



A World of Applications



Intellitec PMC System User Manual

Revision C



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Chapter 1

The PMC System

The PMC System

INTRODUCTION

The Intellitec **Programmable Multiplex Control (PMC)** 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. The flexibility 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 PMC CPU 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 II System** uses two loops of 160 channels to transmit data throughout the vehicle, providing 320 input, or output channels. The 160 channel CPU has only one loop. The function of each of these channels can be defined by the designer to be an input, or 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 relationship of these input 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.)* Simply stated, Boolean algebra is a means of describing logic relationships using "AND", "OR" and "NOT" functions.

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, lower costs, weight and improve reliability.

Multiplexing is not a new idea. It has been in use for more than fifty years. There are many different methods of multiplexing that are 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 attractive for more and more applications. It is now the practical solution for the increasing wiring problems in today's modern vehicles.

Intellitec's multiplexing 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", or loop, 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. On the 320 channel system, there are two loops of 160 channels that make up the 320 channels. Communication is taking place on both loops at the same time, so all 320 channels occur in the .040 second time frame. Prior to processing a boolean to turn an output on, the system looks to see if the input involved has been present for two cycles.

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 320 channel system has a Yellow and Blue Loop, each having 160 channels.

The multiplex 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 the 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 below.*

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.

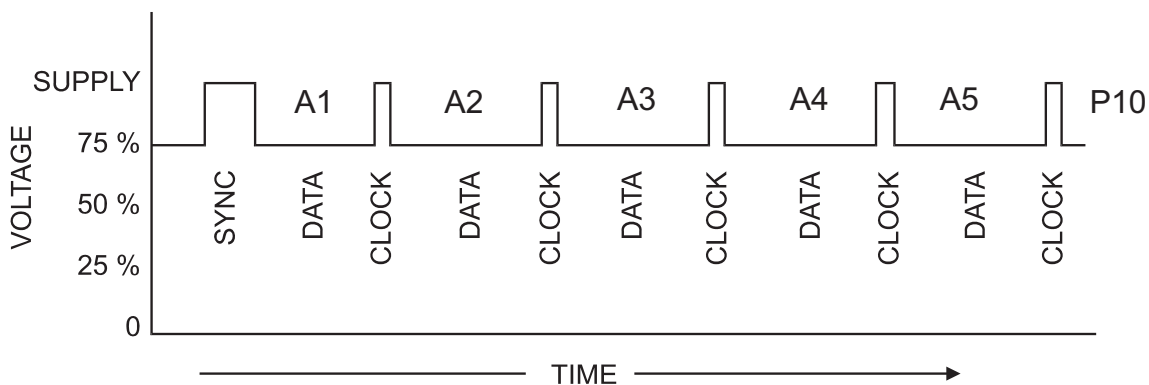


Figure 7

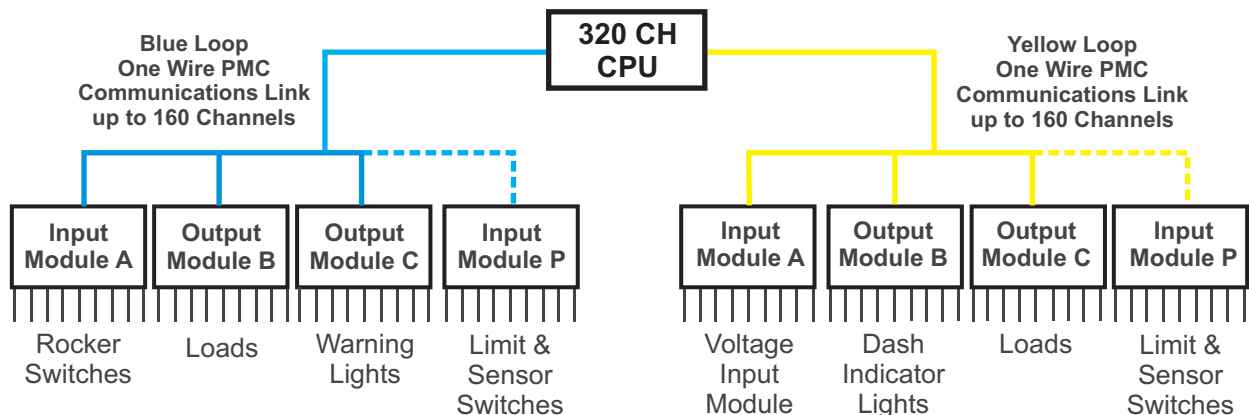
The PMC System

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 32 unique addresses for I/O modules; each module can include up to ten

channels and each channel represents a switch input, or output to operate a load. The address of the I/O modules is identified by dip switches, or jumpers on each module, with an address of A through P (1 - 16). On the 320 channel system, modules can be physically wired to either the Blue or Yellow Loop of the CPU. The 160 channel CPU has only one loop; each loop handles 16 modules. Each channel of a module will have a unique address that can be controlled by the CPU. The CPU is programmed to determine which channels are outputs and what input events allow an output to turn on.

Up to 32 modules provide for as many as 320 inputs or outputs



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

TIMERS The 320 channel system has 160 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. The 160 channel system has 10 timers.

CHANNEL IDENTIFICATION Each channel has the capability of being labeled by the OEM. Label names are usually kept simple. For example, "Left Turn Signal SW". This allows for easier programming. The names are also stored in the CPU for future diagnostics.

DIAGNOSTICS Although 99% of the PMC system can be diagnosed with a commonly available Volt Meter, a diagnostic system is incorporated in the

Windows™ software. *Other diagnostic test equipment is also available from Intellitec.*

SLEEP MODE If sleep mode is enabled, all loads are automatically turned off, if ignition is off and inputs have been idle for a selected time period. During this mode, the CPU and I/O module significantly reduce battery drain.

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

VIRTUAL CHANNELS For the 320 channel system, there are 160 virtual channels that exist in memory on the CPU that are used as extra memory to expand input to output relationships. This allows the programmer to write complex vehicle logic requirements. The 160 channel system has 10 virtual channels.

Set-Up Example

Booleans

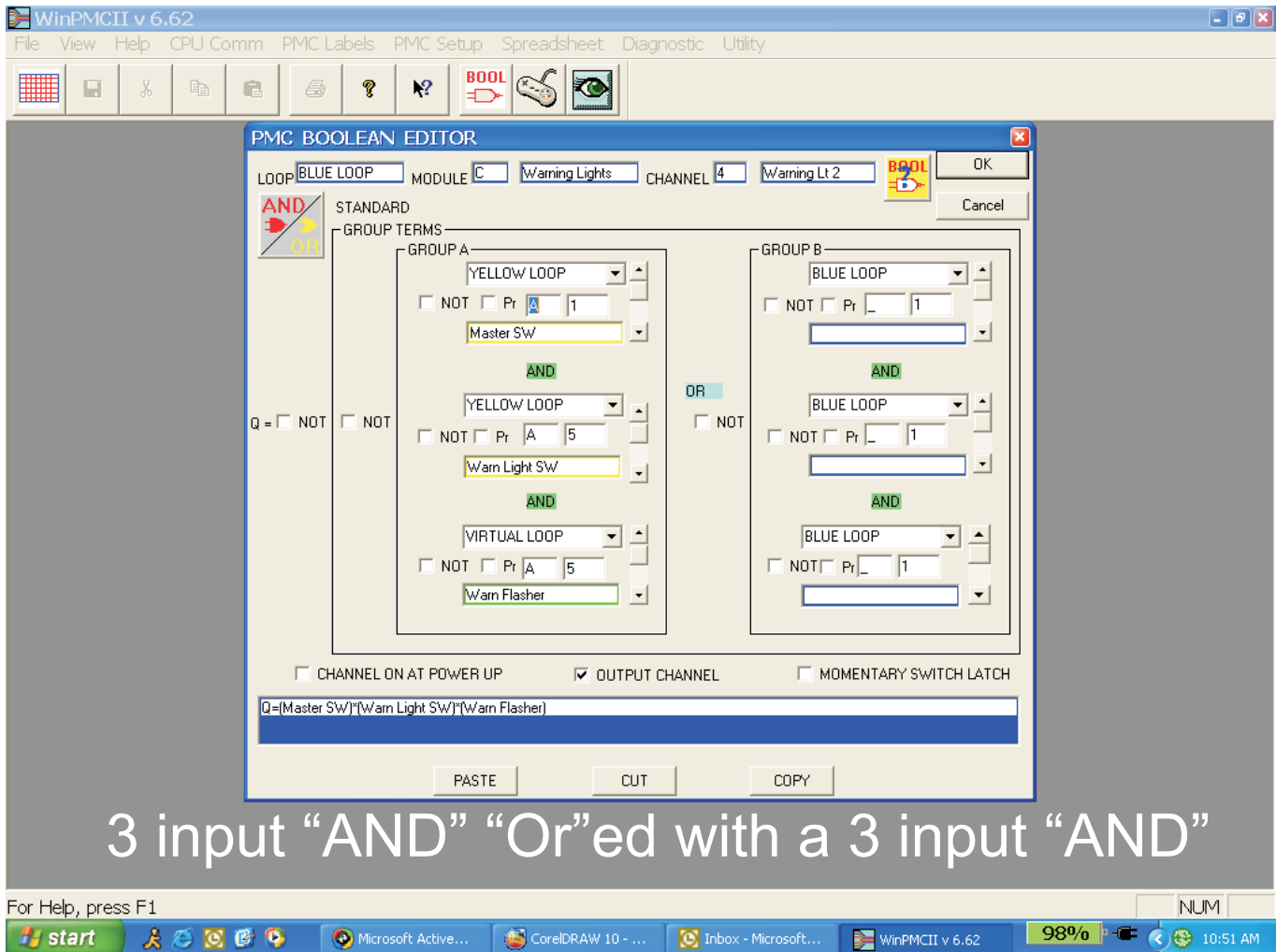
Setup using Boolean Algebra may sound complicated, but it is really very simple. The picture below represents just one of the graphical user interfaces used in the PMC II Windows™ based software. The software allows you to label each of the modules, as well as their inputs and outputs. This makes them all easily recognizable and programming the vehicle less confusing.

The Boolean editor screen is used to define how a particular output is turned on. In this case, Blue Loop channel C4, "Warning Light 2", is turned on when the Master switch, Warning Light switch and the virtual warning flasher are all on. You will note, that the switch inputs are connected to the Yellow Loop. Changing the relationship is as simple as a few mouse clicks. Any switch connected as an input, anywhere in the system, Blue Loop or Yellow

Loop, it doesn't matter, can be used to control as many outputs as you like. For example, you may wish to use the neutral safety switch to act as an interlock for a number of different outputs.

As you can see in the diagram, the items listed vertically produce a 3 input "AND" relationship. The screen below is a 3 input "AND" that is "Or'ed" with another 3 input "AND". Although it may appear that the number of AND and OR's are limited, you will see in further chapters, that *the number of "AND's" and "ORs" are almost unlimited*. There are also screens for a 6 input "AND", 6 input "OR", as well as a 3 input "OR" that is "AND'ed" with a 3 input "OR". With the use of virtual channels these relationships can be expanded even further.

Further explanation of these screens will be provided in later chapters.



Chapter 2

Data Sheets

PMC Modules

| | |
|--|---|
| 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 Out +12V 10/20 Amp Fused, Relay Output |
| | 00-00838-410 | 10 Channel Relay Out +12V 10/20 Amp Fused, Relay Output |
| 2-13 | 00-00844-500 | 10 Solid-state latching outputs w/lamp dimmer control 10 Amp Fused, Solid-state Output |
| | 00-00844-510 | 10 Solid-state latching outputs w/lamp dimmer control 10 Amp Fused, Solid-state Output |
| 2-15 | 00-00937-516 | Scene Control Lamp Dimmer +12V 6 dimmable Solid-state Output |
| | 00-00937-506 | Scene Control Lamp Dimmer +24V 6 dimmable Solid-state Output |
| 2-17 | 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 |
| 2-19 | 00-00846-606 | 4 point DC Input/6 point protected FET Out +24V 20/10 Amp self protected, Solid-state Output |
| | 00-00846-616 | 4 point DC Input/6 point protected FET Out +12V 20/10 Amp self protected, Solid-state Output |
| 2-21 | 00-00802-600 | 10 Solid-state protected FET Out +24V 10 Amp self protected, Solid-state Output |
| | 00-00802-616 | 10 Solid-state protected FET Out +12V 10 Amp self protected, Solid-state Output |
| 2-23 | I/O Modules Acceptable Load Distribution | |
| 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 |
| 2-27 | 00-00916-120 | Quad "H" Output Module +12V 10 Amp Relay Outputs connected in four "H" bridge configurations. |
| 2-29 | 00-00917-120 | 6 Relay Output/4 Input +12V 6 Floating nondedicated contacts/4 pos or Neg Inputs |
| | 00-00917-240 | 6 Relay Output/4 Input +24V 6 Floating nondedicated contacts/4 pos or Neg Inputs |
| Input Modules | | |
| 2-31 | 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 |
| Load Manager Voltage Input Module | | |
| 2-33 | 00-00809-120 | Inputs 4 voltage thresholds +12V |
| | 00-00809-240 | Inputs 4 voltage thresholds +24V) |

| Page | Part No. | Description | | |
|--|--------------|--|----------|---|
| Rocker Switch Direct Plug-in Adapters | | | | |
| 2-35 | 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) |
| 2-37 | 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) |
| 2-39 | 00-00842-024 | 5 Stack-able Rocker Switch Adapter | +24V | 5 Carling switches with programmable lights |
| | 00-00842-012 | 5 Stack-able Rocker Switch Adapter | +12V | 5 Carling switches with programmable lights (Use standard Carling Contura Series switches) |
| Programmable Lighted Key pads | | | | |
| 2-41 | Various | 4, 6 and 10 button lighted, programmable key pads (See pages 42-44 for part numbers) | | |
| 2-45 | 00-00759-000 | 6 button programmable, lighted keypad | | |
| Warning Lamp Direct Plug-in Adapters | | | | |
| 2-47 | 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 |
| Diagnostic Test Equipment | | | | |
| 2-49 | 00-00739-000 | PMC Module Simulator | +12V/24V | Emulate any module in the system Force outputs ON, Simulate inputs, View channel status |
| 2-51 | 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 |

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).

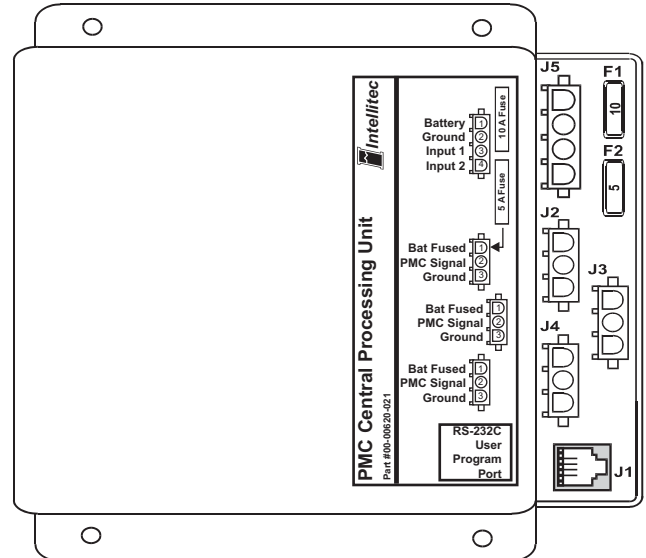
As additional modules are developed, they can be added to this section of your book. The following pages describe each of the modules, along with their performance and specifications. *Check with Intellitec, as new modules continue to be developed.*

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.

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.*

| 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 (<i>Note 1</i>) |
| 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. (<i>see Chapter 3 of the Users Guide</i>) |
| Pin 3 | Multiplex Ground | 14 awg Min. (<i>see Chapter 3 of the Users Guide</i>) |
| 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 | (<i>Note 1</i>) |
| 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.

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.

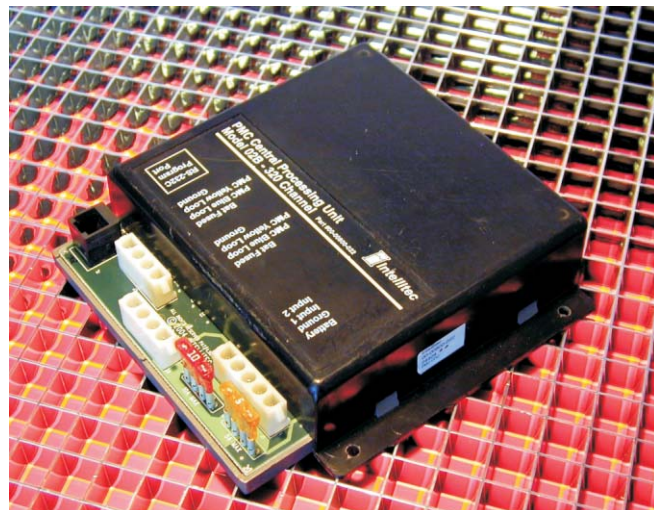
A system can be as small as one CPU and one I/O module, or it can communicate with up to 32 I/O modules. Each module can have a combination of up to 10 inputs, or outputs.

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.

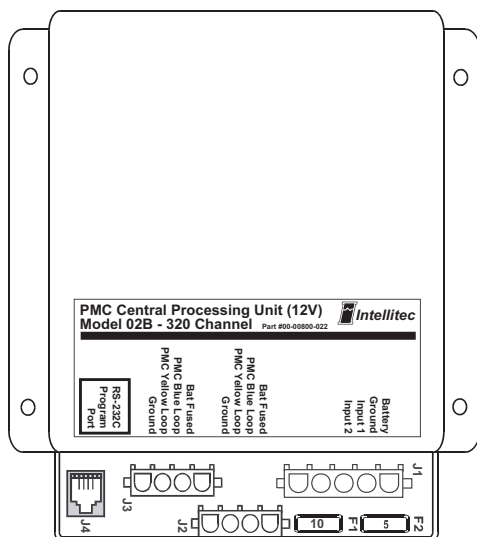
Through the use of Intellitec's WinPMC II Windows based software program and the connection of a PC to the RS-232C port, the user can easily set up the relationships between the switch inputs, timers and outputs.

If 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-volatile 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.

SPECIFICATIONS

| | | |
|---------------|---------------------|-----------------------|
| Part Number | 00-00800-022 | 00-00800-240 |
| Voltage | 12V | 24V |
| Voltage Range | up to +16 Volts | +10 Volts to 36 Volts |



SYSTEM CAPACITY

| | |
|-------------------|--------------|
| Program Memory | EPROM |
| User Memory | Non Volatile |
| Module Capacity | 32 |
| I/O per Module | 10 |
| Total I/O Control | 320 |
| Virtual Channels | 160 |
| Timer Channels | 160 |

COMMUNICATIONS

| | |
|-----------------|-------------------|
| CPU/Module | PMC two wire 4KHZ |
| EMI/RFI | High Immunity |
| User PC Program | WinPMCI |

CONNECTOR PIN DESIGNATIONS

| | |
|-------|-------------------------------------|
| J4 | RS-232C |
| J2-J3 | PMC Communications |
| Pin 1 | Fused Power for remote backlighting |
| Pin 2 | Multiplex Signal Blue Loop |
| Pin 3 | Multiplex Signal Yellow Loop |
| Pin 4 | Communications Ground |
| J1-1 | Battery |
| J1-2 | Ground |
| J1-3 | Aux In 1 (+12V disables sleep mode) |
| J1-4 | Aux In 2 (+12V disables sleep mode) |

PC Communications (Note 1)
 (All three connectors identical)
 16 awg Min. Fuse F2 5 Amps Max.
 16 awg Min. (see Chapter 3 of the Users Guide)
 16 awg Min. (see Chapter 3 of the Users Guide)
 14 awg Min. (Make no other connections)
 Fuse F1 10 Amps Max.

| | |
|------------|----------------------|
| Sleep Mode | 4.7K Input Impedance |
| 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) |

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.

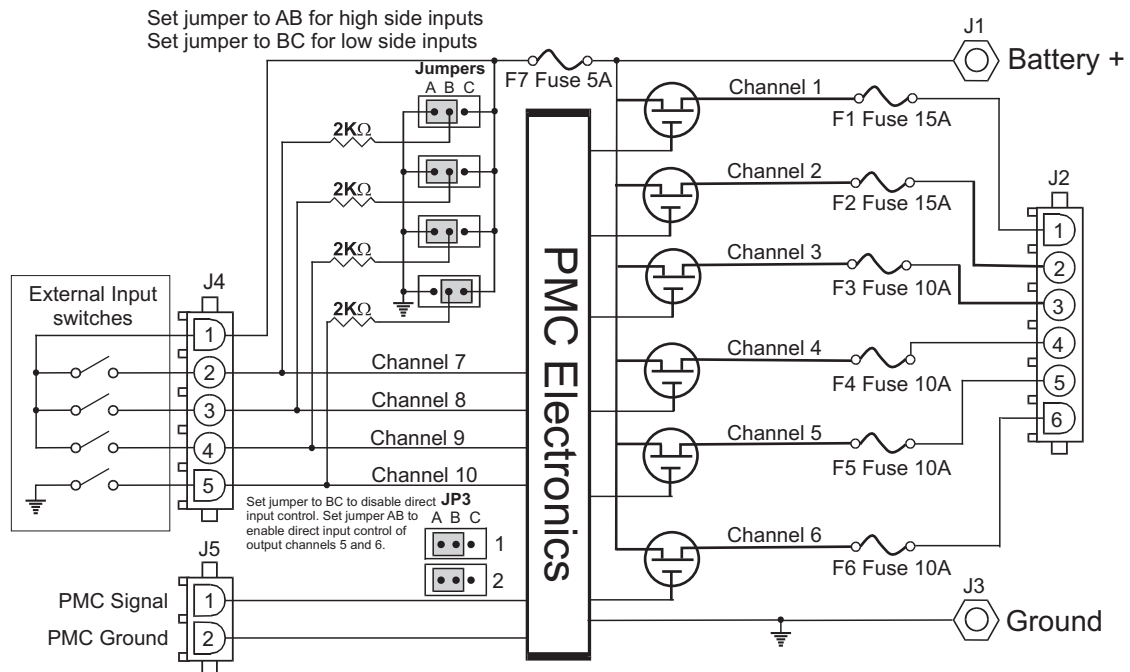
The 406/416 provides power fusing, switching, and distribution in one module. It has two, 15 amp SPST relays and four, 10 Amp SPST relays for switching loads to the battery. Each fuse position can be filled with a fuse, or circuit breaker. The total module current should not exceed 50 Amps.

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.

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.

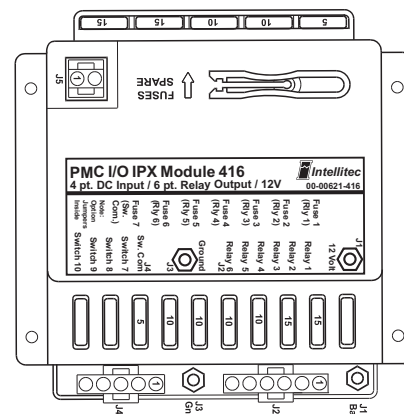
MATING CONNECTIONS

| Designator | Function | Connector | Mating Part # | Contact, Typical |
|------------|----------|----------------------|---------------|-----------------------------|
| J1 | Battery | #10/32 Ring Term | | for 14-18 AWG for 10-12 AWG |
| 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 | MODULE | JUMPERS | MODULE |
|---------|---------|---------|---------|
| 4 3 2 1 | Address | 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 |



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.

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 work 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.*

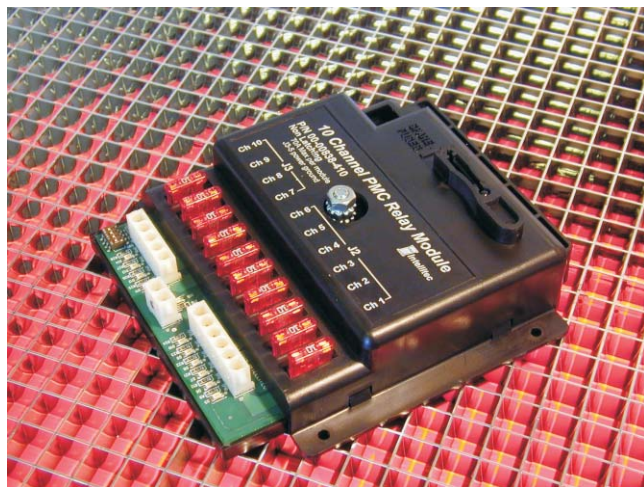
LATCHING VS NON-LATCHING

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

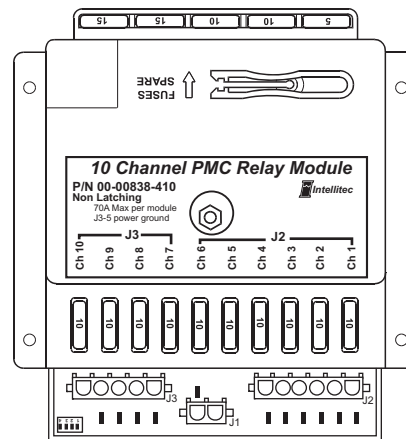
MATING CONNECTIONS

| Designator | Function | Connector | Mating Part # | Contact, Typical |
|------------|---------------|----------------------|---------------|-----------------------------|
| J4 | Battery | #10/32 Ring Term | | for 14-18 AWG for 10-12 AWG |
| 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 | MODULE | SWITCH | MODULE |
|---------|---------|---------|---------|
| 4 3 2 1 | Address | 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 |



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.

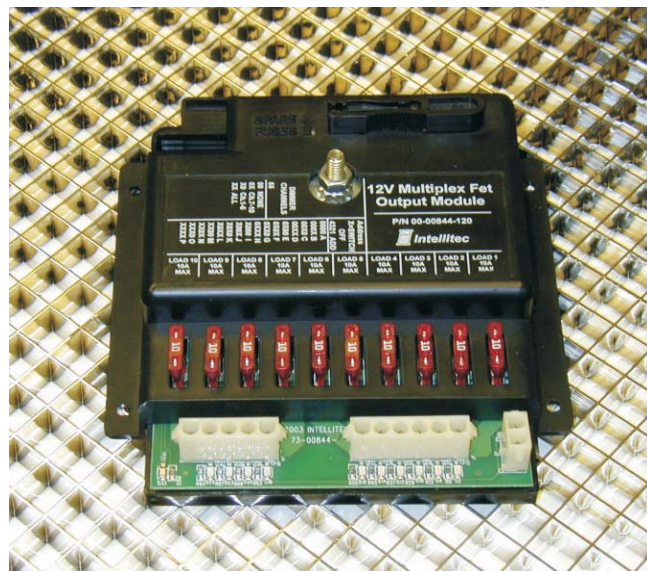
By adjusting the dip switch, it is possible to select the channels that will operate to dim lights. *See the chart on the next page for dip switch settings.*

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.

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.

$$I_1^2 + I_2^2 + I_3^2 + I_4^2 + I_5^2 + I_6^2 + I_7^2 + I_8^2 + I_9^2 + I_{10}^2 < 350$$

Failure to follow this rule may cause module failure.

MATING CONNECTIONS

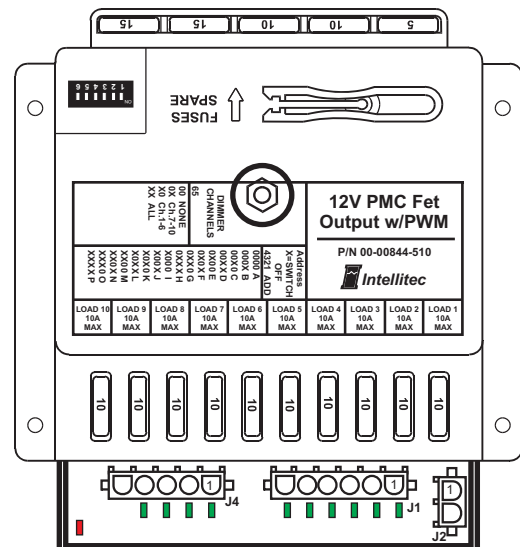
| Designator | Function | Connector | Mating Part # | Contact, Typical |
|------------|---------------|----------------------|---------------|-----------------------------|
| | Battery | #10/32 Ring Term | | for 14-18 AWG for 10-12 AWG |
| J2 | Communication | 2 Pin Amp Mate-N-Lok | 1-480698-0 | 350919-3 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 | MODULE | SWITCH | MODULE |
|-------------|---------|-------------|---------|
| 6 5 4 3 2 1 | Address | 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 |

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



The PMC Output Modules 00-00937 are members of Intellitec's Programmable Multiplex Control family, as well as the 160 Channel Multipoint Switching System. These output modules work in combination with the PMC CPU or the 160 channel IPX Master and other standard, semi-custom, or custom I/O modules. They provide solid-state outputs with the capability of dimming lights and allow the vehicle user to preset 4 different scenes.

The modules provide power fusing, switching, and distribution. Switching is accomplished via long life, field effect transistors instead of relays. Four outputs are rated at a maximum of 10 Amps and two outputs are rated at a maximum of 20 Amps. The total module current is limited by the "I squared rule" on the following page.

The approximate module dimensions are 3.80" X 5.03" X 1.80". It should be installed in a protected environment, inside the vehicle.

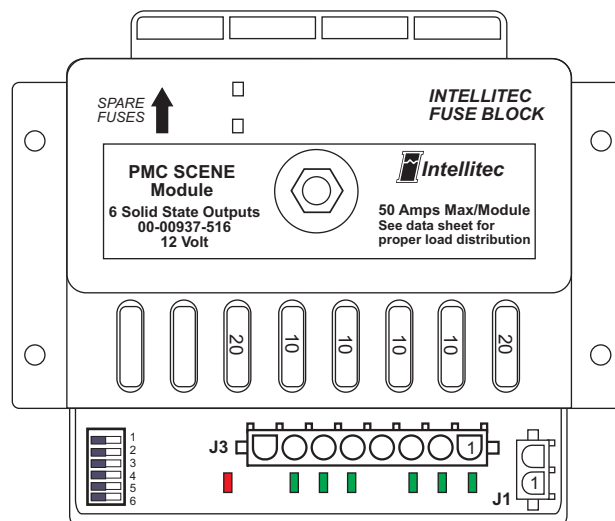
The 937 module can be set for module addresses, A-P. Using the chart on the next page, set the dip switches 1-4 to address the module.

PULSE-WIDTH MODULATION (PWM) PROVIDES VARIABLE POWER

The 937 modules provide the ability to dim lights from any Intellitec multiplex keypad or momentary switch. 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.

Pressing and releasing the button quickly will cause the output to toggle on or off. 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. The output will remember it's last intensity setting.

When using Intellitec programmable momentary push button switches, a switch is set for the same multiplex 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 switch programming GUI and setting a switch for BL/MR (back light/Master Reset), instructs the module to turn all 6 outputs off when the switch is held for 3 seconds.



PRESETS

The module includes the ability to store up to four preset levels of brightness for all six channels. To store a given set of brightness levels (including off), the vehicle owner sets the desired brightness of the six channels. Then pressing and holding one of the programmed buttons on a keypad for three seconds, the lights will blink to indicate those levels are stored. Scene buttons on the keypads are programmed to be channels 7, 8, 9 or 10. These channels can also be activated via PMC Booleans. To return to this set of brightness levels, the owner can momentarily press that scene button again.

By adjusting dip switches on the module, two, four, or all six channels can be included in the group. When selecting four outputs, Channel 6, a 20 Amp channel, can be included or not in the group by proper setting of the dip switches.

When using a PMC System, Booleans can be written providing scene signals to multiple modules allowing nearly unlimited number of lights to be included in the scene group.

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.

SPECIFICATIONS

Modules

00-00937-506, 00-00937-516

Nominal Vehicle Voltage

24V (00-00937-506), 12V (00-00937-516)

NOTE: Output latches On/Off when channel turns on momentarily

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 | J3-1 | FET Output | 20 Amp Max ** |
| 2 | J3-2 | FET Output | 10 Amp Max ** |
| 3 | J3-3 | FET Output | 10 Amp Max ** |
| | J3-4 | Power Ground | |
| 4 | J3-5 | FET Output | 10 Amp Max ** |
| 5 | J3-6 | FET Output | 10 Amp Max ** |
| 6 | J3-7 | FET Output | 20 Amp Max ** |
| | J3-8 | No Connect | |
| 7 | Ch 7,8,9,10 | Scene 1 input | |
| 8 | is sent from keypads | Scene 2 input | |
| 9 | | Scene 3 input | |
| 10 | | Scene 4 input | |

"I SQUARED RULE"

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

$$\frac{I_1^2}{2} + \frac{I_2^2}{2} + \frac{I_3^2}{2} + \frac{I_4^2}{2} + \frac{I_5^2}{2} + \frac{I_6^2}{2} < 350$$

Failure to follow this rule may cause module failure.

MATING CONNECTIONS

| Designator | Function | Connector | Mating Part # | Contact, Typical |
|------------|---------------|--------------------------|---------------|-----------------------------|
| | Battery | 1/4" or 1/4-20 Ring Term | | for 14-18 AWG for 10-12 AWG |
| J1 | Communication | 2 Pin Amp Mate-N-Lok | 1-480698-0 | 350919-3 640310-3 |
| J3 | Outputs | 8 Pin Amp Mate-N-Lok | 640586-1 | 350919-3 640310-3 |

MODULE SETTINGS

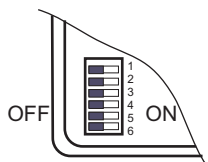
Module can be set for 1 of 16 address, A-P. Set six dip switches per table on right.

X = Switch is OFF

SWITCH POSITIONS 5 & 6

0 0 Channels 1 & 2 in scene group
0 X Channels 1 - 4 in scene group
X 0 Channels 1,2,5, 6 in scene group
X X All channels in scene group

| SWITCH | MODULE | SWITCH | MODULE |
|-------------|---------|-------------|---------|
| 6 5 4 3 2 1 | Address | 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 |

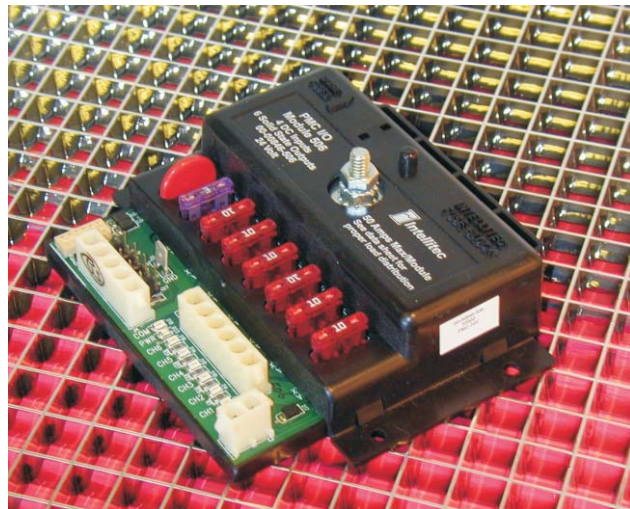


The PMC I/O Module 846-506/516 is a member of Intellitec's Programmable Multiplex Control family. It works in combination with the PMC CPU and other standard, semi-custom, or custom I/O modules.

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 37 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° 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
 $I1^2/2 + I2^2 + I3^2 + I4^2 + I5^2 + I6^2 = <350$

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

SPECIFICATIONS

General Connections

Nominal Vehicle Voltage

Maximum Operating Temperature

Module Current

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.

J4-2-5 Input Channels 7-10

J5 Module Ground

00-00846-516

12V

65° C

50 Amps Max

00-00846-506

24V

65° C

50 Amps Max

3 Amps Max

18 awg Min.

16 awg Min.

CHANNEL DESIGNATIONS

| Channel | Connection | Type |
|---------|----------------|------------|
| 1 | J1-1 | FET Output |
| 2-6 | J1-2 thru J1-6 | FET Output |

Rating

20 Amps Max @65° C Ambient

10 Amps Max @65° C Ambient

Use Channel 1 for highest amperage output.

Do not exceed 50 Amps total or 350 per below.

$$I_1^2/2 + I_2^2 + I_3^2 + I_4^2 + I_5^2 + I_6^2 < 350$$

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

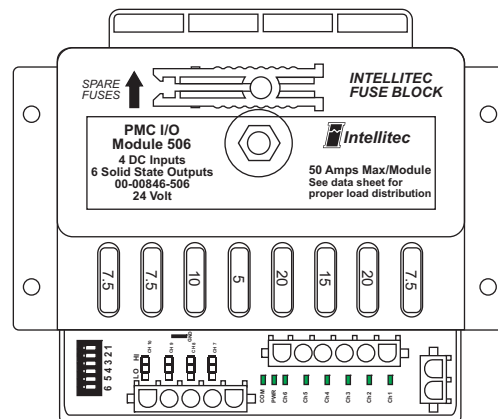
| Designator | Function | Connector | Mating Part # | Contact, Typical | |
|------------|----------|----------------------|---------------|------------------|---------------|
| | | | | For 14-18 AWG | for 10-12 AWG |
| J1 | Outputs | 6 Pin Amp Mate-N-Lok | 640585-1 | 350919-3 | 640310-3 |
| J2 | PMC/Com | 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 | Module | SWITCH | Module |
|-------------|---------|-------------|---------|
| 6 5 4 3 2 1 | Address | 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 846-506/516 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 37 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.

DIRECT CONNECT OUTPUTS 5 AND 6

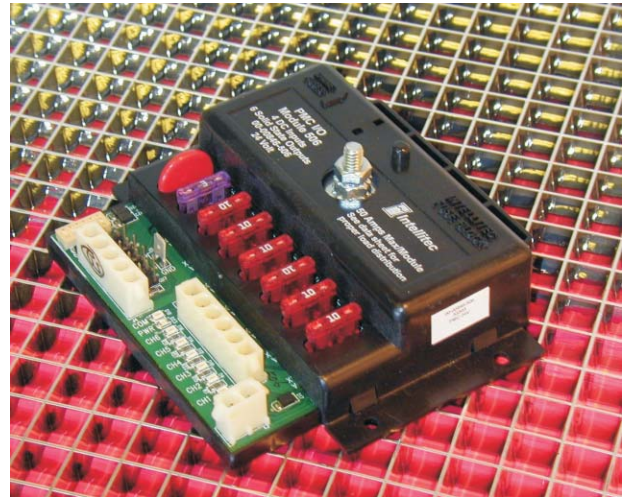
Direct Connection between inputs 7 and 8 and outputs 5 and 6 can be accomplished by setting dip switch 5 and 6 to the on position. When set for direct connect, the respective output will turn on within 1ms of receiving an input at 7 or 8. The purpose of the direct connect outputs is to eliminate the 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° 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.



Dimensions 5-3/4 X 5 inches

LOAD DISTRIBUTION

Max load current per module 37 Amps

Max load current per output one through six, 10 amps

I = the current in amps

$$I_1^2/2 + I_2^2 + I_3^2 + I_4^2 + I_5^2 + I_6^2 \leq 200$$

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

SPECIFICATIONS

General Connections

Nominal Vehicle Voltage

Maximum Operating Temperature

Module Current

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

J4-2-5 Input Channels 7-10

J5 Module Ground

00-00846-616

12V

65° C

37 Amps Total Max

00-00846-606

24V

65° C

37 Amps Total Max

3 Amps Max.

18 awg Min.

16 awg Min.

3 Amps Max

18 awg Min.

16 awg Min.

CHANNEL DESIGNATIONS

| Channel | Connection | Type |
|---------|----------------|------------|
| 1-6 | J1-1 thru J1-6 | FET Output |

Rating

Ch 1 15Amps Max, Ch 2-6 10 Amps Max
@65° C Ambient. Use Channel 1 for highest
amperage output. Do not exceed 37 Amps
total or 200 per below.

$$I_1^2/2 + I_2^2 + I_3^2 + I_4^2 + I_5^2 + I_6^2 = < 200$$

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

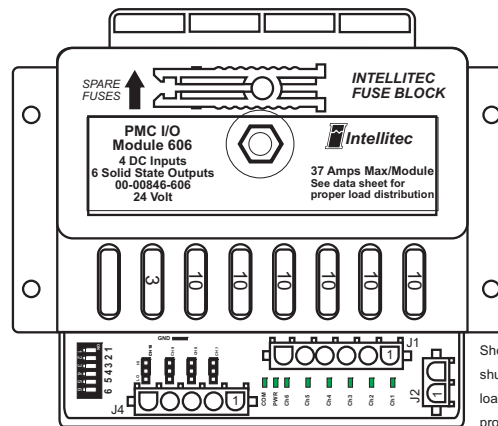
| Designator | Function | | Connector | Mating Part # for 14-18 AWG | Contact, Typical for 10-12 AWG |
|------------|----------|----------------------|------------|--------------------------------|-----------------------------------|
| J1 | Outputs | 6 Pin Amp Mate-N-Lok | 640585-1 | 350919-3 | 640310-3 |
| 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 | Module | SWITCH | Module |
|-------------|---------|-------------|---------|
| 6 5 4 3 2 1 | Address | 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 |



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

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.

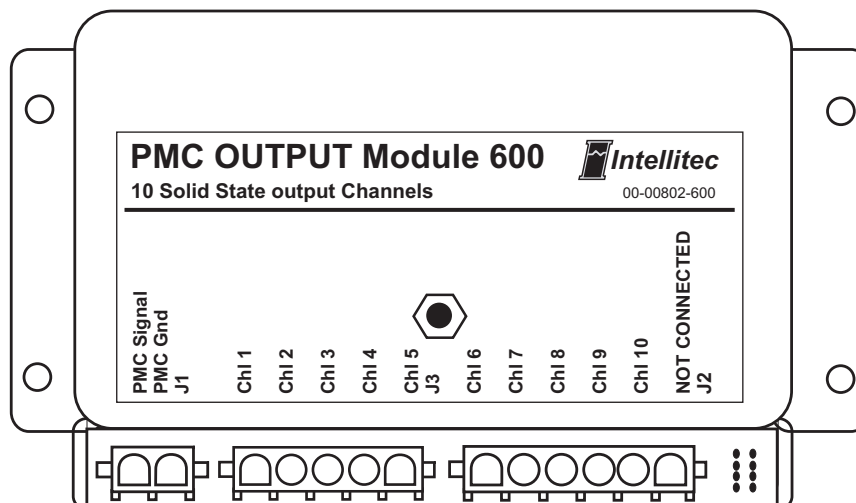
The 600/610 module provides power switching, and distribution in one module. With it's ten, solid-state, high-side outputs, it is capable of controlling a total of 50 Amps. Each output is capable of controlling a maximum of 10 Amps. ***Please refer to the tables in this brochure for proper load distribution.* 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**

$$I1^2 + I2^2 + I3^2 + I4^2 + I5^2 + I6^2 + I7^2 + I8^2 + I9^2 + I10^2 \leq 255$$



SPECIFICATIONS

General Connections

| | | |
|-------------------------------|----------------------------|----------------------------|
| Nominal Vehicle Voltage | 00-00802-610 12V | 00-00802-600 24V |
| Maximum Operating Temperature | 65° C | 65° 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° C Ambient. |
| 6-10 | J3-1 thru J3-5 | Protected FET Output | 10 Amps cont. Any output @65° C Ambient. |
| Pwr GND | J3-6 | | <u>See formula & examples on "Determining Acceptable Load Distribution" page.</u> |

+ 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. $I_1^2 + I_2^2 + I_3^2 + I_4^2 + I_5^2 + I_6^2 + I_7^2 + I_8^2 + I_9^2 + I_{10}^2 = 255$

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 | Module | JUMPERS |
|---------|---------|-----------------|
| 4 3 2 1 | Address | 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 |

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 $I_1^2+I_2^2+I_3^2+I_4^2+I_5^2+I_6^2=350$ or Less and $I_T \leq 50$ Amps

For 00-00846-606 and 616 modules $I_1^2+I_2^2+I_3^2+I_4^2+I_5^2+I_6^2=200$ or Less and $I_T \leq 37$ Amps

For 00-00802-600 and 610 modules $I_1^2+I_2^2+I_3^2+I_4^2+I_5^2+I_6^2+I_7^2+I_8^2+I_9^2+I_{10}^2=255$ or Less and $I_T \leq 50$ Amps

For 00-00888-600 and 610 modules $I_1^2+I_2^2+I_3^2+I_4^2+I_5^2+I_6^2+I_7^2+I_8^2+I_9^2+I_{10}^2 = 350$ or Less and $I_T \leq 50$ Amps

Examples for 00-00846-506/516 Modules $I_1^2/2 + I_2^2 + I_3^2 + I_4^2 + I_5^2 + I_6^2 = 350$

| Channel | No. | Amps | I^2 |
|---------|-----------|------------|-----------|
| 1 | $I_1^2/2$ | 10 | 50 |
| 2 | I_2^2 | 8 | 64 |
| 3 | I_3^2 | 8 | 64 |
| 4 | I_4^2 | 8 | 64 |
| 5 | I_5^2 | 8 | 64 |
| 6 | I_6^2 | <u>6.5</u> | <u>42</u> |
| Total | | 48.5 | 348 |

| Channel | No. | Amps | I^2 |
|---------|-----------|----------|-----------|
| 1 | $I_1^2/2$ | 10 | 50 |
| 2 | I_2^2 | 10 | 100 |
| 3 | I_3^2 | 10 | 100 |
| 4 | I_4^2 | 7 | 49 |
| 5 | I_5^2 | 4 | 25 |
| 6 | I_6^2 | <u>5</u> | <u>25</u> |
| Total | | 47 | 349 |

| Channel | No. | Amps | I^2 |
|---------|-----------|----------|----------|
| 1 | $I_1^2/2$ | | 43.5 |
| 2 | I_2^2 | 20 | 200 |
| 3 | I_3^2 | 2.5 | 6 |
| 4 | I_4^2 | 10 | 100 |
| 5 | I_5^2 | 5 | 25 |
| 6 | I_6^2 | 3 | 9 |
| Total | | <u>3</u> | <u>9</u> |

Examples for 00-00846-606/616 Modules $I_1^2/2 + I_2^2 + I_3^2 + I_4^2 + I_5^2 + I_6^2 = 200 < 200$

| Channel | No. | Amps | I^2 |
|---------|-----------|----------|-----------|
| 1 | $I_1^2/2$ | 12 | 72 |
| 2 | I_2^2 | 5 | 25 |
| 3 | I_3^2 | 5 | 25 |
| 4 | I_4^2 | 5 | 25 |
| 5 | I_5^2 | 5 | 25 |
| 6 | I_6^2 | <u>5</u> | <u>25</u> |
| Total | | 37 | 197 |

| Channel | No. | Amps | I^2 |
|---------|-----------|----------|-----------|
| 1 | $I_1^2/2$ | 10 | 50 |
| 2 | I_2^2 | 8 | 64 |
| 3 | I_3^2 | 5 | 25 |
| 4 | I_4^2 | 2 | 4 |
| 5 | I_5^2 | 6 | 36 |
| 6 | I_6^2 | <u>4</u> | <u>16</u> |
| Total | | 35 | 195 |

| Channel | No. | Amps | I^2 |
|---------|-----------|----------|-----------|
| 1 | $I_1^2/2$ | | 35.5 |
| 2 | I_2^2 | 15 | 112.5 |
| 3 | I_3^2 | 5 | 25 |
| 4 | I_4^2 | 4 | 16 |
| 5 | I_5^2 | 2.5 | 6.25 |
| 6 | I_6^2 | 5 | 25 |
| Total | | <u>4</u> | <u>16</u> |

Examples for 00-00802-600/610 Modules $I_1^2 + I_2^2 + I_3^2 + I_4^2 + I_5^2 + I_6^2 + I_7^2 + I_8^2 + I_9^2 + I_{10}^2 = 255$

| 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 | | <u>5</u> | <u>25</u> |
| 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 | | <u>3</u> | <u>9</u> |
| Total | | 46 | 252 |

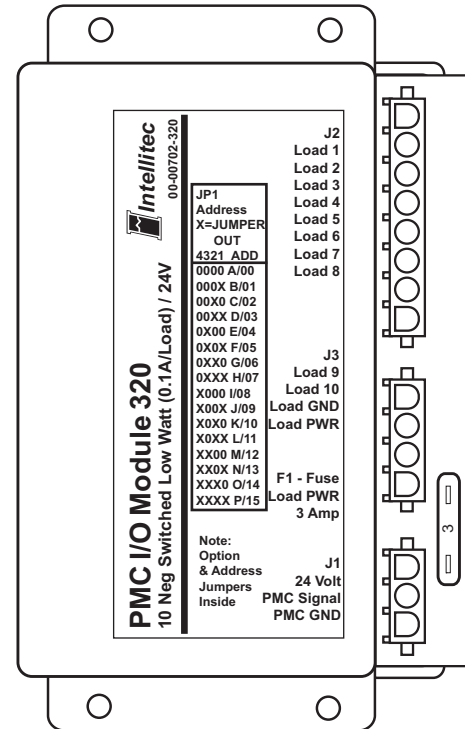
| Channel | No. | Amps | I^2 |
|---------|-----|----------|----------|
| 1 | | 10 | 100 |
| 2 | | 10 | 100 |
| 3 | | 3 | 9 |
| 4 | | 3 | 9 |
| 5 | | 3 | 9 |
| 6 | | 3 | 9 |
| 7 | | 2 | 4 |
| 8 | | 2 | 4 |
| 9 | | 2 | 4 |
| 10 | | <u>2</u> | <u>4</u> |
| Total | | 40 | 252 |

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.

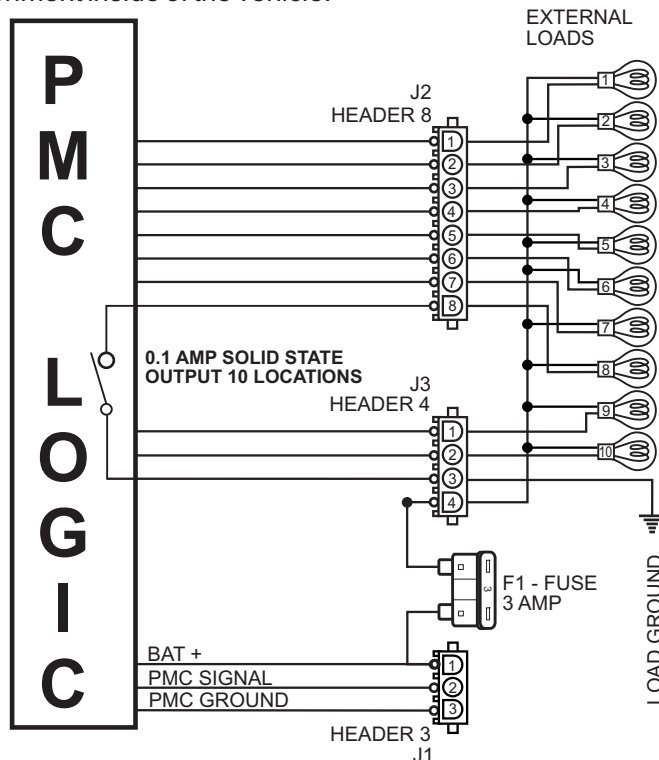
There are ten connections for low wattage loads, such as dash warnings lights, or beepers. The PMC CPU utilizes input information from other modules on the system, and via the PMC communications link controls the ten loads of this module. All of the output harnesses are connected with AMP Mate-N-Lok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

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



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



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 | MODULE | JUMPERS | MODULE |
|---------|---------|---------|---------|
| 4 3 2 1 | Address | 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 |

*** 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.)

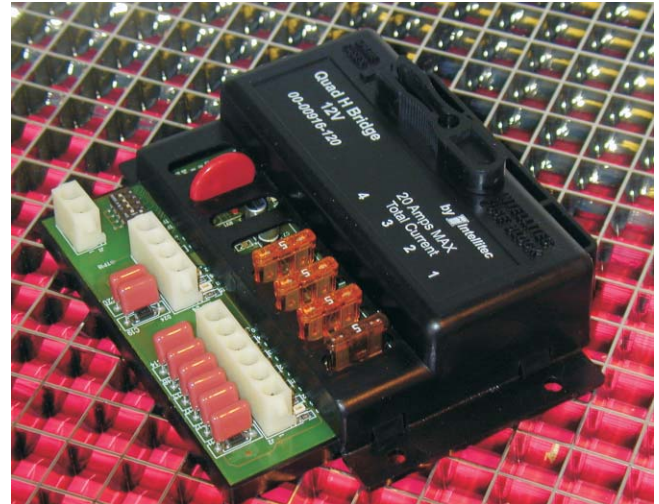
The Quad "H" Bridge Module is a member of Intellitec's Multiplex Control family. It works in combination with the PMC CPU and other standard, semi-custom, or custom I/O modules.

The 916-120 provides power fusing, switching, and distribution all in one module. It would typically be used to operate reversible motor loads. This module has eight, 10 amp SPDT relays connected in four "H" bridge configurations. When a channel is activated, it connects one end of the load to the Battery, while the other end is connected to Ground. Each of the four "H" bridges is fed from a fuse position that can be filled with a fuse, or circuit breaker. The total module current should not exceed 20 Amps.

The Quad "H" Bridge Module includes 9 diagnostic LED's. One indicates the loss of the communication signal and the others indicate the activation of the individual outputs.

Each of the first eight channels will turn on one of the relays in the four "H" bridges. A channel 9 signal will turn on all the odd numbered channel relays and channel 10 signal will turn on all the even channels. This allows simultaneous operation of the four motor loads with a single input.

Each of the outputs can also be used as individual outputs with the understanding that the load will be grounded when turned off. This allows the module to power up to 8 individual loads.



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

All of the output harnesses are connected with AMP Mate-N-Lok connectors to reduce installation time and errors.

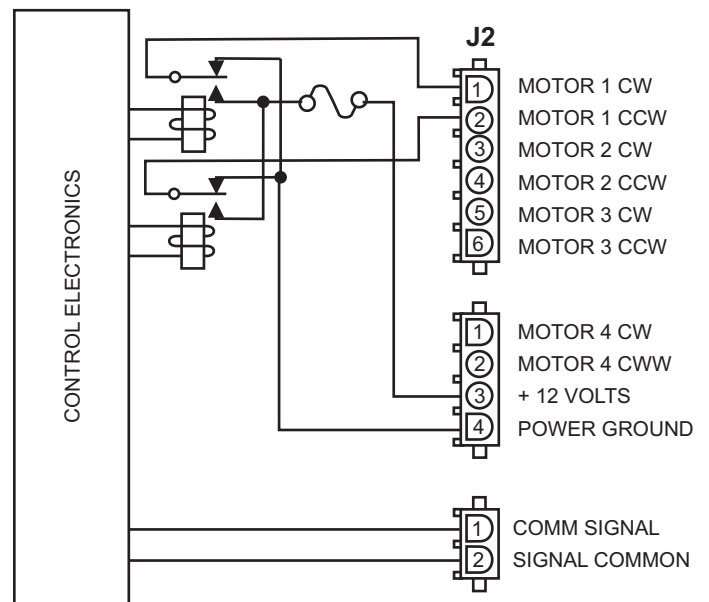
The approximate module dimensions are:
5.8" X 5.0" X 1.45" (147mm X 127mm X 36mm).

The module should be installed in a protected environment, inside the vehicle.

| TRUTH TABLE EXAMPLE | | | | | | |
|---------------------|----------|----------|-----------|---------|------|------|
| PMC CH 1 | PMC CH 2 | PMC CH 9 | PMC CH 10 | MOTOR 1 | J2-1 | J2-2 |
| OFF | OFF | OFF | OFF | OFF | GND | GND |
| ON | OFF | OFF | OFF | CW | BAT+ | GND |
| OFF | ON | OFF | OFF | CCW | GND | BAT+ |
| ON | ON | OFF | OFF | OFF | BAT+ | BAT+ |
| OFF | OFF | ON | OFF | CW | BAT+ | GND |
| OFF | OFF | OFF | ON | CCW | GND | BAT+ |

Repeat for motors 2,3 and 4
Channels 9 & 10 affect all motors

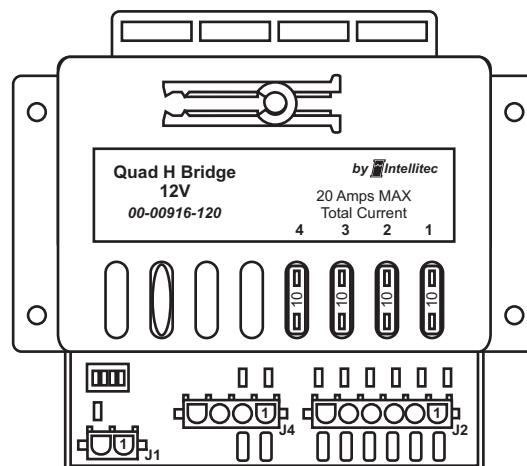
NOTE: Only one output circuit shown



SPECIFICATIONS

General Connections

| | | 00-00916-120 |
|-------------------------|------------|--------------|
| Nominal Vehicle Voltage | | 12V |
| Module Current | | 20 Amp Max |
| J4-3 | + 12 Volts | |
| J4-4 | Ground | |
| J1-1 | PMC Signal | 18 awg Min |
| J1-2 | PMC Ground | 14 awg Min |



CHANNEL DESIGNATIONS

| Channel | Relay | Connection | Type | Fuse | Rating |
|---------|---------------------------|------------|-----------------------------|--------|------------|
| 1 | Relay 1 | J2-1 | Relay Output, Form C (SPDT) | Fuse 1 | 10 Amp Max |
| 2 | Relay 2 | J2-2 | Relay Output, Form C (SPDT) | Fuse 1 | 10 Amp Max |
| 3 | Relay 3 | J2-3 | Relay Output, Form C (SPDT) | Fuse 2 | 10 Amp Max |
| 4 | Relay 4 | J2-4 | Relay Output, Form C (SPDT) | Fuse 2 | 10 Amp Max |
| 5 | Relay 5 | J2-5 | Relay Output, Form C (SPDT) | Fuse 3 | 10 Amp Max |
| 6 | Relay 6 | J2-6 | Relay Output, Form C (SPDT) | Fuse 3 | 10 Amp Max |
| 7 | Relay 7 | J3-1 | Relay Output, Form C (SPDT) | Fuse 4 | 10 Amp Max |
| 8 | Relay 8 | J3-2 | Relay Output, Form C (SPDT) | Fuse 4 | 10 Amp Max |
| 9 | All Odd Number Relays ON | | | | |
| 10 | All Even Number Relays ON | | | | |

NOTE:

The relays provide a fused source of voltage to the Load from the Battery when ON and Ground when OFF.

MATING CONNECTIONS

| Designator | Function | Connector | Mating Part # | Contact, Typical |
|------------|---------------|----------------------|---------------|------------------|
| J1 | PMC/Com | 2 Pin Amp Mate-N-Lok | 1-480698-0 | 350919-3 |
| J2 | Outputs | 6 Pin Amp Mate-N-Lok | 640585-1 | 350919-3 |
| J4 | Outputs/Power | 4 Pin Amp Mate-N-Lok | 1-480700-0 | 350919-3 |

MODULE SETTINGS

Module can be set for 1 of 16 address.
Set four position dip switch 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 |

The PMC 6 Relay / 4 Input I/O Module 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 917 module provides six undedicated relays for switching floating signals. Each relay can carry up to 10 amps of current. There are diagnostic LED's for each of the relay circuits. These LED's will light when the respective relay is closed.

In addition to the six output diagnostic LED's on the outputs, there is also one that indicates the failure of communications. This LED will light in the event of loss of signal.

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. There are four jumpers on the board that can be set to have the input be a high side or low side input.

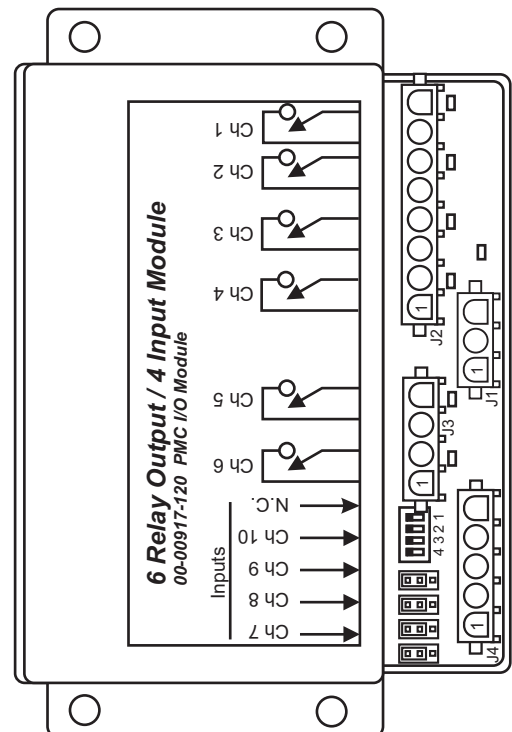


With the jumper closest to the edge of the board, the inputs will be high side. In other words, when the input is high, there will be an output on the PMC bus.

The module address can be set from A through P by use of the dip switch located on the edge of the board. Addressing information is available on the back of this brochure.

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 4.375" X 1.625" (162mm X 111mm X 42mm). *It should be installed in a protected environment, inside the vehicle.*



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

SPECIFICATIONS

General Connections

| | | 00-00917-120 | 00-00917-240 |
|-------------------------|---------------|--------------|--------------|
| Nominal Vehicle Voltage | | 12V | 24V |
| J1-1 | PMC +12 volts | 18 awg Min | 18 awg Min |
| J1-2 | PMC Signal | 18 awg Min | 18 awg Min |
| J1-3 | PMC Ground | 14 awg Min | 14 awg Min |

MATING CONNECTIONS

| Designator | Function | Connector | Mating Part # | Contact, Typical | |
|------------|----------|----------------------|---------------|------------------|---------------|
| | | | | for 14-18 AWG | for 10-12 AWG |
| J1 | PMC/Com | 3 Pin Amp Mate-N-Lok | 1-480700-0 | 350919-3 | 640310-3 |
| J2 | Outputs | 8 Pin Amp Mate-N-Lok | 640586-1 | 350919-3 | 640310-3 |
| J3 | Outputs | 4 Pin Mate-N-Lok | 1-480702-0 | 350919-3 | 640310-3 |
| J4 | Inputs | 5 Pin Mate-N-Lok | 1-480763-0 | 350919-3 | 640310-3 |

CHANNEL DESIGNATIONS

| Channel | Connection | Type | Name | Rating |
|---------|------------|---------------------------------|----------|---------------------|
| 1 | J2-7 & 8 | Relay Output, Form A (SPST),(1) | Relay 1 | 10 Amp Max |
| 2 | J2-5 & 6 | Relay Output, Form A (SPST),(1) | Relay 2 | 10 Amp Max |
| 3 | J2-3 & 4 | Relay Output, Form A (SPST),(1) | Relay 3 | 10 Amp Max |
| 4 | J2-1 & 2 | Relay Output, Form A (SPST),(1) | Relay 4 | 10 Amp Max |
| 5 | J3-3 & 4 | Relay Output, Form A (SPST),(1) | Relay 5 | 10 Amp Max |
| 6 | J3-1 & 2 | Relay Output, Form A (SPST),(1) | Relay 6 | 10 Amp Max |
| 7 | J4-1 | Input, Positive or Negative | Switch 1 | 2K Input Resistance |
| 8 | J4-2 | Input, Positive or Negative | Switch 2 | 2K Input Resistance |
| 9 | J4-3 | Input, Positive or Negative | Switch 3 | 2K Input Resistance |
| 10 | J4-4 | Input, Positive or Negative | Switch 4 | 2K Input Resistance |

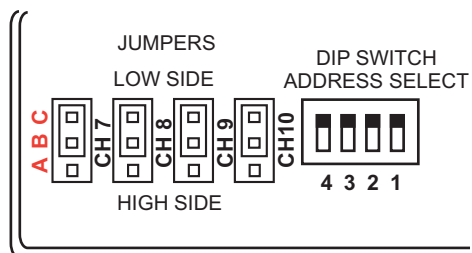
MODULE SETTINGS

Module can be set for 1 of 16 address.

Set four dip switches per table to the right.

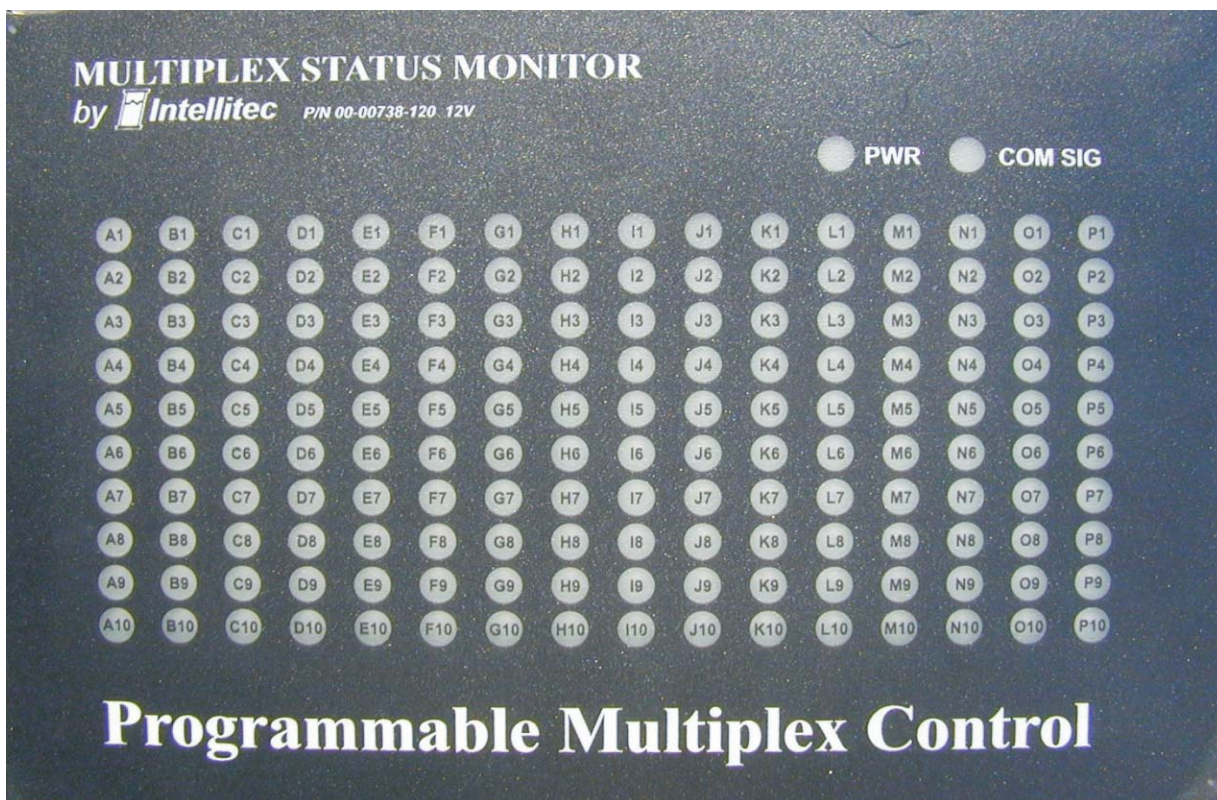
X = Switch is OFF.

(Switches shown in ON position.)



| DIP SWITCH | MODULE | DIP SWITCH | MODULE |
|------------|---------|------------|---------|
| 4 3 2 1 | Address | 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 |

Four inputs, CH7 thru CH10, 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.



Part Number
00-00738-120 12 Volt
00-00738-240 24 Volt

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, it 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 troubleshooting, 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.

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.

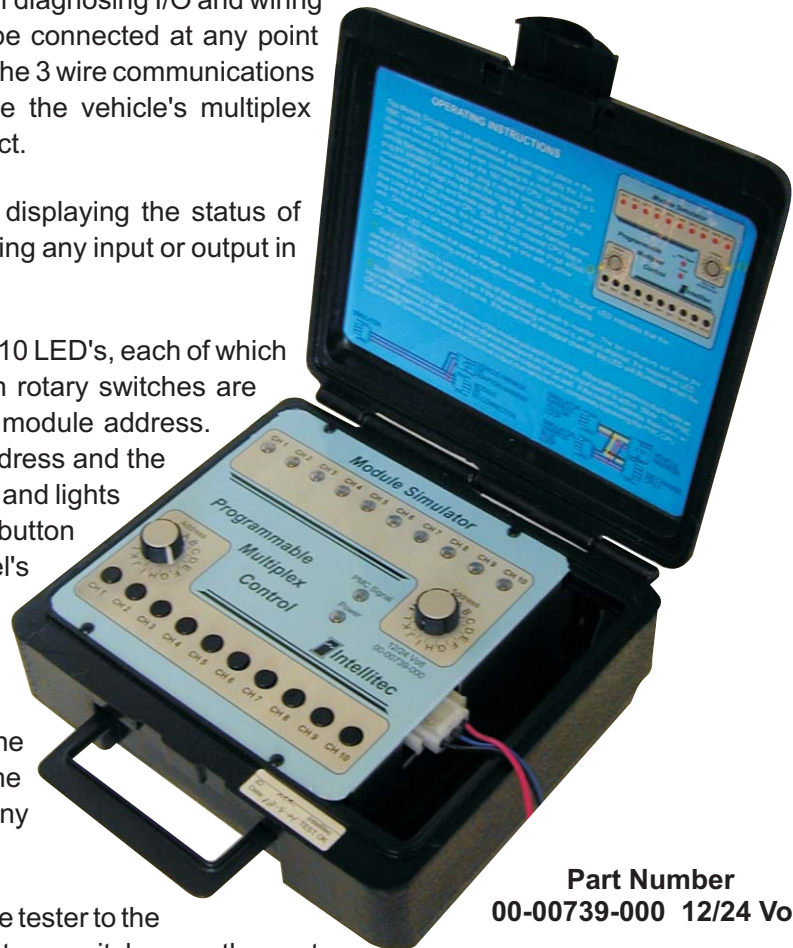
The tester has 10 push button switches and 10 LED's, each of which are related to a channel. Two, 16-position rotary switches are used to set the switches and lights to any module address. The switches can be set for one module address and the lights can be set for another, or the switches and lights 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.



Part Number
00-00739-000 12/24 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.

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.

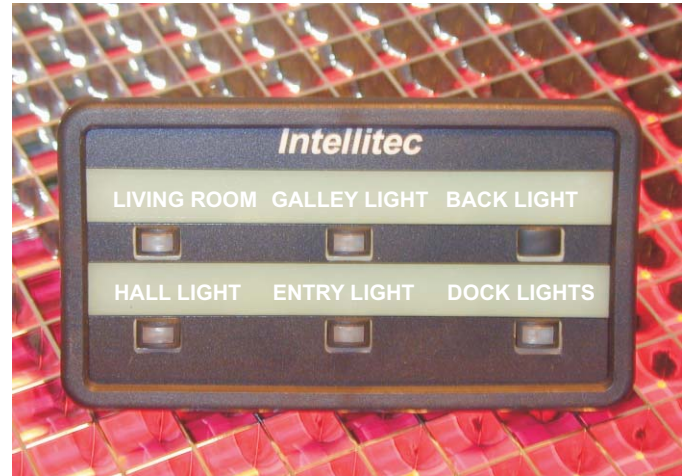
The switch LEDs can be programmed as any other output in the system and will come on based on the boolean logic statement written for them. The most common use is to set them equal to the output that they turn on. When this is done, the LED will indicate the actual state of the output. In other words, 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.

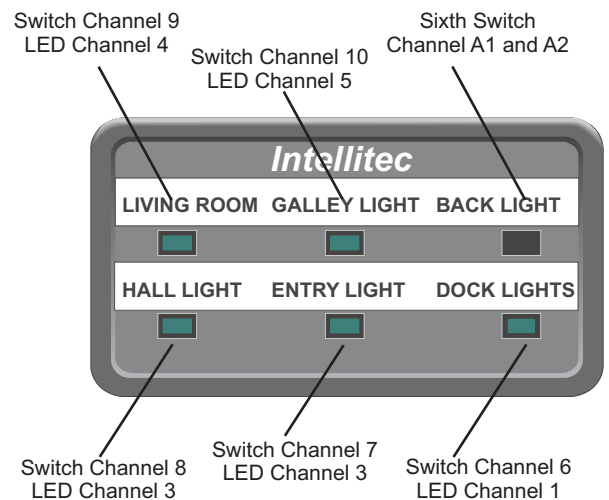
If you choose, Channel A1 can be used with a timer as a master off switch. By pressing and holding the sixth switch, you can cause outputs that you select to turn off when the button is held. In this case, a latching boolean for the outputs would be written, instead of latching the switch that is cleared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



Switch Legends printed on paper with computer printer. Paper placed under overlay w/clear windows.

Size 2-5/8 x 4-3/4

CHANNELS



00-00759-000 12 VOLT

Multi-point Switching

6 BUTTON MULTIPLEX SW PNL 53-00841-000

The **Intellitec RV Multiplex system** is a flexible, 160 channel, communications system designed primarily for the RV industry. The system utilizes low speed, noise immune communications across standard wire and connections. A “building block” approach allows a designer to use as much, or as little of the system as he requires for his specific application.

RV Multiplex Master

The heart of the system is the **Intellitec RV Multiplex Master**. The Master generates the 160 channel, 4 kilohertz, **Intellitec** proprietary signal for system communications. It also supplies the power for the back-lighting of the switch panels. There are diagnostic LED's on-board to help in trouble shooting any problems which may occur.

Latching Relay Output Module

The Latching Relay Output Module has 10 relay switched outputs. Each output communicates an indicator signal, back through the communications wire to the switch panels to indicate which state the output is in. There are five, fused 20 amp outputs and five, fused 10 amp outputs on each module. Each output has a diagnostic LED on board to help in any trouble shooting which may be necessary.



Solid State Latching Output Module

The Solid State Output Module has 10 solid-state high-side switched outputs, all rated for 10 amps each. This module also generates an indication signal back to the switch panels. All of the outputs are dim-able using pulse-width modulation. The dimming function operates by holding down the corresponding switch. When the switch is held down, the output will decrease and increase slowly until the desired level is reached and the switch is no longer pressed. A single press of the switch turns the output off. The next press of the switch will turn the output back on to the previous level the output was at, when it was turned off.

Programmable Switch Panel

The switch panels are all configurable, back-lit, and have status indication for each channel. The programming is a simple, “Windows” based system, with point and click programming to assign each switch a channel. This allows for very flexible, easy to change designs. The switch panels come in 10 and 6 channel configurations.



1485 Jacobs Rd Deland FL 32724
386 738 7307

P/N 53-00320-001 REV C 071519

Multi-point Switching

6 BUTTON MULTIPLEX SW PNL 53-00841-000

RV Multiplex Master

Part Number: 00-00837-000
Input Voltage Range: 9-16 volts DC
Standby Current: approximately 10 milliamps
Max Current Draw: 5 amps
Signal Frequency: 4Khz
Operating Environment: Out of direct weather



Latching Relay Output Module

Part Number: 00-00838-000
Input Voltage Range: 9-16 volts DC
Standby Current: approximately 8 milliamps
Output Rating: 5 outputs of 10 amps max
5 outputs of 20 amps max
100 amps max total
Operating Environment: Out of direct weather

Latching Solid State Output Module

Part Number: 00-00844-120
Input Voltage Range: 9-16 volts DC
Standby Current: approximately 8 milliamps
Output Rating: 10 amps max per output
Operating Environment: Out of direct weather

Configurable Switch Panel

Part Numbers:
Black 10 Button: 00-00869-010
Black 6 Button: 00-00869-006
White 10 Button: 00-00869-110
White 6 Button: 00-00869-106
Pumice 10 Button: 00-00869-210
Pumice 6 Button: 00-00869-206

Standby Current: approximately 8 milliamps
Operating Environment: Out of direct weather



Intellitec

1485 Jacobs Rd Deland FL 32724
386 738 7307

P/N 53-00320-001 REV C 071519

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. *There 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
- 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.intellitec.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 |
|-----------------|--|--------------|------------------------------|-------------------|------------------|
| 00-00870-010 | | 10 | Bright Grn/Amber | Yes | 870 |
| 00-00870-210 | | 10 | Bright Grn/Red | Yes | 870 |
| 00-00874-006 | | 6 | Bright Grn/Amber | Yes | 874 |
| 00-00874-206 | | 6 | Bright Grn/Red | Yes | 874 |
| 00-00870-006 ** | | 6 | Bright Grn/Amber | Yes | 874 |
| 00-00870-206 ** | | 6 | Bright Grn/Red | Yes | 874 |
| 64-00274-000** | | 6 | Cover Plate (specific) | | |
| | | | | | |
| PMC 24V | | # of Buttons | Back light / Indicator Light | Dimmable Lighting | Windows Software |
| 00-00879-010 | | 10 | Bright Grn/Amber | Yes | 870 |
| 00-00879-210 | | 10 | Bright Grn/Red | Yes | 870 |
| 00-00880-006 | | 6 | Bright Grn/Amber | Yes | 874 |
| 00-00880-206 | | 6 | Bright Grn/Red | Yes | 874 |

**Switch Panel p/n 00-00870-006 and -206 are 6 button switch panels; each has 4 inputs to be used with remote switches. The cover p/n is 64-00274-000.

All 6 Button Switch Panels may be modified to make a 4 Button Switch Panel available, if desired.

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

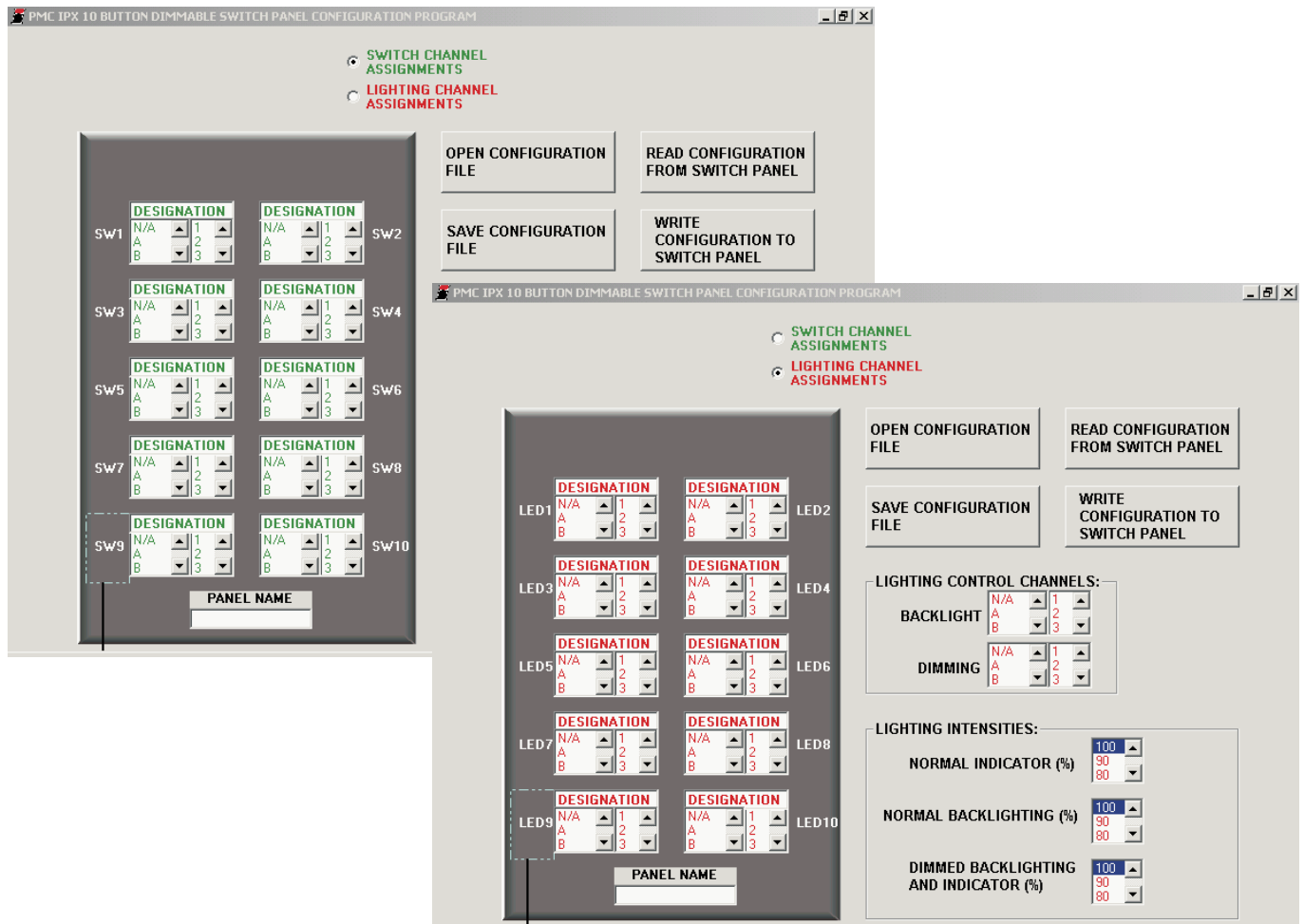
PMC KEYPAD FUNCTION

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 keypad.

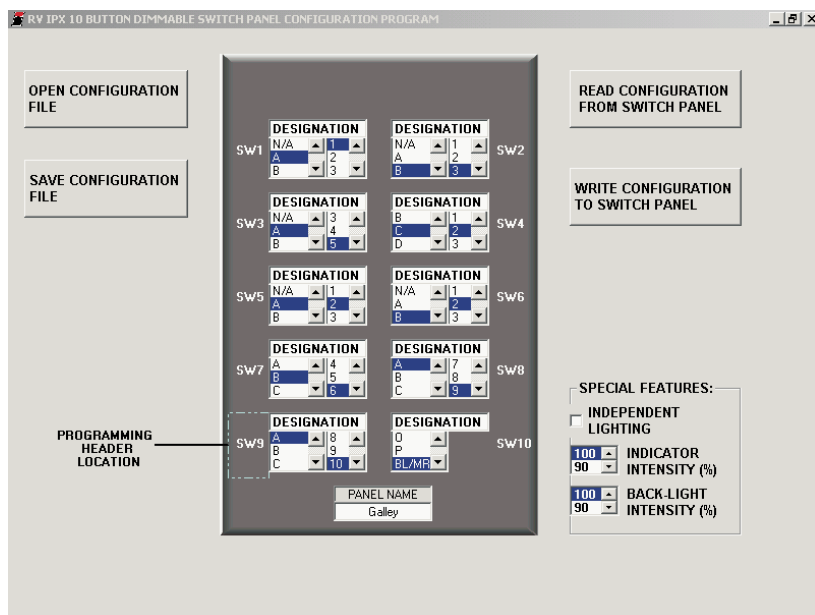
KEYPADS FOR USE WITH THE MULTIPOINT (RV MPX) SYSTEM USING MASTER 00-00837-000

| RV Multiplex | # of Buttons | Back light / Indicator Light | Dimmable Lighting | Windows Software |
|--------------|--------------|------------------------------|-------------------|------------------|
| 00-00869-010 | 10 | Bright Grn/Amber | Yes | 869 |
| 00-00869-210 | 10 | Bright Grn/Red | Yes | 869 |
| 00-00873-006 | 6 | Bright Grn/Amber | Yes | 873 |
| 00-00873-206 | 6 | Bright Grn/Red | Yes | 873 |

**Switch Panel p/n 00-00869-006 and -206 are 6 button switch panels; each has 4 inputs to be used with remote switches. The cover p/n is 64-00274-000.

All 6 Button Switch Panels may be modified to make a 4 Button

| RV Multiplex | # of Buttons | Back light / Indicator Light | Dimmable Lighting | Windows Software |
|----------------|--------------|------------------------------|-------------------|------------------|
| **00-00869-006 | 6 | Bright Grn/Amber | Yes | 869 |
| **00-00869-206 | 6 | Bright Grn/Red | Yes | 869 |
| **64-00274-000 | 6 | Cover Plate (specific) | | |



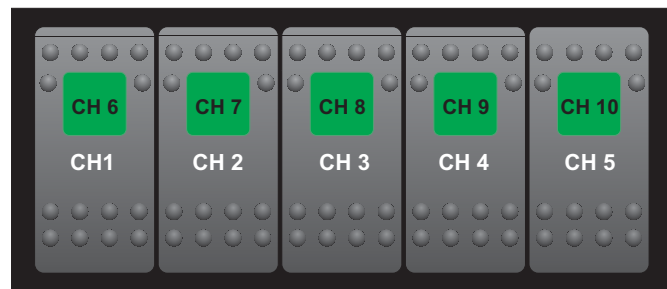
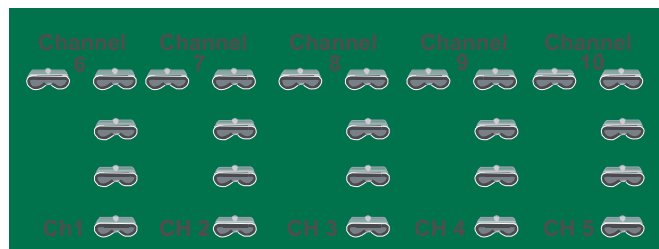
| # of Buttons | Cover Plate | Color |
|--------------|--------------|--------|
| 10 | 64-00272-000 | Black |
| 4 | 64-00276-000 | Black |
| 6 | 64-00277-000 | Black |
| 10 | 64-00272-100 | White |
| 4 | 64-00276-100 | White |
| 6 | 64-00277-100 | White |
| 10 | 64-00272-200 | Pumice |
| 4 | 64-00276-200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

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**

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 | |

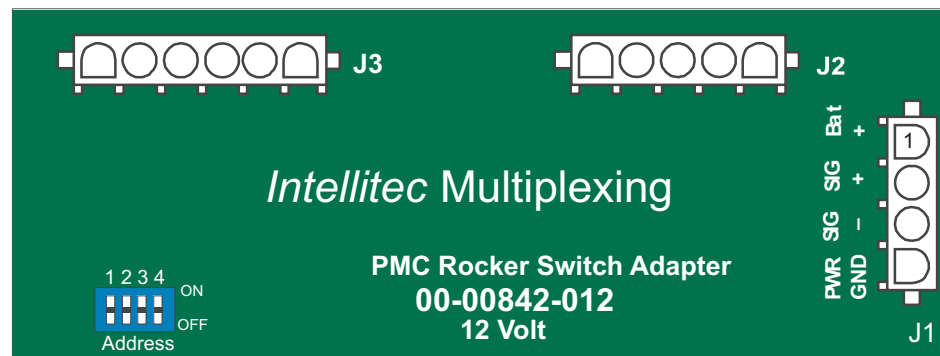
3 POSITION ON/OFF/ON SWITCH

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 | MODULE | Dip SW | MODULE |
|---------|---------|---------|---------|
| 4 3 2 1 | Address | 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 |

Chapter 3

Designing and Wiring a System

Designing a System

Creating an I/O List

The first step in designing the system, is to determine the functions that will be multiplexed on the vehicle. These can include most switched functions, such as; lighting, heating, air conditioning, 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 capability and flexibility through programming. 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. 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 in two columns one headed inputs and the other outputs. An input is a switch, such as door switches, panel switches, oil pressure switches, neutral safety, etc. **We call this an I/O list.**

The next step is to decide which modules to use and where to put them. Chapter two provides information on each module that is available for the system. As time passes additional modules will become available. *To obtain the latest specifications and module functions, visit our website at www.intellitec.com.*

Module choices are relay or solid-state outputs, current ratings, push buttons or rocker switches, etc. The best approach for choosing which modules to use is to visualize the vehicle; it would be better yet 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, which will be located as needed throughout the vehicle. 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 do not be concerned, modules can always be added 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.* **When programming the system, the programmer will always ask himself, "What turns the output on?"** This is often just a single switch, but can also be any combination of inputs, timers and even other outputs. *We will explore programming in more detail in later chapters.*

The following pages of this chapter provide information regarding the communications wiring.

Designing a System

IPX OR PMC SYSTEMS

GENERALLY CONSISTS OF THREE MAJOR SYSTEM COMPONENTS

DEFINITIONS:

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. 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. The Slaves communicate their status to the rest of the system and to 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, consisting 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 Communications Harness, the other major system component, 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:

COMMUNICATION HARNESS GUIDELINES

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 or CPU, with a 5A or smaller fuse. In the case of an output module, this lead does not supply power to the loads. A separate high current power connection is supplied on the output module.
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 **should not** be shielded, or twisted. This has been found to be detrimental to the communications signal. Three-conductor, over-molded cable, can be used on very short harnesses, but generally should be avoided because 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. Individual wires, such as those used in the rest of the vehicle should be used.

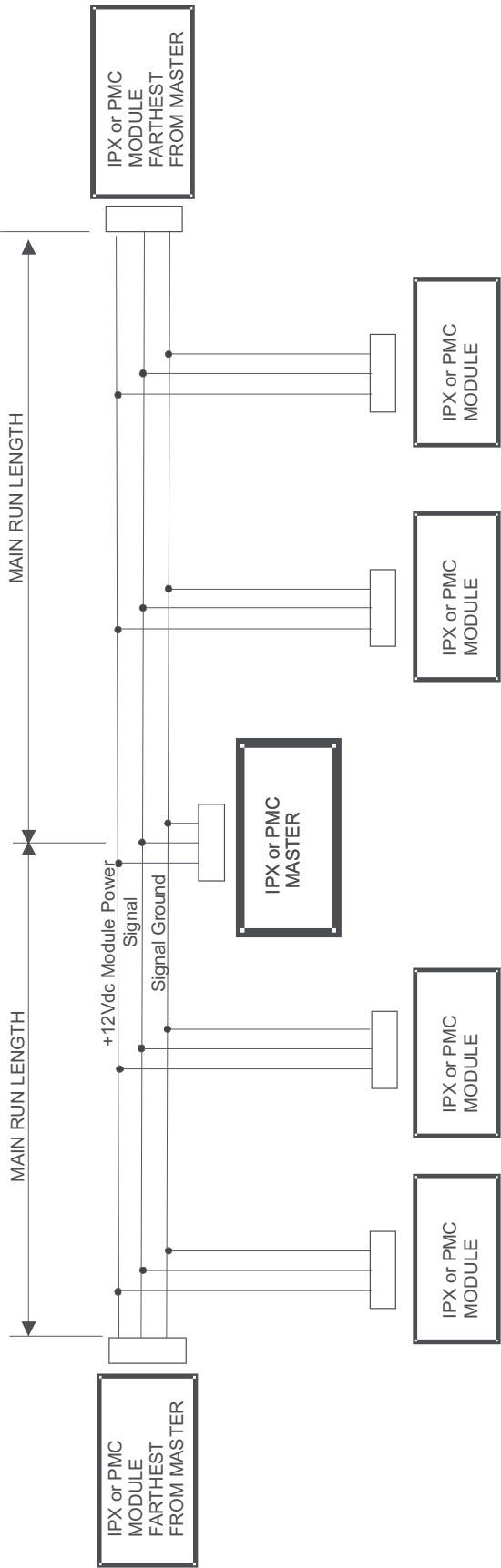
Designing a System

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. To minimize the equivalent length of the main run on very large vehicles, it is advisable to locate the Master centrally with respect to the main run, by essentially dividing it in half.
6. On systems where multiple modules are connected to the Communications Harness and the main run is 50ft. or less in length, 18 Awg wire is suitable for all three wires. If the main run is from 50 to 100 feet in length, 16 Awg wire is required. If the main run is greater than 100 feet in length, 14 Awg wire is required. **When switch panels or other modules that place back-light current on the communication ground are connected, we recommend 14 Awg wire for communication ground from the switch panels back to the CPU.**
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.

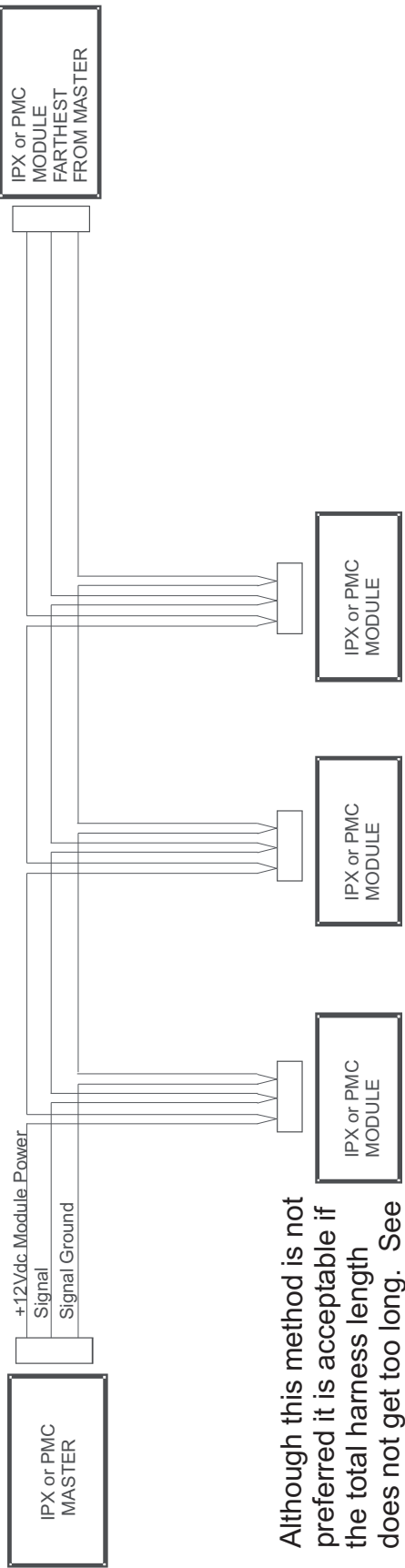
Refer to the following page for a graphic illustration.

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

Preferred wiring method

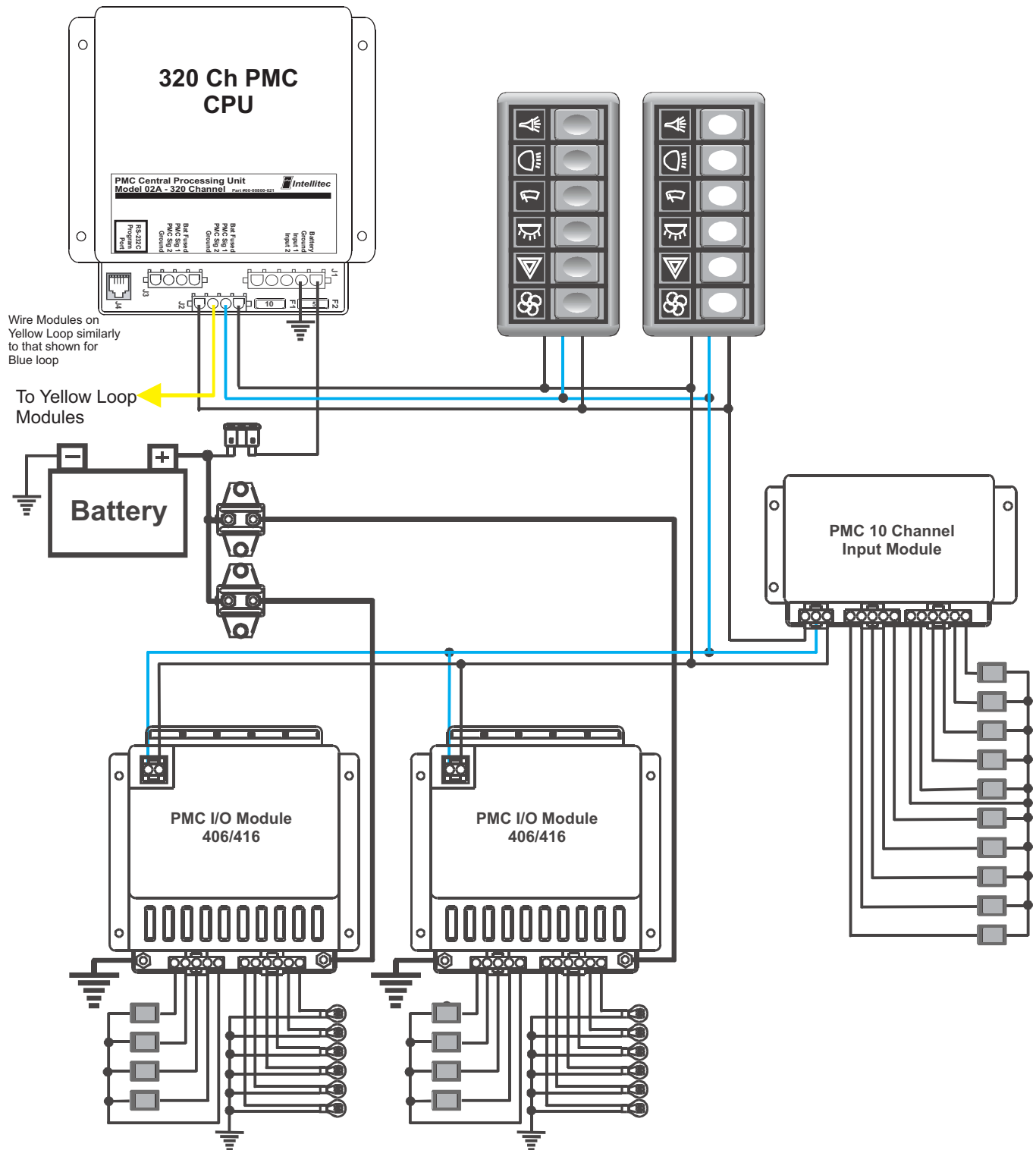


**Non preferred method.
increases total harness
length.**



Although this method is not preferred it is acceptable if the total harness length does not get too long. See the preceding page for wire gauge based on harness length.

COMMUNICATIONS HARNESS



Chapter 4

Getting Ready to Program Labeling the System, Modules and Channels

Getting Ready to Program the System

After 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 record them. Two words must be emphasized here: **organization** and **documentation**. This can't be emphasized enough. Without 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 along.

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**

In the future we will refer to these relationships as Booleans.

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

Light = Switch OR Ignition

(This statement means that if either the switch is on or ignition is on, the light will be on.)

Light = Switch AND Ignition

(This statement means that both the switch and ignition inputs must be on for the light to be on.)

Another operator that needs to be discussed is the **NOT** function.

This is written into the Boolean logic statement as follows: **Light = Switch AND NOT ignition**

(This statement means that the light will be on when the switch is on and ignition is not on.)

The last and final operator is **PR**, which stands for **prior state**.

This will be discussed in detail later in this chapter.

Short hand is as follows OR = +, AND = *, NOT = !, Prior State = Pr

Example: Light = Switch + ! Ignition

Just as you would in algebra, parenthesis can also be used to group items.

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 (I/O list) and relationships of the inputs and outputs have been determined and recorded, then it is time to program the system. All the programming is done using a computer with Windows™ and the Intellitec WinPMC programming software. The first step is to install the program on a computer. There are two versions of the programming software. WinPMC allows you to program the 160 channel CPU and WinPMCII allows you to program the 320 channel CPU.

Some features such as Pr (prior state) are not available with the 160 channel system.

Once you have installed the program, an icon will appear on your desktop. Double click the icon to open WinPMC II. Once opened, the tip of the day screen will appear. The "tips" screen should be closed by clicking on the "X" in the upper right-hand corner of the window.

To gain programming rights, contact intellitec for a password. After you have obtained the password, open the WinPMC II software and open the utility menu. Select password and enter it on the screen provided. The password enables programming rights. Without the password, the program can be used to read relationships previously programmed into a vehicle, or it may be used to upload/download previously written programs to and from a CPU. This is useful if an OEM wishes to email changes to a dealer, to allow the dealer to download them to the vehicle. This allows the OEM to maintain control over the functions of the vehicle.

Getting Ready to Program the System

This password is only required one time immediately after software installation to enable programming rights. Once you have entered the password on your computer, it will not be needed again. The password expires 2 weeks after it has been issued. If you wish to install the software on another computer at a later date, a new password can be obtained from Intellitec.

IMPORTANT

To begin programming from scratch, **be sure there are no commands remaining in the computers memory. This is IMPORTANT! as the previous program you had written could mix with the new program you are about to write.** To clear the memory click on **"PMC Labels"**, select **"Clear All"**. The panel will appear asking if you want to clear the entire system. Click **"OK"**. This clears the memory.

WARNING *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 to the CPU via the RS232 cable while writing the program. The program can be written and stored as a file on your computer, then downloaded to the PMC CPU at a later time. With the port open and CPU connected, changes made to Booleans (logic statements) are immediately transmitted to the CPU and take effect immediately.

TO MODIFY AN EXISTING PROGRAM THAT IS ALREADY ON THE VEHICLE

Begin by clearing the memory in the computer with the port closed.

Then do one of the following:

- Open the port and upload the file from the CPU

- Open the port and download the new file from your computer and transfer it to the PMC CPU.

Make modifications as necessary.

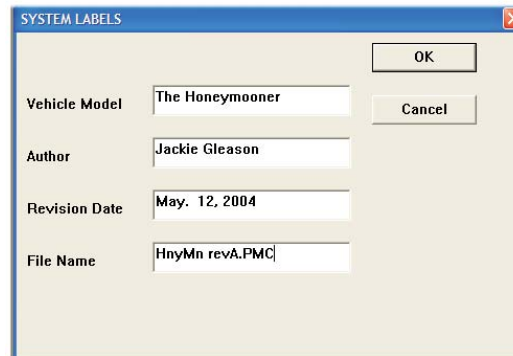
LABELING

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, as well as in your computer and will appear on the spreadsheet. *The PMC spreadsheet will be discussed later.* From the PMC Labels menu, select "System Label". 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. The revision date changes automatically, when the program is revised.

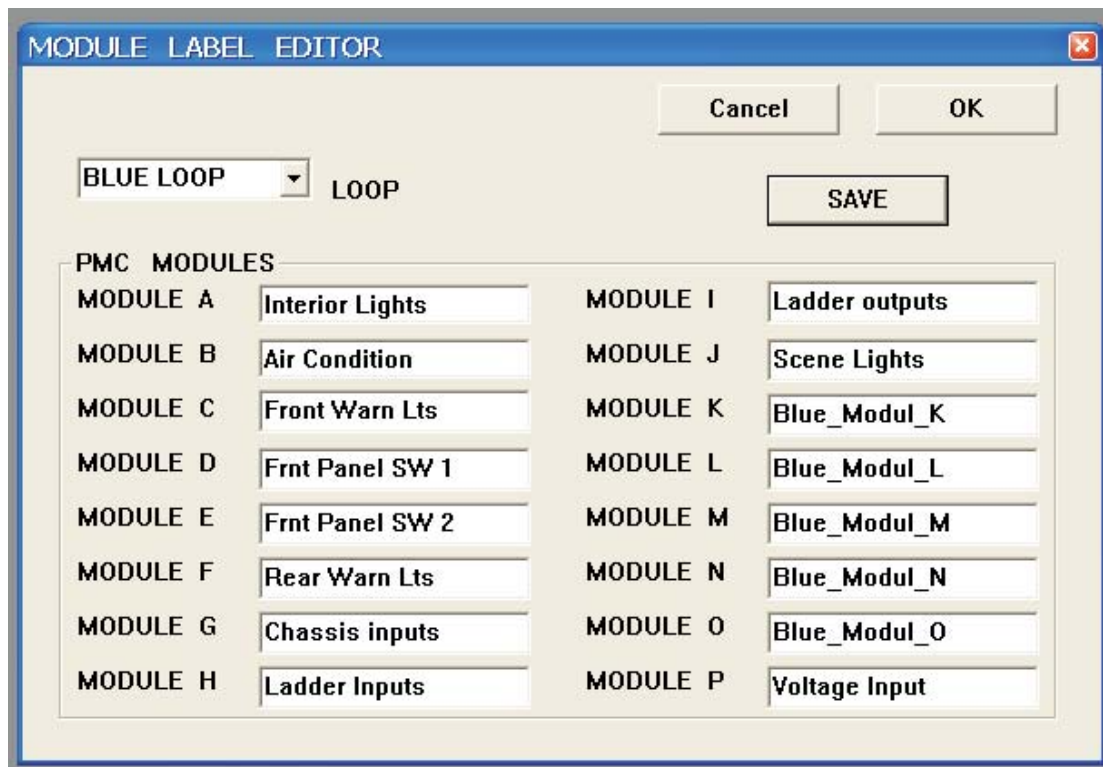
Getting Ready to Program the System



A dialog box titled "SYSTEM LABELS" with a close button (X) in the top right corner. It contains four text input fields: "Vehicle Model" with the text "The Honeymooner", "Author" with "Jackie Gleason", "Revision Date" with "May. 12, 2004", and "File Name" with "HnyMn revA.PMC". There are "OK" and "Cancel" buttons in the top right corner.

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.



A dialog box titled "MODULE LABEL EDITOR" with a close button (X) in the top right corner. It features a "Cancel" button and an "OK" button in the top right. Below these is a dropdown menu showing "BLUE LOOP" and a "LOOP" label. A "SAVE" button is located below the "LOOP" label. The main area is titled "PMC MODULES" and contains two columns of module labels, each with a text input field for naming the module.

| PMC MODULES | |
|-------------|-----------------|
| MODULE A | Interior Lights |
| MODULE B | Air Condition |
| MODULE C | Front Warn Lts |
| MODULE D | Frnt Panel SW 1 |
| MODULE E | Frnt Panel SW 2 |
| MODULE F | Rear Warn Lts |
| MODULE G | Chassis inputs |
| MODULE H | Ladder Inputs |
| MODULE I | Ladder outputs |
| MODULE J | Scene Lights |
| MODULE K | Blue_Modul_K |
| MODULE L | Blue_Modul_L |
| MODULE M | Blue_Modul_M |
| MODULE N | Blue_Modul_N |
| MODULE O | Blue_Modul_O |
| MODULE P | Voltage Input |

To name a module, select the loop that the module is attached to, either Blue or Yellow. Then, click in the box of the module you want to name. Enter a name that describes the module, application, or location for that module. The names are limited to 15 characters. Continue to do this for each module in the system. When you have finished, click on Save before changing loops, or "OK" to exit the Module Editor.

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. ***Since input and output names are often similar, we recommend that you label inputs and switches with a descriptor. For example “Head Lt SW”.*** This way you will not be confused later on as to whether the channel is an input or output. ***Do not use the same label for more than one channel.***

To label channels, 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 the loop selector (*the 160 channel CPU does not have a loop selector*) and then, on the up or down arrow. Enter the label for each channel in the module. After each channel has been labeled, click on “Save” prior to moving on to the next module. Repeat this process for each module.

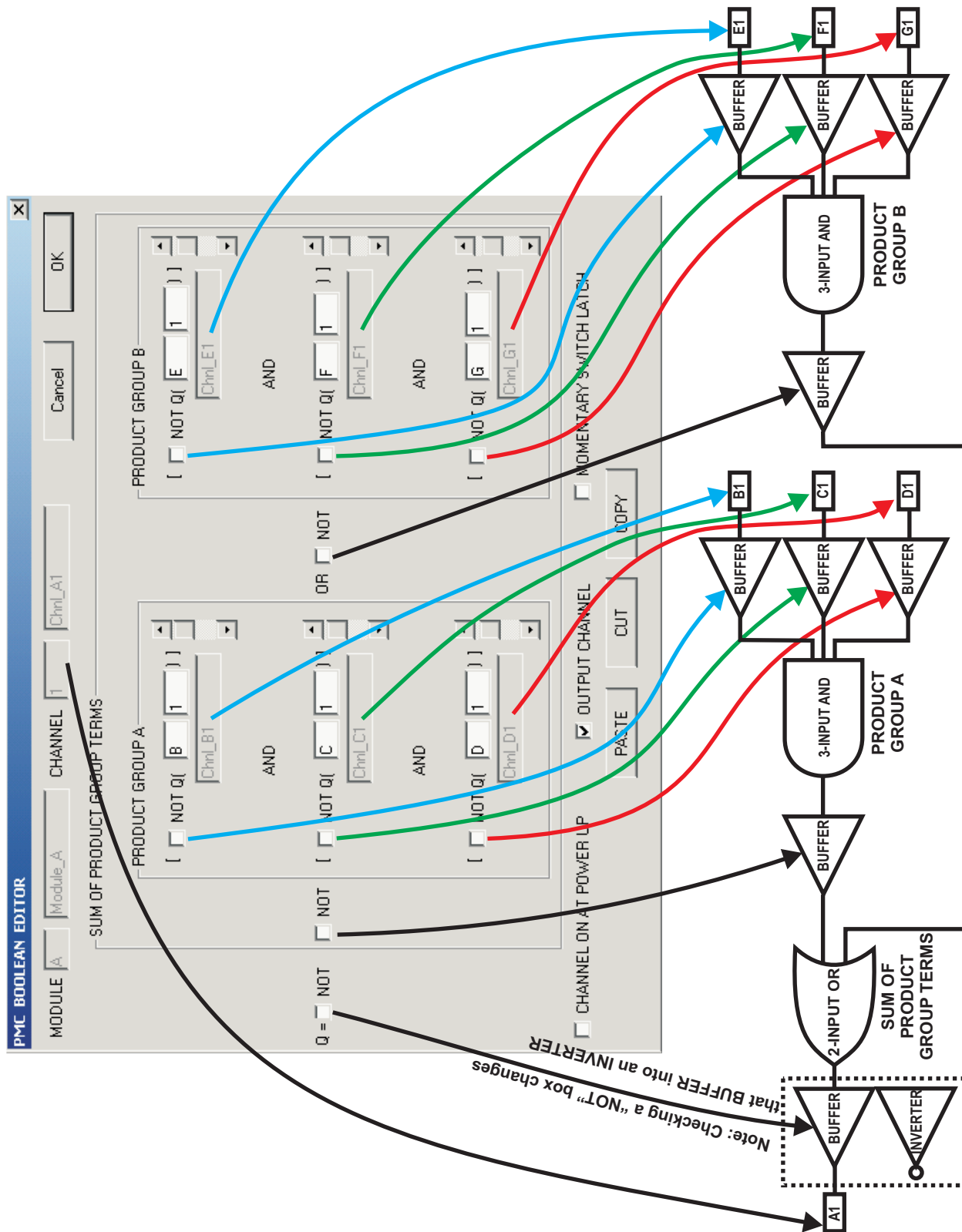
| CHANNEL | Label |
|------------|-----------------|
| CHANNEL 1 | Left Dome Lts |
| CHANNEL 2 | Right Dome Lts |
| CHANNEL 3 | Flourescent Lts |
| CHANNEL 4 | Crew cab Lts |
| CHANNEL 5 | RR stepwell Lts |
| CHANNEL 6 | Side door Lts |
| CHANNEL 7 | Rear door Lts |
| CHANNEL 8 | Action Area Lts |
| CHANNEL 9 | Vacuum Pump |
| CHANNEL 10 | Spare |

SAVING DATA

Now, you will save the data you have entered. Click on "File" to produce the “flyout”. Then, click on "Save as". The first time you do this for a particular system, you will have to name the file. Again, as mentioned previously, 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 the "Save" box.

Chapter 5

Set UP Logic Using PMC Software




SCHEMATIC LOGIC SYMBOL OF THE PMC BOOLEAN EDITOR SCREEN

Set Up Logic Using PMC Software

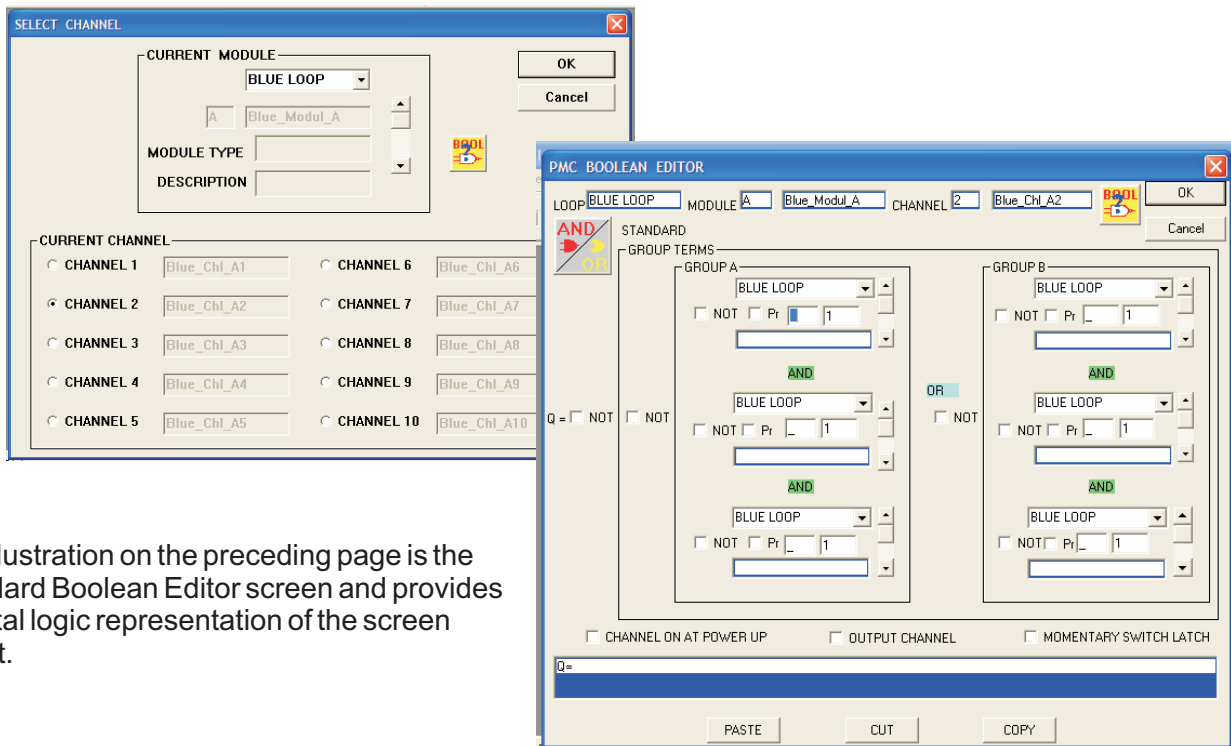
BOOLEANS

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 outputs are programmed. Boolean expressions must never be written for input channels.** Booleans are expressed as functions of the inputs. When writing a program, we should always ask ourselves “What turns the output on?” Never ask “What does the switch do?” This may seem to be the same thing, however; it will be helpful to you if this way of thinking is followed.


To begin, 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. Then, click on the "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.

The screens look like this:



The illustration on the preceding page is the Standard Boolean Editor screen and provides a digital logic representation of the screen layout.

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 theorem this single screen can also 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 further explanation). The screen shown above is from WinPMC II and the 320 channel CPU. You will note the AND/OR Icon. 

By repeatedly clicking this Icon, the screen can be changed to a 6 input AND, 6 input OR, 3 input OR AND'ed with a 3 input OR. With the 160 channel system, only the 3 input AND, Or'ed with a 3 input AND is available. DeMorgans theorem must be used to write a 6 input AND or OR.

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 put the output or light on channel BA1 and the input or switch on channel YC1. The equation for this function is written as:

$$\text{Light} = \text{Switch} \\ \text{BA1} = \text{YC1}$$

B = Blue Loop Y = Yellow Loop.

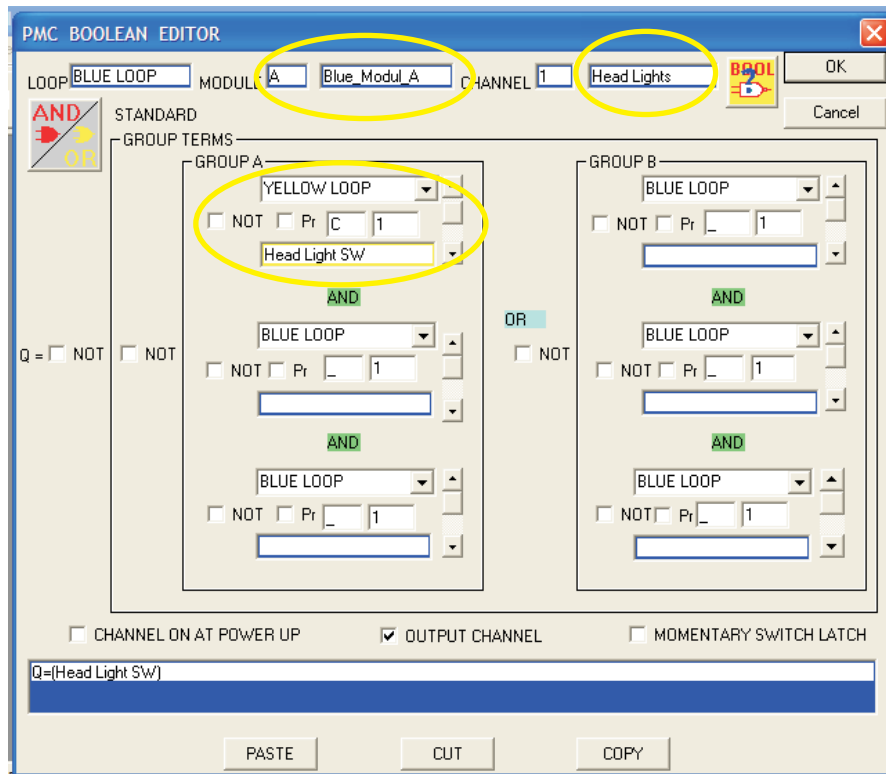
Note that the 160 channel CPU has only one loop, it's addresses do not include a B or Y.

With this equation, the output to the light on channel BA1 will go on when the switch YC1 goes on.

To input this equation, click on the red Bool icon in the task bar.  Select the loop and module whose output you want to program; in this case, "Blue Loop and Module A", clicking the up or down boxes until the loop and module you want is shown 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 its name and "Channel A1" and its 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 inverts that term in the expression. For example, the screen above says, that when the light switch YC1 is on, the light output BA1 will be on. If the "NOT" box were to be checked it would change the operation so that when the switch is off, the light is on.

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 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. **This box should never be checked for an input channel.** If you write a boolean and forget to check the box, the system will remind you.

The third small box, labeled "MOMENTARY SWITCH LATCH", indicates to the system that this is a momentary switch input 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 as though the pushbutton is a toggle switch, by latching the switch on and off 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. Depending upon the requirements of the system you may wish to write a boolean that will latch an output on, instead of latching the switch on. *We will discuss latching outputs later in this chapter.*

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

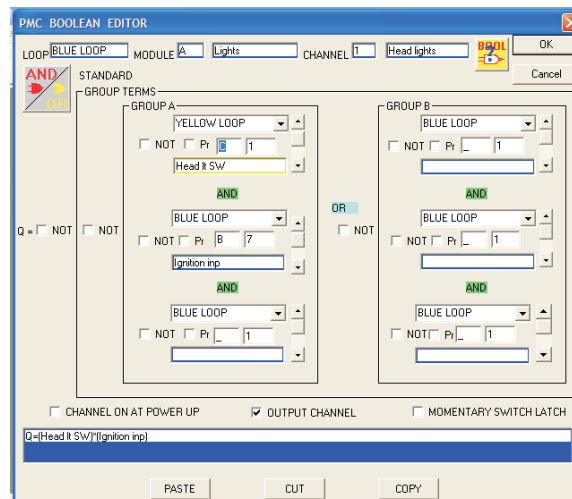
EXAMPLE

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 BA1, the head light switch on input channel YC1 and an ignition input on channel B B7, we would write the following Boolean.

Headlight = Headlight switch AND Ignition
BA1=YC1 AND BB7, or in short hand BA1=YC1*BB7

Let's see how we can use this screen to input the data of our example. Click on the Bool icon and navigate to the blue loop channel A1. In the top line of Product Group A, select yellow loop and the input C1, by clicking on the up or down boxes on the slide bar. The Tab key will step you through to the next box. In the second line of product group A, select the blue loop and B7, then click on the "Output Channel" at the bottom of the screen to designate this channel to be an output. If you forget to click on output channel, the program will ask you if you want it to be an output after you click on OK. When asked click "yes".

The screen will look like this:



As you write Boolean equations, remember that it is acceptable to set one output equal to another. 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 located 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

PMC BOOLEAN EDITOR

LOOP: BLUE LOOP MODULE: A Channel: 1 Head lights

AND OR

STANDARD GROUP TERMS

GROUP A:

- YELLOW LOOP AND Head lt SW
- BLUE LOOP AND Ignition inp
- BLUE LOOP

GROUP B:

- VIRTUAL LOOP AND Flasher virt
- BLUE LOOP AND Ignition inp
- BLUE LOOP

OR

Q = ☐ NOT ☐ NOT

☐ CHANNEL ON AT POWER UP ☒ OUTPUT CHANNEL ☐ MOMENTARY SWITCH LATCH

$Q = (\text{Head lt SW}) * (\text{Ignition inp}) + (\text{Flasher virt}) * (\text{Ignition inp})$

PASTE CUT COPY

THE EXAMPLE ABOVE SAYS

Headlights are ON, when the headlight switch and ignition is ON, or when the flash virtual channel is on and ignition is on.

Other ways to write this are:

Headlight = headlight switch AND Ignition OR flasher virt AND ignition

or

BA1=YC1*BB7+VA1*BB7

Assuming that virtual channel VA1 is programmed to flash, the headlight will flash when ignition is on and will burn steady when ignition is on and the headlight switch is on.

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 not limited to just these equations. Any channel can be used as an input for an expression. The system includes virtual channels at address Q for the 160 channel system. On the 320 channel CPU, there are 160 virtual channels in the virtual loop. These channels exist only in the software. In other words, there is no physical module with the address of Q, or on the virtual loop.

As in the example on the previous page, an expression can be written in a virtual channel. Then the virtual channels 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 channels, any nonexistent hardware module can be used as a virtual module. Any unused channel of an existing module can be used the same way. For example, 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. This is most important when using the 160 channel CPU, since it only has 10 virtual channels in the Q module.

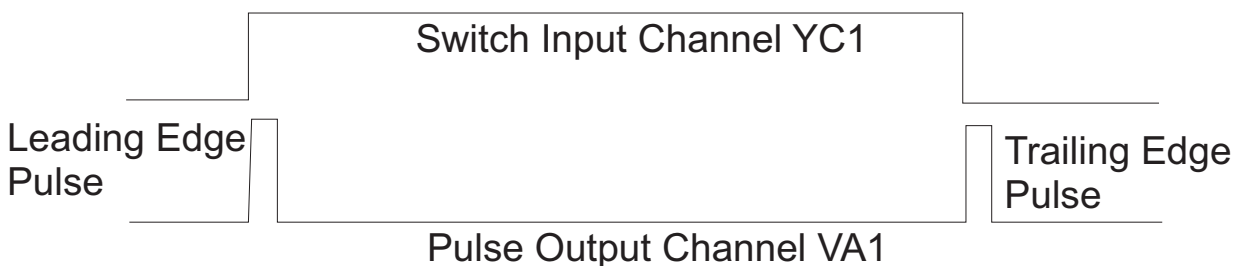
PRIOR STATE- EDGE DETECTION

You may have noticed check boxes on the Boolean Editor screen labeled PR. Prior State is most often used to create a pulse on another channel when a switch is first operated, or released. This is often referred to as edge detection. *Refer to the picture on the previous page and the description of the multiplex signal. As previously discussed, the multiplex signal consists of a sync pulse, followed by 160 clock pulses. This is a cycle that occurs every .040 seconds. The CPU also evaluates the position of every input and output during this cycle. When the prior state box is checked, the CPU remembers the state of the channel in the prior cycle and compares it with the present cycle. Edge detection is most often used in Booleans to latch outputs on and off. Examples of edge detection and latched outputs follow.*

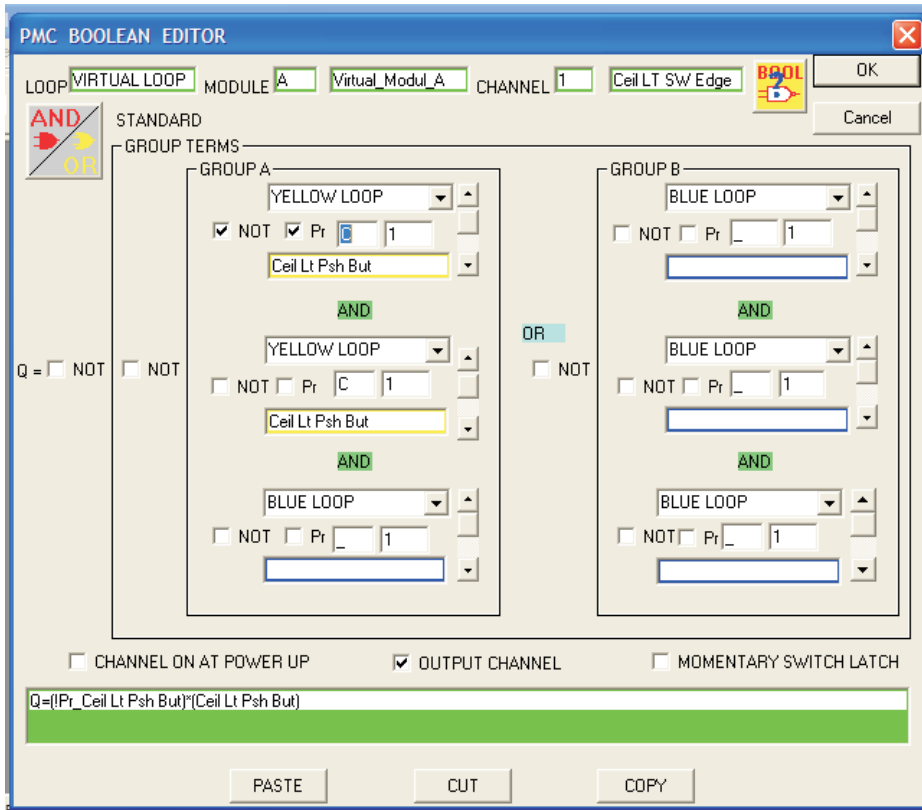
EDGE DETECTION 320 CHANNEL CPU

The purpose of edge detection is to create a short pulse on a channel when a switch is opened or closed. *If the pulse occurs when the switch is closed, we refer to this as the **leading edge**. If the pulse occurs when the switch is opened, we refer to this as the **trailing edge**.* The pulse channel will be on for only 0.040 seconds until the boolean for the pulse channel is evaluated again.

EDGE DETECTION 160 CHANNEL CPU (See page 9-19)



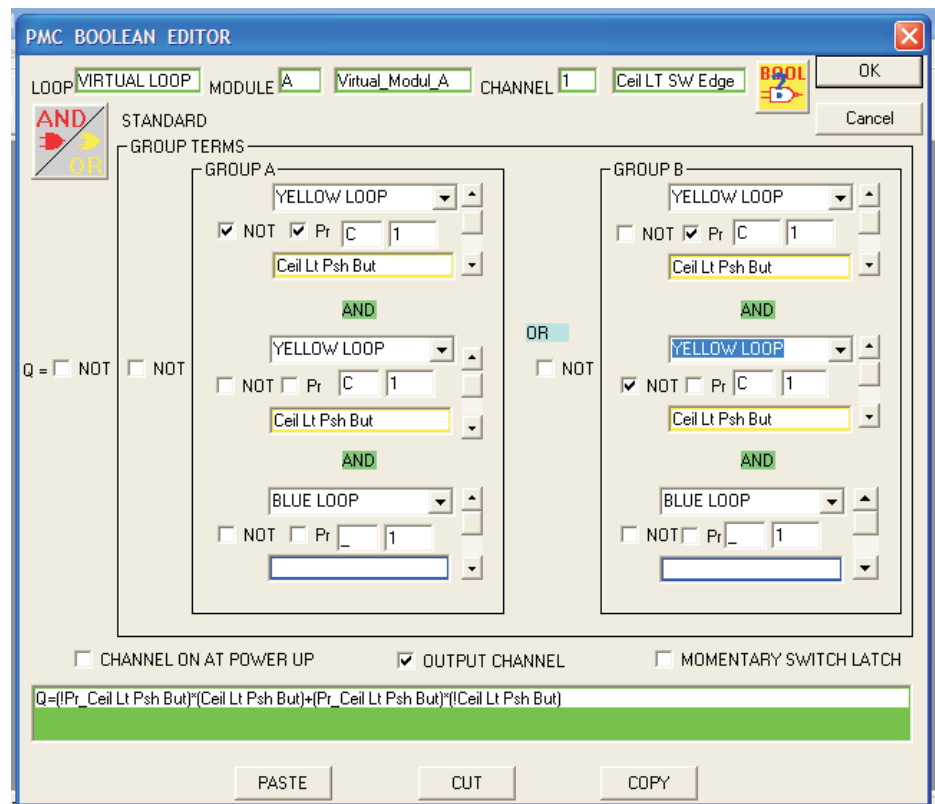
Creating an Edge Pulse



This Boolean will create a **leading edge** pulse, on virtual channel VA1, when the switch YC1 is pressed.

The Boolean above will create a **leading edge** pulse, on virtual channel VA1, when the switch is pressed and a **trailing edge** pulse when the switch is released.

To create a single pulse that occurs only when the switch is released, enter a boolean as shown in Group B, to the right on the screen.

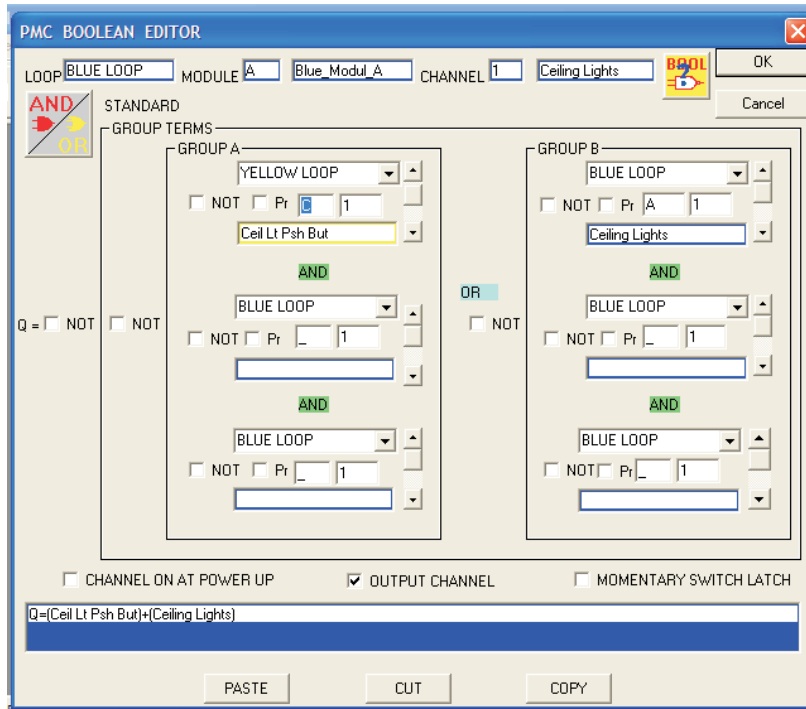


Latching an Output

To latch an output, simply set the output equal to itself.

For example: BA1 = YC1 OR BA1

BA1 turns on when the switch YC1 is on. Since the program says OR BA1, it keeps itself on. With this configuration, BA1 will turn on and will not turn off unless you turn power off to the CPU.



To latch an output on, simply set the output equal to itself.

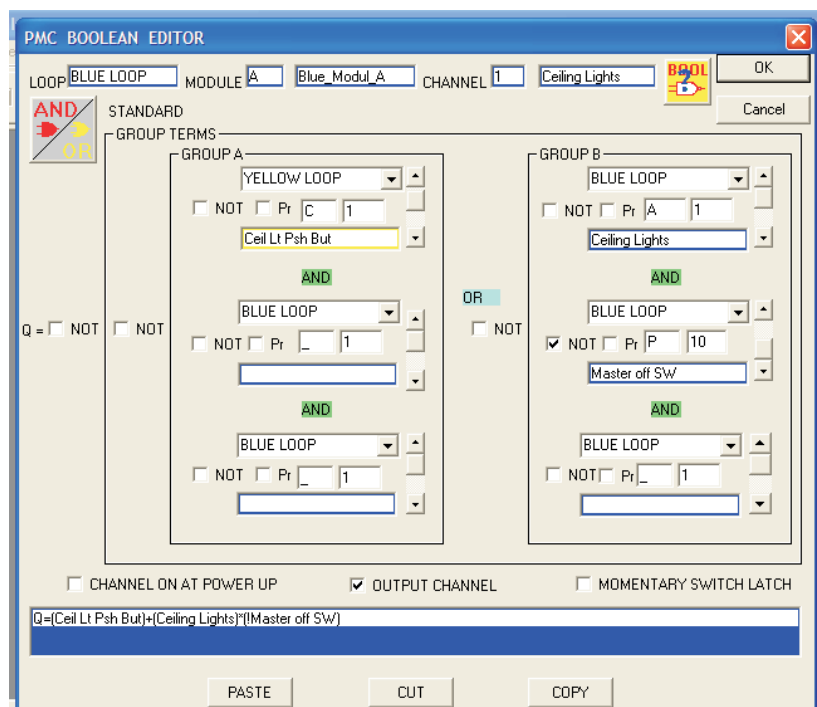
For example:
BA1=YC1 OR BA1

BA1 turns on when the switch YC1 is on. Since the program says OR BA1, once it has turned on, it will keep itself on.

With this configuration BA1 will turn on and will not turn off unless you turn power off to the CPU.

In the the Boolean Editor screen to the right, BA1 will latch on when YC1 turns on. Turning YC1 off will have no effect. You will notice that in Group B, on the right side of the screen, it says BA1 AND Not BP10.

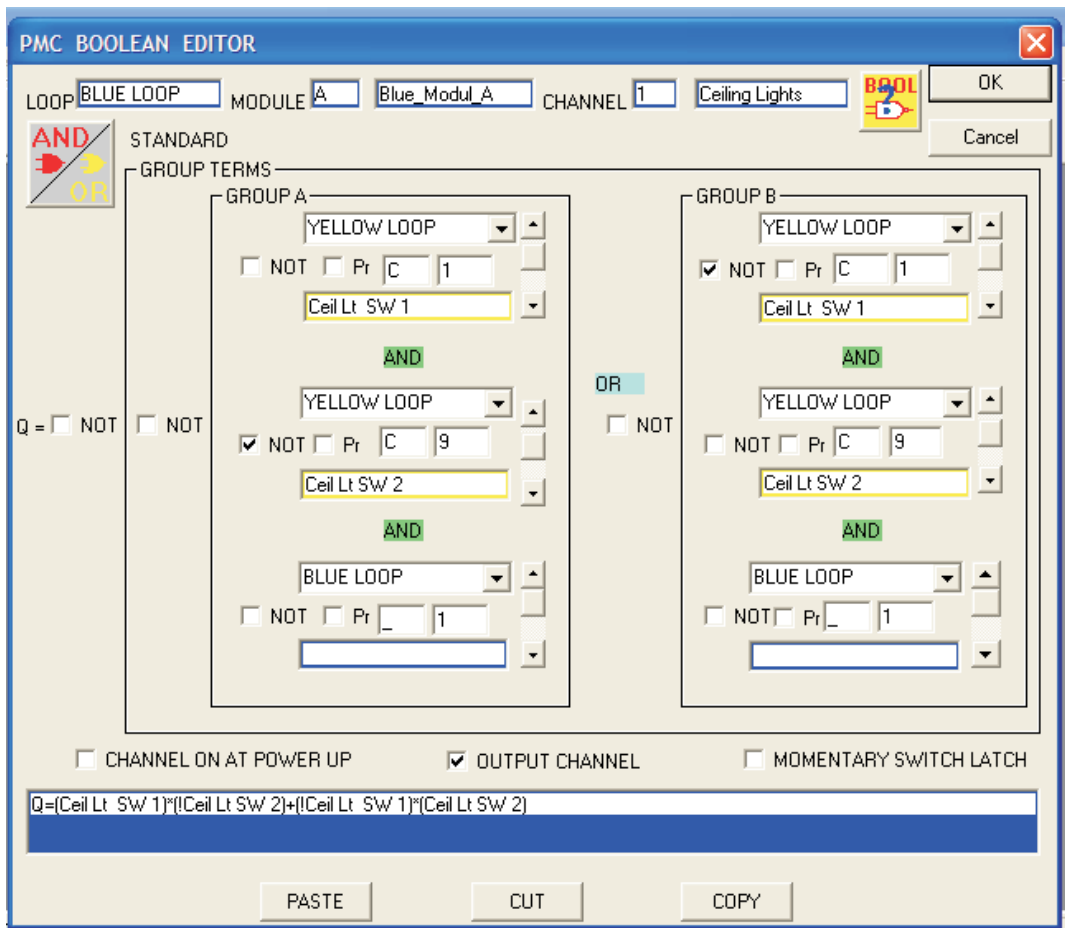
Once BA1 is latched on, it will stay latched until channel BP10 comes on. Momentarily turning BP10 on will cause BA1 to turn off until YC1 is operated again.



Latching an Output

EXCLUSIVE OR

An exclusive OR is a special kind of OR that works with two or more inputs. In a two input Exclusive OR arrangement, the output will only be on if one of the inputs is on. The output will be off, if both inputs are off, or if both are on. An example of this is a switch at each end of a hallway.



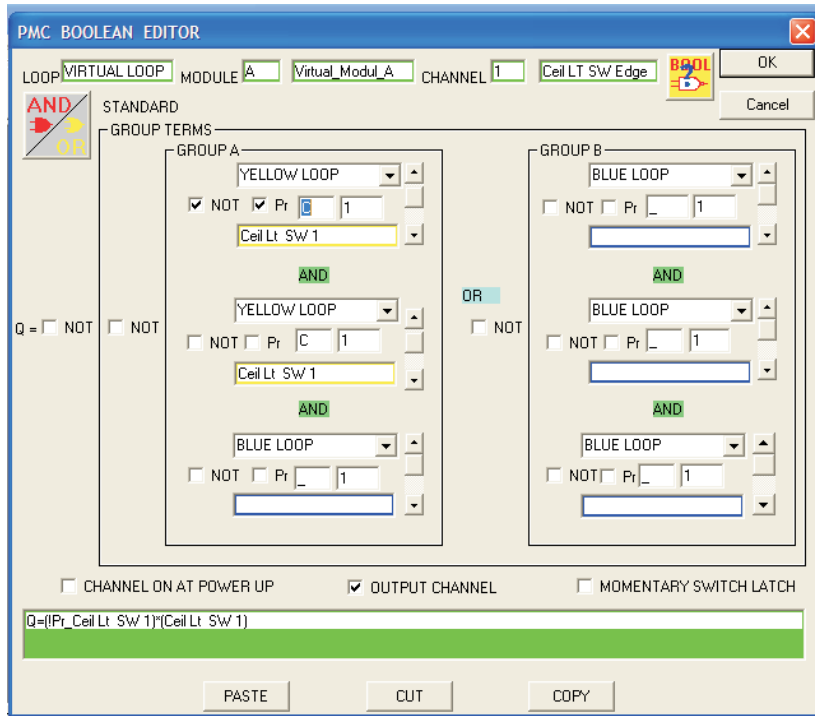
In the example above, YC1 and YC9 are toggle switches at either end of the hall. To read the screen above we need to break the screen into two parts, Group A and Group B. If we look at Group A first, we find that Group A will be true and turn output BA1 on, when YC1 is on, and YC2 is off. If we look at Group B, output BA1 will be on when YC1 is off and YC2 is on.

The truth table looks like this:

| | | | | | |
|------|-----|-----|-----|-----|-----|
| IF | YC1 | OFF | ON | OFF | ON |
| IF | YC9 | OFF | ON | ON | OFF |
| Then | BA1 | OFF | OFF | ON | ON |

Next, let's explore using **edge detected pulses** and the **Exclusive OR** to latch a channel on and off with each edge pulse.

Latching ON, Latching OFF using a Pulse



The Boolean on VA1 to the left, creates a short leading edge pulse each time switch YC1 turns on.

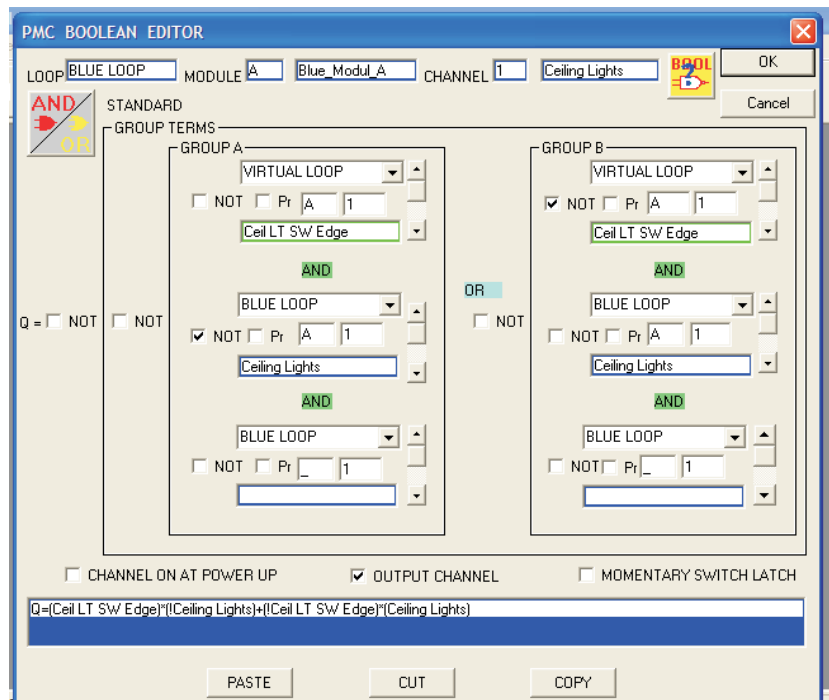
The pulse can be created on any channel in the virtual, Blue Loop, or Yellow Loop.

We can use the pulse we created on VA1 in a boolean to latch BA1 ON and OFF.

This is particularly useful when using momentary push buttons.

We will again look at Group A and Group B separately. To understand how this boolean works, it is important to remember that booleans are processed every communication cycle. Lets look at the first cycle and assume that the edge pulse occurs during this cycle. During the first cycle, BA1 is OFF and VA1 is ON. This makes Group A true and causes BA1 to turn ON. In the second cycle, since the pulse only lasts for 1 cycle, we see that VA1 is OFF and BA1 is ON, which makes Group B true and Group A false. If you study Group B, you will see that it creates a latch because $BA1 = BA1$. Channel BA1 will now stay on until another pulse comes along. If the edge pulse occurs again, it makes Group B false which unlatches BA1.

With a boolean such as this, a channel will latch on and then off upon alternate pulses.



In the example section of this manual you will see how we can use timer pulses to create a flasher.

Using Timers

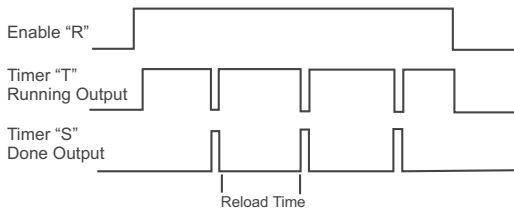
TIMER FUNCTIONS

There are ten timers included in the 160 channel system. Seven of these timers can be set in 0.1 to 25.4 second intervals and are used when that kind of precision is needed. The other three timers can be set in 10 to 2540 second intervals, or 42.33 minutes. The 320 channel system has 16 timer modules, each having 10 timers. The first 6 timers in each module can be set from .1 to 25.4 seconds, and the last 4 can be set up to 2540 seconds in 10 second intervals.

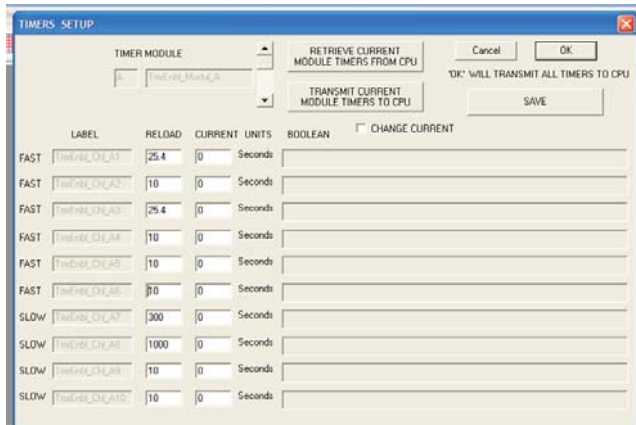
Each timer has two outputs (channels). In the 160 channel system, Timer Running Output "T" and the Timer Done Output "S" and one input, Enable "R". In the 320 channel system, there are timer modules A through P each having 10 timers. In this case you will have timer channels such as Timer enable A1, Timer runA1 and Timer Done A1.

A timer starts to run when the Enable input goes high (is on) and will continue to run as long as it is high. Once the enable input is gone, the timer stops.

The input and two output signals appear as shown here:



The Timer Done channel, "S", is present for only 40 milliseconds and is high when the Timer Running channel 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 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**.

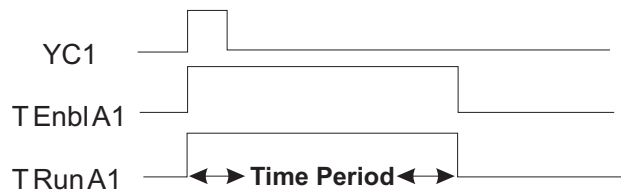
In this application, the timer is started by an input switch and it will stay on for a fixed period of time. If the input switch is used to initiate the timer, the timer will have to be latched on to keep it going. A latching equation needs to be used. The equations would be:

T Enbl A1 = THE TIMER ENABLE (Timer Loop)

YC1 = THE SWITCH INPUT

T Run A1 = THE TIMER'S RUNNING OUTPUT

T Enbl A1 = YC1+ T Run A1



Making the Enable R1 equal to the input switch YC1, starts the timer. Then, the timer keeps itself running (enabled) for the time period TrunA1. At the end of the time period, neither YC1 or TrunA1 is present and the timer is no longer enabled. The input, YC1 could be a momentary pushbutton, or a pulse created at the edge of switch. This pulse would be 40 milliseconds long. That is long enough to start the timer, which may be minutes long.

TIMED OUTPUT A typical application for a timed output is a check out light on an ambulance. This is an output that is turned on with a momentary switch, latches on for 15 minutes and then turns off after the time period is up. Lets look at the booleans to make this happen.

TmrEnblChl_A8 = THE TIMER ENABLE CHANNEL
YC1 = A SWITCH INPUT CHANNEL

TmrRun_ChI_A8 = THE TIMER'S RUNNING OUTPUT
BA1 = THE OUTPUT CHANNEL

TmrEnblChl_A8 = YC1+ TmrRun_ChI_A8

(The timer is started with the momentary switch and runs until the run pulse goes low)

BA1 =TmrRun_ChI_A8

(The output BA1 will be on, as long as the timer running output is on) In the PMC setup/ timer set up menu, set the time to 15 minutes menu.

A Flasher

Using A Timer Pulse And Latched Output

FLASHER

A boolean for the timer enable must be created to create a flasher. Let's say that we want the timer to operate when a switch on YC1 is ON. In the PMC setup, timer set up menu, enter the time of the ON/OFF periods in timer A1. A good setting for a turn signal is 0.3 sec.

The first Boolean will be:

$$T \text{ Enbl } A1 = YC1$$

This means that the timer will be running as long as the switch on input YC1 is on. To create the flash, we create an Exclusive OR with the timer done pulse and the output to a light, which here we will call BA1. An exclusive OR means that the output will be ON only when one input is on, but not both.

This equation will be:

$$BA1 = (BA1 * !T \text{ done } A1) + (!BA1 * T \text{ done } A1)$$

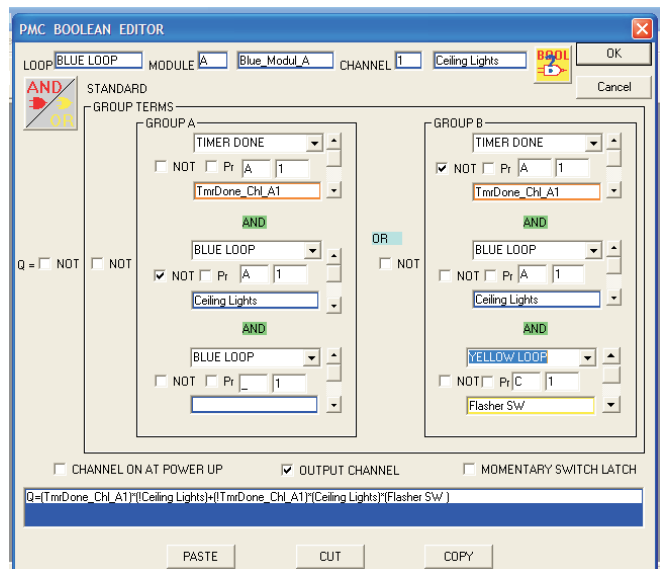
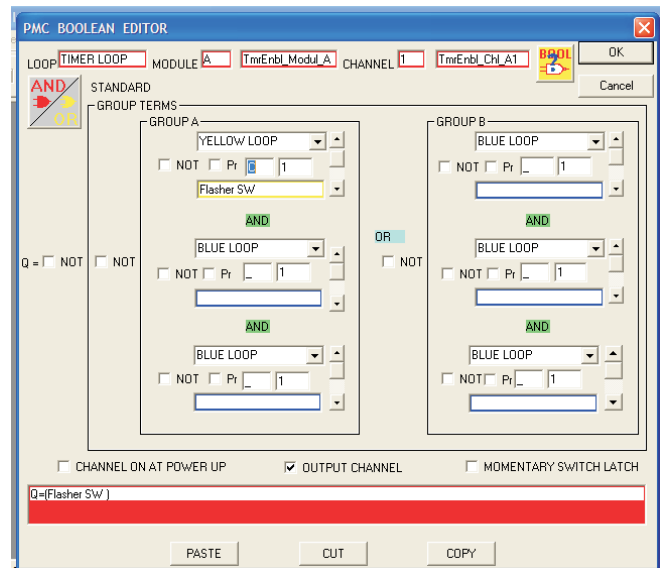
One slight problem with this equation, is that the output BA1 is indeterminate when the switch YC1 is turned off. It may be on or off, depending on exactly when the switch YC1 is turned off. To be sure the output is off when the switch is off, the input YC1 should be AND'ed with the timer equation for BA1. Then, BA1 can only be on when the switch is on.

The equation will then be:

$$BA1 = (Tmr \text{ done } A1 * !BA1) + (!Tmr \text{ done } A1 * BA1 * YC1)$$

With each timer done pulse, the output will flash on and off.

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



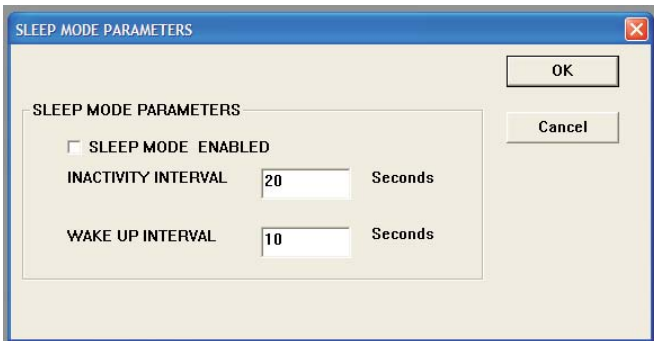
Sleep Mode

SLEEP MODE

The system includes a sleep mode, which puts it to "sleep" to save battery power when the vehicle is not in use. When the system goes to sleep, any output that is on will turn off. 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. As long as the ignition is on, the system will remain on and will not enter sleep mode. 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 period of time. 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 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 settings to be made on this screen: Sleep Mode Enabled, Inactivity Interval, and Wake Up Interval. The Inactivity Interval timer can be set from 10 to 2540 seconds, which 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, which 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 that an input has changed. 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.

High Speed Channels

There are 4 high-speed channels available, on both the 160 channel system and the 320 channel system. The 320 channel system has high-speed channels on the Blue Loop only. 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 cannot 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:

| Channel | Input Module | Input Channel | Output Module | Output Channel |
|---------|--------------|---------------|----------------|----------------|
| 1 | Sensors | Brake L1 Sw | Chassis lights | Brake lights |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |

Using the Up/Down arrow buttons for "Input Module 1", select which module, A-P, 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.

As you may recall from previous pages, the CPU evaluates when to turn a channel on and does it in order from channel A1 to channel P10. The system takes .040 seconds to scan from A1-P10. In most cases, when an input switch changes state, the system sees it in the first cycle, looks to see if it is still present in the second cycle, and then processes the boolean to turn the appropriate output on. Depending upon the channels involved, it can take from a little more than .040 seconds to .080 seconds for the output channel to come on after the input appears. With a high-speed channel, the delay is .040 maximum, depending upon the channels involved. *If this delay is still too long for your specific application, see the data sheets on I/O module 00-00846-506 and 516.* These modules have two inputs and outputs that can be tied together by a dip switch setting and will function as a solid-state relay. In this case, there is practically no delay.

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 that 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 a file 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. 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 its associated boolean are shown. **NOTE** that *Boolean statements cannot be changed from the spreadsheet, however;* you may 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 scale box by checking 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. Print preview to see how it will turn out.

PMC Spreadsheet

From System Label

PMC software version used to write the file

From Module types

Boolean logic statement (what causes the output to turn on)

Channel labels

From Module Label

| | A | B | C | D | E | F | G |
|----|---|-----------------|------------------------------------|---|---|---|---|
| 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 Rht | 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

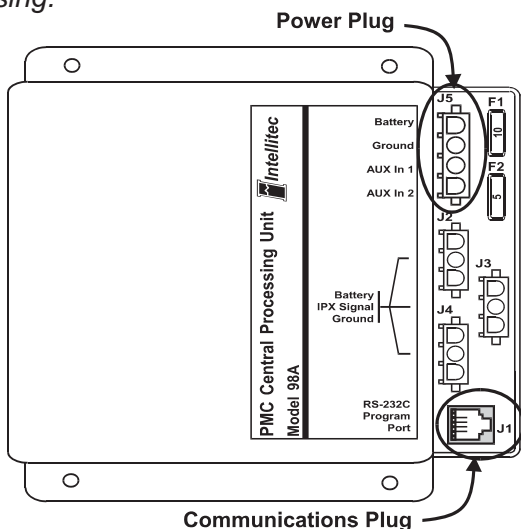
Communicating with the CPU

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 a 12-24V power supply.

See the data sheet in Chapter 2 for the CPU that you are using.



Connect the computer to the CPU Module using the RJ11 telephone cable and the hardware adapter key. Plug the adapter into the serial port of the computer. Plug the RJ11 cable into the adapter and then into the module.

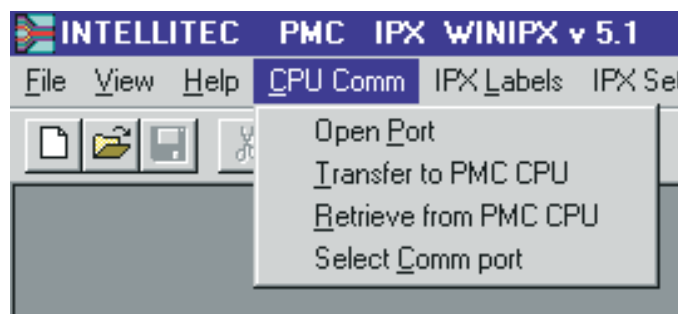
The system is now ready to accept the program.

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 list offers four choices. *This flyout will*

appear:



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. If your computer does not have serial port, our recommendation is to purchase either a single or dual port, RS-232, PC card, this is a PCMCIA-style peripheral. There are several manufacturers in this market and the one manufacturer that we use at Intellitec is SIIG, website is www.siig.com. The model number for a single serial port device is IO1037, which uses 32-bit technology. These can be found at most electronic equipment outlets or purchased online.

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.

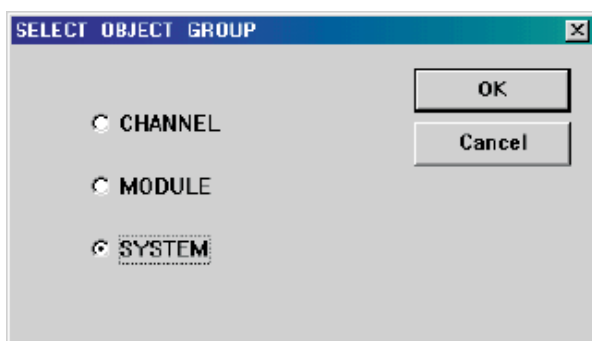
When the port is open, changes made to Boolean statements occur immediately. This is often useful when working on the vehicle to improve it. The effects of your changes occur as soon as you select "OK" from the Boolean editor screen. If you do not want changes sent to the PMC CPU, close the port.

Communicating with the CPU

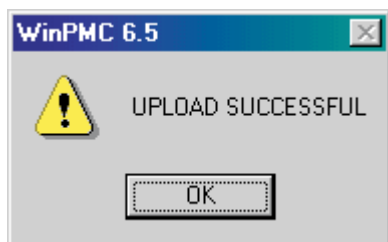
SENDING THE PROGRAM

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 take some time. Once the program has been loaded, a message will come up announcing...



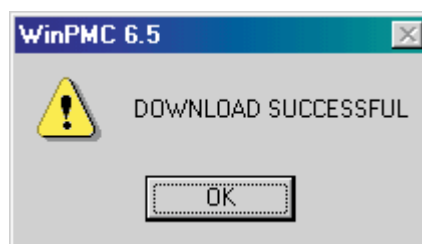
Please wait for this message. Click on "OK". The program can now be tested. Your computer can remain connected with the port open. After testing the program, you may want to make some minor changes to it. To do this, simply change the areas that you want. As long as the port is opened, those changes 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", or "Save as" 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.



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

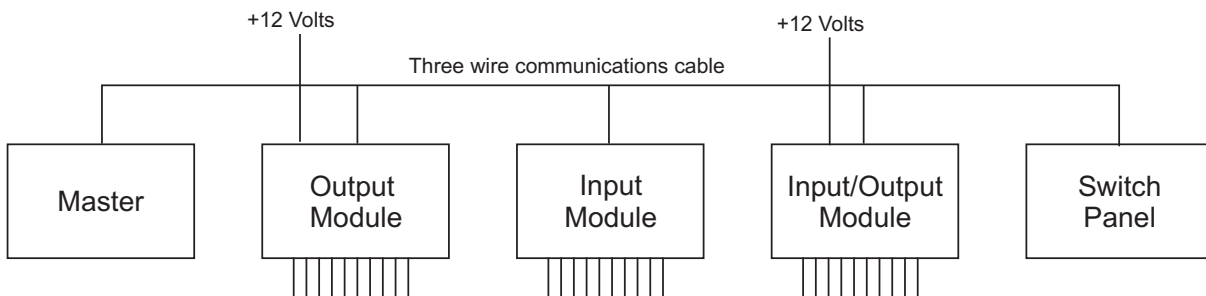
Troubleshooting Diagnostics

Programmable Multiplex Control

Trouble-shooting Guide

The PMC Multiplex Switching Systems are different from conventional wiring systems, yet still fairly easy to trouble-shoot, should the need arise. With these systems, the power is supplied to switching/output modules and controlled and distributed from them. The switching modules are signaled from the switch panels and/or the CPU (Central Processing Unit), instructing them to turn the loads on or off.

The following pages assume that the vehicle program, or booleans have been tested and that the program has been downloaded to the CPU successfully.



Typical System Configuration
Figure 1

Trouble-shooting

IMPORTANT 1ST STEP

Many of the problems often associated with a Multiplex Systems are attributed to the battery being nearly dead, therefore; the system is not performing as expected.

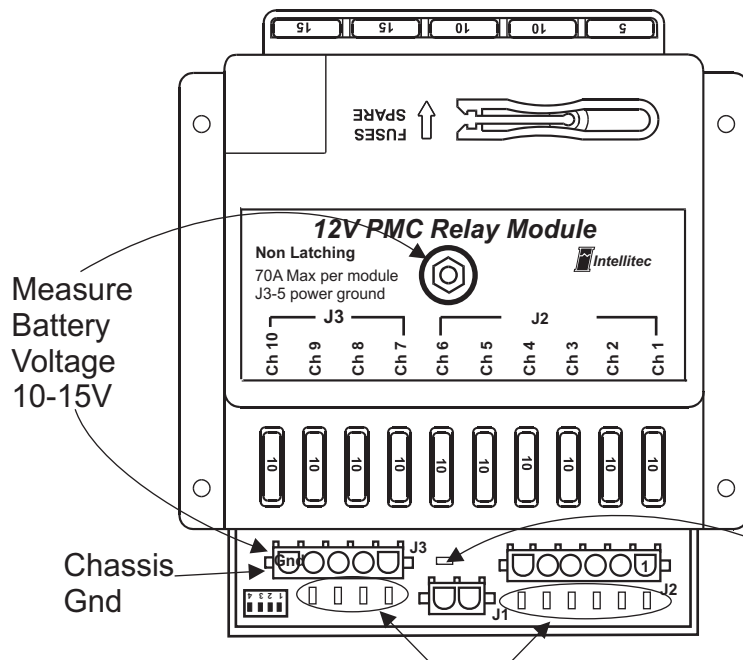
Before proceeding with any other diagnostic measure, check the condition of the battery by measuring the voltage on the system. *If the voltage is below 10 volts, or momentarily dips below 10 volts, recharge the battery.* The voltage may measure greater than 10 volts and then dip below when loads are turned ON. If this is the case, charge the battery. If the vehicle is a motor coach, connect the coach to shore power or start the generator to be sure there is enough power for the loads.

If the supply voltage is correct, define one of the following:

Symptoms

1. A single load is not operating properly.
2. All of the loads associated with a single output module are not functioning.
3. All outputs in the system are dead.
4. All outputs in the system are stuck ON.
5. None of the buttons, or switches on a single switch panel operate.

Post Delivery Trouble-shooting Guide



Red Communications LED will light if power is present at the Module, **but** communications is bad. Modules whose part number begin 00-00846 have a green LED indicating that communications is OK.

Check for 7.5-9V at the communications connector. For this module, it comes from the two pin connector that plugs into J1.

See www.intellitec.com for module data sheets.

Diagnostic Load LED's will light if the output is ON and the fuse is good

FIGURE 2

A SINGLE LOAD IS NOT OPERATING PROPERLY

If a single load is not operating properly, the first thing to do is to locate the Output Module feeding that load. Once located, observe the **green** diagnostic LED on the Module associated with that channel. Operate the switch to turn the load ON and determine if the LED is ON. (See figure 2) If it is ON, then the problems is with the load. Check the load and the wiring to it.

If the green LED is out, check the fuse associated with that load. Some output modules do not have fuses and have self protecting outputs check the module data sheet for additional diagnostic information. The fuse can be inspected with a test light or ohmmeter, or the fuse can be removed and checked visually. If the fuse is faulty, replace it and check for proper performance. If the fuse blows again, the problem is with the load, or the wiring to it. Check both the load and the wiring to it. Repair as necessary.

If the problem still exists, it may be with the switch panel and/or other inputs that are required by the programming. To determine if the switch panel is defective, or whether inputs are present, a Module Simulator or a System Status Monitor (available from Intellitec), can be used to verify if the proper inputs are present. This requires knowledge of what inputs are needed to turn the output on. If the problem is still not corrected, assuming that the proper inputs are present, the problem may be with the Module. To check the Module, remove and replace it with another that is addressed with the same address as the one taken out. Depending upon the module, addresses are set with either a dip switch or with jumpers.

Post Delivery Trouble-shooting Guide

NONE OF THE LOADS OF ONE SWITCHING MODULE ARE PERFORMING PROPERLY, OTHER MODULES are OK

If all of the loads on a switching Module are not performing properly, locate that Module and observe the Communications LED on it. If the LED is out, check for 12 volt power on the power input stud located on the Module. If power is not available, locate the source of the power and correct the fault. Also check to be sure the Module has a good ground. This can be done by measuring the voltage on the ground pin of the Module relative to a known good ground. Consult the Module's data sheet to locate the ground pin.

Data sheets are available at www.intellitec.com.

If the *red communications* LED is *ON*, the Module is receiving power, but not receiving the communications signal. This problem can be caused by faulty wiring at the Module, at the point of signal origination, or points in between. To localize the problem, using a voltmeter, measure the DC voltage between the communications signal wire and the signal ground wire. (Usually a two pin connector) This voltage should be approximately 7.0 to 9 volts DC. If it is not in this range, then the problem is with the wiring from the source of the signal, which is the CPU module. The problem might be either with the signal wire, or the signal ground wire. The source of this problem can be located using standard techniques to locate the fault. Substitution of the wires from the source to the output switch Module may help to verify that the module is operating properly and determine which wire is at fault.

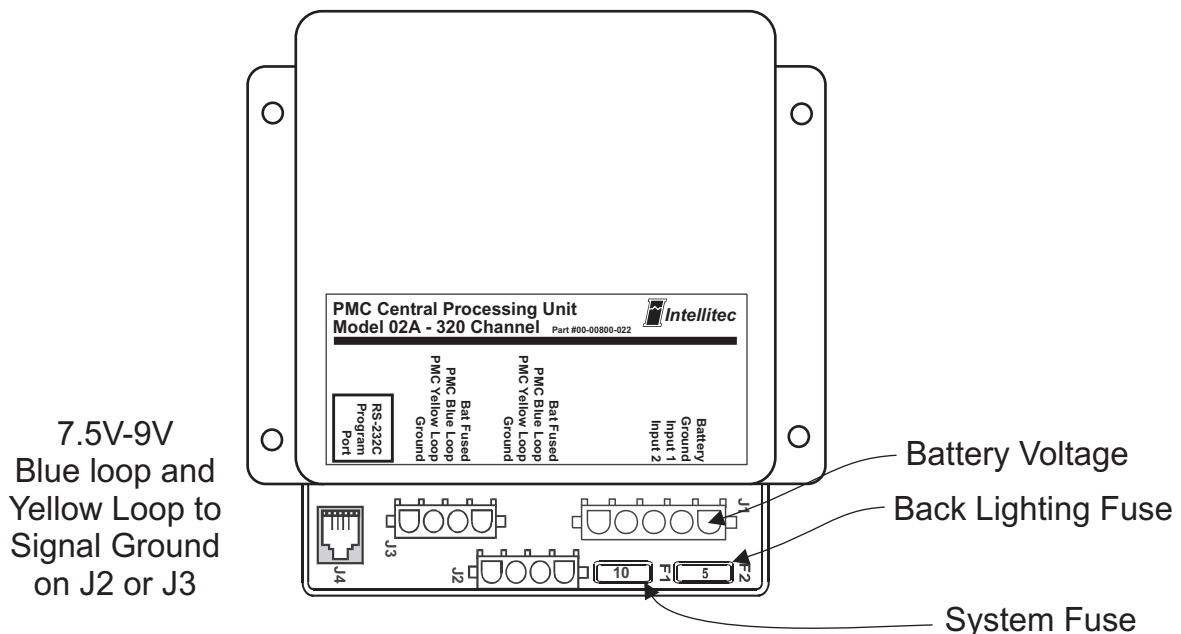


Figure 3

Data sheets are available at www.intellitec.com

Post Delivery Trouble-shooting Guide

NONE OF THE SWITCHES OR BUTTONS OF ONE SWITCH PANEL WORK

Unplug the three-pin or four-pin plug from the switch panel or switch adapter. Using a voltmeter, measure the voltage from pin 1 to pin 3. You should measure battery voltage. Measure the voltage from pin 2 to pin 3. You should measure the communication signal of 7.0-9 volts. If you do not, check the wiring. If you do, try replacing the switch panel. A push button switch panel that has not been programmed will not operate any of the outputs. (***Push button switch panels must be programmed correctly at the factory***) If you find that the push button switch panel operates the wrong functions, it is likely that the switch has been programmed with the wrong button allocations, or is the incorrect panel for that location. Rocker switch panels must have their address set correctly via the dip switch or jumpers and J1 pin 4 must be connected to chassis ground.

ALL THE OUTPUTS OF THE SYSTEM ARE DEAD

If all the outputs of the system are dead, this indicates either the battery voltage may be low, or a problem with the communications wiring. **First, using a voltmeter, determine that power is being applied to all the Modules, and the system fuse (F1) and the fuse (F2) for back lighting on the CPU Module are good.** Check the voltage on the CPU Module to ensure that the 12 volt power to the Module is present and the 7.0-9 volt signal voltage is present at the blue and yellow loop pins. On the 160 channel CPU, the signal voltage is measured from pin 2 of the 3-pin connector to pin 3. On the 320 channel CPU, communications is measured on the 4-pin connectors from pin 2 to 4 and pin 3-4. If the signal voltage is not normal, ***unplug all*** the communications wires from the CPU and measure the power and signal voltages available at the CPU again. If the voltages on the communications plugs are still not normal with all the communications wires unplugged (12 volts for power and 7.0- 9 volts for signal) and the fuses are good, replace the CPU module. **Make sure that the replacement has been programmed.**

If these voltages are normal, unplug the communications cables from all of the system Modules and reconnect them to the CPU. Measure the voltages at the CPU again. If the communications signal goes away, the communications wire in the harness is grounded and should be repaired. If you measure battery voltage on the communication wire, the harness is somehow connected to the battery; this fault should be corrected. In either case, communications is not working due to a problem in the harness.

If all the voltages check out, begin plugging the communications cables back into the Modules, one at a time, to determine which one loads the CPU. It is possible that one of the system modules is bad, or that one of the communications connectors to a module is pinned wrong. As you plug each Module in, you may notice that the system begins to work until the connector or module with the fault is plugged in. When the faulty Module or plug is identified, leave it disconnected and continue until all Modules are connected. It is likely that you will find that the system is functioning. Plug the suspect Module back in. If the system goes down, check the wiring at the plug to see if it is pinned wrong. If the wiring is ok, replace the faulty Module.

ONE OR NONE OF THE BUTTONS ON A SINGLE PUSH BUTTON SWITCH PANEL OPERATE THE LOADS

If *one* of the buttons on a single switch panel does not operate, a Module Simulator can be used to determine if the switch panel is putting out a signal. If it is not, replace the panel. If *all* of the buttons on a single switch panel do not operate, the wiring to the switch panel may be faulty. Check the voltages on the three wires to be sure the 12 volt supply, the signal voltage, and ground are present. If they are not, repair the wiring. If they are and the panel still doesn't work, replace the panel with one that has been programmed the same as the original. If the push button panel operates the wrong loads, check the program in that panel.

Trouble-shooting Diagnostics

Communications

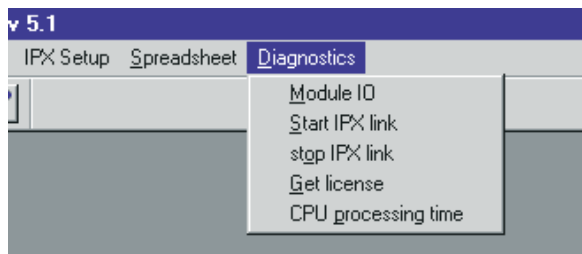
Module communications problems can be diagnosed with a voltmeter by measuring the voltage on the communication lines. Problems here can cause all outputs to be OFF, or all outputs to be ON.

Measure from the PMC ground wire to the PMC signal wire, pin 2-3 on the three-wire communications line at any module. This voltage should be approximately 7.0-9 volts. Also, measure battery voltage between the ground wire and the fused battery power wire from the CPU, pin 1-3 on a three-pin connector. (See individual module data sheets for connectors and pins). Most output modules have a two-pin communications connector. The LED's on the 00-00739-120 and 00-00739-240 *Module Simulator* can also be used to verify the proper voltages.

If the communications wire measures battery voltage, it will blind the system and nothing will respond to inputs. Check for a 3-pin plug that is mis-wired. If the communications wire is inadvertently grounded, or connected to ground through a resistance, outputs may turn on depending upon the output module. Check for mis-wiring of a communications connector. It is also common to find that a screw has shorted the harness to ground.

Assuming that the voltages are correct, you can move to diagnosing the software. The system has a number of tools to help you trouble-shoot the system in the event that it does not do what you expect. To enter the diagnostic mode, click on "Diagnostics".

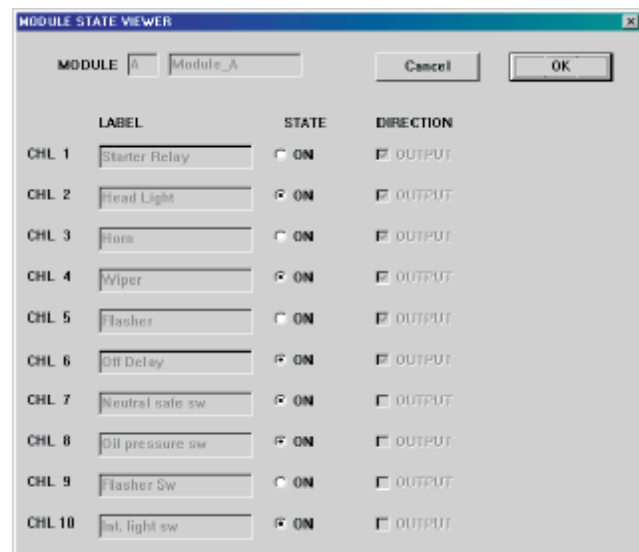
The window flyout below shows the choices you have.



MODULE I/O

Clicking on Module I/O 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 to see those inputs and any dependent outputs change. **NOTE** your computer screen is not updated as fast as the PMC system, so you may see the dots appearance delayed from the actual event.



This screen is available on the 160 Channel CPU.

If the output communication channel is ON, but the load is not, check the output module and load for problems.

This screen can also be used to determine if an input is present. If an output is programmed to come ON, if both ignition and the switch is ON, you can check to see if the system sees both inputs. If not, check to see if the input is attached to the proper connection on the input module. For inputs you will also want to check to see if the HI/LO jumpers are set correctly. If it is not convenient to connect a lap top to the system, the Module Simulator or System Status Monitor can be used as well.

Troubleshooting Diagnostics

Communications

TROUBLESHOOTING DIAGNOSTICS COMMUNICATIONS *(continued)*


START PMC LINK/STOP PMC LINK

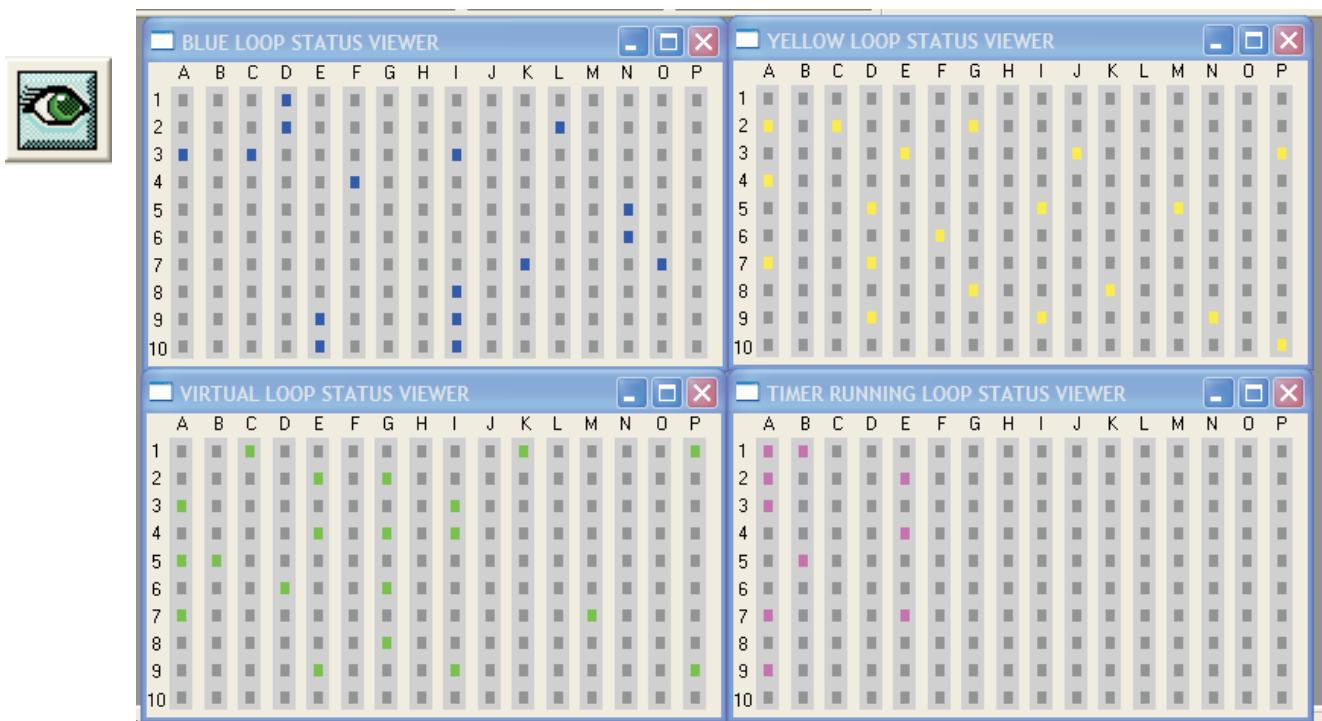
This command allows you to stop or start the PMC communications link between the modules of the system. ***This is not the serial link between your computer and the CPU.*** It could be helpful if something that the system has turned ON is being damaged. You may also want to stop the PMC link if you are 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.


Diagnostics on the 320 Channel System

The 320 channel CPU has enhanced diagnostic capabilities. By clicking on the  icon, the following screens can be opened on your laptop. In order to read the status of the channels, you must have the port open. Communications through the port is slower than PMC. You will see a slight delay when a channel is turned ON, before you will see it on the screen. These screens provide the same function as the system status monitor. In addition, they are also capable of showing the status of virtual and timer channels. This can help



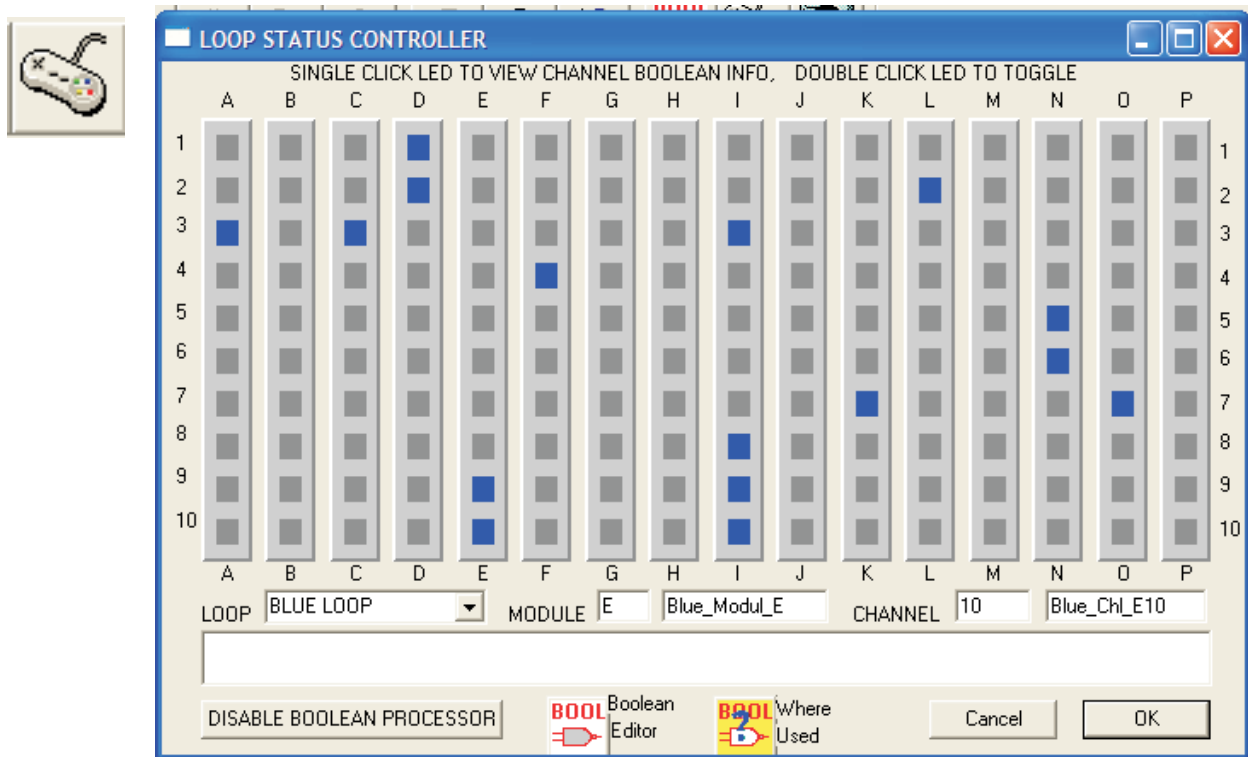
320 Channel System Diagnostics

LOOP STATUS CONTROLLER

By clicking on the  icon you can bring up the Loop Status Controller screens for each of the loops in the 320 channel CPU. In addition to providing the status of a communication channel, an output can be forced ON by clicking on “disable the boolean processor” and double clicking on the channel button.

A channel cannot be forced ON in this manner, unless the “Output Channel” box has been checked in the Boolean Editor screen. If a channel has been defined in this way as an output, it can be forced ON and OFF. The Boolean processor must be disabled by clicking on the box. If the boolean calls for a switch to be turned ON and the switch is in the OFF position, the boolean processor will turn the output OFF .040 seconds after you forced it ON.

This feature is useful to check if an output module is working when you can not physically reach the switch that turns it on.



TEST EQUIPMENT

1. Module Simulator (Force inputs and outputs ON and determine Status of I/O)
2. I/O Status Monitor (Views 160 I/O points simultaneously)

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

Chapter 9

Boolean Logic Examples

Boolean Shorthand

! = NOT function

+ = OR function

* = AND function

Pr = Prior State

(prior communication cycle)

B = Blue Loop

(input and output modules can be connected to this loop)

Y = Yellow Loop

(input and output modules can be connected to this loop)

V = Virtual Loop

T XX enable = Timer Enable Loop

T XX done = Timer Done Loop

TXX run = Timer Run Loop

Boolean Logic Examples

Simple “OR”

In this example, Load A1 will be ON, if input B1 or B2 is ON, or if both are 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: $A1 = B1 + B2$

PMC BOOLEAN EDITOR

MODULE OUTPUT CHANNEL

SUM OF PRODUCT GROUP TERMS

PRODUCT GROUP A

(☐ NOT Q ())

AND

(☐ NOT ☐ NOT (☐ NOT Q ())

AND

(☐ NOT Q ())

PRODUCT GROUP B

(☐ NOT Q ())

AND

(☐ NOT Q ())

AND

(☐ NOT Q ())

(☐ NOT ☐ NOT (☐ NOT Q ()) OR ☐ NOT (☐ NOT Q ())

☐ CHANNEL ON AT POWER UP ☐ OUTPUT CHANNEL ☐ MOMENTARY SWITCH LATCH

Boolean Logic Examples

Multiple Input “OR”

This example will work with either the 160 channel CPU, or the 320 channel CPU. In the 320 channel CPU, you will find an AND/OR icon that will change the Boolean Editor screen to allow easy programming for multiple OR's. This technique is used any time 3 or more inputs need to be Or'ed.

In this example, Load A1 will be ON, if any of the inputs B1, B2, B3, or B4 is ON, or if any combination is ON. 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 DeMorgan's Theorems in Chapter 11.

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.

The screenshot shows the 'PMC BOOLEAN EDITOR' window. At the top, 'MODULE' is set to 'A' and 'Lighting'. 'CHANNEL' is '1' and the description is 'CS Interior lights'. There are 'Cancel' and 'OK' buttons. The main area is titled 'SUM OF PRODUCT GROUP TERMS'. It contains two product groups, A and B. Product Group A has three terms: ([X] NOT Q ([X] NOT Q ([X] []))) OR [X] NOT ([X] NOT Q ([X] [])) AND ([X] NOT Q ([X] [])). Product Group B has three terms: ([X] NOT Q ([X] [])) AND ([X] NOT Q ([X] [])) AND ([X] NOT Q ([X] [])). The terms are labeled with inputs: FRONT LT SWITCH, REAR LT SWITCH, DOOR OPEN SW, and FIRE SIGNAL. At the bottom, there are checkboxes for 'CHANNEL ON AT POWER UP', 'OUTPUT CHANNEL', and 'MOMENTARY SWITCH LATCH', along with 'PASTE', 'CUT', and 'COPY' buttons.

Boolean Logic Examples

Exclusive “OR”

Two or more switches operate the same load

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. This example is used with either the 160 or 320 channel CPU. The loop designation must be selected with the 320 channel CPU.

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. For more than two switches in an exclusive “OR” arrangements, write an exclusive “OR” in a virtual channel, then, write another exclusive “OR” using the virtual channel. This would put 3 inputs in a exclusive arrangement.

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

A1 = INTERIOR LIGHTS

B1 = FRONT SWITCH

B2 = REAR SWITCH

The screenshot shows the 'PMC BOOLEAN EDITOR' window. At the top, 'MODULE' is set to 'A', 'Lighting' is selected, 'CHANNEL' is '1', and the load is 'Interior lights'. Below this is the 'SUM OF PRODUCT GROUP TERMS' section. It contains two product groups, A and B, separated by an 'OR' operator. Product Group A is configured as 'NOT (NOT (NOT Q (Front Switch) AND (NOT Q (Rear Switch) AND ())))'. Product Group B is configured as 'NOT (NOT Q (Front Switch) AND (NOT Q (Rear Switch) AND ())))'. The 'NOT Q' checkbox is checked for both groups. At the bottom, there are checkboxes for 'CHANNEL ON AT POWER UP' (unchecked), 'OUTPUT CHANNEL' (checked), and 'MOMENTARY SWITCH LATCH' (unchecked). There are also 'PASTE', 'CUT', and 'COPY' buttons.

PMC BOOLEAN EDITOR

MODULE CHANNEL

SUM OF PRODUCT GROUP TERMS

PRODUCT GROUP A

(☐ NOT Q ())

AND

(☐ NOT ☐ NOT (☒ NOT Q ()) OR ☐ NOT (☐ NOT Q ())

AND

(☐ NOT Q ())

PRODUCT GROUP B

(☒ NOT Q ())

AND

(☐ NOT Q ())

AND

(☐ NOT Q ())

☐ CHANNEL ON AT POWER UP ☒ OUTPUT CHANNEL ☐ MOMENTARY SWITCH LATCH

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 that must be closed to release the park brake. C
If more than 3 inputs need to be in an “AND” relationship see *DeMorgan’s Theorems in Chapter 11*, 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

PMC BOOLEAN EDITOR

MODULE Output CHANNEL

SUM OF PRODUCT GROUP TERMS

PRODUCT GROUP A

(☐ NOT Q ())

AND

(☐ NOT ☐ NOT (☐ NOT Q ()) OR ☐ NOT

AND

(☐ NOT Q ())

PRODUCT GROUP B

(☐ NOT Q ())

AND

(☐ NOT Q ())

AND

(☐ NOT Q ())

☐ CHANNEL ON AT POWER UP ☒ OUTPUT CHANNEL ☐ MOMENTARY SWITCH LATCH

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. This technique works with either the 160 or 320 channel CPU. With the 320 channel CPU, simply open the 6 input AND editor screen using the AND/OR icon.



$$A1 = B1 * C2 * C3 * F1 * F10 * E1$$

or in other terms

$$A1 = !((B1 * C3 * F10) + (C2 * F1 * E1))$$

$$A1 = !((B1 * C3 * F10) + (C2 * F1 * E1))$$

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 DeMorgan’s Theorems in Chapter 11. 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.

PMC BOOLEAN EDITOR

MODULE Output CHANNEL Brake Release

SUM OF PRODUCT GROUP TERMS

| | |
|---|--|
| <p>PRODUCT GROUP A</p> <p>(<input type="checkbox"/> NOT Q (<input type="text" value="B"/> <input type="text" value="1"/>))</p> <p>Frnt door Sw</p> <p>AND</p> <p>(<input checked="" type="checkbox"/> NOT <input checked="" type="checkbox"/> NOT (<input type="checkbox"/> NOT Q (<input type="text" value="C"/> <input type="text" value="3"/>))</p> <p>Middle Door</p> <p>AND</p> <p>(<input type="checkbox"/> NOT Q (<input type="text" value="F"/> <input type="text" value="10"/>))</p> <p>Rear Door</p> | <p>PRODUCT GROUP B</p> <p>(<input type="checkbox"/> NOT Q (<input type="text" value="C"/> <input type="text" value="2"/>))</p> <p>Ramp Stowed</p> <p>AND</p> <p>(<input type="checkbox"/> NOT Q (<input type="text" value="F"/> <input type="text" value="1"/>))</p> <p>WC Lift Stowed</p> <p>AND</p> <p>(<input type="checkbox"/> NOT Q (<input type="text" value="E"/> <input type="text" value="1"/>))</p> <p>Lug Door closed</p> |
|---|--|

☐ CHANNEL ON AT POWER UP ☒ OUTPUT CHANNEL ☐ MOMENTARY SWITCH LATCH

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.

The screenshot shows the 'PMC BOOLEAN EDITOR' window. At the top, 'MODULE' is set to 'A', 'Output' is selected, 'CHANNEL' is '1', and the description is 'Over Speed Ind.'. There are 'Cancel' and 'OK' buttons. Below this is a section titled 'SUM OF PRODUCT GROUP TERMS'. It contains two product groups, A and B. Product Group A has a single term: ([] NOT Q ([B] [1])). Below this is an 'AND' label. Product Group B has a single term: ([] NOT Q ([A] [1])). Below this is an 'AND' label. The main logic expression is shown as: ([] NOT [] NOT ([] NOT Q ([] [])) OR [] NOT ([] NOT Q ([] [])). Below this are two 'AND' labels. At the bottom, there are three checkboxes: 'CHANNEL ON AT POWER UP' (unchecked), 'OUTPUT CHANNEL' (checked), and 'MOMENTARY SWITCH LATCH' (unchecked). There are also 'PASTE', 'CUT', and 'COPY' buttons.

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

In this example, output A1 will latch ON when switch B1 is pressed momentarily and switch B2 is OFF. The statement reads, A1 equals B1 OR (A1 and not B2). If B1 and B2 were momentary switches, the load A1 would turn on when B1 is closed and would latch ON because $A1 = A1$. Once A1 is latched ON, it will turn OFF when B2 comes ON. This happens because the statement $(A1 \text{ AND NOT } B2)$ is false.

Boolean Logic Examples

FLASHER 160 Channel CPU

160 Channel CPU

R1 = TIMER enable channel

B1 = SWITCH INPUT

A3 = FLASHING LAMP OUTPUT

S1 = DONE PULSE OF TIMER R1

R1 = B1

Group A Group B

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

A timer is used to create a flasher. "Timer enable 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" timer channels 1-10 are shown. 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.

In this example, module A, output channel 3, is being used for the flasher output. S1 is the timer done output for timer R1. A pulse occurs on output S1 at the end of each time period. *These pulses continue at the 0.3 second interval as long as the timer is enabled.* 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 in Group A causes output A3 to latch on itself. When the time pulse from S1 comes on again, the half of the boolean in Group B causes A3 to turn OFF. This means that the output will latch ON and OFF with each pulse that occurs on S1.

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.

An example using the 320 channel system is shown on the following page.

Boolean Logic Examples

FLASHER 320 Channel CPU

320 Channel CPU

TA1 = Timer

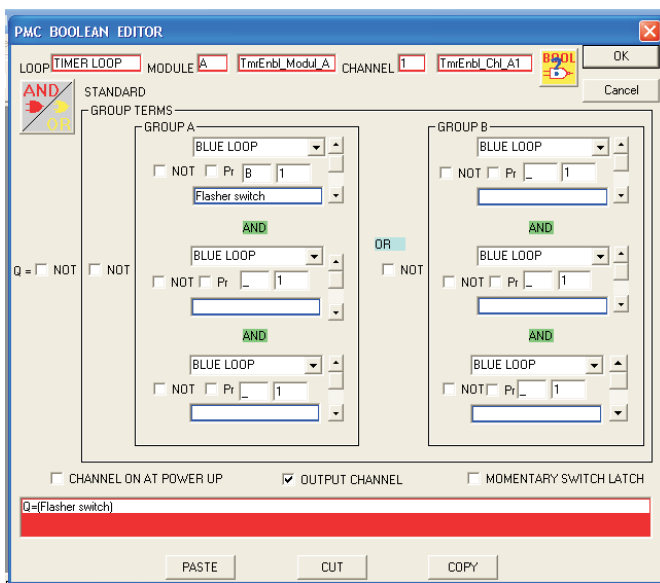
BB1 = Switch Input

BA3 = Flashing Lamp Output

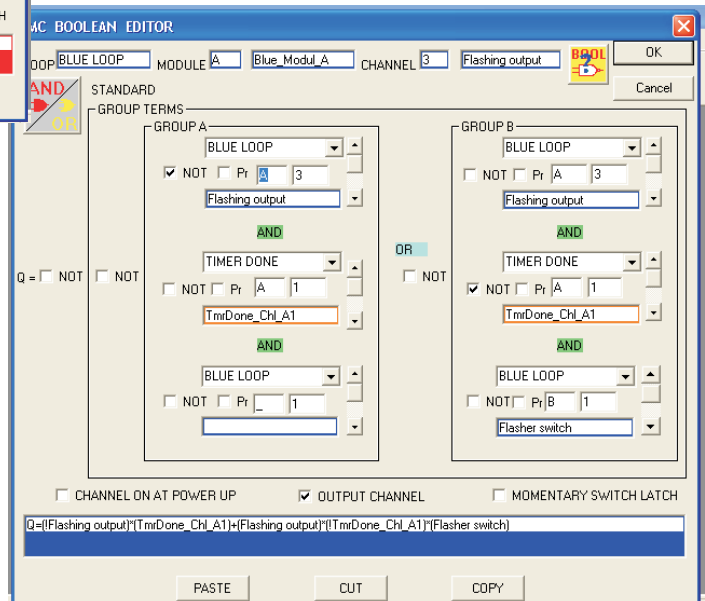
T done A1 = Done Pulse of Timer A1

T enable A1=BB1

$BA3 = (BA3 * !T \text{ done A1} * BB1) + (!BA3 * T \text{ done A1} * BB1)$



Enables the timer



Latches the output on and off with
each timer done pulse

Boolean Logic Examples

OFF DELAY (INTERIOR LIGHT DELAY) 160 CH CPU

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.

| CHL | LABEL | RELOAD | CURRENT | UNITS | BOOLEAN |
|-----|-----------------|--------|---------|---------|--|
| R1 | Uldy_T_TmrEnb | 10 | 10 | Seconds | $Q = (Chnl_Q2)(Chnl_Q1) + (Chnl_T1)(IFRONT\ DR\ SWtCH)$ |
| R2 | Chnl_R2_TmrEnb | 5 | 10 | Seconds | |
| R3 | Chnl_R3_TmrEnb | 0.3 | 10 | Seconds | |
| R4 | Chnl_R4_TmrEnb | 5 | 10 | Seconds | |
| R5 | Chnl_R5_TmrEnb | 15 | 10 | Seconds | |
| R6 | Chnl_R6_TmrEnb | 0.5 | 10 | Seconds | |
| R7 | Chnl_R7_TmrEnb | 10 | 10 | Seconds | |
| R8 | Chnl_R8_TmrEnb | 300 | 10 | Seconds | |
| R9 | Chnl_R9_TmrEnb | 300 | 10 | Seconds | |
| R10 | Chnl_R10_TmrEnb | 600 | 10 | Seconds | |

☐ CHANGE CURRENT VALUES

Boolean Logic Examples

PMC BOOLEAN EDITOR

MODULE ☐ q ☐ Virtual Mod q CHANNEL ☐ 1 ☐ Chnl Q1 ☐ Cancel ☐ OK

SUM OF PRODUCT GROUP TERMS

PRODUCT GROUP A
☐ NOT q (☐ q ☐ 2))
☐ Chnl Q2
 AND
☐ NOT ☐ NOT (☐ NOT q (☐)) OR ☐ NOT
 AND
☐ NOT q (☐))

PRODUCT GROUP B
☐ NOT q (☐))
 AND
☐ NOT q (☐))
 AND
☐ NOT q (☐))

☐ CHANNEL ON AT POWER UP ☐ OUTPUT CHANNEL ☐ MOMENTARY SWITCH LATCH

PASTE CUT COPY

PMC BOOLEAN EDITOR

MODULE ☐ q ☐ Virtual Mod q CHANNEL ☐ 2 ☐ Chnl Q2 ☐ Cancel ☐ OK

SUM OF PRODUCT GROUP TERMS

PRODUCT GROUP A
☐ NOT q (☐ B ☐ 1))
☐ Frnt Door Sw
 AND
☐ NOT ☐ NOT (☐ NOT q (☐)) OR ☐ NOT
 AND
☐ NOT q (☐))

PRODUCT GROUP B
☐ NOT q (☐))
 AND
☐ NOT q (☐))
 AND
☐ NOT q (☐))

☐ CHANNEL ON AT POWER UP ☐ OUTPUT CHANNEL ☐ MOMENTARY SWITCH LATCH

PASTE CUT COPY

PMC BOOLEAN EDITOR

MODULE ☐ A ☐ Output CHANNEL ☐ 1 ☐ Interior Lights ☐ Cancel ☐ OK

SUM OF PRODUCT GROUP TERMS

PRODUCT GROUP A
☐ NOT q (☐ T ☐ 1))
☐ Chnl T1, TmrRun
 AND
☐ NOT ☐ NOT (☐ NOT q (☐)) OR ☐ NOT
 AND
☐ NOT q (☐))

PRODUCT GROUP B
☐ NOT q (☐ B ☐ 1))
☐ Frnt door sw
 AND
☐ NOT q (☐ q ☐ 1))
 AND
☐ NOT q (☐))

☐ CHANNEL ON AT POWER UP ☐ OUTPUT CHANNEL ☐ MOMENTARY SWITCH LATCH

PASTE CUT COPY

PMC BOOLEAN EDITOR

MODULE ☐ R ☐ TmrEnbModR CHANNEL ☐ 1 ☐ Ltdivy T Tmr Enb ☐ Cancel ☐ OK

SUM OF PRODUCT GROUP TERMS

PRODUCT GROUP A
☐ NOT q (☐ q ☐ 2))
☐ Chnl Q2
 AND
☐ NOT ☐ NOT (☐ NOT q (☐ q ☐ 1)) OR ☐ NOT
☐ Chnl Q1
 AND
☐ NOT q (☐))

PRODUCT GROUP B
☐ NOT q (☐ T ☐ 1))
☐ Chnl T1 TMR Run
 AND
☐ NOT q (☐ B ☐ 1))
☐ Frnt door switch
 AND
☐ NOT q (☐))

☐ CHANNEL ON AT POWER UP ☐ OUTPUT CHANNEL ☐ MOMENTARY SWITCH LATCH

PASTE CUT COPY

Boolean Logic Examples

ON DELAY

An "On Delay" turns an output on **X** seconds after an input occurs and turns the output OFF when the input goes away.

Example:

Input=BF1

Output= BC2

Timer= TA4

VA4 = leading edge pulse from BF1

VA4=!prBF1*BF1

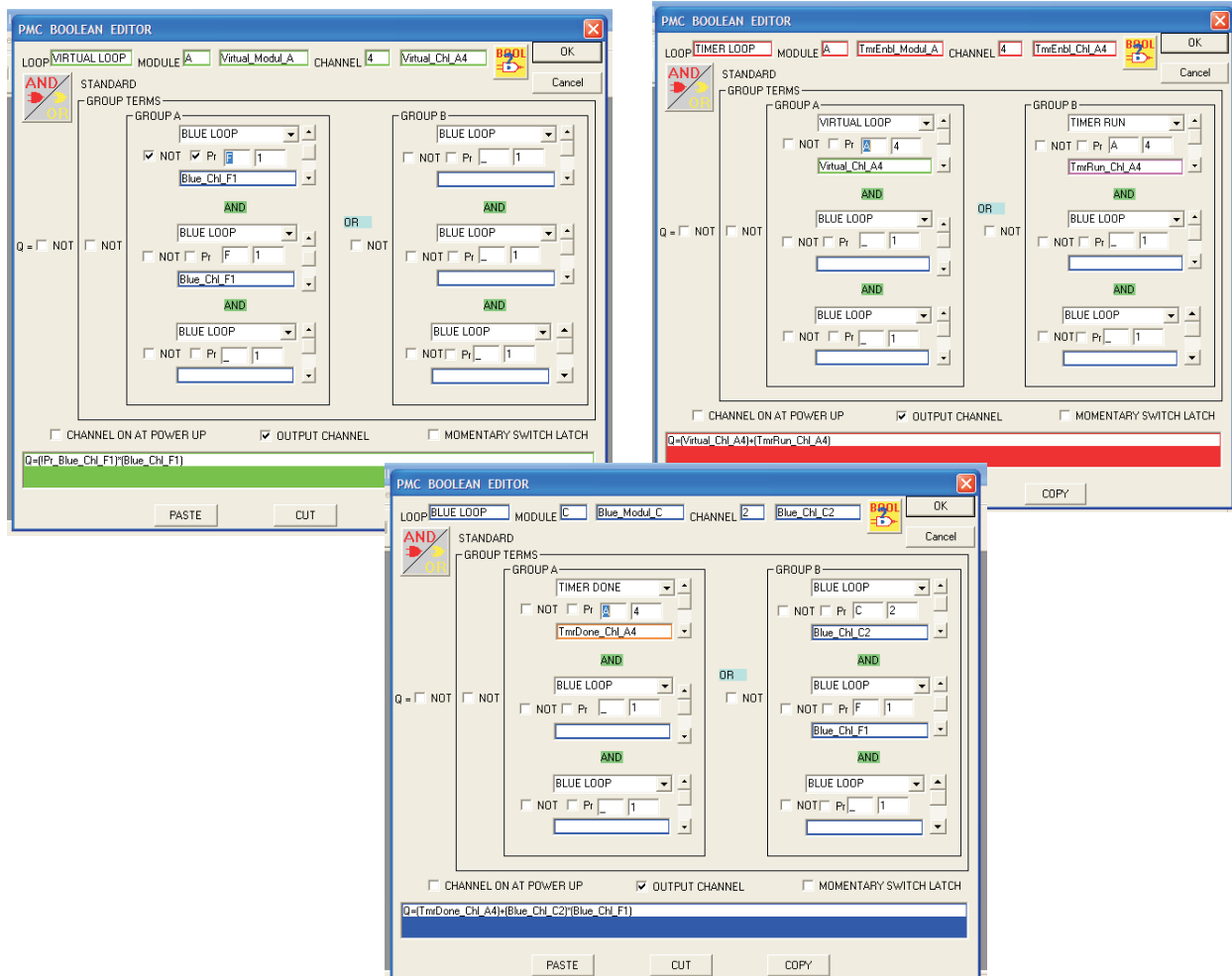
When input BF1 occurs, a pulse will occur on channel VA4

T enable A4= VA4+T run A4

The timer starts with the pulse on VA4 and stays ON because the timer run pulse latches it ON. At the end of the time period, the run pulse goes away unlatching the Timer enable. If input BF1 goes away before the end of the period, the timer is disabled.

BC2=T done A4+BC2*BF1

The output BC2 turns ON with the timer done pulse and latches ON, as long as input BF1 is present.



Boolean Logic Examples

DOOR OPEN/CLOSE WITH LOCK 160 CH CPU

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 pushbutton 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 pushbuttons 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, then shut them OFF.

When either pushbutton is pressed the door will open or close, with one exception. When the interior button is used to close the door, the exterior pushbutton 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
A2 = DOOR CLOSE OUTPUT
C1 = INSIDE SWITCH INPUT
C2 = OUTSIDE SWITCH INPUT
Q1 = VIRTUAL OUTPUT CHANNEL
Q5 = VIRTUAL OUTPUT CHANNEL

Q6 = VIRTUAL OUTPUT CHANNEL
Q6 = VIRTUAL OUTPUT CHANNEL
Q8 = VIRTUAL OUTPUT CHANNEL
Q9 = VIRTUAL OUTPUT CHANNEL
Q10 = VIRTUAL OUTPUT CHANNEL
R1 = THE ENABLE TO START TIMER 1
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.

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.

Channel Boolean Logic Statement

A1 = $Q8 \cdot T1 + S3$
A2 = $!Q8 \cdot T1$
Q1 = $(A2 \cdot C1) + (Q1 \cdot !A1)$
Q5 = $(C1 \cdot !Q6) + (C2 \cdot !Q6 \cdot !Q1)$
Q6 = $C1 + (C2 \cdot !Q1)$
Q8 = $(Q5 \cdot !Q8) + (!Q5 \cdot Q8)$
Q9 = Q10
Q10 = C2
R1 = $Q5 + T1$
R3 = C2

You may use different channels to accomplish this, however; it is important 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.

One Shot Timer

A **one shot timer** turns an output ON when an event first occurs. The output will stay ON for a predetermined time. To cycle again, the input must be removed and then re-applied.

In this example we will have the event sensed on input channel BE1.

Channel BC1 is the output channel.

Channel VA1 is a virtual channel on which we will create an *edge detected pulse* that will occur when input BE1 first appears. We will use Timer A3.

For this example the timer will be set for 5 seconds.

Example shown uses the 320 channel CPU and WinPMC II

BE1=input
BC1=output
VA1=virtual channel with edge pulse created by BE1
T enbl A3= the timer enable channel
T Run A3= the timer running channel
T Done A3= the timer done pulse

CREATING THE EDGE PULSE ON VA1

VA1=!prBE1*BE1

Creates a leading edge .040 second on pulse when input BE1 occurs.

ENABLING AND STARTING THE TIMER

T enbl A3=VA1 + T Run A3

The pulse on VA1 enables the timer.

It remains enabled as long as the timer is running.

TURNING THE OUTPUT ON

BC1=VA1+BC1 * !T done A3

When the pulse occurs on VA1, BC1 will turn ON and then latch ON because it is equal to itself.

BC1 will stay latched ON until the timer done pulse occurs. When the pulse occurs, BC1 turns OFF.

Boolean Logic Examples

1-3 INPUT, MIRROR HEAT,
DEFROST TIMER,
ONE SHOT TIMER
160 CH CPU

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 the 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

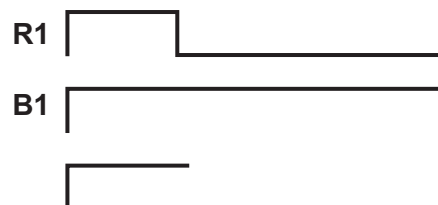
 $Q1 = S1 + (Q1 * Q2)$
 $Q2 = (B1 * B2 * B3)$
 $R1 = (B1 * B2 * B3 * !Q1) + T1$ REDUCING TERMS $R1 = (Q2 * !Q1) + T1$
 $A1 = T1 + (A1 * !Q1)$
T = SET TIME

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 160 CH CPU

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 Example

7 STEP SEQUENCER WITH ADJUSTABLE ON INTERVAL AND ADJUSTABLE OFF INTERVAL 320 CH CPU

This example allows you to program loads to come on in a sequence and turn off in a sequence. The time interval between steps can be set to whatever period is desired. This example uses virtual modules O and P, Timers A1 and A2, and Blue channel F1. You can use any virtual or real modules. If you use real channels, instead of virtual channels, you can use a status monitor to observe what is happening as the sequence progresses.

The only restriction is that the order of the booleans for Virtual Module O and Virtual Module P be as shown in this example. In other words, Step 1 must start with channel 10, step 2, channel 9, step 3, channel 8, and so on. The reason for this is the order in which PMC processes booleans. Booleans are processed from Channel A1 through P10 in order. After P10 is processed it starts again at A1. These cycles repeat every .04 seconds. When done in reverse channel order, channel 10 gets processed in one boolean cycle, channel 9 in the next and so on. In this manner we can have each subsequent step evaluate what happened in the previous step. In other words, channel 9 turns ON only if channel 10 is ON, 8 only if 9 is ON, and so forth.

When the booleans for the virtual channels and timers have been written, any output in the PMC system can be programmed to come on with a sequence step by ANDing it with a virtual step in virtual module P.

FOR EXAMPLE

A fire truck has individual switches for each load that are AND'ed with a Master Switch. This would mean that if all the individual switches were in the ON position, all of the loads would turn ON and OFF simultaneously when the Master Switch is turned ON or OFF. Depending upon the load, this may be undesirable. The sequencer can be used to prevent this. In this example, the first step in the sequence is channel VP10, the second VP9, the third VP8, the fourth VP7, the fifth VP6, the sixth VP5, and the seventh VP4.

After having written the booleans on the following two pages, simply AND the step with the switch that operates the load. This can be done for as many outputs as necessary.

Light Bar Red = light b red sw AND VP10 (turns ON with the first step)

Light Bar White = light b white sw AND VP9 (turns ON with the second step)

Scene Light = scene light sw AND VP8 (turns ON with the third step)

NOTE that the Master Switch is not used in the boolean for the output.

Don't forget to set the time period for timer A1 and A2. Practical values to prevent load dump, or a sudden load application would be 0.2 - 0.5 seconds. Timer A1 sets the sequence up time and timer A2 sets the down time.

See the following two pages for booleans needed to produce the sequencer.

Boolean Logic Example

7 STEP SEQUENCER (Continued from previous page)

| CHANNEL | DESCRIPTION (B= Blue Loop, V= Virtual Loop, != Not, pr= Prior State, *= AND, += OR) |
|-------------|--|
| BF1 | Master Switch This can be any maintained contact or latched push button switch input channel you choose. Since this is an input <u>no</u> boolean should be written. |
| VO1 | Leading edge pulse created using Master Switch BF1. See edge detection for more detail Vo1 = !prBF1*BF1 |
| VP1 | Trailing edge pulse created using Master Switch BF1. See edge detection for more detail Vp1 = prBF1*!BF1 |
| T enable A1 | Timer A1 begins to run when the pulse occurs on VO1 and latches on until channel VO4 comes ON. This timer sets the interval between ON steps. Set the time period in "PMC setup / Timer setup". T enable A1 = (VO1)+(T enable A1*!VO4) |
| T enable A2 | Timer A2 begins to run when the pulse occurs on VP1 and latches on until channel VO1 comes on. This timer sets the interval between off steps. Set the time period in "PMC setup / Timer setup". T enable A2 = (VP1)+(T enable A2*!VO1) |

THE FOLLOWING CHANNEL ORDER IS CRITICAL

| | |
|------|--|
| VP10 | Turns ON when Master Switch BF1 is ON. AND this channel with every output that should come ON with step 1 VP10=BF1 |
| VP9 | Latches ON if Master Switch BF1 and Timer done A1 and VP10 is ON. Unlatches when VO9 comes ON. AND this channel with every output that should come ON with step 2. VP9=(BF1)*(TmrDone A1)*(VP10)+(VP9)*(!VO9) |
| VP8 | Latches ON if Master Switch BF1 and timer done A1, and VP9 is ON. Unlatches when VO8 comes ON. AND this channel with every output that should come ON with step 3. VP8=(BF1)*(TmrDone A1)*(VP9)+(VP8)*(!VO8) |
| VP7 | Latches ON if Master Switch BF1 and timer done A1, and VP8 is on, Unlatches when VO7 comes ON. AND this channel with every output that should come ON with step 4. VP7=(BF1)*(TmrDone A1)*(VP8)+(VP7)*(!VO7) |
| VP6 | Latches ON if Master Switch BF1 and timer done A1, and VP7 is on, Unlatches when VO6 comes ON. AND this channel with every output that should come ON with step 5. VP6=(BF1)*(TmrDone A1)*(VP7)+(VP6)*(!VO6) |
| VP5 | Latches ON if Master Switch BF1 and timer done A1, and VP6 is on, Unlatches when VO5 comes ON. AND this channel with every output that should come ON with step 6. VP5=(BF1)*(TmrDone A1)*(VP6)+(VP5)*(!VO5) |
| VP4 | Latches ON if Master Switch BF1 and timer done A1, and VP5 is ON, Unlatches when Vo4 comes ON. AND this channel with every output that should come ON with step 6. VP4=(BF1)*(TmrDone A1)*(VP5)+(VP4)*(!VO4) |

Boolean Logic Example

7 STEP SEQUENCER *(Continued from previous page)*

| CHANNEL | DESCRIPTION |
|---------|-------------|
|---------|-------------|

| | |
|-------------|--|
| VO10 | This channel latches ON with the trailing edge pulse ON VP1 and when virtual VP10 is OFF. VO10 will unlatch when the Master Switch is turned OFF and VO9 is not ON. You will not use this channel in any booleans, except for Virtual P module. VO10= (VP1)*(!VP10)+(VO10)*(!BF1)*(!VO9) |
| VO9 | This channel latches ON if BF1 is OFF, Tmr doneA2 is ON and VO10 is ON, it unlatches if VO8 or VP10 turns ON. You will not use this channel in any booleans, except for Virtual P module. VO9 is used to unlatch VP9 in sequence when the Master Switch is turned OFF. VO9=(!BF1)*(TmrDone A2)*(VO10)+(VO9)*(!VO8)*(!VP10) |
| VO8 | This channel latches ON if BF1 is OFF, Tmr doneA2 is ON and VO9 is ON, it unlatches if either VO7 or VP10 turns ON. You will not use this channel in any booleans, except for Virtual P module. VO8 is used to unlatch VP8 in sequence when the Master Switch is turned OFF. VO8=(!BF1)*(TmrDone A2)*(VO9)+(VO8)*(!VO7)*(!VP10) |
| VO7 | This channel latches ON if BF1 is OFF, Tmr doneA2 is ON and VO8 is ON, it unlatches if either VO6 or VP10 turns ON. You will not use this channel in any booleans, except for Virtual P module. VO7 is used to unlatch VP7 in sequence when the Master Switch is turned OFF. VO7=(!BF1)*(TmrDoneA2)*(VO8)+(VO7)*(!VO6)*(!VP10) |
| VO6 | This channel latches ON if BF1 is OFF, Tmr doneA2 is ON and VO7 is ON, it unlatches if Either VO5 or VP10 turns ON. You will not use this channel in any booleans, except for Virtual P module. VO6 is used to unlatch VP6 in sequence when the Master Switch is turned OFF. VO6=(!BF1)*(TmrDoneA2)*(VO7)+(VO6)*(!VO5)*(!VP10) |
| VO5 | This channel latches ON if BF1 is OFF, Tmr doneA2 is ON and VO6 is ON, it unlatches if either VO4 or VP10 turns ON. You will not use this channel in any booleans, except for Virtual P module. VO5 is used to unlatch VP5 in sequence when the Master Switch is turned OFF. VO5=(!BF1)*(TmrDoneA2)*(VO6)+(VO5)*(!VO4)*(!VP10) |
| VO4 | This channel latches ON if BF1 is OFF, Tmr doneA2 is ON and VO5 is ON, it unlatches when VP10 turns ON. You will not use this channel in any booleans, except for Virtual P Module. VO4 is used to unlatch VP4 in sequence when the Master Switch is turned OFF. VO4=(!BF1)*(TmrDoneA2)*(VO5)+(VO4)*(!VP10) |

This completes the booleans needed to create the 7 step sequencer.

Boolean Logic Examples

MOMENTARY PUSH AND HOLD ON, PUSH AND HOLD OFF 160 Channel CPU

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 time period.

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

MOMENTARY PUSH AND HOLD ON, PUSH AND HOLD OFF 160 Channel CPU

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 time period.

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 160 CH CPU

See Chapter 5 for edge detection with the 320 CH CPU

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 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.

Boolean Logic Examples

USING EDGE DETECTION *(Continued from previous page)*

LET'S BUILD THE A1 BOOLEAN IN STEPS: *(Continued)*

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.

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)

Boolean Logic Examples

FAN SPEED CONTROL FUNCTION

To make a three speed fan control, a four step function is needed; three speeds and OFF. One way to do this is to first create a pulse from a switch input. Then, using this pulse, trigger a series of three channels to make a divide by four.

This is done in the following way:

The pulse is created on Channel B1 in this example. The three channels involved with the counter are C1, C2, and C3.

The Booleans are as follows:

$C1 = B1 \text{ And } !C2 \text{ Or } !B1 \text{ And } C1$

$C2 = B1 \text{ And } C3 \text{ Or } !B1 \text{ And } C2$

$C3 = B1 \text{ And } C1 \text{ Or } !B1 \text{ And } C3$

The truth table for this group is:

| COUNT | C1 | C2 | C3 |
|-------|----|----|----|
| 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 |
| 2 | 1 | 1 | 1 |
| 3 | 0 | 1 | 0 |
| 4 | 0 | 0 | 0 |

Then, each of the states is decoded with a three input “And” Boolean to produce three separate outputs:

$C4 = C1 \text{ And } !C2 \text{ And } C3$

$C5 = C1 \text{ And } C2 \text{ And } C3$

$C6 = !C1 \text{ And } C2 \text{ And } !C3$

Boolean Logic Examples

FOUR STEP PUSH BUTTON SWITCH FUNCTION OFF-LOW-MEDIUM-HIGH-OFF FAN SPEED CONTROL

With this example, Virtual channel VN8, VN9 and VN5 turn on in sequence each time pushbutton BA7 is pressed. You can of course use any module to create this effect. If you would like to perform this function with a 160 channel CPU, you would use virtual module Q, or an unused real module.

This example is shown using a virtual module.

! = NOT function

+ = OR function

*** = AND function**

B = Blue Loop

V = Virtual Loop

BA7 = Push Button Switch

BC1 = Fan low speed Winding

BC2 = Fan Medium speed Winding

BC3 = Fan High speed Winding

VN8 = Virtual Low

VN9 = Virtual Medium

VN5 = Virtual High

VN1 = (BA7 * !VN7) + (VN1*!VN7) Turn on first step when switch is pressed, but only if not in the middle of the cycle, latch it with VN1 itself, unlatch with VN7 .

VN2 = (VN1 * !BA7) + (VN2 * !VN7) Sense when switch is released, latch condition, and unlatch with VN7.

VN3 = (VN2 * BA7) + (VN3 * !VN7) Sense when switch is pressed second time, latch condition, and unlatch with VN7.

VN4 = (VN3 * !BA7) + (VN4 * !VN7) Sense when switch is released, latch condition, and unlatch with VN7.

VN5 = (VN4 * BA7) + (VN5 * !VN7) Sense when switch is pressed third, latch condition, and unlatch with VN7.

VN6 = (VN5 * !BA7) + (VN6 * !VN7) Sense when switch is released, latch condition, and unlatch with VN7.

VN7 = (VN6 * BA7) + (VN7 * BA7) Sense when switch is pressed fourth time, maintain condition only as long as switch is pressed.

VN8 = (VN1 * !VN3) Low speed occurs when low is requested but not medium.

VN9 = (VN3 * !VN5) Medium speed occurs when medium is requested but not high.

BC1 = VN8 Low speed winding

BC2 = VN9 Medium speed winding

BC3 = VN5 High speed winding.

Chapter 10

Edge Detection / System Timing On the 160 Channel CPU

System Timing

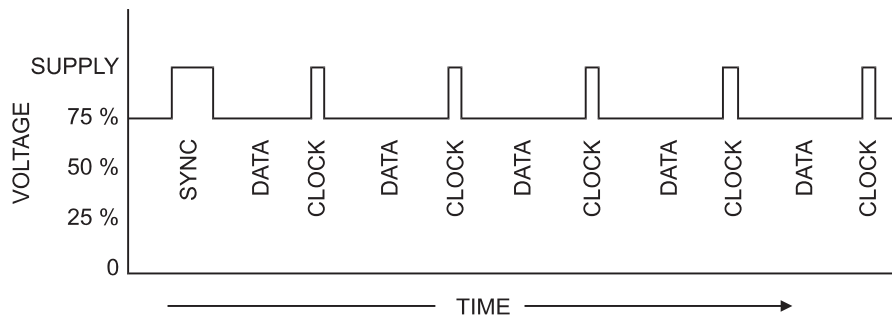
The PMC system has a total of 160 channels for information. These channels appear serially on the PMC multiplex bus, every 40 milliseconds.

The multiplex 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, which 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 below.*

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.



CREATING AN EDGE PULSE ON THE 160 CHANNEL CPU

Creating and using an edge detected pulse has been demonstrated for the 320 Channel CPU in previous chapters. *The following example is the use of the timing aspect to create 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

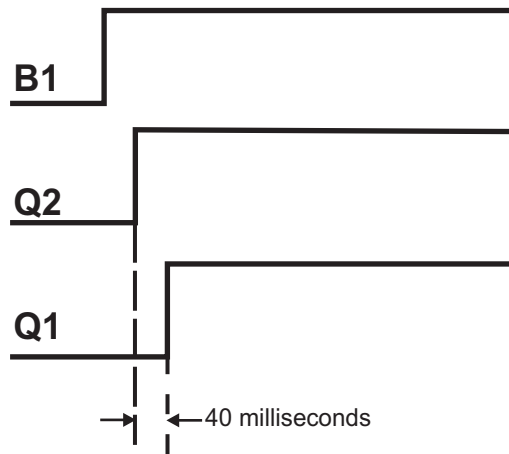
**Switch = B1
Virtual Module = Q
Q2 = B1
Q1 = Q2**

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 has not 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

CREATING AN EDGE PULSE ON THE 160 CHANNEL CPU (Continued)

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 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

$$\begin{aligned} Q9 &= Q10 \\ Q8 &= Q9 \\ Q7 &= Q8 \end{aligned}$$

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 11

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, etc. However, this is not the only kind of algebra.

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 look at a couple of examples. The first example is the function of a simple light switch, that 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 headlights are ON. Let's call the fog light switch A, the headlight 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 headlight 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 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 ?

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:

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

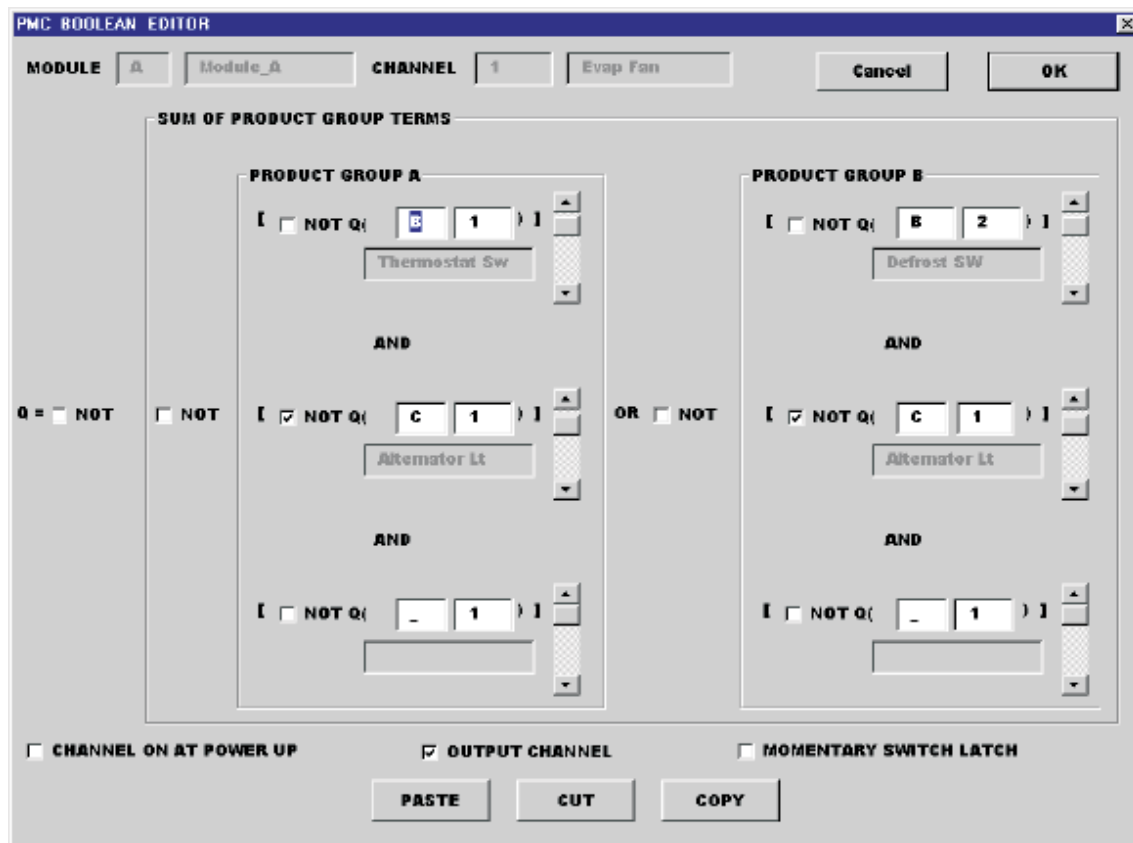
Stated another way:

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

Let's define our terms:

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

The PMC Screen will look like this:



Chapter 12

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 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:

$$\begin{aligned}A + B &= !(A * B) \\ A * B &= !(A + B)\end{aligned}$$

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 true 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 that 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, $!AB$ 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.

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:

$$Q = A!B + !A B$$

If both switches are OFF, or 0, the expression is 0, 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 assist you.



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Appendix A

Design Worksheets



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Programmable Multiplex Control

I/O List

| Channel | Input/Output Name | I/O | Input H/L Output Amps | Location/Zone |
|---------|-------------------|-----|--------------------------|---------------|
| 1 | | | | |
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Programmable Multiplex Control

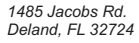
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Programmable Multiplex Control

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

| Channel | Input/Output Name | I/O | Input H/L Output Amps | Location/Zone |
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Intellitec PMC System



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Programmable Multiplex Control

Module and Channel Assignment

| | |
|----------------------------|--|
| 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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