| J3 | Ground | .250 Tab Terminal | | | |
| J4 | Inputs | 5 Pin Amp Mate-N-Lok | 1-480763-0 | 350919-3 | 640310-3 |

## *MODULE SETTINGS*

Module can be set for 1 of 16 address, A-P.
Set six dip switches per table on right.

X = Switch is OFF

| ***SWITCH* 6 5 4 3 2 1** | ***Address*** | ***SWITCH* 6 5 4 3 2 1** | ***Address*** |
|---|---|---|---|
| 0 0 0 0 | A | X 0 0 0 | I |
| 0 0 0 X | B | X 0 0 X | J |
| 0 0 X 0 | C | X 0 X 0 | K |
| 0 0 X X | D | X 0 X X | L |
| 0 X 0 0 | E | X X 0 0 | M |
| 0 X 0 X | F | X X 0 X | N |
| 0 X X 0 | G | X X X 0 | O |
| 0 X X X | H | X X X X | P |

Turning switch 5 on causes Output Ch 5 to be operated directly from Input Ch 7 (Acts like a relay)
Turning switch 6 on causes Output Ch 6 to be operated directly from Input Ch 8 (Acts like a relay)

Four inputs Channel 7-10 can be individually set for either positive (high-side) switched to the battery, or negative (low-side) switched to ground.

The PMC I/O Module 600/610 is a member of Intellitec's Programmable Multiplex Control family. It works in combination with the PMC CPU and other standard, semi-custom, or custom I/O modules.

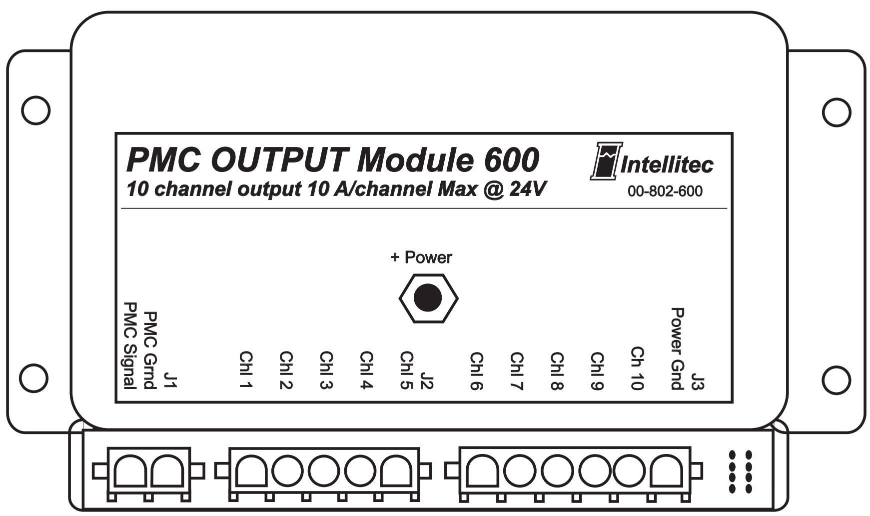
The 600/610 module provides power switching, and distribution in one module. With it's ten, solid-state, high-side outputs, it is capable of controlling a total of 50 Amps. Each output is capable of controlling a maximum of 10 Amps. ***Please refer to the tables in this brochure for proper load distribution.* The outputs are controlled by field effect transistors and are ideal for high use applications, such as turn signals, brake lights and emergency vehicle flashers.

The advanced FET outputs in the 600/610 module are self protecting in the event of a short circuit. The electronic over current and short circuit protection will shut current flow off very quickly in the event of either a short circuit or over temperature condition. In the event that overcurrent or a short circuit is detected, the output will turn off and remain off until the PMC channel that is controlling it is turned off and then on again. If the fault is still present, the output will turn off again.

The unique design of this module provides protection for the FET outputs in the event of wiring errors or failures that produce loss of ground. With most competitive units, loss of ground can cause their solid state outputs to turn partially on when they are not directed to do so. In addition to creating a hazard due to loss of control, this will also destroy the output. In the event of loss of ground the Intellitec output will remain off. All of Intellitec's FET output modules are protected for this as well as other conditions such as load dump and voltage spikes that are common to vehicles.

** Determining Acceptable Load distribution

$$I1^2 + I2^2 + I3^2 + I4^2 + I5^2 + I6^2 + I7^2 + I8^2 + I9^2 + I10^2 <= 255$$



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## *SPECIFICATIONS*

| **General Connections** | **00-00802-610** | **00-00802-600** |
|---|---|---|
| Nominal Vehicle Voltage | 12V | 24V |
| Maximum Operating Temperature | $65^{0}$ C | $65^{0}$ C |
| Module Current | 50 Amps Total Max | 50 Amps Total Max |

## *CONNECTORS*

| | | | |
|---|---|---|---|
| J1-1 | PMC Signal | 18 awg Min. | 18 awg Min. |
| J1-2 | PMC Ground | 14 awg Min. | 14 awg Min. |

## *CHANNEL DESIGNATIONS*

| **Channel** | **Connection** | **Type** | **Rating** |
|---|---|---|---|
| 1-5 | J2-1 thru J2-5 | Protected FET Output | 10 Amps cont. Any output @$65^{0}$C Ambient. |
| 6-10 | J3-1 thru J3-5 | Protected FET Output | 10 Amps cont. Any output @$65^{0}$C Ambient. |
| Pwr GND | J3-6 | | *See formula & examples on "Determining Acceptable Load Distribution" page.* |

+ BAT Power stud 1/4 - 20

***NOTE:*** The FET outputs of channels 1-10 provide a protected source of voltage to the Load from the Battery. The maximum current for the entire module is 50 Amps. Due to the need to dissipate heat, the current being controlled by each output must be considered.

**For reliability, the sum of the current in each channel squared must equal less than 255 and total module current must not exceed 50 Amps.** $I1^2 + I2^2 + I3^2 + I4^2 + I5^2 + I6^2 + I7^2 + I8^2 + I9^2 + I10^2 = 255$

Do not exceed 50 Amps total and stay within the recommendations for the combination of outputs described in this data sheet. *Contact Intellitec for assistance determining if your particular load distribution will provide for a reliable design.*

## *MATING CONNECTIONS*

| **Designator** | **Function** | **Connector** | **Mating Part #** | **Contact, Typical** *for 14-18 AWG* | *for 10-12 AWG* |
|---|---|---|---|---|---|
| J1 | PMC/Com | 2 Pin Amp Mate-N-Lok | 1-480698-0 | 350919-3 | 640310-3 |
| J2 | Outputs | 5 Pin Amp Mate-N-Lok | 1-480763-0 | 350919-3 | 640310-3 |
| J3 | Outputs | 6 Pin Amp Mate-N-Lok | 640585-1 | 350919-3 | 640310-3 |

## *MODULE SETTINGS*

Module can be set for 1 of 16 address, A-P.
Set four jumpers on jumper block JP2 per table on right.

X = Jumper is OUT

| ***JUMPERS 4 3 2 1*** | ***Module Address*** | ***JUMPERS 4 3 2 1*** | ***Address*** |
|---|---|---|---|
| 0 0 0 0 | A | X 0 0 0 | I |
| 0 0 0 X | B | X 0 0 X | J |
| 0 0 X 0 | C | X 0 X 0 | K |
| 0 0 X X | D | X 0 X X | L |
| 0 X 0 0 | E | X X 0 0 | M |
| 0 X 0 X | F | X X 0 X | N |
| 0 X X 0 | G | X X X 0 | O |
| 0 X X X | H | X X X X | P |

# PMC Sealed Output Module with Short Circuit Protection and Lamp Dimmer Control

**00-00888-600/610/604/614**

The PMC Output Modules, 00-00888, are members of Intellitec's Programmable Multiplex Control family. They work in combination with the PMC CPUs and other standard, semi-custom, or custom I/O modules. These modules provide protected solid-state outputs eliminating the need to add fuses or circuit breakers on each output. In addition, the -604 and -614 modules provide the capability of dimming lights that are connected to outputs 5-10.

The modules provide power switching, circuit protection and distribution. Switching is accomplished via long life, field effect transistors instead of relays. Circuit protection is accomplished by using short circuit protected FETs and proprietary design elements. Each output will handle 10 Amps. The total module current is limited by the *"I squared rule"* on the following page.

The approximate module dimensions are 6.6" X 4.250" X 1.75" (16.8mm X 10.8mm X 4.4mm). These modules are water-proof and can be located where moisture may be present.

The 888 module can be set for module addresses, A-P. *Using the chart on the next page, connect jumpers in the plug, J1.*

### PWM (PULSE WIDTH MODULATION) PROVIDES VARIABLE POWER

The 888-600 and 610 modules do not have dimmable outputs.

The 888-604 and 614 modules provide the ability to dim lights from any Intellitec multiplex keypad or momentary switch input. Channels 5-10 on the -604 and -614 are dimmable outputs.

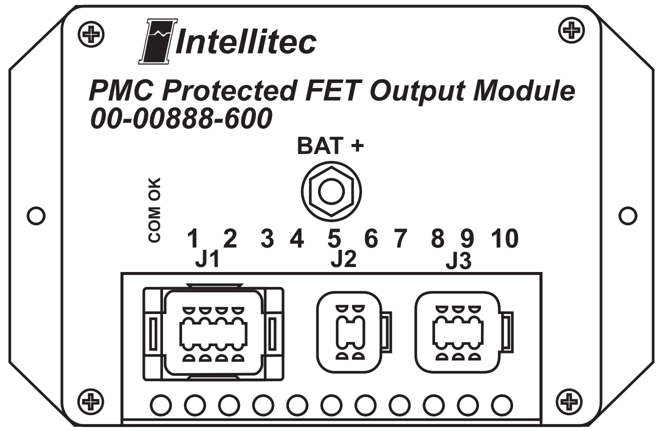
These modules dim the lights using pulse width modulation or PWM. Variable power is applied to the load by quickly turning the power on and off. Varying the duty cycle will vary the intensity of the lamp.

The six outputs coming out of J3(ch 5-10) will operate to dim lights. The four outputs coming out of J2 (ch 1-4) are not dimmable and can be used to power loads such as water pumps or flourescent lights that should not be connected to variable voltage.

For the dimmable outputs, the output will latch on at the output module. To turn the output on, all that is required is that it's PMC channel be turned on momentarily. When the channel comes on, the output turns on and latches. When the channel turns off, the output remains latched until the channel turns on again, at which time the output turns off.

### VERSION 00-00888-600 AND 610 non-dimmable

The outputs on these units will operate as any other PMC output. To keep the output on, it's channel must be on.




### OPERATING EXAMPLE FOR DIMMABLE OUTPUT

If the lighting output channel is B3 and a momentary push button is placed at D5 you could write a boolean such as B3=D5. When momentary button D5 is pressed and released the output associated with B3 will turn on at 100% intensity and remain on even though switch channel D5 is off. When D5 is pressed and released a second time, output B3 will turn off. This happens because the output is latched on and off at the module.

When button D5 is pressed and held, the output will begin to ramp up, increasing the lamp intensity. When the button is let go, the lamp will remain at that intensity. Pressing and holding the button a second time will cause the intensity to begin ramping down. When the button is released, the lamp will remain at that intensity. Pressing and releasing the button quickly will cause the output to toggle off. If power has been maintained at the module, the output will remember it's last intensity setting next time it is turned on.

### PROGRAMMING A GLOBAL RESET OF LATCHED DIMMABLE CHANNELS

Because the dimmable channels latch on or in other words can be on when the associated PMC channel is off, Intellitec has provided channel P1 as a global reset channel.

If one or more out puts on one or more modules is latched on, they can all be turned off by momentarily turning on PMC channel P1. This could be accomplished in two ways. A momentary push button on the Intellitec keypad could be set to channel P1. By pressing this button all latched outputs will turn off. An alternative would be to write a boolean that momentarily turns channel P1 on when another input is turned on.

### LED DIAGNOSTIC INDICATORS

A row of diagnostic LEDs has been provided on the module. The first LED will be on when the module receives a valid PMC communications signal. LEDs 2-11 will illuminate when their associated output is on.

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# *PMC Sealed Output Module with short circuit protection and Lamp Dimmer Control*

***00-00888-600/610/604/614***

| ***SPECIFICATIONS*** | ***Non-dimmable outputs*** | | ***Dimmable outputs*** | |
|---|---|---|---|---|
| ***Modules*** | **00-00888-600** | **00-00888-610** | **00-00888-604** | **00-00888-614** |
| Nominal Vehicle Voltage | 24V | 12V | 24V | 12V |

***NOTES:***

Non-dimmable outputs: Outputs do not latch. The associated PMC channel must be kept ON to keep an output ON.

Dimmable outputs: Dimmable outputs 5-10, latch on and off when their associated PMC channel is momentarily turned ON.

For non dimmable outputs the associated PMC channel must be kept ON to keep the output ON.

## *GENERAL CONNECTIONS*

| | | |
|---|---|---|
| J1-1 | No Connection | |
| J1-2 | Communications Signal + (from Master or CPU) | 16 Awg Min. |
| J1-3 | Communications Signal - (from Master or CPU) | 14 Awg Min. |

## *CHANNEL DESIGNATIONS*

| Channel | Connection | Type | Rating |
|---|---|---|---|
| 1 | J2-1 | FET Output | 10 Amp Max ** |
| 2 | J2-2 | FET Output | 10 Amp Max ** |
| 3 | J2-3 | FET Output | 10 Amp Max ** |
| 4 | J2-4 | FET Output | 10 Amp Max ** |
| 5 | J3-1 | FET Output | 10 Amp Max ** |
| 6 | J3-2 | FET Output | 10 Amp Max ** |
| 7 | J3-3 | FET Output | 10 Amp Max ** |
| 8 | J3-4 | FET Output | 10 Amp Max ** |
| 9 | J3-5 | FET Output | 10 Amp Max ** |
| 10 | J3-6 | FET Output | 10 Amp Max ** |

### *"I SQUARED RULE"*

** Total module current is limited by the following. The sum of the current squared for each output may not exceed 350.

$$I1^2+I2^2+I3^2+I4^2+I5^2+I6^2+I7^2+I8^2+I9^2+I10^2<350$$

***Failure to follow this rule may cause module failure.***

## *MATING CONNECTIONS*

| Designator | Function | Connector | Mating Part # |
|---|---|---|---|
| Stud | Battery | 1/4" Ring Term | |
| J1 | Communication and address | Deutsch DT04-8PA | Deutsch DT06-08SA |
| J2 | Outputs | Deutsch DT04-4P | Deutsch DT06-04S |
| J3 | Outputs | Deutsch DT04-6P | Deutsch DT06-06S |

## *MODULE SETTINGS*

A module can be set for 1 of 16 addresses or A-P. This is done with wire jumpers from pin J1-4 to pins J1-5 through J1-8 as listed in the table shown here. This makes the method of setting the address waterproof.

**1 = connect to J1-4**

This method of address setting vs dip switches or jumpers provides the additional advantage of having the module address set by the harness. Replacement parts do not require that the address be set prior to shipment.

| J1-4 connected to J1- ***8 7 6 5*** | ***MODULE Address*** |
|---|---|
| 1 1 1 1 | A |
| 1 1 1 X | B |
| 1 1 X 1 | C |
| 1 1 X X | D |
| 1 X 1 1 | E |
| 1 X 1 X | F |
| 1 X X 1 | G |
| 1 X X X | H |

| J1-4 connected to J1- ***8 7 6 5*** | ***MODULE Address*** |
|---|---|
| X 1 1 1 | I |
| X 1 1 X | J |
| X 1 X 1 | K |
| X 1 X X | L |
| X X 1 1 | M |
| X X 1 X | N |
| X X X 1 | O |
| X X X X | P |

## DETERMINING ACCEPTABLE LOAD DISTRIBUTION

Per the data sheet, any output on a 506/516 module may be used to control as much as 20 Amps; on a 600/610/606 or 616 module 10 Amps. It is important that we consider the amount of current being drawn on each of the 6 outputs and the total amount of heat generated by the FETs for reliability reasons to keep the field effect transistors within their rated operating temperature. *If for example, with a 506 module, you anticipate that all of the outputs could be on at the same time and one of the outputs draws 20 Amps, the others should be limited to approximately 3.2 Amps each.* If one of the outputs were 10 amps instead, the others could each be as much as 8.4 amps. As you can see, the relationship is *not linear* and *does not always* add up to the module's total current capacity of 50 amps.

To determine if your particular load distribution is acceptable, please use the following formula, or stay within the examples shown on this sheet. These calculations assume an ambient temperature of 65°C or less. The calculations also assume that all 6 channels are on continuously at the same time. If because of the operating logic, it is impossible for two outputs to be on at the same time, use 0 in the formula for the lower current output and perform the calculation. For a 506/516 module, the resultant of the formula should be 450, or less. For a 606/616 it should be 255 or less. If an output is on for a short duration, (10 seconds) and does not repeat for several minutes, then 0 may be used in the equation.

The field effect transistors are kept within their operating temperature by dissipating their heat into the surrounding air. *It is important that the metal heat sink on the top of the module is not covered by carpeting, paint, labels, or any other type of insulating material.* It is OK to mount the module inside an enclosure, provided that there is a volume of at least 200 cubic inches.

When continuously operating the module close to it's full load capacity, the heat sink will become hot. This is normal. *Care should be taken so that materials that may be damaged by heat, such as plastics, are not in contact with the metal heat sink.*

### I = average channel current

**For 00-00846- 506 and 516 modules $I1^2/2+I2^2+I3^2+I4^2+I5^2+I6^2=350$ or Less and $I_T$< or = 50 Amps**

**For 00-00846-606 and 616 modules $I1^2/2+I2^2+I3^2+I4^2+I5^2+I6^2=200$ or Less and $I_T$< or = 37 Amps**

**For 00-00802-600 and 610 modules $I1^2+I2^2+I3^2+I4^2+I5^2+I6^2+I7^2+I8^2+I9^2+I10^2=255$ or Less and $I_T$< or = 50 Amps**

**For 00-00888-600 and 610 modules $I1^2+I2^2+I3^2+I4^2+I5^2+I6^2+I7^2+I8^2+I9^2+I10^2 = 350$ or Less and $I_T$< or = 50 Amps**

## *DETERMINING ACCEPTABLE LOAD DISTRIBUTION*

### *Examples for 00-00846-506/516 Modules* $I1^2/2+I2^2+I3^2+I4^2+I5^2+I6^2=350$

| Channel | No. | Amps | $I^2$ |
|---|---|---|---|
| 1 | $I^2/2$ | 10 | 50 |
| 2 | $I^2$ | 8 | 64 |
| 3 | $I^2$ | 8 | 64 |
| 4 | $I^2$ | 8 | 64 |
| 5 | $I^2$ | 8 | 64 |
| 6 | $I^2$ | 6.5 | 42 |
| Total | | 48.5 | 348 |

| Channel | No. | Amps | $I^2$ |
|---|---|---|---|
| 1 | $I^2/2$ | 10 | 50 |
| 2 | $I^2$ | 10 | 100 |
| 3 | $I^2$ | 10 | 100 |
| 4 | $I^2$ | 7 | 49 |
| 5 | $I^2$ | 4 | 25 |
| 6 | $I^2$ | 5 | 25 |
| Total | | 47 | 349 |

| Channel | No. | | 43.5 |
|---|---|---|---|
| 1 | $I^2/2$ | Amps | $I^2$ |
| 2 | $I^2$ | 20 | 200 |
| 3 | $I^2$ | 2.5 | 6 |
| 4 | $I^2$ | 10 | 100 |
| 5 | $I^2$ | 5 | 25 |
| 6 | $I^2$ | 3 | 9 |
| Total | | 3 | 9 |

### *Examples for 00-00846-606/616 Modules* $I1^2/2+I2^2+I3^2+I4^2+I5^2+I6^2=200<200$

| Channel | No. | Amps | $I^2$ |
|---|---|---|---|
| 1 | $I^2/2$ | 12 | 72 |
| 2 | $I^2$ | 5 | 25 |
| 3 | $I^2$ | 5 | 25 |
| 4 | $I^2$ | 5 | 25 |
| 5 | $I^2$ | 5 | 25 |
| 6 | $I^2$ | 5 | 25 |
| Total | | 37 | 197 |

| Channel | No. | Amps | $I^2$ |
|---|---|---|---|
| 1 | $I^2/2$ | 10 | 50 |
| 2 | $I^2$ | 8 | 64 |
| 3 | $I^2$ | 5 | 25 |
| 4 | $I^2$ | 2 | 4 |
| 5 | $I^2$ | 6 | 36 |
| 6 | $I^2$ | 4 | 16 |
| Total | | 35 | 195 |

| Channel | No. | Amp | 35.5 |
|---|---|---|---|
| 1 | $I^2/2$ | s | $I^2$ |
| 2 | $I^2$ | 15 | 112.5 |
| 3 | $I^2$ | 5 | 25 |
| 4 | $I^2$ | 4 | 16 |
| 5 | $I^2$ | 2.5 | 6.25 |
| 6 | $I^2$ | 5 | 25 |
| Total | | 4 | 16 |

### *Examples for 00-00802-600/610 Modules* $I1^2+I2^2+I3^2+I4^2+I5^2+I6^2+I7^2+I8^2+I9^2+I10^2=255$

| Channel No. | Amps | $I^2$ |
|---|---|---|
| 1 | 5 | 25 |
| 2 | 5 | 25 |
| 3 | 5 | 25 |
| 4 | 5 | 25 |
| 5 | 5 | 25 |
| 6 | 5 | 25 |
| 7 | 5 | 25 |
| 8 | 5 | 25 |
| 9 | 5 | 25 |
| 10 | 5 | 25 |
| Total | 50 | 250 |

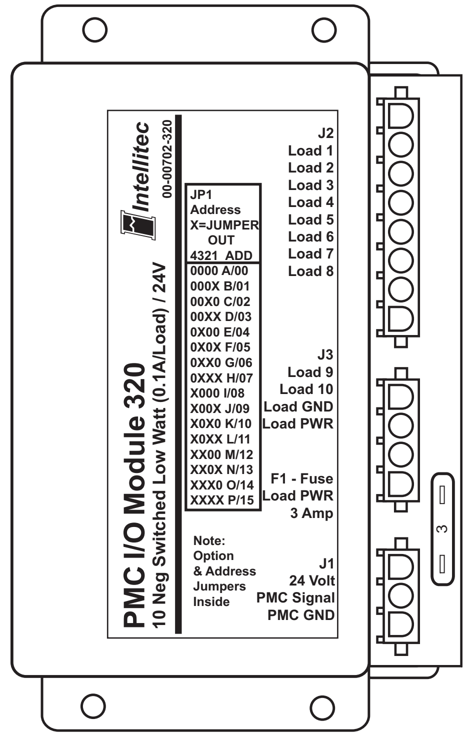
| Channel No. | Amps | $I^2$ |
|---|---|---|
| 1 | 10 | 100 |
| 2 | 5 | 25 |
| 3 | 5 | 25 |
| 4 | 5 | 25 |
| 5 | 5 | 25 |
| 6 | 4 | 16 |
| 7 | 3 | 9 |
| 8 | 3 | 9 |
| 9 | 3 | 9 |
| 10 | 3 | 9 |
| Total | 46 | 252 |

| Channel No. | Amps | $I^2$ |
|---|---|---|
| 1 | 10 | 100 |
| 2 | 10 | 100 |
| 3 | 3 | 9 |
| 4 | 3 | 9 |
| 5 | 3 | 9 |
| 6 | 3 | 9 |
| 7 | 2 | 4 |
| 8 | 2 | 4 |
| 9 | 2 | 4 |
| 10 | 2 | 4 |
| Total | 40 | 252 |

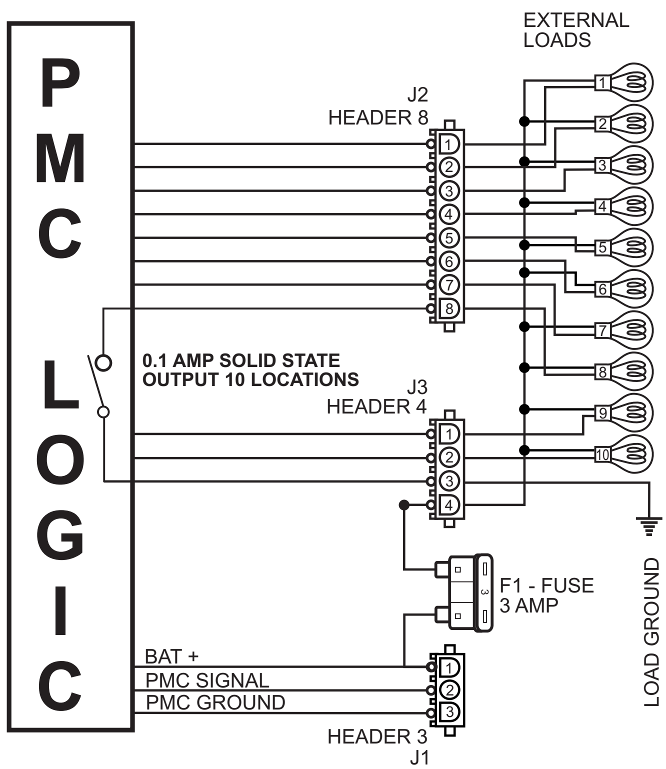
PMC I/O Modules 00-00702-320 and 330 are members of Intellitec's Programmable Multiplex Control family. They work in combination with the PMC CPU and other standard, semi-custom or custom I/O modules, allowing you to create the exact system configuration that you want from basic to all encompassing.

There are ten connections for low wattage loads, such as dash warnings lights, or beepers. The PMC CPU utilizes input information from other modules on the system, and via the PMC communications link controls the ten loads of this module. All of the output harnesses are connected with AMP Mate-N-Lok connectors to reduce installation time and errors.

All loads are negative (low-side), switched to a local load ground which needs to be provided to the module. In other words, the outputs are connected between the load and ground. *(Different than the 406/416 module which provides for high-side switching).* A fused load power connection is available at the module which can be used for loads requiring a power source.




**Pat. No. 4,907,222 & 6,011,997**



# *10 Negative Switched Low Watt Outputs (0.1A Load)*

## *00-00702-320/330 PMC Output Modules*

### *SPECIFICATIONS*

| *General Connections* | | 00-00702-330 | 00-00702-320 |
|---|---|---|---|
| Nominal Vehicle Voltage | | 12V | 24V |
| J3-4 | Fuse 1, Load Power | 3 Amps Max. | 3 Amps Max. |
| J3-3 | Local Load Ground | | |
| J1-1 | External Power from CPU | 5 Amps Max. | 5 Amps Max. |
| J1-2 | PMC Signal | 18 awg Min. | 18 awg Min. |
| J1-3 | PMC Ground | 14 awg Min. | 14 awg Min. |

### *CHANNEL DESIGNATIONS*

| Channel | Connection | Type | Name | Rating |
|---|---|---|---|---|
| 1 | J2 -1 | Output, Negative Switch to Gnd | Load 1 | 0.1 Amp |
| 2 | J2 -2 | Output, Negative Switch to Gnd | Load 2 | 0.1 Amp |
| 3 | J2 -3 | Output, Negative Switch to Gnd | Load 3 | 0.1 Amp |
| 4 | J2 -4 | Output, Negative Switch to Gnd | Load 4 | 0.1 Amp |
| 5 | J2 -5 | Output, Negative Switch to Gnd | Load 5 | 0.1 Amp |
| 6 | J2 -6 | Output, Negative Switch to Gnd | Load 6 | 0.1 Amp |
| 7 | J2 -7 | Output, Negative Switch to Gnd | Load 7 | 0.1 Amp |
| 8 | J2 -8 | Output, Negative Switch to Gnd | Load 8 | 0.1 Amp |
| 9 | J3 -1 | Output, Negative Switch to Gnd | Load 9 | 0.1 Amp |
| 10 | J3 -2 | Output, Negative Switch to Gnd | Load 10 | 0.1 Amp |

### *MATING CONNECTIONS*

| Designator | Function | Connector | Mating Part # | Contact,Typical | |
|---|---|---|---|---|---|
| | | | | *For 14-18 AWG* | *for 10-12 AWG* |
| J1 | PMC Link | 3 Pin Amp Mate-N-Lok | 1-480700-0 | 350919-3 | 640310-3 |
| J2 | Loads | 8 Pin Amp Mate-N-Lok | 1-480702-0 | 350919-3 | 640310-3 |
| J3 | Loads, Power, GND | 4 Pin Amp Mate-N-Lok | 640586-1 | 350919-3 | 640310-3 |

### *MODULE SETTINGS*

Module can be set for 1 of 16 address, A-P.
A-P. Set four jumpers on jumper block JP2 per table on right.

X = Jumper is OUT

| *JUMPERS 4 3 2 1* | *MODULE Address* | *JUMPERS 4 3 2 1* | *MODULE Address* |
|---|---|---|---|
| 0 0 0 0 | A | X 0 0 0 | I |
| 0 0 0 X | B | X 0 0 X | J |
| 0 0 X 0 | C | X 0 X 0 | K |
| 0 0 X X | D | X 0 X X | L |
| 0 X 0 0 | E | X X 0 0 | M |
| 0 X 0 X | F | X X 0 X | N |
| 0 X X 0 | G | X X X 0 | O |
| 0 X X X | H | X X X X | P |

***NOTE Heavier loads can be connected to this module if the following guidelines are observed.** Any single Load shall not exceed 0.5 Amps, and neither the sum of the currents in Loads 1-5, nor the sum of the currents in Loads 6-10 shall exceed 0.5 Amps. (Example1: Load 1=0.25 Amps, Load 2=0.05 Amps, Load 3=0.1 Amps, Load 4=0.1 Amps, Load 5=No Connection, Load 1-5 sum =0.5 Amps is an acceptable configuration. Example 2: Load 6=0.5 Amps, Load 7=No Connection, Load 8=No Connection, Load 9=No Connection, Load 10=No Connection, Load 6-10 sum =0.5 Amps is an acceptable configuration.)

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1485 Jacobs Rd.
Deland, FL 32724   386.738.7307
www.intellitec.com

# 6 Warning Light Direct Plug-In Adapter

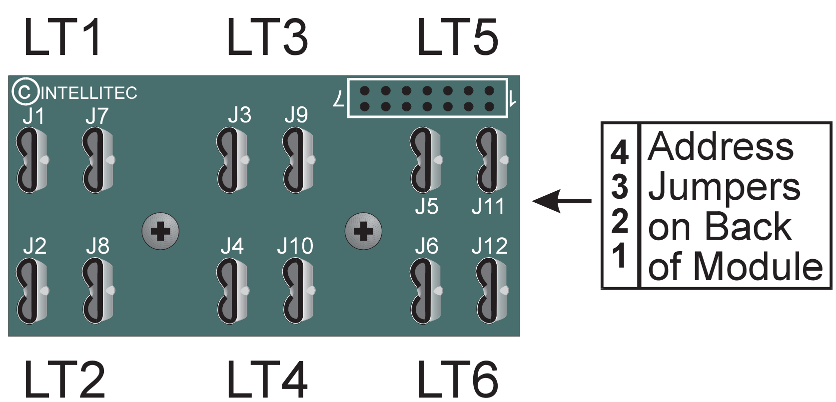
### *00-00644-806/816  PMC Warning Light Adapter*

PMC Warning Light Adapters 806 & 816 are members of Intellitec's Programmable Multiplex Control family. They work in combination with the PMC CPU and other standard, semi-custom or custom I/O modules.

ITT warning lamps *(also know as SWF, Britax, or Sprague, not provided)* plug directly into the 806 or 816 Adapter, eliminating the need for a harness or separate wiring to each lamp. The lamps are controlled by the central PMC CPU via the two wire PMC communications link. The third wire provides power to the lamps. The 3 wire PMC connection is made with an AMP Mate-N-Lok connector to reduce installation time and errors. The six warning lights require only 3 wires vs. conventional wiring scheme needing as many as 12.

*Contact Intellitec if adapters are needed for other lamp manufacturers or other layouts.* Intellitec can also design and manufacture custom lamp or switch panels to fit your specific requirement.

The approximate module dimensions are 3.00" wide X 1.90" tall X 2.30" deep (75.6mm X 48.3mm X 58.5mm). *The module should be installed in a protected environment inside of the vehicle.*




**Uses ITT, Spague Warning lights**

Intellitec
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www.intellitec.com

# 6 Warning Light Direct Plug-In Adapter

## 00-00644-806/816 PMC Warning Light Adapter

### SPECIFICATIONS

| *General Connections* | | **00-00644-816** | **00-00644-806** |
|---|---|---|---|
| Nominal Vehicle Voltage | | 12V | 24V |
| Max Lamp Current (applies to 12/24V) | | 5 Amps/Module (0.083 Amps/Lamp) | |
| J13-1 | Power for Indicator Lamps | 5 Amps Max. | 5 Amps Max. |
| J13-2 | Multiplex Signal | 18 awg Min | 18 awg Min |
| J13-3 | Multiplex Ground | 14 awg Min | 14 awg Min |

### CHANNEL DESIGNATIONS

| Channel | Connection | Type | Name |
|---|---|---|---|
| 1 | J1/7 | Warning Lamp | Light 1 |
| 2 | J2/8 | Warning Lamp | Light 2 |
| 3 | J3/9 | Warning Lamp | Light 3 |
| 4 | J4/10 | Warning Lamp | Light 4 |
| 5 | J5/11 | Warning Lamp | Light 5 |
| 6 | J6/12 | Warning Lamp | Light 6 |
| 7 | | Not Available | |
| 8 | | Not Available | |
| 9 | | Not Available | |
| 10 | | Not Available | |

Channels 7 thru 10 may
Be used as virtual channels
When programming the vehicle.

### SPRAGUE / ITT PART NO.

| | **00-00644-816** | **00-00644-806** | |
|---|---|---|---|
| Typical Warning Lamp | 511 502 | 511 503 | *(not supplied)* |
| Bezel | 595 502 | 595 502 | *(not supplied)* |

### MATING CONNECTIONS

| Designator | Function | Connector | Mating Part # | Contact,Typical *For 14-18 AWG* | *for 10-12 AWG* |
|---|---|---|---|---|---|
| J13 | PMC Link | 3 Pin Amp Mate-N-Lok | 1-480700-0 | 350919-3 | 640310-3 |

### MODULE SETTINGS

Module can be set for 1 of 16 address, A-P.
Set four jumpers on jumper block JP1 per table on right.

X = Jumper is OUT

| *JUMPERS 4 3 2 1* | *MODULE Address* | *JUMPERS 4 3 2 1* | *MODULE Address* |
|---|---|---|---|
| 0 0 0 0 | A | X 0 0 0 | I |
| 0 0 0 X | B | X 0 0 X | J |
| 0 0 X 0 | C | X 0 X 0 | K |
| 0 0 X X | D | X 0 X X | L |
| 0 X 0 0 | E | X X 0 0 | M |
| 0 X 0 X | F | X X 0 X | N |
| 0 X X 0 | G | X X X 0 | O |
| 0 X X X | H | X X X X | P |

# 9 Rocker Switch Direct Plug-In Adapter

## 00-00656-909/919 PMC Rocker Switch Adapter

PMC Rocker Switch Adapters 909 & 919 are members of Intellitec's Programmable Multiplex Control Family. They work in combination with the PMC CPU and other standard, semi-custom, or custom I/O modules.

ITT rocker switches (also known as SWF, Britax, or Sprague) plug directly into the 909, or 919 Adapter, eliminating the need for a harness, or separate wiring to each switch. All switch information is directly communicated to the PMC CPU via the two wire PMC communications link. The third wire provides power to the lamps. The PMC connection is made with an AMP Mate-N-Lok connector to reduce installation time and errors. The switch indicator lamps are controlled directly on the adapter. When the switch is off, half of the battery voltage is supplied to the lamp for backlighting. When the switch is turned on, full battery voltage is applied to the lamp.

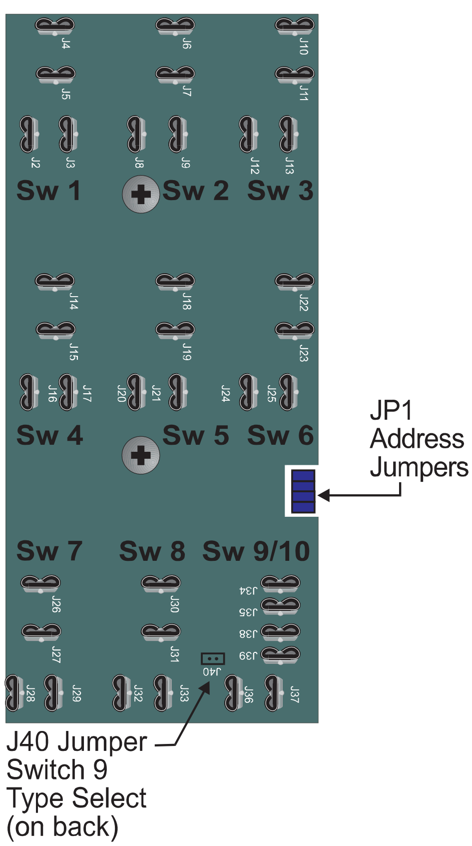
The switches do not control the loads or functions directly, they simply communicate information to the PMC CPU. Due to this fact, the switches do not have to be complex, eliminating the need for multiple poles or multiple throws. The switches can be more simple and less expensive, reducing the different types of switches used. The Windows based setup replaces the need for SPDT, DPDT and other switch configurations.

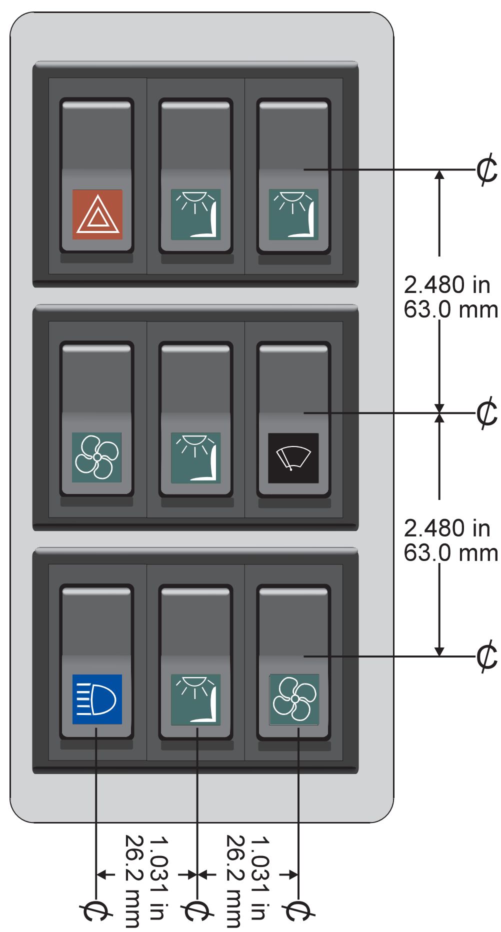
*Contact Intellitec if adapters are needed for other switch manufacturers, or other layouts.* Intellitec can also design and manufacture custom switch panels to suit your specific requirement.

The approximate module dimensions are 2.75" wide X 6.40" tall X 1.375" deep (69.9mm X 162.6mm X 34.9mm). It should be installed in a protected environment inside of the vehicle.

***Sprague/ITT Switches and Bezels not Included***

Patent No. 4,907,222 & 6,011,997



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www.intellitec.com

# 9 Rocker Switch Direct Plug-In Adapter

## 00-00656-909/919 PMC Rocker Switch Adapter

### SPECIFICATIONS

| General Connections | | 00-00656-919 | 00-00656-909 |
|---|---|---|---|
| Nominal Vehicle Voltage | | 12V | 24V |
| J1-1 | Power for Indicator Lamps | 5 Amps Max. | 5 Amps Max. |
| J1-2 | Multiplex Signal | 18 awg Min | 18 awg Min |
| J1-3 | Multiplex Ground | 14 awg Min | 14 awg Min |

### CHANNEL DESIGNATIONS

| Channel | Connection | Type | Name |
|---|---|---|---|
| 1 | J4/5 | Rocker Switch Type 1 | Switch 1 |
| 2 | J6/7 | Rocker Switch Type 1 | Switch 2 |
| 3 | J10/11 | Rocker Switch Type 1 | Switch 3 |
| 4 | J14/15 | Rocker Switch Type 1 | Switch 4 |
| 5 | J18/19 | Rocker Switch Type 1 | Switch 5 |
| 6 | J22/23 | Rocker Switch Type 1 | Switch 6 |
| 7 | J26/27 | Rocker Switch Type 1 | Switch 7 |
| 8 | J30/31 | Rocker Switch Type 1 | Switch 8 |
| 9 | J34/38 | Rocker Switch Type 1, 2 or 3 | Switch 9/10 |
| 10 | J35/39 | *(Combined with Channel 9)* | |

***NOTE*** *Rocker switches 1 thru 8 can only be Type 1. Rocker Switch 9 can be 1, 2, or 3 with proper setting of Jumper J40. As Type 2 o r 3 the CPU views the single switch as two separate switches receiving information in one position on Channel 9 and the other position on channel 10.*

*Switches and bezels not included (Bezel ITT P/N 595 502)*

| Rocker Switch | Function | Jumper J40 | 00-00656-909 | 00-00656-919 |
|---|---|---|---|---|
| Type 1 | SPST N.O. | OUT | 511 002 | 511 001 |
| Type 2 | SPDT (2 speed fan) (3-pos. OFF/LOW/HI) | IN | 511 028 | 511 027 |
| Type 3 | SPDT (2-pos. Momentary w/Center OFF) | IN | 511 067 | 511 066 |

### MATING CONNECTIONS

| Designator | Connector | Mating Part # | Contact,Typical *For 14-18 AWG* | Contact,Typical *for 10-12 AWG* |
|---|---|---|---|---|
| J1PMC | 3 Pin Amp Mate-N-Lok | 1-480700-0 | 350919-3 | 640310-3 |

### MODULE SETTINGS

Module can be set for 1 of 16 address, A-P.
Set four jumpers on jumper block JP1 per table on right.

X = Jumper is OUT

| JUMPERS 4 3 2 1 | MODULE Address | JUMPERS 4 3 2 1 | MODULE Address |
|---|---|---|---|
| 0 0 0 0 | A | X 0 0 0 | I |
| 0 0 0 X | B | X 0 0 X | J |
| 0 0 X 0 | C | X 0 X 0 | K |
| 0 0 X X | D | X 0 X X | L |
| 0 X 0 0 | E | X X 0 0 | M |
| 0 X 0 X | F | X X 0 X | N |
| 0 X X 0 | G | X X X 0 | O |
| 0 X X X | H | X X X X | P |

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# 6 Rocker Switch Direct Plug-In Adapter

## 00-00643-906/916 PMC Rocker Switch Adapter

PMC Rocker Switch Adapters 906/916 are members of Intellitec's Programmable Multiplex Control Family. They work in combination with the PMC CPU and other standard, semi-custom, or custom I/O modules.

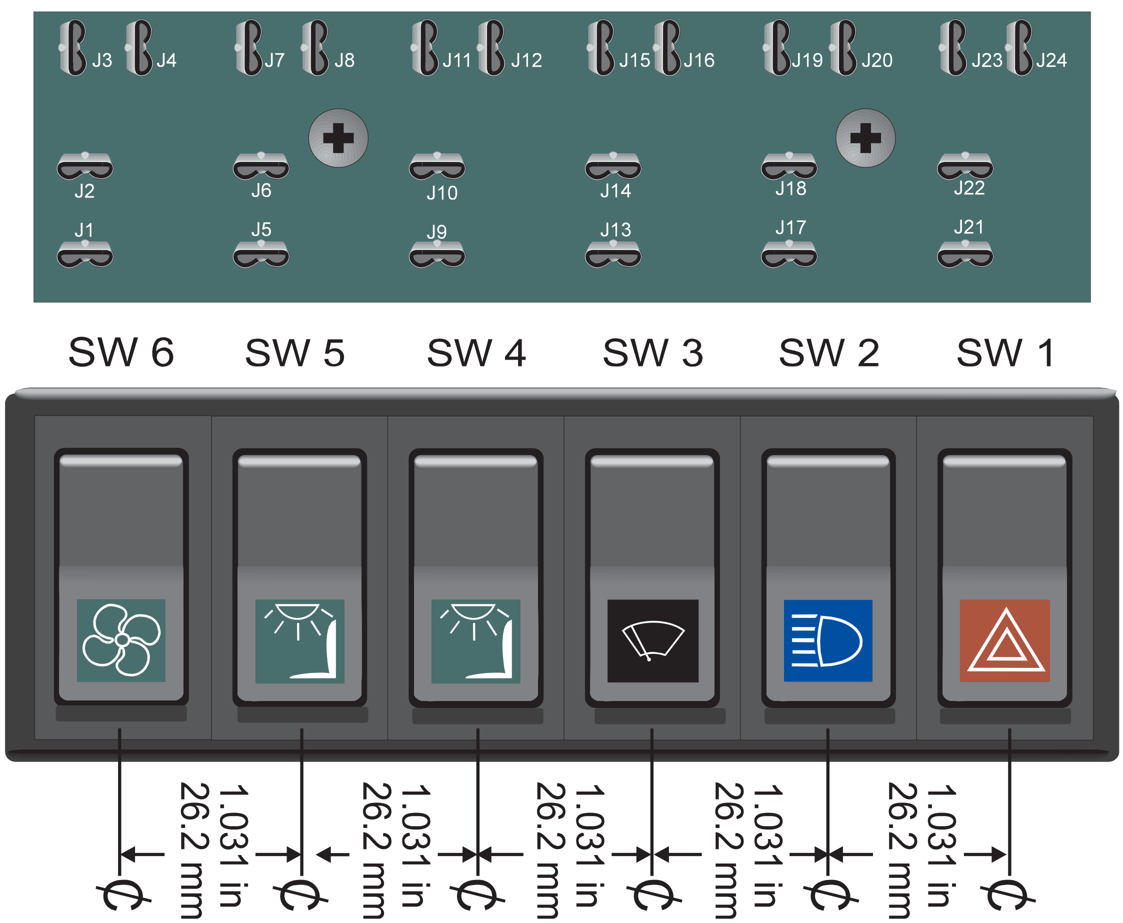
ITT rocker switches (also known as SWF, Britax, or Sprague) plug directly into the 909 or 919 Adapter, eliminating the need for a harness, or separate wiring to each switch. All switch information is directly communicated to the PMC CPU via the two wire PMC communications link. The third wire provides power to the lamps. The PMC connection is made with an AMP Mate-N-Lok connector to reduce installation time and errors. The switch indicator lamps are controlled directly on the adapter. When the switch is off, half of the battery voltage is supplied to the lamp for backlighting. When the switch is turned on, full battery voltage is applied to the lamp.

The switches do not control the loads, or functions directly, they simply communicate information to the PMC CPU. Due to this fact, the switches do not have to be complex, eliminating the need for multiple poles, or multiple throws. The switches can be simpler and less expensive, reducing the different types of switches used. The Windows based setup replaces the need for SPDT, DPDT and other switch configurations.

*Contact Intellitec if adapters are needed for other switch manufacturers or other layouts.* Intellitec can also design and manufacture custom switch panels to suite your specific requirement.

The approximate module dimensions are 2.75" wide X 6.40" tall X 1.375" deep (69.9mm X 162.6mm X 34.9mm). It should be installed in a protected environment inside of the vehicle.

***Sprague/ITT Switches and Bezels not Included***



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# 6 Rocker Switch Direct Plug-In Adapter

## 00-00643-906/916 PMC Rocker Switch Adapter

### SPECIFICATIONS

| General Connections | | 00-00643-916 | 00-00643-906 |
|---|---|---|---|
| Nominal Vehicle Voltage | | 12V | 24V |
| J25-1 | Power for Indicator Lamps | 5 Amps Max. | 5 Amps Max. |
| J25-2 | Multiplex Signal | 18 awg Min | 18 awg Min |
| J25-3 | Multiplex Ground | 14 awg Min | 14 awg Min |

### CHANNEL DESIGNATIONS

| Channel | Connection | Type | Name |
|---|---|---|---|
| 1 | J1/2 | Rocker Switch Type 1 | Switch 1 |
| 2 | J5/6 | Rocker Switch Type 1 | Switch 2 |
| 3 | J9/10 | Rocker Switch Type 1 | Switch 3 |
| 4 | J13/14 | Rocker Switch Type 1 | Switch 4 |
| 5 | J17/18 | Rocker Switch Type 1 | Switch 5 |
| 6 | J21/22 | Rocker Switch Type 1 | Switch 6 |
| 7 | | Not Available | |
| 8 | | Not Available | |
| 9 | | Not Available | |
| 10 | | Not Available | |

**NOTE** *Rocker switches 1 thru 8 can only be Type 1.*
*Switches and bezels not included*

| Rocker Switch | Function | SPRAGUE / ITT PART NO. 00-00643-906 | 00-00643-916 |
|---|---|---|---|
| Type 1 | SPST N.O. | 511 002 | 511 001 |
| | SPST N.O. Momentary | 511 009 | 511 008 |
| | 6 pos. Switch w/Bezel | 595 902 | 595 902 |

### MATING CONNECTIONS

| Designator | Connector | Mating Part # | Contact,Typical For 14-18 AWG | for 10-12 AWG |
|---|---|---|---|---|
| J1PMC Link | 3 Pin Amp Mate-N-Lok | 1-480700-0 | 350919-3 | 640310-3 |

### MODULE SETTINGS

Module can be set for 1 of 16 address, A-P.
Set four jumpers on jumper block JP1 per table on right.

X = Jumper is OUT

| JUMPERS 4 3 2 1 | MODULE Address | JUMPERS 4 3 2 1 | MODULE Address |
|---|---|---|---|
| 0 0 0 0 | A | X 0 0 0 | I |
| 0 0 0 X | B | X 0 0 X | J |
| 0 0 X 0 | C | X 0 X 0 | K |
| 0 0 X X | D | X 0 X X | L |
| 0 X 0 0 | E | X X 0 0 | M |
| 0 X 0 X | F | X X 0 X | N |
| 0 X X 0 | G | X X X 0 | O |
| 0 X X X | H | X X X X | P |

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# 5 Rocker Switch Direct Plug-In Adapter

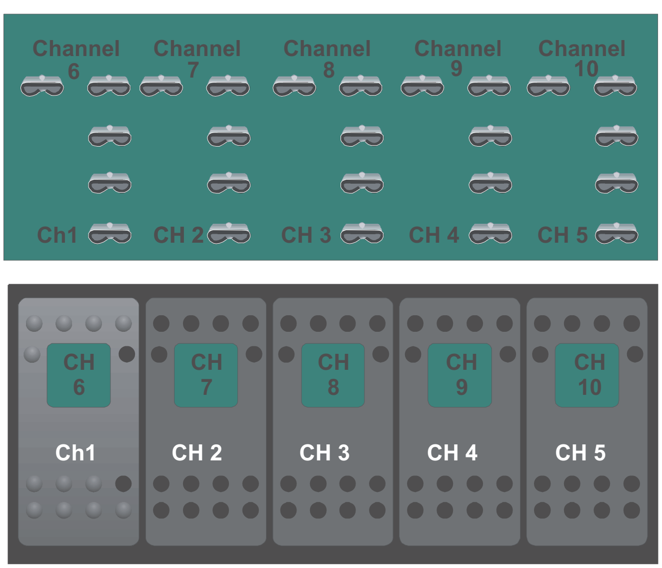
## 00-00842-012/024 PMC Rocker Switch Adapter

PMC Rocker Switch Adapters 842 are members of Intellitec's Programmable Multiplex Control Family. They work in combination with the PMC CPU and other standard, semi-custom, or custom I/O modules.

Carling Contura II Series rocker switches plug directly into the adapter, eliminating the need for a harness, or separate wiring to each switch. All switch and indicator light information is directly communicated to and from the PMC CPU via the two wire PMC communications link. A third and fourth wire provides power and ground for the lamps. The PMC connection is made with an AMP Mate-N-Lok connector to reduce installation time and errors. The switch indicator lamps are controlled by the CPU and are treated in the same fashion as any other output. Each switch provides an input signal to the system (Channels 1-5) and each indicator lamp is a programmable output (Channels 6-10).

If more than 5 switches are required, the switch adapters may be daisy chained and will mount end to end and allow the switch spacing to be maintained. The switches do not carry the loads directly; they simply communicate information to the PMC CPU.

### CHANNEL DESIGNATIONS




**Switch spacing 1.00 Inches**
**Adapter Dimensions 5" x 1.5"**

Since the switch indicator lights are programmable outputs, the indicators will operate based on logic instructions. For example, if an output is programmed to operate from more than one switch, the indicator lights for each switch can be programmed to come on when the output is on. Switch indicators could be made to flash or light steady depending upon variable conditions. This might be used if you program a load management feature and the load manager has shed the load.

### 3 POSITION ON/OFF/ON SWITCH

In some instances, it is desirable to use a 3 position switch. Typical applications would be a two speed fan or bright/dim lighting. In this case, a single switch location will require two inputs.

On the back of the switch adapter, connector J2 provides a means of connecting to the second switch contact on each switch. The first contact, on each switch is connected to inputs 1-5 on the adapter. When using an ON/OFF/ON switch, the second contact can now be brought to another input in the system. This input could be any high side input available in the system, such as an open input on a 00-00622-110 module. As an alternative you may have an unpopulated switch location on this or any other switch adapter. Connector J3 allows you to make connections to the inputs located on the switch adapter. The switch adapter inputs are high side inputs (+Battery Volts).

If a switch location is not populated, you may also use the unused indicator light output from that location to switch the ground side of another panel indicator light.

This module should be installed in a protected environment inside of the vehicle.

### CARLING SWITCH CONTURA II SERIES

| Rocker Switch | Function | 12 Volt | 24 Volt |
|---|---|---|---|
| SPST N.O. | ON/OFF | V1D1A6B | V1B1A8B |
| SPDT | ON/OFF/ON | V6D1A6B | V6B1A8B |

Carling part numbers are not complete. Additional digits describe actuators, color, legends etc. *Contact Carling for details.*

***Carling Contura II Switches not included***

Intellitec
1485 Jacobs Rd.
Deland, FL 32724   386.738.7307
www.intellitec.com

# 5 Rocker Switch Direct Plug-In Adapter

## 00-00842-012/024  PMC Rocker Switch Adapter

### SPECIFICATIONS

**General Connections**

| | | |
|---|---|---|
| **00-00842-012** | **12 Volt** | |
| **00-00842-024** | **24 Volt** | |
| J1-1 | + Bat (from CPU) | 18 awg Min |
| J1-2 | SIG + (from CPU) | 18 awg Min |
| J1-3 | SIG - (from CPU) | 14 awg Min |
| J1-4 | Power Ground | 14 awg Min |

| | |
|---|---|
| J2-1 | SW1 Carling Terminal 1 (Used with SPDT center off switch) |
| J2-2 | SW2 Carling Terminal 1 (Used with SPDT center off switch) |
| J2-3 | SW3 Carling Terminal 1 (Used with SPDT center off switch) |
| J2-4 | SW4 Carling Terminal 1 (Used with SPDT center off switch) |
| J2-5 | SW5 Carling Terminal 1 (Used with SPDT center off switch) |
| J3-1 | Input Channel 1 |
| J3-2 | Input Channel 2 |
| J3-3 | Input Channel 3 |
| J3-4 | Input Channel 4 |
| J3-5 | Input Channel 5 |
| J3-6 | No Connection |

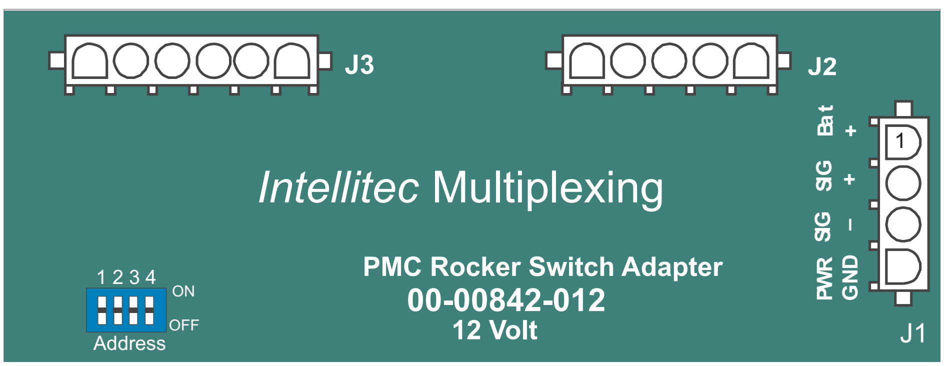
### 3 POSITION ON/OFF/ON SWITCH

**EXAMPLE**

A two position switch is placed in switch positions 1, 2 and 4. Position 3 has a 3 position switch and position 5 is not populated.

To bring the additional switch contact from switch 3 in as an input to the system, make a connection from J2-3 to J3-5. Channel 5 on this module will now represent the second switch contact of switch 3.

If all switch positions are filled with a switch you could bring a wire from J2-3 to any high-side input on any module in the system.




**Pins J1-1, J1-2, and J1-3 from CPU**

**SWITCH ADAPTER BACKSIDE**

### MATING CONNECTIONS

| Designator | Function | Connector | Mating Part # | Contact, Typical |
|---|---|---|---|---|
| J1 | PMC Link | 4 Pin Amp Mate-N-Lok | 1-480702-0 | 350919-3 for 14-18 AWG |
| J2 | Switch Contact | 5 Pin Amp Mate-N-Lok | 1-480763-0 | 350919-3 for 14-18 AWG |
| J3 | Input Channels | 6 Pin Amp Mate-N-Lok | 640585-1 | 350919-3 for 14-18 AWG |

### MODULE SETTINGS

Module can be set for 1 of 16 addresses, A-P.
Set four switches per table to the right.

X= Switch OFF

| Dip SW 4 3 2 1 | MODULE Address | Dip SW 4 3 2 1 | MODULE Address |
|---|---|---|---|
| 0 0 0 0 | A | X 0 0 0 | I |
| 0 0 0 X | B | X 0 0 X | J |
| 0 0 X 0 | C | X 0 X 0 | K |
| 0 0 X X | D | X 0 X X | L |
| 0 X 0 0 | E | X X 0 0 | M |
| 0 X 0 X | F | X X 0 X | N |
| 0 X X 0 | G | X X X 0 | O |
| 0 X X X | H | X X X X | P |

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# Programmable Keypads
## PMC and Multipoint Switching System

Intellitec's Programmable Keypads are members of Intellitec's Programmable Multiplex Control Family, as well as the 160 Channel Multipoint Switching System (RV Multiplex). They work in combination with the 160 Channel IPX Master (00-00837-000) or the PMC CPUs (00-00622-021 or 00-00800-022) and other standard, semi-custom, or custom I/O modules. T*here are a variety of different keypads to select from.*

## *FEATURES*

- Available in 4, 6 and 10 button versions
- Available with Green backlighting and Red Indicators, or Green backlighting and Amber indicators
- Some units have *extra bright* LEDs that can be dimmed via PMC programming or software
- Push button legends are easily created and applied by the installer
- Programmable via a Windows interface and GUI provided by Intellitec. Each button, indicator and backlighting can be easily programmed by the installer to communicate on any PMC System, or Multipoint Switching System channels
- Wall cover plates are available in white, black, or pumice
- Keypads can be mounted behind a panel with cut-outs, or on the surface with wall cover plates

## *LEGENDS*

The installer can determine what the legend will be for each button. With the cover plate removed, a strip of paper can be inserted into the keypad which will legend 5 buttons at one time. The paper strips with legend can be made on a computer printer. You may wish to experiment with different kinds of paper as the lighting effect will vary with the paper used. We have found drafting mylar used in a laser printer, or copy machine provides a good effect.

## *WIRING*

Regardless of the number of buttons, each keypad has a 3-pin Amp Mate-N-Lok connector. When connected to a PMC CPU or multipoint switching master (RV multiplex) only 3 wires are needed . These same 3 wires connect to every switch panel in the vehicle. For example, a motor coach may have 10 or more 10 button switch panels. That's 100 lighted switches connected by only 3 wires !

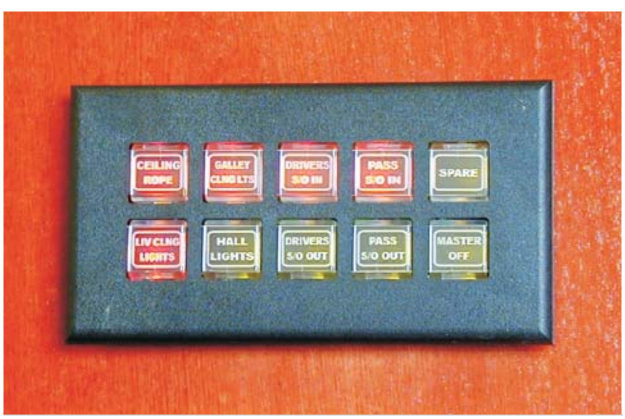
## *BACKLIGHTING*

Backlighting for the keypads is provided by green LEDs. Depending upon programming and the keypad selected, backlighting can be turned on, off or dimmed.

If backlighting is off, then anytime a pushbutton is pressed, the backlighting for that local keypad will turn on for 15 seconds. During this time other keypads in the system will remain un-lit.

For PMC keypads, backlighting can be programmed to respond to a specific channel allowing it to turn on, off, or dim.

For the Multipoint Switching System momentarily activating a button assigned to channel BL/MR will turn the backlighting on for all keypads connected to the system. Momentarily activating it again will turn the backlighting off. This can be done by using the programming GUI to assign channel BL/MR to one or more of the buttons in the system. Keypads can also be programmed so these functions only affect the local keypad.
*(Further details to follow)*



### MATING CONNECTIONS

| Function | Connector | Mating AMP Part # | Contact *(for 14-18 AWG)* |
|---|---|---|---|
| PWR & COMM | 3 Pin Amp Mate-N-Lok | 1-480700-0 | 350919-3 |

| | | |
|---|---|---|
| J1-1 | External PWR from CPU | 16 awg Min. |
| J1-2 | Multiplex Signal | 18 awg Min. |
| J1-3 | Multiplex Ground (Sig-) | 14 awg Min. |

CAUTION Please use 14 awg Min. on multiplex Ground (Sig-) Pin 3

J2 4-Pin Programming connection, located on front side of keypad. Allows programming after installation.

**Programming Kit, *P/N 10-00849-000***
***Software download available at www.intellitecsve.com***

### KEYPADS FOR USE WITH THE PMC SYSTEM USING CPUs 00-00622-021 AND 00-00800-022

| PMC 12V | | # of Buttons | Back light / Indicator Light | Dimmable Lighting | Windows Software |
|---|---|---|---|---|---|
| 00-00850-010 | | 10 | Red / Green | | 850 |
| 00-00850-006 ** | | 6 | Red / Green | | 850 |
| 00-00860-004 | | 4 | Red / Green | | 860 |
| 00-00860-006 | | 6 | Red / Green | | 860 |
| 00-00870-010 | | 10 | Bright Grn/Amber | Yes | 870 |
| 00-00870-110 | | 10 | Red / Green | Yes | 870 |
| 00-00870-210 | | 10 | Bright Red/Grn | Yes | 870 |
| 00-00874-004 | | 4 | Bright Grn/Amber | Yes | 874 |
| 00-00874-104 | | 4 | Red / Green | Yes | 874 |
| 00-00874-204 | | 4 | Bright Red/Grn | Yes | 874 |
| 00-00874-006 | | 6 | Bright Grn/Amber | Yes | 874 |
| 00-00874-106 | | 6 | Red / Green | Yes | 874 |
| 00-00874-206 | | 6 | Bright Red/Grn | Yes | 874 |
| ** Has 4 additional PMC inputs - Software download @ www.intellitecsve.com | | | | | |

| PMC 24V | | # of Buttons | Back light / Indicator Light | Dimmable Lighting | Windows Software |
|---|---|---|---|---|---|
| 00-00879-010 | | 10 | Bright Grn/Amber | Yes | 870 |
| 00-00879-110 | | 10 | Red / Green | Yes | 870 |
| 00-00879-210 | | 10 | Bright Red/Grn | Yes | 870 |
| 00-00880-004 | | 4 | Bright Grn/Amber | Yes | 874 |
| 00-00880-104 | | 4 | Red / Green | Yes | 874 |
| 00-00880-204 | | 4 | Bright Red/Grn | Yes | 874 |
| 00-00880-006 | | 6 | Bright Grn/Amber | Yes | 874 |
| 00-00880-106 | | 6 | Red / Green | Yes | 874 |
| 00-00880-206 | | 6 | Bright Red/Grn | Yes | 874 |

The PMC and Multipoint Switching System are multiplexed systems consisting of 16, 10 channel modules for a total of160 addressable channels.  Each of the 16 modules has a designated letter address of A-P.  Each of the 160 channels is designate A1 thru A10, ... P1 thru P10.  The 320 channel system has two communications loops of 160 channels each.

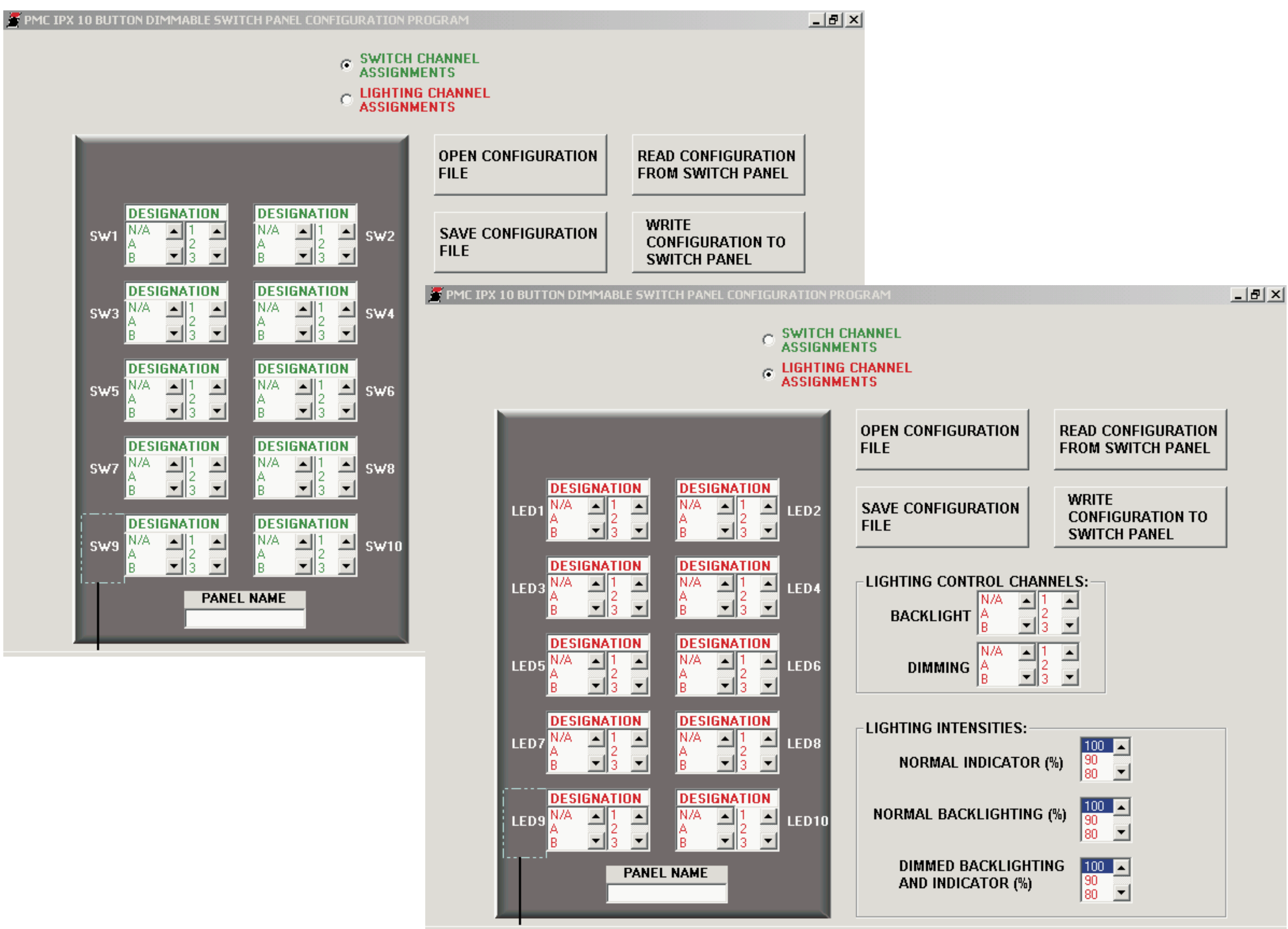
## PMC KEYPAD FUNCTION

Using a Windows based software program each button on a keypad can be programmed to  be an input which communicate on any of the 160 channels.

The keypad backlighting can be programmed as an output communicating on any channel on the system so that it can be turned on or off via logic commands.

Each push button indicator light can be programmed to be any output channel in the system.  This allows logic commands to turn the switch indicator light on or off.  You could for example have the indicator only turn on when the output is on.  For example, in an emergency vehicle, you could turn the load off and the switch indicator light turns on whenever the voltage gets to be too low.

The indicator lights and backlighting are dimmable on some switch models.  Specific channels can be programmed which will cause the backlighting and indicator lights to dim.  For example, you may wish to dim the indicators when the headlights are on.  Using the programming GUI, the intensity of the LEDs can be programmed.  An example of the Windows GUI screen that is used to program a keypad is shown below.  Once the settings have been made, a file can be saved on your computer, so that you may program additional keypads in the future.

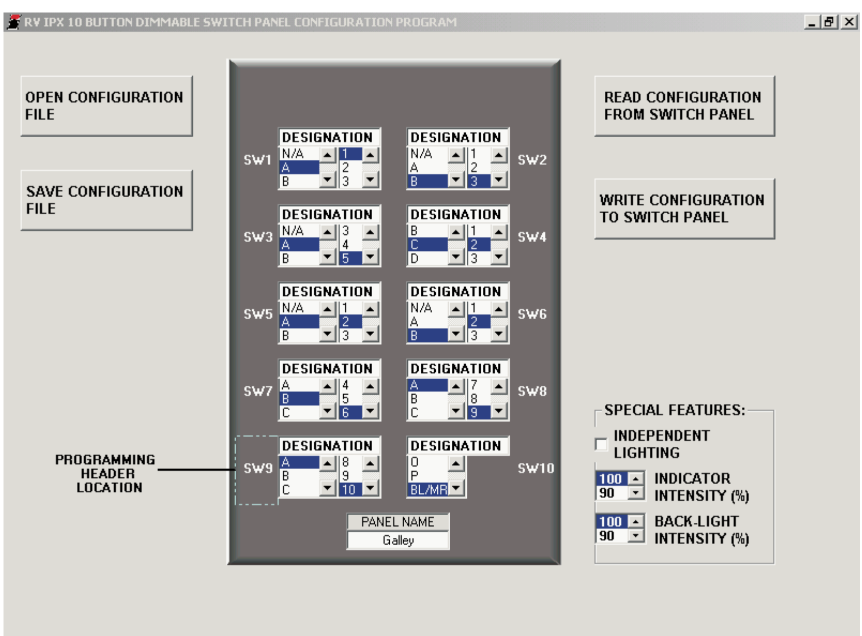


## MULTIPOINT RV MULTIPLEX KEYPAD FUNCTION

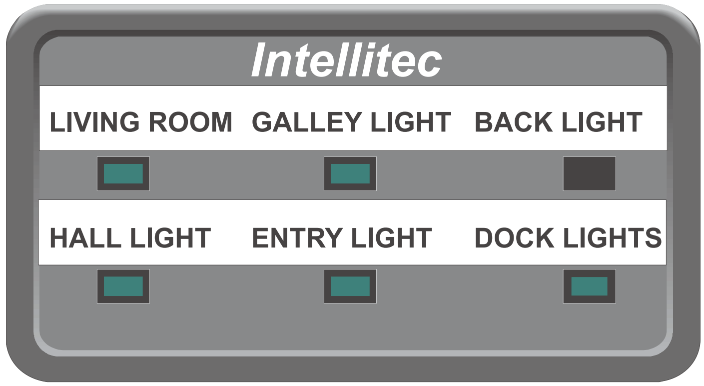
In this system each pushbutton can be programmed for one of the systems 160 channels. When using the 00-00837-000 Master and latching output modules, each pushbutton is programmed to the same channel that the output is on. For example, if you wish to control the output with address B5, you would program one or more pushbuttons to channel B5 using the Windows GUI below. The 869 and 873 GUI can be used to set the intensity of the LEDs. *In addition, the GUI can be used to set a Keypad for independent backlighting control.* When this box is checked, the backlighting and indicators can be toggled on/off locally without affecting other keypads in the system. This is accomplished by assigning BL/MR to one of the buttons. A momentary press of this button will turn the backlighting and indicators off for that switch panel. Pressing and holding the button set for BL/MR will turn all outputs and keypad lights off in the entire vehicle. If the local box is not checked, a momentary press of a BL/MR button will turn off all backlighting and indicators in the vehicle. Pressing and holding a BL/MR button will turn every output and keypad light off. If backlighting is turned off, a momentary press of any button will turn backlighting on for that keyp

### *KEYPADS FOR USE WITH THE MULTIPOINT (RV MPX) SYSTEM USING MASTER 00-00837-000*

| RV Multiplex | | # of Buttons | Back light / Indicator Light | Dimmable Lighting | Windows Software |
|---|---|---|---|---|---|
| 00-00841-010 | | 10 | Red / Green | | 841 |
| 00-00841-006 | | 6 | Red / Green | | 841 |
| 00-00854-004 | | 4 | Red / Green | | 854 |
| 00-00854-006 | | 6 | Red / Green | | 854 |
| 00-00869-010 | | 10 | Bright Grn/Amber | Yes | 869 |
| 00-00869-110 | | 10 | Red / Green | Yes | 869 |
| 00-00869-210 | | 10 | Bright Red/Grn | Yes | 869 |
| 00-00873-004 | | 4 | Bright Grn/Amber | Yes | 873 |
| 00-00873-104 | | 4 | Red / Green | Yes | 873 |
| 00-00873-204 | | 4 | Bright Red/Grn | Yes | 873 |
| 00-00873-006 | | 6 | Bright Grn/Amber | Yes | 873 |
| 00-00873-106 | | 6 | Red / Green | Yes | 873 |
| 00-00873-206 | | 6 | Bright Red/Grn | Yes | 873 |




| # of Buttons | Cover Plate | Color |
|---|---|---|
| 10 | 64-00272-000 | Black |
| 4 | 64-00276-000 | Black |
| 6 | 64-00277-000 | Black |
| 10 | 64-00272-100 | White |
| 4 | 64-00276-100 | White |
| 6 | 64-00277-100 | White |
| 10 | 64-00272-200 | Pumice |
| 4 | 64-00276-200 | Pumice |
| 6 | 64-00277-200 | Pumice |




Switch Legends printed on paper with computer printer.
Paper placed under overlay w/clear windows.
*Size 2-5/8 x 4-3/4*

Model 759 Push Button Switch Module provides 5 addressable momentary switches and 5 addressable LEDs. Connection is made to the PMC system via a 3-pin Mate-N-Lok connector. As with other PMC modules, a jumper block on the back of the switch panel is used to set the module address for the panel. If two switch panels are set for the same address, their buttons will control the same outputs. Boolean logic statements can be written so that selected buttons on any keypad at any address will control the same outputs.

The switch LEDs can be programmed as any other output in the system and will come on based on the boolean logic statement written for them. The most common use is to set them equal to the output that they turn on. When this is done, the LED will indicate the actual state of the output. In other words, if two switches are used to turn a light on, then the LED at each panel can be made to be on when the light is on. The sixth switch when pressed provides an input on Channels A1 and A2 of the PMC system regardless of the address the switch panel is set for. For this reason, the switch panel should not be set to address A.

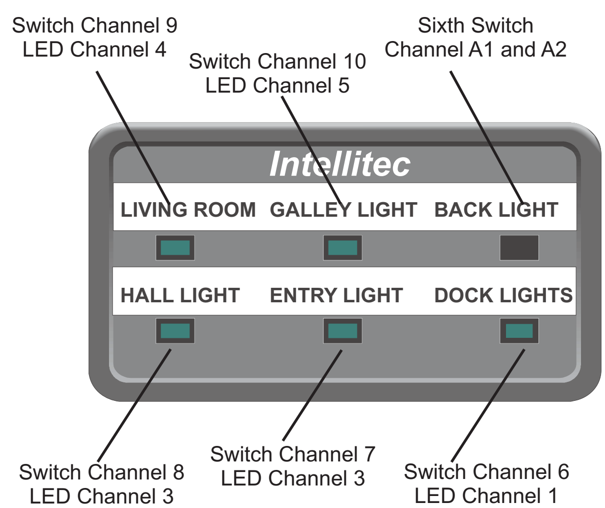
### *UTILIZING THE SIXTH SWITCH*

Channel A2 is connected to the panels incandescent backlighting. By checking the latched switch box on the boolean editor screen for channel A2, the backlighting can be turned on and off using the sixth switch from any switch panel in the system.

Using the "momentary switch latch" check box in the boolean editor screen for the switch channels allows any momentary switch to operate in a push on/push off fashion.

If you choose, Channel A1 can be used with a timer as a master off switch. By pressing and holding the sixth switch, you can cause outputs that you select to turn off when the button is held. In this case, a latching boolean for the outputs would be written, instead of latching the switch that is cleared by A1 and the timer.

### *CHANNELS*




***00-00759-000 12 VOLT***

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# 10 Inputs High-side or Low-side

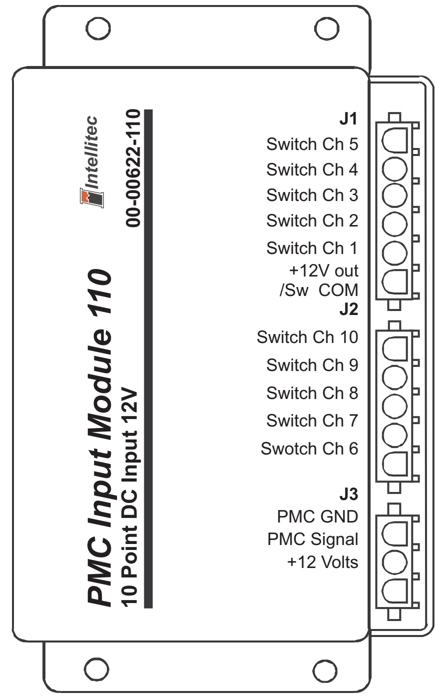
## 00-00622-100/110 PMC 10 Channel Input Module

PMC Input Modules 100 and 110 are members of Intellitec's Programmable Multiplex Control family. They work in combination with the PMC CPU and other standard, semi-custom or custom I/O modules.

There are ten input connections for rocker, limit, or sensor switches. Each individual input can be configured as either a switch to ground, or a switch to battery. All input information is directly communicated to the CPU via the PMC communications link. The CPU utilizes this information to control other PMC output modules. All of the output harnesses are connected with AMP Mate-N-Lok connectors to reduce installation time and errors.

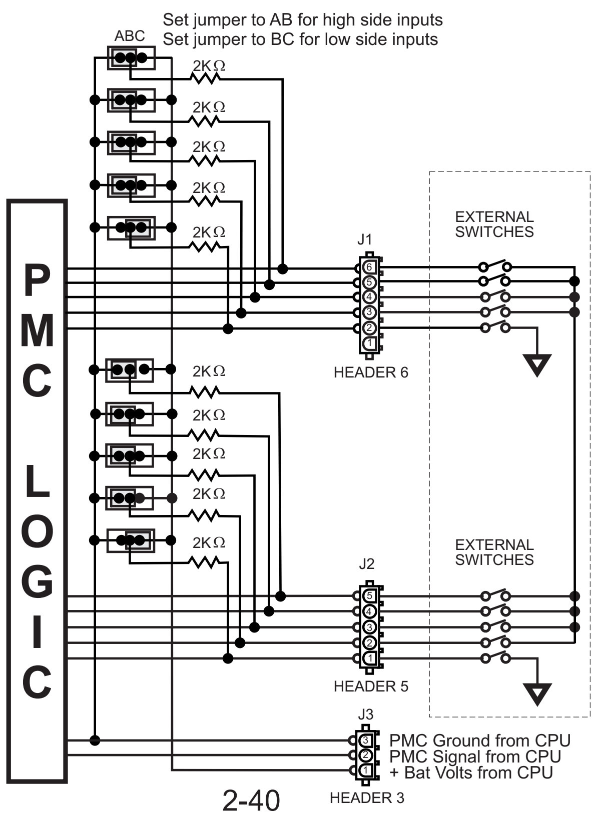
The approximate module dimensions are 6.375" X 3.750" X 1.875" (16.2mm X 9.5mm X 4.8mm). The module should be installed in a protected environment inside of the vehicle.

To reduce wiring and if your panel switches are grouped together, you may consider using Intellitec's standard switch adapters, custom adapters or custom switch panels. Several standard switch adapters are available.




Pat. No. 4,907,222 & 6,011,997

Rocker switches can be plugged directly into these adapters which plug into the PMC Multiplex bus. This eliminates the wiring between standard rocker switches and the 100/110 PMC I/O module.



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www.intellitec.com

# 10 Inputs High-side or Low-side

## 00-00622-100/110 PMC 10 Channel Input Module

### SPECIFICATIONS

| General Connections | | 00-00622-110 | 00-00622-100 |
|---|---|---|---|
| Nominal Vehicle Voltage | | 12V | 24V |
| J1-1 | Fuse 1, Power for positive switched inputs | 3 Amps Max. | 3 Amps Max |
| J3-1 | External Power from CPU | 3 Amps Max. | 3 Amps Max |
| J3-2 | Multiplex Signal | 18 awg Min. | 18 awg Min. |
| J3-3 | Multiplex Ground | 16 awg Min. | 16 awg Min. |

### CHANNEL DESIGNATIONS

| Channel | Connection | Type | Name | Rating |
|---|---|---|---|---|
| 1 | J1-2 | Input, Positive or Negative | Switch 1 | 2K Input Resistance |
| 2 | J1-3 | Input, Positive or Negative | Switch 2 | 2K Input Resistance |
| 3 | J1-4 | Input, Positive or Negative | Switch 3 | 2K Input Resistance |
| 4 | J1-5 | Input, Positive or Negative | Switch 4 | 2K Input Resistance |
| 5 | J1-6 | Input, Positive or Negative | Switch 5 | 2K Input Resistance |
| 6 | J2-1 | Input, Positive or Negative | Switch 6 | 2K Input Resistance |
| 7 | J2-2 | Input, Positive or Negative | Switch 7 | 2K Input Resistance |
| 8 | J2-3 | Input, Positive or Negative | Switch 8 | 2K Input Resistance |
| 9 | J2-4 | Input, Positive or Negative | Switch 9 | 2K Input Resistance |
| 10 | J2-5 | Input, Positive or Negative | Switch 10 | 2K Input Resistance |

### MATING CONNECTIONS

| Designator | Function | Connector | Mating Part # | Contact, Typical for 14-18 AWG | Contact, Typical for 10-12 AWG |
|---|---|---|---|---|---|
| J1 | Inputs | 6 Pin Amp Mate-N-Lok | 640585-1 | 350919-3 | 640310-3 |
| J2 | Inputs | 5 Pin Amp Mate-N-Lok | 1-480763-0 | 350919-3 | 640310-3 |
| J3 | PMC Com | 3 Pin Amp Mate-N-Lok | 1-480700-0 | 350919-3 | 640310-3 |

### MODULE SETTINGS

Module can be set for 1 of 16 address.
Set four jumpers on jumper block JP2 per table on right.

X = Jumper is Out

| JUMPERS 4 3 2 1 | Address | JUMPERS 4 3 2 1 | Address |
|---|---|---|---|
| 0 0 0 0 | A | X 0 0 0 | I |
| 0 0 0 X | B | X 0 0 X | J |
| 0 0 X 0 | C | X 0 X 0 | K |
| 0 0 X X | D | X 0 X X | L |
| 0 X 0 0 | E | X X 0 0 | M |
| 0 X 0 X | F | X X 0 X | N |
| 0 X X 0 | G | X X X 0 | O |
| 0 X X X | H | X X X X | P |

Ten Inputs labeled Switch 1-10 can be individually set for either positive (high-side) switched to the battery, or negative (low-side) switched to ground. Setting a jumper to short pins AB selects positive switch. Setting a jumper to short pins BC selects negative switch.

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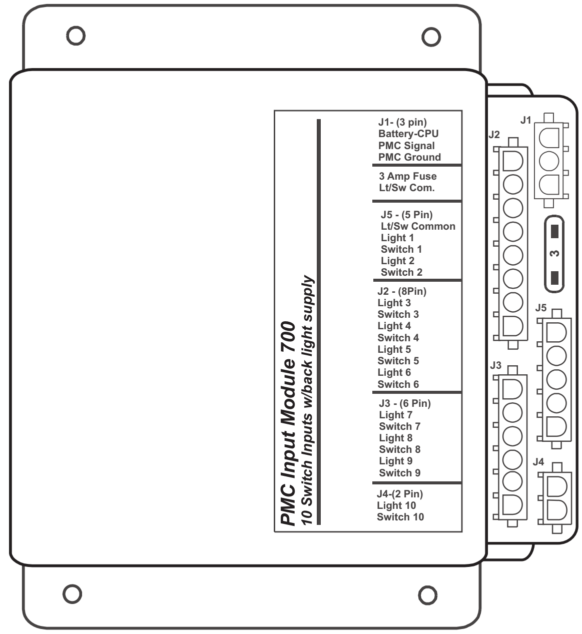
# 10 Switch Inputs with Back light Supply

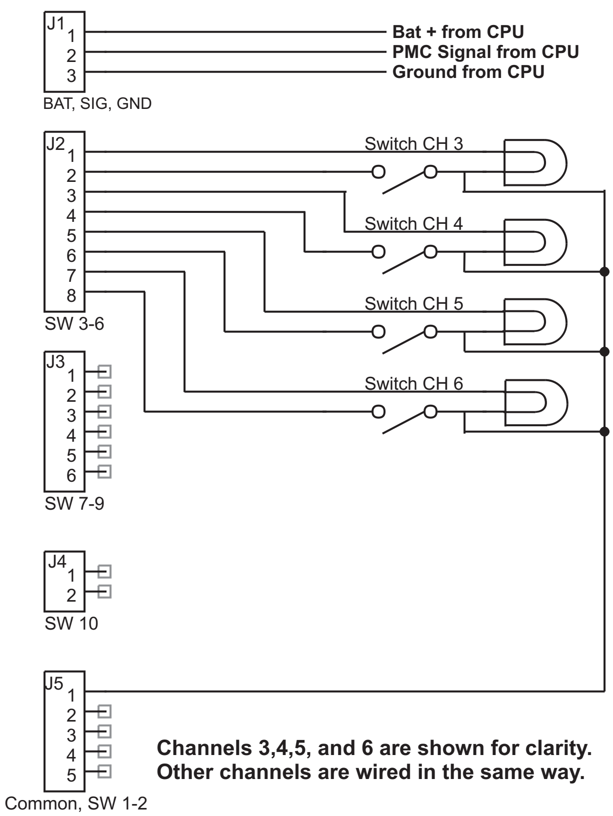
## 00-00645-700/710 PMC Input Module

PMC Input Modules 700 and 710 are members of Intellitec's Programmable Multiplex Control family. They work in combination with the PMC CPU and other standard, semi-custom, or custom I/O modules.

This module has ten input connections for rocker or push-button switches and is intended to be used when back-lit switches are scattered. When switches are located in a group, consider the 906 and 909 switch adapters.

A connection for back-lighting is provided for each switch. The switch back-light lamps are controlled by the module. When the switch is off, half of the battery voltage is supplied to the lamp for back-lighting. When the switch is turned on, full battery voltage is applied to the lamp.




All input information is communicated directly to the CPU via the PMC communications link. The CPU utilizes this information to control other PMC modules.

All of the harnesses are connected with AMP Mate-N-Lok connectors to reduce installation time and errors. The module's address may be set for 1 of 16 addresses (A-P) via jumpers on the circuit board.

The approximate module dimensions are 6.375" X 6.250" X 1.875" (16.2mm X 15.9mm X 4.8mm). *The module should be installed in a protected environment inside of the vehicle.*

# 10 Switch Inputs with Back light Supply

## 00-00645-700/710 PMC Input Module

### SPECIFICATIONS

| General Connections | | 00-00645-710 | 00-00645-700 |
|---|---|---|---|
| Nominal Vehicle Voltage | | 12V | 24V |
| J1-1 | Battery + from CPU | 3 Amps Max. | 3 Amps Max |
| J1-2 | PMC Signal from CPU | 18 awg Min. | 18 awg Min. |
| J1-3 | PMC Ground from CPU | 14 awg Min. | 14 awg Min. |
| J5-1 | Switch Lamp + Common | 3 Amps Max. | 3 Amps Max. |

### CHANNEL DESIGNATIONS

| Channel | Connection | Type |
|---|---|---|
| 1 | J5-2 | Lamp out, Switch 1 |
| 1 | J5-3 | Input, Positive Ch 1 |
| 2 | J5-4 | Lamp out, Switch 2 |
| 2 | J5-5 | Input, Positive Ch 2 |
| 3 | J2-1 | Lamp out, Switch 3 |
| 3 | J2-2 | Input, Positive Ch3 |
| 4 | J2-3 | Lamp out, Switch 4 |
| 4 | J2-4 | Input, Positive Ch 4 |
| 5 | J2-5 | Lamp out, Switch 5 |
| 5 | J2-6 | Input, Positive Ch 5 |
| 6 | J2-7 | Lamp out, Switch 6 |
| 6 | J2-8 | Input, Positive Ch 6 |
| 7 | J3-1 | Lamp out, Switch 7 |
| 7 | J3-2 | Input, Positive Ch 7 |
| 8 | J3-3 | Lamp out, Switch 8 |
| 8 | J3-4 | Input, Positive Ch 8 |
| 9 | J3-5 | Lamp out, Switch 9 |
| 9 | J3-6 | Input, Positive Ch 9 |
| 10 | J4-1 | Lamp out, Switch 10 |
| 10 | J4-2 | Input, Positive Ch 10 |

### MATING CONNECTIONS

| Designator | Connector | Mating Part # | Contact, Typical for 14-18 AWG | for 10-12 AWG |
|---|---|---|---|---|
| J1 | 3 Pin Amp Mate-N-Lok | 1-480700-0 | 350919-3 | |
| J2 | 8 Pin Amp Mate-N-Lok | 1-480702-0 | 350919-3 | 640310-3 |
| J3 | 6 Pin Amp Mate-N-Lok | 640585-1 | 350919-3 | 640310-3 |
| J4 | 2 Pin Amp Mate-N-Lok | 1-480698-0 | 350919-3 | 640310-3 |
| J5 | 5 Pin Amp Mate-N-Lok | 1-480763-0 | 350919-3 | 640310-3 |

### MODULE SETTINGS

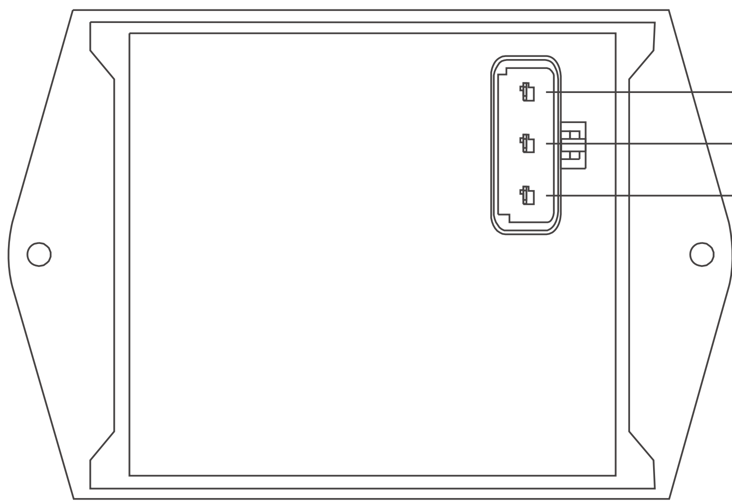
Module can be set for 1 of 16 addresses.
Set four jumpers on "Add Select" jumper block
Per table on right.

X = Jumper is Out

| JUMPERS 4 3 2 1 | Address | JUMPERS 4 3 2 1 | Address |
|---|---|---|---|
| 0 0 0 0 | A | X 0 0 0 | I |
| 0 0 0 X | B | X 0 0 X | J |
| 0 0 X 0 | C | X 0 X 0 | K |
| 0 0 X X | D | X 0 X X | L |
| 0 X 0 0 | E | X X 0 0 | M |
| 0 X 0 X | F | X X 0 X | N |
| 0 X X 0 | G | X X X 0 | O |
| 0 X X X | H | X X X X | P |

# PMC Load Manager

## 00-00809-120/240 Voltage Input Module




The Load Manager Voltage Input Module provides 4 inputs to the PMC system corresponding to specific battery voltages. In order to provide an accurate indication of system voltage, the Voltage Input Module should be located physically close to the vehicle's battery. *Care should be taken to minimize any voltage drop that may occur between the battery and the module.*

**Only 3 connections to the module are needed.**

A. Battery + (Wire should be connected to the + Battery post. ***Do not use*** the + 12 volts provided by the PMC CPU)
B. PMC Communications Bus
C. PMC Ground (Wire should be connected to the Battery - post. The CPU should be grounded to the Battery - post as well)

This module has been potted and provided with a Metripac water-tight connector to facilitate placement near the battery. This module has been addressed at the factory as module "P".

***FOR 12 VOLT SYSTEMS***

Channels P7, P8, P9, and P10 will be on as follows.

P7 is ON when the battery voltage is >13.3 Volts

P8 is ON when the battery voltage is >12.8 Volts

P9 is ON when the battery voltage is >12.3 Volts

P10 is ON when the battery voltage is >11.8 volts.

***FOR 24 VOLT SYSTEMS***

P7 is ON when the battery voltage is > 26.6 Volts

P8 is ON when the battery voltage is > 25.6 Volts

P9 is ON when the battery voltage is > 24.6 Volts

P10 is ON when the battery voltage is >23.6 volts.

The inputs from this module can be used in the PMC system with boolean logic statements to force selected loads off as the system voltage falls. You may also wish to turn an output on to indicate to the engine controller that high speed idle is needed.

Channels P1 through P6 are still available to be used as virtual channels, or a module such as a 6-position rocker switch adapter or a push button switch module could be addressed for module P.

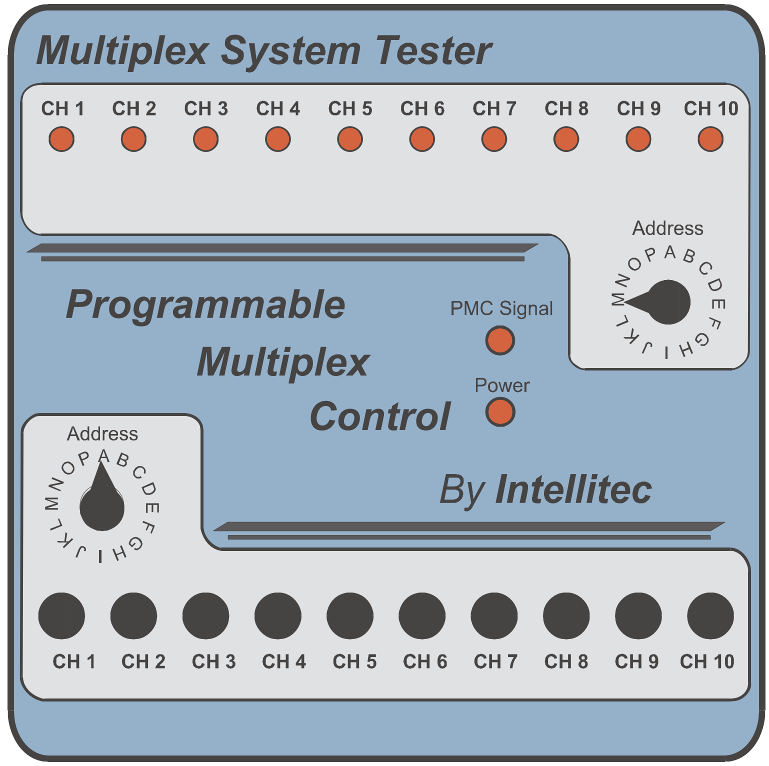
***CONNECTIONS FOR 18 AWG WIRE***

Connector with 5.5 inch pigtail
*(Intellitec P/N 11-00393-000)*

***<u>OR USE</u>***

Delphi Packard Metripack
12110293 Connector
12048074 Contact
12110213 Cable Seal
12052845 Lock

**P/N 00-00809-120 12 Volt**
**P/N 00-00809-240 24 Volt**




The PMC Signal Tester aids in the process of diagnosing I/O and wiring problems in the vehicle. The tester may be connected at any point around the vehicle where there is access to the 3 wire communications bus. The connection may be made while the vehicle's multiplex system is operating, without detrimental effect.

When connected, the tester is capable of displaying the status of every input and output in the system, or forcing any input or output in the system on.

The tester has 10 push button switches and 10 LED's, each of which are related to a channel. Two, 16-position rotary switches are used to set the switches and lights to any module address. The switches can be set for one module address and the lights can be set for another, or the switches and lights may be set for the same address. If a push button on the tester is set to an output channel's address, pushing the button will cause the output to turn on. The LEDs will light to reflect the status of both inputs and outputs.

Since it is acceptable to have more than one module in the PMC system with the same address, the tester can be set to duplicate any module from A through P.

To use the tester, the technician will attach the tester to the 3 wire bus via the cable set provided. The rotary switches are then set to the address of the modules being simulated. If a channel is active (Output is on, or Input is on) the associated channel LED will illuminate. If a channel is an input channel and the associated push button is pressed, the PMC system will respond as though the actual input switch is active. If the channel is an output channel, pressing the associated button will force the system to turn the channel on regardless of the boolean written for the channel, in which case the load associated with the channel should turn on. If it doesn't, a simple test using a test light can be used to check the output and wiring from the output module to the load. This allows the tester to be used to test the functionality of every module and every input, or output in the system.

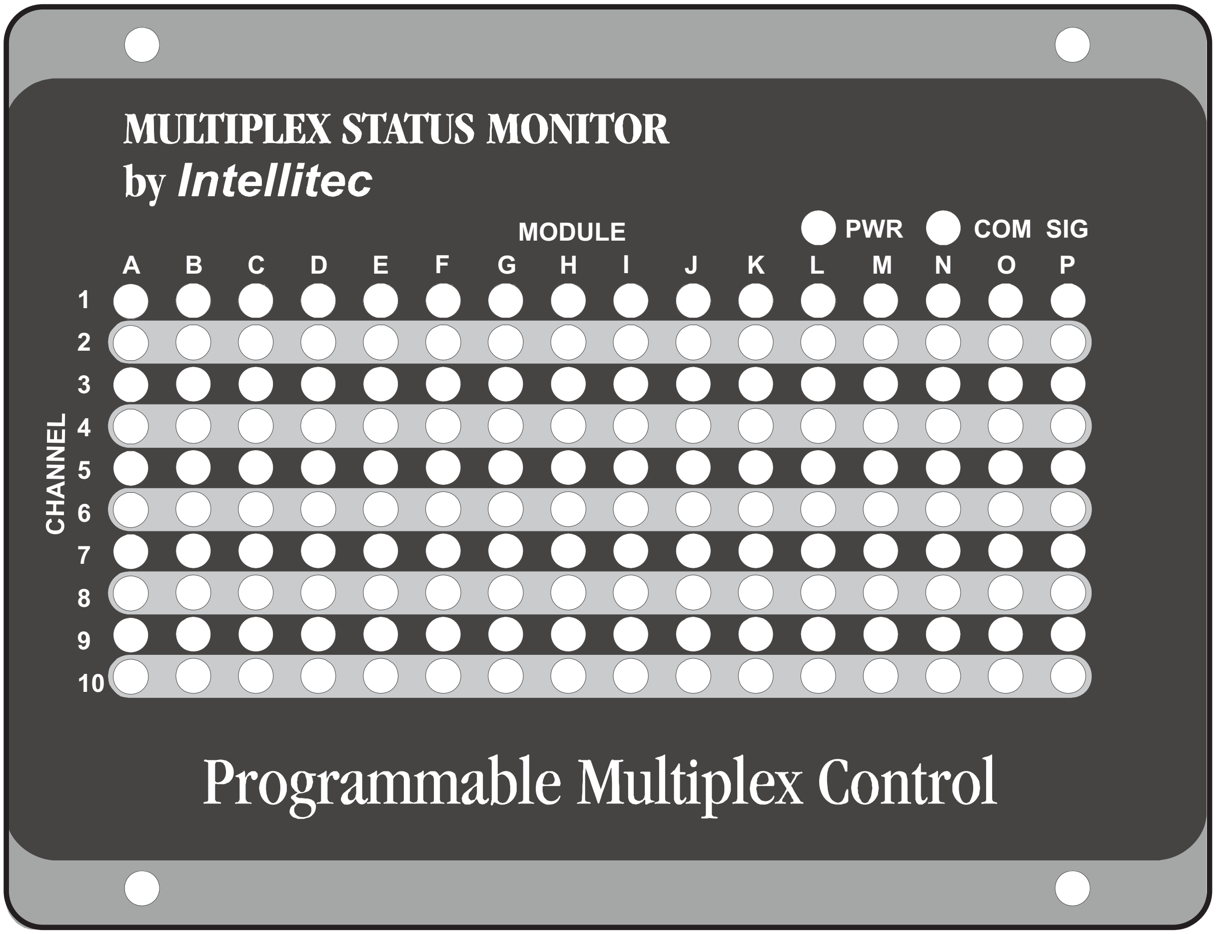
The PMC signal indicator light indicates that communication with the CPU and the tester is working. This tests the functionality of the CPU and the 3 wire communications bus.

The test set is provided in an 8.5 X 7.8 X 3.75 inch plastic box with hinged lid.

**12 Volt - 00-00739-120**
**24 Volt - 00-00739-240**

# Diagnostic Test Equipment

## 00-00739-120/240 Multiplex Module Simulator




The PMC System Status Monitor may be used as portable test equipment, or it can be mounted permanently or semi-permanently to the vehicle. It measures 8.6" X 6.6".

The Status Monitor is connected to the PMC system using a 3-pin, AmP Mate-N-Lok connector. The connection can be made at any point around the vehicle where there is access to the 3 wire communications bus.

When connected, the Status Monitor will simultaneously display the status of every input, or output in the system. If an input or output is active, (on ) its associated LED will be illuminated.

If the Status Monitor is mounted semi-permanently can be moved from one location to another while PMC is operating and can be plugged in at any convenient point in the system.

Plugging and unplugging modules will not upset the PMC system. This feature saves the technician time during trouble shooting, as he does not have to move from zone to zone to observe LEDs on individual modules. He can determine if an input is present or if an output is on or off from any zone.

Two additional LEDs on the Status Monitor indicate if the system is connected to power and if the CPU and communications bus are working.

**12 Volt - 00-00739-120**
**24 Volt - 00-00739-240**

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# PMC Multiplex Control

## 00-00741-120/240 PMC Bulb Out Sensor 741

The PMC Bulb Out Input Sensor is a member of Intellitec's Programmable Multiplex Control family. The module works in combination with the PMC system and other standard, semi-custom, or custom I/O modules.

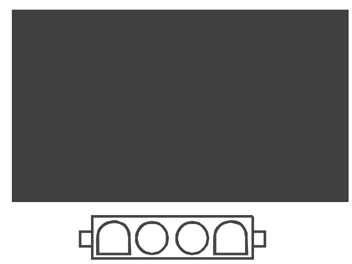
The Bulb Out Input Sensor is used to detect and report to the PMC system when current is flowing through a load. The most common application for this device is to provide a high-side input to the PMC system when a lamp is operating.

The sensor is wired as shown below. The load current is sensed and provides a high-side switch input that can be sent to any PMC input. The sensor is designed for either a one, or two bulb system. In a two bulb circuit the sensor will send an input to the PMC system if one or both bulbs burn out.

The sensor is optimized for 21 Watt lamps.
*<u>If</u> lamps of a different wattage are to be used <u>contact Intellitec</u>.*

By writing a Boolean Logic statement using the PMC software, the PMC system can respond to the loss of the input signal by operating another output, which may be a warning lamp on the dash, an auxiliary lamp, or both.

Connections to the Bulb Out Input Sensor are made with a standard 4 pin Amp Mate-N-Lok connector. The small size and weight of the sensor allows it to be connected to the wiring harness without mounting.

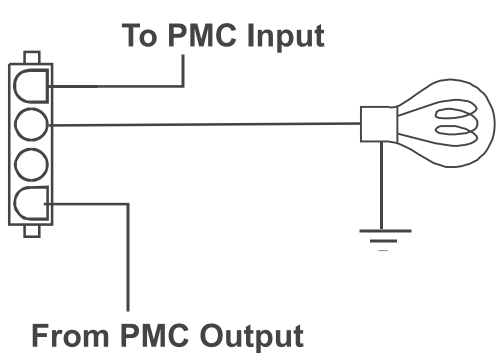


Dimensions 1” x 1.75”

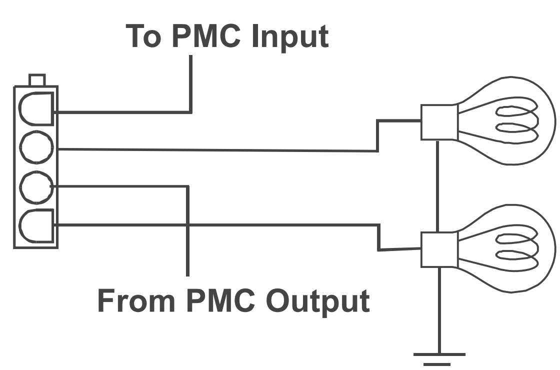
**12 Volt 00-00741-120**
**24 Volt 00-00741-240**

## *WIRING DIAGRAM*

### for One Bulb




### For Two Bulbs




**Pat. No. 4,907,222 & 6,011,997**

# Chapter 3
# Designing and Wiring a System

# Designing a system

The first step in designing the system is to determine the functions that will be multiplexed on the system. These can include most switched functions such as lighting, heating/air conditioning, engine warning signals, safety warning signals, etc. These functions will be determined by the vehicle being designed. When selecting the functions to multiplex, remember the primary objective is to reduce the amount of wire used in the vehicle and gain flexibility for the future. The interactive control of functions created by the logic programmed into the system will allow you to make modification via the software instead of the wire harness. For example, if you think that you may want to create an interlock using the transmission neutral safety switch, make sure that you bring that switch into one of the systems inputs. Remember you can use that input as many times as you like in relationship with as many outputs as you like.

At this point, it must be stressed that it is most important to organize and document the functions of the system. The functions to be multiplexed should be listed. The next step is to decide which modules to use and where to put them. The best approach is to visualize the vehicle. Better yet, is to be in the vehicle. While viewing the vehicle, the functions can be grouped by location. The modules can then be selected to provide the appropriate number of inputs and outputs. Typically, these functions are grouped in certain physical areas in the vehicle. Examples of this might be the functions at the rear of the vehicle, such as the lights and possibly certain sensors. Another area would obviously be at the dash where a number of switches and indicators are located. Still another location might be at the engine, where certain functions such as oil pressure, or temperature are to be monitored. It is a good idea to have a few spare inputs and outputs in each location to allow for future expansion. If it turns out that you don't have enough spares don't worry, as you can always attach another module to the PMC communications wires at a later date. Once the modules and their functions have been selected, the functions and relationships must be written down to document the system. An Intellitec Module Function Work Sheet should be filled out to begin the documentation of the system. The Module Function Work Sheet is included as *Appendix A.*

Intellitec has been involved in multiplexed vehicular control systems with as few as 10 channels and as many as 320 channels. Each channel is normally assigned to an input or output function, however, channels may also serve as both an input and output. For the sake of simplicity we refer to the simpler systems as “IPX” (Intelliplex) systems – those systems with hardware dedicated channel assignments and the more complex systems as “PMC” (Programmable Multiplex Control) systems-those systems with user programmable channel assignments. They have been used in over-the-road and local delivery trucking industry, conversion vans, Rv’s, buses (both transit and mini), ambulances, and fire trucks.

The basis for all of these systems is a patented Master/Slave Time Division Multiplexing communication protocol proprietary to Intellitec. For those of you more technically inclined, you may refer to *“THE INTELLIPLEX SYSTEM –THEORY OF OPERATION”* available from Intellitec as a separate document. The beauty of this system is its simplicity; therefore its cost effectiveness, reliability, immunity to noise, lack of noise generation, as well as flexibility.

# Designing a system

**IPX OR PMC SYSTEMS GENERALLY CONSISTS OF THREE MAJOR SYSTEM COMPONENTS:**

1. The Master or CPU – The module that generates the communication signal that synchronizes the rest of the system. Masters may have dedicated inputs and outputs and some versions may be capable of being programmed by the end user; using custom MS Windows™ based interface programs to process channel data.
2. The Slaves – Input modules that accept inputs from sensors and switches and communicate their status to the rest of the system, and the output modules that switch power to devices based on the state of sensors or switches. The output modules may also communicate the state of their outputs to the rest of the system. Some versions of these modules may also be capable of being programmable by the end user; using custom MS Windows™ based interface programs to assign their inputs and outputs to various channels.
3. The Communications Harness – Cabling that provides communication and power for IPX or PMC modules. The Communication Harness in an IPX or PMC system consists of three wires; +12Vdc module power, signal and signal ground. In most cases, these wires are supplied via a three-pin plug on the Master.

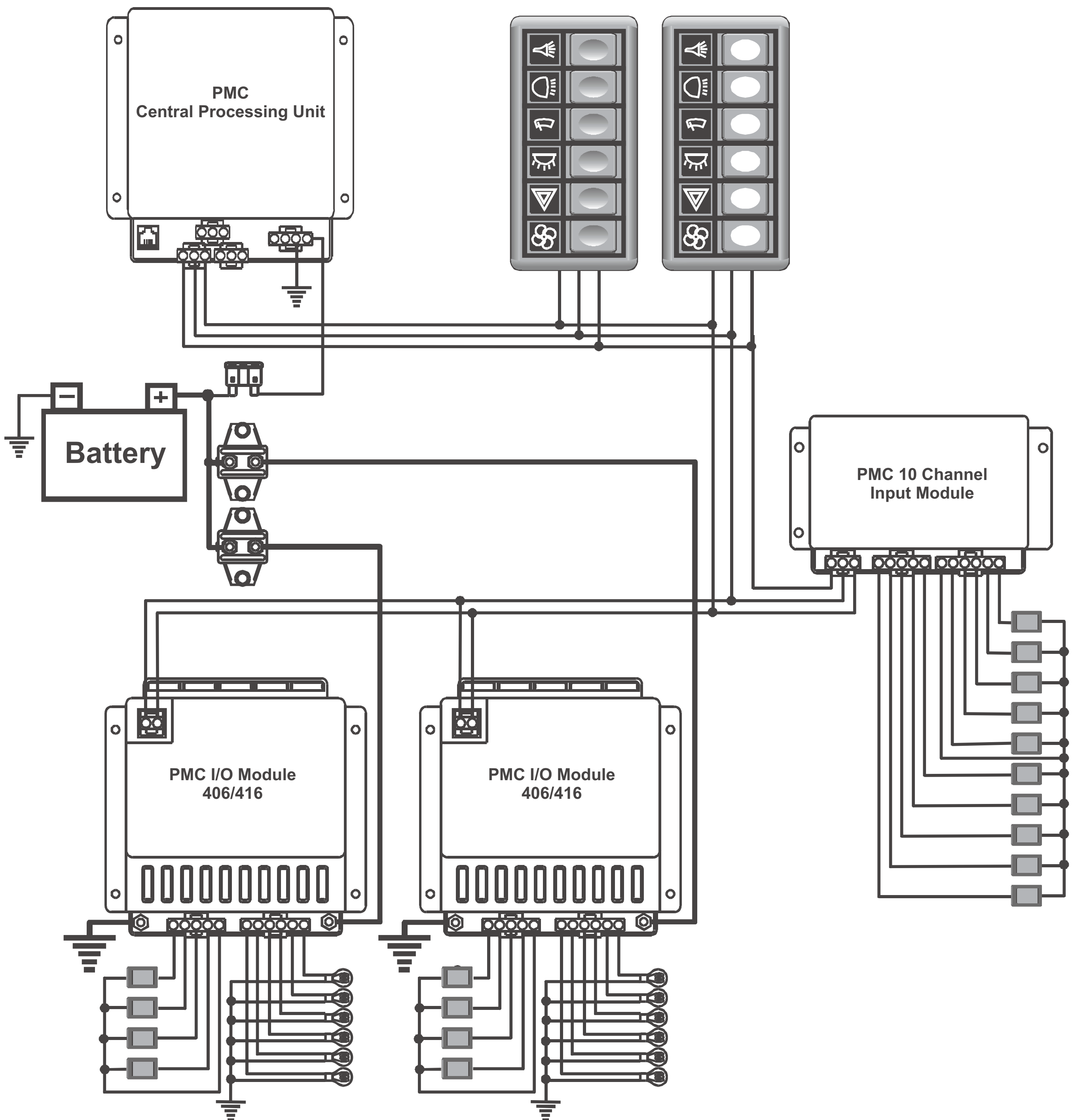
Intellitec designs the masters and slaves to conform to internal IPX and PMC standards that guarantee interchangeability in the system. The other major system component, the Communications Harness, is generally designed by the OEM customer to conform to his design and production standards. The wiring for an IPX or PMC multiplexed communication system is fairly simple; however, it has been our experience that it has a major affect on system reliability. Therefore, we would like to present several guidelines on the construction of the Communications Harness based on our experience:

1. The +12V module power lead in the communications harness supplies power to IPX or PMC modules. Nothing but the IPX or PMC Master, Input Modules, or Output Modules can be connected to this lead. In most cases it is fused on the master with a 5A or smaller fuse. In some cases, when this lead provides +12Vdc power to output loads, a separate connector is provided on the master for each individual output module. In those cases, each output module has a separate communications harness leading to the master and the +12V module power for each output is fused on the master for the output rating.
2. The signal lead carries the communications between modules. Nothing but the IPX or PMC Master, Input Modules, or Output Modules can be connected to this lead.
3. The signal ground lead supplies a ground return for the signal and +12VDC module power. Nothing but the IPX or PMC Master, Input Modules, or Output Modules can be connected to this lead. It is good practice to use a wire color other than black, white, or green for this lead so that installers of after-market devices will not assume that it is an accessible ground wire. We normally recommend a brown wire for this lead.
4. The wires do not need to be shielded or twisted. Three-conductor over-molded cable can be used on short harnesses, but generally should not be used on longer harness. The reason is that this type of cable has the wires closely spaced in a compact configuration that greatly increases the capacitance between the wires, degrading the communications signal. In general, individual wires such as those used in the rest of the vehicle should be used.

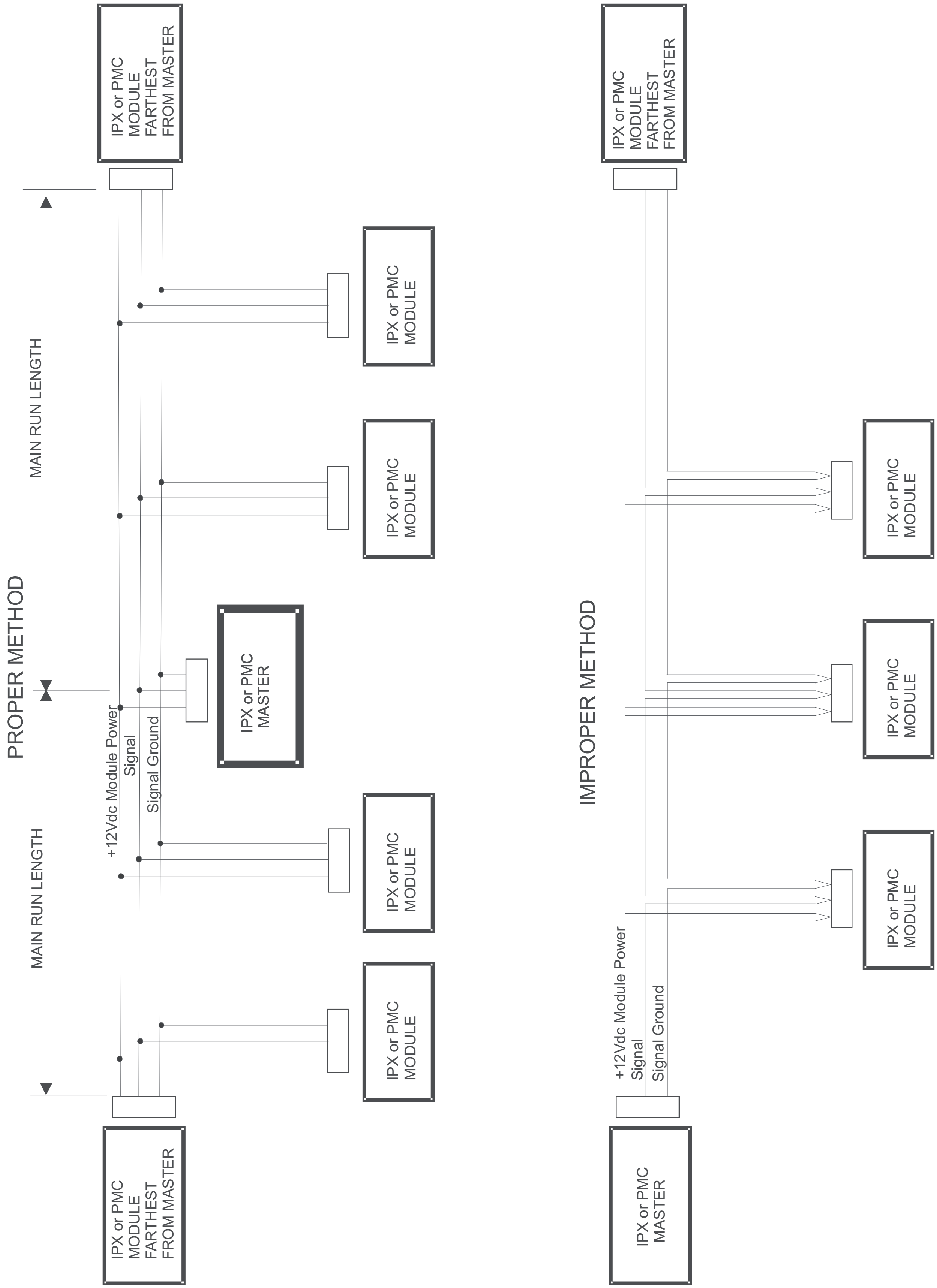
# Designing a system

5. The main run of the Communications Harness is defined as the length of the harness from the Master to the farthest IPX or PMC module. In order to minimize the equivalent length of the main run it is advisable to locate the Master centrally in the vehicle with respect to the main run, essentially dividing it in half.
6. Generally, on systems where multiple modules are connected to the Communications Harness, and the main run is 50ft. or less in length, 18Ga wire is suitable for all three wires. If the main run is from 50 to 100 feet in length, 16Ga wire is required. If the main run is greater than 100 feet in length, 14Ga wire is required. On modules that are directly linked to the Master with their own port the wire size should be based on the output rating for that module.
7. The main run of the Communications Harness should be designed to be as short as possible. This is generally accomplished using “T” stubs from the main run to the various IPX or PMC modules. It is our experience that daisy chaining the connectors for various IPX or PMC modules can lead to excessive cable length because each stub is essentially twice as long as a “T” stub. A 40ft. long vehicle can easily end up with a Communications Harness exceeding 200ft. using the daisy chain method of wiring. The most successful applications consist of a centrally located main run in the vehicle with “T” stubs leading to single modules or small groups of modules. *Refer to Appendix “A” for a graphic illustration.*

***Following these simple guidelines should help you to avoid any pitfalls concerning the design of the Communications Harness.***


PMC
Central Processing Unit
Battery
PMC 10 Channel
Input Module
PMC I/O Module
406/416
PMC I/O Module
406/416

# APPENDIX "A"


PROPER METHOD
MAIN RUN LENGTH
MAIN RUN LENGTH
IPX or PMC MODULE FARTHEST FROM MASTER
IPX or PMC MODULE
IPX or PMC MODULE
IPX or PMC MASTER
+12Vdc Module Power
Signal
Signal Ground
IPX or PMC MODULE
IPX or PMC MODULE
IPX or PMC MODULE FARTHEST FROM MASTER
IMPROPER METHOD
IPX or PMC MODULE FARTHEST FROM MASTER
IPX or PMC MODULE
IPX or PMC MODULE
IPX or PMC MODULE
+12Vdc Module Power
Signal
Signal Ground
IPX or PMC MASTER

# Chapter 4
# Getting Ready to Program

# Labeling the System, Modules and Channels

# Getting Ready to Program the System

Once you have created your I/O list, the next step before you begin programming a system is to determine the relationships between the inputs and outputs, and to record them. Two words must be emphasized here; *organization* and *documentation*. This can't be emphasized enough. Without the effort here, a lot of confusion and mistakes will be made later. These interrelationships must be written out to aid in the understanding of all the functions. In some simple applications, this step may seem unnecessary, but it will often prove helpful as the process moves.

Some examples of these interrelationships would be;

If a light should be on when a switch is on, the statement would be written:

**Light = Switch**

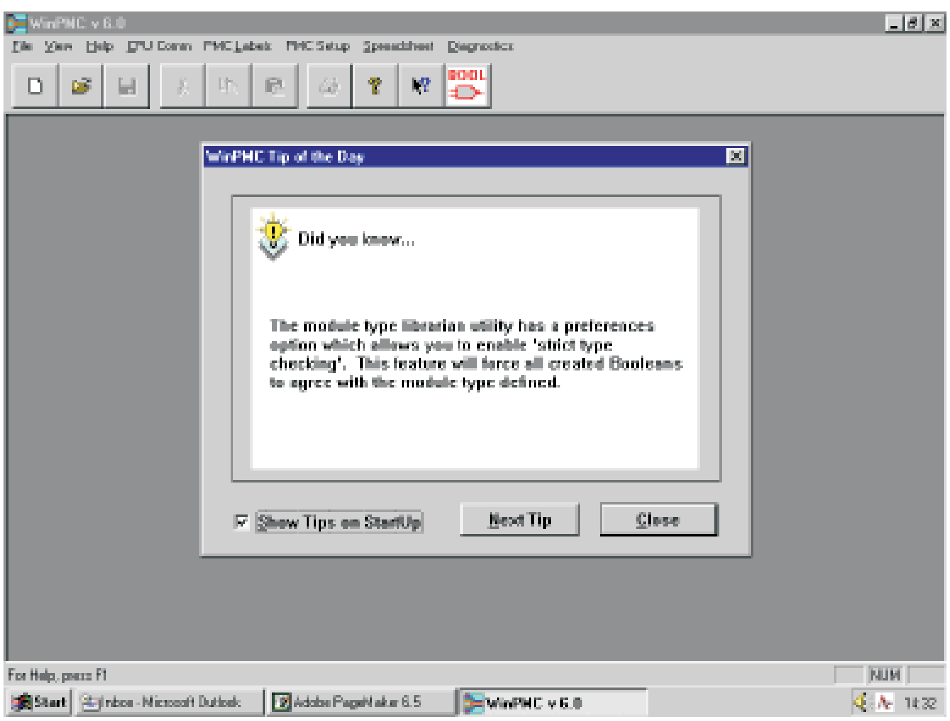
If there are more conditions, then it might be written as:

**Light = Switch OR Ignition**

These relationships can become fairly complex when interlocks and timers get involved. By writing them out this way, it will help you when you begin to enter your program.

Once all the names and relationships of the inputs and outputs have been determined and recorded, it is time to program the system. All the programming is done using a computer with Windows 95™ or greater and the Intellitec PMC programming software. The first step is to install the program on a computer. Detailed installation instructions are given in chapter 10. (We assume you are familiar with the use of Windows 95™ and applications programs under Windows 95™. If you are not, there are many sources that can get you started with Windows 95™ before working with the PMC program.)

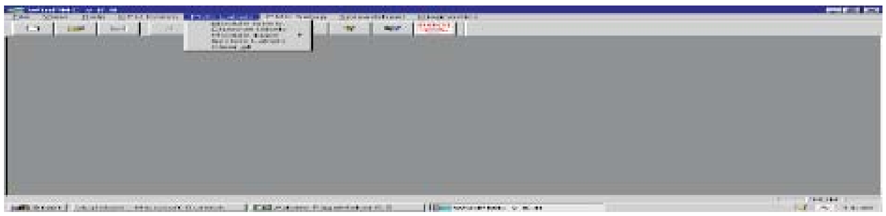
Once you have installed the program, an icon will appear on your desktop. Double click the icon to open WinPMC. Once it is opened, the screen will appear as shown here.



# Getting Ready to Program the System

The "tips" screen should be closed by clicking on the "X" in the upper right-hand corner of the tips window. To be sure there are no commands remaining in the memory, it should be cleared before beginning. To do this, click on "PMC Labels".

The menu will drop down, to look like this:



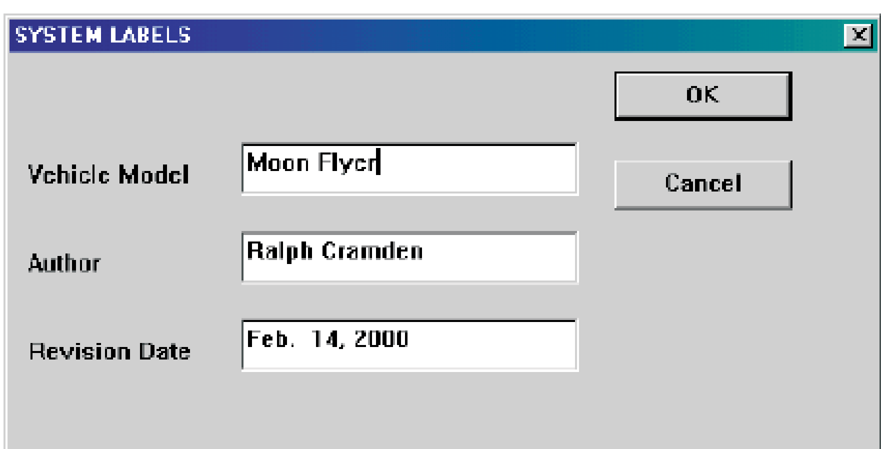
Select "Clear All". The panel will appear asking if you want to clear the entire system. Click "OK". This clears the memory. If the port is open and the RS232 cable is connected to the CPU and computer, any program stored in the CPU will also be cleared. To see if the port is open or closed, click on CPU Comm. "Open Port" means that the port is closed. Clicking on it will open the port. It is not necessary to have the port open, or the computer connected via the RS232 cable while writing the program. The program can be written and stored as a file on your computer and downloaded to the PMC CPU at a later time.
*(See Chapter 7 for additional details regarding communicating with the CPU)*

### *LABELING*

The first step in setting up the system is to label all of the modules and each of their channels. This is a very important step in the process, as it helps to keep track of the functions of the system. Careful labeling will be very important later in the programming process. DO NOT skip this step.

### *SYSTEM LABELS*

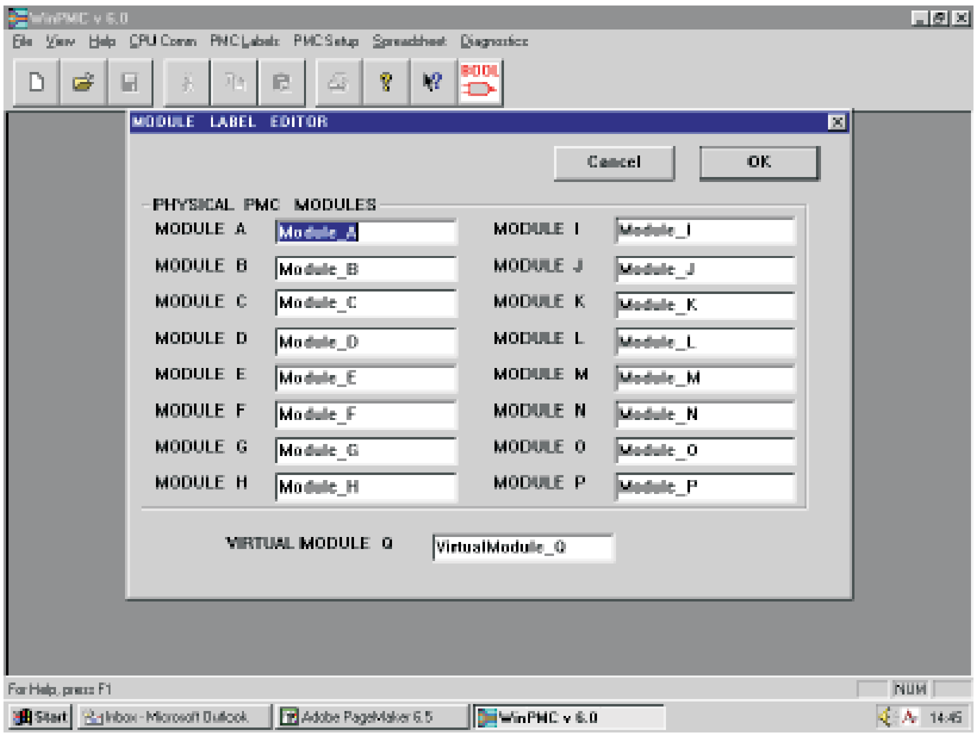
System labels provide a place for you to identify the vehicle. This information is stored in the PMC CPU, in your computer and will appear on the spreadsheet. The PMC spreadsheet will be discussed later. From the PMC Labels menu, select "System Label". The following box will appear. We have defined the fields as vehicle model, Author and Revision date. You can enter any information that may be appropriate. You may wish to put a document number in place of author; it is entirely up to you. This information will become most important when you retrieve a program from the CPU after a long period of time. You will be able to determine what version of software the vehicle was programmed with.



# Getting Ready to Program the System

### *MODULE LABELS*

The next step is to label each module in the system. To do this, click on "PMC Labels" in the task bar. This will create a flyout list of functions. Move down this list to "Module Labels" and click. The Module Label editor screen will appear, as shown here. This screen allows you to identify each of the modules in the system. While the screen allows you to identify *all* the modules, you need only identify those you are using.




To name a module, click in the box of the module you want to name. Enter a name that describes the specific application for that module. The names should be descriptive of the module's location or function, such as "Front Lamps". (The names are limited to 15 characters.) Continue to do this for each module in the system. When you have finished, click on OK to exit the Module Editor.

To label the channels, click in the channel box to be labeled and type in the name. The name is limited to 15 characters. These names should be descriptive of the function of that channel, such as Right Brake Lt. Once each of the channel labels in a module is entered, click on "OK" box. Repeat the channel labeling process for each Module.

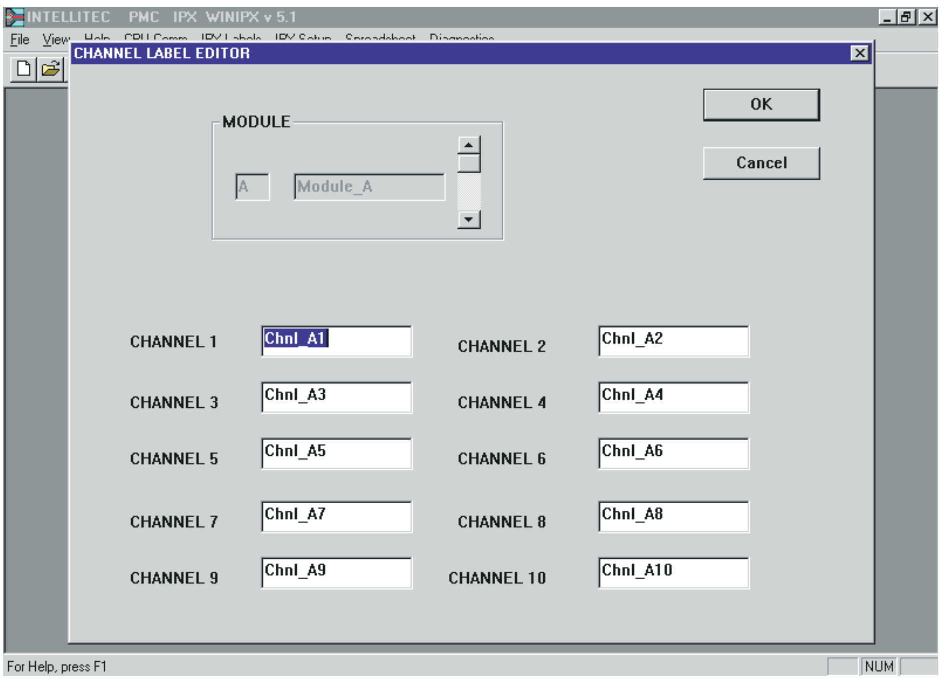
# Getting Ready to Program the System

### *CHANNEL LABELS*

The next step in the process is to label the function of each channel in the system. Again, this is a very important step in the process to keep things well documented.

The labels should be descriptive of the function of that channel. To do this, click on "PMC labels" in the task bar. This will create a flyout. Move down this list to "Channel Labels" and click. The screen should appear as shown here.

Select the module to be labeled by clicking on the up or down arrow and then enter the label for each channel in the module. Repeat the process for each module.




### *SAVING DATA*

The next step is to save the data you have entered. To do this, click on "File" to produce the flyout. Then click on "Write PMC File". The first time you do this for a particular system, you will have to name the file. Again, as before, the name should be descriptive. A suggestion would be the name or model and revision of the vehicle. This will allow you to keep track of the files. After the name is typed in, click on "Save" box.

# Chapter 5
# Set UP Logic
# Using PMC Software

# Set Up Logic Using PMC Software

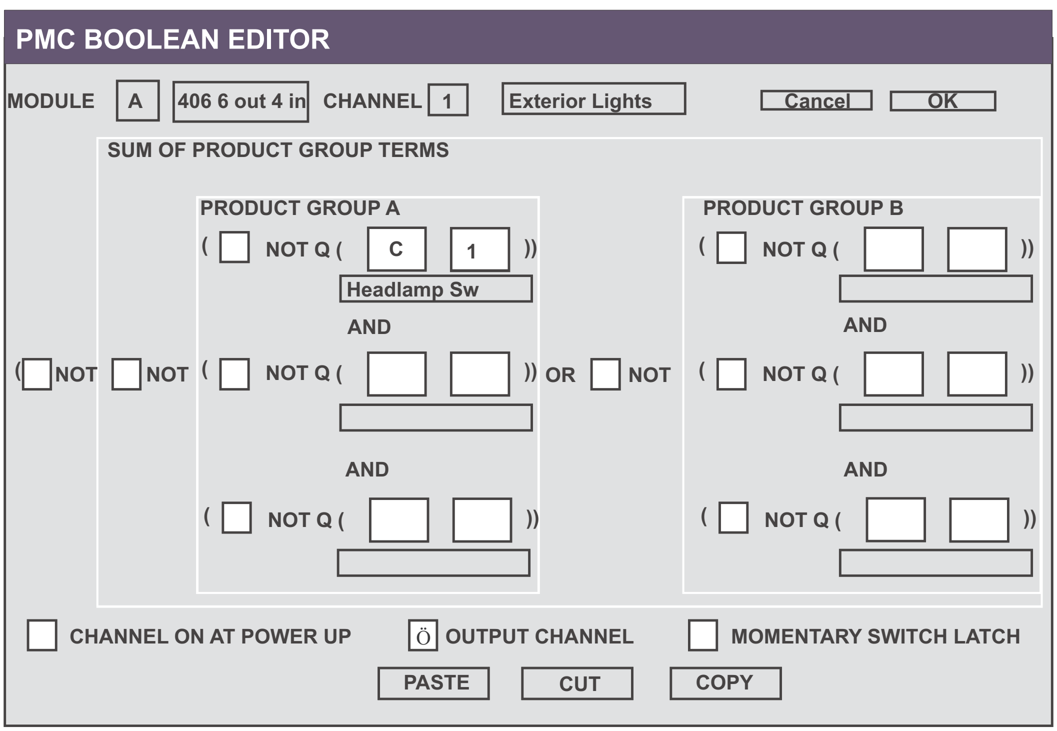
***BOOLEANS***

Once the module and channel labels are fully entered and saved, the actual programming can begin. In this step, you will enter the relationships between the inputs and outputs. This step is done through Boolean algebra expressions. Only *output* functions should be programmed. They are expressed as functions of the inputs.

To do this, click on "PMC Setup" in the task bar to produce the flyout. Click on "Booleans". Another flyout will appear. Click on "Editor", or simply click on the red Bool icon on the task bar. Using the up/down arrows, select the output module containing the output you wish to program. The Select Channel screen will come up. Select the channel you want to program by clicking in the circle in front of the channel you want to program and then click on "OK" box.

The PMC Boolean Editor screen will come up. This screen is the area in which the actual relationship between inputs and the output will be determined through the Boolean equation.

It looks like this:




This general set up allows you to write an expression that includes a three input AND, OR'ed with another three input AND. Using DeMorgans theory this single screen can be used to write a 6 input OR, or a 6 input AND (See chapter 9 for examples and the chapters on Boolean Algebra for more explanation).

# Set Up Logic Using PMC Software

The simplest equation that can be written is one in which the output is a direct function of the input, such as the light goes on when the switch is turned on. Let's make the output on channel A1 and the input channel C1. The equation for this function is written as:

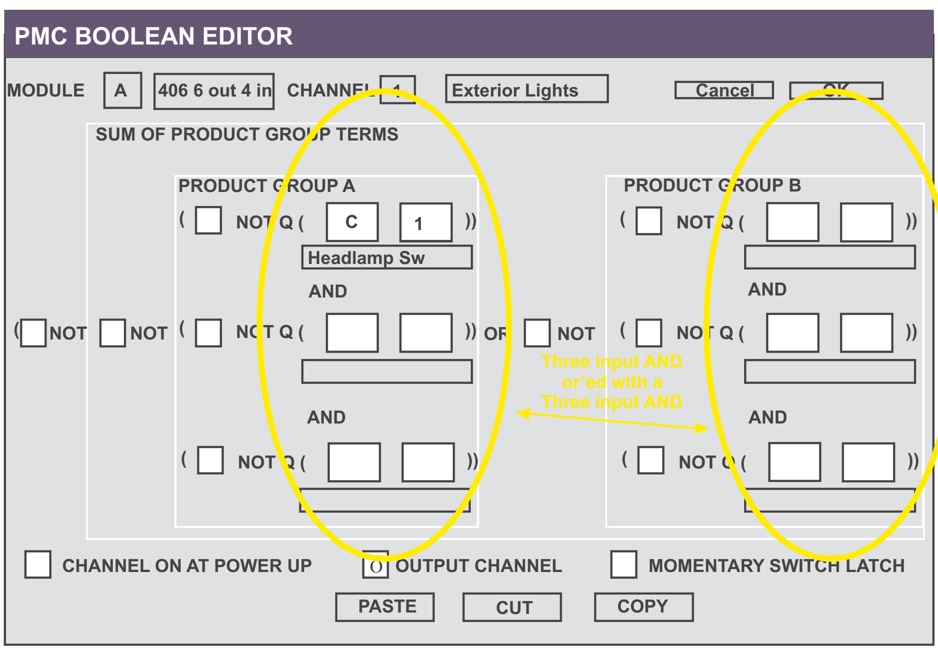
**A1 = C1**

With this equation, the output to the Head lamp, A1, will go on when the switch, C1, goes on.

To input this equation, click on the red Bool icon in the task bar. Select the module whose output you want to program, in this case "A", by clicking the up, or down boxes until the module letter you want is showing in the box. Remember, only the outputs need to be programmed.

Next, select the channel you want to program; in this case channel 1, by clicking in the small circle in front of the desired channel. Then click on "OK". The Boolean Editor screen will come up, with Module "A" and it's name and "Channel A1" and it's name will appear at the top of the screen.

This screen is the general input screen. It is a three input AND, OR'ed with another three input AND.




There are "NOT boxes" next to each entry, at the beginning of the expression and between the three input AND's. Checking these boxes NOT's inverts that term in the expression. At the bottom of the screen, there are a few more useful tools. The first small box, labeled "Channel, on at Power up", is used to set the output of a channel to a 1, or ON when the power is first applied.

# Set Up Logic Using PMC Software

The second box, labeled "OUTPUT CHANNEL" indicates to the system that this channel is an output, as opposed to an input channel.

The third small box, labeled "MOMENTARY SWITCH LATCH", indicates to the system that this is a momentary switch channel. This is the only time that the boolean editor screen will be used for an input channel. This is useful for systems requiring momentary switch inputs. The system will respond alternately on each press of the switch. Again this is the only entry that is made for an input channel. Selecting this for a switch input makes the switch act as a push/on, push/off switch.

The "PASTE, CUT, and COPY" commands are the same as used in other WINDOWS applications. They can be used to program multiple channels with the same or similar inputs.

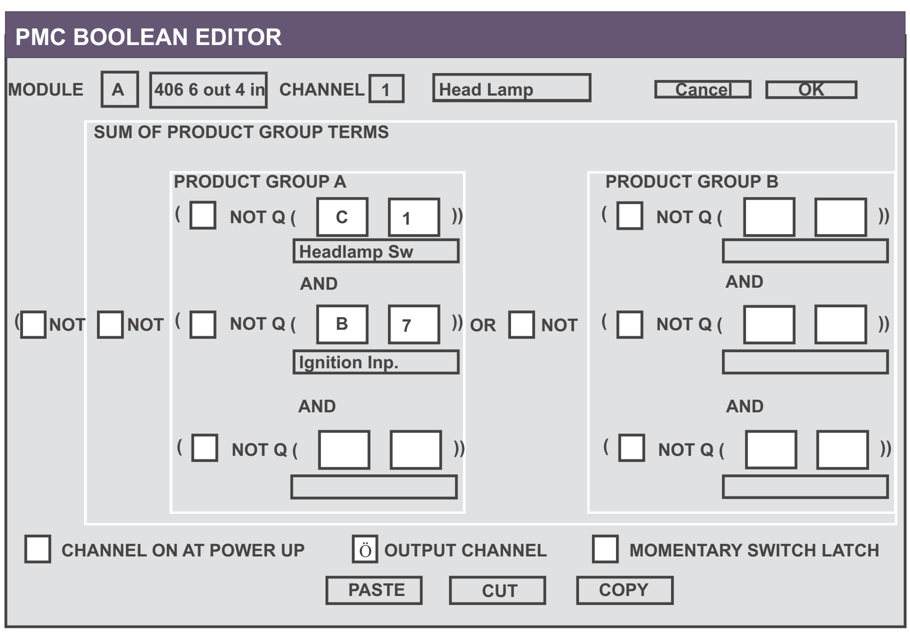
***EXAMPLE***

*Lets look at an example*. Suppose that you would like to turn the head lights on, but only when the ignition is on. If the headlights are located on output channel A1, the head light switch on input channel C1 and an ignition input on channel B7, we would write the following Boolean.

**A1=C1 AND B7** **A1=C1*B7**

Now let's see how we can use this screen to input the data of our example. In the top line of Product Group A, select the input C1, by either typing the channel designations in the boxes, or clicking on the up or down boxes on the slide bar. If you type the designations in, the Tab key will step you through to the next box. In the second line of product group A, select B7, then click on the "Output Channel" at the bottom of the screen to designate this channel to be an output.

The screen will look like this:




As you write Boolean equations, remember that it is acceptable to set one output equal to another. In other words, it is not necessary to have a switch input turn an output on. For example, you may wish to have the tail lights on whenever the headlights are on. If the headlights are on output channel A1 and the tail lights are on output channel D1, you could write the following statement: **D1=A1.**

# Set Up Logic Using PMC Software

***VIRTUAL MODULES***

On the Boolean Editor screen, the three input AND, OR'ed with another three input AND allows a lot of flexibility in creating expressions for functions of the system. The system is however, not limited to just these equations. Any channel can be used as an input for an expression. The system includes a virtual module at address Q. This module exists only in the software. In other words there is no physical module with the address of Q.

An expression can be written for a channel of the virtual module and then its output can be used as an input expression for another channel. This allows the "stacking" of expressions to provide almost limitless factors in the expression. In addition to the use of the virtual module Q, any nonexistent hardware module can be used as a virtual module. Furthermore, any unused channel of an existing module can be used the same way. For example, since every module address has 10 channels, if you were using a six rocker switch adapter there would be 4 unused channels available to be used as virtual channels.

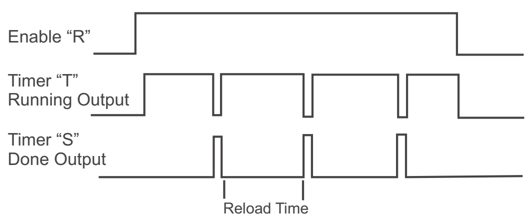
See the chapter 9 on Boolean examples.

# Set Up Logic Using PMC Software

***TIMER FUNCTIONS***

There are ten timers included in the system. Seven of these timers can be set in 0.1 second intervals, to 25.4 seconds. These timers are used when that kind of precision is needed. The other three timers can be set in 10 second intervals, to 2540 seconds, or 42.33 minutes.

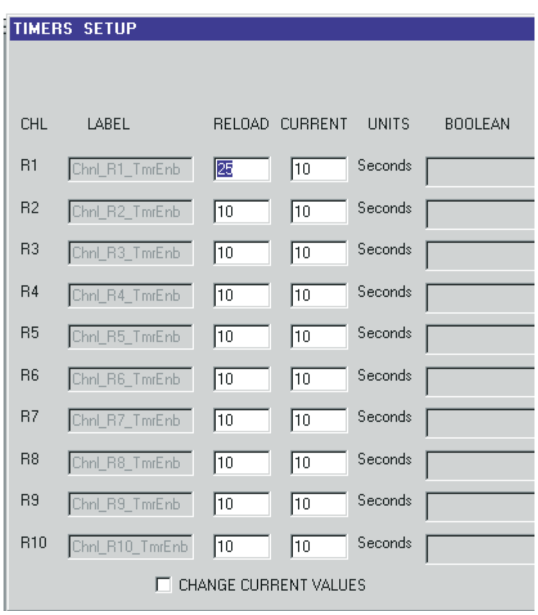
**Each** timer has two outputs, Timer Running Output, "T" and the Timer Done Output, "S", and one input, Enable "R". A timer starts to run when the Enable input goes high and will continue to run as long as it is high. Once the input is gone, the timer stops. The input and two output signals appear as shown here:




The Timer Done signal, "S", is present for only 40 milliseconds, the length of a word. It is high when the Timer Running Output is low.

To set up the time intervals of the timers, click on "PMC Setup". Move the cursor to "Timer Setup" and click to bring up the Timer Setup screen.

It appears as shown here:



TIMERS SETUP

| CHL | LABEL | RELOAD | CURRENT | UNITS | BOOLEAN |
|---|---|---|---|---|---|
| R1 | Chnl_R1_TmrEnb | 25 | 10 | Seconds | |
| R2 | Chnl_R2_TmrEnb | 10 | 10 | Seconds | |
| R3 | Chnl_R3_TmrEnb | 10 | 10 | Seconds | |
| R4 | Chnl_R4_TmrEnb | 10 | 10 | Seconds | |
| R5 | Chnl_R5_TmrEnb | 10 | 10 | Seconds | |
| R6 | Chnl_R6_TmrEnb | 10 | 10 | Seconds | |
| R7 | Chnl_R7_TmrEnb | 10 | 10 | Seconds | |
| R8 | Chnl_R8_TmrEnb | 10 | 10 | Seconds | |
| R9 | Chnl_R9_TmrEnb | 10 | 10 | Seconds | |
| R10 | Chnl_R10_TmrEnb | 10 | 10 | Seconds | |

CHANGE CURRENT VALUES

Timers can be used for either a repetitive function such as a flasher, or a lamp delay. Let's look at how each of these functions are used. First, let's look at using a timer in a delay function.

In this application, the timer is typically started by an input switch and it will stay on for a fixed period of time. If the input switch is used to initiate the timer, the timer will have to be latched on to keep it going. To keep the timer going, a latching equation needs to be used. The equations would be:

**R1 = THE TIMER ENABLE**
**B1 = THE SWITCH**
**T1 = THE TIMER'S RUNNING OUTPUT**

**R1 = B1**
**T1 = R1 + T1**

In other words making the Enable R1, equal to the input B1, starts the timer and then the timer keeps itself running. The input here could be a pulse created at the edge of switch, *as shown in the System Timing chapter.* This pulse would be 40 milliseconds long. That is long enough to start the timer, which may be minutes long. An example application would be a light delay that would keep the light on for 20 seconds after the switch was turned off. Let's look at how this would be done.

***LIGHT DELAY***

First let's call the light switch B1. The light will be C1. We want the light on when the switch, B1, is on and for 20 seconds after the switch is turned off. First, we write the expression in words:

**Light = Switch OR Timer**

Timer = starts when switch goes off and runs for 20 seconds. (We can't use the switch to turn on the timer, since then the timer wouldn't have a time relationship to when the switch goes off. It may go off at any time during the timer sequence.)

Now we can write the Booleans.

The output will be:

**C1 = B1 + T1**

Now we have to create a pulse when the switch is turned off, or the trailing edge. *(The explanation of this function is explained in the System Timing chapter.)* To do this we use 2 virtual modules, address Q1 and Q2.

**Q2 = B1**
**Q1 = Q2**

Then to start and run the timer:

**R1 =( !Q2 * Q1) + T1**

Let's look at this function. The light comes on when the switch is on, OR when the timer is running, T1. The timer is started when the switch is turned off by the creation the pulse at the trailing edge of the switch. It is held on by the Timer Running signal, T1.

### *FLASHER*

To create a flasher, or repetitive type signal with the timer, first a Boolean for the timer input, R, must be created. Let's say that we want the timer to operate when a switch on C1 is on.

The first Boolean will be:

**R1 = C1**

This means that the timer will be running all the time the switch on input C1 is on. To create the flash, we create an Exclusive OR with the timer and the output to a light, which here we will call D1. An exclusive OR means that the output will be ON only when one input is on, but not both.

This equation will be:

**D1 = (D1 * !S1) + (!D1 * S1)**

This equation looks strange and deserves some explanation. As discussed in the *System Timing section*, the Booleans are calculated in rotation, starting with the earliest equation and proceeding to the next. When the system calculates this equation the first time, let say D1 is false or 0. S1 is also 0.

The equation calculates to be:

**D1 = 0 * 1 + 1 * 0 = 0**

At the end of the timer period, S1 will be 1.

The equation is then:

**D1 = 0 * 0 + 1 * 1 = 1**

This turns the output D1 to true (or on).
The next time the timer completes its cycle, the equation will be:

**D1 = 1 *1 + 0 *0 = 0**

This turns the output D1 to false (or off). As you can see, we have created a flashing signal on D1, whose time period is set by the timer S1.

One slight problem with this equation, is the output D1 is indeterminate when the switch C1 is turned off. It may be on or off, depending on exactly when the switch C1 is turned off. To be sure the output is off when the switch is off, the input of C1 should be AND'ed with the timer equation for D1. In this way, D1 can only be on when the switch is on.

The equation will then be:

**D1 = ( D1 * !S1 * C1) + ( !D1 * S1 * C1)**

This is an important function of the system and can often be used to replace other timers and flashers.

**Many people find this logic difficult to follow. Don't be concerned. There is a chapter in this manual with examples of common Boolean Logic statements used in vehicles.**

### *SLEEP MODE*

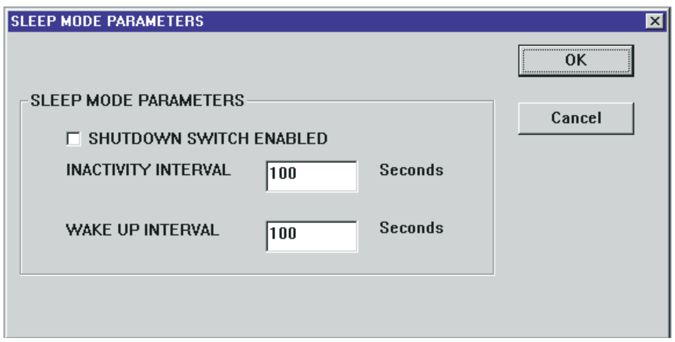
The system includes a sleep mode which puts it to "sleep" to save battery power when the vehicle is not in use. There are two inputs on the CPU Module that are used to signal the system to enter into "Sleep Mode". These would typically be connected to an ignition source. With this connection, as long as the ignition is on, the system will remain on and will not enter sleep mode.

# Set Up Logic Using PMC Software

Once the ignition is turned off and the system does not sense any activity from any inputs, the system will go to sleep after a time period; one that you have set in the Sleep Mode Timer. When the system is asleep, it will turn itself back on periodically and check if any of the inputs have changed. If it senses a change in any input, it will wake up and resume normal operation. If the there are no changes in inputs, it will go back to sleep.

To set up the Sleep Mode Timer, click on "PMC Setup". Move the cursor to Sleep mode and click. This will bring up the Sleep Mode Timer screen.

It will look like this.




There are three inputs to be made to this screen: Shutdown Switch Enabled, Inactivity Interval, and Wake Up Interval. The Inactivity Interval timer can be set from 10 to 2540 seconds. This is the time the CPU will use to decide that there hasn't been any activity on the system, allowing it to shut itself down. If this time is set too long, the system will be wasting battery power. If it is set too short, it may go off before the driver has left the vehicle. To set this timer, move the cursor to the box, click on it and type in the new value. If you input a value out of the range, the program will prompt you to correct it.

The Wake Up Interval Timer can be set from 10 to 254 seconds. This is the amount time the CPU will wake up for to determine if there is any activity on the system. If this interval is set too long, the CPU may take a long time to see an input change. If it is set too short, it will be waking up too often and waste battery power. ***Suggested settings are 240 seconds for inactivity and 5 seconds for wake up.*** To set this timer, move the cursor to the box, click on it and type in the new value. If you input a value out of the range, the program will prompt you to correct it.

The CPU will provide power during sleep mode to back light switches via pins J2-1, J3-1 and J4-1. If you are using switch adapters or the lighted rocker switch module, consideration should be given to the current draw from the backlit switches.

It is up to the designer to decide to use this function and the times to be used for the particular application.

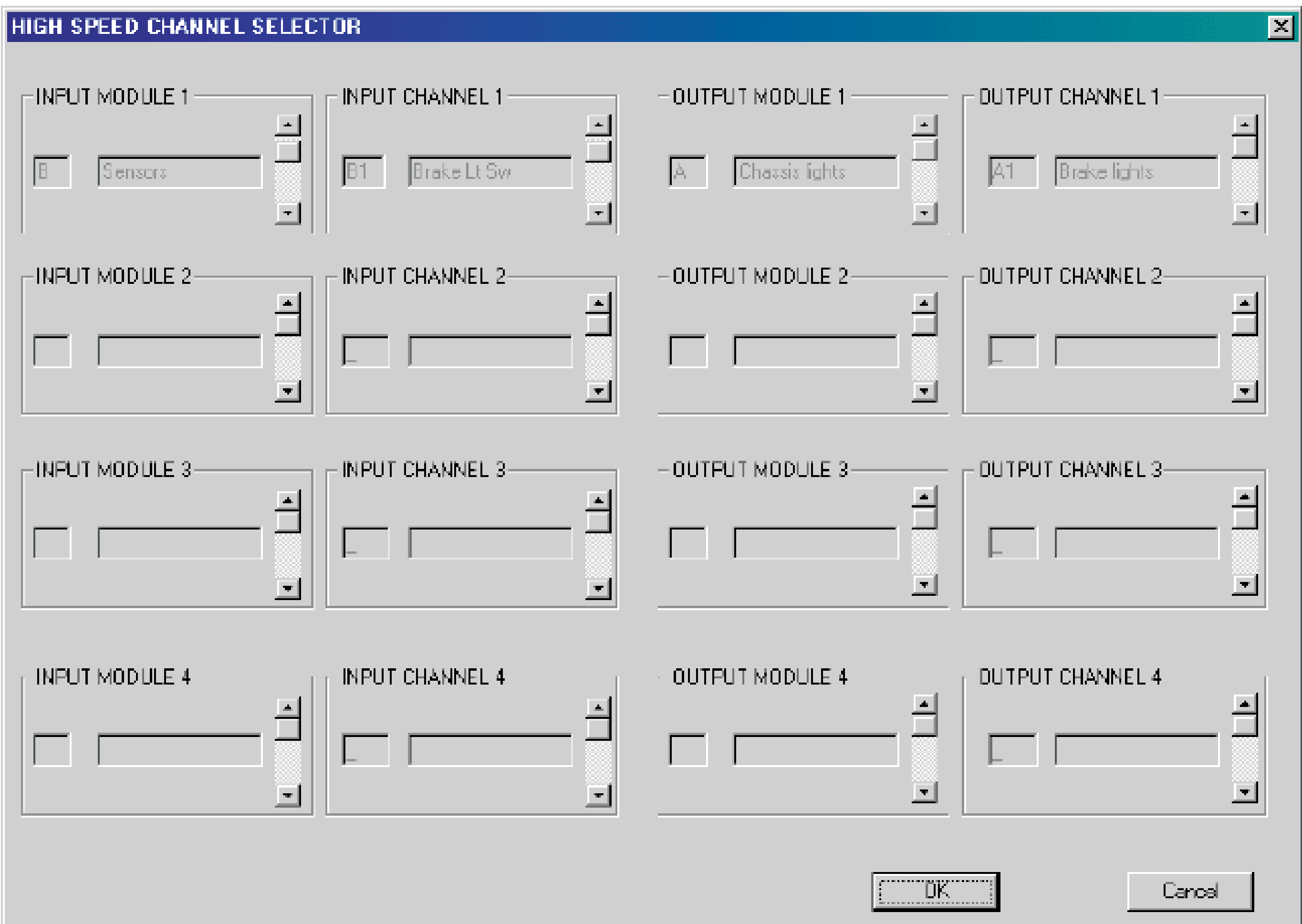
# Set Up Logic Using PMC Software

***HIGH SPEED CHANNELS***

There are 4 high speed channels available. These channels are to be used for functions that demand very short delays through the system, such as brake lights. These channels have direct relationships between the inputs and outputs. The CPU does not spend any time evaluating a Boolean. Booleans can not be written for a channel that has been defined as a high-speed channel. The relationship between the input and output is defined on the high-speed channel selector screen.

Any output channel on any module may be defined as a high-speed channel. To define a channel as a high-speed channel, select "PMC SET UP" from the task bar, then click on high-speed channels.

The screen below will appear:




Using the Up down arrow buttons for "input module 1", select the module containing the input channel you would like to use to operate the high speed channel. Move to the next box "input channel 1"select the input channel (switch) that will control the output. In the next box 'output module 1" select the module that contains the output you would like to operate. In the final box select the output channel you wish to control. Click on OK and the channel is set up as a high speed channel.

# Chapter 6
# The Spreadsheet

# The Spreadsheet

The PMC software is designed to help you document the vehicle's electrical system as you enter the information during set up. In earlier steps you have selected module types, labeled each module, labeled each channel and labeled the system. You have also written Boolean statements for each output channel. All of this information has been recorded in the spreadsheet.

The spreadsheet functions are similar to other windows spreadsheets you may be familiar with. You can add notes, print or perform calculations.

To view the spreadsheet, click on "spreadsheet" in the task bar and then click on "designer" (or click on the red spreadsheet icon in the task bar). A window will open and display the spreadsheet for the vehicle file you have open. If you have retrieved from the PMC CPU you will be able to view the details of what had been previously programmed in the vehicle. If you have opened a file from the hard drive you will view the information from that file. As you will see, the system label information is shown first followed by the PMC software and hardware version.

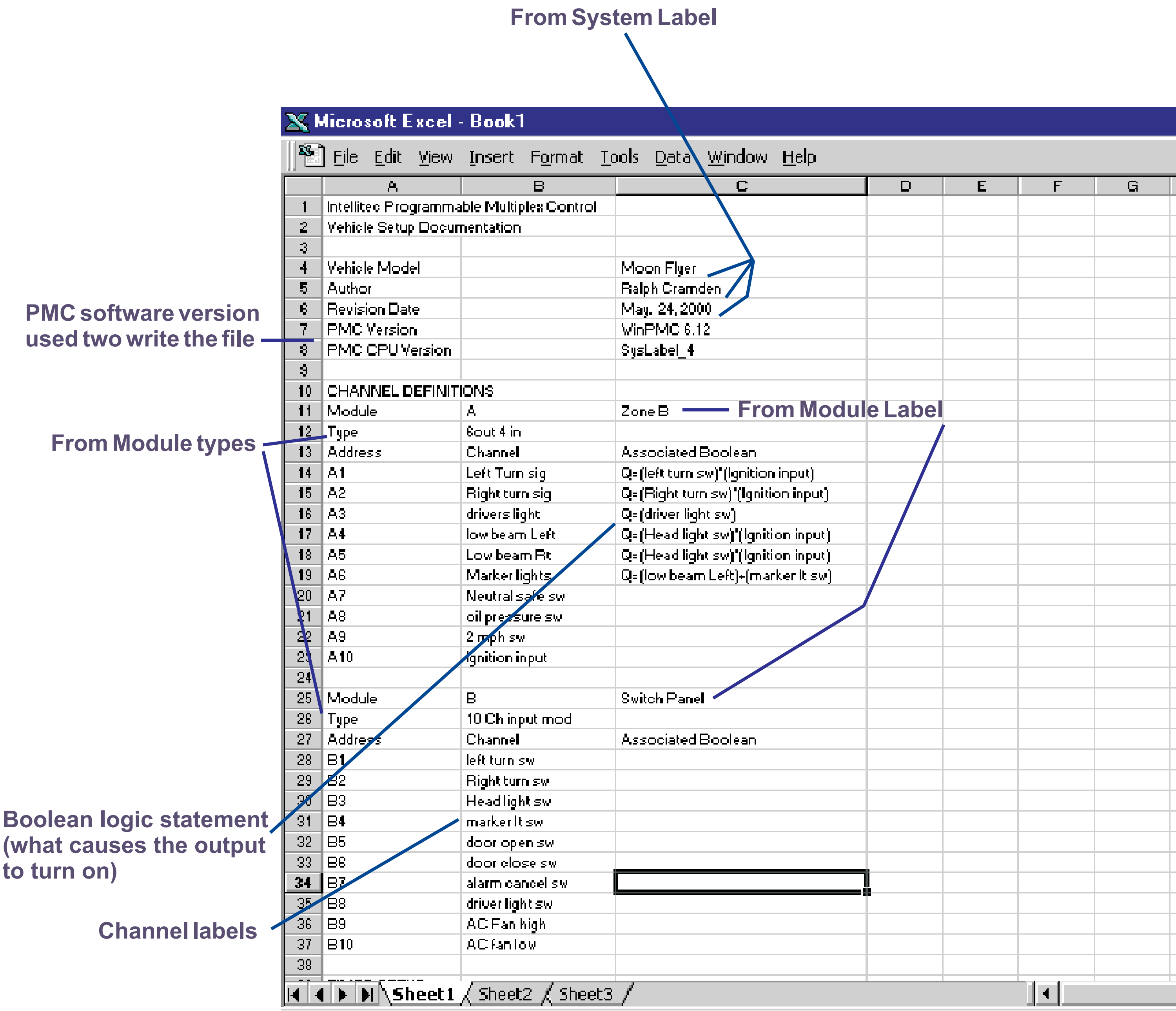
In the channel definition you will find the module address and module type if you have selected module type for each module in the label menu.

The address, channel label, and it's associated boolean are shown. Note that Boolean statements cannot be changed from the spreadsheet. You may however add notes, or modify the spreadsheet for documentation purposes.

Timer settings, sleep mode settings, and high speed channel settings are also shown.

To print the spread sheet, select print from the file menu and change your printer setting to landscape. To print in portrait instead of landscape, you can select page setup from the file menu and in the scale box check the fit to pages box. Leave the pages wide setting at 1 and set pages high to a number that will display the entire spreadsheet. You can use print preview to see how it will turn out.

# PMC Spreadsheet




| | A | B | C |
|---|---|---|---|
| 1 | Intellitec Programmable Multiplex Control | | |
| 2 | Vehicle Setup Documentation | | |
| 3 | | | |
| 4 | Vehicle Model | | Moon Flyer |
| 5 | Author | | Ralph Cramden |
| 6 | Revision Date | | May. 24, 2000 |
| 7 | PMC Version | | WinPMC 6.12 |
| 8 | PMC CPU Version | | SysLabel_4 |
| 9 | | | |
| 10 | CHANNEL DEFINITIONS | | |
| 11 | Module | A | Zone B |
| 12 | Type | 6out 4 in | |
| 13 | Address | Channel | Associated Boolean |
| 14 | A1 | Left Turn sig | Q=(left turn sw)*(Ignition input) |
| 15 | A2 | Right turn sig | Q=(Right turn sw)*(Ignition input) |
| 16 | A3 | drivers light | Q=(driver light sw) |
| 17 | A4 | low beam Left | Q=(Head light sw)*(Ignition input) |
| 18 | A5 | Low beam Rt | Q=(Head light sw)*(Ignition input) |
| 19 | A6 | Marker lights | Q=(low beam Left)+(marker lt sw) |
| 20 | A7 | Neutral safe sw | |
| 21 | A8 | oil pressure sw | |
| 22 | A9 | 2 mph sw | |
| 23 | A10 | Ignition input | |
| 24 | | | |
| 25 | Module | B | Switch Panel |
| 26 | Type | 10 Ch input mod | |
| 27 | Address | Channel | Associated Boolean |
| 28 | B1 | left turn sw | |
| 29 | B2 | Right turn sw | |
| 30 | B3 | Head light sw | |
| 31 | B4 | marker lt sw | |
| 32 | B5 | door open sw | |
| 33 | B6 | door close sw | |
| 34 | B7 | alarm cancel sw | |
| 35 | B8 | driver light sw | |
| 36 | B9 | AC Fan high | |
| 37 | B10 | AC fan low | |
| 38 | | | |

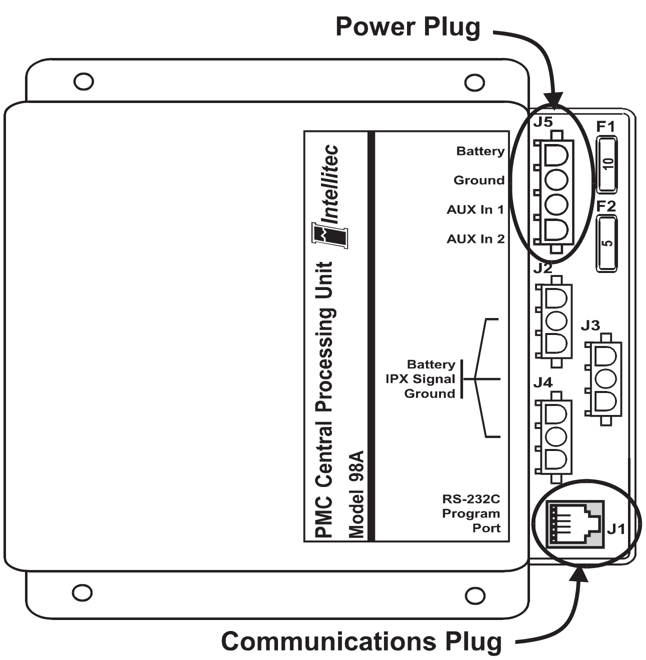
# Chapter 7
# Communicating with the CPU

# Communicating with the CPU

Once the program has been developed, it can be loaded into the PMC CPU for testing. The program will be stored and run from the non-volatile memory in the CPU Module. The program can be loaded into the CPU Module if it is either free standing, or connected in a vehicle system. To do this we have to set up communications between your computer and the CPU module.

### *CONNECTING THE CPU MODULE*

The first step to loading the program is to power the CPU Module and connect it to your computer. If the module is connected in a vehicle, it is obtaining it's power from the vehicle. (*Be sure the battery power is being applied to the module*) If it is not in a vehicle, it can be powered from the power supply included in the programming kit. Plug the cable from the power supply into the four pin plug, J5, on the CPU Module. Plug the *adapter* into a live wall outlet.

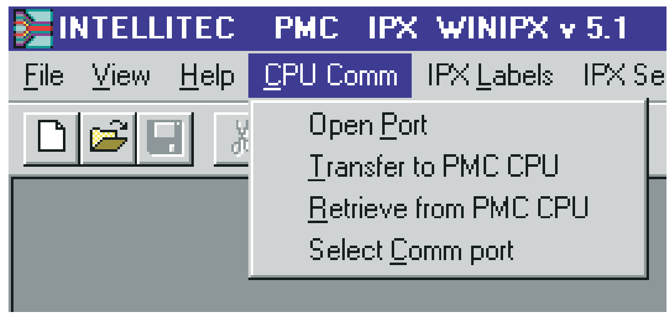



Connect the computer to the CPU Module using the RJ11 telephone cable and the hardware adapter key that comes with the programming kit. Plug the adapter into the serial port of the computer. Plug the RJ11 cable into the adapter and then into the module. The system is now ready to accept the program.

### *COMMUNICATING WITH THE CPU*

Once the CPU has been connected and powered, communications can be established. To start the communications, go to the Main Menu and click on "CPU Comm".

This flyout will appear. This list offers four choices.




### *SELECTING THE COMM PORT*

The software selects Comm Port 1 as the default. This should normally work for most computers. If this setting causes a conflict with some other device on your computer, you can go to this function and select a different port.

### *OPENING AND CLOSING THE PORT*

When the program starts, the port between your computer and the CPU Module is closed. This keeps changes you make to the program from getting into the CPU Module. To communicate with the CPU Module, the port has to be opened. To open the port, click on "Open Port". The port is now open. Only one active PMC program can establish communication with the CPU. Be careful not to open more than one session of PMC on your computer. A second session will not be able to open or close the port.

Once the port is open, it can be closed in a similar manner. To close the port, click on "CPU Comm" and the flyout will show "Close Port", instead of "Open Port". Clicking on this will close the port.

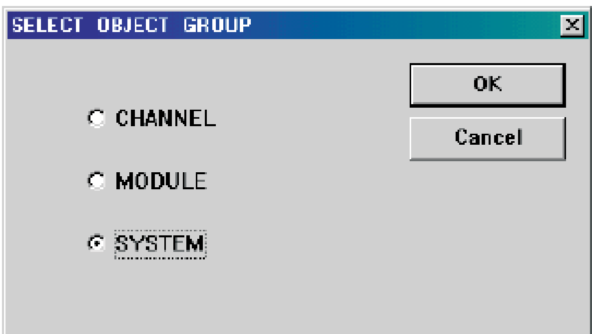
When the port is open, changes you make to Boolean statements occur immediately. This is often useful when working on the vehicle to improve it. The effects of your changes occur as soon as you select OK from the Boolean editor screen. If you do not want changes sent to the PMC CPU, close the port.

# Communicating with the CPU

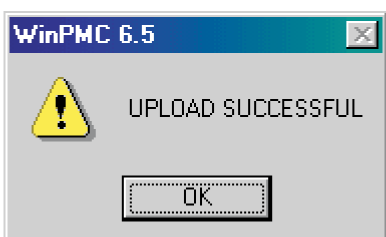
***SENDING THE PROGRAM***

Once the CPU has been connected, the program can be loaded from the computer. If the vehicle file is not active, go to "File" on the task bar and select "Read PMC file". Open the file you wish to download to the CPU.

From the Main Menu, click on "CPU Comm". Open the Port to the CPU by clicking on "Open Port". Move the cursor to "Transfer to PMC CPU" and click. A window will open asking you to select a channel, module, or system.




In most cases you will select system. Click on OK. The program will be transferred from your computer to the CPU. This process will require 20-30 seconds. Once the program has been loaded, a message will come up announcing:



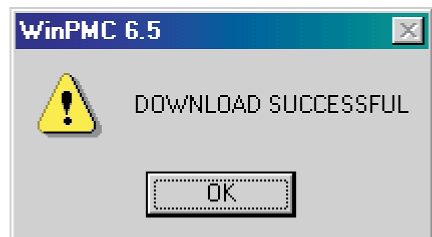

Please wait for this message. Click on OK. The program can now be tested. Your computer can remain connected with the port open. After testing the program, you may want to make some minor changes to it. To do this, simply change the parts that you want and as long as the port is opened, those changes will automatically be loaded into the CPU. Then you can test the changes.

If you wish to prevent the changes from instantly going into the CPU Module, close the port before making any changes.

After making changes, remember to select *"Write PMC File"* from the file menu to save the file.

***RETRIEVING THE PROGRAM***

Once a program is loaded into the CPU, it can be retrieved in a similar manner to loading. Connect the communications cable to the PMC. From the Main Menu, click on "CPU Comm". Open the port. Move the cursor to "Retrieve from PMC CPU" and click. The program that is resident in the CPU Module will be retrieved into your computer. The Select Object Group box will be displayed. Select system and wait for the following box:




Click OK.
This will also retrieve all the information including module and channel labels. If need be the file can now be saved to your hard drive or floppy drive by clicking on the File menu and selecting "Write PMC File".

Once you have retrieved the file from the CPU, you can make changes to the existing program. Remember, that if the port is open, the changes will take effect as soon as you select OK in the screen where you have made the change. *If you don't want the changes to take effect right away, close the port.* If the port is closed while you make the changes, just open the port and select "Transfer to PMC CPU" to make them take effect.

**IMPORTANT!!**
**SYNCHRONIZE THE PC AND PMC CPU**

***WHENEVER YOU CONNECT THE PC TO THE CPU, IT IS IMPORTANT TO SYNCHRONIZE THE TWO UNITS.*** **Open the port and either retrieve from the PMC CPU, or download a program from your computer. This will prevent the computer from running one program and the PMC CPU from running another.**

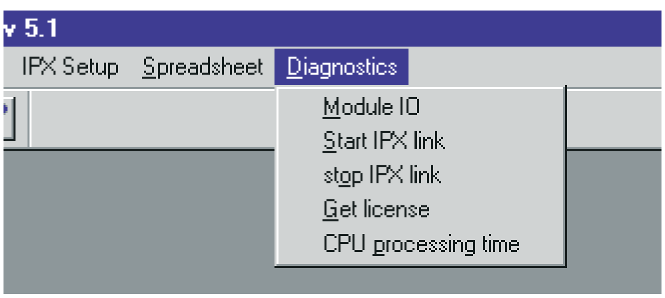
**If you wish to start with the program that is already in the vehicle, retrieve from the CPU.**

# Chapter 8
# Troubleshooting
# Diagnostics

# Troubleshooting Diagnostics

While the system is fairly simple, there can be an occasional "glitch" in a program or system that prevents it from performing the way you intended. Module connection problems can be diagnosed with a voltmeter by measuring the voltage on the communication lines. Measure from the PMC ground wire to the PMC signal wire on the three-wire communications line at the module. This voltage should be approximately 3/4 of the battery voltage. You should also measure battery voltage between the ground wire and the fused battery power wire from the CPU. *(See individual module data sheets for connectors and pins).* The LEDs on the 00-00739-120 and 00-00739-240 PMC signal tester can also be used to verify the proper voltages.

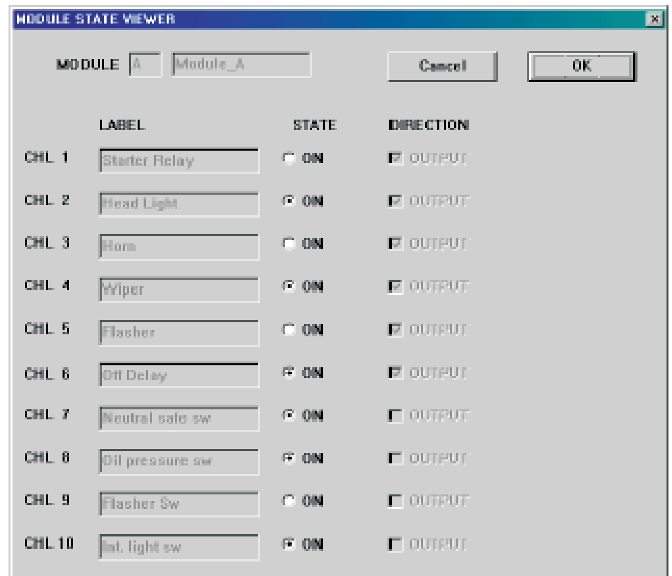
Assuming that the voltages are correct, you can move to diagnosing the software. The system has a number of tools to help you troubleshoot the system in the event that it doesn't do what you expect. To enter the diagnostic mode, click on "Diagnostics". The flyout shows the choices you have.




### *MODULE I/O*

The first choice could be Module I/O. Clicking on this selection will bring up a screen that allows you to select a module I/O to diagnose. Select the module you want and click on "OK". This will bring up a screen that displays the state of each channel, for that module. From this screen, you can see if each channel is doing what you expect. If an output channel is marked with a dot and shown to be on , but the output is not, check the fuses on the module or the wiring to the load. At the output, using your voltmeter or trouble light you can check for voltage at the output module. If you change inputs to the system, you should be able see those inputs and any dependent outputs change.

Note that your computer screen is not updated as fast as the PMC system, so you may see the dot's appearance delayed from the actual event.




### *START PMC LINK/STOP PMC LINK*

This command allows you to stop or start the PMC communications link between the modules of the system. *(This is not the serial link between your computer and the CPU)* This could be helpful if something that the system has turned on is being damaged. You may also want to stop the PMC link if you are programming with the port open, but do not want any of the outputs to turn on. If you select "stop PMC link", outputs that are on will turn off and the system will no longer respond. You will be able to continue programming via the RS232 port. When you select "start PMC link", the system will come back to life. If you find that the system is not responding to inputs, select "start PMC link" from the diagnostics menu.

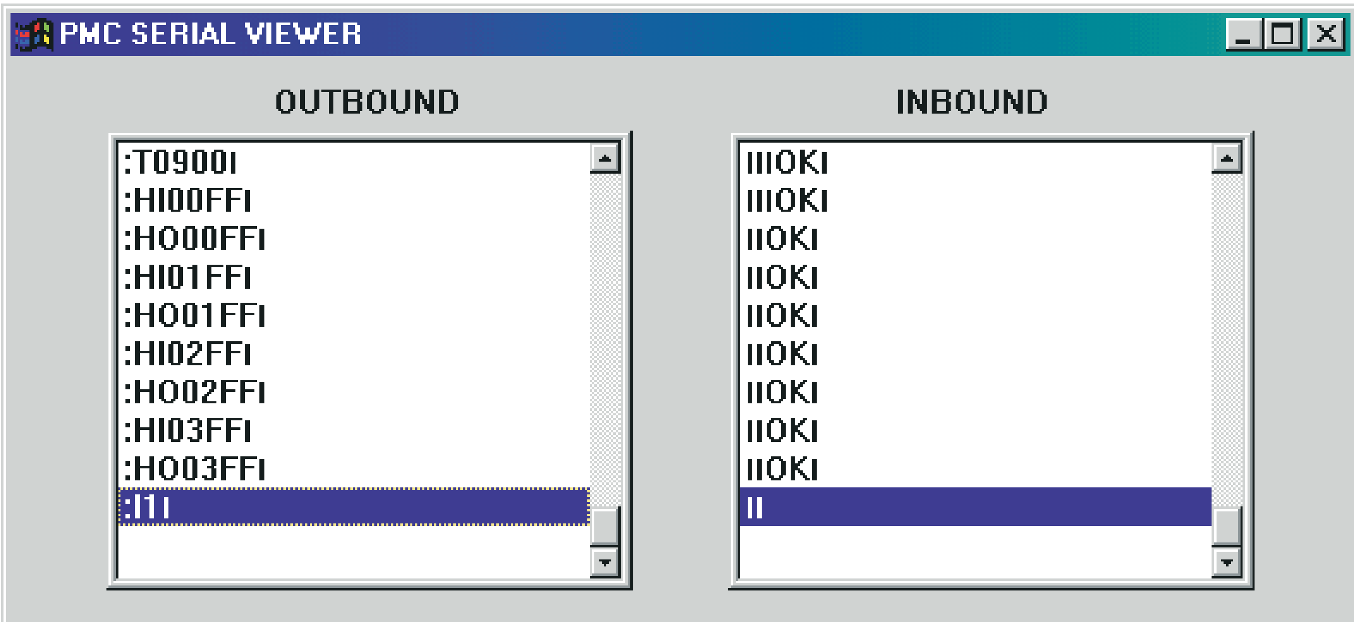
### *CPU PROCESSING TIME*

This command allows you to see how much time the calculations of all the Boolean equations require. If this number exceeds 0.04 seconds, the calculations will exceed the time of one pass of the system. This will cause some of the actions of the system to be slowed.

# Troubleshooting Diagnostics

***SERIAL VIEWER***

When you select serial viewer from the diagnostic menu, a double window will open which will show communications between your computer and the PMC CPU. This is often helpful when you wish to determine if you have established communications or not. If you open the serial viewer when you transfer to, or retrieve from the CPU, you should see lines of code scrolling in the window while the transfer takes place. If you don't see this, check to see if the CPU has power and that the serial cable is connected to the computer and CPU. Check to see that the cables are connected securely. When the transfer is complete the code will stop scrolling. If you select "clear all" from the PMC labels menu with the serial viewer open, you will see code scroll after a small delay. Please wait until it is complete before you perform any other actions.




***TEST EQUIPMENT***

1. Signal Tester (Force inputs and outputs and determine Status of I/O)
2. I/O Status Monitor (View 160 I/O points simultaneously)

*See Chapter 2 for available test equipment.*
*Contact Intellitec* as new equipment may be available.

# Chapter 9
# Boolean Logic
# Examples

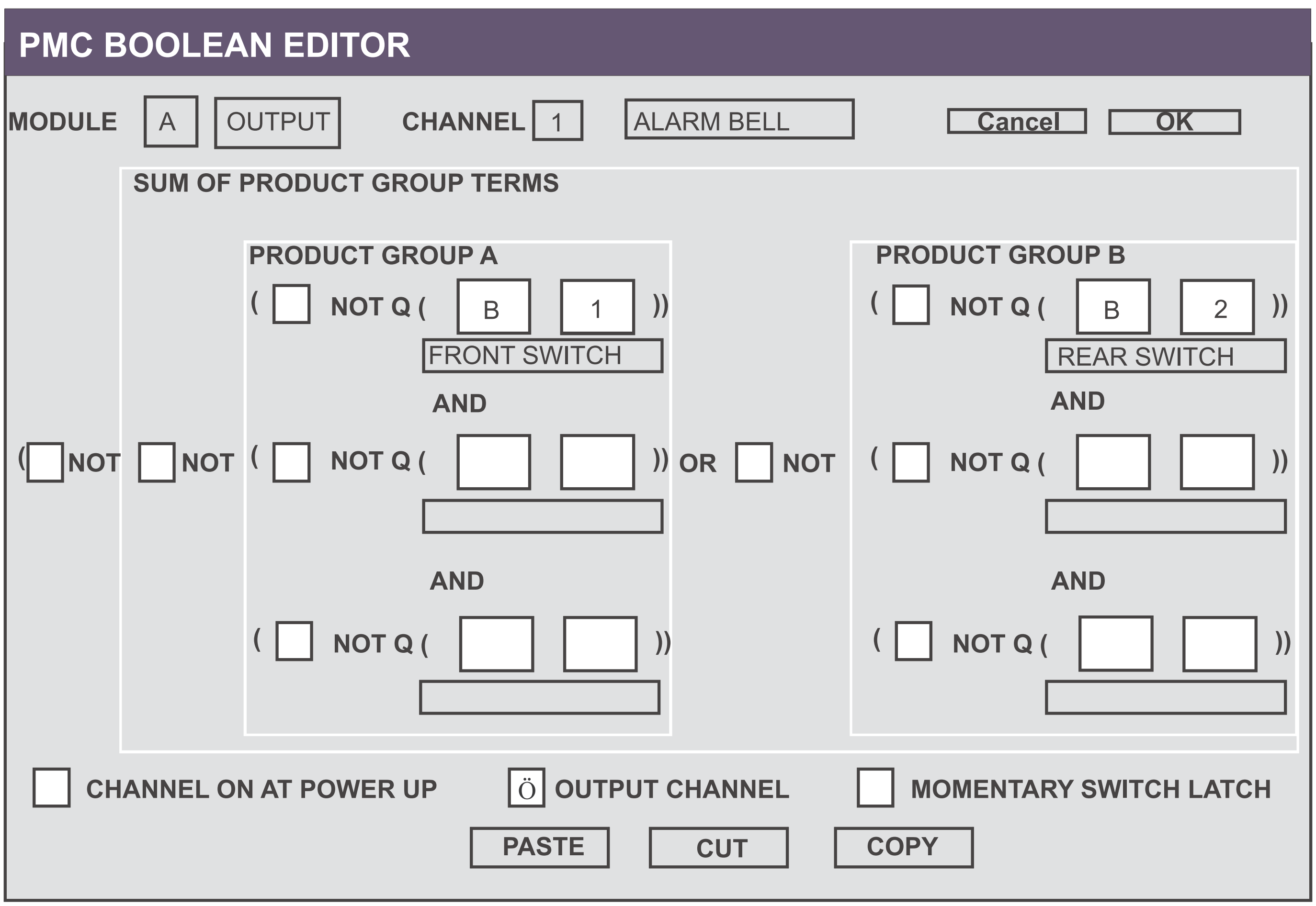
# Boolean Logic Examples

## Simple “OR”

In this example, Load A1 will be on, if, input B1 or B2, or both is on.  B1 and B2 could be any two inputs from any input channel in the PMC system.  A possible application would be an alarm bell that would ring if either one switch, or both switches are on.

**Alarm Bell equals Front Switch or Rear Switch**

**A1 = ALARM BELL OUTPUT**
**B1 = FRONT SWITCH**
**B2 = REAR SWITCH**
**Formula:  A1 = B1+B2**



# Boolean Logic Examples

## Four Input “OR”

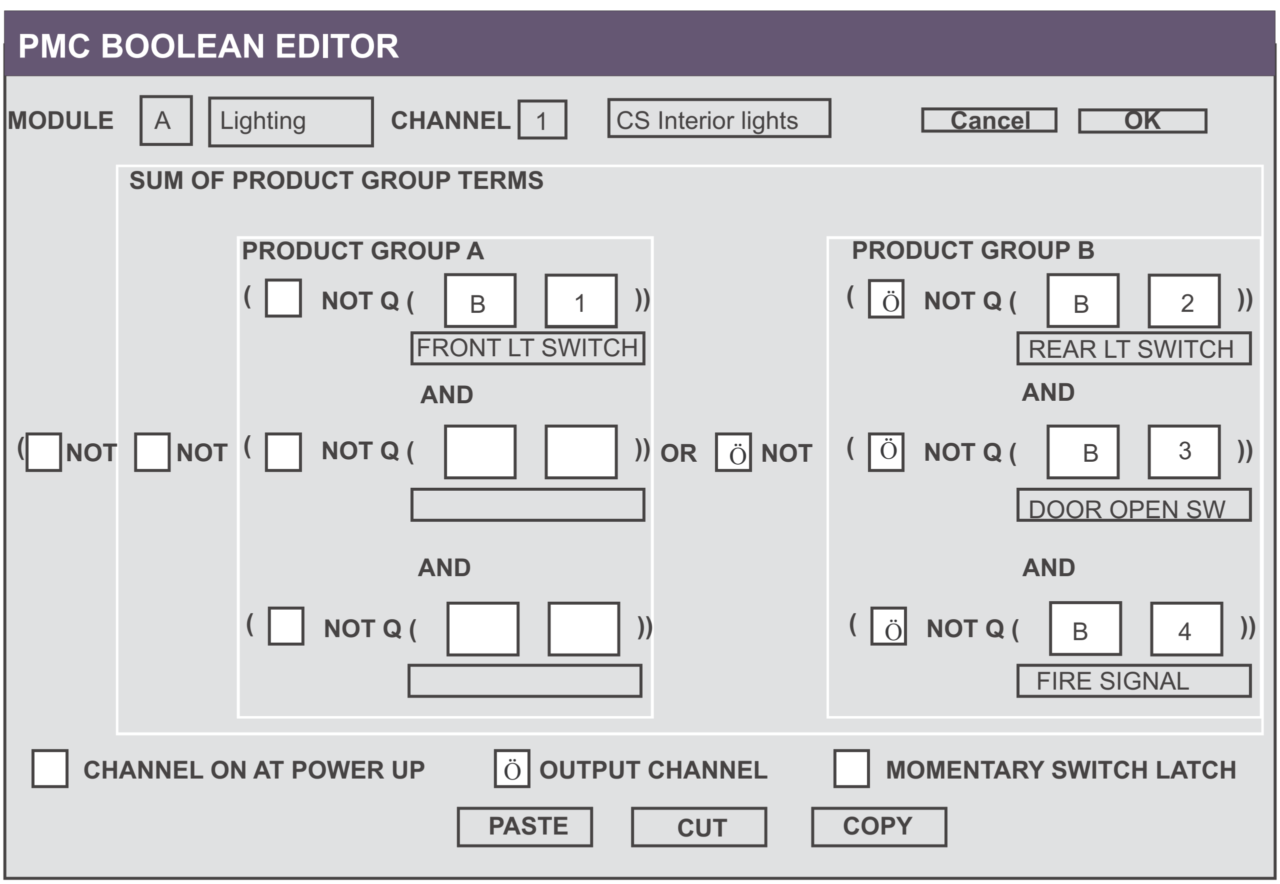
In this example, Load A1 will be on, if, input B1, B2, B3 or B4 is on, or if any combination.   B1,2, 3, and 4 could be any four inputs from any input channel in the PMC system.

**A1 = CS INTERIOR LIGHTS**
**B1 = FRONT LIGHT SWITCH**
**B2 = REAR LIGHT SWITCH**
**B3 = DOOR OPEN SWITCH**
**B4 = FIRE SIGNAL**

**Formula:** **A1 = B1+B2+B3+B4**
**Or in other terms**
**A1 = B1+!(!B2*!B3*!B4)**

*For a detailed description of the logic behind this function please refer to the PMC users manual and DeMorgan’s Theorems.*

The screen shown below “NOTs” the inputs and outputs of B2, B3, and B4 to create the “OR” function from the “AND” function. If more than 6 inputs must work in an “OR” relationship, a virtual channel (Q module) can be used.



# Boolean Logic Examples

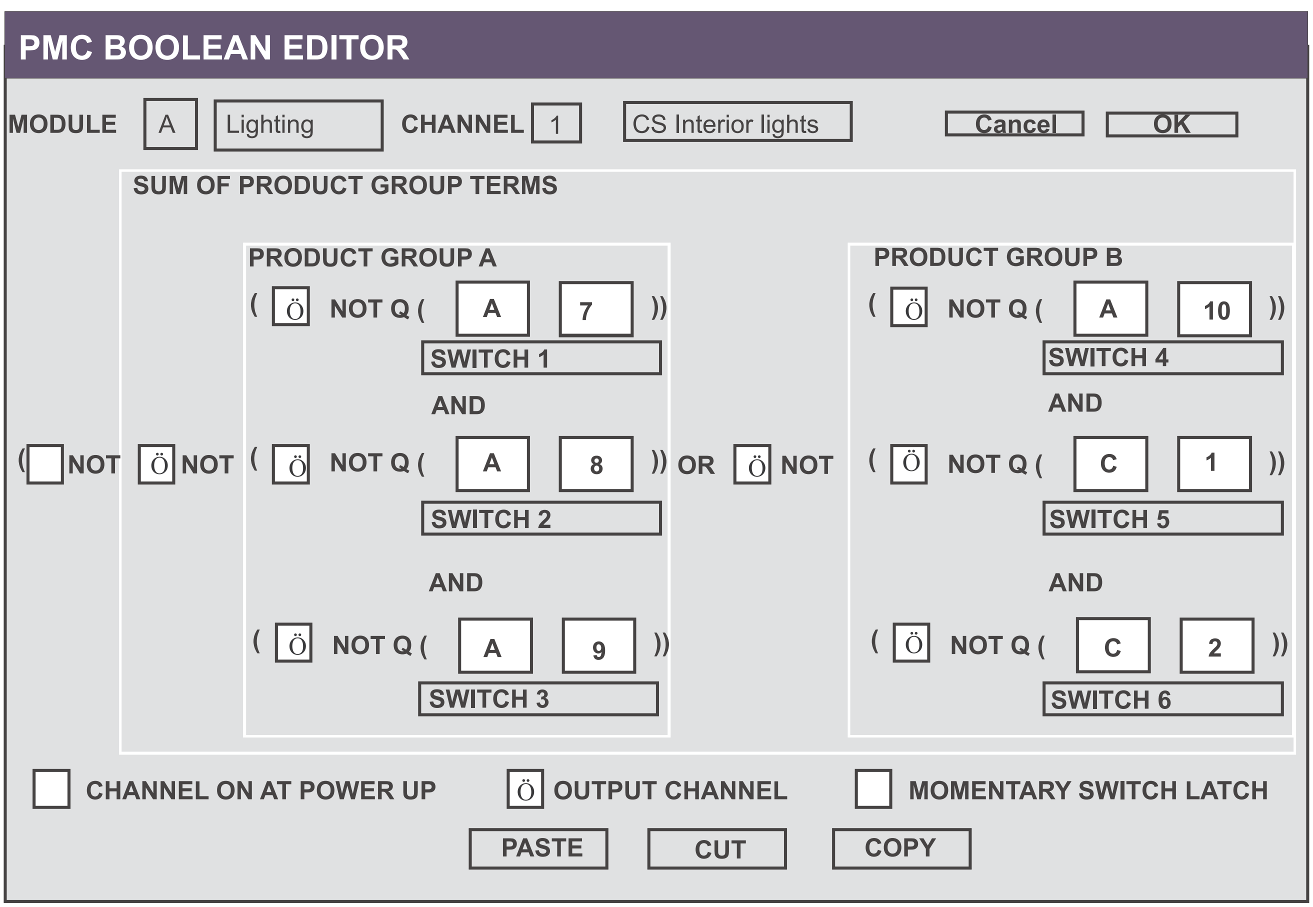
## Six Input "OR"

In this example, Load A1 will be on, if, input A7, A8, A9, A10, C1 or C2, or any combination is on.  The six inputs could be any six  inputs from any input module, or input channel in the PMC system.

**Formula:** **A1 = A7+A8+A9+A10+C1+C2**
**Or in other terms**
**A1 = !(!A7*!A8*!A9)+!(!A10*!C1*!C2)**

*For a detailed description of the logic behind this function please refer to the PMC Users Manual and DeMorgan's Theorems.*

The screen shown below "NOTs" the inputs of A7, A8, A9, A10, C1, C2  and "NOTs" the product groups, to create the "OR" function from the "AND" function.  If more than 6 inputs must work in an "OR" relationship a virtual channel (Q module) can be used.



# Boolean Logic Examples

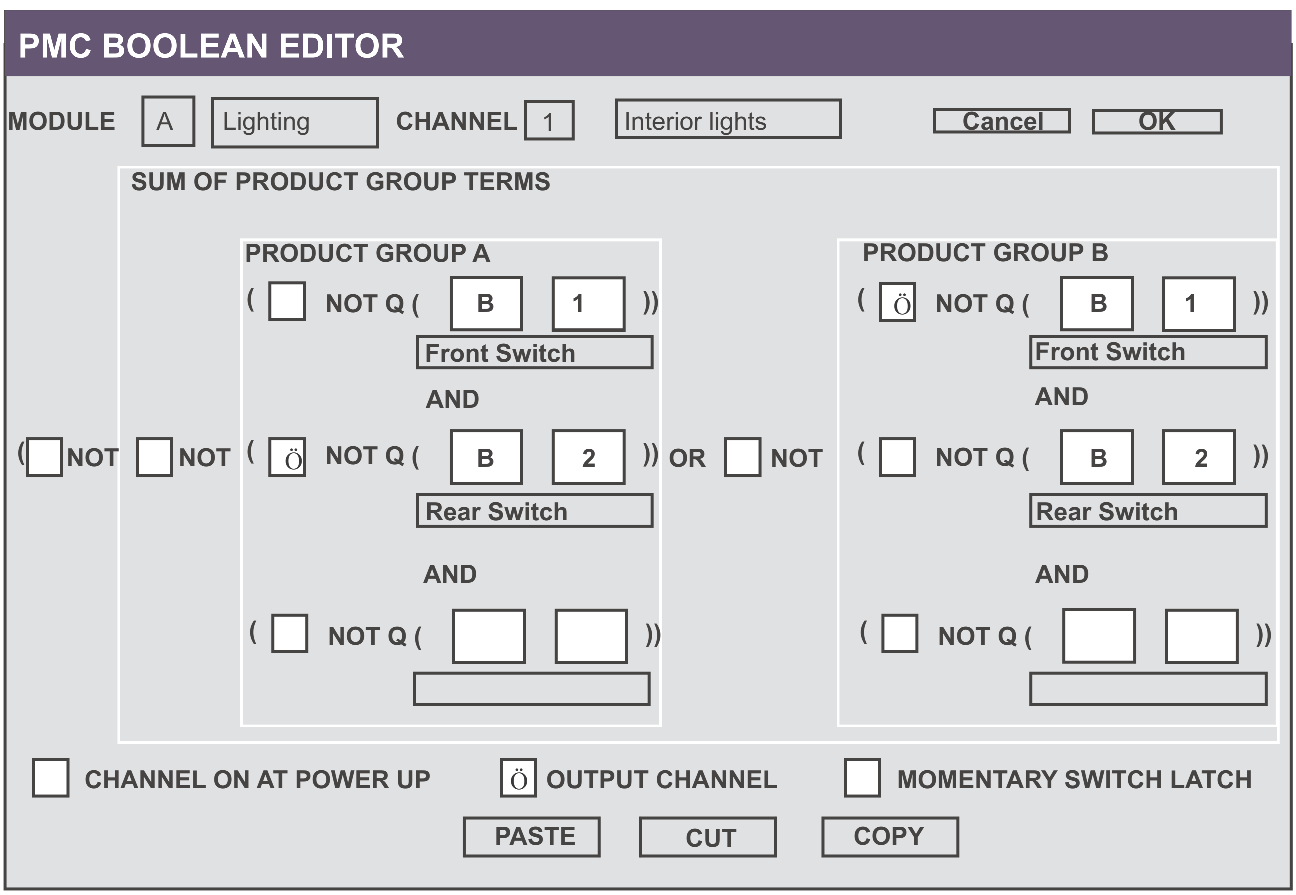
## Exclusive “OR”

In this example load A1 will be on if input B1, or B2  is on, but not both.  B1,and B2 could be inputs from any input module or input channel in the PMC system.

The exclusive “OR” could be used for a light switch at each end of a vehicle.  Either switch will turn the light on or off.

**Formula:** **A1 = (B1*!B2)+(!B1*B2)**

**A1 = INTERIOR LIGHTS**
**B1 = FRONT SWITCH**
**B2 = REAR SWITCH**



# Boolean Logic Examples

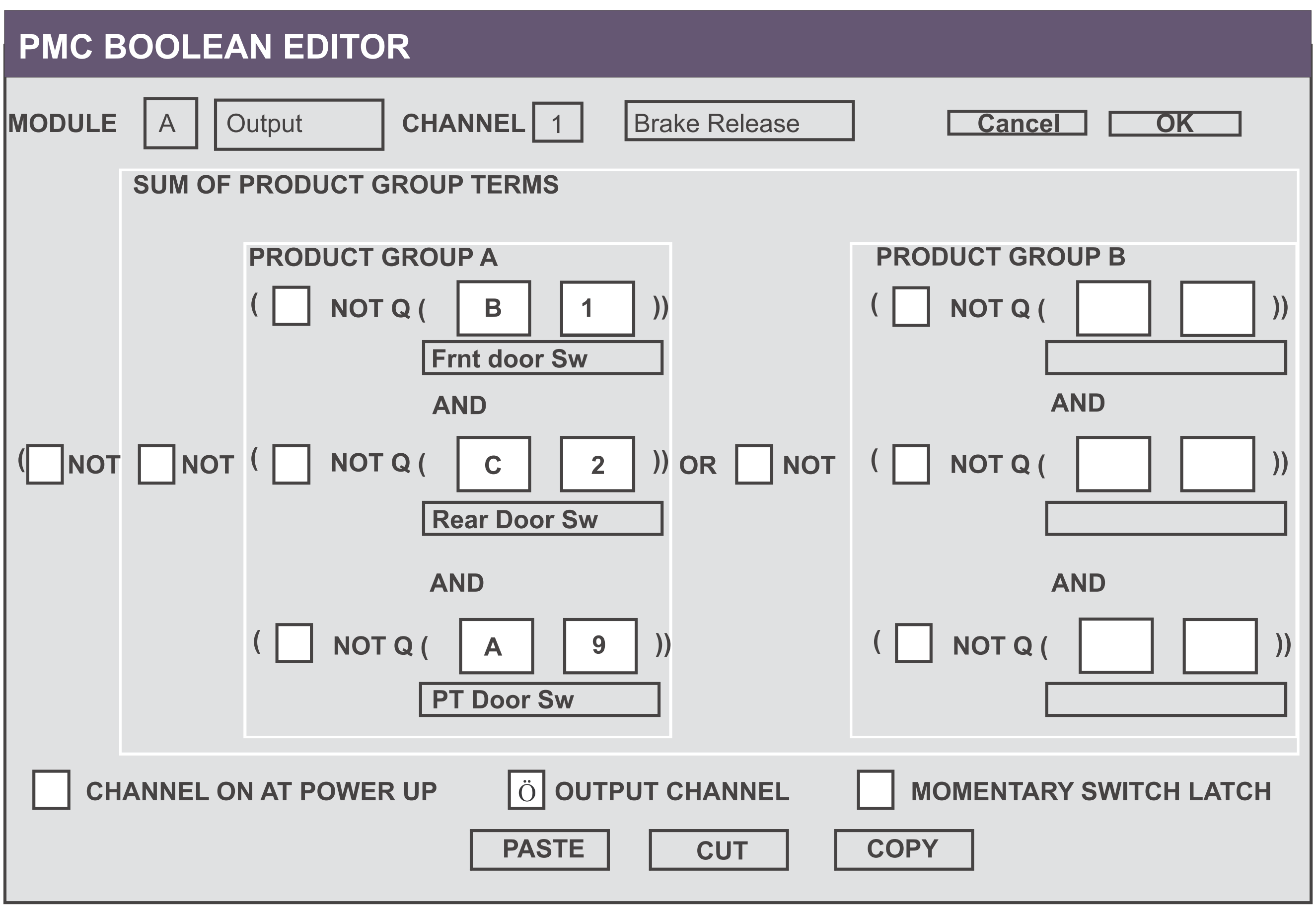
## Simple “And”

In this example load A1 will be on if input B1 and C2 and A9 are on.  B1, C2,and A9 could be any three inputs from any 3 input channels in the PMC system.  A possible application would be 3 door switches which must be closed to release the park brake.

If more than 3 inputs need to be in an “AND” relationship *see DeMorgan’s Theorems in chapter 3,* or use a channel from the virtual module Q.

**Formula:** **A1 = B1*C2*A9**

**A1 = OUTPUT**
**B1 = FRONT DOOR CLOSED SWITCH**
**C2 = REAR DOOR CLOSED SWITCH**
**A9 = PT DOOR CLOSED SWITCH**



# Boolean Logic Examples

## SIX INPUT “AND”

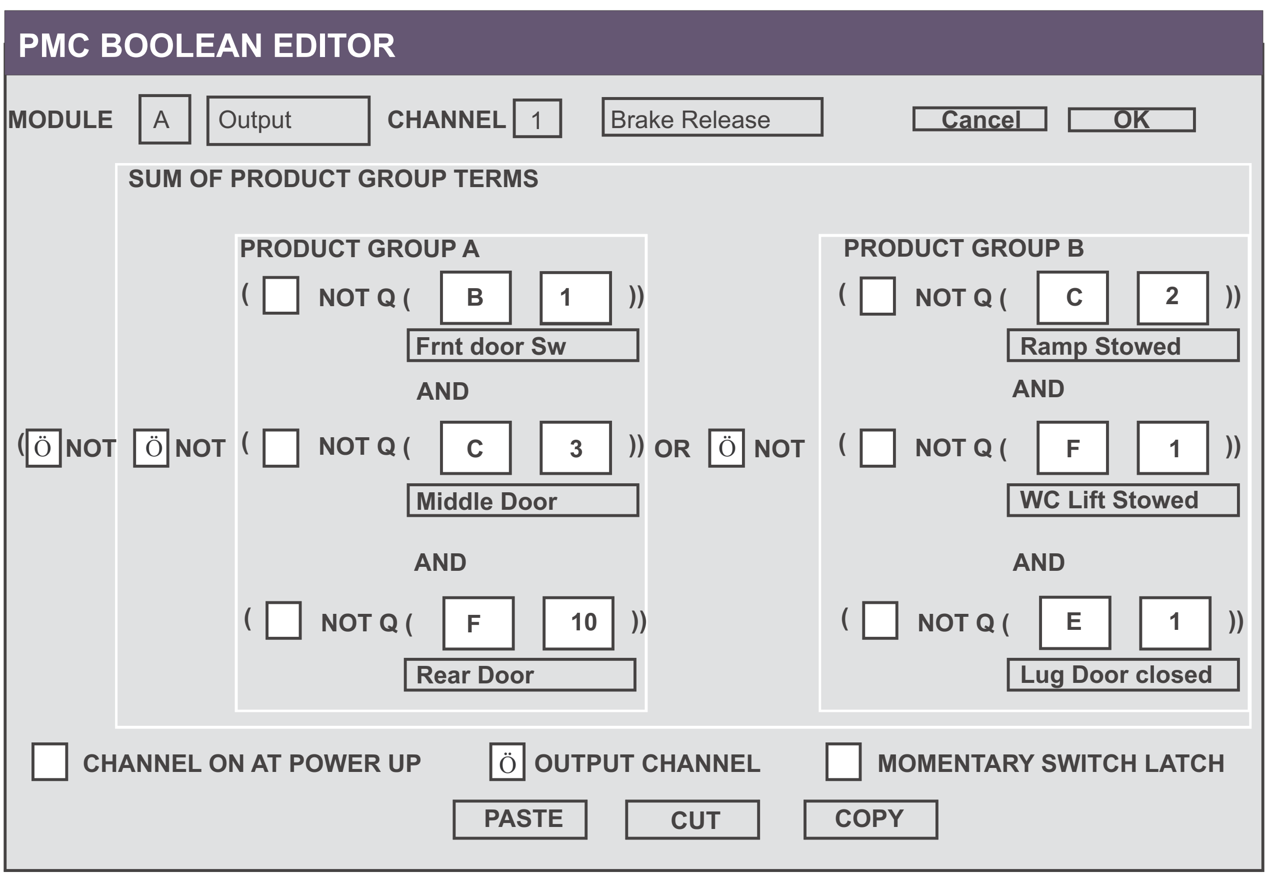
Looking at the Boolean editor screen it would appear that a 3 input “AND” function would be the most that is possible. Using DeMorgan’s theorem, we can create a 6 input “AND” without using a virtual module.

**A1 = B1*C2*C3*F1*F10*E1**
**or in other terms**
**A1 = !(!(B1*C3*F10)+!(C2*F1*E1))**

**A1 = OUTPUT**
**B1 = FRONT DOOR CLOSED SWITCH**
**C2 = RAMP STOWED SWITCH**
**C3 = MIDDLE DOOR CLOSED SWITCH**
**F1 = WHEEL CHAIR LIFT STOWED**
**F10 = REAR DOOR CLOSED SWITCH**
**E1 = LUGGAGE DOOR CLOSED SWITCH**
*Any input from any module may be used in the And function*

*For a detailed description of the logic behind this function please refer to the PMC users guide and DeMorgan’s Theorems.*

The screen shown below “NOTs” all of the outputs to create the AND function. If more than 6 inputs must work in an “AND” relationship, a virtual channel (Q module) can be used.



# Boolean Logic Examples

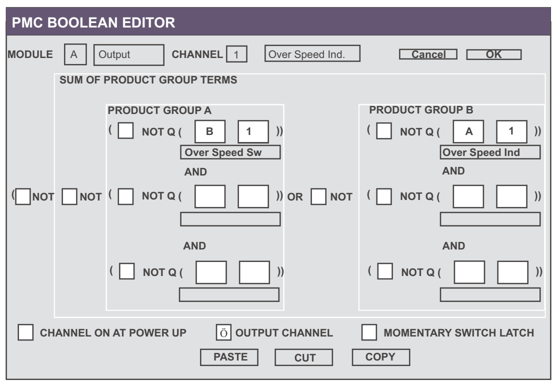
## LATCHED OUTPUT

**A1 = OVER SPEED INDICATOR LAMP OUTPUT**
**B1 = OVER SPEED SWITCH**
**B2 = LATCH CLEAR SWITCH**

In this example, once the output turns on it will remain on. The latched output is often used as a part of other functions, such as timed on delays and flashers. You may choose to latch an output on until a service technician or timer pulse clears it.

**A1=B1+A1**

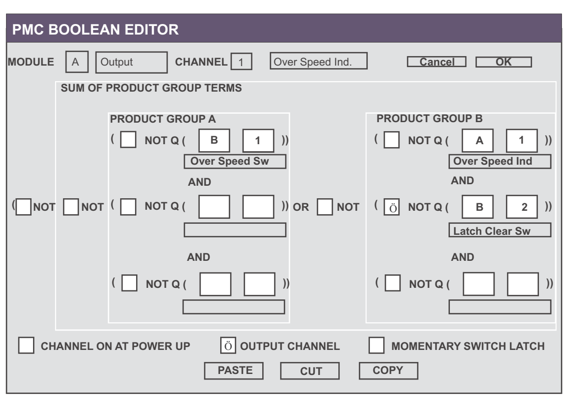
The output A1 will be on when switch B1 is on or when A1 (itself) is on. This statement will cause output A1 to latch on. There is however no way to turn it off because once it is on it is latched on.




**A1 = B1+(A1*!B2)**

In this example output A1 will latch on when switch B1 is pressed momentarily and switch B2 is off. The statement reads A1 equals (A1 and not B2) or B1. If B1 and B2 were momentary normally open switches, the load A1 would latch on when B1 is closed and would latch off when B2 is closed.

***NOTE*** Momentary push-button switches may be used with the PMC system and will operate with an assigned output as a push/on, push/off switch. In the boolean editor screen for the input channel, check the momentary switch latch box. This is the only time you will use the boolean editor screen for an input channel.



# Boolean Logic Examples

## FLASHER

**R1=B1**
**A3=(A3*!S1*B1)+(!A3*S1*B1)**

**R1=TIMER**
**B1=FLASH SWITCH**
**A3=FLASHING LAMP OUTPUT**
**S1=DONE PULSE OF TIMER R1**

A timer is needed to create a flasher. In the boolean screen to the right, timer channel R1 is activated by switch B1. When switch input B1 is turned on, timer R1 is running.

By clicking “PMC SET UP” and selecting “Timer Set UP” the screen to the right will be displayed. Timer channels 1-10 are shown. For the flasher example, we will be using timer R1. Enter the flasher time you would like in the column marked reload. In this example the timer is set for 0.3 seconds.

The light will be on for .3 seconds and off for .3 seconds. The duty cycle will be 50%. To change the on off time just change the entry on this screen.

In this example, module A, output channel 3, is being used for the flasher. S1 is the timer done output for timer R1. *(See the PMC users guide for a more detailed description of timers)*. A pulse occurs on output S1 at the end of each time period. In this example an exclusive “OR” function is used. The output A3 may be on only when A3, or S1 is on, but not both. When A3 turns on, the boolean causes it to latch on. When the time pulse from S1 comes on, the boolean causes A3 to turn off.

We have included an “AND” function with the switch B1 to ensure that when the switch is off the light will be off. If this were not done, the light might remain on, depending upon when the switch B1 was turned off

# Boolean Logic Examples

## OFF DELAY
## (INTERIOR LIGHT DELAY)

An off delay may be used to turn a load off some time period after an event. For example, turn a light off 10 seconds after a door closes.

In this example load A will turn on immediately after switch B1 is turned on. When B1 is turned off the light will remain on for 10 seconds and then turn off.

**Q1 = Q2**
**Q2 = B1**
**A1 = T1+B1+Q1**
**R1 = (!Q2*Q1) + (T1*!B1)**
**SET TIMER R1=10 SECONDS**

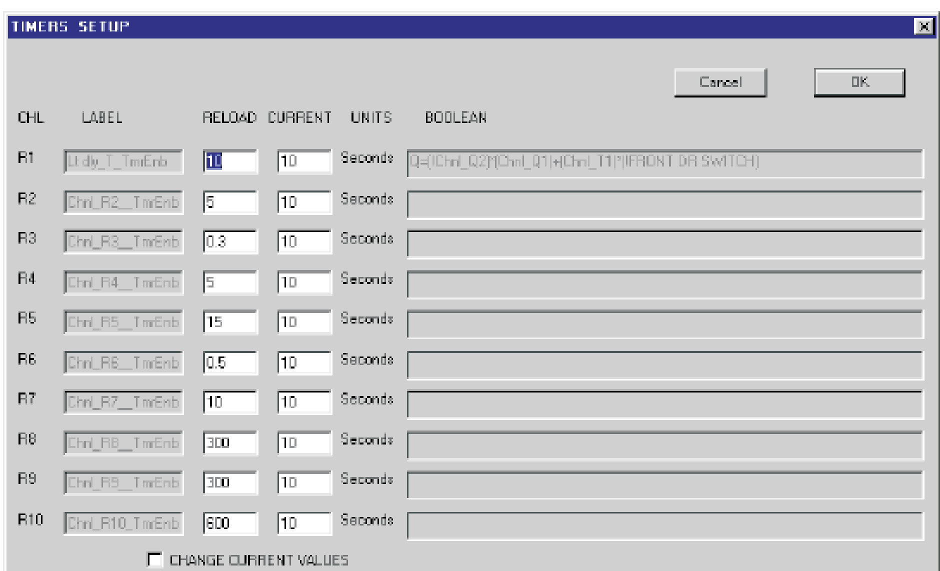
**Q1 AND Q2 ARE VIRTUAL MODULES**
**A1 = OUTPUT**
**R1 = TIMER**
**T1 = THE RUN OUTPUT OF TIMER R1**
**B1 = SWITCH**

The statement Q1=Q2 and the statement Q2=B1 creates a trigger pulse that occurs when the switch B1 is opened. This is also referred to as edge detection.

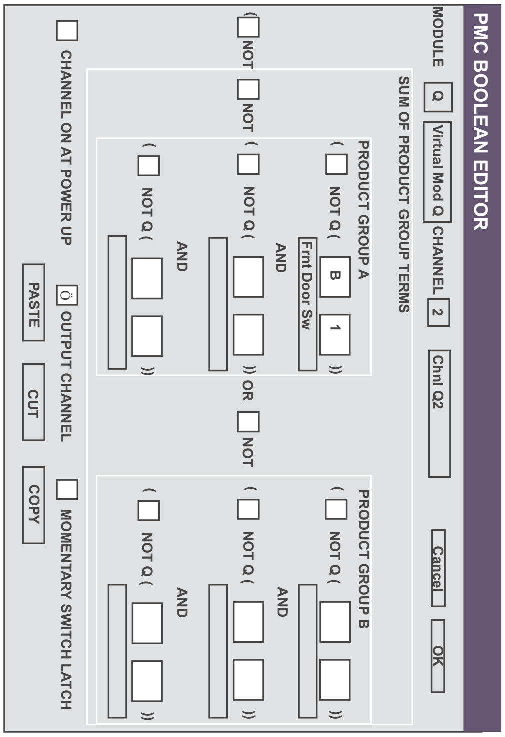
The load A1 will be on when T1, or B1, or Q1 is on. Q1 is necessary to prevent the output A1 from flashing during the time the switch is turned off and when the timer takes over.

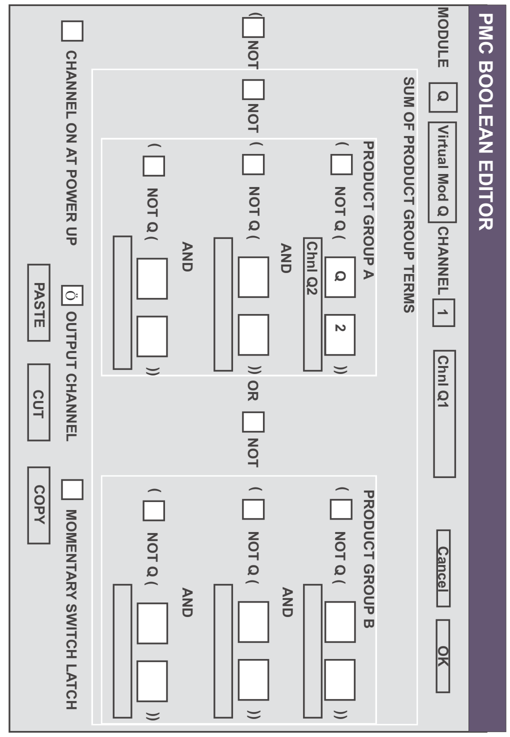
The timer R1 will run when Q2 and Q1 are on, or when T1 is on and B1 is off. B1 is added to ensure that the timer is reset if the door is opened and closed during the timer delay.

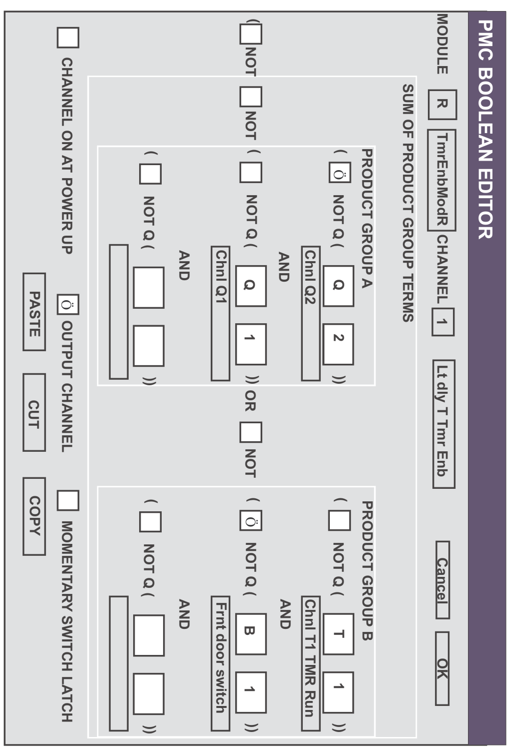
For further clarification see the following boolean screens.

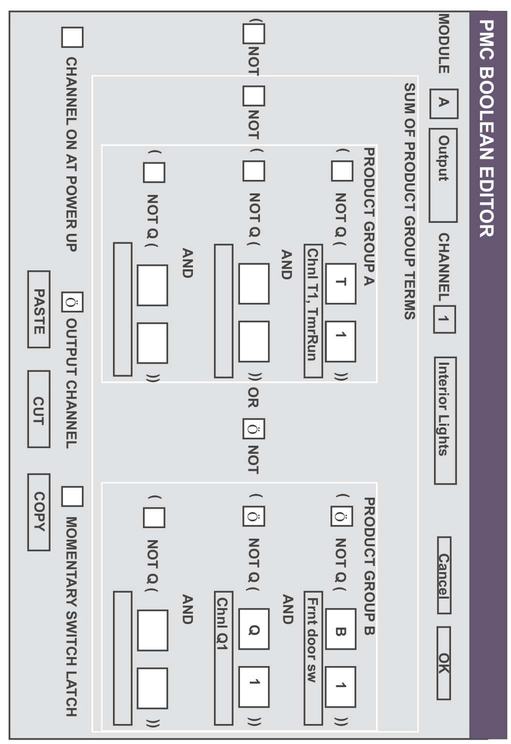


# Boolean Logic Examples



# Boolean Logic Examples

## ON DELAY WITH LATCH

An "On Delay" turns the load on, some time period after an event occurs. For example, you may have a transient condition that occurs for short periods of time and wish to delay a warning lamp until the condition has persisted for some time period.

**R1 = B1**
**A1 = (B1*S1)+(A1*B1)**

**R1 = TIMER CHANNEL 1 ENABLE**
**A1 = OVER HEAT IND. (OUTPUT)**
**B1 = OVER HEAT SW**
**S1 = TIMER R1'S DONE OUTPUT**

In this example switch B1 starts timer R1.

Output A1 will turn on when switch B1 and the timer done output S1 are on, or when A1 is on and switch B1 is on.

The output can not turn on unless B1 remains closed and until the timer times out. (Done pulse S1 occurs.) Once the output A1 is turned on, it latches on until switch B1 is turned off because of the statement +(A1*B1).

Latching the output A1 on is necessary because the timer done output is a 40 ms pulse. Without the latch the indicator light would flash on for 40 ms and then turn off.

The time period is set by using the timer setup screen. In this example you enter the appropriate time into timer R1.

# Boolean Logic Examples

## DOOR OPEN/CLOSE WITH LOCK

In this application, there is an air operated door controlled by a solenoid actuated shuttle valve. The shuttle valve has two control coils. One coil positions the valve to open the door and the other positions it to close the door. The coils do not need to be kept energized to hold the door in position. The designer would like to use a single push button on the exterior of the door and another on the interior of the door.

Since the solenoid coils do not need to be energized continuously and push buttons will be used as inputs to initiate the action, it was determined that the PMC outputs would need to be held on just long enough to ensure that the valve was properly positioned and then turned off. In this example, we will use a timer to keep each of the PMC outputs on long enough to perform the mechanical operation and then shut them off.

When either push button is pressed the door will open or close, with one exception. When the interior button is used to close the door, the exterior push button will be disabled, in effect locking the door. When the interior button is used to open the door the exterior button is enabled and may be used to close and open the door.

Since this application is not a high security application, it was deemed necessary to have a means of opening the door from the outside. If the door is closed from the inside, it can be opened from the outside by pushing and holding the exterior button for 3 seconds, after which the door will open. A PMC timer will be used to establish this time. The time can be set to any value that is comfortable.

The programming of this function is a bit complex, but can be accomplished easily by following the steps outlined below. If assistance is needed please feel free to call Intellitec for help.

**CHANNEL**

| | |
|---|---|
| **A1 = DOOR OPEN OUTPUT** | **Q6 = VIRTUAL OUTPUT CHANNEL** |
| **A2 = DOOR CLOSE OUTPUT** | **Q8 = VIRTUAL OUTPUT CHANNEL** |
| **C1 = INSIDE SWITCH INPUT** | **Q9 = VIRTUAL OUTPUT CHANNEL** |
| **C2 = OUTSIDE SWITCH INPUT** | **Q10 = VIRTUAL OUTPUT CHANNEL** |
| **Q1 = VIRTUAL OUTPUT CHANNEL** | **R1 = THE ENABLE TO START TIMER 1** |
| **Q5 = VIRTUAL OUTPUT CHANNEL** | **R3 = THE ENABLE TO START TIMER 3** |

Using the select channel screen, select each of these channels and enter the following Boolean statement for each channel.

| Channel | Boolean Logic Statement |
|---|---|
| A1 = | Q8*T1 + S3 |
| A2 = | !Q8*T1 |
| Q1 = | (A2*C1) + (Q1*!A1) |
| Q5 = | (C1*!Q6) + (C2*!Q6*!Q1) |
| Q6 = | C1 + (C2*!Q1) |
| Q8 = | (Q5*!Q8) + (!Q5*Q8) |
| Q9 = | Q10 |
| Q10 = | C2 |
| R1 = | Q5 + T1 |
| R3 = | C2 |

Don't forget to go to PMC setup and select timer set up. Enter the delay time in seconds for timer 1 and timer 3 here.

You may of course use different channels to accomplish this. It is important however, to consider the following. Channels Q10, Q9, and Q8 produce an edge detected pulse when the switch is operated. It is important that if different channels are selected that they are written in this order. You may for example have used Q4, Q3, and Q2 instead. In this case substituting in each equation Q4 for Q10, Q3 for Q9 and Q2 for Q8.

If virtual module Q is not available you may use any unused module address as a virtual module.

# Boolean Logic Examples

## 1-3 INPUT, MIRROR HEAT, DEFROST TIMER, ONE SHOT TIMER

In this application, the PMC user would like to have an output turn a heating element on and then off after a period of time, if 3 inputs are present. In the event that one or more of the inputs is removed, the output will stay on until the timer times out.

If all three inputs are present when the timer times out the output will turn off. To start another cycle one of inputs must be removed and then all 3 inputs must be re-applied.

**The Boolean equations to accomplish this are as follows:**

**A1 = THE HEATER OUTPUT**
**B1 = INPUT (MASTER SWITCH)**
**B2 = INPUT (DEFROST FLAG)**
**B3 = INPUT (DEST. SIGN THERMO SWITCH)**
**R1 = TIMER 1 ENABLE**
**S1 = TIMER 1 DONE OUTPUT**
**T1 = TIMER 1 RUN OUTPUT**
**Q1 AND Q2 ARE VIRTUAL CHANNELS**

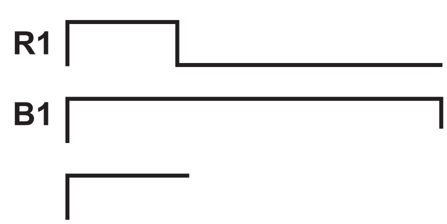
**Q1 = S1 + (Q1*Q2)**
**Q2 = (B1*B2*B3)**
**R1 = (B1*B2*B3*!Q1) + T1 REDUCING TERMS R1=(Q2*!Q1)+T1**
**A1 = T1 + (A1*!Q1)**
**T = SET TIME**

Set the time interval by clicking on PMC Setup, then Timer Setup. Enter the time in seconds for timer R1.

If you would like to create a one shot timed output, that is triggered from a single input, enter the following Booleans. This example should not be used for an interior light delay as the light would turn off, even if the switch was still on. See page 9-9 for an interior light delay.

**A1 = THE OUTPUT**
**B1 = INPUT SWITCH**
**R1 = TIMER 1 ENABLE**
**S1 = TIMER 1 DONE OUTPUT**
**T1 = TIMER 1 RUN OUTPUT**
**Q1 = VIRTUAL CHANNEL**

**R1 = (B1*!Q1) + T1**
**Q1 = S1 + (Q1*B1)**
**A1 = T1 + (A1*!Q1)**
**T = SET TIME**



# Boolean Logic Examples

## 5 STEP SEQUENCER

This example creates a 5 step sequence using a timer and ten virtual channels. The example is written using real channels so that the outputs can be displayed on the status monitor. Any group of 10 free channels, virtual or real, may be used and any available timer may be used.

### *CHANNEL DEFINITION*

**A3 = MASTER SWITCH**
A3 triggers the sequence and could be any channel you wish to use.

C5 through C1 are virtual outputs that will sequence on one at a time, when A3 is turned on. They will sequence off one at a time after A3 is turned off. The first channel to come on after A3 is turned on is C5 followed by C4 etc. . Set the timer using the timer set up menu to set the interval between steps.

R1 is the timer enable for timer 1. The timer determines the time between sequence steps. You may of course use any available timer.

**S1= TIMER DONE PULSE** This should correspond to the timer # that you are using. In the "PMC set up", "Timer set up" screen, set the time you would like between events.

C6-10 are virtual channels that allow C1-C5 to cycle off after they have been turned on.

C5 is the first virtual load to come on after Switch A3 is turned on and the last to turn off after A3 is turned off.

By “AND”ing C1 through C5 with another switch , loads can be sequenced on and off.
For example a boolean that stated "**Light Bar = C1 AND light bar switch"** would cause the light bar to turn on when the Master (A3) is on and only after items “AND”ed with C5-C4 came on. In other words the light bar would be the last to turn on in the sequence and the first to turn off.

**Boolean expressions to create the sequencer are as follows.**

**R1 = (A3 * !C1) + (!A3*C5)**
**C1 = (A3*S1*C2) + (C1*!C6)**
**C2 = (A3*S1*C3) + (C2*!C7)**
**C3 = (A3*S1*C4) + (C3*!C8)**
**C4 = (A3*S1*C5) + (C4*!C9)**
**C5 = (A3*S1)+(C5*!C10)**
**C6 = !A3*S1**
**C7 = !A3*S1*!C1**
**C8 = !A3*S1*!C2**
**C9 = !A3*S1*!C3**
**C10 = !A3*S1*!C4**

# Boolean Logic Examples

## MOMENTARY PUSH AND HOLD ON, PUSH AND HOLD OFF

In this application a momentary push button is used to turn an output on when the button has been held for a predetermined period of time. Once the output is on, pushing and holding the button will turn the output off after the same predetermined time.

**A1 = PUSHBUTTON (DO NOT CHECK MOMENTARY SWITCH LATCH BOX)**

**R1= TIMER 1 ENABLE**

**S1= TIMER DONE PULSE**

**B1= OUTPUT**

Write the Booleans as follows:
**R1=A1**
**B1= (!B1*S1)+(B1*!S1)**

In timer set up adjust the time in timer 1 for the button hold time you would like.

### *OPERATION*

When A1 is pressed and held the timer R1 runs and a pulse is produced on S1 at the end of the time period. If A1 is released prior to the end of the time period the timer stops running and no pulse appears on S1.

When the S1 pulse occurs B1 will turn on because !B1*S1 is true. The next time the boolean is evaluated, 40ms later, the pulse S1 will be gone and the statement B1 *!S1 will be true. This causes B1 to latch on.

When the button is pressed and held again a pulse will appear on S1 when the timer is done. At this time !B1*S1 is false, and B1*!S1 is false. This causes B1 to unlatch.

You may notice that this application is the same as a flasher. If the button is held continuously the output will turn on and off and on and off.

# Boolean Logic Examples

## EDGE DETECTING A SWITCH

Normally when a switch is pressed, the PMC system will react to the switch as long as it is held. In some applications you may wish the PMC system to ***react only at the moment the switch is first pressed or released.*** In these special instances, it is not important to the application that the switch is on, only that the switch changed from off to on or on to off. Edge Detection Booleans must be used to detect the ***transition*** of a switch, either to the on or off state.

In order to accomplish this, we take advantage of the fact that the PMC CPU processes one Boolean at a time, in order, from A1 to Q10, and then starts at A1 again. Therefore, if we have a switch at F1, we can use two other virtual channels to create edge detection. ***Any two channels can be used as long as the order of the channels is maintained,*** however, for simplicity, in this example we will use F1, F2, & F3.

***Boolean Expression*** **(detects when a switch is first turned on)**
F1 will be the switch input and as such will not require any Booleans.
(A Switch will physically have to be wired to Module F Input 1)

**F3 = F1** In this Boolean an output F3 will be simply and directly affected by the F1 switch.
(Although this channel is only used as a virtual channel for edge detection, if a test light were connected to an F3 output, the light would turn on.)

Now a Boolean is placed in between these two channels.
**F2 = F1 * !F3**

As soon as the switch (F1) is pressed F2 will be on because F1 is on and F3 is not on. The following channel F3, has not yet had a chance to process so that F3 will still be off. Immediately following F2, the CPU will process and calculate F3. F3 will turn on because F3 equals the switch F1. ***The next time thru*** the Boolean calculation loop, F2 will turn back off because of the statement not F3. In this example F2 will only be on for a single Boolean processor loop (approximately .040 seconds).

**Boolean Expression (detects when a switch is first turned off)**
By changing nothing else except the Boolean for F2, PMC can detect when a switch is released:
**F2 = !F1 * F3**

**Boolean Expressions (detects when a switch is first turned on or off)**
In this example any change in the switch position will be detected.

By combining the two Booleans for F2 above, PMC can detect either transition of a switch:
**F2 = (F1 * !F3) + (!F1 * F3)**

***SUMMARY***

**Boolean Statements - Leading edge detection**
F1=input
F2= (edge detection pulse occurs here)
F3=virtual channel

F3=F1
F2= F1*!F3 (F2 will turn on for 0.040 seconds when input F1 first turns on)

**Trailing edge detection**
F3=F1
F2= !F1*F3 (F2 will turn on for 0.040 seconds when input F1 turns off)

**Leading or trailing edge detection**
F3=F1
F2 = (F1 * !F3) + (!F1 * F3) (F2 will turn on for 0.040 seconds when input F1 turns on or off)

# Boolean Logic Examples

## USING EDGE DETECTION

***MASTER ON/OFF SWITCH***

This is a practical application, which requires a single momentary Master Switch to turn many outputs off and then back to their original settings. What will be accomplished is that if the Master Switch is pressed and held for 2 seconds, all lights will turn off. If the Master Switch is pressed again the lights will come on. While the Master is on, individual lights can be turned on and off.

(Note this example uses “Edge Detection”, “Latching”, “Virtual Channels” and “Timers”. It is recommended that these functions be reviewed. A working knowledge of these applications is necessary before proceeding.)

***CHANNEL DESCRIPTIONS***

**F1 = MASTER SWITCH (MOMENTARY)**
**A1 = MASTER VIRTUAL CHANNEL**
**A10 = DELAY VIRTUAL CHANNEL**
**R1 = TIMER ENABLE (TIMER1 SET FOR 2 SECONDS)**
**S1 = TIMER DONE PULSE**

**F1** Channel to which the physical Master switch is wired.
**A1** Master virtual channel, which will be used in other Booleans to keep track of master on/off state. Pressing the Master switch F1 turns A1 on. Pressing and holding F1 for two seconds will turn A1 off. A1 can then be used in any load Boolean to turn that load off and then return it to its previous state.
**A10** Will be used in conjunction with A1 to help sense when the Master Switch is first pressed. Note: Although any channels can be used for this function, the address relationship between A10, A1, and F1 must be maintained. In other words, the CPU processes channel Booleans A1 – Q10 and then back to A1 again in circular loop. The Master channel (A1) must be processed after the Master Switch (F1), but before the Delay channel (A10).
**R1** Timer1 enable input, which should be set as two-second timer.
**S1** Timer1 done output signal.

***BOOLEAN’S – MASTER ON/OFF***

**R1= F1** (timer runs whenever F1 Master Switch is on)
S1 will provide a pulse if the Master Switch has been pressed for 2 seconds
**A10 = F1** (A10 is a delayed signal that F1 has turned on, it will be used in A1 to detect when the switch is first pressed)
Let’s build the A1 Boolean in steps.
First, we want to sense when the Master Switch F1 is first turned on (Edge Detection).
A1 = (F1 * !A10)
When F1 is first pressed, A1 Boolean will be true, because in the order of the Boolean processor, A10 has not yet been processed. A1 will pulse quickly anytime the Master switch is pressed.
Second, let’s now latch the Master channel on, when we sense the pulse
A1 = (F1 * !A10) + A1
Once the first part of the equation pulses A1 on, the second half of the equation will latch it on.
Now since we do not wish to latch A1 on forever, let’s turn off the Master channel, in the event the switch has been held for two seconds.
**A1 = (F1 * !A10) + ( A1 * !S1)**
Now the Master channel will stay latched on as long as we do NOT have a pulse from Timer 1, and this is our final Boolean.

Now A1 can be used in other simple Booleans.
D1 (Light) = A1 (Master Virtual Channel) * H2 (Light Switch)
This Boolean will turn on the Light only if the Master Virtual Channel AND Light Switch are on.

It is important to remember that in this application the switch must be momentary. Do not check the momentary switch latch box in the Boolean editor screen. If you do check the box, the switch will appear to only operate every other key press and the lights will turn on, and then off again in two seconds.

# Boolean Logic Examples

## USING EDGE DETECTION (continued)

### *BACKLIGHTING*

This is a practical application, which requires a single momentary Master Switch to turn switch panel backlighting on and off. What will be accomplished is that each press of the Master Switch will toggle switch panel backlighting on and off. Note this backlighting example can be combined with the previous Master On/Off example to have one switch perform both functions.

(Note this example uses “Edge Detection”, “Latching”, “Toggle” and “Virtual Channels”. It is recommended that these functions be reviewed. A working knowledge of these applications is necessary before proceeding.)

### *CHANNEL DESCRIPTIONS*

**F1 = MASTER SWITCH**
**A2 = BACKLIGHT VIRTUAL CHANNEL**
**A9 = EDGE DETECT VIRTUAL CHANNEL**
**A10 = DELAY VIRTUAL CHANNEL**

**F1** Channel to which the physical Master switch is wired.
**A2** Backlight virtual channel, which will be used in switch panel Booleans to turn on and off backlighting. Pressing the Master switch F1 toggles A2 on and off
**A9** Will be used to sense when the Master Switch is first pressed.
**A10** is a delayed signal that F1 has turned on; it will be used in A9 to detect when the switch is first pressed
***NOTE*** Although any channels can be used for this function, the address relationship between A10, A9, and F1 must be maintained. In other words, the CPU processes channel Booleans A1 – Q10 and then back to A1 again in circular loop. The Edge channel (A9) must be processed after the Master Switch (F1), but before the Delay Channel (A10).

### *BOOLEAN’S – BACKLIGHTING*

**A10 = F1** (A10 is a delayed signal that F1 has turned on, it will be used in A9 to detect when the switch is first pressed)
**A9 = F1 * !A10** (Edge detect when switch is first pressed, and produce a short pulse)
**A2 = (A9 * !A2) + (!A9 * A2)**, A2 toggles on and off with each press of switch F1

If you wish to combine Master On/Off function with Backlighting then the A1 channel developed on the previous page needs to be added to the A2 Boolean above to turn backlighting off if the Master Switch is held for two seconds. The new Boolean would be:
**A2 = (A9 * !A2) + (!A9 * A2 * A1)**

It is important to remember that in this application the switch must be momentary. Do not check the momentary switch latch box in the Boolean editor screen. If you do, the switch will appear to only operate every other key press.

(Note: if switch F1 is not being used for any other Boolean Function, such as Master On/off, then this entire Backlighting function can be accomplished by checking the momentary switch latch box in the Boolean editor screen for F1, and then setting A2 = F1)

# Chapter 10
# Software Installation

# Software Installation

The PMC software will only work on computers with these minimum system requirements:

- Windows 95, 98, 2000, ME, NT™
- Minimum 16 mb RAM
- Mouse
- Pentium 90 processor
- Minimum 20 mb hard drive space
- CD Rom Drive
- SVGA video
- 9 pin serial port or 25 pin serial port *(adapter required)*

*Installation in other equipment will not work.*

Installation of the software is much like any other Windows 95™ software. Locate the PMC program CD and insert it into your CD rom drive. Click on the start menu and select Run. From the run screen type the drive letter of your CD rom in the window and select browse. You should see a folder Win PMC 6.X. Double click on Win PMC6.X. Highlight *Setup.exe* and click open. The Run box will appear with WinPMX6.x\Setup.exe in the window. Click on OK. Follow the onscreen prompts to complete the installation.

### *DISPLAY SETTINGS*

To be able to view all the screens in this program, the resolution of the computer display should be set for 600 X 800, and the fonts should be set for "Small". To do this, click on Start in the Windows screen. Move the cursor to the settings and click on Control Panel. Click on Display. Select the Settings tab. Move the slide bar in the desk top area to the left, selecting 600 X 800 resolution. Select small fonts in the Font Size box and click on "OK".

### *LAUNCH THE PROGRAM*

A WinPMC icon will be placed on your desktop. Double click on this icon to launch the program. You may wish to test the programs communications capability by connecting the RS232 cable to a CPU module and your computer and then retrieve from or send a program to the CPU. Remember to provide power to the CPU either from a vehicle or from the portable power supply.

# Chapter 11
# System Timing

# System Timing

The PMC system has a total of 160 channels for information. These channels appear serially on the PMC multiplex bus, every 40 milliseconds. The signal is divided into 16 module groups of ten channels each. At the beginning of a module data group, there is a system reset pulse. Channel A1 occurs at the end of this reset pulse. At the end of the first data window, a clock pulse is sent.

Channel A2 follows A1 followed by another clock pulse and so forth. At the end of ten channel A group, there is a synchronization pulse that signals the system that the next group of ten channels is beginning. This sync pulse is shorter than the system reset pulse. The sync pulses also act as clock pulses. The signal appears as shown here.

The CPU acts as a master, sets up these timing signals and puts them on the PMC multiplex bus for use by all the slave input and output modules. The signal is generated by the microprocessor in the CPU module.

In addition to the timing function, the processor is performing the Boolean logic that has been programmed into the system. The Booleans are calculated in order, starting with the earliest equation. In other words, the Boolean for channel A1, if there is one, will be the first to be calculated. Then the one for channel A2, if there is one, will be calculated. This is an important point to remember when writing certain Booleans, as the value of the earliest channels may change before the later channels are calculated. This can also be of help in performing certain latching and timing functions and when programming the timers. These calculations are not synchronous with the system timing.

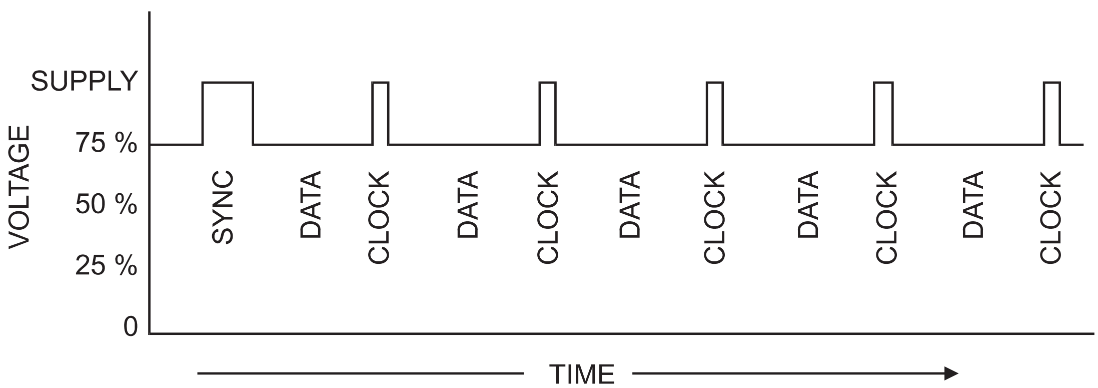



Figure 7

***CREATING A PULSE***

An example of the use of the timing aspect is the ability of creating a pulse when a switch is turned on/off.

First, a channel of a virtual module is made equal to an input. Then this channel is made to equal another *earlier* channel.

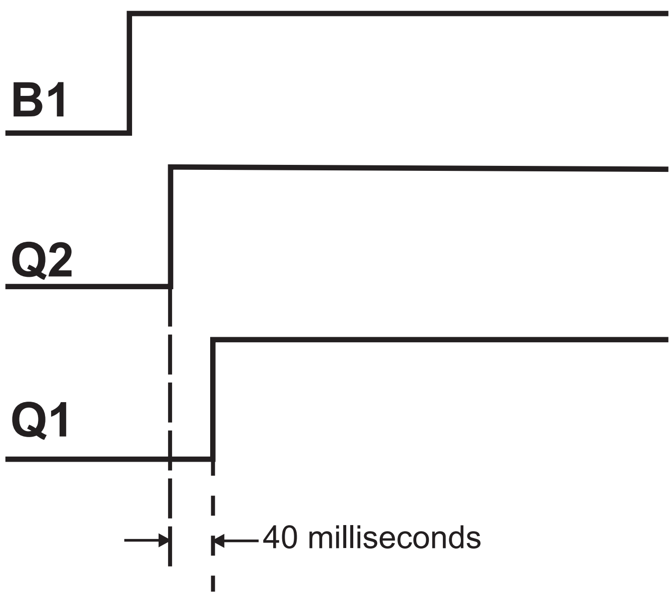
*Here is an example:*

**Switch = B1**
**Virtual module = Q**
**Q2 = B1**
**Q1 = Q2**

With these equations, Q2 equals the input B1, and Q1 equals Q2. Q1=Q2 will not be calculated until it comes around again after having calculated all therefore low. At some point in time, input B1 is switched high. Since Q1 is calculated before Q2, it will be a 0 or low, since Q2 hasn't been calculated yet. When Q2 is calculated, it will be set equal to B1, making it a 1 or high. The next time Q1 is calculated and made equal to Q2, it will then become a 1 or high. This has happened approximately 40 milliseconds later.

# System Timing

Therefore, the edges of the two signals are delayed by the 40 milliseconds as shown here.




By creating a Boolean with these two signals, pulses can be formed.

A Boolean that will create a pulse when the input switch goes high, or in other words, at the leading edge, would be the following:

**Q3 = Q2 * !Q1**

This will create a pulse which starts when Q2 goes high and ends when Q1 goes high. Similarly, a pulse can be created between the two signals when the switch goes off instead of going on. This would be done by inverting Q2 instead of inverting Q1.

The Boolean would be:

**Q3 = !Q2 * Q1**

By creating an Exclusive OR between these two signals, a pulse will be created each time the input switch changes states.

This equation would be:

**Q3 = Q1 * !Q2 + !Q1 * Q2**

This technique can also be used to create longer pulses by adding additional steps in the process, such as starting with B1 = Q10.

Then:

**Q9 = Q10**
**Q8 = Q9**
**Q7 = Q8**

Finally:

**Q3 = Q10 * !Q4**

This step by step process adds 40 milliseconds for each time through the Boolean processor. This process can be made quite long by continuing this process through a number of modules.

This is not the only way time delays can be produced. The system includes ten, programmable timers, whose function and use is explained in chapter five. The technique of creating a pulse at the edge of a input switch function can be useful in starting a timer.

# Chapter 12
# Boolean Algebra

# Boolean Algebra

When we hear the word Algebra", we usually think of high school algebra with its positive and negative numbers, simultaneous equations, quadratic equations, and so on. This is not the only kind of algebra, however.

*Relax ! Boolean algebra is considerably easier than high school algebra.*

George Boole (1815-1864) invented a new algebra to describe logic and thought. Since the time of the early Greek philosophers, much logic and reasoning has been done using *true* and *false* statements. For many years mathematicians tried to include the laws of true-false logic in the realm of algebra but failed. Boole succeeded with the publication of "An Investigation of the Laws of Thought,..." in 1854. What Boole did was to symbolize logic by a new kind of algebra. In other words, he showed that some types of thinking and reasoning could be done by manipulating symbols.

Boole's algebra stayed in the domain of pure mathematics until almost a century later. In 1938, Claude Shannon wrote a paper titled "A Symbolic Analysis of Relay and Switching Circuits." This paper applied the new algebra to switching circuits and since then Boolean algebra has been widely used in telephone and digital systems. Most computers use this algebra as the basis for all of their operations.

In this chapter, you will become familiar with the basics of Boolean algebra so you can program the PMC. There are only three functions to learn, OR, AND and NOT.

Boolean algebra differs from ordinary algebra in some ways. In ordinary algebra when we solve an equation for its roots, we can get any real number: positive, negative, fractional and so forth. In other words, the set of numbers in ordinary algebra is infinite.

In Boolean algebra when we solve an equation, we get either a 1 or a 0. No other answers are possible because the set of numbers includes only the binary digits 1 and 0. These numbers are also referred to as true and false, and high and low. In the PMC system, a 1 would represent a closed switch input, or an output that is on. An 0 represents an open switch, or an output that is off. This lack of other numbers gives rise to a number of new thoughts, such as the meaning of the plus sign.

In Boolean algebra there are three basic functions, OR, AND and NOT.

### *THE OR FUNCTION*

The OR function means that the output is true if *any* input is true. In other words, the OR function is an *any or all* function.

If Q is the output and A and B are inputs, the simple OR equation is written:

**Q is the output on (relay)**
**A and B are inputs (switches)**
***Q = A + B***

This means that A and B are OR'ed together. The OR function has a 1 output when either *A, or B,* or both are 1. In PMC the load is on if either input switch A, or B are on. The following table lists the input-output conditions of the OR function. This table, called a "truth table", shows all the input-output possibilities for a logic circuit. 1= on 0 = off.

| Inputs | | Output |
|---|---|---|
| A | B | Q |
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |

# Boolean Algebra

The point to remember about the OR function is that it has a 1 output when either *A, or B,* or both are 1.

### *THE AND FUNCTION*

The AND function means that the output is true only if *all* the inputs are true. In other words, the AND function is an *all or nothing* function.

The simple AND equation is written:

$$Q = A * B$$

This means that A and B are AND'ed together. The truth table for this function is as shown below:

| Inputs | | Output |
|---|---|---|
| A | B | Q |
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

In PMC, the load Q will be on only if both switches A and B are closed.

### *THE NOT FUNCTION*

The NOT function is a simple function that inverts the input. The output is *not* the same as the input. This is normally written as a prime, or an over-score.

The simple NOT function is written:

$$Q = A' \text{ or } \overline{A}$$

For purposes of our typing, we will use an exclamation point in front of a term to mean NOT. So the function will be written as:

$$Q = !A$$

The truth table for the NOT function is:

| Input | Output |
|---|---|
| A | Q |
| 0 | 1 |
| 1 | 0 |

Through the use of just these three functions, all logic can be expressed. They can be combined into various equations to create more complex functions that are useful in describing logic for control systems.

With these few functions, you will be able to describe the electrical functions of a vehicle.

### *SOME EXAMPLES*

Let's take a couple of examples. The first example is the function of a simple light switch, we will call input A. A can either be 0 for off, or 1 for on. The output to the light is *Q*.

The switch function can be described as:

$$Q = A$$

Simple isn't it. The output to the light is the same as the output of the switch. When the switch is on, the light is on. When the switch is off, the light is off.

Now let's say that we want the switch to be turned on from two different switches, A or B. This might be useful to operate interior lights from door switches. The switch on the first door will be A, the switch on the second door will be B, and the output to the light *Q*.

That equation would be written:

$$Q = A + B$$

This means if either switch A *or* B are on, the light will be on. Or in other words, in our example, if either door or both is open, the interior light will be on.

Let's take another example of light that wants to be on only if two switches are on. We will turn on the fog lights only if the head lights are on. Let's call the fog light switch A, the head light switch B, and the fog light output *Q*.

The fog light equation would be written as follows:

$$Q = A * B$$

This means that both the head light switch *and* the fog light switch have to be on to turn the fog lights on.

# Boolean Algebra

These first examples have been simple, using only two terms to describe an output. Although you will find that most of your system can be simply defined, Output functions are not limited to just two input terms. As a more elaborate function, let's consider the control of an air conditioner evaporator fan on a bus. Obviously, the fan should run when the temperature is too high, so the thermostat should be one of its inputs. Let's also say that we *also* want it to run if the defroster fans are on, but *don't* want it to run if the alternator light is on. What would the equation for this function be ?

Let's define our terms:

**A1 = Evaporator Fan**
**B1 = Thermostat switch**
**B2 = Defroster Switch**
**C1 = Alternator Light**

In Boolean terms, we want the evaporator fan to run if the thermostat switch is on, OR if the Defroster Switch is on, AND NOT if the Alternator light is on.

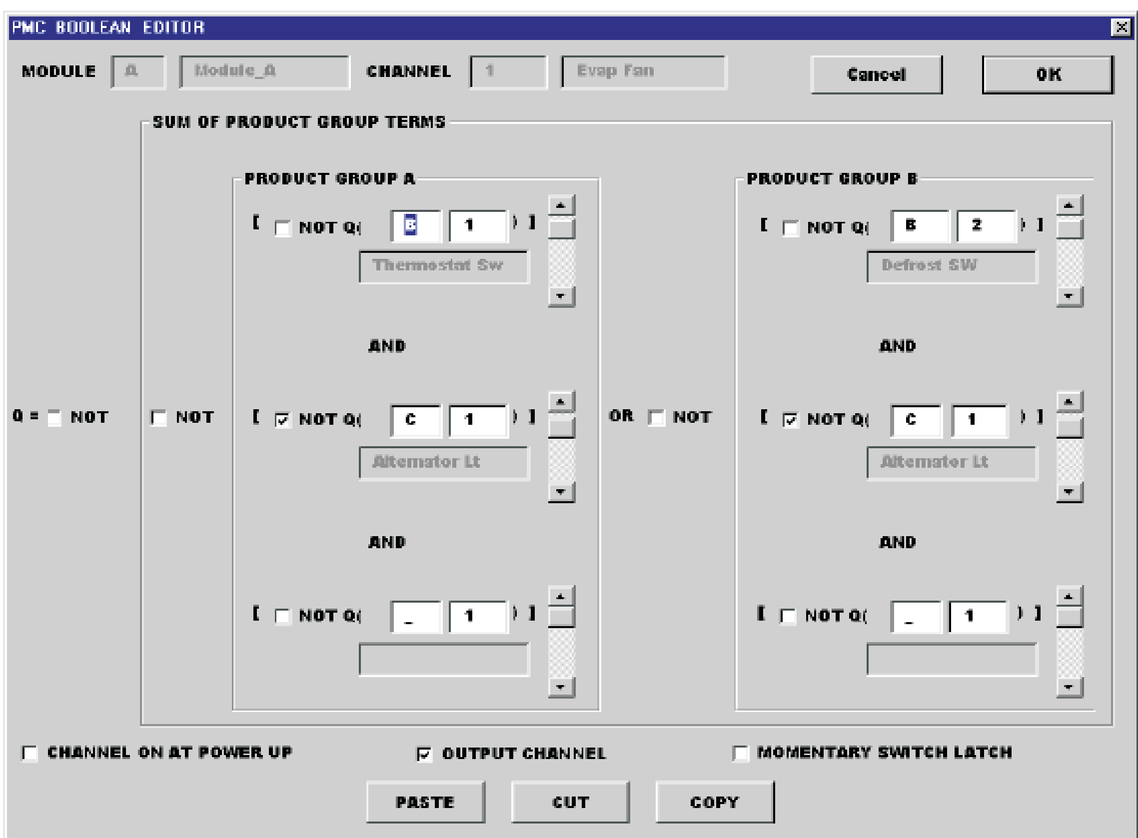
The equation would be written:

**A1= (B1+ B2) * !C1**

Stated another way:

**A1=(B1*!C1)+(B2*!C1)**

***The PMC Screen will look like this:***



# Chapter 13
# Advanced
# Boolean Algebra

# Advanced Boolean Algebra

While much of the logic needed for a vehicle can be programmed using just the three basic functions of Boolean Algebra, you may find need for more complex functions. This chapter deals with some more advanced functions that are "built" from the three basic functions. It also introduces one of the more important theorems, De Morgan's.

***DE MORGAN'S THEOREMS***

De Morgan was a great logician and mathematician, as well as a friend of Boole's. Among De Morgan's important contributions to logic are these two theorems:

**A + B = !(!A * !B)**
**A * B = !(!A + !B)**

In words, the first equation says that *the statement A OR B is the same as the statement NOT (NOT A AND NOT B)* This set of equations will allow you to use PMC to create statements having many ANDs and ORs.

An AND function can be restated using OR, by "NOT"ing the inputs and outputs. An OR function can be restated using AND, by "NOT"ing the inputs and outputs. In simple vehicles, you may never require this function. For example, a three (or greater) input OR function can be developed by using several Virtual Channels (extra memory). However, in more complicated systems, utilizing DeMorgan's Theorem, the extra memory can be saved and the entire equation can be written on a single Boolean Editor Screen.

***Q* = A * B * C = !(!A + !B +!C)**

***THE EXCLUSIVE-OR FUNCTION***

Another example of combining these simple functions is the Exclusive-OR. The output of the Exclusive-OR is <u>true</u> whenever the two inputs are different.

The truth table for this function is as follows:

| Inputs | | Output |
|---|---|---|
| A | B | Q |
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

The reason for the name exclusive-OR is this: a 1 output occurs when A or B is 1, *but not both.* Stated another way, the exclusive-OR function has a 1 output only when both inputs are different; the output is 0 when the inputs are the same.

The Exclusive-OR function can be created from the simpler AND *and* OR functions as follows:

***Q* = (A * !B) + (!A * B)**

Let's go through this equation to examine how this algebra works.

The first case is when both inputs are 0. The first term, A!B is A AND'ed with !B, or 0 AND 1. The result is 0. The second term, !A B is !A AND'ed with B, or 1 AND 0. The result is 0. OR'ing these two zeros gives an output of 0.

The next case is when A is 0 and B is 1. The first term is A!B, or 0 AND 0. The result is 0. The second term is !AB, or 1 AND 1. The result is 1. OR'ing the 0 and the 1 gives an output of 1.

The third case is similar to the second.

The fourth case is when A and B are equal to 1. The first term, A!B is A AND'ed with !B, or 1 AND 0. The result is 0. The second term, !AB is !A AND'ed with B, or 0 AND 1. The result is 0. OR'ing these two zeros gives an output of 0.

# Advanced Boolean Algebra

The Exclusive-OR function gives us a new kind of function to work with. We will use the symbol $\oplus$ to stand for this function. That is when we want to describe an exclusive-OR function, we can write:

$$Q = A \oplus B$$

An example of the use of this function is making a three way switch for a light. If we use two switches as the inputs for the Exclusive-OR function, they will make the light go on or off from either switch.

Let's take a look at how this works.

If we let: A = Switch 1
B = Switch 2
Q = Light

Then the exclusive OR Boolean expression will be:

**Q = A!B + !AB**

If both switches are off, or 0, the expression is 0 and therefore the light is off. If either switch is turned on (they don't match), the expression will be 1, the light will be on. If both switches are turned on (they match), the expression will be 0 and the light will be off.

An additional switch can be added to the control group by using the output from this expression to be an input to another Exclusive-OR expression (rather than being the light), with it's output being the light.

The two expressions would be:

C = Switch 3
D = Temporary Memory Location (virtual module)

**D = A * !B + !A * B**
**Q = C * !D + !C * D**

With this expression, the light will be controlled by any of the three switches. Additional switches can be added to the control by writing more of these expressions.

*See Chapter 9 for PMC program examples, or call Intellitec.* We will be happy to asist you.

# Appendix A
# Design
# Worksheets

| Channel | Input/Output Name | I/O | Input H/L Output Amps | Location/Zone |
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| Channel | Input/Output Name | I/O | Input H/L Output Amps | Location/Zone |
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| Channel | Input/Output Name | I/O | Input H/L Output Amps | Location/Zone |
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***NOTES***

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| Vehicle Identification | |
| Date | |
| Module Name | |
| Module Address A-P | |
| Module Type or Description | |
| Module Location or Zone | |

| Channel Number | Channel Name | In/Out | High/Low Amps | Boolean Expression |
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