PYRODIGITAL PHASE III SYSTEM NETWORK

USERS GUIDE

PYRODIGITAL CONSULTANTS
CALIFORNIA

TABLE OF CONTENTS

SECTION 5

HARDWARE USAGE

SECTION 5

HARDWARE USAGE

THIS PAGE INTENTIONALLY LEFT BLANK

OPERATORS MANUAL FOR PYRODIGITAL PHASE III;

FIRING NETWORK COMPOSED OF FIRING MODULES

INTRODUCTION, THE PHASE III SYSTEM

Pyrodigital Consultant's Phase III Firing System is a Professional Level Tool. This tool is an integrated hardware system which provides a means in which to fire industry standard pyrotechnic squibs under the control of a dedicated personal computer, the Pyrodigital Field Controller, or other Pyrodigital Phase III Controller.

Pyrodigital Consultant's Phase III Firing System as a Professional Level Tool is designed, intended, and only to be used by Professional Pyrotechnic Operators in a controlled Professional Environment permitted by the Fire Authority having jurisdiction, in conjunction with Class C or Class B explosives ONLY that have been examined and issued Federal EX numbers by the US Department of Transportation. The Pyrodigital Firing System is not designed nor shall be used to ignite any Class A explosive.

If you do not understand this usage of the Pyrodigital Phase III Firing System or intend to use the Pyrodigital Firing System for any other purpose - STOP - do not proceed any further. Consult Pyrodigital Consultants about purchase back of your Firing System or cancellation of your order.

DEFINITIONS - SYSTEM CONTROLLER & SYSTEM NETWORK

For purposes of identification, and in this manual, the Phase III System can be divided into two major components, The SYSTEM CONTROLLER and the SYSTEM NETWORK.

The SYSTEM CONTROLLER is what Controls the operation of the Phase III SYSTEM NETWORK. This Controller is at the Control Location, at the point where the operator controls the Fireworks Display or Special Effects. The System Controller can be either 1) The Pyrodigital Field Controller, 2) another type of Pyrodigital Phase III Controller, or 3) the Pyrodigital Interface Box connected to a Personal Computer.

The SYSTEM NETWORK is composed of the Firing Modules, the Interconnecting Cables, and the Splitter Boxes. This Network originates at the System Controller via the single main Interconnecting Cable that is connected to the System Controller. This main Interconnecting Cable then goes to the first Splitter Box which is then connected with additional Interconnecting Cables to the Firing Modules. One (or more) of these Interconnecting Cables can also go to additional Splitter Box(s) via more Interconnecting Cables to which additional Firing Modules are connected.

The System Network may be also referred to as the Firing Network or simply the Network in various places in this manual. Likewise, the System Controller may sometimes be referred to as simply the Controller.

THIS MANUAL ONLY DESCRIBES OPERATION OF THE SYSTEM NETWORK WHICH IS COMPOSED OF FIRING MODULES (with Interconnecting Cables and Splitter Boxes). For a System Network with PAM's (Pyrodigital Automation Modules) or other Firing Output Devices, please refer to the respective manuals for those devices.

FOR OPERATION OF THE SYSTEM CONTROLLER PLEASE REFER TO THE OPERATIONS MANUAL FOR THAT DEVICE.

There is an operators manual :

1) for the Software that is used to control the System Network via a PC Computer (with the Pyrodigital Interface Box),

2) an operators manual for the Pyrodigital Field Controller, and

3) Operators manuals for any other Pyrodigital System Controllers that may be manufactured.

THIS PAGE INTENTIONALLY LEFT BLANK

GENERAL DISCLAIMER

The Pyrodigital Consultants Phase III Firing System is intended for use by bonafide professional organizations only. You must have the expertise and background in professional pyrotechnics necessary to administer all aspects of pyrotechnics display including your understanding of the necessity of proper training and supervision of all employees handling the complex tasks relating to the use of the Pyrodigital Firing System.

Critical and unforseeable factors beyond the control of the designers, authors, manufacturers, and distributors of this Firing System prevent them from eliminating all risks in conjunction with the use of the Pyrodigital Firing System. Such risks include, but are not limited to: great personal injury or death from unintentional and erratic squib ignition, failure of execution of a display due to system failures. Such risks exist even though the Pyrodigital Firing System is reasonably fit for uses stated in all advertising, brochures, and documentation, and even though all the directions are followed.

By proceeding with the use of the Pyrodigital Consultants Phase III Firing System you hereby accept and assume all risks and liability resulting from the use thereof.

*****WARNING - EXTREME DANGER

DANGER !

Specific Procedures pertaining to the Use and Operation of the Pyrodigital Consultants Phase III Firing System are outlined in this Users Guide. Deviation from any of the Procedures outlined in this Guide are specifically forbidden and absolutely not recommended by Pyrodigital Consultants. Injury or Death to yourself and others could result from deviations to the Procedures as outlined in the Guide. Any deviation from the Procedures as outlined in this Guide are clearly at your own risk.

THIS PAGE INTENTIONALLY LEFT BLANK

ABOUT THIS MANUAL

WARNING - DANGER

DANGER !

IT IS INTENDED AND REQUIRED THAT EACH AND EVERY OPERATOR RESPONSIBLE FOR THE USE OF THE PYRODIGITAL PHASE III FIRING SYSTEM SHALL HAVE THEIR OWN COPY OF THIS MANUAL

EACH OPERATOR'S MANUAL COPY SHOULD BE WITH EACH OPERATOR WHILE OPERATIONS INVOLVING THE USE OF THE PYRODIGITAL PHASE III FIRING SYSTEM ARE ONGOING.

If you do not have your own copy of this manual or to request additional copies of this manual contact Pyrodigital Consultants.

This manual, in its entirety, is a technical reference work for the Operation of the Pyrodigital Phase III System Network composed of Firing Modules.

No part of the manual is an any sense a tutorial, instruction guide, or educational text for learning about Display Fireworks Operations, Pyrotechnic Special Effects Operations, or the subject of safely handling Explosives or Pyrotechnic Materials.

It is assumed and required that you bring this experience and prior knowledge with you BEFORE you attempt to read or understand the subject matter of this Manual.

Like all technical references on a specific advanced subject, this manual immediately concerns itself with the subject matter and may dispense with or not include explanations of foundation or groundwork regarding the subject. It is assumed that the reader is already familiar with such foundations and background, and additionally it is assumed that the reader is familiar with A UNIQUE TECHNICAL LEXICON, OR TERMINOLOGY, THAT IS GENERALLY ACCEPTED IN THE INDUSTRY. If you find yourself at a loss to understand the technical terms used in this manual, or your are unclear as to the general subject matter, then this should be your clue that you DO NOT have the necessary background or qualifications to proceed.

In this case STOP! PROCEED NO FURTHER1 Show your supervisor this paragraph and explain your doubts about your prior knowledge and abilities.

If you have no Supervisor, or your are the top level Supervisor, then contact Pyrodigital Consultants directly and obtain clarification or further assistance before proceeding.

CUSTOMER SUPPORT

If you are having difficulty in operating the Pyrodigital Consultants Phase III Firing System, please;

1) Re read the sections of this manual, or other supporting manuals, concerning the area you are having difficulty with.

2) Assuming that you are in an inert Test Environment, try some other actions to try and work through your difficulty. Since you are in an inert Test Environment, do not worry about making mistakes, you can't break anything or Fire any live material. We all learn from mistakes and if you are not practicing with the Phase III Firing System in an inert Test Environment, then you are not learning as intended.

3) Call Pyrodigital Consultants Technical Support at USA 1-408-375-9489

4) Pyrodigital Consultants Technical Support can also be reached directly on a 24 HR. Bulletin Board, The West Coast Pyro Board. This BBS can be reached at USA 1-209-661-5355 with your modem set at 8,N,1.

OPERATOR AND SITE REQUIREMENTS

The procedures, functions, and all information outlined and described in this Manual assume certain requirements concerning the 1) Operator in Charge who is Operating the Pyrodigital Firing System or directly responsible for the System Operator if he/she is not the System Operator and 2) the Physical site at which the Firing Operations take place.

It is, assumed that in all cases, the System Operator is a working member of a professional team that prepares for, sets up, and executes Public Display Fireworks or Special Effects. It is assumed that these operations, including the Operation of the Pyrodigital Firing System are supervised and controlled in a Top Down fashion by a Master or Journeyman Pyrotechnician who has substantial qualifications and experience in these operations. The Pyrodigital Firing System and all components relating thereto are Professional Level Tools, designed for and intended to be used by working, fully qualified, and extensively experienced Master Pyrotechnicians.

This manual will only cover the Operation and Setup of the Pyrodigital Phase III System Network composed of Firing Modules. The user must refer to the Operators Manuals for System Controller which will be used with the Pyrodigital Phase III System Network.

This Manual will NOT cover specific information relating general Safety related background material in handling Explosive Products including Pyrotechnic Materials. This manual assumes that the user has prior knowledge and experience and that the user brings that knowledge and experience with he/she as he/she reads this manual and gains understanding of how to use the Pyrodigital Phase III Firing System. If you do not have this prior experience you should stop reading here. Proceed no further. Explain to your supervisor or to Pyrodigital Consultants that you do not have the necessary qualifications to proceed with operation of the Pyrodigital Firing System.

This prior knowledge and experience are assumed to exist and remain current regarding the person or persons responsible for use of the Pyrodigital Firing System. This person will hereafter be called "the Operator" or "the Operator in Charge" or "the System Operator".

It will be your responsibility, as the Operator in Charge, to continuously monitor and insure that at every site at which the Pyrodigital Firing System may be in use, that this set of assumed conditions exists, and further that it does not change or deteriorate over time.

IT WILL NOT BE POSSIBLE TO SAFELY OPERATE AT ANY SITE ON WHICH THE INITIAL SET OF ASSUMPTIONS, OR CONDITIONS IS NOT IN PLACE. GREAT BODILY HARM, INJURY OR DEATH TO YOURSELF, YOUR CO-WORKERS, AND INNOCENT BY-STANDERS MAY OCCUR FROM IRRESPONSIBLE OPERATIONS WITH LIVE PROFESSIONAL DISPLAY FIREWORKS AND SPECIAL EFFECTS PYROTECHNICS.

Make sure that you are qualified as explained in the following and preceding paragraphs. If you do not feel that you posses the proper qualifications as outlined above and below you should not proceed with attempting operation of the Pyrodigital Firing System. Contact your Supervisor or Pyrodigital Consultants and explain any questions that you may have before taking it upon yourself to proceed.

General Safety knowledge is gained through familiarity with applicable laws and field experience under the supervision of a competent Pyrotechnics Operator.

Electrical Firing Safety is considered as part of General Safety Knowledge. Safety is a conscious effort to prevent accidents through intelligent understanding of the hazards involved.

Anyone responsible for operating the Pyrodigital Firing System must have at least the following prior qualifications;

1) A state Explosives, Pyrotechnician, or Special Effects License.

2) A minimum of 2 years prior experience under the direct supervision of professional operators.

The Physical site at which any operations take place must have at least;

1) Been permitted by the local fire authority having jurisdiction.

2) Be covered by a general liability insurance policy that names the display operator and the system operator.

3) The display items must be Class C or Class B Display Pyrotechnics ONLY, and these items must have been examined by the US Department of Transportation and have been issued Federal EX Numbers.

SAFETY AND GENERAL GUIDELINES

WARNING - EXTREME DANGER

The Purpose of the Phase III System is to cause initiation of industry standard pyrotechnic squibs to ignite Display Type Fireworks or Pyrotechnic Special Effects. If you do not understand this usage or intend to use the Phase III System for any other purpose do not use the Phase III System.

WARNING - EXTREME DANGER

DANGER !

Fireworks and Special Effects Materials are Explosives which can and may cause personal injuries or death to yourself and other people including Spectators or innocent bystanders in addition to Property Damage.

The use of the Phase III System in no way alleviates any safety / legal / moral responsibilities in the use, loading, transportation or discharge, of Fireworks or Special Effects. The user assumes all responsibility and liability in use of pyrotechnic devices and the use of the Phase III System and must be fully competent.

If you are not qualified or have any doubt as to your qualification do not use the Phase III System. Seek professional assistance and be aware of and follow all safety procedures including compliance with all Federal, State, and Local Laws and/or Laws in the Country in which you are using Phase III.

SAFETY IS YOUR RESPONSIBILITY and is beyond the control of the manufacturer, seller, or their agents.

SAFETY

It is beyond the scope of these instructions or this manual to give general safety instructions pertaining to the use of Fireworks and Special Effects, including but not limited to storage, handling, transportation, discharge, disposal, and compliance with all applicable laws. General safety knowledge is gained through familiarity with applicable Laws and field experience under the supervision of a competent pyrotechnic operator.

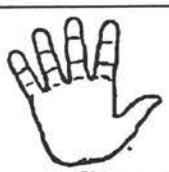
ELECTRICAL FIRING SAFETY IS CONSIDERED AS GENERAL SAFETY KNOWLEDGE.

Specific Safety procedures applicable to the use of Phase III System are highlighted throughout this manual. These Safety related procedures are indicated as;

CAUTION
WARNING - DANGER
WARNING - EXTREME DANGER ;

OBEY THESE SAFETY PROCEDURES. These specific procedures cannot guarantee Safety. Safety is a conscious effort to prevent accidents through intelligent and thorough understanding of the hazards involved. If you do not know what you are doing and the consequences of your actions then STOP! do not proceed.

GENERAL SAFETY GUIDELINES



WARNING - EXTREME DANGER

These General Safety Guidelines cannot, in any way, be considered as complete and are only presented here to remind the user of the potential hazards and precautions, of which the user should already be intimately aware.

Having the Phase III System in a Safe or non Armed condition does not mean that anything is SAFE. Squibs should be handled, stored, and used with the same respect and precautions as one would religiously follow for electric blasting caps, and in fact, the squib is the first initiating stage of a blasting cap.

Squibs are very sensitive devices and can ignite when subjected to friction, impact, and sufficient electrical energy. Some potential sources of electrical energy are static discharges (human, dust, snow, & electrical storms) and RF (radio frequency) energy from TV, microwave, and radio transmitters, as well as the applied electrical energy used to initiate the squib.

Keep your squibs shunted (leg wires (shorted) twisted together) until actual connection into the circuit.

Keep your squibs stored in a sealed METAL container (the metal provides RF shielding) located remote from all other pyrotechnic material.

Don't allow Radio transmitters (police, fire, communications, etc.) within 500 feet as a standard safety procedure. Consult IME (Institute of Makers of Explosives) publication # 20 "Safety Guide for the Prevention of Radio Frequency Radiation Hazards" for safe
distances at known transmitter power and frequencies.

The practice of pre-squibbing shells should be avoided, especially in the case of shipping and transportation.

Do not pull on the leg wires of a squib - separation of the match head from the leg wires can cause initiation of the squib.

If one assumes that any one of the squibs may ignite at any time for whatever reasons, then one can plan safe handling and deployment procedures which will minimize injuries and eliminate any possible fatality should any such squib ignition occur.

THIS PAGE INTENTIONALLY LEFT BLANK

GENERAL OVERVIEW, THE PHASE III FIRING SYSTEM NETWORK

The Phase III system is built around the modular concept. Firing Modules form the basic building blocks of the System Network and may be added as needed (with associated interconnecting Cables and Splitter Boxes). This approach allows for maximum flexibility in both physical Layout of the System Network and the overall size (or capacity) of the entire system.

In usage a single (one) interconnecting cable runs from the firing control location out to the firing site. This cable is connected to a splitter box (or to a single firing module). Interconnecting cables then leave the splitter box and connect to either a firing module, or to another splitter box. All firing modules thus, are then eventually connected into the communications network. See this manual Sections on Interconnecting Cables, Splitter Boxes, and System Layout.

Splitting of the signal (via the interconnecting cables and splitter boxes) can be done as many times as needed and need not follow a logical array. A logical layout of splits (primary, secondary, etc.) however, may be beneficial in a complicated large layout for simplicity and checking. Also see this manual Section on System Layout, the diagrams on possible System Layouts.

Since the squib firing power is sent through the interconnecting cable, this limits the total system expansion to the load to be fired. Normally there would be sufficient power to fire several squibs on one circuit and one would not be concerned over sufficient firing current. Electrical resistance specifications should be checked to insure sufficient squib firing power whenever very long squib extension wires are used, when firing many squibs per circuit, or when many interconnecting cables (in the direct path) are used to connect a firing module. See the Manual section; Squib Firing Power, Maximum Limits.

The Phase III system is physically laid out and all the firing modules are connected via the interconnecting cables and splitter boxes. The correct module address is set via the rotary thumbwheel address switch. (See this manual Sections on Firing Modules, Understanding the Hexadecimal System, Addressing of the Firing Modules, and Determination of Firing Address). The system may then be powered up to check for proper communications to all the firing modules, with all firing modules shunted. The pyrotechnic devices are then connected via the squib legwires to the firing modules. The correct device must, of course, be connected to the correct location of the correctly addressed firing module. Squib status may be checked when all the squibs are

connected in the "status" mode. (after lifting the shunts on the firing modules when the firing area is clear) Last minute changes to the data table may be made if necessary, such as changes due to different shells on location than planned for, changes in address/shot code, and changes in choreography (See this manual section on System Check-Out).

When Operating the System in a Pyromusical Display Situation, when ready, the system is armed and the System Controller is placed in the Auto Fire or Smart Fire mode. In this mode, the Controller quickly generates an internal firing data table. This firing table is the table from which the actual firing commands are issued, and ***is not the same ordering as the scripting table***!. This table has two entries per cue being; 1) the actual firing time , which is the event time minus the pre fire delay, and 2) the address/shot code for that event. The system fires all the squibs (events/cues) according to the firing table time (with the associated address/shot code) against the time code input.

The time code input comes from a feed line off the time track of the master audio tape as it is played (from which the display was originally choreographed and programmed to). The music on the other tracks of the master tape machine is radio broadcast or drives a P A System , or both. This time code feed may be a direct connection to the tape machine (when the music is played on location), may travel over phone lines (from the radio station to the firing control location as an example), or over special radio links (from the P A mixing console as an example). On location audio synchronization of two identical music tracks, with the slave machine outputting time code to the computer, is possible, however less desirable and not as precise. Please see the section of this Manual on Time Code for further detail.

The time code input is provided to the computer as a high impedance line level signal for connection to the RCA play input jack. The computer will switch to internal time drive mode if the time code signal is lost. This will only happen after the computer has received at least one valid time code, and the computer will continue on internal time drive (same crystal reference which generated original time code) until it receives a new valid time code. This automatic switching prevents the display from stopping should the time code data line be intermittent or terminated once the display is started. The operator can always override this feature by stopping the computer. Please see this manual Section on the Auto Time Switchover feature.

PRACTICE AND INERT TESTING

It is required that the user gain total familiarity with the Phase III complete Firing System BEFORE ANY LIVE PYROTECHNICS ARE FIRED OR EVEN PRESENT.

WARNING - EXTREME DANGER

DO NOT OPERATE THE PHASE III FIRING SYSTEM IN A LIVE FIRING ENVIRONMENT UNLESS YOU ARE COMPLETELY FAMILIAR WILL ALL OPERATING PROCEDURES AND WARNINGS IN THIS OPERATORS MANUAL, PLUS THE OPERATORS MANUAL FOR THE SYSTEM CONTROLLER THAT YOU ARE USING. The System Controller Operators Manual would be for 1) the Pyrodigital Field Controller, or 2) other Pyrodigital System Controllers, or 3) the Operators Manual for the Firing Software Version you are using with the Personal Computer / Pyrodigital Interface Box Combination).

DEATH, INJURY, AND PROPERTY DAMAGE MAY OCCUR IF YOU DO NOT KNOW EXACTLY HOW TO OPERATE THE PHASE III FIRING SYSTEM.

The user is expected and encouraged to Operate the Phase III System in an inert Test Environment in which no Pyrotechnic Material is Present. Your System originally came with Test Lamps that are to be used as simulated squibs so that you may practice Firing repeatedly without actually igniting any Pyrotechnic Material. Test Lamps are available from Pyrodigital Consultants, or 12 - 16 volt incandescent Lamps rated at approximately 75 milliamps may be used. Philmore # 495 replacement lamps are a good choice.

Many Options are available for inert Testing with simulated squib test lamps. Initially you may be comfortable inert testing with only 1 Firing Module. At some point you should Layout and Connect your full Firing System to become familiar with all aspects of the complete System. You should inert test and simulate every procedure and function as outlined in this Manual PLUS the manual of your System Controller.

You should create .sho files or data tables and PRACTICE all the procedures

outlined in this manual. Show files and data tables may be specially created to simulate Firings in your Inert Bench Test System Layout. Firing Module Addressing may be done to facilitate your inert testing lamp setup. You may also use the BENCHTST Utility as outlined in this manual for INITIAL testing on 1 Firing Module with the PC Computer / Interface Box combination.

IF YOU HAVE ANY QUESTIONS, OR DO NOT UNDERSTAND ANYTHING WHATSOEVER RELATING TO THE OPERATION OF THE PYRODIGITAL FIRING SYSTEM; PLEASE CALL PYRODIGITAL CONSULTANTS IMMEDIATELY FOR CLARIFICATION.

PYRODIGITAL CONSULTANTS IS AVAILABLE AT 1-408-375-9489 IN THE USA. PYRODIGITAL CONSULTANTS TECHNICAL SUPPORT CAN ALSO BE REACHED DIRECTLY ON A 24 HR. BULLETIN BOARD, THE WEST COAST PYRO BOARD. THIS BBS CAN BE REACHED AT 1-209-661-5355 WITH YOUR MODEM SET AT 8,N,1.

FIRING MODULES

The Firing Module is the final link which connects the squib to the Phase III System. The squib, of course, is connected to (in contact with) the Pyrotechnic Device to be ignited under control of the Phase III System.

The firing module is a small aluminum box which houses various electronic components. Basically the firing module takes input control signals and outputs firing power to the desired squib. The firing module is intended to be near the devices to be fired and thus has various output termination options. Output termination options means the various ways in which the squib may be connected to the firing module, or thus terminated. (Note: squib may mean more than 1 squib per circuit)

Each type of firing module is electrically identical and only varies physically to accommodate different ways in which to connect the squib. Firing modules are therefore completely interchangeable anywhere within the physical layout.

Since the firing modules are electrically identical and interchangeable, the question then is how are the modules distinguished from one another? This is accomplished by a double hex rotary thumbwheel address switch on each module (see the manual section on hexadecimal for further explanation of hex). The thumbwheel switch is externally accessible and a firing module address may be selected in a matter of seconds. This means that any firing module may be positioned anywhere within the physical layout and then simply set to the correct address. The address usage is more fully covered in the ADDRESS Section of this Manual.

Each type firing module has 16 firing circuits. The module type (output termination options) dictates the manner in which the squib is connected to each of the 16 circuits. Each and every squib therefore has a specific module address and a shot address, or the location of a particular squib on that particular module. This address / shot code is the information which the computer uses to talk to a specific squib. Up to 128 module addresses times 16 shots per module gives up to 2048 individually addressable firing circuits (See ADDRESS Section of this Manual).

The Firing module also houses an input connector of the 3 wire XLR professional series. The 3 wire interconnecting cable is thus connected to the module via this connector.

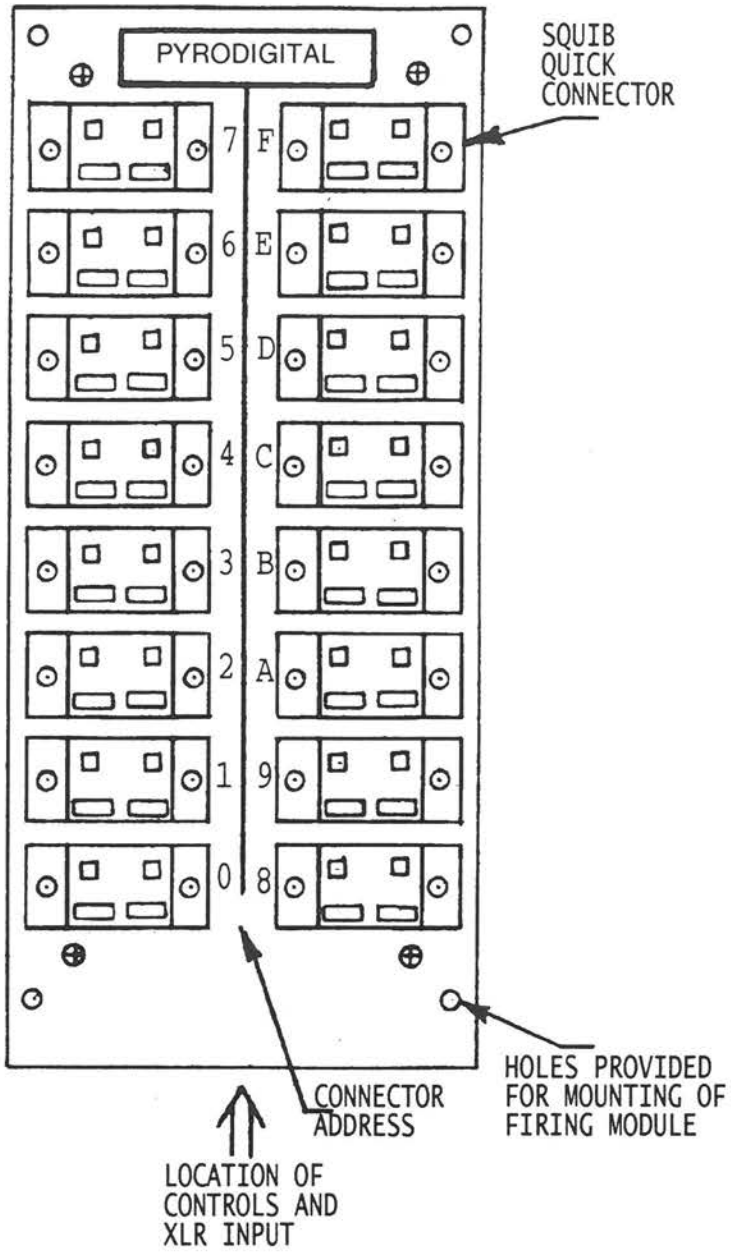
For safety and operational purposes the firing module also has a rotary

shunting switch. This is a 2 position switch, being either shunted or armed (unshunted). In the shunted position all firing power outputs are disconnected and all 16 squib connectors (output termination options) are individually short circuited together (shunted). The module electronics, however, are still operative and the entire system may be powered up for check out in complete safety and in a non fire condition with all squibs shunted. Successful operation and communication within the entire layout of the system at this point (shunted) indicates that all is OK and it is safe to proceed.

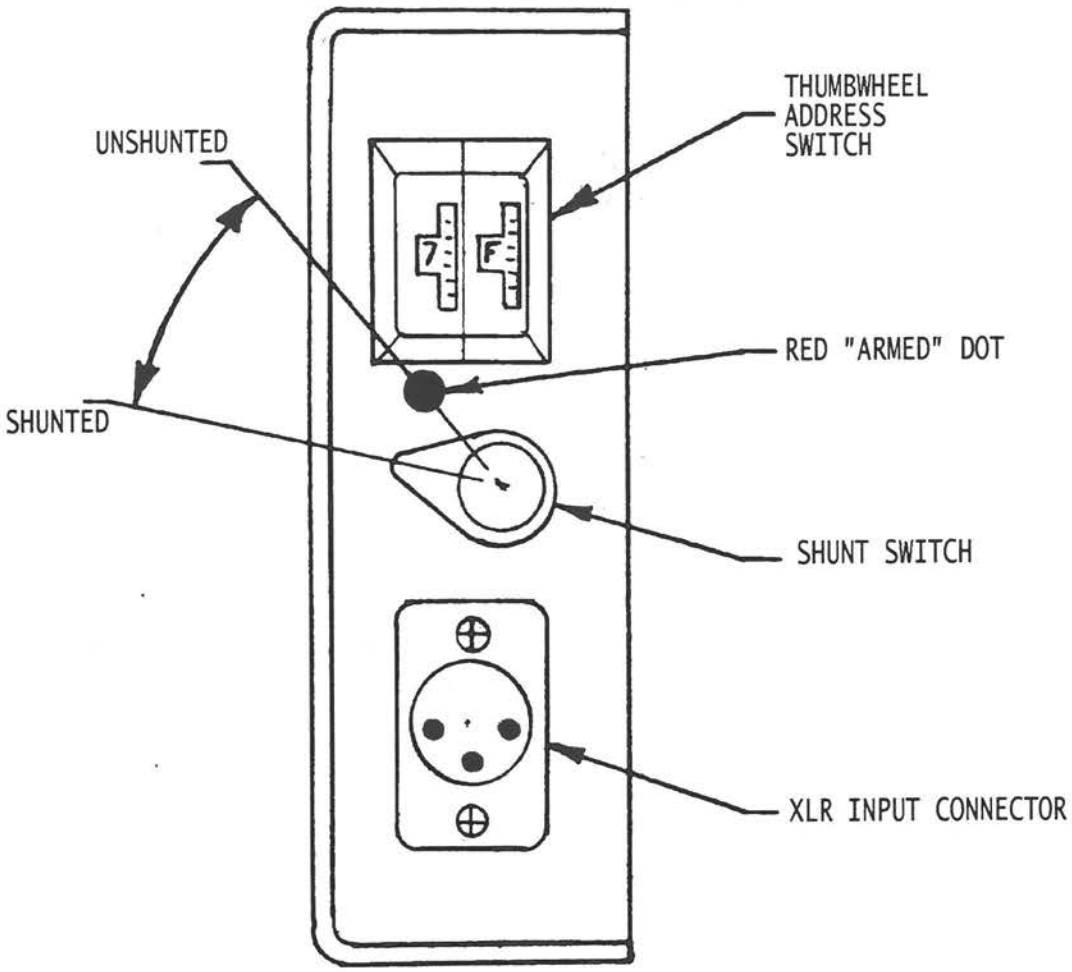
The firing modules also have provisions for sending squib continuity information back to the computer. With the shunts opened the entire layout may then be checked to insure all the squibs are connected and ready to fire.

PLEASE SEE THE ACCOMPANYING DRAWINGS, ON THE FOLLOWING TWO PAGES, WHICH INDICATES THE RESPECTIVE CONTROLS, INPUTS, AND OUTPUTS OF THE FIRING MODULE.

TOP VIEW OF HIGH DENSITY FIRING MODULE



END VIEW OF FIRING MODULE CONTROLS AND INPUT



UNDERSTANDING THE HEXADECIMAL SYSTEM

Hexadecimal is a numbering system that is used by computers. The Phase III System uses Hexadecimal, or hex, as part of it's communication system. Hex allows us to represent 1 of 16 numbers with only 1 character. Notice that the number 16 has two characters, a one (1) and a six (6). In hex we can represent 16 different numbers with only one character. In decimal we can represent only up to ten numbers with one character (0 through 9).

Decimal	Hex
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	A
11	B
12	C
13	D
14	E
15	F

Notice that zero (0) is a valid number. Thus there are 16 total numbers in decimal (base 10) from 0 through 15. In hex (base 16) there are 16 numbers, or characters, from 0 through F. (Hex is based on 2 to the 4th power, or 2 x 2 x 2 x 2 = 16)

Hexadecimal allows us to represent one of 16 numbers with 1 of 16 hex characters, 0 through F, thus using ONLY 1 CHARACTER FOR ONE OF 16 NUMBERS.

Hex is relatively easy to understand, and just remember that we use it so that we can represent any one of 16 numbers with only 1 character. That is it's sole purpose. Consult a mathematics or Computer textbook for further information on hexadecimal.

THIS PAGE INTENTIONALLY LEFT BLANK

ADDRESSING OF THE FIRING MODULES

Each Firing Module has 16 circuits. These circuits are labeled 0 through F on the top of the Firing Module, beside each respective squib quick connector. Each one of these circuit addresses, 0 through F corresponds with part of a communications command from the System Controller. An additional part of the communications command is the Firing Module Address, or "Box" Address. This "Box" address is selected via the external double hex thumbwheel switch on the outside of the Firing Module.

The Firing Module, or Box, address is selected by inserting your fingertip in the gear like cogs of the thumbwheel switch and rotating the wheel of the thumbwheel switch. There are two (2) sections, or thumbwheels on the complete switch. Each Thumbwheel Switch Section has a visible indicator of characters, 0 through F visible in the slot of the switch opening. The specific address of the Firing Module, or the "Box" address is read as you would normally read it, right side up, from left to right.

The Box address (Firing Module address) is determined by these switch settings. The setting is read as you normally read the characters, left to right and not up side down. The maximum usable Box addresses are 00 to 7F = 128 addresses. 80 through FF are not used and will be a repetition of the lower 128 addresses. (00 = 80, 7F = FF, etc.) DO NOT USE BOX ADDRESSES 80 THROUGH FF, but remember PHASE III CAN STILL FIRE THESE FIRING MODULE ADDRESSES as a duplicate of any of the lower 128 addresses.

(There are 16 times 16 [(0 through F) times (0 through F)] possible switch combinations, equals 256, but only the lower 128 are used, box address 00 through 7F).

DANGER !

WARNING - EXTREME DANGER

USE ONLY THUMBWHEEL ADDRESS (BOX ADDRESS) SETTINGS 00 THROUGH 7F. DO NOT USE THUMBWHEEL ADDRESSES (BOX ADDRESSES) 80 THROUGH FF. A thumbwheel address greater that 7F (80 through FF) will be interpreted as a lower duplicative address and a pyrotechnic device may be unexpectedly Fired causing injury or death.

DANGER !

WARNING - DANGER

THE PHASE III SYSTEM CAN FIRE SQUIBS AT EVERY POSSIBLE THUMBWHEEL SWITCH ADDRESS SETTING ON THE FIRING MODULES. NEVER, NEVER SET A FIRING MODULE ADDRESS (thumbwheel switch) TO AN UN-ADDRESSED POSITION IN ORDER TO "REMOVE" THAT DEVICE(S) FROM THE FIRING CIRCUIT.

PHYSICALLY DISCONNECT ANY UNDESIRED PYROTECHNIC DEVICE(S) FROM THE FIRING MODULE(S) AND/OR DISCONNECT THAT(THOSE) FIRING MODULE(S) FROM THE SYSTEM NETWORK.

DANGER !

CAUTION

NOTE: EACH FIRING MODULE MUST HAVE IT'S OWN UNIQUE ADDRESS, as set on the thumbwheel switch. Two or more Firing Modules set on the same address could result in misfires of the squibs connected to those identically set (addressed) Firing Modules. (because the firing current will be split between those Firing Modules with the same address and thus reduced and potentially unbalanced) The System Controller also will be unable to distinguish which module is which for purposes of the squib continuity check (status returns). (See the section of this manual which specifically talks about multiple Firings of Firing Modules set on the same box address).

The complete circuit address is thus a 3 hex character string, from 000 to 7FF. The first 2 characters are the Firing Module Address (Box Address) and the third (or last character) is the specific circuit (0 through F) on that particular Firing Module. This 3 hex character address thus allows the Phase III System to independently fire the squib connected to that one location on that particular Firing Module.

IT SHOULD BE OBVIOUS THAT THE PARTICULAR PYROTECHNIC DEVICE WHICH IS TO BE FIRED AT IT'S PARTICULAR ADDRESS MUST, IN FACT, BE PHYSICALLY CONNECTED TO THAT EXACT ADDRESS.

Sometimes the complete 3 hex character address is referred to as the address / shot code. The address / shot code is another name for the complete address and again specifies at which firing module (box address) and at what location (one of 16 shots on that firing module) the squib is to be fired. The address / shot code corresponds to an exact circuit connection on a particular firing module to which the correct pyrotechnic device for this cue must be connected.

DETERMINATION OF FIRING ADDRESS

The determination of the address may be derived in several ways. The key point is that the address entered into the SYSTEM CONTROLLER must match the Pyrotechnic Device which is desired to be fired at that Event. Restating; An Event is Scripted or Choreographed with a particular Pyrotechnic Device. The Device is related to the Event by the complete 3 hex character Address. The System Controller tells that device to fire by means of the address, which means that the Device must be connected to that address associated with that Event. The address may thus be determined in advance or at the time of connecting the Pyrotechnic Device.

The address may be determined in advance by figuring out the physical layout of the mortars and devices. Addresses may then be assigned according to how the Display is to be loaded. Loading then proceeds to connect each device to the specified address from the loading diagram or computer printout by address.

The address may also be determined at the time of loading. This takes more time and careful note taking because all the addresses must then be entered into the System Controller. A mistake in address will result in the wrong device being fired at the desired time (or Event).
Perhaps the best approach, at least initially is to plan all the addresses in advance. Then at the time of loading some changes can be made to accommodate different loading or different devices than initially planned for. These changes will have to be entered into the System Controller by changing the addresses. It may be desirable to change some addresses for various other reasons, such as convenience in connecting the squibs or mistakes made during planning. As with anything, if many changes are made at the last minute it can become very confusing as to what is going on. It is recommended therefore to plan completely in advance to minimize the confusion.

NOTE THAT WHEN REFERRING TO "ADDRESS" WE ARE TALKING ABOUT THE FULL 3 HEX CHARACTER ADDRESS. It takes the full 3 hex characters to fully tell the SYSTEM CONTROLLER where to Fire. When giving an address IN ONLY 2 HEX CHARACTERS, THIS MEANS "BOX" ADDRESS, or only the first 2 hex characters of the address (the thumbwheel switch setting). A 2 hex character address is used to refer to a specific Firing Module only, as a complete unit (all addresses on the "box" from 0 through F).

SPLITTER BOXES

The Splitter Box is a simple mechanical housing containing 1 (one) male XLR input connector and a number of female XLR output connectors. The Splitter Boxes simply serve to expand the number of Firing Modules which may be connected to the System Network. Splitter Boxes may also be in the form of a "Y" connector, with one input (male XLR) and 2 outputs (female XLR). Even though this is not technically a "box" it is still called a Splitter Box.

The Splitter Boxes are available in various sizes which are determined by the number of outputs, or female XLR chassis connectors. There is only 1 input, being a male XLR chassis connector. The Splitter Box is a simple mechanical unit and contains no electronics. The Splitter box XLR input connector is simply hardwired in parallel to all the output connectors, pin 1 to 1, 2 to 2, and 3 to 3.

The female XLR connectors have a locking device which firmly locks in the corresponding male XLR connector on the Interconnecting Cable. Inserting the male XLR connector on the Interconnecting Cable fully into the female chassis connector on the Splitter Box automatically locks the connector in place. Simply push in on the latch to release the Interconnecting Cable.

The Splitter Box serves to expand the number of Firing Modules which may be connected to the Phase III System. Without a Splitter Box only one Firing Module could be connected to the main Interconnecting Cable.

ALL OF THE FEMALE XLR OUTPUTS ON THE SPLITTER BOXES NEED NOT BE USED. Depending on the size of the System (the number of Firing Modules), there may be one or more Splitter Boxes which may have several outputs unused on each Splitter Box. This is perfectly acceptable and normal.

THIS PAGE INTENTIONALLY LEFT BLANK

INTERCONNECTING CABLES

The concept is to replace the many, bulky, inflexible, heavy, and expensive multiconductor cables emanating from the panel (or board) with 1 (one) simple communications cable. The wiring "rats nest" at the end of the multi-conductor cables is also eliminated.

The Phase III communications system is designed to behave as an unterminated communications network. The system communicates to/from only one particular firing module at any one moment in time. This means that communications and firing power follow whatever direct path is provided by the interconnecting cable layout. It also means that the cable layout may be random and split in any manner convenient to the physical layout. This translates to extreme flexibility in adapting the system to any physical layout by being able to put the firing modules where they are needed without constraints dictated by the interconnecting cable.

The Phase III cables are all 3 wire (twisted pair plus shield) with a male and female XLR professional audio connector on each respective end. The interconnecting cable provides electronics power and communications to/from the firing modules as well as providing the firing power for the addressed squib. Interconnecting cables are all interchangeable and may be plugged together for longer lengths as required.

The Interconnecting Cables provide power and communications to each and every Firing Module and well as the squib firing power. The female pin ends of the Interconnecting Cables have a push & hold to disconnect type of latching mechanism, standard in the XLR series of connectors. The Interconnecting Cables are all twisted pair shielded cable with shield to ground = pin 1, 2 to 2, and 3 to 3. (pin 1 to cable shield, pin 2 to cable black wire, pin 3,center pin, to cable white wire; Hypalon Cable)

The Cables are specifically selected for this application as being extremely flexible, resistant to dross and flaming debris, and having the proper electrical specifications. Since the Cables use standard XLR Professional audio connectors it is possible to substitute a microphone type cable, which is not acceptable.

DANGER !

CAUTION - WARNING

DO NOT USE NON STANDARD INTERCONNECTING CABLES. USE ONLY INTERCONNECTING CABLES PROVIDED BY AND/OR RECOMMENDED BY PYRODIGITAL CONSULTANTS. INCORRECT PIN TO PIN WIRING OR INCORRECT PIN 1 TO SHIELD WIRING WILL CAUSE UNPREDICTABLE AND/OR ERRATIC PERFORMANCE, THUS POSING A LETHAL HAZARD. ADDITIONALLY SEVER DAMAGE TO THE PHASE III SYSTEM WILL RESULT.

Most mic cables use very fine wire which won't carry sufficient power as well as having a non fire resistant jacket which makes their use unacceptable. Also the pin to pin, or pin 1 = shield, may not be wired correctly and severe damage to the Phase III System will result.

Care should be taken of the Interconnecting Cables to avoid cuts and nicks and the Cables should be neatly coiled and stored after use. If Cables are damaged they should be repaired before being used. It is important to avoid dragging the end connectors of the Cables on the ground through the dirt. The connectors should be kept clean and free of dirt and corrosion. The same clean practices should be followed for the connectors on the Firing Modules and Splitter Boxes. It is good practice to keep the connectors of each cable plugged together so as to avoid potential dirt and contamination. When coiling the Cables also avoid gross twisting or wind-up of the cable which places undue stress on the electrical conductors. The best coiling practice is to reverse loop (wind-back) every other wind so that no wind-up is ever established in the cable.

The Interconnecting Cables are all interchangeable and may also be plugged together for longer lengths. Heavier Duty Interconnecting Cables (heavier gauge wire) are recommended for long runs of Cable, such as from the System Controller (control location) to the first Splitter Box. Since the firing power goes through the Interconnecting Cables to the Firing Modules the power drop or line loss of the Cables must be considered. Consult the Manual Section; SQUIB FIRING POWER, MAXIMUM LIMITS

SYSTEM LAYOUT

PLEASE REFER TO THE DRAWINGS ON THE FOLLOWING TWO PAGES FOR POSSIBLE SYSTEM LAYOUTS.

The System Layout is comprised of two distinct areas, the Firing Area and the Control Location. The System Controller is at the Control Location which is separated by some distance from the Firing Area. The Firing Area contains the mortars and Pyrotechnic Devices as well as the Phase III System Network.

The link between the Firing Area and the System Controller is the main Interconnecting Cable. This Cable may be physically identical in every respect to the other Interconnecting Cables and thereby completely interchangeable. It is simply called the main Cable or trunk line. This main Cable may also be a heavier gauge Cable in order to minimize the power loss when traversing a long distance between the System Controller and the Firing Area.

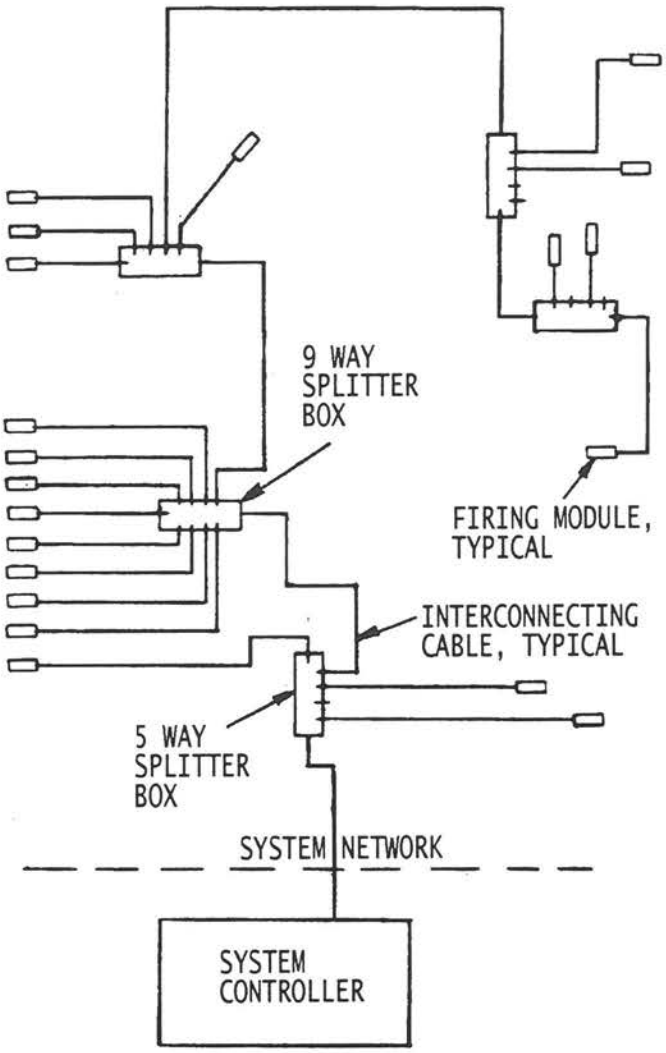
The main Cable physically connects between the System Controller (which can be the Interface Box or Pyrodigital's Computer) and the input on the first Splitter Box. This first Splitter Box may or may not be the only Splitter in the Network. If it is the only Splitter Box then it's number of outputs will determine the maximum number of Firing Modules which may be connected to the System (or Network). Interconnecting Cables would leave the outputs from this single Splitter Box and connect to the Firing Modules. These Interconnecting Cables may be of varying lengths to accommodated the placement of the Firing Modules and still return to the common Splitter.

More than 1 Splitter Box may be used for 2 different reasons. One obvious reason is so that additional Firing Modules may be connected beyond the output capacity of the first or primary Splitter. The second reason is that it may be desirable or necessary to spread out the mortar set up or show layout.

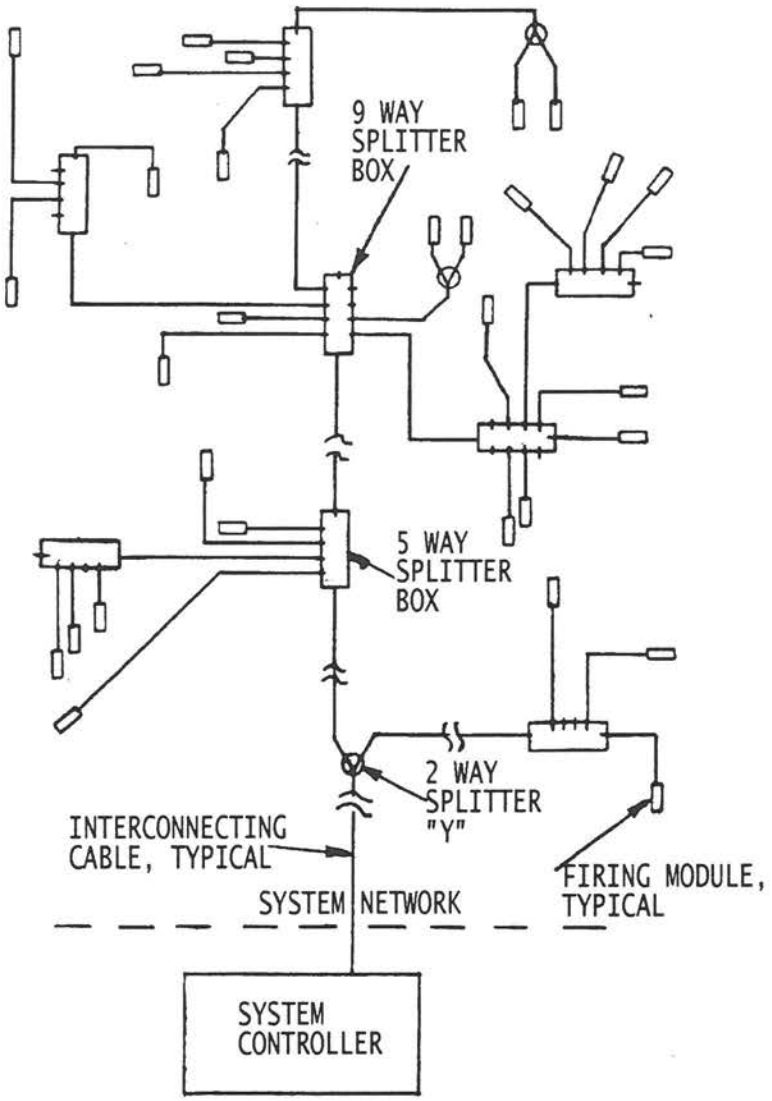
The Splitter Box is like a grouping module. It connects various Interconnecting cables, and thus Firing Modules, to one common point. Several of these groups of Firing Modules may be further grouped by bringing in each common point, via additional Interconnecting Cables, to the primary Splitter. This then collects all the Firing Modules into 1 input which connects to the main Interconnecting Cable. (and to the System Controller)

All this grouping, or the reverse of Splitting, can be random ***and need not follow any set pattern.*** There is no limit to the number of Splitter Boxes, hence Splits that may be used. The limit comes from the amount of Intercon-

POSSIBLE SYSTEM LAYOUT, 20 FIRING MODULES



POSSIBLE SYSTEM LAYOUT, 31 FIRING MODULES



necting Cable which may be used (power loss) and the number of Firing Modules which may be connected, 128 max. It is recommended, however, that the Splitting Sequence follow some logical order. The order should go from primary splits to secondary splits and then so on, before connecting to the Firing Modules. It is possible to connect to both some Firing Modules and additional Splitters from the primary split and then on to additional Splitters and then repeat a similar sequence on the secondary splits, and so on. This method, in fact, would be the most advantageous in economical use of Interconnecting Cables for a large linear and spread out set up.

Generally the setup would proceed in the reverse order, that is from the Firing Modules back through Interconnecting Cables and Splitters back via the main trunk line to the System Controller. THE FIRING MODULES AND THE ENTIRE SYSTEM SHOULD BE LAID OUT BEFORE AND CHECKED OUT BEFORE ANY PYROTECHNIC DEVICES ARE PRESENT AT THE FIRING AREA. This is normal procedure and generally the shooting setup would be laid out first, having mortars placed and dug in, or sanded, or nailed and secured racks, or whatever.

The Firing Modules are placed where they are needed. They are placed close to the mortars or Pyrotechnic Devices to be fired, so that the squib legwires may be connected easily and Safely without requiring scab (extension) wiring. (which eats up precious time) The Firing Modules may be placed on the sides of shoot boxes (if used), on the ground, or attached to the sides of racks. Holes are provided in the Firing Modules for temporary mounting purposes. Again the primary concern is to be able to connect all the squib wires without the use of scab wires, to save time. The Firing Module location should also permit the Shunt Operator to be able to have easy and Safe access and visibility to the Shunt Switch.

PROPER PLACEMENT OF THE FIRING MODULES CANNOT BE OVER EMPHASIZED.

WARNING - EXTREME DANGER

THE FIRING MODULES, ALL ELECTRICAL CONNECTIONS, AND THE SYSTEM CONTROLLER MUST BE PROTECTED FROM THE RAIN OR WET ENVIRONMENTS. IF THE FIRING MODULE IS SUBMERSED OR DRENCHED IN WATER THE INTERNAL ELECTRONICS MAY FUNCTION IN AN ERRATIC AND UNPREDICTABLE MANNER AND PYROTECHNIC DEVICES MAY BE FIRED UPON A STATUS CHECK, OR AT ANY TIME.

DANGER !

IF THE FIRING MODULES, ALL ELECTRICAL CONNECTIONS, AND THE SYSTEM CONTROLLER ARE KEPT AS DRY AS THE PYROTECHNIC DEVICES WHICH YOU ARE ATTEMPTING TO IGNITE, THEN YOU SHOULD HAVE NO PROBLEMS.

KEEP ALL ELECTRICAL CONNECTIONS DRY, SUCH AS THE SPLITTER BOXES AND THE INTERCONNECTING CABLE ENDS. ELEVATE THE FIRING MODULES AND SPLITTER BOXES OFF THE GROUND TO KEEP THEM OUT OF POSSIBLE POOLS OF WATER. COVER AND PROTECT ALL ELECTRICAL CONNECTIONS FROM DIRECT RAINFALL.

OBVIOUSLY THE SYSTEM CONTROLLER SHOULD BE KEPT DRY, ESPECIALLY IF 110VAC IS PRESENT. AN ELECTROCUTION HAZARD IS ADDITIONALLY PRESENT WHEN MIXING WATER WITH 110VAC, AS WELL AS POSSIBLE ERRATIC AND UNPREDICTABLE FIRINGS.

PROPER PLACEMENT OF THE FIRING MODULES CANNOT BE OVER EMPHASIZED. Proper Placement will save time and simplify the squib connection procedure. These placement considerations should be considered well in advance of actually setting up the mortars, etc. Experience is the best guide, keeping in mind all Safety considerations with ease and simplicity of loading and electrical connection of the squibs.

If covering the Firing Modules and Splitter Boxes for protection against possible inclement weather, consider the possibility of the covering material becoming inflamed. Plastic Bags and/or Tarps can catch on Fire and will burn up any Firing Modules or other components that are covered by the Plastic

bags and or Tarps. Plywood or Metal Covering offers better protection against catching Fire.

The Firing Modules should be positioned sideways, with respect to gravity. This is so that flaming debris will not come in permanent contact with the quick connector housing and damage the quick connectors. If bullwhip wires are present on the Firing Module then these wires should be routed so that they wont get burnt up on the ground or by falling debris.

Another very important consideration in FM (Firing Module) placement is the permanent connection of the squib wires. It is possible, especially when squibbing into the lift on an aerial shell or when stuffing excess wire into the mortar, for the squib wire to leave violently with the shell and pull loose or disconnect adjacent squib wires. The placement of the FM should be such that the squib legwires can be connected in an orderly and isolated fashion. This will prevent any one squib legwire from disconnecting any others. It may be also desirable to fix or attach the squib legwires is such a manner that the wire will break before if can become disconnected violently and thus disconnect adjacent wires.

Squib wire disconnection by previously fired shells is generally not a problem when squibbing to match leaders and the squibbed part of the leader hangs outside the mortar. The concern here becomes damage to the squib connectors by the burning match. This can be virtually eliminated by not placing the FM on the ground facing up directly underneath the shell leaders. (where the burning match can fall directly onto the squib quick connectors)

The Firing Module has provisions for connecting a squib to each of it's 16 circuits. The type of squib connector is determined by type of Firing Module. Spring loaded quick connectors are the most common. Crocodile Clip connectors on a bullwhip, or group of wires may also be provided.

The connectors operation is obvious. This is the point at which you connect the squib (or squibs) and possibly any squib extension wire (scab wire) required for the Pyrotechnic Device to be fired. Most connectors are indicated Red for positive voltage and Black for ground. Each pair (red & black) corresponds to one of the 16 circuits so indicated in writing on the Firing Module or Crocodile Clip Boots. It does not matter which legwire of the squib is connected to hot (red) and which one is grounded (black). All the blacks are common ground. Be careful when inserting the wires in the squib quick connector so as to grab the wire, not the wire insulation.

It is possible to connect more than 1 squib on each circuit of each Firing Module. Refer to the Section; SQUIB FIRING POWER, MAXIMUM LIMITS; for limits and simple calculations to determine the maximum number of squibs which may be fired for your System and Layout. The maximum limits vary according to the size of your system, the squibs to be fired, and if any scab (squib extension) wire is used. Remember SERIES CONNECTION ONLY is recommended.

Once the Firing Modules have been placed the connection via the Interconnecting Cables and Splitter Boxes may proceed. The Splitter Box, which is to connect a series of FM, is placed at some distance away from the FM, and away from mortars and Pyrotechnic Devices. Interconnecting Cables, which may be of various lengths, are then connected from the Firing Modules to the Splitter Box. The Splitter Box position may be adjusted to provide maximum separation from the mortars within the lengths of Interconnecting Cable used. Shorter Cables may be used for closer Firing Modules. Experience will dictate a smooth, attractive, and efficient set up which is far more difficult to describe than to do, because of all the variations possible.

The Interconnecting Cables and Splitters thus allow all the Firing Modules to eventually brought back to one common point at the primary Splitter Box. One must be careful to be sure each and every Firing Module is connected by some path of Interconnecting Cables and Splitter Boxes back to the System Controller. A Splitter Box output connected back to it's input will certainly leave some Firing Modules not connected to the Network. From the primary Splitter Box an Interconnecting Cable may then run to the System Controller.

THIS PAGE INTENTIONALLY LEFT BLANK

SYSTEM CONTROLLER - INTERFACE BOX AND PERSONAL COMPUTER

This section of the Operators Manual is included for those users operating the Phase III System Network with a Personal Computer. CONSULT THE OPERATORS MANUAL FOR FIRING SOFTWARE VERSION WHICH YOU ARE USING TO OPERATE THE PHASE III SYSTEM VIA THE PERSONAL COMPUTER.

In order to operate the System Network with a PC, the PC must connect to the System Network through the Pyrodigital Interface Box. The following section describes the connections and use of the Interface Box. Operation of the System Network is via the Firing Software Program running on the PC (VER200P, VER250F, or later updates). Consult the Firing Software PC Operators Manual for Computer Requirements, Operation, and Control of the System Network.

The purpose of the Interface Box is to interface a Personal computer to the Phase III System Network via the RS-232C communications port. The Interface Box contains the necessary electronics to communicate to the firing modules via the 3 wire interconnecting cable. The Interface Box also inputs 24 vdc on the interconnecting cable to power the firing modules as well as providing the power to fire the squibs.

The Interface Box performs 2 separate functions. One function is to provide the communications interface between the computer and the System Network. The second function is to provide the modem for communications between the computer and the tape machine. All the electronics for these 2 functions are housed within the one common Interface Box.

A 120 vac, 60 Hz GROUNDED power source is generally required for the computer and the Interface Box. 110 vac power is normally available to operated the computer (or can be made available with a generator or inverter) and can easily be used to power the Interface Box. The internal power comes from a 110 vac to 24 vdc power supply. The power supply is transformer isolated and earth grounded for safety. A power distribution strip is most convenient and recommended for connection of the various electronic components to the main 120 vac grounded power source. Consult your computer manual for power (wattage) requirements; 500 watts continuous is normally more than ample (The Interface Box draws approximately 150 watts peak). A 3 prong 120 vac chassis connector is provided on the Interface Box to connect the mating cable to the 120 vac GROUNDED power source.

The Interface Box is also provided with a 24 vdc input connection point (on the rear of the box) so that it may be operated from a 24 vdc remote power source. This is, of course, only advantageous when using a computer which can also operate battery or remote power. Normal operation would be to use the same 120 vac grounded power which operates the computer.

The Interface Box has an on/off switch with a GREEN LED line power indicator. Switching the line power on provides power to the both the modem and to the Key Safety Switch. The line power may come from either the grounded 120 vac (converted to 24 vdc internally) or the external 24 vdc input. A key lock safety switch is provided on the Interface Box to lock out and disable all power to the firing modules. The Safety Switch is the rotary Key switch; CCW (left) rotation is OFF and the Key may be removed. CW (right) rotation is ON (or ARMED) and the Key cannot be removed. ARMING the Interface Box (switching Safety Key Switch to ON) will cause the RED ARM LED to light and PROVIDE POWER TO THE PHASE III SYSTEM NETWORK. (if line power is available and switched ON)

WARNING - DANGER

NEVER ARM THE INTERFACE BOX BY SWITCHING THE SAFETY KEY SWITCH TO THE ARMED (CW) POSITION UNLESS IT IS SAFE TO DO SO AS OUTLINED IN THE POWER UP PROCEDURES.

The rear of the Interface Box houses the input connector for the RS-232C cable, a 110 vac grounded power cord connector, and an XLR female output connector for the firing modules. There are 2 circuit breakers on the rear of the Interface Box. The one nearest the 120 vac power plug protects the 120 vac line. The second breaker is for the 24 vdc supply (internal from 120 vac or from external 24 vdc). A YELLOW SHORT LED on the front panel indicates shorts (current limiter in operation) in the System Network. Refer to the Trouble Shooting section if the breakers blow or the YELLOW SHORT LED illuminates for more than a few seconds. IF THE YELLOW SHORT LED CONTINUOUSLY ILLUMINATES, IMMEDIATELY TURN OFF THE

SAFETY KEY SWITCH AND LOCATE/REPAIR THE SHORT BEFORE CONTINUING (Phase III cannot operate with shorts). Sustained operation with a short (as indicated by the YELLOW LED) will blow the 24 vdc circuit breaker.

There are 2 female RCA phono jacks on the rear of the Interface Box. These are for the time code (modem) input and output. These are audio standard high impedance -10 dbv line level input and output. The output jack, the lower of the two labeled rec (for record) is the output to the tape machine. When generating time code (via the Scripting Software) this jack connects to the recording input of the tape machine for recording time code. The input jack, or uppermost of the two, labeled play, is for inputting or playing time code into the modem.

The complete computer with the 2 Async Com Cards installed is connected to the Interface Box by the 2 RS-232C Communications Cables. The Phase III System or Control is connected to Com1 on the computer via the D connectors on one Communication Cable. Com1 or Com2 on the computer is determined by the installation of the Async Com Cards. You should mark the Com Cards in the computer near the D connector for Com1 or Com2 to avoid confusion. The modem section is connected to Com2 similarly. Screw in the screws on the Cable, at both ends, both Cables, to prevent the Cables from becoming disconnected.

DANGER !

CAUTION - DANGER

THE PHASE III SYSTEM CONTROL MUST CONNECT TO COM1 ON THE COMPUTER AND THE MODEM (time code) MUST CONNECT TO COM2 ON THE COMPUTER. REVERSAL OF THE RS-232C COMMUNICATIONS CABLES TO THE INCORRECT COM PORTS ON THE ASYNC COM CARDS WILL PREVENT PROPER OPERATION OF THE PHASE III SYSTEM AND COULD CAUSE POTENTIAL FIRING OF THE SQUIBS IN AN UNCONTROLLED AND THEREFORE DANGEROUS MANNER. ALL FUNCTIONS RELATING TO THE PHASE III SYSTEM WILL BE INOPERATIVE AND/OR ERRATIC AND UNPREDICTABLE.

SEVERE DAMAGE TO THE INTERFACE BOX WILL RESULT IF TIME CODE IS INPUT INTO COM1 (generating time code) WITH THE SAFETY KEY ON. THEREFORE NEVER TURN THE SAFETY KEY ON WHEN GENERATING TIME CODE.

THIS PAGE INTENTIONALLY LEFT BLANK

POWER SOURCES

WARNING - DANGER

USE ONLY A GROUNDED 120 VAC, 60 HZ POWER SOURCE WHEN OPERATING FROM AC POWER. THE COMPUTER, INTERFACE BOX, AND SYSTEM NETWORK ARE ALL TIED TO GROUND VIA THE 3 PRONG 120 VAC GROUNDING POWER CORDS. A GROUNDING LUG IS PROVIDED ON THE BACK OF THE INTERFACE BOX FOR EXTERNAL GROUNDING IF THE 120 VAC POWER SOURCE SHOULD BE UNGROUNDED OR IF THE GROUND IS IN QUESTION.

DANGER !

CHECK THAT THE POWER SOURCE IS IN FACT GROUNDED BY MEASURING THE DC RESISTANCE OF THE COMPUTER CHASSIS, THE INTERFACE BOX CHASSIS, AND THE FIRING MODULES (when connected with no pyrotechnic devices present) WITH RESPECT TO A SUBSTANTIAL AND PERMANENT EARTH GROUND. (such as a pipe, ground stake, or other structure firmly implanted in the earth) THE DC RESISTANCE PATH TO GROUND SHOULD BE LESS THAN 100 OHMS.

USE A 10 GAUGE WIRE TO ELECTRICALLY CONNECT THE GROUNDING LUG ON THE INTERFACE BOX TO A PERMANENT AND SUBSTANTIAL EARTH GROUND IF THERE IS ANY DOUBT ABOUT GROUNDING. IF USING A GENERATOR SET OR OTHER ISOLATED POWER SOURCE BE SURE THAT THE UNIT IS FIRMLY TIED TO EARTH GROUND. IF OVER WATER USE THE WATER AS THE EARTH GROUND.

FAILURE TO HAVE PROPER GROUNDING CAN RESULT IN DEATH FROM BOTH 1) ELECTROCUTION AND/OR 2) POSSIBLE IGNITION OF THE SQUIBS (and thus the pyrotechnic devices) DUE TO VOLTAGES FLOATING WITH RESPECT TO THE GROUND POTENTIAL.

THIS PAGE INTENTIONALLY LEFT BLANK

SYSTEM CONTROLLER - PYRODIGITAL FIELD CONTROLLER

Operation of the System Network with the Pyrodigital Field Controller is covered in the Operators Manual for the Field Controller.

THIS PAGE INTENTIONALLY LEFT BLANK

SYSTEM CHECK-OUT WITH NO PYROTECHNIC MATERIAL PRESENT

WARNING - EXTREME DANGER

NO PYROTECHNIC DEVICES SHOULD BE PRESENT IN THE FIRING AREA OR AT THE SYSTEM CONTROLLER LOCATION DURING SYSTEM CHECK-OUT.

I) SET & VERIFY ALL FIRING MODULE ADDRESSES

Once the System Network connections via the Interconnecting Cables and Splitter Boxes to the System Controller have been completed the Phase III System is ready for check-out. Check each Firing Module's address. SET THE FIRING MODULE ADDRESSES to the correct setting via the thumbwheel switch. If the exact address of each Pyrotechnic Device is to be determined at the time of loading, each Firing Module must still be set to a unique address. This is now the time to determine the Firing Module address (if not done previously). Start at 00 to 01 to 02, etc., following a logical order, in sequence, to the last Firing Module.

II) UNSHUNT ALL FIRING MODULES

THE FIRING MODULE SHUNT SWITCH

Each Firing Module has a Shunt Switch. This switch is a rotary type switch with a black pointer knob extending to the outside of the Firing Module. The switch has 2 positions, rotated CCW (counter clock wise or left) is SHUNTED, and rotation CW (clock wise or right) is UNSHUNTED. The rotation is only about 15 degrees or 1/24th of 1 revolution. There is a click stop detent in each position which will securely hold the switch in the position selected. There is also a RED DOT for UNSHUNTED or DANGER the Firing Module is ARMED.

WARNING - DANGER

If the SHUNT SWITCH DETENT FAILS to hold the Switch in either position, DO NOT USE THE FIRING MODULE - immediately take the Firing Module out of service and have it repaired.

The Shunt Switch actually disconnects the firing output circuitry from the squib connectors and shunts (electrically shorts) the squib connectors together when in the Shunted position. The electronics, however are still operative and the Firing Modules may be powered up by the System Controller for operational checks with the squibs still in a Shunted and non fire condition. When Unshunted the firing output circuits are connected to each respective squib connector.

DANGER !

THE SHUNT SWITCH IS YOUR PRIMARY SAFETY LINE OF DEFENSE.

WARNING - DANGER

ALWAYS HAVE THE SHUNT SWITCH IN THE SHUNTED CCW (Left) POSITION POINTING AWAY FROM THE RED DOT WHENEVER ANY SQUIBS ARE CONNECTED TO ANY OF THE FIRING MODULES.

THE ABOVE RULE MUST BE RELIGIOUSLY FOLLOWED!! This is especially important during the loading phase when personnel are present in the firing area and squibs are being connected to the Firing Modules.

UNSHUNTING PROCEDURE

The Shunt Switch on each and every Firing Module will be Shunted at all times, excepting that;

1) For initial SYSTEM CHECK-OUT when no pyrotechnic material is present in the Firing Area or after all loading operations and connections have been completed; AND the Firing Area is clear of all personnel and it is Safe to proceed.

2) The Operator in Charge may then determine it is Safe to UNSHUNT, following the general safety procedures and;

a) Having the System Controller in a Safe Mode at the top opening menu, not enabled to fire and not checking squib status.

b) Having the Safety Key OFF and removed from the lock on the System Controller.

c) Having disconnected the main Interconnecting Cable from the System Controller and isolating the Cable Connector on the Intercon necting Cable from any potential power sources or ground loops by at least a 1" air gap.

d) Having given the Safety Key to the Shunt Operator.

3) At the OK and knowledge of the Operator in Charge one person (the Shunt Operator) may enter the Firing Area for the purpose of Lifting the Shunts, or UNSHUNTING the Firing Modules, all or only those desired. THIS PERSON (who may be the Operator in Charge) SHALL HAVE THE SAFETY KEY IN HIS POSSESSION AT ALL TIMES WHILE IN THE FIRING AREA.

4) The Shunt Operator shall, upon initial entry into the Firing Area, verify that the main Interconnecting Cable is disconnected from the first Splitter Box. If the main interconnecting Cable is not disconnected, then the Shunt Operator shall disconnect the main interconnecting Cable from the first Splitter Box.

5) The Shunt Operator may proceed to Unshunt the Firing Modules, one at a time by rotating the Shunt Switch to the Unshunted CW (right) position towards the Red Dot. DURING THE UNSHUNTING OPERATION, AND AT ALL TIMES WHILE IN THE FIRING AREA, THE SHUNT OPERATOR SHALL POSITION HIS BODY IN A SAFE MANNER. The body position shall be such that if any ignition of any squib at any location should occur (thus causing ignition of one or more pyrotechnic devices) no injury shall occur to the Shunt Operator. This means, but not limited to having any part of the body over any mortar at any time and being positioned a far away as possible from the pyrotechnic devices.

If any Firing Module is located in a position such that the Unshunting operation would pose undue risk or chance of bodily harm to the Shunt Operator, should an accidental ignition occur, then the Firing Module(s) shall be relocated to a Safer location before EVER being Unshunted.

6) After the Unshunting operation is complete then the Shunt Operator shall proceed out of the Firing Area and connect the main Interconnecting Cable to the first Splitter Box as he/she leaves the Firing Area.

7) The Shunt Operator shall then return the Safety Key to the Operator in Charge.

8) If at any time personnel must go back into the Firing Area, such as for checking faulty electrical connections or for checking the mortars after the Display, then all Firing Modules shall be Re Shunted by the Shunt Operator according to the SHUNTING PROCEDURE.

III) STATUS RETURN CHECK

For the initial Status Return Check have all the Firing Modules UNSHUNTED in order to check the complete circuitry to the squib connector.

As Warned previously, NO PYROTECHNIC DEVICES ARE TO BE PRESENT DURING SYSTEM CHECK-OUT.

NOTE; No detailed information is given here on the exact operation of the System Controller. Refer to the Manual for SOFTWARE OPERATION for the PC Computer / Interface Box combination or the Manual on the Field Controller or other Pyrodigital System Controller that you are using.

The System is checked out for proper operation by powering up the Firing Modules with the System Controller. Be sure that the short circuit light does not light, which would indicate a short somewhere in System Network. IF A SHORT IS INDICATED, BY CONTINUOUS ILLUMINATION OF THE YELLOW SHORT LED, POWER DOWN IMMEDIATELY AND DETERMINE THE CAUSE BEFORE PROCEEDING.

A squib continuity status check (Status Mode) is then performed to see if each and every Firing Module is communicating to the System Controller. If each and every Firing Module is operating properly then it will indicate as such by being present with open circuits on the squib status screen of the System Controller. BE SURE THAT ALL FIRING MODULES ARE RESPONDING BACK TO THE SYSTEM CONTROLLER WITH OPEN SQUIB CONTINUITY STATUS FOR EACH OF THE 16 CIRCUITS ON EVERY FIRING MODULE.

DANGER !

WARNING - EXTREME DANGER

IF EACH AND EVERY FIRING MODULE IS NOT RESPONDING BACK TO THE SYSTEM CONTROLLER BY INDICATING OPEN CIRCUIT ON EACH OF THE 16 CIRCUITS FOR EVERY MODULE, DO NOT PROCEED. DETERMINE THE CAUSE AND EFFECT REPAIR SO THAT EACH FIRING MODULE IS OPERATING PROPERLY AS INDICATED BY OPEN SQUIB STATUS RETURNS. TO PROCEED WITHOUT PROPER COMMUNICATIONS TO EVERY FIRING MODULE (AS INDICATED BY OPEN CIRCUIT SQUIB STATUS ON EACH AND EVERY CIRCUIT) IN THE NETWORK IS DANGEROUS, POTENTIALLY LETHAL, AND CERTAINLY CAN HAVE DISASTROUS RESULTS TO THE DISPLAY.

When all Firing Modules are responding properly, then it is Safe to proceed. THE NEXT PROCEDURE IS SAFE POWER DOWN BEFORE ANY PYROTECHNIC DEVICES ARE ALLOWED IN THE FIRING AREA.

DANGER !

CAUTION - DANGER

CONTINUE THROUGH ALL SYSTEM CHECK-OUT PROCEDURES BEFORE ANY PYROTECHNIC DEVICES ARE ALLOWED IN THE FIRING AREA!

IV) SAFE POWER DOWN

This procedure consists of the SHUNTING PROCEDURE. After the Shunting Procedure the System Controller may be operated for check-out and utility functions (such as Time Code Check, Fire Mode Check, and making changes or inserting event addresses) while personnel are in the Firing Area. Since the System Controller will be disconnected from the System Network no communications are possible with the Firing Modules.

WARNING - DANGER
ALL FIRING MODULES SHOULD NOW BE SHUNTED.

SHUNTING PROCEDURE

1) THE SHUNT SWITCH ON EACH AND EVERY FIRING MODULE SHALL BE SHUNTED AT ALL TIMES WHENEVER ANYONE IS IN THE FIRING AREA. If any or all the Firing Modules have been previously Unshunted for purposes of System Check-Out or Squib Status Checking or in preparation for Firing, THEN ALL FIRING MODULES SHALL BE SHUNTED BEFORE ANYONE IS ALLOWED INTO THE FIRING AREA.

2) The Operator in Charge will determine that System Check-Out, additional loading, adjustments, or electrical connections / corrections must be made in the Firing Area. ALL FIRING MODULES MUST BE SHUNTED BEFORE ANYONE IS ALLOWED INTO THE FIRING AREA (excepting the Shunting Operator as outlined in the following procedures). The Operator in Charge will then determine that it is necessary and it is Safe to SHUNT, following the general safety procedures, and;

a) Having the System Controller in a Safe Mode at the top opening menu, not enabled to fire and not checking squib status.

b) Having the Safety Key OFF and removed from the lock on the System Controller.

c) Having disconnected the main Interconnecting Cable from the System Controller and isolating the Cable Connector on the Interconnecting Cable from any potential power sources or ground loops by at least a 1" air gap.

d) Having given the Safety Key to the Shunt Operator.

3) At the OK and knowledge of the Operator in Charge one person (the Shunt Operator) may enter the Firing Area for the purpose of closing the Shunts, or SHUNTING ALL the Firing Modules. ALL FIRING MODULES MUST BE SHUNTED BEFORE ANYONE (other than the Shunting Operator performing the Shunting Procedure) IS ALLOWED INTO THE FIRING AREA. THIS PERSON (who may be the Operator in Charge) SHALL HAVE THE SAFETY KEY IN HIS POSSESSION AT ALL TIMES WHILE IN THE FIRING AREA.

4) The Shunt Operator shall, upon initial entry into the Firing Area, disconnect the main Interconnecting Cable from the first Splitter Box.

5) The Shunt Operator may proceed to SHUNT the Firing Modules, one at a time by rotating the Shunt Switch to the shunted CCW (left) position away from the Red Dot. DURING THE SHUNTING OPERATION, AND AT ALL TIMES WHILE IN THE FIRING AREA, THE SHUNT OPERATOR SHALL POSITION HIS BODY IN A SAFE MANNER. The body position shall be such that if any ignition of any squib at any location should occur (thus causing ignition of one or more pyrotechnic devices) no injury shall occur to the Shunt Operator. This means, but not limited to having any part of the body over any mortar at any time and being positioned a far away as possible from the pyrotechnic devices.

If any Firing Module is located in a position such that the shunting operation would pose undue risk or chance of bodily harm to the Shunt Operator, should an accidental ignition occur, then the Firing Module(s) shall be relocated to a Safer location before ever being unshunted originally.

6) After the shunting operation is complete then the Shunt Operator shall proceed out of the Firing Area and verify that the MAIN INTERCONNECTING CABLE to the first Splitter Box is DISCONNECTED as he/she leaves the Firing Area.

7) The Shunt Operator shall then return the Safety Key to the Operator in Charge.

8) If at any time personnel must go back into the Firing Area, such as for checking faulty electrical connections or for checking the mortars after the Display, then all Firing Modules shall be Re Shunted by the Shunt Operator according to the SHUNTING PROCEDURE. Instruct all personnel to not

reconnect either end of the Interconnecting Cable. Anyone venturing into the Firing Area can easily see that the System is disconnected at the primary Splitter Box.

DANGER !

WARNING - EXTREME DANGER

DO NOT ASSUME THAT ANYTHING IS SAFE JUST BECAUSE THE SHUNT SWITCH IS IN THE SHUNTED POSITION. THE SHUNT SWITCH IS ONLY AN ADDITIONAL SAFETY THAT SHOULD NOT BE RELIED UPON TO PREVENT SQUIB IGNITION.

SQUIBS ARE VERY SENSITIVE DEVICES AND CAN BE IGNITED BY FRICTION AND IMPACT AS WELL AS BY ELECTRICAL STIMULI.

IF ONE ASSUMES THAT ANY ONE OF THE SQUIBS MAY IGNITE AT ANY TIME FOR WHATEVER REASONS, THEN ONE CAN PLAN SAFE HANDLING AND DEPLOYMENT PROCEDURES WHICH WILL MINIMIZE INJURIES AND ELIMINATE ANY POSSIBLE FATALITY SHOULD ANY SUCH SQUIB IGNITION OCCUR. THIS IS CONSIDERED AS GENERAL SAFETY PROCEDURES.

V) TIME CODE CHECK

For the PC Computer and Interface Box combination, use the procedures outlined in the Section on TIMECHCK to verify the integrity of the time code as received at the Firing Location, which originates from the tape machine at the broadcast location. For the Field Controller or other Pyrodigital System Controller, follow the Time Code Check Procedures listed in the Operators Manual of that System Controller. You should be checking the complete time code link which will be used for actually firing the display. This should be a repeat procedure as you should have already checked the this time code link well prior to the display date.

VI) FIRE MODE CHECK

The Fire Mode Check will check the operation of the entire communications chain from the original master tape time code through to the System Controller.

WARNING - EXTREME DANGER

BE ABSOLUTELY SURE THAT THE MAIN INTERCONNECTING CABLE IS DISCONNECTED AT BOTH ENDS WHEN PERFORMING THE FIRE MODE CHECK. NO PYROTECHNIC DEVICES SHOULD BE PRESENT WHEN CONDUCTING THIS CHECK. THE PHASE III SYSTEM WILL BE OPERATED IN A FULL FIRING MODE, EXCEPTING THAT ONLY THE DISCONNECTION OF THE MAIN INTERCONNECTING CABLE IS PREVENTING ACTUAL FIRING VOLTAGES FROM BEING PRESENT AT THE FIRING MODULES.

Operate the Phase III System in the appropriate Fire Mode with the Interface Box (or Pyrodigital System Controller) fully powered and the Safety Key Armed. Have the master tape played at the actual broadcast location, just as it will be played at display firing time. Check that the computer is actually operating the firing sequences for the entire display.

NOTE THAT NOTHING WILL ACTUALLY BE FIRED BECAUSE, OF THE ABOVE SAFETY PROCEDURES - WHICH YOU MUST FOLLOW;

1) THERE ARE NO PYROTECHNIC DEVICES PRESENT OR CONNECTED TO THE FIRING MODULES, AND

2) THE MAIN INTERCONNECTING CABLE HAS BEEN DISCONNECTED AT BOTH ENDS PREVENTING ANY COMMUNICATIONS OR FIRING POWER FROM REACHING THE FIRING MODULES. Check the Firing Mode operation very carefully and be sure that each and every pyrotechnic event is SIMULATED to be fired correctly.

QUICK REVIEW OF SYSTEM CHECK-OUT WITH NO PYROTECHNIC MATERIAL PRESENT

I) SET & VERIFY ALL FIRING MODULE ADDRESSES

II) UNSHUNT ALL FIRING MODULES

III STATUS RETURN CHECK

IV) SAFE POWER DOWN = SHUNTING PROCEDURE

V) TIME CODE CHECK

VI) FIRE MODE CHECK

SYSTEM CHECK-OUT is complete once you have verified that;

1) All Firing Modules are responding (communicating) to the System Controller by the STATUS RETURN CHECK, and;

2) The time code reception is OK by the TIME CODE CHECK, and;

3) The System Controller will successful operate all firing sequences by the FIRE MODE CHECK.

Since you have verified that the computer can talk to all Firing Modules and can successfully issue all Firing Instructions, you have verified the integrity of the Whole System and can proceed with actually loading the pyrotechnic devices and prepare for the actual Display.

FIRING SYSTEM OPERATION WITH LIVE PYROTECHNICS

NOTE; No detailed information is given here on the exact operation of the System Controller. Refer to the MANUAL for SOFTWARE OPERATION for the PC Computer / Interface Box combination or the Manual on the FIELD CONTROLLER or other Pyrodigital System Controller that you are using.

I) LOADING THE PYROTECHNIC DEVICES

After the Phase III System has been fully checked out and brought to a Safe Power Down condition according to SYSTEM CHECK-OUT WITH NO PYROTECHNIC MATERIAL PRESENT, it is then permissible to proceed to bring the Pyrotechnic Devices into the Firing Area and begin the loading procedures. Follow standard Safety Procedures. Connect the squib legwires paying attention to the legwire routing as indicated in the SYSTEM LAYOUT section.

DANGER !

WARNING - EXTREME DANGER

KEEP ALL PYROTECHNIC MATERIAL AWAY FROM THE SYSTEM CONTROLLER AREA AND ANY OTHER POTENTIAL SOURCES OF ELECTRICAL POWER. A SQUIB COULD BE IGNITED BY CONTACT WITH AN ELECTRICAL POWER SOURCE WHICH COULD CAUSE INJURIES OR FATALITIES BY SUBSEQUENT IGNITION OF THE SQUIBBED PYROTECHNIC DEVICE(S).

WARNING - DANGER

IT IS IMPERATIVE THAT ALL PERSONNEL BE INSTRUCTED IN THE USE AND RECOGNITION OF THE FIRING MODULE SHUNT SWITCH. EVERY PERSON THAT CONNECTS A SQUIB TO ANY FIRING MODULE SHOULD FIRST CHECK THE FIRING MODULE SHUNT SWITCH TO BE SURE THE FIRING MODULE IS IN THE SHUNTED POSITION.

II) POWER UP

The power up procedure will bring the Phase III System to a condition where Pyrotechnic Devices may be fired.

DANGER !

WARNING - EXTREME DANGER

NEVER, NEVER POWER UP UNLESS IT IS SAFE TO DO SO AND THE FIRING AREA IS CLEAR OF ALL PERSONNEL. ALLOW NO ONE INTO THE FIRING AREA FOR WHATEVER REASONS WITHOUT FIRST FOLLOWING THE SAFE POWER DOWN PROCEDURES.

A) Clear the Firing Area.

B) Follow the UNSHUNTING PROCEDURE, as repeated again here for your convenience.

UNSHUNTING PROCEDURE

The Shunt Switch on each and every Firing Module will be Shunted at all times, excepting that;

1) For initial SYSTEM CHECK-OUT when no pyrotechnic material is present in the Firing Area or after all loading operations and connections have been completed; AND the Firing Area is clear of all personnel and it is Safe to proceed.

2) The Operator in Charge may then determine it is Safe to UNSHUNT, following the general safety procedures and;

a) Having the System Controller in a Safe Mode at the top opening menu, not enabled to fire and not checking squib status.

b) Having the Safety Key OFF and removed from the lock on the System Controller.

c) Having disconnected the main Interconnecting Cable from the System Controller and isolating the Cable Connector on the Interconnecting Cable from any potential power sources or ground loops by at least a 1" air gap.

d) Having given the Safety Key to the Shunt Operator.

3) At the OK and knowledge of the Operator in Charge one person (the Shunt Operator) may enter the Firing Area for the purpose of Lifting the Shunts, or UNSHUNTING the Firing Modules, all or only those desired. THIS PERSON (who may be the Operator in Charge) SHALL HAVE THE SAFETY KEY IN HIS POSSESSION AT ALL TIMES WHILE IN THE FIRING AREA.

4) The Shunt Operator shall, upon initial entry into the Firing Area, verify that the main Interconnecting Cable is disconnected from the first Splitter Box. If the main interconnecting Cable is not disconnected, then the Shunt Operator shall disconnect the main
interconnecting Cable from the first Splitter Box.

5) The Shunt Operator may proceed to Unshunt the Firing Modules, one at a time by rotating the Shunt Switch to the Unshunted CW (right) position towards the Red Dot. DURING THE UNSHUNTING OPERATION, AND AT ALL TIMES WHILE IN THE FIRING AREA, THE SHUNT OPERATOR SHALL POSITION HIS BODY IN A SAFE MANNER. The body position shall be such that if any ignition of any squib at any location should occur (thus causing ignition of one or more pyrotechnic devices) no injury shall occur to the Shunt Operator. This means, but not limited to having any part of the body over any mortar at any time and being positioned a far away as possible from the pyrotechnic devices. If any Firing Module is located in a position such that the Unshunting operation would pose undue risk or chance of bodily harm to the Shunt Operator, should an accidental ignition occur, then the Firing Module(s) shall be relocated to a Safer location before EVER being Unshunted.

6) After the Unshunting operation is complete then the Shunt Operator shall proceed out of the Firing Area and connect the main Interconnecting Cable to the first Splitter Box as he/she leaves the Firing Area.

7) The Shunt Operator shall then return the Safety Key to the Operator in Charge.

8) If at any time personnel must go back into the Firing Area, such as for checking faulty electrical connections or for checking the mortars after the Display, then all Firing Modules shall be Re Shunted by the Shunt Operator according to the SHUNTING PROCEDURE.

C) Re check the Firing Area to be sure is is clear of all personnel.

D) Check the System Controller to be sure it is at the opening menu and not in a fire or squib status check mode.

E) Reconnect the main Interconnecting Cable to the System Controller.

F) Insert the Safety Key and Arm the System only as necessary to check squib continuity status or just prior to firing.

G) Remove and secure the Safety Key when not firing or checking squib continuity.

DANGER !

WARNING - EXTREME DANGER

NEVER, NEVER POWER UP UNLESS IT IS SAFE TO DO SO AND THE FIRING AREA IS CLEAR OF ALL PERSONNEL. ALLOW NO ONE INTO THE FIRING AREA FOR WHATEVER REASONS WITHOUT FIRST FOLLOWING THE SAFE POWER DOWN PROCEDURES.

III) SQUIB CONTINUITY STATUS CHECK

After all the Pyrotechnic Devices have been loaded and it is Safe to proceed, follow the POWER UP PROCEDURE. Arm the System with the Safety Key and place the System Controller in the squib status mode as outlined in the appropriate System Controller Operators Manual.

DANGER !

WARNING - EXTREME DANGER

BE AWARE THAT THE PHASE III SYSTEM IS NOW FULLY ARMED AND CONNECTED TO LIVE PYROTECHNIC MATERIAL. IT IS POSSIBLE, NO MATTER HOW UNLIKELY, THAT A PYROTECHNIC DEVICE COULD FIRE, DUE TO SOME UNFORESEEN FAILURE OR ACT OF GOD.

IT IS THEREFORE IMPERATIVE THAT THE FIRING AREA BE CLEAR OF ALL PERSONNEL AND THE FIRING AREA BE SECURED AND SAFE, JUST AS IF ACTUALLY FIRING THE DISPLAY.

DANGER !

WARNING - DANGER

ALWAYS POWER UP BEFORE CHECKING SQUIB STATUS. ALWAYS LEAVE THE SQUIB STATUS SCREEN (STATUS MODE) BEFORE POWER DOWN. ARMING (ON) OR DISABLING (OFF) THE SAFETY KEY WHILE AT THE STATUS SCREEN IS AN UNSAFE PROCEDURE.

Some errors in connection of the squibs are likely to be found at this point. Make notes of the suspect addresses. A printer may be used to printout the status screens or status reports.

1) Bring the System to SAFE POWER DOWN as outlined in SYSTEM CHECK-OUT WITH NO PYROTECHNIC MATERIAL PRESENT and repeated again below under AFTER THE DISPLAY. Be sure to follow the SHUNTING PROCEDURES, which are part of SAFE POWER DOWN.

2) Using extreme caution and following general Safety Procedures, proceed to the Firing Area and check and repair the faulty squib connections.

3) Re secure the area and follow the POWER UP procedure which is outlined above, which includes the UNSHUNTING PROCEDURE.

4) Re check the squib continuity status, as outlined above under SQUIB CONTINUITY STATUS CHECK

5) Repeat steps 1) through 4) directly preceding this step 5) as necessary until all squib connections are correct.

At this point the Display is ready to fire. Secure the area and remove and secure the Safety Key until ready to Arm for actually firing the Display.

IV) FIRING THE DISPLAY

The firing of the Display is totally under the control of the Operator in Charge or his designated Firing Operator who is in control of the System Controller. Please refer to the appropriate OPERATORS MANUAL, FIRING MODE for operation of the SYSTEM CONTROLLER that you are using.

V) AFTER THE DISPLAY

Bring the System to SAFE POWER DOWN, which includes the SHUNTING PROCEDURE, as part of SAFE POWER DOWN, before anyone (other than the Shunt Operator as part of the SAFE POWER DOWN procedure) is allowed into the Firing Area.

DANGER !

WARNING - EXTREME DANGER

CHECK THE MORTARS, AND ALL PYROTECHNIC DEVICES TO BE ABSOLUTELY SURE THAT ANY LIVE MATERIAL REMAINING IS PROPERLY DEALT WITH. FOLLOW ALL NORMAL AND GENERAL SAFETY PROCEDURES. ———> BEFORE ATTEMPTING TO TEAR DOWN THE FIRING SYSTEM.

SAFE POWER DOWN

This procedure consists of the SHUNTING PROCEDURE. After the Shunting Procedure the System Controller may be operated for check-out and utility functions (such as Time Code Check, Fire Mode Check, and making changes or inserting event addresses) while personnel are in the Firing Area. Since the System Controller will be disconnected from the System Network no communications are possible with the Firing Modules.

SHUNTING PROCEDURE

1) THE SHUNT SWITCH ON EACH AND EVERY FIRING MODULE SHALL BE SHUNTED AT ALL TIMES WHENEVER ANYONE IS IN THE FIRING AREA. If any or all the Firing Modules have been previously Unshunted for purposes of System Check-Out or Squib Status Checking or in preparation for Firing, THEN ALL FIRING MODULES SHALL BE SHUNTED BEFORE ANYONE IS ALLOWED INTO THE FIRING AREA.

2) The Operator in Charge will determine that System Check-Out, additional loading, adjustments, or electrical connections / corrections must be made in the Firing Area. ALL FIRING MODULES MUST BE SHUNTED BEFORE ANYONE IS ALLOWED INTO THE FIRING AREA (excepting the Shunting Operator as outlined in the following procedures). The Operator in Charge will then determine that it is necessary and it is Safe to SHUNT, following the general safety procedures, and;

a) Having the System Controller in a Safe Mode at the top opening menu, not enabled to fire and not checking squib status.

b) Having the Safety Key OFF and removed from the lock on the System Controller.

c) Having disconnected the main Interconnecting Cable from the System Controller and isolating the Cable Connector on the Interconnecting Cable from any potential power sources or ground loops by at least a 1" air gap.

d) Having given the Safety Key to the Shunt Operator.

3) At the OK and knowledge of the Operator in Charge one person (the Shunt Operator) may enter the Firing Area for the purpose of closing the Shunts, or SHUNTING ALL the Firing Modules. ALL FIRING MODULES MUST BE SHUNTED BEFORE ANYONE (other than the Shunting Operator performing the Shunting Procedure) IS ALLOWED INTO THE FIRING AREA. THIS PERSON (who may be the Operator in Charge) SHALL HAVE THE SAFETY KEY IN HIS POSSESSION AT ALL TIMES WHILE IN THE FIRING AREA.

4) The Shunt Operator shall, upon initial entry into the Firing Area, disconnect the main Interconnecting Cable from the first Splitter Box.

5) The Shunt Operator may proceed to SHUNT the Firing Modules, one at a time by rotating the Shunt Switch to the shunted CCW (left) position away from the Red Dot. DURING THE SHUNTING OPERATION, AND AT ALL TIMES WHILE IN THE FIRING AREA, THE SHUNT OPERATOR SHALL POSITION HIS BODY IN A SAFE MANNER. The body position shall be such that if any ignition of any squib at any location should occur (thus causing ignition of one or more pyrotechnic devices) no injury shall occur to the Shunt Operator. This means, but not limited to having any part of the body over any mortar at any time and being positioned a far away as possible from the pyrotechnic devices.

If any Firing Module is located in a position such that the shunting operation would pose undue risk or chance of bodily harm to the Shunt Operator, should an accidental ignition occur, then the Firing Module(s) shall be relocated to a Safer location before ever being unshunted originally.

6) After the shunting operation is complete then the Shunt Operator shall proceed out of the Firing Area and verify that the MAIN INTERCONNECTING CABLE to the first Splitter Box is DISCONNECTED as he/she leaves the Firing Area.

7) The Shunt Operator shall then return the Safety Key to the Operator in Charge.

8) If at any time personnel must go back into the Firing Area, such as for checking faulty electrical connections or for checking the mortars after the Display, then all Firing Modules shall be Re Shunted by the Shunt Operator according to the SHUNTING PROCEDURE. Instruct all personnel to not reconnect either end of the Interconnecting Cable. Anyone venturing into the Firing Area can easily see that the System is disconnected at the primary Splitter Box.

DANGER !

WARNING - EXTREME DANGER

CHECK THE MORTARS, AND ALL PYROTECHNIC DEVICES TO BE ABSOLUTELY SURE THAT ANY LIVE MATERIAL REMAINING IS PROPERLY DEALT WITH. FOLLOW ALL NORMAL AND GENERAL SAFETY PROCEDURES. ———> BEFORE ATTEMPTING TO TEAR DOWN THE FIRING SYSTEM.

When tearing down the System be neat and orderly, noting any damaged components. This will save time in the long run and help assure the System is in peak operating condition next time it is used.

It is recommended that the any faulty components be repaired, and that the System be cleaned and fully checked out upon returning to the shop.

THIS PAGE INTENTIONALLY LEFT BLANK

TIME CODE

TIME CODE LINKS

Time code input to the modem section always originates at the master tape machine (via the play RCA phono jack, or in the case of the Field Controller to either the RCA jack or the 600 ohm balanced XLR male pin input jack). The master tape machine plays the music and time code on separate tracks of the tape. The music is routed to the P. A. System, Radio Broadcast, or both. The time code is routed to the play input of the System Controller.

When Firing in the field there are many options for getting the time code audio signal to the System Controller and the Music audio signal to the broadcast point (either P. A. or Radio or both). One way is to have the master tape machine at the firing location. The time code audio may thus be directly connected to the System Controller. The Music audio must then be sent to the broadcast location. This may be over equalized phone lines, special radio, or direct cable. Direct cable lines should be converted to a 600 ohm +4dbv balanced line by a line driver from the high impedance outputs of the tape machine to avoid high frequency audio losses.

If the master tape is played at a radio station then the time code must get reliably from the station to the firing site. This can be a voice grade phone line, special radios, or direct cable. The main disadvantage of having the radio play the tape is that you loose control. You no longer can stop or delay the time the music is played due to Safety or other considerations of which the radio stations may be unaware. IF THE RADIO STATION PLAYS THE TAPE THEN YOU SHOULD DEFINITELY HAVE A DIRECT VOICE LINK TO THE BROADCAST ENGINEER TO GIVE FINAL OK AND INSTRUCTIONS. SO THAT YOU ARE IN CONTROL.

Another possibility is an intermediate broadcast point, or master control location from which the master tape is played. From this point the P. A. is driven and it then becomes the radio stations responsibility to get the music from there. The time code may be direct cabled several thousand feet, using high impedance to 600 ohm balanced line and then back to high impedance. The time code may also be special radio broadcast for long distances or remote/multiple firing locations.

These audio considerations are only mentioned briefly to remind the user of their necessity. Details can be worked out with the sponsor/radio station/etc..

Having a person competent and qualified in professional audio attending to these details can surely help the success of the project.

THE KEY POINT IS THAT THE AUDIO LINKS FOR BOTH THE TIME CODE AND THE MUSIC ARE CRITICAL AND MUST BE RELIABLE. Backups and redundancy should be well considered.

VERIFYING TIME CODE - GENERAL

IT IS IMPERATIVE THAT THE TIME CODE LINK BE CHECKED FOR INTEGRITY AND VALID TIME CODE TRANSMISSION. This means that before the Display you must have the tape played at the Broadcast Location (or wherever the master tape machine is located) and Verify your reception of the Time Code at the System Controller. The Hardware setup should be exactly as used for the Display.

IT IS HIGHLY RECOMMENDED THAT YOU PERIODICALLY CHECK THE TIME CODE LINK, AT LEAST AS SOON AS THE SYSTEM IS SETUP AND THEN JUST PRIOR TO THE DISPLAY. This will give you time to repair the Link or use alternate Firing Procedures should the Link fail just before Showtime.

NOTES ON ACTUAL PYRODIGITAL TIME CODE

It will be helpful to understand the actual structure of the Pyrodigital Time Code in order to properly verify the integrity of the Time Code Data. Knowledge of the time code will also assist the user in determining it's transmission characteristics over phone lines, etc..

The Pyrodigital Time Code is like a mini version of SMPTE (Society of Motion Picture and Television Engineers) Time Code in that it is a "smart" Time Code. By being smart, we mean that each time number is a unique piece of data and the actual time can be determined from any one block of data. Some other non smart Time Codes are simple "pulses" and require resetting to the beginning of the time code stripe on the tape, each time, in order to count from the start. The Pyrodigital Time Code can be started from any point with full recovery of the actual time after only 1 valid frame of time code data.

The time code is actually an off BELL 202 Modem standard, 1200 baud, half duplex, FSK modem signal. Half duplex means that signal is only in one direction and FSK, or frequency shift keying is the type of modulation. This standard was developed, and is suitable for transmission over normal voice grade phone lines, however if transmitting over phone lines precautions must be taken to insure the integrity and quality of the phone line. A dedicated normal voice grade line, with a backup, is recommended at minimum. Full testing of the line using verifying procedures several times is absolutely required.

The time code itself consists of a distinct and unique number every 1/10 of a second. The time code is generated in a sequentially increasing manner, starting from zero to a maximum of 32,768 tenths of a second (16 to the 4th power divided by 2), in 1/10 second increments.

Each time code number starts with an S followed by 6 hex characters, the first 4 of which are the time code number and the last two characters is a truncated check sum. The zero time code is thus S000000, the next is S000101, 33 tenths is S002121. A hex to decimal conversion of the first four hex numbers will give the time in base ten tenths.

It is not important that you actually understand the actual time code structure, but that you understand that the time code must meet certain criteria to be valid. It must be sequential, it must be preceded by an S, and it must have the proper check sum. Any errors in the exact time code will be reported by the verifying procedures.

Some errors may or may not be acceptable. Due to the nature of the Auto Fire Mode (or Smart Fire) if 1 or 2 time codes are lost, the Firing will continue uninterrupted. When the valid time code is re-established, time will be updated to the incoming time code numbers (the Auto Time Switchover Feature). Certainly your time code on the master tape should be error free.

VERIFYING TIME CODE - FIELD CONTROLLER

The Field Controller has an Operating Mode for checking the actual Data of the Time Code. Refer to the Field Controller Operators Manual for Procedures.

VERIFYING TIME CODE - PC COMPUTER AND INTERFACE BOX

There is a Program Provided with the Firing Software called TIMELOOK. The Program is non copy protected and a backup copy of TIMELOOK should immediately be made upon receipt of the disk. TIMELOOK should be loaded into your hard disk if your Firing Computer is so equipped. Use the DOS on the main Program Disk to boot the computer to the A> prompt (you may have to exit the Firing Program and change the directory to the root, cd\ to get to the A> prompt).

Be sure to hook up all the hardware first. How you will hook up will be determined by how the TIMELOOK program is being used. The time code must get to the input play RCA jack on the Interface Box, which must be connected to Com2 on the computer. The program will abort if you have bad cables or com2 card, and you will have to re load the program and start over.

At the A> prompt type in TIMELOOK and press carriage return. TIMELOOK will be loaded into the computer.

TIMELOOK, short for time look check, is a program used to detect errors in the time code. Upon typing TIMELOOK and entering a carriage return the program will begin immediate execution.

The program should be used to verify time code recorded on tape. It was primarily written for verification of any links between the origination point of the time code (tape machine location) and the System Controller at the Firing location. In this case the master tape is played (time code) at the tape machine location the actual hardware set up which will be used at display time. The computer is operated at the Firing location using the TIMELOOK program to verify the integrity of the time code transmission. Verification of the time code is obviously critical when the System Controller is remoted from the broadcast master tape machine by cables, phone lines, or radio links. The time code link should be checked many times, including just before show time.

The TIMELOOK program checks for the following error conditions;

1) Lost or no carrier.
2) Invalid Data Stream.
3) Check Sum errors.
4) Sequencing errors.

The TIMELOOK program provides the following information;

1) Start time reported only for the first received valid time code.

2) No carrier indication is written as CARRIER LOST on the screen. If the carrier is lost the above error line will appear immediately. If the carrier does not come back within 3 seconds then the error message will be repeated.

3) Invalid Data indication is written as RECEIVING INVALID DATA STREAM on the screen. If invalid data is received for longer than 3 seconds then the above error message will be repeated. Invalid data means that the capture buffer is being loaded with data but the data does not conform to the S000000 time code format. This could be a noisy line (just playing music into the modem will load the buffer with invalid data).

4) The Program shows the running Time Code as received in both the hex S000000 format and a decimal conversion to the actual time code number in tenths of a second.

5) Check Sum indication is written as xxxx<—SUM ERROR on the screen. The number xxxx is the time code at which the error occurred. The check sum itself is not displayed.

6) Sequencing indication is written as xxxx<—SEQ ERROR—>yyyy on the screen. Sequencing errors will be displayed after a carrier drop out as well as when glitches occur in the tape drive. The xxxx is the last valid time code before the error occurred, the yyyy is the next valid time code after the error condition has cleared, the difference being the actual drop out time. At program start up the buffer containing the first valid time code is initialized to zero. therefore if the tape time code starts at a time greater than zero a sequencing error will be reported. This is, of course, not a true error and should be disregarded.

7) If the system is locked in a persistent error condition, such as carrier lost,

then press ^C (Ctrl and C keys depressed simultaneously). The program will user abort to the DOS A> prompt within 3 seconds.

8) The only way to exit the Program is to press ^C and the Program will abort in about 3 seconds.

In normal use the entire length of the time stripe is checked, either on the original master just after striping or in the field to verify the time code link. If you run the tape all the way past the last time code, the screen will then repeatedly give Carrier Lost messages because there is no longer any time code.

There should be no errors reported after the first false sequencing error to the Carrier Lost after you have run the tape past the last time code. You may see the receiving invalid data stream message at either the lead in or run out unmodulated carrier tone on the front and back of the time code stripe. In this manner the program may be run unattended, however to many Lost Carrier error messages will scroll the screen off the top and you cannot see if there were any errors.

Some errors in the Time Code Transmission may be tolerated. You certainly must have valid time code to start the Automated Firing Sequence. Please refer to this manual section on Auto Time Switchover for details and ramifications of bad Time Code.

SMPTE TIME CODES AND OTHER TIME CODES

For the PC Computer and the Interface Box System Controller;

The above TIMELOOK Program is for use only with Pyrodigital Time Code. For use in verifying SMPTE or other time codes refer to the Operators Manual for the Software Program which uses SMPTE. It is possible to use the Scripting Program to verify SMPTE Time Code, for Scripting Programs that use SMPTE.

For the Field Controller System Controller;

The Field Controller can read either Pyrodigital Time Code or SMPTE. Refer to the Operators Manual for the Field Controller for operation in verifying time codes.

AUTO TIME SWITCHOVER

Both the Field Controller and the PC Computer / Interface Box System Controllers have a feature called Auto Time Switchover. This feature is used in Auto Fire or Smart Fire when operating the Firing Sequences from external Time Code input. The detailed operation of Auto Time Switchover is described in each respective Operators Manual.

THE IMPORTANT POINT HERE IS TO UNDERSTAND WHAT THE AUTO TIME SWITCHOVER FEATURE DOES AND THE RAMIFICATIONS OF CONTINUING TO FIRE WITHOUT RECEIVING VALID TIME CODE.

The AUTO TIME SWITCHOVER routine can be thought of as a method which RECONSTRUCTS TIME CODE to a perfect sequential and valid time code number for input to the Firing routine regardless of signal present at the Time Code input jack on the System Controller. This provides that the Display will continue in the exact Scripted sequence and timing should the time code link become lost (severed) or noisy, ONLY AFTER THE DISPLAY HAS STARTED.

The Auto Time Switchover routine cannot be activated until the reception of at least 1 valid time code (to start the Display) and can be aborted (Cease Fire) at any time by depression of any Key of the Keyboard (or STOP on the Field Controller). Disarming of the SAFETY KEY (OFF) will also stop Firing (disconnection of electrical power to the Firing Modules), with Firing resumed when the SAFETY KEY is RE-ARMED (ON) (assuming you don't exit the Smart or Auto Fire Mode).

DANGER !

WARNING - EXTREME DANGER

THE AUTO TIME SWITCHOVER FEATURE WILL CONTINUE TO FIRE THE PYROTECHNIC DEVICES CONNECTED TO THE SYSTEM NETWORK EVEN IF THE TIME CODE LINK IS SEVERED OR LOST (once Firing has started). THIS MEANS THAT STOPPING THE TAPE MACHINE (stopping the time code) WILL NOT STOP THE FIRING OF THE PYROTECHNIC DEVICES. YOU MUST DIRECTLY STOP THE SYSTEM CONTROLLER SHOULD YOU WISH TO CEASE FIRE (in the event of lost time code).

STUDY THE BELOW EXAMPLE TO UNDERSTAND THE RAMIFICATIONS OF THE AUTO TIME SWITCHOVER FEATURE.

IF YOU HAVE ANY QUESTIONS ABOUT THE AUTO TIME SWITCHOVER FEATURE OR WHAT IT DOES OR WHAT THE CONSEQUENCES OF THE AUTO TIME SWITCHOVER FEATURE ARE; IMMEDIATELY CALL PYRODIGITAL CONSULTANTS. DO NOT PROCEED WITH ANY LIVE FIRING.

It should be clear as to the Purpose of the Auto Time Switchover feature with it's valid time code reconstruction. This is a very powerful and helpful feature provided by the System Controller.

Consider the below scenario; (FOR PYRODIGITAL TIME CODE ONLY)

(Note that the below scenario was written with the System Network being Controlled by the PC Computer and Interface Box combination. Operation with the Field Controller is similar, only with some of the indicators and controls being different; The Time Code modem is the same unit as incorporated into the Field Controller).

EXAMPLE - A Display has been Scripted and physically set up for Firing from a barge 1,000 feet away from land. A Radio Station 5 miles away is going to broadcast the Music. The Radio Station has been advised of the time code LINK requirements and will provide you with the 2 time code LINK's, a main LINK and backup redundant Link of the time code to your Firing Location on the barge. The main LINK is via a MARTY Radio transmitter which conveys the time code audio from the third track of the original Musical Tape at the Radio Station to a receiver on your barge.

The MARTY receiver output on the barge is matched to the -10 dbv, high impedance (50K to 100K Ohms) unbalanced RCA input required for the modem unit section of the Interface Box (or the time code inputs to the Field Controller which also have 600 ohm balanced inputs). They present you with a RCA patch cable at your Interface Box (w/ time code modem built inside). The time code audio signal level is -5db below the -10 dbv standard, however you know that the time code modem has automatic gain control built in which can compensate for this lower level signal. As long as the signal is not to hot, so as to cause excessive distortion, and not to low, so as to cause excessive noise, the modem will be able to decode the time code signal successfully. You will determine this by testing with the Utility TIMELOOK (or use the

Time Code Operating Mode of the Field Controller for verifying time code). (Note that a Radio Shack grade scanner can also be used successfully to recover the Marty Time Code Transmission, only with Pyrodigital Time Code, NOT SMPTE).

They have also provided you with a second backup redundant LINK which consists of a voice grade dedicated phone line from the Radio Station to a telephone patch point on land near the barge. They have extended from this patch box via a hardwire underwater cable to the barge Firing Location. They have used telephone matching transformers at both ends which converts the high impedance signals for transmission over the 600 ohm unbalanced phone lines. They have provided you with an RCA patch cable, which, thus effectively directly connects you to the broadcast tape machine time code audio output.

They have tested both LINKS for frequency response (voice bandwidth), level, and distortion and found them to be satisfactory. You have tested both LINKS by having the tape played at the Radio Station and monitoring the input to your time code modem with the TIMELOOK Utility on your Computer at the Firing Location on the barge, just as you will be set up for Firing (or Field Controller). You find the MARTY LINK creates some errors in the time code, about 10 errors for the whole 1/2 hour Musical Tape. These errors will be acceptable because of the Auto Time Switchover feature. The land line is error free so you decide to use the land line as your Primary LINK with the MARTY for backup.

Before show time you have checked both LINKS again by having the Radio Station simply play the Music Tape for a few minutes (only broadcasting time code to you, not playing music over the air). You are Operating Phase III in the Fire Mode, however you have shunted all Firing Modules, disconnected both ends of the Main Interconnecting Cable, the Firing Area (and fallout zone) is clear, and are ABSOLUTELY POSITIVE that Phase III cannot Fire because the System is NOT connected to the Interface Box (Main Interconnecting Cable Disconnected). THIS IS ESSENTIALLY THE FIRE MODE CHECK WHICH IS FULLY DESCRIBED IN THIS OPERATORS MANUAL. CONSULT ABOVE REFERENCED SECTIONS FOR FULL PROCEDURES!

Later you start the Display and everything is Firing fine and the Display is gorgeous. You are watching the display as well as the Computer Monitor and notice that the time code drive is now on INTERNAL and COMM 2: indicates NO (the Field Controller would indicate you are running on internal drive).

You grab your SAFETY COMMUNICATIONS RADIO (whose Radio Frequency emissions are acceptable for not closer than 5 feet to squibs & squib wiring which you have determined as acceptable by consulting IME Publications # 20, Radio Frequency Hazards in the Use of Electric Blasting Caps) and check with the Radio Station. They are still broadcasting the Music, have no idea why you are not receiving time code. The Display must continue without interruption. The Display is continuing uninterrupted, however, because of the Auto Time Switchover, however since you are only 2 minutes into the Display, you are concerned that by 30 minutes into the Display you may no longer be in sync with the Music.

You know that the Radio Station's tape machine is a high quality machine and that it's true speed specification is plus/minus 0.2% (typical). If your machine, on which you recorded the time code, was 0.2% slow and the Radio Station's Machine is also 0.2% slow (the typical maximums) then the Radio Station's time code to you could be as much as 0.4% slower than the original reference time code generation. 0.4% of 30 minutes is 0.12 minutes which equals 7.2 seconds. This means that by the end of the Display you could be up to about 7 seconds ahead of the music (in this case with additive slow tape speeds), although typically in practice, professional tape machines usually will play a 30 minute tape within 2 seconds each time it is played.

The show will continue on INTERNAL time drive and at least you can get the show into the air, even if it's timing to the Music may or may not start to progressively drift. At least the Display hasn't stopped and you don't have 100,000 Spectators about ready to riot.

At this point you quickly switch time code LINKS to the MARTY (exchange RCA patch cables or flick switch on your custom made RCA input selector box) and you start receiving valid time code, as indicated on the System Controller. You know that as the Display progresses, if you were to loose this second LINK the possible drift synchronous time error from Internal drive will be continuously lessened as you approach the end of the Display. You also notice that the time code coming over the MARTY is very bad because COMM 2: continuously says YES and the time code drive is flickering between INTERNAL and LINE FEED (Field Controller shows this differently). The assumption is that there are many, many spectators with radios that are "jamming" the airwaves and you are getting time code with a lot of noise. The Auto Time Switchover feature with continuous updating to the Internal clock is executing your Display Perfectly without stopping due to noisy time code and is keeping the Display and Music Perfectly synced to your Scripting.

This is good because you barely have time to watch the Computer Monitor as you are most concerned with the SAFETY of the Display. Since you don't have to concentrate on actually Firing the Display or it's proper execution (the job of the Computer as opposed to you having to push the correct buttons while listening to Firing commands over headphones), you are better equipped to concentrate on all aspects of SAFETY as the Display continues.

Now you get a call on the SAFETY COMMUNICATIONS RADIO that a speed boat has just run over your underwater hard line LINK, (which you already know and have compensated for) and is entering the Fallout Zone. You did not originally see the boat, however the SAFETY COORDINATOR has already stopped the Display by stopping the Music at the Radio Station. You note that your are on INTERNAL time drive (because the tape has been stopped), however the Display is continuing to Fire because you are on INTERNAL time drive. The decision is to STOP the Display so you quickly jam your hand on the Keyboard (or press STOP on the Field Controller), thus depressing any Key and stopping the Firing Software. You also reach over and DISARM the Phase III System by turning OFF the SAFETY KEY.

You immediately go back to the FIRE Mode so that you can be ready to immediately start Firing again as soon as it is SAFE (it takes time to create the Firing table). If you were only going to cease fire for a few seconds, with the Music continuing, you could have simply turned OFF the SAFETY KEY without ever exiting the Fire Mode, since you know that this will be an OK procedure, in this case. You could have gotten the COMM 1: error message, however ARMING the SAFETY KEY would switch the COMM 1: indicator to back to YES and you would continue Firing. The error message would still be on the Fire Screen, however.

Now assume that the speed boat has been escorted out of the Fallout Zone by the Police and it is SAFE to re-start the Display. The Radio Station is advised and they start the tape again from the point at which it was stopped (Don't let them rewind it - you have already shot many shells well into the program which cannot be reloaded). You pick up time code from the MARTY and the show continues and finishes, even through all the MARTY radio airwave noise.

Taking this example 1 step further, when the Radio Station re-starts the tape you are not receiving valid time code. The airwaves are so jammed that the time code cannot get through. The Music is playing but there are no Fire-works. You cannot go back to the land line LINK because it has been severed and your MARTY LINK is not working. PANIC?? - what do you do??

WELL, SINCE YOU HAVE PLANNED FOR THIS POSSIBILITY, NO PROBLEM. You have a Radio Broadcast Monitor Sound System that you have been listening to the Music and you also have a cassette tape deck at your Firing Location (a boom box at minimum). You have duplicate cassette of the MASTER Music Tape, which the Radio Station is now playing. You have previously mixed the Music to be mono on the cassette Left channel and the time code on the Right channel. You had started this cassette at the time the Display started, just in case you lost both LINKS you were going to patch over the cassette time code output to get the show started. However, you forgot to stop the cassette in the confusion of stopping the Display, and the cassette is at the end of the tape and has stopped automatically. You rewind the tape to about where you think it matches the Radio Music broadcast and listen. You make a quick fast forward, because you went to far back, and listen again. You figure you are within about 15 seconds of the proper synchronization point so you patch over the cassette time code. This gives the Computer another first valid time code and the Computer will start Firing from that point.

Now the Display is Firing, however it is out of sync with the Music. Since shells are now being Fired the spectators are happy again and the riot has quelled. Now disconnect the cassette, thus switching to INTERNAL drive, and attempt to fine tune the synchronization between your tape and the Radio Broadcast. Since the pressure is off somewhat (shells are exploding in the air and the crowd is pacified) you can get very close and then re patch the time code from the cassette. This will update the synchronization and you should be very close. Note that you may "machine gun" some shells if you jump ahead very far in the time code numbers (which you can avoid by use of SAFETY KEY OFF). If you jump backwards in time code numbers then nothing will be Fired (as it already has just been Fired) until the time code catches up to what it was previously.

Now re patch to the MARTY LINK. The crowd is happy and have gotten off their radios, so now the airwaves are clear. The time code drive switches back over to LINE FEED and your back in exact sync.

You continue, however, syncing the cassette with the Radio Music broadcast, just in case you have more problems. If you were unable to get the MARTY LINK back the time code drive would still be on INTERNAL and you should continue the cassette to broadcast syncing procedure. You should only update the time code as necessary (when you are very close to sync) by reconnecting the cassette time code patch cable. A variable speed cassette deck with the

capabilities of monitoring both the Radio and cassette Music simultaneously would make this sync tuning procedure less difficult (especially if you can monitor each source separately on each ear piece of a stereo headset, which blocks out the ambient noise and lets you hear what you are doing PLUS PRACTICE AT THESE PROCEDURES).

The above example should provide some insight into how the Auto Time Switchover can save your Display from going dark. It should also indicate some of the problems that can happen and some of the procedures used to avoid and correct for potential problems. It should also be clear that for these or other procedures to be effective they MUST BE PRACTICED AND UNDERSTOOD. In "the heat of battle" is no time to first try to use backup procedures as you must act very quickly to achieve the result; that is the Display continues as if there were no problems. The Auto Time Switchover feature goes a long way in helping you with potential time code communications problems.

AGAIN, PRACTICE AND UNDERSTAND THE ABOVE PROCEDURES. ALWAYS HAVE A BACKUP PLAN THAT IS WELL REHEARSED AND UNDERSTOOD BY EVERYONE (especially the radio station).

THIS PAGE INTENTIONALLY LEFT BLANK

SQUIB FIRING POWER; MAXIMUM LIMITS

Each Phase III Firing Module can fire more than 1 squib on EACH of it's 16 circuits. Calculating the maximum number of squibs, the maximum length of Interconnecting Cables, or the maximum squib extension wire lengths which may be used is simple and straightforward. Such calculation eliminates any uncertainty or need for test firings.

The key to simple calculation is Rmax. Rmax represents the maximum allowable resistance which may be added to the firing circuit. Those resistance elements added to the firing circuit are 1) the Interconnecting Cables, 2) the squib(s), and 3) any squib extension wires. If the sum of these 3 resistances is below Rmax then the squib(s) will fire reliably. Resistances as follows;

1) INTERCONNECTING CABLES; This resistance is the sum of the resistances of all the Interconnecting Cables IN THE DIRECT PATH between the Interface Box (or Pyrodigital Field Controller) and the Firing Module in question. This is NOT the sum of the resistances of all the Interconnecting Cables, but only those Cables in which the squib firing power travels through to get from the Interface Box (or Field Controller) to the one particular Firing Module being addressed to fire. This value will be the same for each Firing Module unless one or more Firing Modules are on longer Interconnecting Cables or have been sub Split and are connected with additional Interconnecting Cables (and Splitter Boxes).

2) SQUIBS; This resistance is the sum of the resistances of the actual squib(s) to be used. PYRODIGITAL CONSULTANTS RECOMMENDS SINGLE SERIES CONNECTION ONLY. Series connections always work reliably because the bridgewire within the squib match head achieves the match composition ignition temperature long before the temperature required to melt the bridgewire. This means all the squibs will be ignited before the series circuit is broken. This also means that ALL THE SQUIBS WITHIN THE SERIES MUST BE OF THE SAME TYPE AND MANUFACTURE.

Single series connection makes continuity checks easier as parallel connections can show continuity with one or more squibs not actually connected. Parallel squib connections also do not provide any increase in the number of squibs which may be fired and usually reduce the number due to the limited current available. Double series connections (2 parallel series) may increase the number of squibs slightly.

3) SQUIB EXTENSION WIRES; If squib(s) are extended with additional wire the resistance of the extension wire must be added.

Note: DO NOT attempt to simultaneously fire squibs on different Firing Modules by selecting identical Firing Module Addresses. This will reduce the squib firing power available (firing power parallel split and potentially unbalanced) and also create problems for the Interface Box to understand multiple Squib Status Returns. Refer to the Section of this Manual on SAME ADDRESS FIRING ON DIFFERENT FIRING MODULES - MULTIPLE SHOTS

BASIC Rmax EQUATION

Rmax >= Resistance of;
[Interconnecting Cables + Squib(s) + Extension Wire]

REFERENCE VALUES

Single Squib Rmax = 45.0 ohm - Single Series Rmax = 13.67 ohm

INTERCONNECTING CABLES*

Pink Cable (ST) 2.2O ohms/100'
20 gauge Hypalon (HP) 1.54 ohms/100'
16 gauge Hypalon (SHP) 0.63 ohms/100'

SQUIB RESISTANCE - Common squibs, nominal

Davey Fire = 1.9 ohms w/ 6' legwires
ICI = 1.6 ohms w/ 6' legwires
Atlas = 1.6 ohms w/ 6' legwires
(Staticmaster) = 1.2 ohms w/ 6' legwires

COPPER WIRE RESISTANCE (ohms/1000', awg)

No. 8	0.628
No. 10	0.999
No. 12	1.59
No. 14 - - - - -	2.53
No. 16	4.02
No. 18	6.38
No. 20	10.15
No. 21 - - - -	12.80
No. 22	16.14
No. 23	20.36
No. 24	25.67

*For non standard or different lengths of Interconnecting Cable simply calculate it's Effective Total Resistance (the sum of 1 conductor plus the shield for the length of the Cable) Example; A 250 foot section of the 16

shield for the length of the Cable) Example; A 250 foot section of the 16 gauge Hypalon Cable would have a resistance of 2.5 times the 100 foot length specification = 1.58 ohms.; or 750 feet of 20 gauge Hypalon = 750 x 1.54 ohms/100' (divided by 100') = 11.55 ohms

EXAMPLE FIRING POWER CALCULATIONS;

EXAMPLE: 256 shot Phase III System, 16 Firing Modules; HP-100 Interconnecting Cable (Interface Box to SPL-16 Splitter Box); 16 ea HP-50 Interconnecting Cables (Splitter Box to Firing Modules), Davey Fire 6' (2 meter) squibs.

What is maximum # of squibs which can be fired on each of the 256 circuits?

Rmax >= Resistance of
Interconnecting Cables + Res Squib(s) + Res Extension Wire

13.67 >= [1.54 ohm (HP-100) + 0.77 ohm (HP-50)] + Resistance Squibs Single Series + 0 ohms

11.36 >= Resistance Squibs in Single Series

11.36 >= 6 squibs x 1.9 ohms ea Davey Fire Squibs

11.36 >= 11.40 @ FALSE but so close (0.04 ohm); 6 squibs = OK MAXIMUM

The Phase III System in the above example is expanded to 304 shots by adding 3 Firing Modules. One of the 16 HP-50 Cables from the SPL-16 Splitter is replaced by a HP-100 Cable which goes to a SPL-05 Splitter. 3 HP-50 Cables go to the new Firing Modules from the added SPL-05 Splitter. It is desired to fire a set piece with 3 ICI squibs simultaneously 200 feet away from one of the new Firing Modules.

Will the squibs fire with 200' of 20 gauge twisted pair extension wire?

Rmax >= Resistance of;
Interconnecting Cables + Res Squib(s) + Res Extension Wires

13.67 >= [1.54 + 1.54 + 0.77] + [3 x 1.6] +
[2 wire x (200' x 10.15 ohm/1000')]

13.67 >= 12.71 @ TRUE, this arrangement fire OK

SUPPORTING DATA & CALCULATIONS

INTERFACE BOX, IB (or Field Controller)

26.5 vdc - Power Supply*
1.5 vdc - Insertion Loss
0 ohm - Added Resistance
4 amp - Maximum Power (current limited)

*if using external battery input use it's actual voltage

MINIMUM FIRING CURRENT, dc

Single Squib 0.5 amp
Single Series 1.5 amp
Parallel/Series 1.5 amps/series
Straight Parallel 1.0 amp/squib

SPLITTER BOXES, SPL; Negligible Added Resistance

FIRING MODULES, FM - 1.5 vdc Insertion Loss, 2.0 ohm Added Resistance

VOLTAGE/CURRENT AVAILABLE AT FIRING MODULE OUTPUT

Max. Voltage Avail. = 23.5 vdc (26.5 vdc - 1.5 vdc IB Loss - 1.5 vdc FM Loss)

Max. Current Avail. = 4 amps, less load of Firing Modules - 0.004 amp/FM

CALCULATED MAXIMUM LOAD RESISTANCE, Rmax

Rmax = The maximum added resistance allowed while still being above the minimum recommended squib firing current. The effects of the Interface Box, the Firing Modules, and the Splitter Boxes have been compensated for in calculating Rmax. The calculations are straightforward using Ohms Law, R = V / I.

Single Squib Rmax = 45.0 ohm = 23.5 vdc/0.5 amp - 2.0 ohm FM Resis.
0.5 amp min. to fire 1 squib

Single Series Rmax = 13.67 ohm = 23.5 vdc/1.5 amps - 2.0 ohm FM Resis. 1.5 amps per series, 1 series = 1.5 amps required

Dbl Series/Parallel Rmax = 5.83 ohm = 23.5 vdc/3.0 amps - 2.0 ohm FM 1.5 amps per series x 2 series = 3.0 amps required

Triple Series/Parallel Rmax = Not Advisable - 4.5 amps > Max. Current

1.5 amps per series x 3 series = 4.5 amps required

Straight Parallel Rmax = 3.88 ohm = 23.5 vdc/4.0 amps - 2.0 ohm FM Res maximum avail = 4.0 amps = 4 squibs x 1 amp/squib = 4.0 amps required

THIS PAGE INTENTIONALLY LEFT BLANK

MAXIMUM SQUIB FIRING POWER - BEYOND THE DESIGN SPECIFICATIONS

It has been observed, tested, and reliably proved that many more squibs can be Fired, per event, than indicated based on the design specification. Those specifications were based on conservative specifications from the Blasting Industry for the use of Electric Blasting Caps (EBC's, of which the squib is the initial initiator). Pyrodigital Consultants and others have tested and successfully Fired Displays with many squibs in series on long runs of extension (scab) wire through one thousand plus feet of Interconnecting Cable.

PYRODIGITAL CONSULTANTS CAN MAKE NO SPECIFIC ENDORSEMENTS CONCERNING FIRING RELIABILITY WHEN USING PHASE III BEYOND IT'S DESIGN SPECIFICATIONS.

THE KEY TO SUCCESSFUL FIRING BEYOND THE DESIGN SPECIFICATIONS IS TO TEST FIRE. AS A GENERAL RULE OF THUMB, TEST FIRE BEYOND YOUR APPLICATION AND THEN "BACK OFF" OR REDUCE THE NUMBER OF SQUIBS BY AT LEAST 2 PER SERIES.

The user may find that the Phase III conservative design Firing specification Limits can be expanded. This is acceptable for Fireworks squib applications, whereas it would be an unacceptable practice in Commercial Blasting where an unfired shot poses an extreme Safety Hazard.

In all applications and testing the DAVEY FIRE SQUIB has been used. THE DAVEY FIRE SQUIB SEEMS TO BE SOMEWHAT MORE SENSITIVE, IN TERMS OF ELECTRICAL POWER REQUIRED TO FIRE, THAN OTHER SQUIBS, although very little testing has been done with squibs other than the Davey Fire.

MAXIMUM FIRING TEST RESULTS

1) Single Series - 1,250' SHP (16ga Heavy Wire) Interconnecting Cable with 8 (eight) Davey Bickford Squibs and aprox. 600 feet of 22 ga. extension wire in series - SUCCESSFUL FIRE 8 SQUIBS. (aprox. 32.8 ohms total resistance; 8 x 1.9 ohms = 15.2 ohms squibs + 600' x 16.14 ohms/1000' = 9.7 ohms extension wire + 1,250' x 3.15 ohms/500' = 7.9 ohms Interconnecting Cable) = 240% beyond Single Series Rmax of 13.7 ohms - with load equivalent to 34.7 ohms (253% overload) No Fire.

2) (See Manual Section SAME ADDRESS FIRING ON DIFFERENT FIRING MODULES - MULTIPLE SHOTS); Multiple same address Firing Modules (FM); 3 Parallel Series - 1 FM w/ 725' HP Interconnecting Cable and 6 Davey Bickford in series (22.6 ohms calc) + 1 FM w/ 425' HP Interconnecting Cable and 8 Davey Bickford in series (21.7 ohms calc) + 1 FM w/ 825' HP Cable and 6 Davey Bickford (24.1 ohms calc) - SUCCESSFUL FIRE 20 SQUIBS in 3 parallel reasonably balanced series on separate Firing Modules.

SAME ADDRESS FIRING ON DIFFERENT FIRING MODULES - MULTIPLE SHOTS

NOTE THAT THE INFORMATION PROVIDED BELOW IS FOR PHASE III SYSTEMS PRIOR TO THOSE MANUFACTURED IN 1991. IN 1991 THE FIRING RATE WAS CHANGED TO 1/100 OF 1 SECOND (from 1/10 of 1 second). FIRING AT THIS RAPID RATE MAKES MULTIPLE FIRING OF FIRING MODULES SET TO THE SAME ADDRESS A NON ISSUE, WITH ABSOLUTELY NO REASON TO DO SO.

NOTICE THAT REVISED SOFTWARE FOR THE SYSTEM CONTROLLER COMPOSED OF THE INTERFACE BOX AND PC COMPUTER (VER250F AND NEWER) INCORPORATE THIS REVISED FIRING RATE, AS WELL AS ALL FIELD CONTROLLERS EVER MANUFACTURED.

ABSOLUTELY DO NOT USE THE BELOW MENTIONED TECHNIQUE OF MULTIPLE MODULES SET ON THE SAME FIRING ADDRESS FOR THE NEW FIRING RATE OF 1/100 OF A SECOND, WHEN SHOTS ARE CLOSER THAN 30 msec (1/30 OF A SECOND). THE FIRE PULSE WILL BE SHORTER (1/100 OF A SECOND) AND IT IS DOUBTFUL THAT THE BELOW TECHNIQUE WILL FIRE RELIABLY.

The existing Phase III user group, including Pyrodigital Consultants, has found it desirous and advantageous to be able to simultaneously Fire pyrotechnic devices from different physical locations within the same single Phase III Firing System Network. This application normally manifests itself in the desire to simultaneously Fire identical Aerial Shells from several widely spaced Firing locations.

This is generally a land based situation, where 1 single Firing System is controlling multiple Firing Sites. If the spacing between Firing Sites becomes very large or variable (multiple simultaneous Displays), then the procedure is to employ 1 Firing System per each Display. Within each Display, however, it may be advantageous to employ multiple Firing Sites. It is then desirable to be able to Fire simultaneously from the multiple Firing Sites within the (each) Display.

One procedure for multiple simultaneous Firing is to interconnect each same device (or desired same Firing time device) by running a series wire connecting each device at each Firing Site. This series would then be connected into a

single Firing Circuit for simultaneous Firing. This procedure works, however it can be a wiring nightmare and also requires a huge expenditure of time (and wire cost) to be spent for the additional series interconnect wiring.

Another method, which seems obvious, is to employ Phase III Firing Modules set at the same Firing Address at each of the Multiple Firing Sites. Then each simultaneous device is connected to the same Firing Circuit on each identically addressed Firing Module. Thus a Firing command for this one address will cause multiple Firing of each same addressed device* note 1. This multiple simultaneous Firing has now been tested and is approved by Pyrodigital Consultants, however, with some limitations and qualifications.

When Firing Modules are set at the same address then they are essentially connected in parallel via the Splitter Boxes. Parallel connection affects both 1) Squib Status Returns and 2) Firing Power.

1) SQUIB STATUS RETURNS FROM MULTIPLE SAME ADDRESS FIRING MODULES

When 2 or more Firing Modules are set on the same address then squib continuity status returns from each Firing Module will return at the same time. This digital communications information will be mixed in parallel at the Splitter Box and arrive together at the Interface Box. The combined digital information may or may not be in phase (from each same addressed Firing Module) and also each Firing Module may be reporting different squib continuity status information. Therefore the Status indication on the Computer Screen may be erroneous, in error, or not behaving properly. The only way to check Status is therefore to have a unique address for each connected Firing Module for purposes of Status Returns.

This means that to correctly check squib continuity Status each Firing Module MUST have it's own individual address. This can be accomplished by switching the thumbwheel address for each identically addressed Firing Module (to be Fired Simultaneously) to it's own different and unique address for purposes of Status Returns Checking. When the Status Checks are made and connections verified then the Firing Modules to be Fired simultaneously can then be re addressed to the same Firing Module Address. Remember that the STATUS RETURNS FOR EACH FIRING MODULE ADDRESS (with more than 1 Firing Module identically selected) WILL NOT BE MEANINGFUL AND MAY NOT BE DISPLAYED AT ALL OR CORRECTLY.

The status check routine of the Software against the Firing Module Addresses (right hand side of split status screen) will indicate connected but not listed for each re addressed Firing Module. This is because the addresses specified for Firing are not the same as those for checking Status (you have switched to different non existent addresses (in the .sho file) for Squib Continuity Status Returns Check). This inconsistency could be solved by a different .sho file for Status Checks (in which the simultaneous Firing addresses have been re specified to unique individual addresses for Squib Status Check).

Another technique to avoid the multiple status returns problem is to selectively disconnect all but one the multiple addressed Firing Modules. Status checks may be then performed on each Firing Module one at a time. BE SURE TO RECONNECT ALL FIRING MODULES BACK INTO THE CIRCUIT WHEN FINISHED.

2) FIRING POWER LIMITS FROM MULTIPLE SAME ADDRESS FIRING MODULES

PYRODIGITAL CONSULTANTS ADVISES THAT A MAXIMUM OF 3 FIRING MODULES PER SET MAY BE SELECTED TO ANY ONE SAME ADDRESS FOR MULTIPLE FIRING. It is permissible to have several sets of up to 3 each Firing Modules per set selected to the same Firing Address. Note also that Firing Modules thus used will be in sets of 16 shots/circuits. WHENEVER YOU FIRE ONE SIMULTANEOUS ADDRESS, ALL MODULES WITH THAT SAME ADDRESS WILL ALSO FIRE! A device could be Fired singly from a multiple address set of Firing Modules, however no other devices must be connected to that same address at the other Firing Module locations because they will be Fired simultaneously!

NOTE THAT THE FIRING POWER (24vdc @ 3 1/2 Amps nominal) WILL BE SPLIT IN PARALLEL ACCORDING TO THE NUMBER OF SAME ADDRESS SELECTED FIRING MODULES!!! The theoretical maximum Firing Power for 3 same addressed Firing Modules would thus be 1 1/6 Amps, which is below the minimum recommended 1 1/2 Amps per each parallel series. THUS, YOU ARE USING PHASE III ABOVE AND BEYOND IT'S DESIGN CRITERIA AND MUST ACTUALLY TEST FIRE SQUIBS to be sure that you will successfully Fire all the desired squibs simultaneously.

TEST FIRING IS ABSOLUTELY RECOMMENDED IN THE EXACT SYSTEM CONFIGURATION THAT YOU WILL BE USING TO FIRE YOUR

DISPLAY. TEST FIRE AT LEAST 2 GREATER THAN THE ACTUAL MAXIMUM NUMBER OF SQUIBS YOU INTEND TO USE, PER FIRING MODULE. Please refer to the previous section, MAXIMUM SQUIB FIRING POWER - BEYOND THE DESIGN SPECIFICATIONS, for actual test data and recommendations!

*note 1; Note that the address refers to the FULL 3 hex character address / shot code which specifies a particular individual circuit on each individual Firing Module so addressed, which MUST also be specified in the .sho file or Firing Instructions AS 1 (ONE) EVENT. Example Shot # 5, Address 12F Fires 3 devices simultaneously, each device connected to 1 of 3 Firing Modules with Thumbwheel selected to 12 on each Firing Module. Each simultaneously Fired device is connected to circuit F on each 1 of 3 Firing Modules which have their address selected to 12.

BENCHTEST

Benchtst, or Bench Testing of Firing Modules, is a diagnostics and verification program used to operate the Firing Modules with the PC Computer and Interface Box System Controller.

IF YOU ARE USING THE FIELD CONTROLLER THEN YOU CANNOT USE THE BENCHTST PROGRAM, HOWEVER YOU CAN STILL USE THE TEST LIGHTS TO SIMULATE SQUIBS AND CREATE VARIOUS DATA TABLES WHICH WILL FIRE THE TEST LIGHTS.

THE PRACTICE OF BENCH TESTING WITH TEST LIGHTS IS TO BE ENCOURAGED AND EVEN EXPECTED SO THE USER CAN GAIN FAMILIARITY WITH THE PHASE III SYSTEM.

DANGER !

WARNING - EXTREME DANGER

BENCHTST PROGRAM IS FOR TESTING OF THE FIRING MODULES UNDER CONTROLLED SHOP TESTING CONDITIONS USING TEST LIGHTS. THE BENCHTST PROGRAM WILL CAUSE FULL OUTPUT FIRING VOLTAGES TO BE SENT TO THE SQUIB CONNECTORS ON THE FIRING MODULES. DO NOT USE THIS PROGRAM IN THE FIELD WITH ANY PYROTECHNIC MATERIAL PRESENT. DO NOT ALLOW THIS PROGRAM TO EVEN BE PRESENT IN OTHER THAN A CONTROLLED BENCH TEST SITUATION WHERE THERE IS NO PYROTECHNIC MATERIAL PRESENT AND YOU ARE USING TEST LIGHTS TO SIMULATE LIVE SQUIBS. NEVER USE THIS PROGRAM WITH LIVE SQUIBS BECAUSE THEY WILL BE FIRED.

Benchtst is a program routine which continuously fires all 16 circuits on one Firing Module until aborted by the user. The System Network is set up consisting of 1 Interconnecting Cable from the Interface Box to 1 Firing Module. It is most convenient to have the Firing Module right next to the computer and Interface Box so that you can observe if the Firing Module is operating correctly. Install 16 test lights, one to each circuit on the single Firing Module.

The Phase III System will be operated in a power up condition, SO BE ABSOLUTELY SURE IT IS SAFE TO APPLY FIRING POWER TO THE FIRING

MODULE. THIS MEANS THAT THERE ARE NO PYROTECHNIC DEVICES ANYWHERE NEAR AND THAT YOU ARE IN A CONTROLLED SAFE ENVIRONMENT. Power up Phase III and arm the Safety Key. Check status using the main program to verify that the Firing Module is responding. Load Benchtst and press C to continue. If the Firing Module is working correctly then it will start firing, as indicated by a light pulse on the test light, with circuit 0. The program will then step to the next circuit and fire. The program thus continues indefinitely firing in a continuously rotating manner from circuit 0 through F, back to 0 up through F, etc. in apx 1 second increments per firing until aborted by pressing any key to stop.

IN ORDER FOR THE PROGRAM TO FUNCTION CORRECTLY THE THUMBWHEEL ADDRESS SWITCH MUST BE SET ONLY ON ADDRESSES FROM 00 THROUGH 12 INCLUSIVE. If the thumbwheel address greater than 12 the program will indicate some number for the active box and the Firing Module will not be fired.

THERE CAN BE ONLY 1 FIRING MODULE CONNECTED TO THE INTERFACE BOX. If two or more Firing Modules (Boxes) are connected the program will abort with an appropriate error message.

The Interface Box must be connected to Com1, powered ON, and Armed (Safety Key) or the program will abort. Failure to have the proper communications will result in the error message COMMUNICATIONS TRANSMIT FAILURE - CHECK SYSTEM to be displayed on the screen. A space bar will abort back to DOS.

The Benchtst program also reports the number of the active box, or the thumbwheel address of the single connected Firing Module. The message is displayed as ACTIVE BOX IS: XX. The XX number is a decimal (base ten) number of the address code. Thus Box 0, zero, is thumbwheel address 00. Box 1 is address 01 and so on through Box 15 is FF, 16 is 10, 17 is 11, and Box 18 is Firing Module thumbwheel address 12 - the largest allowable address. This test 19 possible Firing Modules, which is similar to the status screen display and capability. Note that it is possible to fire Firing Modules on other addresses that from 00 to 12, SO NEVER ASSUME THAT A FIRING MODULE CANNOT BE FIRED BECAUSE IT'S THUMBWHEEL ADDRESS IS NOT WITHIN THE NORMAL PROGRAM PARAMETERS. As mentioned previously, thumbwheel address 80 through are FF are identical repetitions of the lower 128 addresses. Address 00 is equivalent to 80 and 7F is equivalent to FF, similarly up through all upper 128 thumbwheel addresses.

The Benchtst Program is intended to check that the entire Firing electronics, all 16 circuits, of any tested Firing Module are functioning properly. It is recommended that the user operate Benchtst, under bench testing Safe conditions, using test lights, to gain familiarity and confidence in the Firing Module operations and the use of all power up arming procedures.

For diagnostics purposes, if you cannot establish communications to a Firing Module by using the Status Mode of the main program, then Benchtst will not cause the Firing Module to function either. Benchtst may prove that a Firing Module can fire correctly, even if there are incorrect status returns, however communications to the Firing Module must be present. Benchtst can be a quick and reliable test for a suspect or damaged Firing Module as well as a good diagnostic tool for checking all components under "simulated" live conditions. The Smart Fire or Dumb Fire Modes can obviously be operated under bench test Safe conditions using test lights as well.

THIS PAGE INTENTIONALLY LEFT BLANK

TROUBLE SHOOTING

WARNING - EXTREME DANGER

TROUBLE SHOOTING PROCEDURES ARE TO BE USED DURING THE SYSTEM CHECK-OUT PHASE OF SETTING UP OR UNDER BENCH TESTING CONDITIONS WHERE NO PYROTECHNIC DEVICES ARE PRESENT. IF YOU CANNOT GET THE SYSTEM CHECKED OUT PROPERLY IN THE FIELD THEN DO NOT PROCEED TO CONNECT ANY PYROTECHNIC DEVICES TO THE PHASE III SYSTEM. EFFECT REPAIRS BEFORE ANY PYROTECHNIC DEVICES ARE PRESENT. AN IMPROPERLY FUNCTIONING SYSTEM CAN IMPOSE A SEVERE SAFETY HAZARD TO ALL PERSONNEL.

GENERAL

This section of the manual covers some Trouble Shooting procedures for the Phase III System. It also gives general and detailed information about various components of the Phase III System which may be helpful in trouble shooting, bench testing, or detailed understanding of the Phase III System.

As in previous sections of this manual, the Phase III System can be divided into it's two major components; the System Controller and the System Network.

The SYSTEM CONTROLLER consists of the IBM PC or True Compatible Computer and the Interface Box with the associated connecting Cables, or the Pyrodigital Field Controller, or other Pyrodigital Controller. The System Controller would also include the master tape machine and time code link.

The SYSTEM NETWORK consists of the Interconnecting Cables, Splitter Box(s), and the Firing Modules. These components are used in the field for firing the Display and link the Firing Area to the Control Location (where System Controller is located).

BASIC TROUBLE SHOOTING

In most cases the problem is very simple, such as you have forgotten to turn on or connect something. Obviously, check the basic connections, power switches, etc.. Are you operating the Software correctly? Try again.

Does the problem lie with the System Controller or the System Network? This should be fairly obvious to determine. The computer or Field Controller appears to be working but the Firing Modules are not. Trouble shoot the System Network and work your way back, as it is possible the trouble lies in the Interface Box.

To determine if the problem is with the System Controller or the Network first check the System Controller. It will be obvious if the computer or Field Controller appears to be functioning or not.

SYSTEM CONTROLLER TROUBLE SHOOTING

PC Computer and Interface Box Combination

PC Computer

Disconnect everything from the computer but the power cable. Can you load the DOS command file and get to the DOS A> prompt? Try the backup program disk. Try another DOS disk or another program. If you cannot get the bare computer to function then the problem is with the computer. Replace Computer. (it is possible to rent an IBM PC in a jam - make sure you get one with 2 Async Com Cards, consult the Firing Software operators manual for other computer requirements) Consult your computer manual or dealer for Trouble Shooting of the computer itself.

Interface Box

Problems with the Interface Box are more difficult to isolate because you are not sure whether the Interface Box or the System Network is at fault. This will be the case when you are having problems trying to communicate to the System Network. In this case it is advisable to follow the SYSTEM NETWORK TROUBLE SHOOTING Procedures to trace the problem backwards towards the Interface Box.

Other problems may be checked directly at the Interface Box, such as PROB-

LEMS WITH COM2 AND THE TIME CODE, since the System Network is not directly involved. If you cannot get time code to the computer check connections between the tape machine and the Interface Box first. Bring the tape machine (or a backup machine with a time code striped tape) next to the Interface Box and connect directly into the play connector with a good RCA patch cord. Make sure the Com Cable is connected. Swap the Com cable. Does the System Controller respond to the Firing Modules in Status Mode? If it does then try swapping com cables to check the other cable. Play the tape with time code (be sure you are using the right tape track output - use headphones - is there time code on the tape?

If you still cannot get the time code to read, connect the rec output from the modem (Interface Box) to your tape machine. Is the modem tone carrier present? Try generating time code with the appropriate program. If you can get no carrier tone out or no time code out then the modem has probably failed. Replace the Interface Box. Be sure you are checking correctly because connection or monitoring errors may lead you to believe the Interface Box is faulty when it is actually not the problem at all. Is the power on? Green power light shows power? Com2 Cable plugged into correct connectors on both computer and Interface Box?

If you get a carrier tone from the modem but are unable to generate or read time code and the Com Cables are good try the TIMELOOK Program. If the Program is unable to read time code it is possible that there is a problem with the RS-232C Async Card. Swap cards, being sure to switch Com1 for Com2 and visa versa on both cards. Try the computer with a Hayes type modem program to determine if the problem is in the Interface Box or Computer. Try another Interface Box. Try another computer.

PYRODIGITAL FIELD CONTROLLER

Problems with the Field Controller may be difficult to isolate because you are not sure whether the Field Controller or the System Network is at fault. This will be the case when you are having problems trying to communicate to the System Network. In this case it is advisable to follow the SYSTEM NETWORK TROUBLE SHOOTING Procedures to trace the problem backwards towards the Field Controller.

If the Field Controller itself does not appear to be functioning then disconnect everything from the Field Controller. Are the internal batteries dead? Try

inputting 24vdc external power (2 car batteries in series). Use the battery charger and operate off 110vac, if available. Turn off the Field Controller for 30 seconds or so (to reset the internal Software). Try changing the memory of the data table. Have you done anything to the Field Controller recently that might be affecting it's function, such as having changed the internal gel cell batteries and having not got the power connections back on securely; or changed the EPROM Memory which may have not been seated properly. Replace the Field Controller.

Other problems may be checked directly at the Field Controller, such as PROBLEMS WITH THE TIME CODE, since the System Network is not directly involved. If you cannot get time code to the Field Controller check connections between the tape machine and the Field Controller first. Use the Time Code Operating Mode and Monitor Option. Bring the tape machine (or a backup machine with a time code striped tape) next to the Field Controller and connect directly into the play connector with a good RCA patch cord. Play the tape with time code (be sure you are using the right tape track output - use headphones - is there time code on the tape?

If you still cannot get the time code to read, connect the rec output from the fField Controller to your tape machine. Is the modem tone carrier present? Try generating time code. If you can get no carrier tone out or no time code out then the modem section has probably failed. You may be able to run on internal Drive. Be sure you are checking correctly because connection or monitoring errors may lead you to believe the Field Controller modem is faulty when it is actually not the problem at all. Replace the Field Controller.

SYSTEM NETWORK TROUBLE SHOOTING

STATUS RETURN TROUBLE SHOOTING

It is assumed that the System Controller is operating correctly. Refer to SYSTEM CONTROLLER - TROUBLE SHOOTING if the problem lies in the System Controller. This section applies if you are having trouble communicating with the Firing Modules, as indicated by no or partial status returns from the Firing Modules when in the Status Mode.

Be sure the Firing Modules are thumbwheel addressed from 00 through 7F (or 00 through 12 for Benchtst). Check the obvious - are all the Cables connected

(Com Cable, Power Cable, Interconnecting Cable) Is the power ON and is the Safety Key armed? Are some of the Firing Modules still shunted and you are misinterpreting the status display?

DOES THE SHORT LIGHT INDICATE A SHORT?
Yes - Disconnect the main Interface Cable
No - Make sure the circuit breaker is reset and try again.

Does the short go away?
Yes - go to next procedure.
No - replace the System Controller (Interface Box)

SHORT INDICATION IN SYSTEM NETWORK

Start progressively disconnecting Interconnecting Cables and re checking for shorts. Do not allow the short light to be on for more than a few seconds. A sustained short will trip the circuit breaker on the back of the Interface Box. By checking for shorts one piece at a time the faulty piece of hardware can be found and replaced.

SYSTEM DOES NOT RESPOND -
NO SQUIB STATUS INDICATION FOR ANY FIRING MODULES

PC Computer & Interface Box Combination

You may or may not get a Transmit Communications error on the screen (CRT Monitor) during squib status check.

If not, then you have proper communication between the Interface Box and the Computer but you do not have proper communication to the Firing Modules. Check the main Interface Cable - is it plugged in to the Interface Box? Is the Cable good? Change Cables. Try connecting a Firing Module directly to the Interface Box with a different Interconnecting Cable. Make sure the Safety Key is on, both circuit breakers reset on the Interface Box. Change the Firing Module address to 00. If you cannot get response with a single Firing Module then the problem is within the Interface Box. Try several Firing Modules and several Interconnecting Cables. Try the backup software program. Try the BENCHTST Utility. Replace the Interface Box.

If you get a Transmit Communications error then the computer is unable to talk to the Interface Box. Do you have power to the Interface Box? Is the power on? Is the Safety Key on? Are the circuit breakers on the back of the Interface Box tripped? Is the RS-232 cable connected between the computer and the Interface Box? Is this cable connected to com1 on the computer? (if you are having trouble with the Modem then you probably have the cables reversed at the computer) Is the cable good - try swapping it with the other cable for the Modem. Try running one of the utility program BENCHTST to fire an indicator light on the singly connected Firing Module. Try swapping out with another Interface Box. It is possible that the serial port on the computer is not functioning. Try swapping the RS-232C com cards. Try another computer.

Pyrodigital Field Controller

The Field Controller is unable to talk to the System Network for some reason. Check the main Interface Cable - is it plugged in to the Interface Box? Is it plugged into the first Splitter? Is the Cable good? Change Cables.

Do you have power to the Field Controller? Are the Internal Batteries Dead? Is the power on? Is the Safety Key on? Try connecting the battery charger and running on 110vac (through the battery charger) or inputting 24vdc through the external power input.

Try connecting a single Firing Module directly to the Interface Box with a different Interconnecting Cable. Make sure the Safety Key is on. Change the Firing Module address to 00. Try the different status options. Use manual status and directly request status from box address 00 (with that single connected Firing Module set on box address 00). Try using test lights and see if you can manually Fire the test light (DANGER - be sure to directly connect this only 1 Firing Module so that you cannot Fire something else). If you cannot get response with a single Firing Module then the problem is within the Field Controller. Try several Firing Modules and several Interconnecting Cables to be sure. Try changing the memory of the data table. Turn off the Field Controller for 30 seconds or so (to reset the internal Software). Replace the Field Controller.

SQUIB STATUS DOES NOT SHOW RESPONSE FROM ALL FIRING MODULES.

Check to be sure that these Firing Modules not responding have a correct address and are connected into the Network. Try swapping them with other Firing Modules that work. Try switching or cycling the Shunt Switch and thumbwheel address switch. If still no response then the Firing Module is Faulty (be sure to try address 00 singly) If you get response when swapping this indicates that there is no communications at the original location of the Firing Module. Check the Interconnecting Cables for proper connection. Check the Interconnecting Cable to the Module in question by swapping it with one which works (one that's connected to a properly functioning Firing Module). If the problem is the same then the Splitter Box is faulty.

Firing Module(s) Respond Only With 00 Box Address:

A single firing module is checked directly connected to the system controller (Interface Box) and the only address available is 00 , regardless of the thumbwheel switch setting.

Open the Firing Module and check that the thumbwheel switch is connected to the circuit board via it's connector. Remove and replace the connector and cycle each section of the thumbwheel switch several revolutions. If the Firing Module still indicates only address 00 then the thumbwheel switch or the Firing Module circuit board is faulty. Swap switches with another good Module to determine which.

FIRING MODULE ELECTRONICS

The Firing Module may be opened by removing the 4 screws near the 4 corners on the top of the Firing Module. The top may be distinguished (from the bottom) as it will have the quick connectors if provided. If no quick connectors are provided the bottom may be distinguished as having 5 screws with one of the bottom's end flanges holding the XLR connector, the Shunt Switch and the Thumbwheel Switch. Removing the 4 screws on the top will allow separation of the bottom and top halves thus revealing the internal electronics.

Electrical connection to the squib connectors is via connectors to mating pins on the circuit board. The front connector, which is closest to the shunting switch is the hot outputs while the rear connector is 16 common grounds. The connectors may be carefully removed from the pins on the circuit board for complete separation on the 2 module halves. It is now possible to remove the circuit board by removing the shunt switch knob and it's retaining nut underneath, removing the thumbwheel connector from the circuit board, and un soldering the 3 wires from the XLR connector at the circuit board. The 5 bottom screws may now be removed allowing removal of the circuit board from the Firing Module bottom half. It is recommended that the circuit board not be removed, rather the entire module sent back to the Factory for service.

It is possible to exchange the electronics bottom half of the Firing Module with another one should there be a problem with either half. It is this possible to exchange a good bottom half onto a top half. This procedure is definitely not recommended in the field. The field procedure is to swap out the entire module.

The above procedures are only mentioned to assist the advanced user in trouble shooting a Faulty Firing module on the bench. TROUBLE SHOOTING FIRING MODULE COMPONENTS IN THE FIELD IS POTENTIALLY DISASTROUS AND NOT RECOMMENDED. THE PROCEDURE IS TO REPLACE THE FAULTY FIRING MODULE WITH A SPARE and send the faulty Firing Module to the factory for repair. The user may, by switching various major components of a good module with a faulty one, determine the fault and thereby request specific part replacement from the factory. It is recommended that trouble shooting on the circuit board electronics be left to the factory.

THIS PAGE INTENTIONALLY LEFT BLANK