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Lombard, IL 60148

# 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.

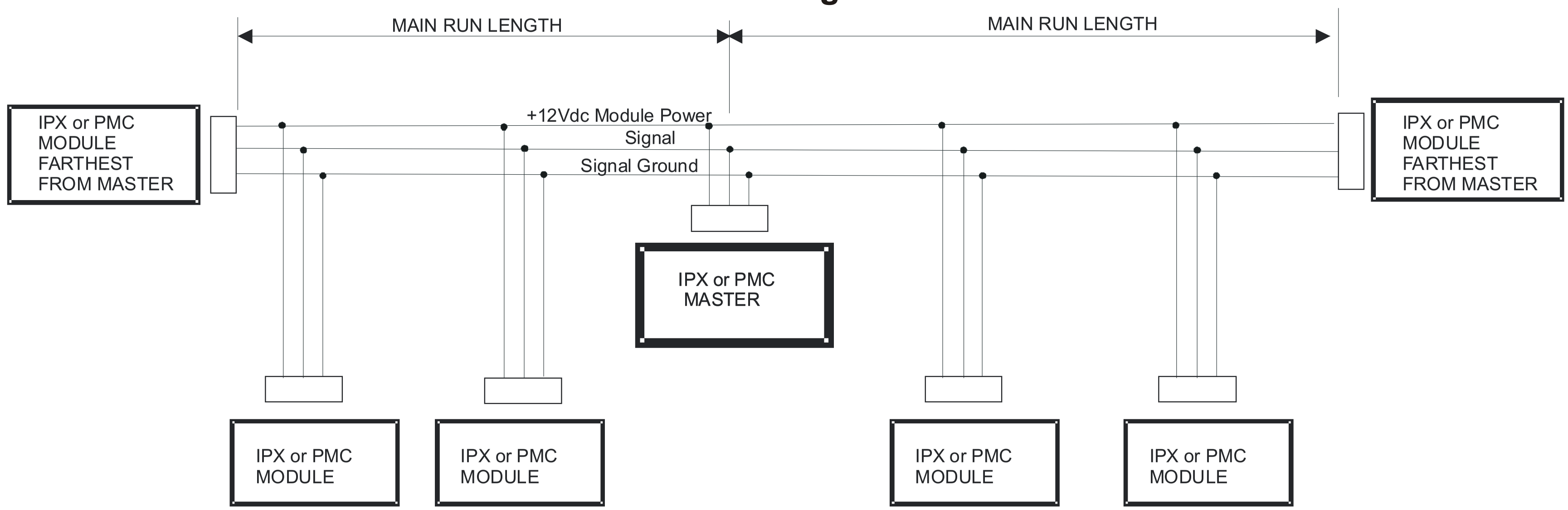
6. On systems where multiple modules are connected to the Communications Harness and the main run is 50ft. or less in length, 18 Awg wire is suitable for all three wires. If the main run is from 50 to 100 feet in length, 16 Awg wire is required. If the main run is greater than 100 feet in length, 14 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.

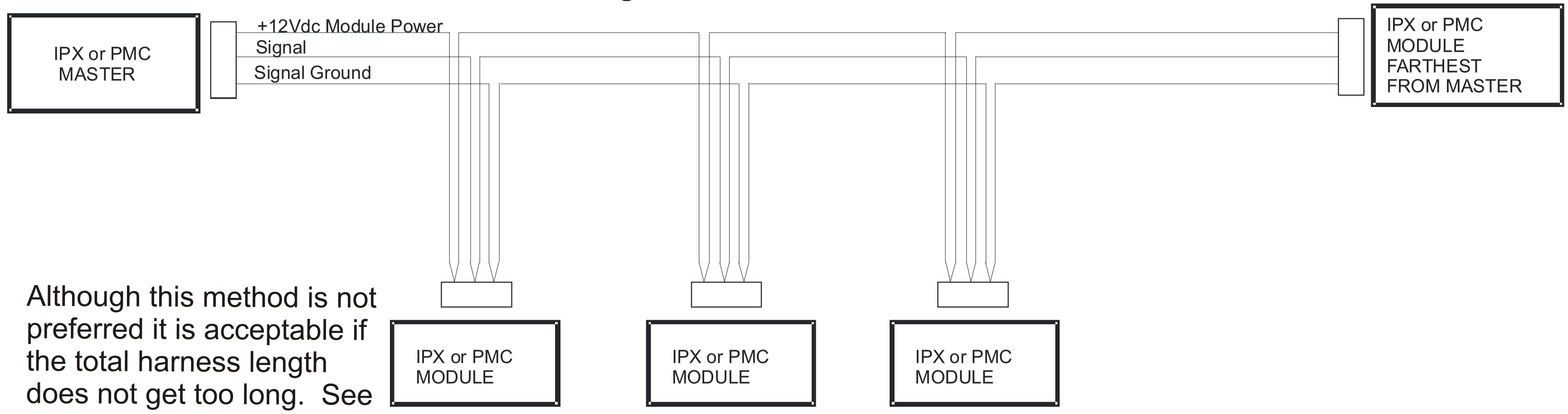
   *Refer to the following page for a graphic illustration.*

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

## Preferred wiring method

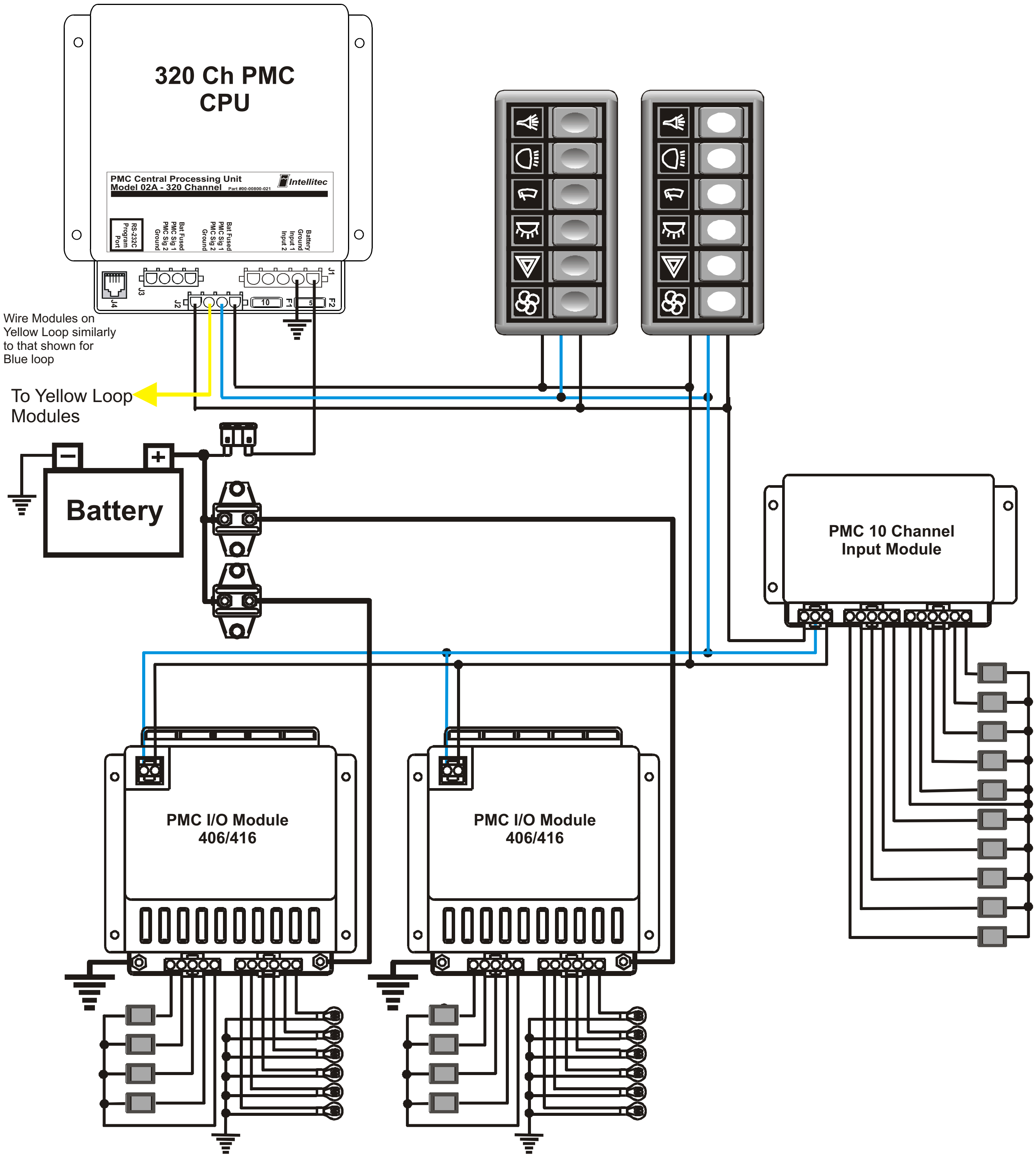



**Non preferred method. increases total harness length.**




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


320 Ch PMC
CPU
PMC Central Processing Unit
Model 02A - 320 Channel
Part #00-00800-021
Intellitec
RS-232C
Program
Port
Bat Fused
PMC Sig 1
PMC Sig 2
Ground
Bat Fused
PMC Sig 1
PMC Sig 2
Ground
Battery
Ground
Input 1
Input 2
J1
J2
J3
J4
10
F1
5
F2
Wire Modules on
Yellow Loop similarly
to that shown for
Blue loop
To Yellow Loop
Modules
Battery
PMC 10 Channel
Input Module
PMC I/O Module
406/416
PMC I/O Module
406/416