ICS-4000™
INTEGRATED CONTROL SYSTEM
INSTALLATION INSTRUCTIONS

BY peterson

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SECTION A - OVERVIEW

The Peterson ICS-4000™ Integrated Control System for pipe organs will perform all of the organ's control functions using a Motorola MC68340 microprocessor for the "main" system in the console and with "satellite" MC68HC12A4 micro-controller/ interface circuits for various input/ output sub-systems both within the console and in the chamber.

The main console system and any satellite sub-systems are connected to each other via Ethernet (LAN). Ethernet is a widely used and universally accepted method of communications between computers. The ICS-4000's Ethernet is fully compliant with industry standards. All interconnecting cables both within the console and chamber(s) and the organ's main cable (from the console to the chamber(s)) are 10BASE-T and use Category 5 cable and RJ-45 modular connectors.

Initial system programming (for specific organs) is accomplished by transferring files on DOS formatted 1.44M, 3.5" floppy disks, or by replacing firmware (ICs). Beginning Summer 2005, USB (Universal Serial Bus) format will be substituted for DOS floppies. A Windows 98/NT-based (32 bit) program provides a graphical means for doing all of the initial system programming functions. This system programming defines all of the organ's keyboards, stops, pistons, indicators, expression, miscellaneous controls, ranks of pipes and their locations and any other aspects required to define a given organ.

The user interface is the Control Display Unit (CDU), which includes a Vacuum Florescent (VF) display and simple controls for accessing all user control functions and programming. These functions include such selections as "Organist Folder™" and memory level, crescendo level, programming and editing of crescendo and tutti settings, MIDI aspects, etc. The VF display provides a bright, crisp display that can easily be viewed from any angle even in bright light.

A "maintenance switch" can be used to access the set-up/ programming and diagnostic modes. This pre-empts the need for technicians to know users' passwords. These modes can also be accessed via the CDU with special "Supervisor" and "Organ Builder" passwords.

All MIDI codes, 31.25K baud rate, opto-isolated (current loop) I/O, pin-outs, etc. comply with the MIDI Manufacturer's Association "MIDI Detailed Specification 1.0, Version 4.2" (or most current).

All of the ICS-4000™ system's circuits, Main and Satellite including cabling meet EMI/RFI standards for FCC Part 15 Class A and European Community certification.

SECTION B - CAPACITIES/ OVERALL SPECS

GENERAL

Organ Voltage	11-18 VDC Standard
Ranks	150 max. (unit) or 1500 max. (as Diode Matrix hybrid) max
Keyboards(Manuals)	8 max.
Stop Controls	512 max.
Transposer	+/- 6 semitones
Expression	128 contacts (8 shoes @ 16 stages typical)
Master/Slave	2 or more consoles can be supported
Connectors	Wire Wrap, Peterson Output Connector, or "Quick Punch™" IDC
Protection	Driver Outputs with Auto Sense Shutdown; Resettable Fusing that meets IEC standards

RELAY

Ranks	1500 max.
Pitch Range	64' - 1/32' (12 octaves) Note range C000-C8.
Load/Drive Standard	40 ohm (400 ma.) continuous.
Load/Drive High Current	20 ohm (800 ma.) continuous (Greater loads require external drivers).
Power Controls	Blower/Chamber Rectifier via relay contacts or Peterson CACC System

COMBINATION ACTION

Pistons	128 max.
Memory Levels	256 max. in Non-Volatile EEPROM (with up/down load to disk or USB for unlimited)
Lock-Outs	One per Organist Folder™ via password.
Crescendos	4 or 8, selectable via the CDU menu.
Tuttis	One per C/A level (256 max); or 8 pistons; or 4 selectable by optional panel.
Load/Drive	20 ohm (1 Amp) intermittent for stop action magnets.

MIDI

Channels	16 sequencer & 16 instrument (optionally 8 seq. & 24 instr.)
Program Changes	128
Banks	16384
Alternate Voices	16 (per each program number)
Pre-Sets (Patches)	128 max. - Pistons OR Stops (not both)
Sequencer	Internal Standard/ External Optional

MISCELLANEOUS

Clock	12 or 24 hour (real time) and Elapsed/ Countdown
Calendar	With leap year
Timer	Programmed event control of any organ functions (future implementation).
Metronome	Audible/Visual (future implementation)

SECTION C - HARDWARE DESCRIPTION

MAIN CAGE (Refer to Figures 5 & 6)

Main Microprocessor (CPU) Board #408101

This board is responsible for gathering all the input data from the satellite card cages ("satellites"), performing all the coupler, relay, combination action and MIDI processing, and then outputting the appropriate data to the satellites. The Main CPU chip is a Motorola 68340. Communications to all satellites and the chamber is via industry standard 10BASE-T Ethernet using Cat 5 cable and RJ-45 connectors. Serial ports included on the CPU card are for the CDU, Floppy Disk Drive and an RS-232 (DB-9) connector intended for an external PC connection in future implementations.

Power Supply Board #408103

This board supplies the regulated and switched voltages needed for the system and also has the MIDI I/O connectors. A constant 10-14 VDC input is required, which is regulated to 5v to operate the power on/off relay circuitry. This constant DC input is supplied by a Class II type DC supply that must be plugged into an unswitched AC outlet. The organ voltage (9-18 VDC) is used as the input to the main (high current and switched) 5 V regulator.

Four system-controlled DC (organ voltage) outputs are provided that can be used to operate relays. These can be utilized to switch other system elements. The MIDI connectors include an Instrument Out (for a sound module/synth) and Sequencer Input and Output (for external record/play). Eight analog inputs are also located on this board. One analog input is for the crescendo shoe and uses an RJ-11 modular connector. Peterson manufactures a crescendo shoe or a potentiometer adaptor is available to mount to existing shoes. The other analog inputs and +5V/GND commons are on plug-in screw terminals. These will be available in the near future for various sensors such as temperature and voltage and/or expression shoes with potentiometers.

SATELLITE CARD CAGES: (Refer to Figures 8 & 9)

Satellite Micro Board #408110

This board includes an M68HC12A4 micro-controller ("uC") and the Ethernet interface. The uC controls up to six satellite boards of any type-- collecting and/or distributing data to/ from the Main CPU Controller. It also includes A/D inputs for remote sensors and can control an optional Chamber MIDI board.

This board has an Address DIP switch that must be set to a unique binary number for each satellite cage. These addresses range from 00000000 - 11111111. These are set properly at the factory during initial set-up and test. However, should it ever become necessary to replace or swap one of these boards, these switch settings must be matched exactly.

Input Board #408111

These are used for keys, pistons, expression and misc. control inputs. Each of these boards has 85 inputs arranged for a standard Peterson 61 note keying cable (common positive feed provided) as used with Master Touch II™ keyboards and Peterson Modular Key Contact Rails. The other inputs are typically used for up to 24 piston or shade inputs. The 61 note input can be converted to a 32 note input (for pedal) via an adaptor. When configured for 32 notes with the adaptor there are also three groups of 16 inputs that can be used for expression and/or toe stud contacts. The input connectors are "Molex" type 90° wafers on .156" centers that will accept Peterson "Wire Wrap" connectors, standard Peterson Output Connector Boards or Peterson "Quick Punch™" IDC (insulation displacement or "punch down") adaptor boards. The standard inputs are for positive DC keying with an 11-18 VDC range.

Stop Action Controller Boards #408112

These boards include stop "sense" inputs and on/off coil drivers required for interfacing to stop action magnets (draw knobs, rockers or tongue tabs). Each board has capacity for 24 stops. The driver outputs use two sections of a UDN2987 driver in parallel which provides the capacity to drive 20 ohm coils (1 Amp intermittent).

Note: Any unused sense inputs could be used for miscellaneous control inputs.

Output (Driver) Boards #408131 (standard) and 408132 (high current)

These boards provide parallel DC outputs to drive magnet loads. There are two versions; the "standard" version for 40

Ohm loads and the "high current" one for 20 Ohm loads. These are similar except the 20 Ohm version uses surface mount technology discrete transistors instead of UDN2987 driver ICs. Each board type has its own ID number, so the system can distinguish between the two types. Both boards have a capacity of 80 outputs arranged in 6 groups of 12 per group (6 octaves), plus a 73rd (top note) and a group of 7 outputs intended for stop control or misc. outputs.

The output connectors are "Molex" type 90^{O} wafers on .156" centers that will accept Peterson "Wire Wrap" connectors, standard Peterson Output Connector Boards or Peterson "Quick Punch^{TM}" IDC (punch down) boards.

CONTROL DISPLAY UNIT (CDU) #408115 (Refer to Figure 11)

The CDU assembly is the user interface/ control panel. This assembly includes a 4 line by 20 character vacuum florescent (VF) display that provides a bright, crisp display which is easily viewed from any angle-- even in bright light. The push buttons and rotary data knob are used to control all of the organ's functions through the use of easy to follow menus and prompts.

SECTION D - MOUNTING AND WIRING

INSTALLATION OVERVIEW

When a complete ICS-4000^{TM} pipe organ control system is purchased from Peterson, the Main and Satellite sub-systems will be provided to you with nearly all of the wiring already done. Any connection not already made will be clearly identified with wiring charts for each Satellite Cage in the system's documentation packet. Our ability to interface complete systems with the rest of the organ is usually only limited by a lack of complete or accurate information provided to us. When some equipment from another manufacturer is being used, or in the case of rebuilds where parts of the original console are being reused, we will make every effort to provide “our part” of the job in a way that is most convenient for you to connect to other existing components.

Following is a summary of the steps required to install, wire, and test the ICS-4000^{TM}. You will likely find that many of these steps have already been completed when the ICS-4000^{TM} is purchased along with other Peterson products. Each of these procedures is explained in detail later in this manual. After carefully unpacking the ICS-4000^{TM} and checking for any obvious shipping damage, proceed as follows:

1. Select a suitable location and mount the ICS-4000^{TM} Main Cage, Satellite Card Cage(s), and any optional equipment.
2. Mount any control panels/ displays such as the ICS-4000^{TM} Control Display Unit, MIDI Port Panel Assembly and Bar Graphs or Tutti Select Panel if these have been purchased.
3. Make all necessary Ethernet wiring connections with the supplied "CAT5/ RJ-45" modular cables from the Main Micro (CPU) card #408101 and the console Satellite Card Cage(s) to the console's Ethernet Switch. See Figures 3, 4, 6 & 8. Be sure that the "Out" terminal of one cage connects to the "In" terminal of another cage.
4. If the ICS-4000^{TM} is being installed in an organ that uses Peterson Master Touch II^{TM} keyboards or Modular Key Contact Assemblies, install the supplied keying cables from the keyboards to the console Satellite Input Boards #408111. (Refer to the supplied wiring chart(s) and Figures 8 & 9.)
5. Wire expression shoe contacts to the expression inputs on the pedal division Input board.
6. Wire all stop controls and pistons that will be used with the ICS-4000^{TM}. This includes stops or pistons that will be used as MIDI presets to send patch changes, and also the organ's “regular” stops and pistons. (Refer to the supplied wiring chart(s) and Figures 8 & 9.)
7. Make all necessary organ rectifier connections to the Satellite Card Cage(s) and to the Power Supply Board #408103 in the Main Cage. (See Figure 6 & 8.) Be sure to observe polarity when making these connections.
8. Wire the organ's On/Off (power) switch to the "SW1" & "SW2" terminals on the Power Supply Board #408103 located in the Main Cage (See Figure 6).
9. Wire the DC Class II ("constant") supply to the Power Supply Board #408103.
10. Plug in the crescendo shoe's modular cable into the Power Supply Board #408103.
11. Connect optional MIDI extender cables from the MIDI Port Panel to the ports (MIDI sockets) on the Power Supply Board #408103 and then from the panel to a sound module or synthesizer.
12. Plug a " PS-2" cable from the CDU connector on the CPU Board #408101 (in the Main Cage) to the CDU #408113.
13. Plug in the "CAT5/ RJ-45" modular main cable from the CPU Board #408101 (in the Main Cage) to the chamber's Ethernet Switch.
14. In the chamber, wire the chest cables, stop controls and expression controls to their

respective pins in the chamber satellite board(s) as indicated by the supplied wiring chart(s).

15. Make all necessary organ rectifier connections to the chamber Satellite Card Cage(s) and to the chest returns. Be sure to observe polarity when making these connections (chest returns must be negative).
16. Wire the chamber rectifier (if used) and blower contactor(s) to their respective control outputs on the chamber hub's Chamber Interface.
17. Follow the Initial Test Instructions to verify basic operation of the system.

A troubleshooting guide will be found later in this manual, which should be useful should any trouble occur. If you have difficulty with any of the above procedures, or have questions after reading the appropriate section of this manual, please contact the factory for assistance.

IMPORTANT INSTALLATION NOTES

1. Caution: Do not use ordinary 8 circuit telephone modular cables as substitutes for the Ethernet cables. Use only Category 5 cable and RJ-45 connectors.
2. Organ rectifier feed and return wires (positive and negative) must be an appropriate size given the circuits within a particular card cage. A cage with Input Boards requires only very little current, however, one with Stop Action Controller Boards or Output Boards may require up to 30 amps. If you are uncertain of a proper wire size, refer to the "Organ DC Wiring" section later in this installation manual.
3. Most input/ output connections (keys, pistons, stops, chest magnets, etc.) can be wired with #26-28 AWG wire. Other size wires are required in some cases (such as feed/ return wires) and these will be clearly called for in the following instructions.

DETAILED MOUNTING AND WIRING

Main CPU Cage

Select a suitable location in the console to mount the ICS-4000™ Main Cage. (Refer to Figures 5 and 6.) Typically, this can be mounted on the key desk or behind the knee panel. When positioning this cage, keep in mind the routing of cables to allow easy access to the top of the cage for wiring, viewing of LEDs and for circuit board removal. Secure the Main Cage using four #8 x 1/2" screws.

Power Supply

Connect organ rectifier feed wires to the plug-in barrier terminals on the ICS-4000™ Power Supply Board (See Figure 6). Observe the polarity as marked. ***Reversal of the polarity will cause damage****.* Connect positive to the “ORG+” terminal and negative to the “NEG” terminal. The size of these feed wires should be at least #18 AWG.

The organ rectifier voltage should be 11-18 VDC. ***This voltage must not drop below 9 VDC*** during normal operation. This would include any ripple at full load conditions. A Peterson “Power Supply Fault Detector” can be used to test the rectifier voltage. Also refer to the "Organ DC Wiring" section later in this manual.

The supplied plug-in Class II 12VDC power transformer wires to the "Constant" and "Common" terminals on the Power Supply Board's plug-in barrier terminals. A clear-coated pair of wires with lugs on the end will be provided to connect the DC transformer to these barrier terminals. This Class II transformer ***will need to be plugged into an unswitched outlet***. Do not plug in at this time.

Connect a wire from the "Earth" terminal of the plug-in barrier terminal, using at least a #18 AWG wire, to a suitable earth ground. This earth ground can be a properly grounded electrical conduit, water pipe or ground stake.

Connect the organ's On/Off switch to the "SW1" and "SW2" terminals on the Power Supply Board's plug-in barrier terminals.

The organ's crescendo shoe plugs into the RJ-11 modular jack on the Power Supply Board (#408103). This is an analog input which requires a potentiometer that is controlled by the shoe. Complete crescendo shoes (#405313) or potentiometer assemblies (#404934) that can be attached to existing shoes are available from Peterson for this purpose.

If the optional MIDI extender cables/ panel (#408173 or #408164) were purchased, mount this panel in a convenient location (such as under the key desk or on the console's back or side, near the floor). Route the cables from this panel to the Power Supply Board (#408103) and plug into their corresponding MIDI jacks.

Four DC control outputs are provided on a plug-in barrier terminal on the Power Supply Board (#408103). These outputs are positive organ voltage switched with the system's power and can be used to control optional equipment such Auxilliary Power Supplies or DC relays to control other devices. Connect each device (as required) to the "Out 1-4" terminals and to the "-Common" terminal.

For a single switched AC outlet a Peterson Single Outlet Control Box (#404308 or #404320) can be used. The Organ "+" and "-" terminal of this Control Box wire to one of the DC control outputs and the "- Common" terminals (respectively) on the Power Supply Board (#408103). See Figure 8. Be sure the control box line cord is plugged into an UNswitched outlet.

If multiple switched AC outlets (up to 4) are required a Peterson (#404465) Console AC Control Box can be used. (This control box also provides four un-switched outlets.) An advantage of using this control box is that it will also provide the required Constant 12 VDC, thereby eliminating the need for the plug-in Class II type 12 VDC power transformer. Refer to Figure 8 for details of wiring this box. Be sure the control box line cord is plugged into an unswitched outlet.

Seven additional "analog" inputs are provided on a plug-in barrier terminal on the Power Supply Board (#408103) that can be used for expression shoes fitted with potentiometers, or for voltage or temperature sensors. These can be wired (see Figure 6) using the "+COM", "-COM" and Inputs "1-7". The use of these inputs must be defined in the system programming.

Connection of the Ethernet Cat 5 cables will be covered in the following section.

Console Satellites Cages

Select a suitable location to mount the ICS-4000™ Satellite Card Cage(s) in the console. (Refer to Figures 8 and 9). Typically, these can be mounted on the key desk or behind the knee panel. Keep in mind when positioning these cages the routing of cables, to allow easy access to the top of the cage for wiring, viewing of LEDs and for circuit board removal. Secure each Satellite Cage using four #8 x 1/2" screws.

Connect organ rectifier feed wires to the Test & Power junction (#400480 or #400480FD). (See Figure 8). Observe the polarity where the red wire is positive and the black wire is negative. ***Reversal of the polarity will cause damage***. Connect positive to the “ORG+” terminal and negative to the “NEG” terminal on the Test & Power junction. (These feed wires are attached within the Satellite Cage at the factory and their size may vary depending on the boards within each cage. Typically, #10 AWG (stranded) wire is used.)

Keyboards

If the ICS-4000™ is being installed in an organ that uses Peterson Master Touch II™ keyboards, Modular Key Contacts or Pedal Key Contacts, install the supplied keying cables from the keyboards to the console Satellite Input Boards (#408111) for their respective manual inputs. (Refer to the supplied wiring chart(s) and Figure 9). Alternately, existing key contacts can be wired to Peterson "Wire Wrap" connectors, Input Boards, or Quick Punch boards. A positive common feed wire is provided next to the highest note's connector terminal.

Pistons

Pre-wired systems or organs that use Master Touch II ™ keyboards with pistons installed will be supplied with cables that include feed wires from each keyboard's thumb pistons or toe studs, which can simply be plugged into their respective piston inputs (refer to the supplied wiring chart(s) and Figure 9). Alternately, wire each piston or toe stud to its respective input, typically located on the same Input Board as its associated keyboard. This includes pistons that will be used as MIDI presets to send patch changes, reversibles, set, cancel, etc.

In some cases one input may connect to two contacts (i.e. General thumb pistons and toe studs, or divisional cancel thumb pistons and divisional nameplate switches.)

Expression

If Peterson expression shoes (#405306, 405309 & 405310) or expression contact assemblies are used, plug the supplied cable from the shoe to the expression inputs. These cables include the required positive feed wire. Alternately, wire expression shoe contacts to expression inputs. The expression inputs will all be on the Pedal Key/Piston Input Card pins #36-60 except on organs having too many expression contacts to fit on this number of pins. Refer to the supplied wiring chart(s).

Stops

Wire all stop controls that will be used with the ICS-4000™ to their stop (sense), on coil, and off coil pins on Stop Action Controller boards. Optional custom wiring harnesses available from Peterson simplify this job. Refer to the supplied wiring chart(s) and Figures 8 & 9.

Miscellaneous Controls

Some additional controls that may need to be connected are: tutti select buttons, sustain switch, signal control inputs, lighted piston outputs, etc. If these were specified at the time the ICS-4000™ was ordered, these controls and their wiring locations will be included in the supplied wiring charts. If any of these were not specified, contact the factory to request a revised wiring chart and required software configuration change.

Console Ethernet Cables

The console Ethernet cables interconnect all of the console Satellite Cages and the Main CPU Cage for local data communications. Make all necessary Ethernet wiring connections, with the supplied "Cat.5/RJ-45" modular cables, from the Main Cage CPU Card #408101 and the Satellite Cage(s) to the console's Ethernet Switch (similar to an Ethernet "hub" but with greater selective routing capabilities). See Figures 3, 4, 6 & 8.

Caution: Do not use ordinary 8 circuit telephone modular cables as substitutes for the RS-422 Ethernet cables. Use only Category 5 cable and RJ-45 connectors.

Control Display Unit (CDU)

Select a suitable location on the name board or stop jamb to mount the CDU. (Refer to Figure 1). Using the template (Figure 1), mark and then carefully cut the required opening. Remove the nuts from the two mounting studs (extending through the back) so that the CDU and its back cover can be separated. Mount the back chassis (cover) in the cut-out using four #6 x 1/2" screws. Remove the protective backing from the adhesive transfer tape (on the back of the front panel), place the CDU in the chassis opening, carefully align and then firmly press into place. Re-install the two # 6-32 nylon thumb nuts or KEPS nuts on the back of the chassis to gently secure the CDU assembly in place, but DO NOT OVERTIGHTEN THESE NUTS. Finally, plug a PS-2 cable into the CDU's receptacle-- route this cable back to the Main Cage and plug it into the CDU receptacle on the CPU Board.

Main Cable (Console to Chamber)

The main cable in an ICS-4000™ is a single Ethernet Cat 5/ RJ-45 cable. Where required, two or more main cables may be run to different chamber locations. An extension from one chamber location to another can be accommodated as well. Main cables may be up to 325 feet long. For distances greater than that, an additional repeater/ hub will be required. In this unusual situation, please consult the factory for assistance.

No additional feed wires or commons are required between the console and chamber, assuming that separate power supplies (organ rectifiers) are utilized for powering the console and chamber equipment. The main cable is transformer-isolated at both ends, which provides reliable data communications even if the supply and/or ground potentials are significantly different. All of the necessary control circuits between the console and chamber are carried in the data transmission lines to the chamber, including chamber rectifier and blower control circuits.

The main cable(s) plug into the console's Ethernet Switch and into the chamber Ethernet Switch (Refer to Figures 3 & 4). The main cable(s) should be routed through conduit wherever possible. To simplify pulling the main cable, the RJ-45 connector can be snipped off. Then an optional punch down connector can be used to re-terminate the cable end (See Figure 4).

If multiple console connection points are required, some special precautions must be observed in order to provide reliable data communications from each point. The simplest way is to use another Ethernet Switch at a centrally located point. Run a Cat 5/ RJ-45 cable from each connection point to this Ethernet Switch and run the Main cable to the chamber from the output of this Switch. The console cable (or each terminating point) will need "gender menders" (adaptors to connect two male ends together or use punch down blocks (See Figure 4).

Various “ruggedized” (reinforced) and other unpluggable junctions for Cat 5 cable are available from Peterson to facilitate a neat and convenient disconnectable cable system. Please contact Peterson customer service for information about what is currently available. In the event that you or a local contractor are providing the network cabling, it is essential that the integrity of all connections be tested with proper test equipment before use.

Chamber Ethernet Switch

Select a suitable location within the chamber to mount the Ethernet Switch. Note: A Class II transformer (with a standard 8' cable) or Ethernet Hub Power Supply Board that runs off the organ rectifier will be required to power this Switch.) The Switch is used as a distribution point for the Cat 5/RJ-45 cables to the chamber Satellite Card Cages and/or to other chamber locations. The standard Ethernet Switch has 8 ports and will source 7 Satellite cages. Ethernet Switches with 12, 16 or 24 ports are optionally available.

Chamber Satellite Cage(s)

Select a suitable location within the chamber to mount the ICS-4000™ Satellite Card Cage(s) that contain the pipe/chest drivers. (Refer to Figures 8 and 9). Typically, these can be mounted on a wall or a panel fastened to chest supports. When positioning these cage(s), keep in mind the routing of cables, allowance for easy access to the top of the cage for wiring, viewing of LEDs and for PCB removal. Secure the Satellite Cage using four #8 x 1/2 screws.

Connect organ rectifier feed wires to the Test & Power junction (#400480). (See Figure 8). Observe the polarity where the red wire is positive and the black wire is negative. ***Reversal of the polarity will cause damage***. Connect positive to the “ORG+” terminal and negative to the “NEG” terminal on the Test & Power junction. These feed wires are attached within the Satellite Cage at the factory and their size may vary depending on the boards within each cage. Typically, #10 AWG (stranded) wire is used. All driver outputs are positive feed, which require negative returns on all chest magnets, stop magnets, etc.

Chests

Up to six Output Boards within a chamber Satellite Card Cage each have 80 outputs (6 octave groups plus one 8 circuit group to provide note 73 plus seven for stop or miscellaneous use), for a total of 480 output circuits. If one were to consider the first output of the first driver as #1 and the first output of the second driver as #81, etc., all of the outputs could then be considered to be one long driver. Any given chest will use as many outputs as it requires and if a particular chest is more than 73 notes it will ordinarily "wrap" to the next driver-- or continue using the "long driver". Refer to the supplied wiring charts for assignments of driver outputs.

Outputs to the next chest will, wherever possible, be arranged to begin on the next full group (octave) so that all C notes are the first note in a twelve note group. This usually leaves unused outputs between chests. These outputs may be assigned to stops, expression or miscellaneous outputs where it makes sense to minimize wasted outputs. Also, in some cases, the top notes of all ranks may be assigned to one group. This may seem awkward for wiring, but is usually done to save the cost of additional drivers that would be incurred to put them in order. (Doing so may require another driver board or even an extra Satellite Card Cage). Proper labelling of each pin as to its function prevents confusion.

For those who prefer chest outputs to be organized more conventionally, optional junctions can be supplied that will be pre-wired from the Satellite Output Boards at the factory. These junctions will be supplied with output connectors or Quick Punch boards for the chest wiring.

Stops

Stop control outputs for straight or Pitman chests, tremolos, etc., wire from their Satellite Output Board terminals to their respective locations in the chamber. If pre-wired junctions are supplied, these stop controls will be located on their own junction (along with expression).

Expression

Expression control outputs wire from their Satellite Output Board terminals to their respective swell shade operator input pins in the chamber. If pre-wired junctions are supplied, these expression controls will be located on their own junction (along with stops).

Miscellaneous Outputs

Miscellaneous control outputs wire from their driver output terminals to their respective locations in the chamber. If pre-wired junctions are supplied, these miscellaneous controls will be located on the junction along with stops and expression.

PRECAUTIONS

Contacts for stop sensing and pistons on older organs that are being rebuilt may be corroded and/or pitted from prior use with unsuppressed magnets. We do our best to make our ICS-4000™ work with poor contacts, but sometimes it becomes necessary to scrape and clean, or preferably replace, the contacts for improved reliability.

Transient Suppression is built into the ICS-4000™ to protect the solid state components and to keep unsuppressed transients from other sources from interfering with its operation. We have found that on some organs where installers have chosen to connect controls without going through the solid state switching, that unsuppressed magnets (such as add-on chime keyboards or volume controls) can cause erratic behavior to occur. This is due to the capacitive coupling of these unsuppressed transients in the cables. It is highly recommended that all controls go through the solid state system to avoid these problems. If this is impossible, some suppression, such as flyback diodes, may have to be added to the interfering source. If you suspect this type of problem we will help you determine your requirements.

Some electromagnet coils manufactured by Kimber Allen used a "metal oxide varistor" ("**MOV**") to suppress reverse voltages of these coils. *These devices are not sufficient to suppress the reverse voltage when used in connection with solid state components*. If there is any question as to whether the device is an MOV or a diode, remove one end from the magnet and check the device with an Ohm meter. Use the RX1000 (or closest scale to it), calibrate the meter, and measure the device with leads across the device one way, then reverse the two meter leads and measure the other way. If it is a diode it will read low resistance one way and high resistance (or open) the other way. If it is an MOV it will read the same (high) resistance both ways. If the MOV device is used on magnets wired to the "sense" inputs, diodes must be added to provide the needed protection (the MOVs do not have to be removed). Sense Protection Boards are available from Peterson.

Cabling of Stop Action Controller Board pins to "on" and "off" coils should, wherever possible, be in separate bundles from the sense and piston wires. These separate bundles can be run next to each other as long as they are not tied tightly together. This practice helps prevent capacitive coupling from the high current outputs to the low current inputs. This is especially important when using long cables, such as when cables are run to a remote location.

Errors in wiring order of "on" and "off" coils and sense wires are not uncommon. It is extremely important to match up #1 "on", #1 "off" and #1 "sense". Be absolutely sure of the wiring order to avoid grief later.

Testing of wiring with a "buzzer" should not be done unless all connectors are unplugged and not connected to solid state components. "Buzzers" can have reverse voltages (flyback voltages) of 100V or more, just like other magnets, but in a buzzer, these voltage transients occur at the "buzz rate" (frequency). This can destroy solid state parts instantly. A safer method is to use a low voltage continuity (lamp) tester or Ohm meter.

The Conductor Sizes of the wires used for connecting organ positive to the ICS-4000™ cages, and organ negative to the stop action magnets, are important. Bear in mind that the positive (+) conductors to the ICS-4000™ cages that include the Stop Action Controllers must be of sufficient size to carry the feed current to all the associated stop action magnets simultaneously. Likewise, the negative (-) conductors from the on and off coil returns must be of sufficient size to carry return current from all stop magnets simultaneously.

Each Stop Action Controller Board will draw up to 17 Amps when operating on a 15 Volt power supply, assuming that each of its 24 on or off coil circuits is used to drive a 21 Ohm coil. Every two adjacent boards in a Satellite Card Cage share a single screw terminal for connecting positive feed wires and, similarly, for connecting negative return wires. Under these criteria a #10 wire or larger should be used for both the positive feed to the Satellite Card Cage and negative return from the stop action magnets. The negative to the ICS-4000™ Satellite Card Cage will not draw more than a few Amps (continuous) so a #16 wire is adequate for this purpose. Individual coil wires will draw approximately 1/2 Amp, so #26 wire is all that is required for these. These wire sizes apply to the short runs within the console only. Note that 10 feet of #10 wire with 60 AMPS flowing through it will drop about 0.6 Volts. Wire size should be increased for longer runs. Bear in mind that an increase of 3 wire sizes (for example 10 to 7AWG) will reduce the resistance and the voltage drop by half.

Aluminum Wire and aluminum lugs are **NOT** recommended for use in feed and/ or return conductors. This applies to any brand or type of combination action or relay. Aluminum wire or lugs that are bolted or screwed to a buss or junction will flow over a period of time and eventually become loose. When aluminum must be used, be sure to use terminating lugs designed for aluminum wire that, when properly installed, minimize the flow problem.

Soldering of wires to connector pins is important except where Peterson Quick Punch™ IDC (punch down terminal) boards are utilized. Wire wrapping alone is not recommended. **Under no conditions should acid flux be used**. We recommend using 60/40 rosin core solder. (Rosin flux may be brushed on if care is taken to avoid getting flux into a connector where contact is made. If magnet wire (or other coated wire) is used be sure enough heat is used to break down the insulation and that the solder is not just covering the wire, but bonding it to the pin. So called "No-Korrode" solder paste is in fact extremely corrosive, and should <u>never</u> be used anywhere around the electrical parts of an organ.

Organ Power Supplies (rectifiers) have an important part to play in how well the completed installation will operate. In general the organ rectifier(s) should be capable of supplying enough current to operate all the stop action magnets and the chest magnets, etc. The nominal voltage should be 11-18 VDC. At no time should the organ rectifier output voltage drop below 8.5 VDC or exceed 25 VDC during surges caused by peak demands. These surges and transients usually cannot be measured with a voltmeter. If you suspect this to be a problem, please contact Peterson's customer service department. (A Power Supply Fault Detector, available from Peterson, detects voltage outside the normal, safe operating range of Peterson equipment and most other solid state equipment for pipe organs.) The minimum voltage under full load can best be measured with a voltmeter while reiterating the general cancel button. The use of Inteli-Power™ switch-mode-type power supplies, which are distributed by Peterson, is recommended.

Rectifiers of Inadequate Size will cause the stop actions to appear sluggish, slow, forgetful, or dead. This is most apparent on general pistons or cancel. To approximate the capacity of the rectifier required, multiply the total number of stops by 0.75, then add 10% of that number to it. Example: 50 stops times 0.75 = 37.5 + 3.75 = 41.25 Amps. This is the current required for the combination action only. If the organ has "all-electric" chest actions, considerably more current may be required. (See "The Organ Power Supply and Feed Wire Work Sheet" later in this section.)

Some Organ Rectifier Designs are not as good as others, and may not be suitable for use with the ICS-4000™. This is due to the brief high peak currents that are required to work all the stop action magnets (coils). Older rectifiers that use **Selenium Rectifiers** have a higher resistance, which can cause severe voltage drops. These rectifiers (diodes) can be identified by their appearance. Selenium rectifiers are made with many plates stacked and bolted together and are sometimes referred to as bread slicers. Also, **Rectifiers That Use a Choke** filter in their output are less desirable. The choke resists the flow of current at the peak demand, causing a momentary voltage drop. Also, when the load is removed, the choke's magnetic field collapses and induces a voltage greater than the normal output. This can be observed by watching the brilliance of any pilot lamp. The lamp will dim at the moment of demand and flash brighter when the load is removed.

Generators or Motor-Generator Sets often work fairly well. However, a large value capacitor may have to be added to eliminate hash and other transients (See "additional capacitors"). Also, because of the slow rate at which the voltage builds on start up, <u>an additional relay may need to be connecte</u>d on the input to the solid state system that switches the voltage to the solid state when the pull-in voltage of the relay is reached (typically 9 VDC for a 12 VDC relay). This may be required because some circuits rely on the rising voltage to reset. If this rise is too slow the reset does not occur.

The Most Suitable Rectifiers are modern switch-mode power supplies such as the Inteli-Power line that is now distributed by Peterson, and the type previously manufactured by Peterson called the P-30. The Inteli-Power models offer high current capacities in small, lightweight, cost-effective packages and are fully protected against overload conditions. Inteli-Powers will start under loaded conditions. The Peterson P-30 used a constant voltage transformer and capacitor filters. The peak demand current is supplied by the energy stored in the capacitors, while the transformer automatically adjusts itself to maintain a steady voltage. Transients generated elsewhere in the organ are also filtered by the output capacitors. This type of design can be severely overloaded (even short circuited) without damaging the unit. Astron "linear" Power Supplies are also suitable. These have solid state regulators that are quite stable, and have over-current protection. The only draw back is if the load is too great, the Astron will not start or may shut down during use. Ratings are given in terms of peak and continuous current. If you choose an Astron power supply, be sure to buy one with the continuous rating that meets the needs of the organ.

Also, greater peak demands can be supplied with the use of **Additional Capacitors**. (A good rule of thumb is 1000 MFD per stop). The use of additional capacitors with older rectifier designs may be helpful; however, interaction between the choke (inductor) and the capacitor(s) can cause ringing in the output voltage (pilot lamps would flutter). This kind of situation can cause malfunctions in the ICS-4000™ and other solid state control systems.

Location of the Rectifier and the size of the conductors from it to the ICS-4000™ are also important. Too small a conductor for too long a run can cause voltage drops that will adversely affect performance. The "Organ Power Supply and Feed Wire Size Work Sheet" (see below) can be used as a guide for selecting the proper feed wire conductor sizes.

Stop Action Magnets manufactured by the Syndyne Corp. may act erractically if the polarity of the stop action magnet does not match the polarity required by the combination action. The SAM polarity is determined by the termination of the coil wires and the direction of the magnetic poles of the permanent magnets. When the wrong polarity is used, residual magnetism on the pole magnet may pull in the reed switch when the stop is turned off. Magnetic fields of adjacent SAMs may also affect the reed switch and cause erratic operation. Therefore, it is important to specify the proper polarity when ordering stop action magnets. Do not reverse the polarity of the coil common unless you reverse the coil wires, or another alternative would be to use inverters. When Peterson stop controls are used, the proper on and off coil common polarity (negative) must be ordered.

ORGAN POWER SUPPLY AND FEED WIRE SIZE WORKSHEET

This worksheet is being supplied as an aid in determining the current required by the stop action magnets and chest magnets. We advise using this worksheet to assure proper operation of the ICS-4000™ combination action and relay. Our experience has shown that most combination action and relay problems are the result of inadequate rectifier and/or feed lines.

1. To determine the current required for the stop action magnets, fill in the blanks and perform the simple arithmetic as shown in the example organ, which has pedal, great, swell and coupler stops totaling 50.

Example

Total Number of Divisions .... = 4

Total Number of Stops .... = 50 x 3/4 = 37.5

Total Amperes (SAMs) .... (Divisions + 3/4 Total Stops) = 42

Worksheet

Total Number of Divisions .... =

Total Number of Stops .... = ________ x 3/4 =

Total Amperes (SAMs) .... (Divisions + 3/4 Total Stops) =

2. To determine the current required by the chests, take the total number ranks and/or primaries that are electro-pneumatic, and multiply by 1.5. Multiply by 3 for ranks that have "all-electric" type valves. The sum of these two is approximately equal to the current required by the organ chests in normal use.

The following example has two electro-pneumatic primaries and eight ranks of "all-electric" type chest magnets.

Total Number of Electro-Pneumatic Ranks .... 2 x 1.5 = 3

Total Number of "Electric" Type Ranks .... 8 x 3 = 24

Total Amperes For Chests .... = 27

Total Number of Electro-Pneumatic Ranks .... ________ x 1.5 =

Total Number of "All-Electric" Type Ranks .... ________ x 3 =

Total Amperes For Chests .... =

3. The required capacity of the organ power supply (rectifier) is the sum of the totals from 1 and 2.

Total Amperes (SAMs) .... = 42

Total Amperes For Chests .... = 27

Total Amperes Required .... = 69

Total Amperes (SAMs) .... =

Total Amperes For Chests .... =

Total Amperes Required .... =

4. The proper wire size for feedlines from the rectifiers can be determined by using the following nomograph. (This graph is based on keeping the voltage drop of the combined feed and return wire to 1 volt or less.)

Total Amps	**Wire Length in Feet**	**Wire Gauge**
		12
100A		
		10
80A		
		8
	10'	
	15’	
60A		
		6
40A		
	50'	
		4
	75’	
30A		
	100’	
		2
	200’	
20A		1
		0
10A		
		00

If existing feed lines must be used and do not meet the above recommendations, refer to "additional capacitors" in the previous section.

5. Some rectifiers, such as older selenium types and choke output types may not be adequate even if rated at the required current (amperage). The higher resistance of the selenium diodes and the series inductance of chokes actually cause momentary drops in voltage when the current is at its peak demand.

It is recommended that these type rectifiers be replaced when a new ICS-4000™ is being installed. (The rectifier types mentioned above can be tried and will not cause damage, but if problems are experienced, such as forgetting, flipping stops when the power comes on, or incomplete canceling, the rectifier should be suspected as the cause.) In some cases, the inadequacies of the rectifier can be overcome with the use of a large value storage capacitor.

6. The use of large value storage capacitors, in many cases, can effectively increase the capacity of rectifiers and feedlines, by supplying the current required for peak demands of short duration.

As much as two times the capacity can be achieved for intermittent loads such as working the stop action magnet coils of a combination action. For constant loads, such as chests, the capacity **cannot** be effectively increased.

Where storage capacitors are used, their minimum capacitance and their placement must be carefully determined. A good rule of thumb for determining the value of the capacitor is 2000 uF per amp, or about 1000 uF per stop. (Our example organ of 50 stops would require 50,000 uF). The voltage rating of these capacitors must be greater than the working voltage. (We recommend 20-25v rating, or higher, for use with 12-15v organ supplies.) Be sure to observe polarity when wiring (+ to positive, - to negative). These capacitors should be mounted as close to the load as possible and wired with a wire gage sufficient to handle peak demand current. In our example organ, if we used a 60,000 uF capacitor to work the combination action, we would mount it in the console, and wire it with #10 wire to the junction points that feed the ICS-4000™ satellite (with the Stop Action Controllers) and the stop action magnets.

If you have any questions about the proper size of rectifiers, feedlines or storage capacitors, give us a call at 1-800-341-3311 and we will be pleased to help.

SECTION E - CONTROL DISPLAY UNIT (CDU) OPERATION

OVERVIEW

The CDU is the user/ installer interface to the ICS-4000. There is a 4x20 character vacuum florescent display (VF) used to show all text/ numeric data for the system; five momentary push buttons (two of these buttons are permanently labeled and have LED indicators above them); and a digital rotary knob that together are used to access and enter data. (See Figure 1, front panel drawing at the end of this document.) The main operational screen, called the Home Screen, initially shows the current Organist Folder™ name and the memory level within that Organist Folder; the current crescendo memory level and crescendo shoe position; lock-out status, and clock. The status of the transposer, MIDI on/off, piston sequencer on/off, and "songlist" on/off will be indicated on line three of the Home Screen when these features are active. Other screens (complete lines of text display) for the combination action, piston sequencer, MIDI functions, clock/timer, etc. may be accessed from this opening screen through various user menus.

The bottom line of the CDU display always defines the current usage of the three dynamic push buttons located directly below the VF display.

The rotary data knob is used to change values, characters and/ or select names. Pressing the "ENTER" dynamic button then enters the selected variable and steps the cursor to the next variable or screen. Pressing a button dynamically labeled "HOME" always returns to the Home screen. Pressing a button labeled "BACK" returns to one screen previous.

Please refer to the ICS-4000™ OPERATING INSTRUCTIONS for complete details on the use and operation of the normal operating screens.

SECTION F - DIAGNOSTICS AND TESTING

INITIAL TEST

PLEASE READ THIS SECTION BEFORE APPLYING ANY POWER!

It is suggested that once you have installed and wired your ICS-4000™ you use the following procedure for testing its operation.

1. First temporarily remove all chest output connectors from their Output boards in the chamber Satellite Card Cages, and unplug the constant voltage class II transformer (or disconnect the wires from the "Constant Voltage" screw terminals) and disconnect the organ positive wire from the Power Supply board (#408103) in the Main CPU Cage. This removes all power from the Main CPU Cage. The organ power to the Satellite Card Cages should be disconnected in the chamber by temporarily removing the feed wire from the rectifier. The organ power to the console satellites can remain connected.

2. Turn on the organ rectifier and check to see that the green power light on the "Test and Power Junction" is illuminated and that indicators on the console Satellite Card Cages also come on during this

test. An illuminated power light indicates that a voltage of the proper polarity is applied to the ICS-4000™. ***IF IT DOES NOT LIGHT, REMOVE THE ORGAN POWER IMMEDIATELY,*** and confirm the polarity of the connections before proceeding. The following section entitled "LEDs" describes the operation of the various indicators on the Satellite Cage(s).

3. Next (with the power off), plug in the constant voltage class II transformer (or connect the wires to the "Constant Voltage" screw terminals and reconnect the organ positive wire to the Power Supply board #408103. Now turn the organ power back on and observe the LED Indicators on the ICS-4000™ Main CPU Cage boards, at the console; there should be some lights lit on all of the cards. (None of the "Change" lights should be on at this time.) If no LEDs are lit, proceed to the Troubleshooting section.

4. Now in the chamber test each note (magnet) of each rank by energizing their chest magnets in the following manner. Using a test wire connected to organ positive, apply power to each chest connection on each output connector while the cable is still removed from the driver(s). Notes which do not play from this point have defects within the chest cable, magnet, chest, pipe, etc. These defects should be repaired before proceeding. The output connectors may be plugged back into the Output Boards ***after*** this test. ***Note that the only a lead from the yellow binding post of a Test and Power Junction with Fault Detector, part #400480FD, should ever be used to test-key a pin that is connected to a UDN2987 driver IC on an Output board. Do not apply Organ Positive from any other source directly to the output side of UDN2987 driver chips, as damage may occur.***

5. The organ feed wire to the chamber Satellite Card Cages can be reconnected with the power off. Turn the organ power back on and observe the LEDs on the chamber Satellites. Some should be lit.

6. The ICS-4000™ is now ready to test from the console. Play each note of every stop for all of the manuals. Write a list of any problems that may be encountered. This will aid in determining whether the cause is in the keys, stops, couplers, unit stops, etc.

Bear in mind that dead or ciphering notes or stops may be due to contact or wiring defects. These can be confirmed or discounted by unplugging the appropriate key or stop connector from their respective inputs and keying directly on the input pin with a test wire connected to organ positive. If the problem is found to be in the ICS-4000™, repair assistance will be found in the Troubleshooting section.

LEDs

All of the circuit boards and/or assemblies within the ICS-4000™ have multiple LED indicators to aide in diagnosing any problems that may occur. These LEDs are color coded according to their use. Any indicators that should normally be illuminated (whenever power is on) are green. Any indicators that are conditional (on under certain conditions) are yellow (e.g. when a key is pressed). Any indicators that should never be continuously lit are red (e.g. Error/Warning).

Following is a listing of each ICS-4000™ circuit board, the name of each indicator on the board, its color and a brief description of its purpose.

Board / #	**Indicator**	**Color**	**Description**
Main CPU Cage			
~~			
Main Micro board			
#408101	Status	Green	CPU is running (& power on)
	Error	Red	Checksum, memory fault, bus fault (on CPU card)
	LAN	Green	Ethernet Carrier present
	Link	Yellow	Ethernet Data detected (transmit or receive)
	Floppy RXD	Green	Receiving Data (carrier) from floppy
	Floppy TXD	Green	Transmitting Data to floppy
	Floppy CHG	Yellow	Control, file, data changed status
	CDU RXD	Green	Receiving Data (carrier) from CDU
	CDU TXD	Green	Transmitting Data to CDU
	CDU CHG	Yellow	Control, VF data changed status

Power Supply board

#408103	Power	Green	Organ voltage applied
	Standby	Yellow	Constant voltage applied
	Alarm	Red	Error or fault on power supply board
	DC Out 1	Yellow	Outputting organ voltage
	DC Out 2	Yellow	Outputting organ voltage
	DC Out 3	Yellow	Outputting organ voltage
	DC Out 4	Yellow	Outputting organ voltage
	MIDI In	Yellow	Receiving Change Data
	Seq. Out	Yellow	Transmitting Change Data
	Inst. Out	Yellow	Transmitting Change Data

CDU

#408115	Status	Green	MCU Active (& power on)
	Change	Yellow	Control, VF data changed status
	Fuse	Red	Indicates open fuse
	Pstn.Seq.	Red	Front panel indicator (exception to color rule)
	MIDI	Red	Front panel indicator (exception to color rule)
	VF	----	Normally displays some text

Satellites

Satellite Micro board

#408110	LAN	Green	Ethernet Carrier present
	Link	Yellow	Ethernet Data detected (transmit or receive)
	STAn	Green	One per satellite card-- see below
	CHGn	Yellow	One per satellite card-- see below

Input board

#408111	Status	Green	MCU Buss Active & board being read
	Change	Yellow	Note, stop or piston changed status

Stop Action Controller board

#408112	Status	Green	MCU Buss Active & board being read
	Change	Yellow	Stop sense or coil changed status

Output board (Standard)

#408130	Status	Green	MCU Buss Active & board being read
	Change	Yellow	Output changed status

Output board (Hi Current)

#408131	Status	Green	MCU Buss Active & board being read
	Change	Yellow	Output changed status

Ethernet Switches

See data sheet supplied with the Ethernet Switch for details of its indicators.

TROUBLESHOOTING GUIDE

One of the powerful features of the ICS-4000™ is its ability to test itself and report problems via the Control Display Unit. Some problems with Ethernet data cables may be reported, but the ICS-4000™ will continue to work; sometimes with performance problems (slower response), but the system will be useable. Problems such as this should be repaired promptly because the problems may get worse and become more apparent.

Some of the things the ICS-4000™ runs self tests on are:

1. The data cable circuits in the console, the main cable, and the data cables in the chamber.
2. Missing or added circuit boards-- it knows when something has changed.

3. Memory problems including the main CPU's EEPROM, RAM and FLASH; also Satellite Microcontroller RAM.
4. Faulty driver ICs on Output boards and Stop Action Controller boards.
5. Stuck thumb pistons, toe studs or other controls.
6. Boards that have not been active (if it knows it's there, it should be doing something).
7. Sections of an Input or Output board that fail to respond.
8. Excessive data errors (checksum errors) or excessive delays in the data.
9. Optionally, DC voltages can be monitored in the chamber and console.

Therefore it is important to view the diagnostic messages whenever a tuning or service call is made. Refer to the diagnostic section on how to view these messages.

Other tests can be manually performed on the ICS-4000™. These tests include reading and displaying data about any inputs to the ICS-4000™ such as keys, stops, pistons, expression, etc. Simply enter the Diagnostic/Test Menu, select the desired test and manually operate the selected input device. For example: to test piston inputs, select that test from the menu and press each piston. The display will read out the piston name, number and Input board number/pin number of each piston as it is pressed. (Refer to the diagnostic section on how to enter this menu.)

Another feature of the Diagnostic/ Test Menu is the ability to simulate any input or output. By selecting a specific input or output and simulating it, one can further determine where a problem is occurring. For example, suppose the Zimbelstern fails to work from its reversible. The piston test (as above) shows the piston is being read into its input circuit. If simulating the output works the Zimbelstern, the problem is within the ICS-4000™. If not, it's time to go test in the chamber.

In some cases the problem may be in the organ wiring, a contact, a connector, or one of the circuit boards. Some effort to isolate the source of the problem could save time in troubleshooting the source of a problem. Usually this can be done by unplugging connectors, swapping connectors and/or boards and if necessary keying with a “hot” lead to help isolate the problem.

Some common sense and a little experimentation can isolate many problems in a very short time. Our experience has shown that very often problems are found to be mechanical in nature (i.e. contacts, connectors, soldering, crimps, magnets, etc.) These types of problems are usually quite easy to locate, with no special tools. A simple test wire or clip lead is all that's needed.

If a contact is the suspected problem, short across the contact with the test wire or clip lead. If it works the problem must be the contact. Alternately, the test lead can be connected to the feed voltage (organ +) and used to "key" (energize) the suspect circuit. This is often called a "hot lead". This method can be used to try various points to locate a problem. For example, suppose that a keying input is dead and shorting the contact does not work either. Using the "hot lead", key the input directly on the circuit board connector pin (not on the connector plugged onto it). If that works, the problem is between that input pin and the contact. Simply use the "hot lead" and key at each point (either side of connectors) working back toward the contact. It should not be difficult to find the break or open circuit.

Likewise, when troubleshooting a dead note in the chamber, start by keying with the "hot lead" on the wire going directly to the chest. If it is dead here, the problem is in the chest. Otherwise, again work your way back toward the driver to see if an open can be located. ***Note an important precaution:*** *Never apply organ rectifier voltage except from the "protected" yellow binding post on a Test and Power Junction with Fault Detector, part #400480FD, to the output pins of any Output board that uses UDN2987 IC driver chips. If a Test and Power Junction with yellow binding post is not available, unplug the cable first and apply organ rectifier voltage for your testing to the cable pins while they are not plugged onto the Output board.*

Swapping ICs is another easy troubleshooting aide. Usually the only ICs to be concerned with are driver ICs. (Input ICs are typically well protected by resistors and diodes.) Since the driver (output) ICs must supply somewhat significant current to their loads, current limiting to protect them cannot be designed in. However, the driver ICs used in the ICS-4000™ do have automatic overload protection "circuit breakers" that shut down and protect the drivers if too great a load is connected (or for short circuits). This protection is not absolute, though, since very high voltages of forward or reverse polarity (such as that induced by lightning) can still damage a driver.

Before swapping a driver IC it is a good idea to turn the organ off and then back on (this resets the driver's internal "circuit breaker") and try playing it again. If some notes (or outputs) work and it then fails again, it is likely a shorted (or very low resistance) magnet/ load that's at fault. Use a hot lead or meter to troubleshoot that output. Once fixed, resetting by the power off/ on method will restore the driver. If this method fails, then swap the driver IC with a known good one and retest.

Another simple method of troubleshooting is board and/ or cable swapping, since there are usually more than one each of the Satellite Micro board (408110), Input board (408111), Stop Action Controllers board (408112) and Output board (408131 and/or 408132). Each of these boards is totally interchangeable with others of the same number.

Note that each of the Satellite Micro boards has an eight position DIP switch that programs the cage's "address" number. Each board/cage must have a different setting. These settings are binary combinations 00000000-11111111 (0-255 decimal). These are normally set at the factory when the system is built. When swapping or replacing boards, be sure to match the settings. (These "address" numbers are also included in the system's documentation.)

In fact, you can swap boards without physically moving the board, by simply changing their addresses. The ICS-4000™ will see that board with its address no matter where it's plugged into the system. Thus, you can change the addresses of two boards move their input cables to try another board of the same type (part number).

Here's another neat trick! With appropriate software configuration, an Input board from the console can be plugged into an available empty slot of a chamber Satellite Card cage. You now have a remote keyboard input in the chamber that can be used to test by playing keys (with a "hot lead") while you troubleshoot a driver output.

The following troubleshooting chart can be used as a guide to determine how to isolate a problem. Use the methods described above along with this chart and you should be able to isolate and/or fix most problems.

SYMPTOM	PROBABLE CAUSE	HOW TO ISOLATE
KEYBOARD NOTES DEAD		
A. One note key of the manual is dead on all stops or couplers.	1. Key contact defective or not making.	Using a test wire, short the contact to see if it will play.
	2. Connector or wiring to contact is open .	Using a test wire apply Organ + directly to the input pin of the Input board (408111).
	3. Defective diode or I.C. on the Input board (408111).	Using an Ohm meter, measure the diode(s) in question. Swap or replace the I.C. (74HC541)
B. Dead notes repeat in a pattern (i.e. every 8th key) on only one keyboard.	1. Open in data line to the Input board (408111).	Test for continuity from data bus (D0-D7) on connector of Input board (408111) to data bus (D0-D7) on the Backplane board (408120).
C. Dead notes repeat in a pattern (i.e. every 8th key) on all keyboards.	1. Open in data line on Backplane (408120) or Satellite Micro (408110)	Try one of the Input boards in a different Satellite Cage. Swap Satellite Micro (408110) with a known good one.
D. One entire group of notes on a keyboard is dead (i.e. 8 notes).	1. Defective I.C. (74HC541) on the Input board (408111).	Swap or replace I.C. with a known good one. Swap Input board (408111) with a known good one.
E. All notes of a keyboard are dead and its pistons (or expression) are dead.	1. One of the I.C.s U13-16 is defective.	Swap I.C. in question with another known good one or swap Input boards (408111) with another keyboard.
	2. Defective Input board 408111	Swap with a known good one.
RANK NOTES DEAD		
A. One note of a rank is dead.	1. Pipe, chest magnet or chest problem.	Use a test wire from organ + to the UNPLUGGED output (chest) connector to see if it will play. Measure the resistance of the chest magnet to be sure it is not open (or shorted).
	2. Connector or wiring to chest is open .	Using a test wire apply Organ + from YELLOW Test & Power binding post directly to the output pin of the Output board (408131-2) before the output connector.
	3. Defective driver I.C. on the Output board #408131 or transistor on #408132.	Swap or replace the driver I.C. (UDN2987) or transistor.
B. Dead notes repeat in a pattern (i.e. every 8th note) on only one rank.	1. Open in data line to the Output board (408131-2).	Test for continuity from data bus (D0-D7) on connector of Output board (408131-2) to data bus (D0-D7) on the Backplane board (408120).

C. Dead notes repeat in a pattern (i.e. every 8th note) on all ranks in one chamber Satellite.	1. Open in data line on Backplane (408120) or Satellite Micro (408110)	Try one of the Output boards in a different Satellite Card Cage. Swap Satellite Micro (408110) with a known good one.
SYMPTOM	**PROBABLE CAUSE**	**HOW TO ISOLATE**
D. One entire group of 8 consecutive notes on a rank is dead.	1. One chest magnet within the group is shorted or has too low a resistance (partially shorted).	Use a test wire from organ + to the UNPLUGGED output (chest) connector to see if it will play. With an ohm meter measure the resistance of the chest magnets to be sure none are shorted or reading too low. (Turning power off &back on will reset the driver.)
	2. Defective driver I.C. (UDN-2987) or transistor on Output board (408131-2).	Swap or replace I.C. or transistor with a known good one. Swap Output board (408131-2) with a known good one.
E. One entire group of 24 consecutive notes on a rank is dead or group of 12 notes on a rank is dead.	1. Defective fuse on a std. Output board (408131).	Fuses automatically reset themselves. Allow to cool and try again.
	2. Defective fuse on a High Current Output (408132).	
F. All notes of an entire rank are dead or all of the notes for part of a rank are dead.	1. One of the I.C.s U22-29 is defective.	Swap I.C.s in question with another known good one or swap Output boards (408131-2).
	2. DIP switch setting incorrect.	Check system documents for listing of settings for each board.
KEYBOARD NOTES PLAY WHEN THEY SHOULD NOT		
A. One note ciphers with no keys depressed.	1. Defective I.C. (74HC541).	Swap or replace I.C. with a known good one, or swap or replace Input board (408111).
	2. Short in key contact or wiring.	Unplug connector from key contact or unplug cable from the Input board (408111).
B. A single adjacent note “runs”.	1. Short in key contacts or wiring. 2. Short on Input board.	Visually inspect or check with an ohm meter. Unplug connector from key contact or unplug cable to Input board (408111) and use organ + on input to verify.
RANK NOTES PLAY WHEN THEY SHOULD NOT		
A. One note of a rank ciphers with no keys depressed.	1. Chest magnet or chest problem.	Unplug chest connector from Driver Board (408131-2).
	2. Defective Driver I.C. (UDN2987) or transistor.	Swap or replace I.C. or transistor with a known good one, or swap or replace Output brd (408131/408132).

B. A single adjacent note of a rank "runs".	1. Short in wiring. 2. Short on Output board.	Visually inspect or check with an Ohm meter. Unplug output connector from Output board (408131/408132) and use organ + on cable pin to verify.
STOPS DEAD (CONTACT or SENSE)		
A. One stop is dead.	1. Stop contact defective or not making.	Using a test wire, short the contact to see if it will play.
	2. Connector or wiring to contact open.	Using a test wire apply organ + directly to the Stop Action Controller board (408112) .
	3. Defective diode or I.C. on Stop Action Controller board (408112).	Using an Ohm meter, measure the diode(s) in question. Swap or replace the I.C. (74HC541)
B. Dead stops repeat in pattern (i.e. every 8th stop).	1. Open in data line to the Input Board (408111).	Test for continuity from data bus (D0-D7) on connector of Input Board (408111) to data bus (D0-D7) on the Backplane Board (408120).
SYMPTOM	**PROBABLE CAUSE**	**HOW TO ISOLATE**
C. A group of eight stops are dead.	1.Defective I.C. on Stop Action Controller board (408112).	Swap or replace the I.C. (74HC541)
D. All stops are dead on a specific Stop Action Controller board (408112).	1. One of the I.C.s U22-29 is defective.	Swap I.C.s in question with another known good one or swap Input boards (408111) with another keyboard.
	2. DIP switch setting incorrect.	Check system documents for listing of settings for each board.
STOP ACTION DEAD (ON or OFF COIL)		
A. One stop is dead.	1. Stop action magnet defective (coil open or shorted, excessive friction or binding.)	Using a test wire apply organ + directly to the stop action magnet coil terminals. Visually examine for alignment defects, etc.
	2. Connector or wiring to stop action open.	Using a test wire apply organ + directly to the stop action magnet coil terminals. Using an Ohm meter check for continuity in wiring.
	3. Defective driver I.C. on Stop Action Controller board (408112).	Swap or replace the driver I.C. (UDN2987)
B. Dead stop actions repeat in pattern (i.e. every 8th stop).	1. Open in data line to the Stop Action Controller board (408112).	Test for continuity from data bus (D0-D7) on connector of Stop Action Controller board (408112) to data bus (D0-D7) on the Backplane board (408120).
C. A group of six consecutive stops are dead.	1.Tripped fuse on Stop Action Controller board (408112).	Fuses automatically reset themselves. Allow to cool and try again.
D. A group of eight consecutive stops are dead.	1.Defective driver I.C. (UDN2987) on Stop Action Controller board (408112).	Swap or replace the driver I.C. (UDN2987)
	2. One stop action magnet within the group is shorted or has too low a resistance (partially shorted).	Use a test wire from the yellow T&P binding post to the On or Off Coil connector to see if it will work. With an Ohm meter measure the resistance of the coils to be sure none are shorted or reading too low. (Turning the power off and back on will reset the driver.)

E. All stops are dead on a specific Stop Action Controller board (408112).	1. One of the I.C.s U22-29 is defective.	Swap I.C. in question with another known good one or swap Stop Action Controller boards (408112) with another one.
	2. DIP switch setting incorrect.	Check system documents for listing of settings for each board.
STOPS PLAY WHEN THEY SHOULD NOT		
A. One stop stuck on with no stop controls active	1. Stuck or shorted stop contact.	Visually inspect or check with an Ohm meter.
	2. Short in stop or wiring to the Stop Action Controller.	Unplug connector from stop contact or unplug cable from the Stop Action Controller board (408112).
	3. Defective I.C. (74HC541) on Stop Action Controller board (408112).	Swap I.C. in question with another known good one or swap Stop Action Controller boards (408112) with a known good one.

SYMPTOM	PROBABLE CAUSE	HOW TO ISOLATE
B. Adjacent stops “run” (work together).	1. Short in stop wiring.	Visually inspect or check with an Ohm meter. Unplug connector from stop contact or unplug cable from Stop Action Controller board (408112) and use organ + on input to verify.
	2. Short or defective I.C. (74HC541) on Stop Action Controller board (408112).	Swap I.C. in question with another known good one or swap Stop Action Controller board (408112) with a known good one.
UNUSUAL PROBLEMS		
A. MIDI notes stutter or intermittently transpose.	1. MIDI cable too long or picking up interference.	Try shorter cable or re-routing the cable.
B. Any 1 or 2 stops will play but any 3rd or 4th stop added kills all the stops.	1. Blown fuse in stops Output board in the chamber.	Fuses automatically reset themselves. Allow to cool and try again.
	2. Defective stops Output board in the chamber.	Swap the Output board (408131 or 408132) with a known good one.
C. Tuning control and cancel have no effect on any MIDI instrument.	1. MIDI Instrument plugged into the Sequencer Out port.	Move the cable to the Instrument Out port.
D. System goes into diagnostics when the organ is turned on.	1. The maintenance switch was accidentally left on.	Turn off the maintenance switch.

The preceding guide should enable any organ service person, regardless of his familiarity with electronics, to repair nearly any trouble in the ICS-4000™ that may develop. If a problem does arise which the repair person is unable to correct, the modular construction of the PETERSON ICS-4000™ permits the troublesome part to be isolated by unplugging the suspected module and swapping it with one known to be good. If the problem moves with the module, that module is defective. If further assistance is required, Call 1-708-388-3311 or toll free 1-800-341-3311.

A simple phone call may save much time and money !

SECTION G - COUPLER/ RELAY DETAILS

GENERAL

Organ voltage range for any key, stop, miscellaneous control, or other input is 11-18 VDC standard.
There are a maximum of eight physical keyboard (manual) inputs and 512 stops controls (including couplers, transfers, divides, ventils, duplexes, speaking stops, MIDI stops, trems or any other controls) . Note: Floating divisions with no "home keyboard" can be created within the coupling in addition to these eight manuals.

The transposer allows 6 half steps sharp (+) and 6 half steps flat (-) offset in keying. Transposing can be controlled via the CDU Transpose screen or by optional external up/down and on/off buttons or a rotary knob defined through the WinTool. When transposing flat, or when a 16' coupler is being used, a "wire-back" circuit causes the lowest notes to play the proper note name one octave higher so there are no "dead" notes. In the case of 4' couplers and/or transposing sharp, for unit stops (that have the range) the proper pitches will be played. Optionally "wire back" (similar to that described above) can be used for ranks (or stops) that do not have the range to extend the top.

There are 128 expression contact inputs maximum. These could be used for up to eight shoes @ 16 stages each. These same expression shoe inputs may be used to control MIDI voices and can be shared or independent. Where desired, expression shoes with potentiometers instead of discrete contacts can be supported.

Dual consoles, playing one or more organs selectively, can be supported. Please contact the factory to discuss your specific requirements.

DC Input/Output connectors for keyboards, stops, chests, etc. are capable of accepting Peterson E-Z Wire™ wire wrap connectors, Peterson Output Connector boards, or Peterson Quick Punch™ IDC (punch down) connector boards.

Protection for output drivers wired to magnets is accomplished using Auto Sense Shutdown via the UDN2987 drivers, except on High Current Output boards #408132, which use discrete SMT type transistors instead of UDN2987 driver chips. Also, fusing to meet NEC standards is provided.

In addition to normal organ relay functions, power controls for the blower, chamber rectifier, MIDI sound modules, and other DC relay or switched AC outlets may be provided via the control system. These control outputs will be ~14 VDC (organ voltage) that can operate relays/contactors.

COUPLERS

Any conceivable inter-manual or intra-manual coupler can be accommodated including unique couplers (see special functions below). Each coupler's pitch, source (manual or division), destination (division) and special coupler attributes will be selectable in its configuration (system programming via the "WinTool" set up program).

Pitch selections for couplers are <u>not</u> limited to standard coupler pitches. Therefore, couplers such as Quints, Harmonics, etc. can be easily created.

The coupler source can be defined as being from a manual or division. This permits both "To" and "On" couplers for floating divisions. (A manual source would be used for "To" couplers and a (coupled) division source would be used for "On" couplers. Another unique coupler, "Only On", can be defined by using the intra-manual coupler output as the source (this excludes inter-manual coupling).

Destination divisions may be "floating" divisions with no home keyboard. The number of destination divisions is limited to sixteen.

Special coupler attributes include melody couplers, bass couplers, auto pedal, pizzicato, and sostenuto. (See the "special coupler attributes" section below).

Both coupled and uncoupled output data can be available for use within the relay system so that stops such as Chimes or Trompette En Chamade can be made to not couple.

SPECIAL COUPLER ATTRIBUTES

Melody Couplers

The Melody Coupler ignores all but the highest manual note being played. Only the top note couples. Any time a new higher note is played (added) the output changes to that note. The output note may be affected by pitch as well. (For example: The top note can be shifted to become 4' pitch.) Any pitch from Figure 4F can be used. If keys are being held when the Melody Coupler is turned on, the highest note (at the selected pitch) is output immediately. "Deglitching" prevents unwanted, momentary changing of the coupled note if the actual high note unintentionally breaks contact for an instant.

Bass Note Couplers

The Bass Note Coupler ignores all but the lowest manual note being played. Only the bottom note couples. (Note: this is different from "Auto Pedal" described below.) Any time a new lower note is played (added) the output changes to that note. The output note may be affected by pitch as well. (For example: The low note can be shifted to become 16' pitch.) Any pitch from Chart F can be used. If keys are being held when the Bass Note Coupler is turned on, the lowest note (at the selected pitch) is output immediately. If the lowest key is released, the next lowest key will not couple until it is re-pressed.

Auto Pedal

Planned as a future enhancement but not yet available, Auto Pedal is more sophisticated than the Bass Note Coupler. The combination of notes being played is "looked up" to determine what chord is actually being played and then this coupler outputs the root note for that chord in the bottom octave of the pedal. (The bass note may not be the root note.) Example: Notes G2, C3 and E3 comprise a "C" chord. The lowest note played is a "G", but the root note that would be output is "C".

Pizzicato Couplers

Pizzicato Couplers are active for a pre-determined time period. Typically, this is about 30-40 mS. Any time one or more notes are played, they are output (on) for 30-40 mS. and then turn off. Additional new notes played also "Pizz". Keys being held when the Pizzicato stop is activated also "Pizz" initially. The "Pizz" time is adjustable separately for each note over the entire keyboard. The "on" time in mSec. can be selected from the CDU.

Sostenuto

Sostenuto Couplers sustain (latch on) any notes being played while the sostenuto control is active. If notes are being played when the sostenuto control is turned on, those notes become latched on but any additional notes played (added) play normally without getting latched on. Any latched-on notes become unlatched when the sostenuto control is released.

SPECIAL FUNCTION COUPLERS

Unison Offs

The 8' Unison couplers or Unison Offs (in the intra-manual couplers) are normally on and go off when these stop controls are active. (Note that this is backwards from normal couplers.)

Manual Transfer

The Manual Transfer effectively swaps the physical keyboard inputs of one manual with another. Typically the Great and Choir keyboards are affected, however any combination is allowed. Thus for example the physical Great keyboard plays the Choir division and the physical Choir keyboard plays the Great division. When the Manual Transfer is active the divisional pistons and coupler reversible pistons associated with each manual are also "swapped" with the other's. Transfer of divisional cancels is optional as determined in set-up because these may be connected to toe studs that should not transfer.

MIDI Couplers

MIDI TO X couplers are treated as if the MIDI is a floating division. The MIDI responds to the specified coupler but is not affected by any other couplers for that manual. MIDI ON X couplers are affected by couplers for that division.

Pedal Divide

Pedal Divide, as its name implies, allows dividing (splitting) the pedal keyboard inputs to control its output notes differently. The outputs may control the pedal normally, output pedal stops only (no coupled data), output coupled data only (no pedal stops), or selectively control certain pedal couplers/stops. Therefore, selection of desired stops is permitted for each group independently.

The divide point is typically between low B and tenor C of the pedal board. However, this is selectable and there are also provisions for optional control inputs to select different divide points.

Ventils

"Ventils" can be programmed to include/exclude any other stop or family of stops. i.e. All Reeds Off, Strings Only, etc.

Duplexed

"Duplexed" stop controls can be programmed to require two (or more) stops to be active before performing the defined control function. Control functions can include/ exclude any other stop or family of stops. For example, when Celeste stops are on and the tutti is activated, the Celeste stops are disabled. Or, for theater organs, a traps stop and the traps keying line are required to control the trap.

All Swells to Swell/ Expression Couplers

The All Swells to Swell control is an expression shoe coupler which, as its name implies, causes all expression shades to be controlled from one shoe (the Swell). However, for total flexibility, the source (controlling) shoe is selectable and the destination shade sets are also selectable. Multiple expression couplers of various configurations may be desirable in some cases and are supported.

Jesse Crawford Roll/ Glissando

This is essentially an automated transposer affecting both the manual(s) and pedal. Any notes being played when this feature is activated are transposed sharp in half step increments at a pre-determined (but selectable) rate. The range of transposition is normally one octave (13 notes), however, it may be desirable to go two octaves (25 notes), which is also supported. Note outputs will remain at the higher pitch until all of the notes are released. This feature overrides the sostenuto if it is activated.

UNIT RELAYS

Relay outputs are limited to 1500 ranks maximum. This total includes any unit ranks, straight (or primary) drivers, offset chests, and chimes (or other percussions). Each output of the standard Satellite Output board (part #408131) is capable of driving a 50 ohm (350 ma.) load. The rating of each output of a standard driver with heatsinked driver I.C.s (part #408133) is 40 ohms (400ma.). Optionally available is a high current driver with each output capable of driving 20 ohms (800 ma.)(part #408132) and a driver with transistor outputs rated for loads as low as 6 ohms (2.5-3 A).

Unit stops are fully programmable with source manual/ division (coupled or uncoupled), destination rank (stop), pitch and special attributes (pizzicato, re-it, etc.).

All pitches including fractional ones ranging from 64' through 1/32' (a 12 octave range) are available. Fractional pitches include thirds, fifths, sevenths, ninths, etc. See the pitch table (Chart F) in the reference section.

SPECIAL RELAY FUNCTIONS

Borrows

Borrows allow using (sharing) pipes from another rank to "fill in". For example, the low 12 notes of a particular stop may be borrowed from or shared with another stop to save cost. Therefore, borrowed stops are allowed to be defined specifying either by note or octave as to what their destination will be. This is accomplished in the system programming when defining the stop.

Derived (Wired) Mixtures

Derived or Wired Mixtures are a unique form of unification that typically use pipes from 2-3 ranks at various pitch combinations which change at pre-determined breakpoints throughout the keyboard. Therefore, breakpoints are definable and the pitch(s) of each stop to be played within that group are also definable. This is accomplished in the system programming when defining the stop.

Re-it

Re-it (Reiteration) causes the outputs to intermittently be turned on and off at a pre-determined rate. The rate and duty cycle is adjustable and may be scaled throughout the keyboard range. The re-it rates from note to note are random, not locked or synchronized. (Locking or synchronizing the re-it is optional, though.) Re-it rates and duty cycle of individual notes can be adjusted via the CDU.

SECTION H - COMBINATION ACTION DETAILS

GENERAL

A maximum of 128 piston inputs can be configured. These piston inputs are used for all generals, divisionals, reversibles, cancels, and special-purpose momentary controls . The layout of the ICS Satellite Input board provides 24 extra pins which may be used for pistons or other input functions in addition to the 61 inputs typically used for keyboard inputs.

There are 256 memory levels maximum using flash memory as the non-volatile storage. Optionally, uploading and downloading of memory to/ from the internal system floppy disk or a USB memory device can be provided allowing unlimited storage. Memory levels are selected via the Control Display Unit. A selectable number of memory levels can be assigned to each organist and conveniently organized under headings called "Organist Folders", each of which can be given an alphanumeric name, usually the organist's name. All available memory levels that are not assigned to other Organist Folders are distributed equally between Organist Folders called "Guest A" and "Guest B". The memory levels within each Organist Folder are numbered beginning with #1. In addition to provisions for selecting the desired memory level from the CDU, external push-buttons or pistons 7-segment LED readouts can be used to select and display the memory level number within any Organist Folder.

Note: All memory levels are initialized (in a new system) to all 0's (all stops off).

Lock-outs to prevent setting/ changing of stored data are provided via passwords (lock-out codes) that can be entered and/or edited from the CDU. All the memory levels and certain other organist settings within any given Organist Folder are locked/ unlocked with a single password. An organist may chose to have his or her Organist Folder automatically lock when the organ power is turned off, or remain unlocked.

The two guest Organist Folders are not lockable, so pistons on their memory levels remain available for anyone to change. The pistons in all Organist Folders can be used without restriction, even when locked.

Separate "Supervisor" and "Organ Builder" passwords prevent unauthorized use of certain ICS-4000 functions. Holders of these passwords may view and change individual Organist Folder passwords.

A maximum of 8 crescendo memory levels are provided. Any of these can be builder/installer programmed with and locked using the Organ Builder password. All other crescendos are user programmable and can be selected via the CDU.

Tuttis can be configured in a variety of ways. Memory for a separate tutti setting on each memory level within each Organist Folder may be provided, and for convenience the tutti setting on one memory level can be easily copied to any one other memory level or to all of the memory levels within the same or a different Organist Folder. Alternately, up to eight separate tutti pistons can be used, or one tutti piston can be used with an optional "Tutti Select Panel" that allows selecting which of four tutti memory levels will apply. With one of these options is chosen, any of the tutti memory levels (or tutti pistons) can be set and then "protected" with the Organ Builder password.

The combination action-related feature set includes a full-featured Piston Sequencer that allows organists to create lists of piston presses (piston sequences) of any length and including pistons from any memory levels within the current Organist Folder. Pistons can then be activated by pressing "Next" or "Previous" pistons, which may include permanently designated pistons as well as any conveniently-located General and/or Divisional pistons that will assume the role of a Next or Previous piston only when the Piston Sequencer is turned on. Each piston sequence can be given a unique name of up to eleven characters. Provisions will be found for appending, inserting, deleting, replacing, and changing the memory level of pistons in the piston sequence. An alternate implementation of the Piston Sequencer, call the European Piston Sequencer, is also available and is described below.

Stop Action Controller boards have a capacity of 24 stops each (24 on and 24 off coil outputs and 24 sense inputs. The drawknob/ stop action magnet output drivers' load/ drive capacity is 20 ohms (1 amp intermittent).

Highly detailed and illustrated instructions for operating virtually all of the available functions related to the combination action system including pistons, crescendo, tutti, piston sequencer, master pistons, accent stops, and others are provided in the ICS-4000 User’s Instruction Manual.

SECTION I - MIDI DETAILS

MIDI OVERVIEW

Complete MIDI In/Out capabilities are provided, including all of the features of the Peterson MIDI Resource System™, plus “built in” performance recording/playback features, downloading of performance files to the ICS-4000 Floppy Drive Unit or USB-compatible removable memory device, and a highly intuitive menu system for setting up MIDI piston or “Pre-Stop” settings. The CDU is used to access all MIDI features, and MIDI functionality can be globally turned on or off by pressing the reversing MIDI button on the CDU.

Keying, stop, and expression data is derived from the coupler section of the ICS-4000, thus allowing up to 8 MIDI keyboards. MIDI transposing follows the coupler transposing. Stop information for record/playback is handled in Peterson Sysex Format. Expression is also handled by sysex for sequencer record/playback and with Master Volume (Control 07) for instrument (sound module) outputs.

MIDI preset patch data can be saved and recalled (sent) using either pistons or Pre-Stops. The preset method must be selected at the time of setup/ programming. Pistons can be shared or independent and can have layered patch data. Presets can be locked out, sharing the combination action lockout(s) via password for each Organist Folder™.

Optional external DC controls for MIDI specific features can be defined using general purpose (Key/Piston or spare Stop Action Controllers) input circuits. These optional controls include: Start, Stop, Continue, All Stops Off, Resend, and Sustain. Auto Logical Stops and velocity (touch sensitive) contacts will be available in the future.

Highly detailed and illustrated instructions for operating virtually all of the available MIDI functions are provided in the ICS-4000 User’s Instruction Manual.

Power-On Assignments/Defaults

Factory default MIDI channel/ manual numbers on Power Up - *MIDI In and Out*

1. Swell	(Orch)
2. Great	(Great)
3. Choir	(Accp.)
4. Pedal	(Pedal)
5. Solo	(Solo) - (top man. of a 4 man.)
6. Antiphonal	(Acc.2nd)
7. Echo	(Great 2nd)
8. Eighth Manual	
9. Use for Instrument w/organ	
10. Use for Instrument w/organ	
11. Use for Instrument w/organ	
12. Use for Instrument w/organ	
13. Use for Instrument w/organ	
14. Use for Instrument w/organ	
15. Use for Instrument w/organ	
16. Use for Instrument w/organ	

The MIDI Programming Menus will allow choosing other organ channel assignments including Allen or Rodgers compatibility.

Organ- only channels are the MIDI channels used to record/ play the organ via a MIDI sequencer. Synthesizer/ Sound Module ("instrument") voices should not be programmed to use these channels. Any non-organ channels can be assigned to become "instrument" channels. Another feature called "+8" can optionally provide "instrument" channels 17-24 (on the CDU) which are output on channels 9-16 of the Sequencer Out port. Refer to the ICS-4000™ operating manual for more information about the use and application of the "+8" feature.

MIDI IMPLEMENTATION DETAILS

1. See "MIDI Implementation Chart" (located at end of this spec) for additional information.
2. "Running status" is used whenever possible to reduce MIDI overhead (see MMA spec. pg.56). The status byte is refreshed every few seconds (see orig src for current time).
3. A default velocity value of 60H is used for note on. This value can be selected in the MIDI Programming Menus.
4. For note off, Note On -Velocity 0 (9nH 0) is used to avoid changing status. Key Off codes (8nH) are recognized.
5. All Notes Off - Sends a note off message (9n vv 00) for every key on every channel.
6. The Basic Channel for receiving Mode Messages is channel #0(1). The default Multi Mode allows each MIDI channel to be polyphonic and have its own voice(s) controlled by program change commands.
7. If system exclusive is required while keys are on, keys are checked to see if they need turning off (or new keys turned on) between sysex "blocks". A new Status Byte is sent immediately following the EOX to restart running status.
8. If keys are being played and a preset change occurs with a channel/ program change, note offs are sent on the old channel and note ons on the new channel, but only for channels that a program changes on.
9. MIDI In recognizes both 8n NN VV and 9n NN 00 for note offs.
10. Any unrecognized MIDI messages/ commands are ignored and not misinterpreted. (i.e. Meta events in a standard MIDI file header).
11. "Patch" data is sent even if logical #35 (MIDI On/Off) stop(s) is off.
12. For any program change (on an instrument channel) the current volume data and pitch bend data is also sent.
13. When a "patch" is sent, sound variation and bank are also sent if needed.
14. Special MIDI Couplers (melody/bass) are "assigned" stops (per manual). When one of these MIDI Couplers is active any Instrument Out channels associated with that manual are affected by this coupler.
15. Allen/Rodgers modes- use their respective manual assignments and stop control formats.
16. If two manuals are mapped (via patch data) to the same organ dedicated channels, the Instrument Out port for that channel will be played by both keyboards. However, the Sequencer Out port for the dedicated organ channels cannot be re-mapped.

MIDI SYSTEM START-UP BEHAVIOR DETAILS

Note: Sequencer Output Port channels 1-8 (0-7) are the default channels assigned to organ keyboards. MIDI In will assume key data on these channels routes to their respective organ manual outputs. Sequencer Out Port channels 9-16 (8-15) can be mapped for recording synthesizer voices. MIDI In will merge program change, control change and key data for these channels with channel 9-16 data from the keyboards going to the Instrument Out Port. See Channels 9-16 detail section. Channels 9-16 on the Sequencer Out Port are subject to the same Cancel rules as the Instrument Port Outputs. The "channels + 8" feature is detailed in the "+8 feature" section.

If organ channels have been reassigned in set-up the organ /instrument channels may be different than 1-7. Also, the sysex device ID# on MIDI In will determine channel usage. See the Peterson Sysex Format Section.

"1/2 Soft Thru"

This passes all data from MIDI In channels 9-16 (or non-organ channels) to the instrument output channels 9-16 (or non-organ channels). This would include key, volume and program change data.

The data from MIDI In is merged with local keyboard data. This is done so that a Note On from either input will send a note ON to the output(s). If the same note is On for both MIDI In and keyboard inputs for the same channel, both must be off before a note off is sent. Volume data is merged with local volume and the highest value of the two inputs is used to send to the output if the channels are the same. Program changes from MIDI In, Pistons (or pre-stops), or Send are passed thru to the Instrument Out port.

Channels +8

When the +8 switch is on, the control panel channel numbers will range from 1-24. The first sixteen channels are used as follows: 1-7 for organ channels to the Sequencer Out port, and 9-16 to the Instrument Out port. Channels 17-24 are the Sequencer Output channels 9-16, but are treated just like Instrument Out channels. This permits different programs on 9-16 of the sequencer and instrument outputs. Thus there are essentially two Instrument Outs.

Note: These MIDI channel numbers relate to the displayed channel numbers. Actual transmitted values are zero based, which is one less (-1) of the displayed value.

MIDI In channels 9-16 (or non-organ channels) will use the soft thru method above to allow replaying MIDI instruments along with the organ. The data from MIDI In 8-16 (or non-organ channels) will be copied to only the sequencer output 9-16 (or non-organ channels). MIDI In on channels 1-7 (or organ only channels) will be copied to the Instrument out 1-8 (or organ only channels) only if a program change had been received for that channel.) However, any instrument sounds on these channels will not be able to be cancelled via stop control due to organ keying being non-switched.) Therefore, it is advised that with +8 active, channels 17-24 (seq.9-16) be used for record/play of instruments with the organ. (The sound module on the Sequencer Out must be programmed to ignore channels 1-7.)

The 17-24 is primarily intended for someone that wants to connect two instruments and have separate control of them.

MIDI OPTIONS

Sustain/Sostenuto

The sustain/ sostenuto option can be supplied as a "skate clamp" switch or toe stud which activates this mode. When this input is active, code Bn 40 7Fh is sent. However, if setup has sostenuto selected then code Bn 42 7Fh is sent. Code Bn 4X 00h (where X=0 or 2) is sent when the DC input for this function #15 is released.

Start/Stop/Continue

External pistons (or other controls of the organbuilder's choice) for these functions are to be installer wired. These are used to control and synchronize an external sequencer and/or other real time devices. Codes are Fah, Fch or Fbh (respectively) followed by F8h.

MIDI In /Sequencer Out/ Instrument Out Panel Assembly

This consists of an extension cable and mounting plate (bracket) that allows the installer to mount these plugs in the back of the console, under the key bed, etc.

External Sequencer (not manufactured by Peterson)

On MIDI In: Special data handling by Peterson includes; recognizing 8n nn vv note off as well as 9n nn 00, handling running and/or normal status messages, ignoring FF Meta Events and most system common messages, ignoring F8h timing clocks and FEh active sensing, ignoring any unrecognized MIDI command/ messages, recovering sysex data that may have added delta time, and adding and "escape" F7 inserted within our sysex format.

EXPRESSION ON MIDI IN

Normally expression is handled via sysex (stop format) for sequencing in the Peterson format. However, MIDI Control Code 07s can be enabled and used in place of sysex expression in the Allen and Rodgers formats. In these cases, the received expression control change (Bn 07 VVh) values are converted according to the following table (selected in MIDI Programming Menus).

Columns 1-4 represent the MIDI (decimal) values based on the minimum volume selected in setup. For expression shoes with 16 stages, the values between are interpolated to find the values for each stage. These different value ranges (minimum numbers) allow balancing the organ's expression (via shades) with a MIDI sound module.

Stage #	**1 VV**	**2 VV**	**3 VV**	**4 VV**	Use VV <= to find stage
none	59	41	23	04	
1	71	50	36	19	
2	79	61	49	34	
3	87	72	62	49	
4	95	83	75	65	
5	103	94	88	80	
6	111	105	101	96	
7	119	116	114	112	
8	127	127	127	127	

SECTION J - MISCELLANEOUS

What You Should Know About EMI/RFI & the FCC

Definitions

First, let's start with some definitions. Electro-Magnetic Interference (EMI) and Radio Frequency Interference (RFI) are essentially the same thing, EMI being a more broadband term. Electro-magnetic radiation is the principle involved in the transmission of radio waves. Thus any device that is capable of producing electro-magnetic radiation is a transmitter. If the transmitter's frequency has a sufficient energy level, a receiving device could detect this signal. If the received signal is not the desired signal, it is interference.

Besides electro-magnetic radiation, unwanted or interference signals can be conducted (coupled) inductively, capacitively or by common mode. Common mode means through a common path such as ground.

In the United States, the Federal Communications Commission (FCC) ① is the body responsible for the control of EMI. Part 15 of the FCC Rules and Regulations pertains to the control of EMI related to computing devices. Devices intended for commercial and scientific applications with limited usage are governed by class A limits. Devices intended for home or consumer use are covered by class B limits.

Class A equipment is tested and certified by the manufacturer where Class B equipment must be tested and certified by the FCC. Class B limits are also 22 dB lower in level of conducted interference and 10 dB lower in level of radiated interference. Measurements of emissions must meet specific levels in dBuV/m at frequencies from 30 Hz. to 10 Ghz. and are measured at a distance of 30 meters for Class A, compared to 3 meters for Class B. In checking with an FCC Field Engineer, we find that pipe organs and equipment used in pipe organs being custom built for church or institutional use fall within the class A guidelines.

Note, however, this does not exclude building organs for residential use. Unlike mass produced electronic organs intended for consumer use, pipe organs are custom built, no two the same, with regards to the specification, equipment employed, cabling, etc.

Does Peterson equipment comply?

Peterson has been concerned with EMI and the FCC rules since designing it's first clocked digital system, the OrgaPlex™ switching system, in 1985. This system was intentionally designed with a low clock rate (10 KHz) that excluded it from any need for certification.

As we began to develop our line of microprocessor controlled equipment (including the Master Stop Processor™, MIDI Resource System™, later-generation Duo-Set Combination Action, Model 450 and AutoStrobe strobe tuners, and RC-150 Swell Shade Operator) we also researched the FCC requirements pertaining to our equipment (assemblies) and their application in pipe organ installations.

① In Canada and Europe other agencies are responsible.

Measurements have been made on these products to ensure that they comply with Part 15 of the rules and regulations for Class A devices.

Since the ICS-4000™ has multiple processors located both within the console and in the chamber(s), and because of our intention to distribute this product in European countries, we made the decision to have the ICS-4000™ tested for compliance by an independent certification laboratory, for both FCC and European Community standards.

Our certification labeling reads:

This equipment complies with the requirements in Part 15 of the FCC rules for Class A computing devices. Operation of this equipment in a residential area may cause unacceptable interference to Radio or TV reception requiring the operator to take whatever steps necessary to correct the interference.

What about specific console/ job wiring?

Although each product (assembly) has been tested and certified, it would be nearly impossible to test each complete system (organ) with the exact component placement, cable lengths and routing, etc. that would be used in its final installation.

Wherever possible, circuits have been designed to provide isolation to susceptible signals from long cables. Some cables must carry signals that could be a source of radiation. In these cases, the cables are limited in length or are shielded. However, radiated signals may be induced into other cables which act as antennas, causing unwanted radiation.

The likelihood of enough energy being coupled to cause a problem is very small but this can potentially occur. As always, Peterson stands behind our products even for these kinds of problems. Please carefully review the remaining paragraphs in this section before calling for assistance.

How do you know if you comply (or cause interference)?

First of all, start with the obvious. If the church has a public address system, try putting the organ through its paces with the PA system on. Likewise, if they use wireless microphones, see if there is a problem when it is used. Is there a contemporary service where portable instrument amplification might be used? If so, test to see if there is any interference to these devices.

Other things to watch for would be churches with closed circuit TV. Does the church broadcast any services on radio or TV? If so check with the technicians involved in this service to verify that there are no problems.

Without going to great lengths and expense, you may not know if the finished installation is in total compliance at all frequencies. However, if there is a concern, some additional simple tests could be performed as follows:

Using a portable AM/ FM radio, start with the AM band and tune to a dead spot between stations at the low end of the band (near 550 KHz). Holding the radio near the console electronics, radiated digital noise can be heard as a whistling, whining, or raspy clarinet tone that may vary in pitch and amplitude in quasi- rhythmic patterns. If these types of tones are heard, turn the organ off. If the tones stop, they're obviously from the organ. Then with the organ on, carry the radio away from the console while listening to those tones. At 30-40 feet away the tones should fade and white noise (normally heard between AM stations) should be predominant. If the digital noise remains predominant, tune to the nearest station and see if the digital noise can be heard in the background. If so, there's a potential problem and further action may be taken. See the troubleshooting/ remedy section below. Likewise, try the above test at the high end of the AM band (near 1600 KHz.).

In the FM band, using the method described above try the test(s) at or near 88Mhz., 90Mhz., 100Mhz. and 108Mhz. These frequencies are most likely to show problems.

Using a portable TV (like a WalkMan), tune to channel 2. Holding the TV near the console electronics, radiated digital noise will appear as rolling bars, horizontal streaks or a herringbone effect. Again, while walking away from the console those patterns should fade away. The lower channels (2-5) would be most susceptible.

If a problem is found or reported, what should I do?

Troubleshooting

1. First of all find out in as much detail as possible what the reported interference is, how it manifests itself, when it occurs, etc.
2. Confirm that the organ is the cause by duplicating the interference and then turning the organ off. If the problem persists, it isn't the organ. If turning the organ off does clear the interference proceed to the next step.
3. Disconnect the organ power or unplug the Class II transformers associated with each of the organ's electronics systems. (i.e. The ICS-4000™ system's various satellites.) Then reconnect or plug them back in one at a time while monitoring the interference. Its very likely that only one of the satellites is the culprit.
4. Having isolated the satellite involved, the next step is to disconnect all cables (including the CDU cable), but not essential power wiring. With all cables disconnected, see if the interference clears up. Then plug the cables back in one at a time to see if one or more of the cables are the radiators.

Suggested Remedies

1. If the interference persists even with all cables unplugged, try an AC Line RFI Filter (not surge protector). A Radio Shack #61- 2794 could be used. The AC Line RFI Filter could also be tried in the line cord to the device being interfered with. Another possibility would be to try plugging either the console or the Class II transformer of the device being interfered with into a different AC line circuit.
2. If the interference is only present or is much worse with one particular cable attached, try rerouting that cable away from other cables to avoid coupling. Another alternative would be to wrap the offending cable with foil tape to provide shielding. A snap- on ferrite choke could be tried. Radio Shack carries two versions, part numbers 273-104 and 273-105. This should be snapped onto the cable as close as possible to the electronic assembly.
3. If the device being interfered with is a portable device, see if it can be moved to another location. Sometimes even a short distance or re-orientation can make a significant difference.
4. If none of the above remedies are satisfactory, call for assistance from our customer support staff.

WHAT YOU SHOULD KNOW ABOUT LIGHTNING

Our experience gained during over 55 years as a builder of solid state equipment for organs has shown that there are a number of factors that can make an organ installation (and even a building) be AT RISK for lightning damage.

An installation may be vulnerable when:

The building's environment is on the highest point on a hill, or immediately next to a metal freestanding structure, or in a part of the country known as having more severe lightning than most.

The organ is installed where the console and organ (chambers) are in a balcony, OR at significantly different levels than each other, OR where cable runs are long and/or especially where cables run vertically for a distance.

The type of main cable used between the console and the chamber(s) is unshielded and is not enclosed in a metal raceway or conduit.

The main cable is shielded, but the shield is not connected via an adequate sized conductor to some point of fixed electrical potential such as a rectifier terminal or buss bar, nor connected to Earth Ground such as via a grounding stake or water pipe.

The organ rectifier is some distance from the console and/or chamber (i.e. basement) and very long and/ or undersized feed wires are used.

The On/Off switch (or relay) for the AC feed to the Organ Rectifier has only one leg of the rectifier switched rather than both legs.

Main Cable Protection

One of the following main cable protection schemes is recommended to be used. ("Main cable" refers to the cable from the console to the chamber, which usually includes key mains, stops, and swell shade wires.)

Use shielded main cables. The shield must be connected at one or both ends to Organ Negative, or connected to earth ground at one end only. Never connect both ends to earth ground since ground potential differences can have an adverse effect. Never connect to both organ negative and earth ground.

Use grounded metal conduit for the main cable shield. Continuity of the conduit must be checked by connecting a wire (running through the conduit) to one end of the conduit and then with an Ohm meter, measuring from the other end of the wire to the conduit. The resistance must be less than 15 Ohms per 100 feet of length. (To check, be sure to use a meter set on the R x 1 scale and then properly calibrated). The conduit MUST cover all vertical runs. Horizontal runs of up to 20 feet outside conduit are generally acceptable.

Test the continuity of the earth ground to be used for the conduit, if applicable. This test can be done in one of the following ways: A 3-wire outlet may be used if you use a 3 wire outlet analyzer (available from Radio Shack, Catalog Number 22-106, for approximately $6.00 or from most hardware stores), and test the 3 wire outlet as follows: (Be sure to turn off the circuit breaker when handling wires or removing the outlet!) Plug the analyzer into the outlet, checking to be sure it indicates correct wiring. Remove the cover plate and then the outlet so that it is no longer connected to the conduit. The analyzer should now indicate an open ground. Visually inspect the wiring to be sure the neutral is not frayed or cut, possibly shorting to the conduit. Also inspect conduit couplings to be sure they are tight. If there is any question about the wiring or integrity of the conduit ground, an electrician should be consulted.

With an Ohm meter set to the R x 1 scale, measure the resistance of the ground. This is done by connecting one lead of the meter to the conduit to be tested, the other lead through a separate wire to an earth ground source (preferably the electric company or phone company ground stake or wire). Alternately, measure to several cold water pipes at different locations. A reading of less than 15 Ohms per 100 feet is acceptable.

Run a new wire, #12 or heavier, from the conduit or shield, using the shortest possible length, to a cold water pipe (where it enters the building) or to a ground stake about 8' long. If using a cold water pipe inspect it for plastic couplings, especially at the meter. Use a strap around the meter if necessary.

Chest Cables

Generally, chest cables are not as significant a problem as main cables, because they are typically shorter and run horizontally. In cases where a chest cable might be longer or run vertically (i.e. to an En Chamade or multi-level chambers), these cables should be treated the same as main cables.

Check to be sure that the organ negative side of the DC power supply (organ rectifier) is NOT connected to earth ground.

The following theory explains why this is important:

The long wires of the main cable act as "antennas" in which a static discharge (lightning) can induce dangerously high voltage potentials. The longer the wires, the nearer the strike, or the closer the wires are oriented to be in vertical alignment with the strike, the higher the voltage potential. Generally, one end of the cable will look like a high impedance (solid state or inductor/ magnet) and the other end (usually closest to the organ rectifier) will look like a lower impedance. Since the rectifier(s) can be installed at either end, both ends, or somewhere in between (such as in a basement), the paths can be different from installation to installation. If Organ Negative is connected to earth ground, the induced voltage seeks one or more paths to earth ground, THROUGH THE SOLID STATE COMPONENTS, thus destroying them. This usually involves many parallel paths destroying many components. If the organ negative is isolated from earth ground the entire solid state system can raise in potential with respect to earth, but the potential differences across the components is minimized. Note, however, that there now exists a voltage potential difference between organ negative and earth ground. The discharge path will likely be at the rectifier-- a short path with minimal components. Many times these components can withstand a discharge or have protection. At worst case the cost of a rectifier may be much less than the cost of labor and parts to repair many driver boards and other control system circuits.

Astron Ground

Some Astron brand rectifiers commonly used in organs may be shipped to customers with a removable internal connection between the DC Negative terminal and the chassis, which in turn gets connected to earth ground via the third prong on the line cord plug. Problems can occur for several reasons in solid state equipment built by virtually any manufacturer, if this path from Organ Negative to earth ground is in place. With the wire connected, 60 cycle hum can appear in the DC circuit, which may create undesirable noise in audio circuits. Vulnerability to damage from lightning can be much higher if the DC Negative is grounded because a static charge may place a high voltage at one end of a long wire, and since the other end of the wire is at ground, a high voltage may be caused to appear across the wires, instantly damaging the equipment. There can also be referencing problems wherein notes or stops may not turn off dependably when this earth ground connection is made and two or more Astron rectifiers are connected together in certain ways.

The third, or grounding, prong on the Astron's line cord plug is AND SHOULD BE connected to the rectifier's chassis, but not to organ negative.

There are, of course, many other factors in the design of our equipment related to impedances, current limiting, selection of components, stress testing, etc., that have evolved with our years of experience in manufacturing organ components. These combined with the main cable protection and grounding schemes explained herein have yielded excellent results in minimizing damage due to nearby lightning strikes.

SOFTWARE LICENSE AGREEMENT AND SOFTWARE WARRANTY

The ICS-4000™ software (firmware) and documentation are owned by PETERSON ELECTRO MUSICAL PRODUCTS, Inc. and are protected by United States copyright laws and international treaty provisions. Therefore, you must treat the ICS-4000™ software (firmware) like any other copyrighted material.

You must not copy the software or written materials accompanying the software. The software (firmware) must not be used in any device other than the ICS-4000™ hardware that it was intended for. You may not reverse engineer, decompile, or disassemble the ICS-4000™ software (firmware).

PETERSON ELECTRO-MUSICAL PRODUCTS, Inc. grants the use of its ICS-4000™ software (firmware) in the ICS-4000™ hardware that it was supplied with.

PETERSON ELECTRO-MUSICAL PRODUCTS, Inc. warrants the physical media (EPROM) in which the ICS-4000™ software is contained to be free from defects and shall replace any such defective media free of charge.

PETERSON ELECTRO-MUSICAL PRODUCTS, Inc. further agrees to provide any licensee of it's ICS-4000™ software (firmware) with any updated version(s) of the ICS-4000™ software free of charge for a period of one year upon request. This upgrade agreement applies to the software (firmware) only and does not include shipping or installation costs and further requires the return of the software (firmware) that is being replaced.

GENERAL LIMITED WARRANTY

(Effective October 1, 1987, as revised from time to time)

Peterson warrants the equipment that it manufactures to be free from defects in material or workmanship under normal use for a period of ten (10) years from the date of the original shipment to the buyer unless otherwise specified in writing. (See exceptions to 10 Year Warranty). Peterson's sole obligation under this warranty shall be that upon the return of goods to the Peterson factory, transportation charges prepaid, Peterson will, at its option, repair or replace any equipment which it deems to contain defective material or workmanship and will return the repaired or replaced equipment to buyer, transportation charges prepaid. Peterson shall have the sole right upon inspection of any item of equipment or part thereof, to determine whether or not the defect is covered by the terms of this warranty.

Peterson will also warrant all of its equipment in a particular installation against indirect lightning strikes. If the installation is considered as a high risk to lightning strikes it is required that certain precautionary installation procedures be followed. These procedures will be specified in writing by Peterson. It is the responsibility of the buyer to check with Peterson prior to the installation as to whether the installation is considered a high risk. This warranty is not valid in the case of direct lightning strikes. Peterson considers a direct strike when the building or the building's electrical system is physically damaged by the lightning strike. By electrical system damage Peterson is referring to electrical wiring, electrical panel, motors, etc., not other electronic equipment in the building. Peterson reserves the right to inspect the installation site, and Peterson's determination as to whether the proper installation procedures were followed will be final. Peterson's sole obligation under this warranty will be the same as listed above in its standard warranty.

This warranty shall not apply to any equipment, or part thereof, which has been repaired by others in such a manner that does not conform with the Peterson standard for quality and/or workmanship, or which has been improperly used, abused, altered, damaged, subjected to accident, flood, fire, or acts of God; or on which any serial numbers have been altered, defaced, or removed. Peterson will not be responsible for any dismantling, reassembly, or reinstallation charges. This warranty is in lieu of any other warranties expressed or implied, including, without limitations, warranty for merchantability and fitness for particular purpose as well as all other representations made to the purchaser. No person is authorized to give any other warranties or to assume any other liabilities on behalf of Peterson unless made or assumed by Peterson in writing. Peterson will not be liable for any special, indirect, incidental, or consequential damages claimed in connection with any rescission of the agreement by the buyer.

Peterson's warranty does not include the Yamaha MDF2 or any other third party sequencer(s). These devices are covered by their manufacturer's warranty.

Peterson's warranty, as herein above set forth, shall not be enlarged, diminished, or affected by, and no obligations or liability shall arise or grow out of Peterson's rendering of technical advice or service in connection with buyer's order of goods furnished hereunder. The warranty gives you specific legal rights which may vary from state to state.

SUPPORT POLICY

Peterson Electro-Musical Products, Inc. will provide any necessary telephone support to aid in the sales, installation, set up/configuration, operation, and service of the ICS-4000™. This support extends to the interface with diode matrix relays, OrgaPlex™ relays, MSP-1000™ and Duo-Set™ combination actions manufactured by Peterson. This also includes software/ operating questions beyond the scope of the manuals.

We are not able to support other manufacturers' equipment which may be connected to the ICS-4000™. To the extent that we are familiar with another manufacturer's equipment, we will do our best to advise on its use with our MIDI interface system. However, due to the large number of MIDI synthesizers, sound modules, sequencers, patch bays, etc., we cannot support or answer questions on these devices or on their interconnection. We recommend that you direct questions to the manufacturer or distributor of the product of interest.

Note: The Peterson ICS-4000™ conforms to the MIDI Manufacturers Association, MIDI 1.0 Specification, Version 4.2 and will operate properly with other equipment that conforms to this specification (or earlier versions). Some equipment that conforms to this specification nevertheless may not recognize certain MIDI messages such as "Pitch Bend", Master Volume (expression), Sustain, Tremolo, Bank Select, etc..

SECTION K - THE ICS ConfigTool™ Organ Configuration Program

SYSTEM PROGRAMMING

A Windows 98/NT® based program incorporating an intuitive user interface format has been developed as the primary means for use by Peterson to pre-program all ICS-4000™ systems before they are shipped. The ICS ConfigTool™ program provides a convenient method of entering all the relevant data about an organ's specification and feature set. The completed ICS-4000™ configuration file is then compiled and uploaded to the ICS-4000™ directly via either a 3.5" floppy disk or a USB-compatible removable memory device (such as a USB Flash Memory Stick). A copy of this file is saved in our customer records for future reference/ use, and in newer ICS-4000s the file is also saved into the internal memory of the ICS-4000 installation itself. The ICS ConfigTool will also print out the required wiring diagrams.

For those installer/ builders that require the ability to program their own systems via the ICS ConfigTool, the requirements are: A Pentium class computer (133 MHZ or greater) with 16 MEG of RAM (minimum), 10 MEG of free hard drive space (minimum), SVGA monitor, mouse, a 3-1/2" floppy drive or USB port (used to upload compiled data from the PC to the ICS-4000™), and an ink jet or laser printer (for labels).

Please contact the factory for more details.

SECTION L - DEFINITIONS

Auto Pedal - A coupler that only responds to the root key of the chord being played.
Bass Coupler - A coupler that only responds to the lowest key being played.
Blind Combination - A combination that affects the stops, but does not cause the stop control to indicate that it is on.
Combination Action - Apparatus for storing (writing) and re-calling (reading) desired combinations (data) of stop controls on an organ console.
Capture - Method of storing (writing) stop control combinations using a set button.
Coupler(s) - Control(s) that causes keyboard information to be "Or-ed" with octavely related keyboard data from itself or other keyboards.
Crescendo - Shoe (foot pedal) control with 60 contacts (address') each of which can be programmed with a different combination. These combinations are "blind" (do not indicate, but do activate stop).
Clock - One of the (control) signals used in multiplexing (demultiplexing) to accomplish the time division (and synchronization).
DeMultiplexer - Circuitry that converts time division multiplexed signal back to parallel outputs.
Division - Refers to a particular keyboard (manual) and its related stops, stop controls and pistons. Usually, division data is after coupling (keyboard/manual data is before coupling.
Divisionals - Refers to the piston buttons (presets) that affect a particular division.
Duo-Set -Can be set by tripper and capture methods of storing (writing) stop combinations.
Expression - Means of controlling the volume of an organ.
Expression Shoe (Pedal)- Foot operated (pedal) device that controls the expression shades.
Expression Shades - Moveable part of expression mechanism that "blocks" the sound when closed and lets the sound out when open.
Floating Division - A division that has no "home" keyboard. Floating divisions are played from other key boards via couplers.
Footage -The pitch descriptor related to couplers and pipe stops.
Frame - Time period required to scan a keyboard (manual) and convert to serial data. Note: There are 5 serial division outputs plus 2 floating division outputs and 3 stop channel serial outputs that all must occur within one frame period.
Generals - Pistons that affect all divisions.
Great/Choir Transfer - A switching function that essentially swaps the keyboard inputs for these two keyboards (manuals). (a.k.a. Manual Transfer).
Inter-manual Coupler - Keyboard information (data) from one keyboard (manual) is coupled (transferred) to another manual.
Intra-manual Coupler - Keyboard information (data) from one keyboard (manual) is coupled (transferred) on the same manual.
Instrument (Output) Port - MIDI data output that connects to an instrument (Sound Module or Synthesizer).
Keyboard - The physical device played by the organist. The keyboard contacts are the physical keying input for the couplers and MIDI.
Lock-Out(s) - Means of preventing setting (writing).
Manual - Keyboard (and its contacts).
Manual Transfer - A switching function that essentially swaps the key contacts (and pistons) of one keyboard to another division and that divisions keys connect to the other division. (a.k.a. Great/Choir Transfer.)
Matrix - An array of "parallel" circuits ("inputs" and "outputs") in which any input circuit can be connected to any output circuit.
Melody Coupler - A coupler that only responds to the highest key being played (top note of a chord).
MIDI - Musical Instrument Digital Interface.
Memory Levels (Memories) - Separate sections of memory used to store different stop combinations for the same pistons.
Multiplex(er) - Circuitry that scans multiple parallel inputs (keys, stops, expression) and converts the parallel signals into one time division signal.
OrgaPlex -Peterson Trade Mark name for time division multiplexed relay system.
Patch - A MIDI term referring to the combination of control messages that select the channel, program(voice) and/or other modifiers to select a desired sound or effect.
Pedal Divide - Typically the "Divide" splits the pedal keyboard where the low 12 notes play as usual and the upper 20 notes only play **stops coupled to the pedal division.**
Pistons - Momentary switches that cause stored stop combinations to be activated. Also used for setting (writing) stop combinations.
Pizzicato - A switching mechanism that allows the key contact(s) to only be active for a short (40-50mS.) time,

thus causing a staccato effect.
(MIDI) Preset - A means of storing and recalling MIDI patches, use via a piston.
"Pre-Stop" - A Peterson term referring to a preset that is controlled by a stop control rather than by a piston.
Program Number - A MIDI term referring to a data variable for selecting a specific sound (voice).
Relay - Apparatus that causes the proper pipe(s) to speak (sound) when its stop control and keyboard are active.
Reversibles - Momentary switches (piston buttons) that latch on with one closure and turn off with the next closure. These can be used to control specific stops (usually couplers) or used to (blindly) control multiple stops (i.e. Tutti).
Set (Setter Piston) - Causes stop combinations to be written to memory.
Sequencer Port - MIDI data output that connects to a sequencing device or computer (with sequencing software) for the purpose of recording an organ performance via control data (not sound).
Serial (Data) - Refers to time division multiplexed data (stream).
Sforzando - Reversible piston button that affects all divisions (likea general) but is "blind" (does not indicate, but does affect stops).
Shoe - A.K.A. expression shoe. Foot operated control device.
Sostenuto - A switching mechanism that causes only the notes being held to "latch" on when the Sostenuto control is activated. Subsequent notes play normally. The "latched" on notes are released when the Sostenuto control is de-activated.
Stop(s) - Refers to a rank (set) of pipes (or voice) played at a particular footage (pitch) from a particular keyboard (manual). Stops are turned on by the stop controls.
Stop Control(s) -Refers to the electro/mechanical (latching) apparatus that turns on a particular stop. This can be operated manually by the organist or electrically by the combination action.
Strobe(s) - One of the (control) signals used in multiplexing (demultiplexing) that provides synchronization and acts as a new frame marker.

Sustain - A switching mechanism that causes any notes played (while the Sustain control is active) to "latch" on.
Transposer - Causes the keyboard information (via the relay) to play the pipes at another pitch (key).
Tripper - Method of storing (writing) stop control combinations after holding a piston button for approximately 2 seconds.
Tutti - Another name for Sforzando.
Unison Off - A switching function that turns OFF the 8' coupler data when it is activated.
Unit Stop(s) - Stops playable at more than one pitch and/or manual.
16' Coupler - Keyboard plays pitch one octave lower.
8' Coupler - Keyboard plays pitch unaltered.
5 ⅓' Coupler - Keyboard plays pitch one fifth higher (C key plays G)
4' Coupler - Keyboard plays pitch one octave higher.

SECTION M - REFERENCES

Note: For both division and piston names and abbreviations, the builder/ installer will be able to enter "custom" names if a required name is not in the list.

DIVISION NAME ABBREVIATIONS

SW	Swell
GT	Great
CH	Choir
PED	Pedal
POS	Positiv
SOL	Solo
MID	MIDI
ANT	Antiphonal
ECH	Echo
CEL	Celestial
GSW	Gallery Swell
GGT	Gallery Great
GPD	Gallery Pedal
CSW	Chancel Swell
CGT	Chancel Great
CPD	Chancel Pedal
REC	Recit
BRU	Brustwerk
RPS	Ruckpositiv
HWK	Hauptwerk
RGW	Rugwerk
OBW	Oberwerk
RES	Resonance
GCH	Grand Choer
ACC	Accompaniment
BOM	Bombarde
G2T	Great 2nd Touch
P2T	Pedal 2nd Touch
A2T	Accompaniment 2nd Touch
UD1	User Defined 1
UD2	User Defined 2
UD3	User Defined 3
UD4	User Defined 4
UD5	User Defined 5
UD6	User Defined 6
UD7	User Defined 7
UD8	User Defined 8

PISTON NAME ABBREVIATIONS

BOUR	Bourdon
ZIMB	Zimbelstern
BOMB	Bombarde
PRI	Principal (pitch handled seperately)
POS	Posaunne
COR	Cornet
POM	Pommer
USATZ	Untersatz
C FAG	Contra Fagato
VIOL	Viole
TREM	Tremolo
TRAPS	TrapsRST Restore
REV	Reversible (# handled seperately, 32 max.)
SRV	Settable Reversible (# handled seperately, 4 max.)
PPCSW	Pedal Piston Coupler Swell
PPCGT	Pedal Piston Coupler Great
PPCCH	Pedal Piston Coupler Choir
PPCPO	Pedal Piston Coupler Positiv
PPC	Pedal Piston Coupler (# handled seperately, 8 max.)
ALLSW	All Swells to Swell
ALLRS	All Reeds Off
ALLMX	All Mixtures Off
TUT	Tutti
NXT	NextPRV Previous
MANTR	Manual Transfer
MID	MIDI (# handled seperately, 32 max.)
CUST	CUSTOM (# handled seperately,8 max.)

MANUAL NAME ABBREVIATIONS

SW	Swell
GT	Great
CH	Choir
PED	Pedal
POS	Positiv
SOL	Solo
MID	MIDI
ANT	Antiphonal
ECH	Echo
CEL	Celestial
GSW	Gallery Swell
GGT	Gallery Great
GPD	Gallery Pedal
CSW	Chancel Swell
CGT	Chancel Great
CPD	Chancel Pedal
REC	Recit
BRU	Brustwerk
RPS	Ruckpositiv
HWK	Hauptwerk
RGW	Rugwerk
OBW	Oberwerk
RES	Resonance
GCH	Grand Choer
ACC	Accompaniment
BOM	Bombarde
G2T	Great 2nd Touch
P2T	Pedal 2nd Touch
A2T	Accompaniment 2nd Touch

KEYBOARD TYPES
Master
Slave
Floating
2nd Touch
Velocity

PITCH NAMES
--- None
64
42 2/3
32
25 3/5
21 1/3
16
12 4/5
10 2/3
9 1/7
8
7 1/9
6 2/5
5 1/3
4 4/7
4
3-5/9
3 1/5
2 2/3
2 2/7
2
1 3/5
1 1/3
1 1/7
1
4/5
2/3
4/7
1/2
2/5
1/3
2/7
1/4

RANK TYPES

Straight
Unit
Offset

STOP TYPES

Straight
Unit
Coupler
Offset
Phantom
MIDI
Wired
Control Only
Ventil
Duplex
Divide

STOP ATTRIBUTES

---- None
Sostenuto
Pizzicato
Melody
Bass

MIDI CHANNEL TYPE

Instrument
Organ

AMPLITUDE TYPES

Volume
Velocity

ALLOWED CHARACTERS FOR PASSWORDS AND CDU NAMES

A-Z, 0-9

PISTON TYPES

DIV	(divisional)
DVC	(div.cancel)
GEN	(general)
GC	(gen. cancel)
TUT	(tutti)
MST	(master)
MAC	(master cancel)
MID	(midi)
MDC	(midi cancel)
RR	(regular rev.)
SR	(settable rev.)
BR	(blind rev.)
SET	
RST	(restore)
NXT	(next)
PRV	(previous)
PHN	(phantom)
CMP	(compass)
XFR	(transfer)

GENERAL MIDI PROGRAM NAMES (BASE 1)

1. Acoustic Grand Piano
2. Bright Acoustic Piano
3. Electric Grand Piano
4. Honky-Tonk Piano
5. Electric Piano 1
6. Electric Piano 2
7. Harpsichord
8. Clavichord
9. Celesta
10. Glockenspiel
11. Music Box
12. Vibraphone
13. Marimba
14. Xylophone
15. Tubular Bells
16. Dulcimer
17. Drawbar Organ
18. Percussive Organ
19. Rock Organ
20. Church Organ
21. Reed Organ
22. Accordion
23. Harmonica
24. Tango Accordion
25. Acoustic Guitar(nylon)
26. Acoustic Guitar(steel)
27. Electric Guitar(jazz)
28. Electric Guitar(clean)
29. Electric Guitar(muted)
30. Overdriven Guitar
31. Distortion Guitar
32. Guitar Harmonics
33. Acoustic Bass
34. Electric Bass (finger)
35. Electric Bass (pick)
36. Fretless Bass
37. Slap Bass 1
38. Slap Bass 2
39. Synth Bass 1
40. Synth Bass 2
41. Violin
42. Viola
43. Cello
44. Contrabass
45. Tremolo Strings
46. Pizzicato Strings
47. Orchestral Harp
48. Timpani
49. String Ensemble 1
50. String Ensemble 2
51. SynthStrings 1
52. SynthStrings 2
53. Choir Aahs
54. Voice Oohs
55. Synth Voice
56. Orchestra Hit
57. Trumpet
58. Trombone
59. Tuba
60. Muted Trumpet
61. French Horn
62. Brass Section
63. SynthBrass 1
64. SynthBrass 2
65. Soprano Sax
66. Alto Sax
67. Tenor Sax
68. Baritone Sax
69. Oboe

70. English Horn
71. Bassoon
72. Clarinet
73. Piccolo
74. Flute
75. Recorder
76. Pan Flute
77. Blown Bottle
78. Shakuhachi
79. Whistle
80. Ocarina
81. Lead 1 (square)
82. Lead 2 (sawtooth)
83. Lead 3 (calliope)
84. Lead 4 (chiff)
85. Lead 5 (charang)
86. Lead 6 (voice)
87. Lead 7 (fifths)
88. Lead 8 (bass+lead)
89. Pad 1 (new age)
90. Pad 2 (warm)
91. Pad 3 (polysynth)
92. Pad 4 (choir)
93. Pad 5 (bowed)
94. Pad 6 (metallic)
95. Pad 7 (halo)
96. Pad 8 (sweep)
97. FX 1 (rain)
98. FX 2 (soundtrack)
99. FX 3 (crystal)
100. FX 4 (atmosphere)
101. FX 5 (brightness)
102. FX 6 (goblins)
103. FX 7 (echoes)
104. FX 8 (sci-fi)
105. Sitar
106. Banjo
107. Shamisen
108. Koto
109. Kalimba
110. Bagpipe
111. Fiddle
112. Shanai
113. Tinkle Bell
114. Agogo
115. Steel Drums
116. Woodblock
117. Taiko Drum
118. Melodic Tom
119. Synth Drum
120. Reverse Cymbal
121. Guitar Fret Noise
122. Breath Noise
123. Seashore
124. Bird Tweet
125. Telephone Ring
126. Helicopter
127. Applause
128. Gunshot

MIDI IMPLEMENTATION CHART Date 9-25-00
MODEL: PETERSON ICS-4000TM Version: ICS 1.0

Function	Transmitted	Recognized	Remarks
Default Chan.	1=Sw 2=Gt 4=Ch 4=Pd 5=So (4th 6=Anti 7=Echo (1-16/1-24)	1-16 (1-24)	User Configurable See Note 2 Default channels as listed.
Mode	No	No	Modes supported: Multi
Note Number	24-108	24-108	
Velocity			User selected.
Note On	Yes	No	Sent instead of
Note Off	No	No	expression. (Cntl.Chg.7)
After Touch			
Keys	No	No	
Channels	No	No	
Pitch Bend	Yes	No	
Control Change			
0	Yes	No	Bank Select MSB (00)
7	Yes	Yes	Ch.1=Sw Ch.2=Gt Ch.3=Ch Ch.4=Pd Ch.5=So
32	Yes	No	Bank Select LSB (0-127)
46	Yes	Yes	
64	Yes	No	User Selected
66	Yes	No	User Selected
70	Yes	No	
92	Yes	No	
Program Change	0-127	0-127	
System Exclusive	Yes	Yes	Sysex ID # 00 00 57h Also see Note 1.
System Common			
Song Position	No	No	
Song Select	No	No	
Tune	No	No	
System Real Time			
Start	Yes	No	
Continue Yes	No		
Stop	Yes	No	
Local On/Off	No	No	
All-Notes-Off	Yes	Yes	
Active Sense	No	No	
Reset	No	No	

Notes: 1. Also recognize Allen Organ sysex ID # 00 00 35h, Rodgers Instrument sysex ID # 00 00 2Dh and Roland (Ro
2. Channels 17-24 are alternate Synth channels on the Sequencer Out

Mode 1: Omni On, Poly Mode 2: Omni On, Mono
Mode 3: Omni Off, Poly Mode 4; Omni Off, Mono

PETERSON UNIVERSAL STOP LIST

Each physical organ stop control will have a pre-assigned stop name and pitch from the Peterson "Universal Stop List (MAP)". The stops on any particular organ will be assigned to their corresponding logical bit in the appropriate division stop group, thus making MIDI files interchangeable between organs of any size and stop list. Even files made on a theater organ could be used on a classical organ or vice versa.

Most frequently used stop controls/ pitches will be in the first (0) stop subgroup and the least used will be in the 8th subgroup. Subgroups 9-11 are used for "Fast Config." assignments. Subgroups 12-16 would be used for unique stops/controls that would not likely translate to any another organ specification. Consult Peterson on the use of these unassigned subgroups to avoid conflicts in compatible files. Channel 7(8) is reserved for encoding general couplers and piston data. A means of masking and/or disabling the piston data is provided as piston changes are not likely compatible from organ to organ. Piston bits should only be used if compatibility is not required and where visual (or mechanically moving) stop control from a combination action is desired or from an assigned receive program change. An alternate method of encoding/decoding pistons (as stops) using subgroups 12-16 is preferred.

The Universal Stop List (MAP) begins below and is broken down by subgroups showing prioritizing. There are currently 207 stop controls with 296 stop names (including alternates) provided for in this list. These utilize 8 subgroups. Additional stop controls and/or alternate names can be added. There are 17 unassigned bits in the 1-8 subgroups and most of the bits in subgroups 12-16 for this purpose. Bear in mind that this list is reused for each of 7 divisions, so a 1358 stop organ could be accommodated.

An example/ legend is provided at the beginning of the "Universal Stop List (MAP)" below that explains the format used.

PETERSON "UNIVERSAL STOP LIST (MAP)"

Example: 65. 2.09 8' DULCIANA (AEOLINE)

LEGEND

65	=	Assignment number
2	=	Stop Subgroup
09	=	Second bit of 2nd byte
8'	=	Pitch
DULCIANA	=	Stop name
(AEOLINE)	=	Alternate stop name(s)

UNIVERSAL STOP LIST Revised 6-17-98

143.	5.03	64'	GRAVISSIMA (RESULTANT)
196.	6.28	64'	REED/DIAPHONE
142.	5.02	32'	OPEN DIAPASON (FLUTE OUVERTE)
141.	5.01	32'	PRINCIPAL
208.	7.12	32'	UNTERSATZ (MAJOR BASS)
136.	4.24	32'	CONTRA VIOLONE
95.	3.11	32'	CONTRA BOURDON
111.	3.27	32'	POSAUNE
135.	4.23	32'	CONTRA BOMBARDE (DIAPHONE)
134.	4.22	32'	CONTRA FAGOTTO
195.	6.27	32'	CONTRA BASSOON
54.	1.26	32'	RESULTANT
96.	3.12	16'	OPEN DIAPASON (DIAPHONIC DIAPASON, FLUTE OUVERTE)
10.	0.10	16'	PRINCIPAL (MONTRE)
209.	7.13	16'	PRESTANT
128.	4.16	16'	CONTRA BASS
129.	4.17	16'	VIOLONE
210.	7.14	16'	SUBBASS
11.	0.11	16'	BOURDON (TIBIA CLAUSA)
97.	3.13	16'	GEMSHORN (SPITZFLUTE)
98.	3.14	16'	GAMBA
138.	4.26	16'	CELLO (VIOLON CELLO)
12.	0.12	16'	LIEBLICH GEDACKT
99.	3.15	16'	QUINTATON (ROHR BOURDON, POMMER, FLUTE a CHEMINEE)
130.	4.18	16'	BOMBARDE (OPHECLIEDE)
131.	4.19	16'	TROMBONE (POSAUNE, DIAPHONE, BAZUIN)
137.	4.25	16'	TUBA (TUBA MAGNA, TUBA MAJOR)
13.	0.13	16'	FAGOTTO (BASSON, OBOE HORN)
243.	8.19	16'	OBOE (HAUTBOIS)
14.	0.14	16'	TRUMPET (TROMPETTE)
132.	4.20	16'	DULZIAN (CLARINET, CROMORNE, KRUMMHORN)
133.	4.21	16'	TROMPETTE-EN-CHAMADE

219.	7.23	16'	SAXOPHONE
220.	7.24	16'	BRASS TRUMPET
221.	7.25	16'	ENGLISH POST HORN
108.	3.24	16'	VOX HUMANA
109.	3.25	16'	RESULTANT
100.	3.16	10 2/3'	GROSS QUINTE
113.	4.01	8'	STENTORPHONE (GRAND DIAPASON, DIAPHONIC DIAPASON)
57.	2.01	8'	OPEN DIAPASON (1st OPEN DIAPASON)
1.	0.01	8'	PRINCIPAL (2nd OPEN DIAPASON)
249.	8.25	8'	VOCE UMANA (PRINCIPAL CELESTE)
58.	2.02	8'	GEIGEN PRINCIPAL (3rd OPEN DIAPASON, VIOLIN DIAPASON)
245.	8.21	8'	SUBBASS
59.	2.03	8'	FLUTE MAJOR (GROSS FLUTE, SOLO TIBIA CLAUSA, TIBIA CLAUSA)
2.	0.02	8'	BOURDON (2nd FLUTE)
60.	2.04	8'	FLUTE HARMONIQUE (CONCERT FLUTE, MELODIA, HOHLFLUTE)
61.	2.05	8'	GEDACKT (STOPPED DIAPASON, HOLZGEDECKT)
247.	8.23	8'	ROHRFLUTE (CHIMNEY FLUTE , SPILLFLOTE, KOPPELFLOTE)
246.	8.22	8'	DOPPELFLOTE (DOUBLE FLUTE)
62.	2.06	8'	QUINTADE (QUINTADENA, POMMER)
244.	8.20	8'	VIOLONE
3.	0.03	8'	VIOLA (VIOL DA GAMBA, VIOL D. ORCHESTRE)
4.	0.04	8'	VIOLA CELESTE
187.	6.19	8'	GEMSHORN (SPITZFLUTE)
188.	6.20	8'	GEMSHORN CELESTE (SPITZFLUTE CELESTE)
63.	2.07	8'	SALICIONAL
64.	2.08	8'	VOIX CELESTE
114.	4.02	8'	FLAUTO DOLCE (ERZAHLER)
115.	4.03	8'	FLUTE CELESTE (ERZAHLER CELESTE)
65.	2.09	8'	DULCIANA (AEOLINE, DOLCAN)
139.	4.27	8'	CELLO (VIOLIN CELLO)
140.	4.28	8'	CELLO CELEST
116.	4.04	8'	UNDA MARIS (AEOLINE CELESTE, DOLCAN CELESTE)
66.	2.10	8'	TUBA (TROMBA, HARMONIC TUBA, TUBA MIRABILIS)
5.	0.05	8'	TRUMPET (TROMPETTE, CORNOPEAN, BRASS TRUMPET)
6.	0.06	8'	OBOE (HAUTBOIS, ORCHESTRAL OBOE)
67.	2.11	8'	HARMONIC TRUMPET (TROMPETTE HARMONIQUE)
241.	8.17	8'	FAGOT (BASSON, OBOE HORN)
242.	8.18	8'	BOMBARDE (POSAUNE)
68.	2.12	8'	FRENCH HORN
250.	8.26	8'	CORNO DI BASSETTO (COR D' ORCHESTRE)
117.	4.05	8'	ENGLISH HORN (COR D' ANGLAIS)
69.	2.13	8'	CLARINET (KRUMMHORN, CROMORNE)
70.	2.14	8'	VOX HUMANA (VOIX HUMAINE)
118.	4.06	8'	TROMPETTE-EN-CHAMADE (TROMPETTE REAL, FANFARE TRUMPET)
214.	7.18	8'	STATE TRUMPET (FESTIVAL TRUMPET)
159.	5.19	8'	ENGLISH POST HORN
160.	5.20	8'	KRUMMET (KRUMMHORN, KORNET, CROMORNE)
161.	5.21	8'	SERPENT
162.	5.22	8'	MUSETTE
163.	5.23	8'	SOLO VOX HUMANA
164.	5.24	8'	SAXOPHONE (BRASS SAXOPHONE)
165.	5.25	8'	KINURA
168.	5.28	6 2/5'	GRAND TIERCE
71.	2.15	5 1/3'	QUINT
119.	4.07	5 1/3'	QUINT TROMPETTE
27.	0.27	4 4/7'	MUTATION
7.	0.07	4'	OCTAVE
72.	2.16	4'	PRINCIPAL
73.	2.17	4'	PRESTANT
110.	3.26	4'	GEIGEN OCTAVE
8.	0.08	4'	CHIMNEY FLUTE (ROHR FLUTE, KOPPEL FLOTE)
74.	2.18	4'	GEDACKT (SUBBASS, BOURDON, TIBIA)
75.	2.19	4'	SPITZ FLUTE (SPITZ PRINCIPAL, GEMSHORN)
76.	2.20	4'	OPEN FLUTE (NACHTHORN, COR DE NUIT, WALDFLOTE)
77.	2.21	4'	HARMONIC FLUTE (FLUTE TRAVERSO, ZAUBERFLOTE, CONCERT FLUTE, TRAVERSFLUTE)
120.	4.08	4'	FUGARA (VIOLINA)
78.	2.22	4'	SALICET
121.	4.09	4'	CELESTE
79.	2.23	4'	GAMBETTE
166.	5.26	4'	UNDA MARIS
122.	4.10	4'	CELESTINA
80.	2.24	4'	DULCET

85.	3.01	4'	HARMONIC TUBA (HARMONIC CLARION)
9.	0.09	4'	CLARION (Ped. BOMBARDE, Ped. POSAUNE)
86.	3.02	4'	CHALUMEAU (ROHR SCHALMEI)
87.	3.03	4'	OBOE (FAGOT, HAUTBOIS)
124.	4.12	4'	TROMPETTE EN CHAMADE
189.	6.21	4'	KRUMMHORN (CLARINET)
167.	5.27	4'	VOX HUMANA
125.	4.13	3 1/5'	GROSS TIERCE
23.	0.23	2 2/3'	QUINTE (TWELFTH)
88.	3.04	2 2/3'	NAZARD
21.	0.21	2'	PRINCIPAL (FIFTEENTH, SUPER OCTAVE, OKTAVLEIN)
89.	3.05	2'	SPITZ FLUTE (SPITZ PRINCIPAL)
248.	8.24	2'	SPILLFLOTE
22.	0.22	2'	BLOCK FLUTE (PICCOLO)
90.	3.06	2'	HARMONIC PICCOLO
251.	8.27	2'	WALDFLOTE
252.	8.28	2'	REGAL
126.	4.14	2'	KORNET (KRUMMHORN, CROMORNE)
24.	0.24	1 3/5'	TIERCE (TERZ)
29.	1.01	1 1/3'	QUINT (LARIGOT)
127.	4.15	1 1/7'	SEPTIEME
91.	3.07	1'	SIFFLOTE (FIFE)
56.	1.28	8/9'	MUTATION
145.	5.04	2/3'	QUINT
28.	0.28	2/5'	MUTATION
123.	4.11	1/2'	MUTATION
146.	5.05		HARMONICS
147.	5.06		FULL MIXTURE
224.	7.28		GROSS CORNET (GRANDE CORNET)
206.	7.10		GRAND FOURNITURE
30.	1.02		FOURNITURE
55.	1.27		PLEIN JEU
31.	1.03		SHARFF
207.	7.11		TIERCE MIXTURE
92.	3.08		CYMBAL
147.	5.07		ACUTA
32.	1.04		SESQUIALTERA (ZINK)
93.	3.09		CORNET
94.	3.10		SEPTERZ
53.	1.25		II MIXTURE
25.	0.25		III MIXTURE
26.	0.26		IV MIXTURE
211.	7.15		V MIXTURE
212.	7.16		VI MIXTURE
213.	7.117		VII MIXTURE
20.	0.20		TREMULANT I-FAST (PRIMARY OR FIRST)
148.	5.08		TREMULANT II-SLOW
171.	6.03		TREMULANT MAIN A
172.	6.04		TREMULANT MAIN B
173.	6.05		TREMULANT TIBIA
174.	6.06		TREMULANT VOX
175.	6.07		TREMULANT BRASS
176.	6.08		TREMULANT REEDS
187.	6.19		GLOCK RE-IT
188.	6.20		XYLO RE-IT
189.	6.21		MARIMBA RE-IT
15.	0.15	16'	SUB COUPLER
16.	0.16	8'	UNISON COUPLER (UNISON OFF)
194.	6.26	5 1/3'	QUINT COUPLER
17.	0.17	4'	OCTAVE COUPLER
37.	1.09	16'	SOLO TO X
38.	1.10	8'	SOLO TO X
194.	6.26	5 1/3'	SOLO TO X
39.	1.11	4'	SOLO TO X
40.	1.12	16'	SWELL TO X
41.	1.13	8'	SWELL TO X
42.	1.14	4'	SWELL TO X

43.	1.15	16'	GREAT TO X	
44.	1.16	8'	GREAT TO X	
45.	1.17	4'	GREAT TO X	
46.	1.18	16'	CHOIR TO X	
47.	1.19	8'	CHOIR TO X	
48.	1.20	4'	CHOIR TO X	
222.	7.26		PEDAL TO X	
152.	5.12		ECHO ON X	
153.	5.13		ANTIPHONAL ON X	
154.	5.14		POSITIV ON X	
190.	6.22	16'	GALLERY GREAT TO X	(OR REMOTE)
191.	6.23	8'	GALLERY GREAT TO X	(OR REMOTE)
192.	6.24	4'	GALLERY GREAT TO X	(OR REMOTE)
191.	6.23	16'	GALLERY SWELL TO X	(OR REMOTE)
191.	6.23	8'	GALLERY SWELL TO X	(OR REMOTE)
191.	6.23	4'	GALLERY SWELL TO X	(OR REMOTE)
191.	6.23	16'	GALLERY PEDAL TO X	(OR REMOTE)
191.	6.23	8'	GALLERY PEDAL TO X	(OR REMOTE)
191.	6.23	4'	GALLERY PEDAL TO X	(OR REMOTE)
191.	6.23	16'	GALLERY CHOIR TO X	(OR REMOTE)
191.	6.23	8'	GALLERY CHOIR TO X	(OR REMOTE)
191.	6.23	4'	GALLERY CHOIR TO X	(OR REMOTE)
34.	1.06	16'	MIDI TO X	
35.	1.07	8'	MIDI TO X (MIDI ON/OFF)	
36.	1.08	4'	MIDI TO X	
49.	1.21	16'	MIDI "A"	
50.	1.22	16'	MIDI "B"	
102.	3.18	16'	MIDI "C"	
103.	3.19	16'	MIDI "D"	
18.	0.18	8'	MIDI "A"	
19.	0.19	8'	MIDI "B"	
104.	3.20	8'	MIDI "C"	
105.	3.21	8'	MIDI "D"	
51.	1.23	4'	MIDI "A"	
52.	1.24	4'	MIDI "B"	
106.	3.22	4'	MIDI "C"	
107.	3.23	4'	MIDI "D"	
81.	2.25	8'	MIDI MELODY	
82.	2.26	4'	MIDI MELODY	
83.	2.27	16'	MIDI BASS	
84.	2.28	8'	MIDI BASS	
155.	5.15		MANUAL TRANSFER	
223.	7.27		PEDAL DIVIDE	
112.	3.28		X SHOE TO SWELL	
156.	5.16		ALL SWELLS TO SWELL	
157.	5.17		BASS COUPLER	
158.	5.18		MELODY COUPLER	
169.	6.01		PIZZICATTO COUPLER	
170.	6.02		SOSTENUTO	
181.	6.13	16'	PIANO	
182.	6.14	8'	PIANO	
183.	6.15	4'	PIANO	
184.	6.16		PIANO SUSTAIN	
215.	7.19		REMOTE ORGAN ON/OFF	
216.	7.20		REMOTE OCNSOLE ON/OFF	
217.	7.21		LOCAL ORGAN ON/OFF	
218.	7.22		LOCAL CONSOLE ON/OFF	
33.	1.05		CHIMES	
149.	5.09		HARP	
150.	5.10		CELESTA	
151.	5.11		CARILLON	
185.	6.17		TOWER CHIMES	
177.	6.09		MARIMBA HARP	
178.	6.10		CHRYSOLGLOTT	
179.	6.11		XYLOPHONE	
180.	6.12		GLOCKENSPIEL	
186.	6.18		TUNED SLEIGH BELLS	
101.	3.17		ZIMBELSTERN	
191.	6.23		GONG	
192.	6.24		TRIANGLE	

212.	7.16		SLEIGH BELLS
200.	7.04		CRASH CYMBAL
201.	7.05		TAP CYMBAL
202.	7.06		BRUSH CYMBAL
214.	7.18		FINGER CYMBAL
203.	7.07		SNARE DRUM
199.	7.03		BASS DRUM
204.	7.08		SNARE DRUM ROLL
205.	7.09		TOM TOM
206.	7.10		TYMPANI
207.	7.11		TAMBORINE
208.	7.12		CASTINETS
209.	7.13		CHINESE BLOCK
210.	7.14		WOOD BLOCK
211.	7.15		SAND BLOCK
197.	7.01		STEAMBOAT WHISTLE
198.	7.02		BIRD WHISTLE
190.	6.22		SIREN
213.	7.17		GLADSTONE AFTERBEAT
225.	8.01		SWELL SHADE 1
226.	8.02		SWELL SHADE 2
227.	8.03		SWELL SHADE 3
228.	8.04		SWELL SHADE 4
229.	8.05		SWELL SHADE 5
230.	8.06		SWELL SHADE 6
231.	8.07		SWELL SHADE 7
232.	8.08		SWELL SHADE 8
233.	8.09		SWELL SHADE 9
234.	8.10		SWELL SHADE 10
235.	8.11		SWELL SHADE 11
236.	8.12		SWELL SHADE 12
237.	8.13		SWELL SHADE 13
238.	8.14		SWELL SHADE 14
239.	8.15		SWELL SHADE 15
240.	8.16		SWELL SHADE 16

The following is a duplicate “Universal Stop List (MAP)” that has been sorted by it's assignment (sysex subgroup) numbers. Use for checking assigned stops.

1.	0.01	8'	PRINCIPAL (2nd OPEN DIAPASON)
2.	0.02	8'	BOURDON (2nd FLUTE)
3.	0.03	8'	VIOLA (VIOL DA GAMBA, VIOL D. ORCHESTRE, GEMSHORN)
4.	0.04	8'	VIOLA CELESTE (GEMSHORN CELESTE)
5.	0.05	8'	TRUMPET (TROMPETTE, CORNOPEAN, BRASS TRUMPET, BOMBARDE, POSUANE)
6.	0.06	8'	OBOE (FAGOT, HAUTBOIS, BASSON, ORCHESTRAL OBOE,OBOE HORN)
7.	0.07	4'	OCTAVE
8.	0.08	4'	CHIMNEY FLUTE (ROHR FLUTE, KOPPEL FLUTE)
9.	0.09	4'	CLARION (Ped. BOMBARDE, Ped. POSUANE)
10.	0.10	16'	PRINCIPAL (MONTRE)
11.	0.11	16'	BOURDON (SUBBASS, TIBIA CLAUSA)
12.	0.12	16'	LIEBLICH GEDACKT
13.	0.13	16'	FAGOTTO (BASSON, HAUTBOIS, OBOE, OBOE HORN)
14.	0.14	16'	TRUMPET (TROMPETTE)
15.	0.15	16'	SUB COUPLER
16.	0.16	8'	UNISON COUPLER (UNISON OFF)
17.	0.17	4'	OCTAVE COUPLER
18.	0.18	8'	MIDI A
19.	0.19	8'	MIDI B
20.	0.20		TREMULANT I-FAST (PRIMARY OR FIRST)
21.	0.21	2'	PRINCIPAL (SUPER OCTAVE, OKTAVLEIN)
22.	0.22	2'	BLOCK FLUTE (PICCOLO)
23.	0.23	2 2/3'	QUINTE
24.	0.24	1 3/5'	TIERCE (TERZ)
25.	0.25	III	MIXTURE
26.	0.26	IV	MIXTURE
27.	0.27	4 4/7'	MUTATION
28.	0.28	2/5'	MUTATION
29.	1.01	1 1/3'	QUINTE (LARIGOT)
30.	1.02		FOURNITURE
31.	1.03		SHARFF
32.	1.04		SESQUIALTERA

33.	1.05		CHIMES
34.	1.06	16'	MIDI TO X
35.	1.07	8'	MIDI TO X (MIDI ON/OFF)
36.	1.08	4'	MIDI TO X
37.	1.09	16'	SOLO TO X
38.	1.10	8'	SOLO TO X
39.	1.11	4'	SOLO TO X
40.	1.12	16'	SWELL TO X
41.	1.13	8'	SWELL TO X
42.	1.14	4'	SWELL TO X
43.	1.15	16'	GREAT TO X
44.	1.16	8'	GREAT TO X
45.	1.17	4'	GREAT TO X
46.	1.18	16'	CHOIR TO X
47.	1.19	8'	CHOIR TO X
48.	1.20	4'	CHOIR TO X
49.	1.21	16'	MIDI “A”
50.	1.22	16'	MIDI “B”
51.	1.23	4'	MIDI “A”
52.	1.24	4'	MIDI “B”
53.	1.25	II	MIXTURE
54.	1.26	32'	RESULTANT
55.	1.27		PLEIN JEU
56.	1.28	8/9'	MUTATION
57.	2.01	8'	OPEN DIAPASON (1st OPEN DIAPASON)
58.	2.02	8'	GEIGEN PRINCIPAL (3rd OPEN DIAPASON, VIOLIN DIAPASON)
59.	2.03	8'	FLUTE MAJOR (GROSS FLUTE, SOLO TIBIA CLAUSA, TIBIA)
60.	2.04	8'	FLUTE HARMONIQUE (CONCERT FLUTE, MELODIA, HOHLFLUTE)
61.	2.05	8'	GEDACKT (STOPPED DIAPASON, HOLZGEDEKT)
62.	2.06	8'	QUINTADE (QUINTADENA)
63.	2.07	8'	SALICIONAL
64.	2.08	8'	VOIX CELESTE
65.	2.09	8'	DULCIANA (AEOLINE, DOLCAN)
66.	2.10	8'	TUBA (TROMBA, HARMONIC TUBA, TUBA MIRABILIS)
67.	2.11	8'	HARMONIC TRUMPET (TROMPETTE HARMONIQUE)
68.	2.12	8'	FRENCH HORN (CORNO DI BASSETTO, COR D' ORCHESTRE)
69.	2.13	8'	CLARINET (KRUMMHORN, CROMORNE)
70.	2.14	8'	VOX HUMANA (VOIX HUMAINE)
71.	2.15	5 1/3'	QUINT
72.	2.16	4'	PRINCIPAL
73.	2.17	4'	PRESTANT
74.	2.18	4'	GEDACKT (BOURDON, SUBBASS, TIBIA)
75.	2.19	4'	SPITZ FLUTE (SPITZ PRINCIPAL, GEMSHORN)
76.	2.20	4'	OPEN FLUTE (NACHTHORN, COR DE NUIT, WALDFLOTE)
77.	2.21	4'	HARMONIC FLUTE (FLUTE TRAVERSO, ZAUBERFLOTE, CONCERT FLUTE, TRAVERSFLOTE)
78.	2.22	4'	SALICET
79.	2.23	4'	GAMBETTE
80.	2.24	4'	DULCET
81.	2.25	8'	MIDI MELODY
82.	2.26	4'	MIDI MELODY
83.	2.27	16'	MIDI BASS
84.	2.28	8'	MIDI BASS
85.	3.01	4'	HARMONIC TUBA (HARMONIC CLARION)
86.	3.02	4'	CHALUMEAU (ROHR SCHALMEI)
87.	3.03	4'	OBOE (FAGOT, HAUTBOIS)
88.	3.04	2 2/3'	NAZARD
89.	3.05	2'	SPITZ FLUTE (SPITZ PRINCIPAL)
90.	3.06	2'	HARMONIC PICCOLO
91.	3.07	1'	SIFFLOTE (FIFE)
92.	3.08		CYMBAL
93.	3.09		CORNET
94.	3.10		SEPTERZ
95.	3.11	32'	CONTRA BOURDON
96.	3.12	16'	OPEN DIAPASON (DIAPHONIC DIAPASON, FLUTE OUVERTE)
97.	3.13	16'	GEMSHORN (SPITZFLUTE)
98.	3.14	16'	GAMBA
99.	3.15	16'	QUINTATON (ROHR BOURDON, POMMER, FLUTE a CHEMINEE)
100.	3.16	10 2/3'	GROSS QUINTE
101.	3.17		ZIMBELSTERN
102.	3.18	16'	MIDI “C”
103.	3.19	16'	MIDI “D”

104.	3.20	8'	MIDI “C”
105.	3.21	8'	MIDI “D”
106.	3.22	4'	MIDI “C”
107.	3.23	4'	MIDI “D”
108.	3.24	16'	VOX HUMANA
109.	3.25	16'	RESULTANT
110.	3.26	4'	GEIGEN OCTAVE
111.	3.27	32'	POSAUNE
112.	3.28		X SHOE TO SWELL
113.	4.01	8'	STENTORPHONE (GRAND DIAPASON, DIAPHONIC DIAPASON)
114.	4.02	8'	FLAUTO DOLCE (ERZAHLER)
115.	4.03	8'	FLUTE CELESTE (ERZAHLER CELESTE)
116.	4.04	8'	UNDA MARIS (AEOLINE CELESTE, DOLCAN CELESTE)
117.	4.05	8'	ENGLISH HORN (COR D' ANGLAIS)
118.	4.06	8'	TROMPETTE-EN-CHAMADE (TROMPETTE REAL, FANFARE TRUMPET)
119.	4.07	5 1/3'	QUINT TROMPETTE
120.	4.08	4'	FUGARA (VIOLINA)
121.	4.09	4'	CELESTE
122.	4.10	4'	CELESTINA
123.	4.11	1/2'	MUTATION
124.	4.12	4'	TROMPETTE EN CHAMADE
125.	4.13	3 1/5'	GROSS TIERCE
126.	4.14	2'	KORNET (KRUMMHORN, CROMORNE)
127.	4.15	1 1/7'	SEPTIEME
128.	4.16	16'	CONTRE BASS
129.	4.17	16'	VIOLONE
130.	4.18	16'	BOMBARDE (OPHECLIEDE)
131.	4.19	16'	TROMBONE (POSAUNE, DIAPHONE, BAZUIN)
132.	4.20	16'	DULZIAN (CLARINET, CROMORNE, KRUMMHORN)
133.	4.21	16'	TROMPETTE-EN-CHAMADE
134.	4.22	32'	CONTRA FAGOTTO
135.	4.23	32'	CONTRA BOMBARDE (DIAPHONE)
136.	4.24	32'	CONTRA VIOLONE
137.	4.25	16'	TUBA
138.	4.26	16'	CELLO (VIOLIN CELLO)
139.	4.27	8'	CELLO (VIOLIN CELLO)
140.	4.28	8'	CELLO CELEST
141.	5.01	32'	PRINCIPAL
142.	5.02	32'	OPEN DIAPASON (FLUTE OUVERTE)
143.	5.03	64'	GRAVISSIMA (RESULTANT)
144.	5.04	2/3'	QUINT
145.	5.05		HARMONICS
146.	5.06		FULL MIXTURE
147.	5.07		ACUTA
148.	5.08		TREMULANT II-SLOW
149.	5.09		HARP
150.	5.10		CELESTA
151.	5.11		CARILLON
152.	5.12		ECHO ON X
153.	5.13		ANTIPHONAL ON X
154.	5.14		POSITIV ON X
155.	5.15		MANUAL TRANSFER
156.	5.16		ALL SWELLS TO SWELL
157.	5.17		BASS COUPLER
158.	5.18		MELODY COUPLER
159.	5.19	8'	ENGLISH POST HORN
160.	5.20	8'	KRUMMET (KRUMMHORN, KORNET, CROMORNE)
161.	5.21	8'	SERPENT
162.	5.22	8'	MUSETTE
163.	5.23	8'	SOLO VOX HUMANA
164.	5.24	8'	SAXOPHONE (BRASS SAXOPHONE)
165.	5.25	8'	KINURA
166.	5.26	4'	UNDA MARIS
167.	5.27	4'	VOX HUMANA
168.	5.28	6 2/5'	GRAND TIERCE
169.	6.01		PIZZICATO COUPLER
170.	6.02		SOSTENUTO
171.	6.03		TREMULANT MAIN A
172.	6.04		TREMULANT MAIN B
173.	6.05		TREMULANT TIBIA
174.	6.06		TREMULANT VOX

175.	6.07		TREMULANT BRASS	
176.	6.08		TREMULANT REEDS	
177.	6.09		MARIMBA HARP	
178.	6.10		CHRYSOLGLOTT	
179.	6.11		XYLOPHONE	
180.	6.12		GLOCKENSPIEL	
181.	6.13	16'	PIANO	
182.	6.14	8'	PIANO	
183.	6.15	4'	PIANO	
184.	6.16		PIANO SUSTAIN	
185.	6.17		TOWER CHIMES	
186.	6.18		TUNED SLEIGH BELLS	
187.	6.19	8'	GEMSHORN (SPITZFLUTE)	(GLOCK RE-IT)
188.	6.20	8'	GEMSHORN CELESTE (SPIZFLUTE CELESTE)	(XYLO RE-IT)
189.	6.21	4'	KRUMMHORN (CLARINET)	(MARIMBA RE-IT)
190.	6.22	16'	GALLERY GREAT TO X	(SIREN)
191.	6.23	8'	GALLERY GREAT TO X	(GONG)
192.	6.24	4'	GALLERY GREAT TO X	(TRIANGLE)
193.	6.25	5 1/3'	QUINT COUPLER	
194.	6.26	5 1/3'	SOLO TO X	
195.	6.27	32'	CONTRA BASSOON	
196.	6.28	64'	REED/DIAPHONE	
197.	7.01	16'	GALLERY SWELL TO X	(STEAMBOAT WHISTLE)
198.	7.02	8'	GALLERY SWELL TO X	(BIRD WHISTLE)
199.	7.03	4'	GALLERY SWELL TO X	(BASS DRUM)
200.	7.04	16'	GALLERY PEDAL TO X	(CRASH CYMBAL)
201.	7.05	8'	GALLERY PEDAL TO X	(TAP CYMBAL)
202.	7.06	4'	GALLERY PEDAL TO X	(BRUSH CYMBAL)
203.	7.07	16'	GALLERY CHOIR TO X	(SNARE DRUM)
204.	7.08	8'	GALLERY CHOIR TO X	(SNARE DRUM ROLL)
205.	7.09	4'	GALLERY CHOIR TO X	(TOM TOM)
206.	7.10		GRAND FOURNITURE	(TYMPANI)
207.	7.11		TIERCE MIXTURE	(TAMBOURINE)
208.	7.12	32'	UNTERSATZ (MAJOR BASS)	(CASTANETS)
209.	7.13	16'	PRESTANT	(CHINESE BLOCK)
210.	7.14	16'	SUBBASS - ALT.	(WOOD BLOCK)
211.	7.15		V MIXTURE	(SAND BLOCK)
212.	7.16		VI MIXTURE	(SLEIGH BELLS)
213.	7.17		VII MIXTURE	(GLADSTONE AFTERBEAT)
214.	7.18	8'	STATE TRUMPET (FESTIVAL)	(FI NGER CYMBAL)
215.	7.19		REMOTE ORGAN ON/OFF	
216.	7.20		REMOTE CONSOLE ON/OFF	
217.	7.21		LOCAL ORGAN ON/OFF	
218.	7.22		LOCAL CONSOLE ON/OFF	
219.	7.23	16'	SAXOPHONE	
220.	7.24	16'	BRASS TRUMPET	
221.	7.25	16'	ENGLISH POST HORN	
222.	7.26		PEDAL TO X	
223.	7.27		PEDAL DIVIDE	
224.	7.28		GROSS CORNET (GRANDE CORNET)	
225.	8.01		SWELL SHADE 1	
226.	8.02		SWELL SHADE 2	
227.	8.03		SWELL SHADE 3	
228.	8.04		SWELL SHADE 4	
229.	8.05		SWELL SHADE 5	
230.	8.06		SWELL SHADE 6	
231.	8.07		SWELL SHADE 7	
232.	8.08		SWELL SHADE 8	
233.	8.09		SWELL SHADE 9	
234.	8.10		SWELL SHADE 10	
235.	8.11		SWELL SHADE 11	
236.	8.12		SWELL SHADE 12	
237.	8.13		SWELL SHADE 13	
238.	8.14		SWELL SHADE 14	
239.	8.15		SWELL SHADE 15	
240.	8.16		SWELL SHADE 16	
241.	8.17	8'	FAGOT (BASSON, OBOE HORN)	
242.	8.18	8'	BOMBARDE (POSAUNE)	
243.	8.19	16'	OBOE (HAUTBOIS)	
244.	8.20	8'	VIOLONE	
245.	8.21	8'	SUBBASS	
246.	8.22	8'	DOPPELFLOTE (DOUBLE FLUTE)	
247.	8.23	8'	ROHRFLUTE (CHIMNEY FLUTE, SPILLFLOTE, KOPPELFLOTE)	
248.	8.24	2'	SPILLFLOTE	
249.	8.25	8'	VOCE UMANA (PRINCIPAL CELEST)	

250.	8.26	8'	CORNO D' BASSETTO (COR D' ORCHESTRE)
251.	8.27	2'	WALDFLOTE
252.	8.28	2'	REGAL
253.	thru	280.	UN-ASSIGNED
281.	thru	306.	Ahlborn Stops (All Models)
307.	thru	448.	UN-ASSIGNED

SECTION N - FIGURES

Figure 1 - CDU (Control Panel) Mounting and Template Drawing.
Figure 2a - Optional Bar Graphs Panel/nameplates Drawing
Figure 2b - Optional MIDI Panel/Nameplates Drawing
Figure 2c - Optional Tutti Selects Panel/Nameplates Drawing
Figure 3 - ICS Hardware Block Diagram
Figure 4 - Ethernet Wiring
Figure 5 - Main (CPU) Cage
Figure 6 - Main Cage Wiring Details
Figure 7 - CACC System Wiring Details
Figure 8 - Satellite Card Cage
Figure 9 - Satellite Cards
Figure 10 - Satellite Micro Board
Figure 11 - Floppy Mounting Details

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http://www.petersontuners.com

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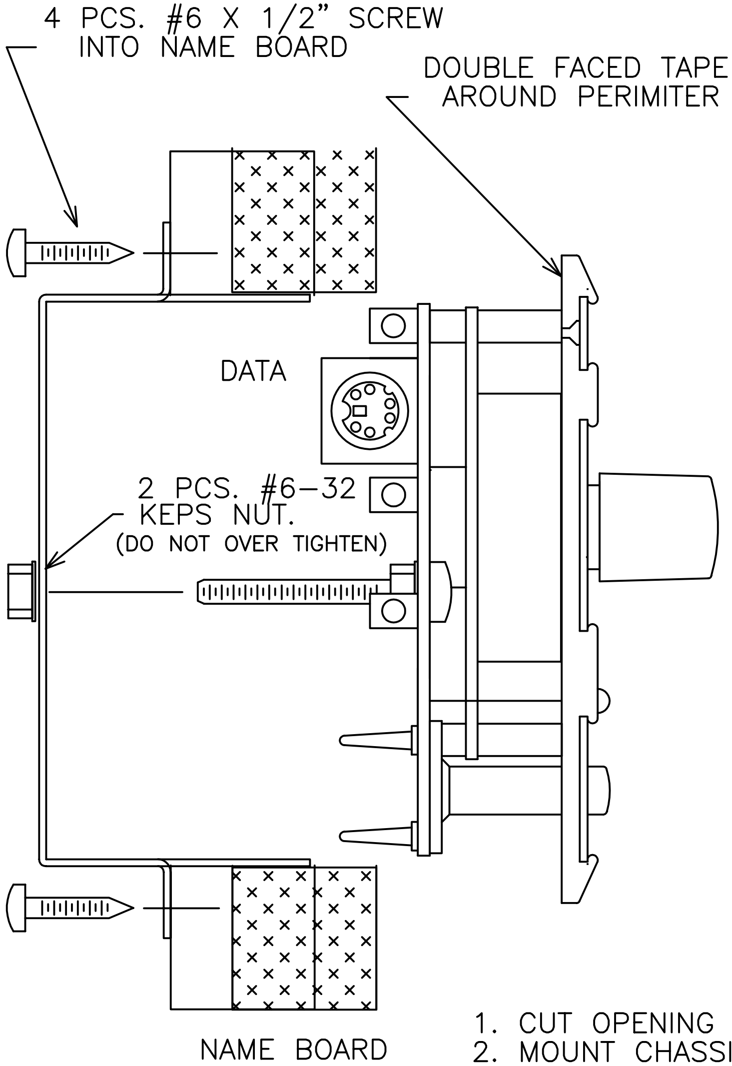
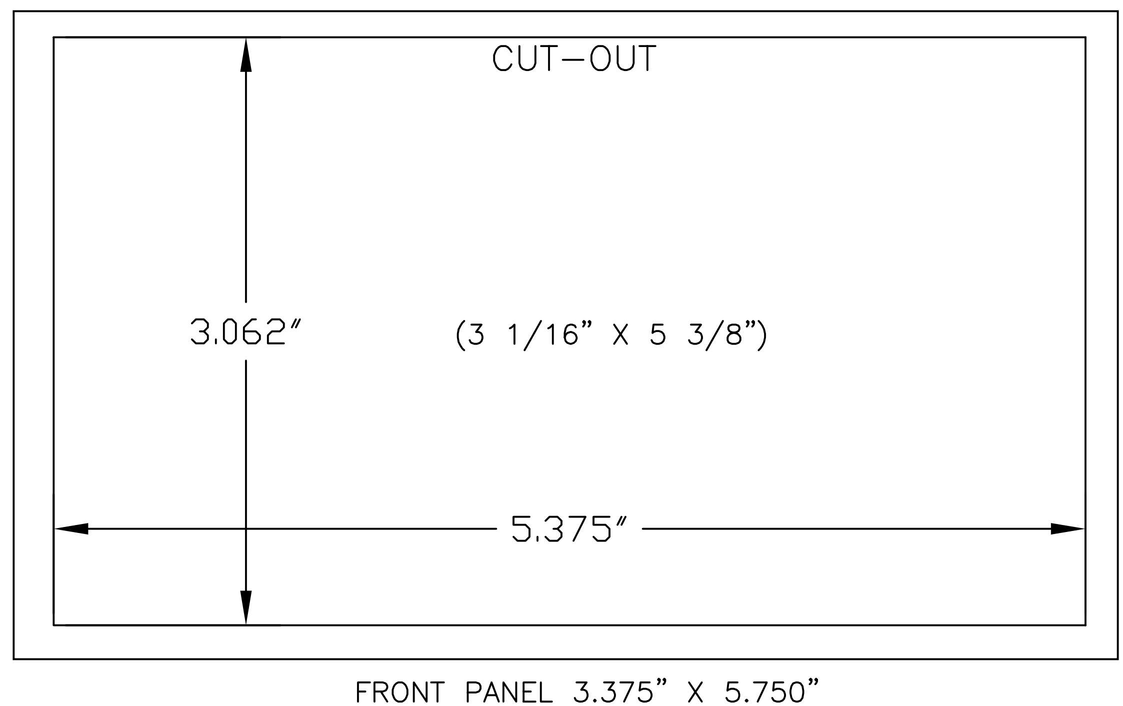
Last edited 5-16-05 SRP

CONTROL DISPLAY UNIT MOUNTING



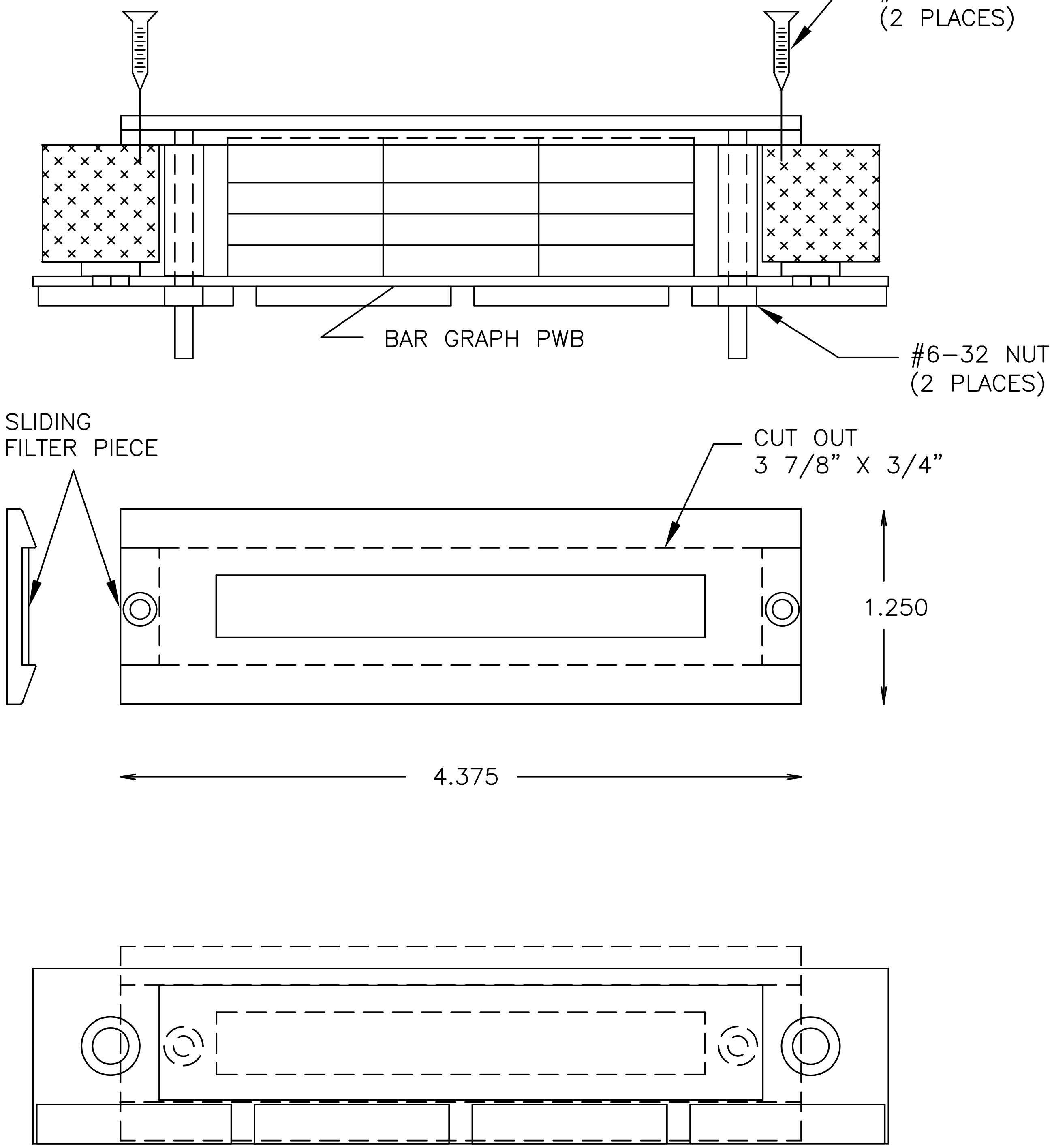


1. CUT OPENING IN NAME BOARD 3 1/16" X 5 3/8".
2. MOUNT CHASSIS FROM BACK WITH FOUR #6 X 1/2" SCREWS.
   BE SURE POWER/DATA OPENINGS ARE TO THE LEFT (FRONT VIEW).
3. REMOVE FACING FROM DOUBLE SIDED TAPE ON PANEL BACK.
4. INSERT CONTROL DISPLAY UNIT INTO CHASSIS/OPENING.
5. TAKE CARE TO ALIGN PANEL, THEN PRESS INTO PLACE.
6. INSTALL TWO #6-32 KEPS NUTS FROM REAR OF CHASSIS. DO NOT OVER TIGHTEN.
7. SLIDE TOP NAME INSERT(S) BACK INTO FRONT PANEL.
8. PLUG THE PS-2 CABLE INTO THE CDU AND ROUTE TO MAIN CAGE AND PLUG IT IN.

FIGURE 1

198002 REVISED 4-28-05 KWH

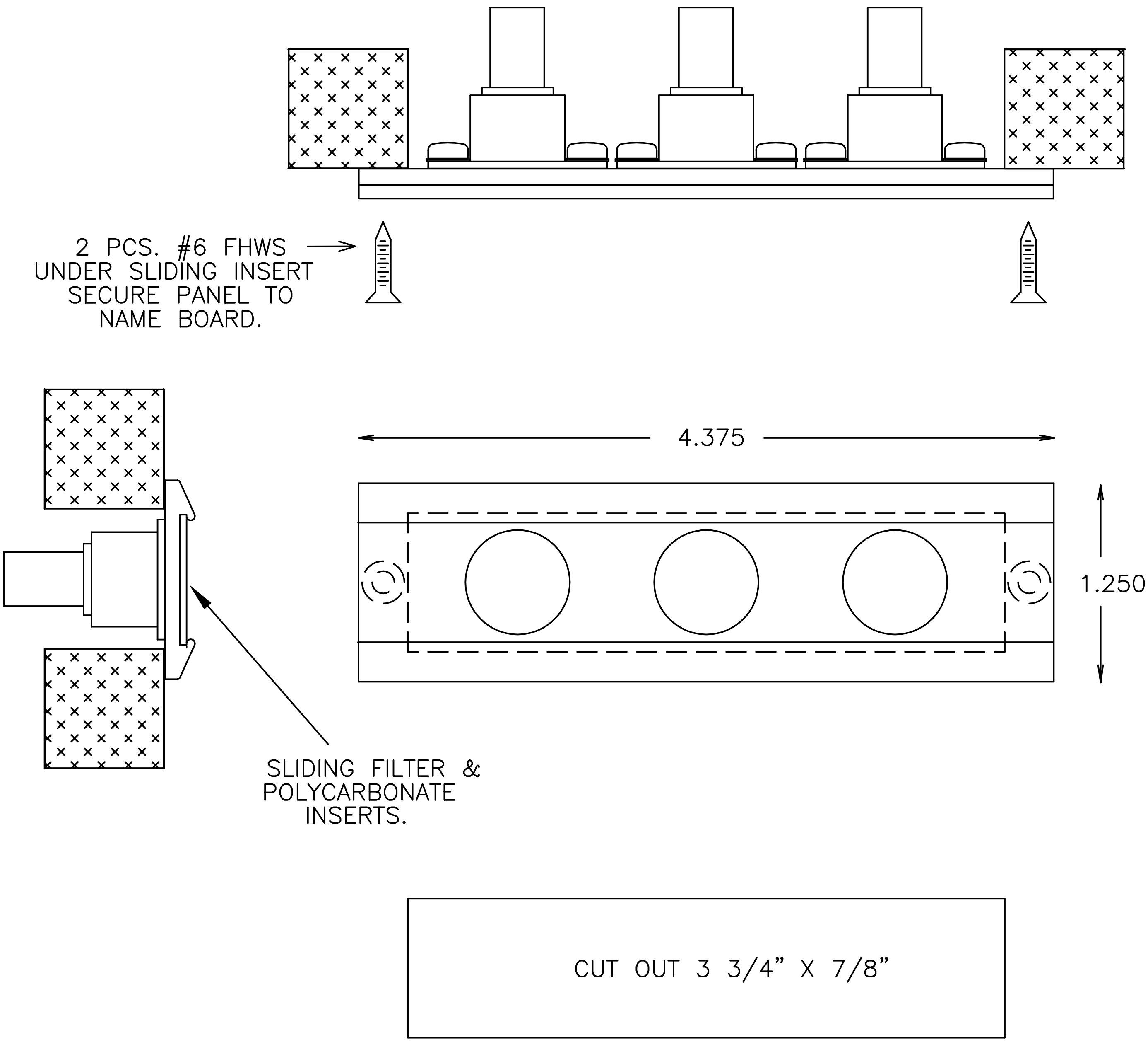
BARGRAPH MOUNTING DETAILS



1. CUT OPENING IN NAME BOARD.
2. INSERT BARGRAPH PWBA FROM BACK SIDE, AND INSERT FRONT PANEL (WITH STANDOFFS) FROM THE FRONT SIDE. ALIGN THE TWO AND INSTALL 2 #6-32 NUTS ON THE STUDS (BACKSIDE).
3. ALIGN FRONT PANEL - SLIDE OUT FILTER, INSTALL 2-#6-32 SCREWS.

FIGURE 2A 198003

MIDI PANEL MOUNTING DETAILS

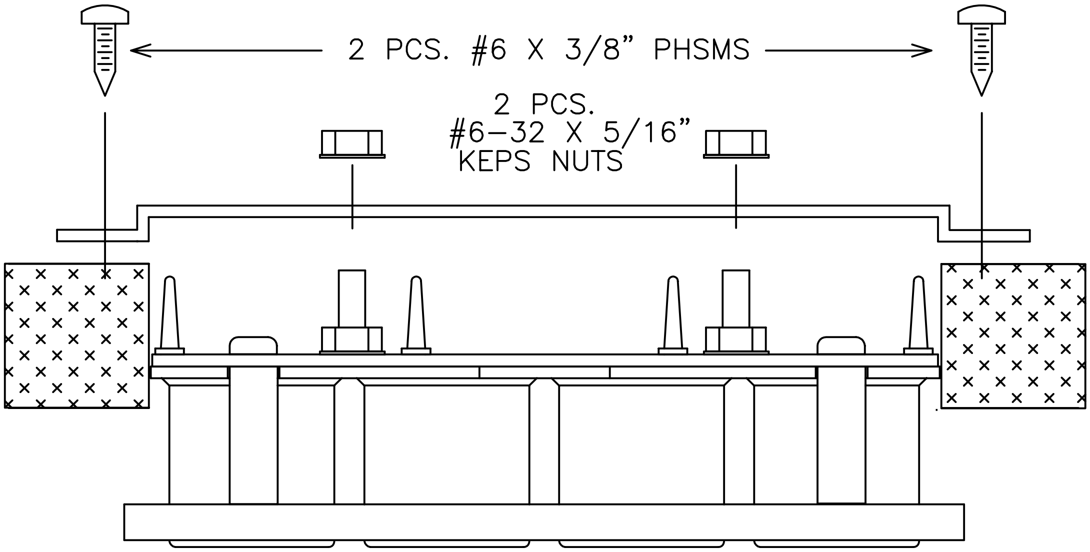


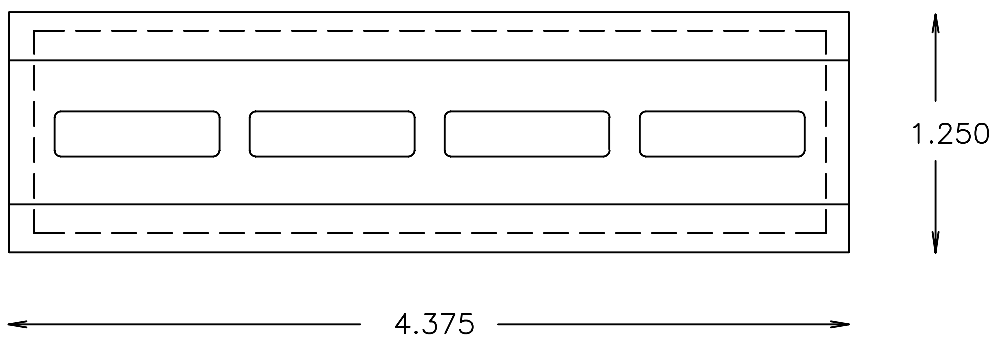
1. CUT OPENING IN KNEE BOARD OR SUITABLE LOCATION.
2. INSERT MIDI CABLES THROUGH CUT OUT.
3. POSITION FRONT PANEL IN THE CENTER OF THE CUT OUT.
4. MOUNT THE MIDI PANEL WITH 2 PCS. #6–32 SCREWS.
5. SLIDE IN INSERT AND FILTER WINDOW.

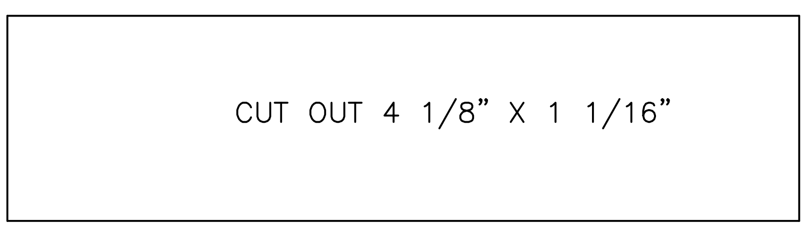
198004 2/26/02 RWJ

FIGURE 2B

TUTTI SELECT MOUNTING DETAILS







1. CUT OPENING IN NAME BOARD.
2. INSERT TUTTI SELECT PANEL ASSY THROUGH CUT OUT.
3. PLACE MOUNTING BRACKET OVER THE #6–32 MOUNTING STUDS.
4. START AND LIGHTLY TIGHTEN THE #6–32 KEPS NUTS ON THE STUDS.
5. ALIGN THE PANEL, THEN PRESS INTO PLACE AND TIGHTEN THE KEPS NUTS.
6. INSTALL 2 PCS. #6 X 3/8" PHSMS THROUGH MOUNTING BRACKET TO SECURE TO THE NAME BOARD.

198005 9/16/00 RWJ

FIGURE 2C

ICS HARDWARE BLOCK DIAGRAM

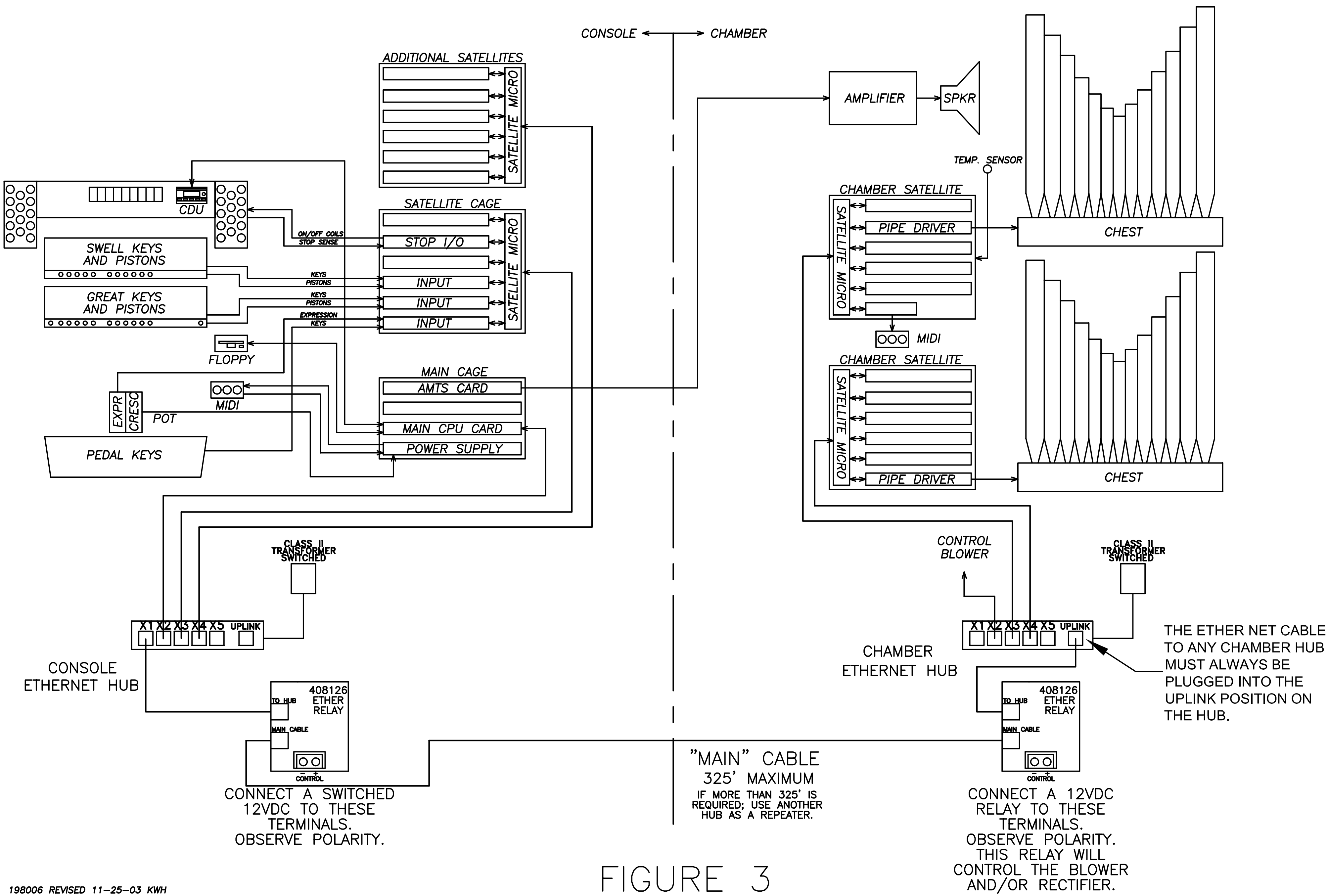
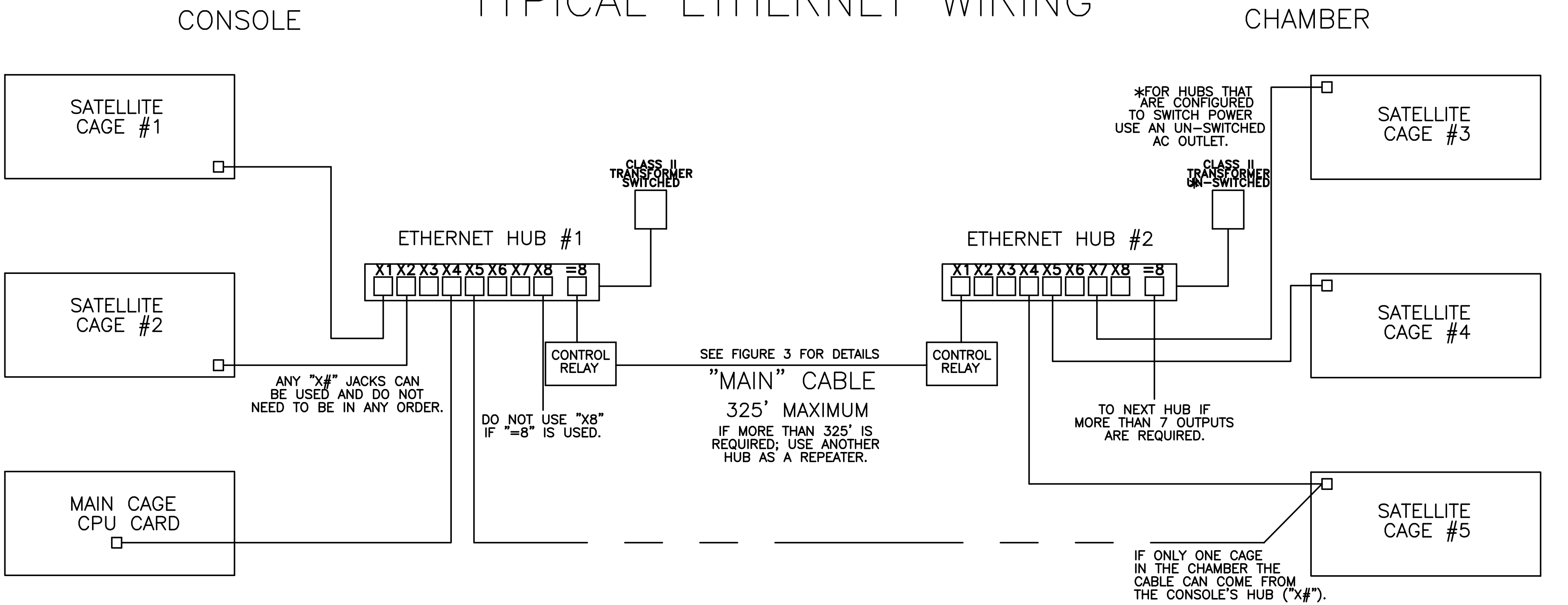
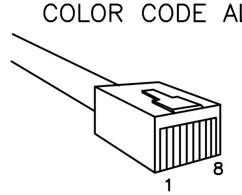


FIGURE 3

TYPICAL ETHERNET WIRING

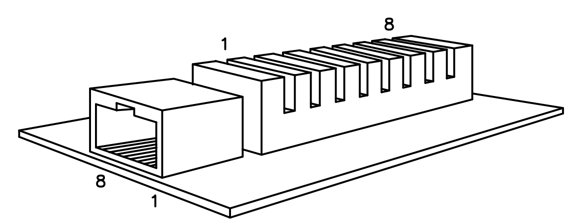


COLOR CODE ALL CONNECTORS



1. WHITE/ORANGE
2. ORANGE
3. WHITE/GREEN
4. BLUE
5. WHITE/BLUE
6. GREEN
7. WHITE/BROWN
8. BROWN

OPTIONAL PUNCH DOWN DETAIL



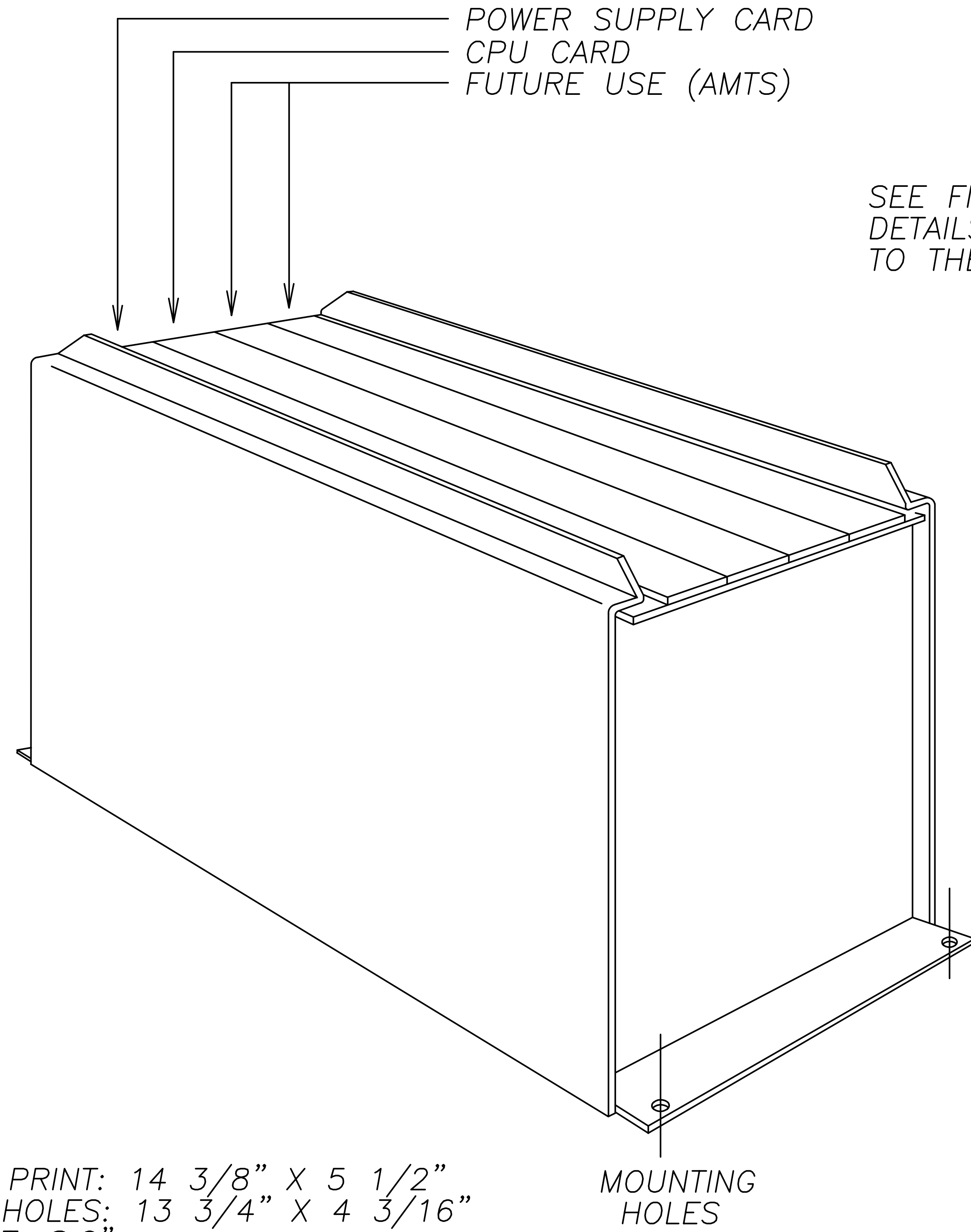
THE OPTIONAL PUNCH DOWN CONNECTOR CAN BE USED TO TERMINATE THE MAIN CABLE AT ONE OR BOTH ENDS. THIS PERMITS THE MAIN CABLE TO BE PULLED THROUGH A CONDUIT WITHOUT CONNECTORS CAUSING INTERFERENCE. A SHORT CABLE IS THEN USED TO CONNECT THE PUNCH DOWN TO THE HUB.

NOTES:
1. FOR A SMALL ORGAN WITH ONLY ONE CAGE IN THE CHAMBER; ITS CABLE CAN CONNECT TO THE CONSOLE HUB IF LESS THAN 325'.
2. FOR LARGER ORGANS, HUBS ARE AVAILABLE IN 12, 16 AND 24 PORT SIZES.
3. CABLES CAN BE PLUGGED INTO ANY "X#" PORT AND DO DO NOT NEED TO BE IN ANY ORDER.
4. USE THE "=8" PORT TO DAISY CHAIN TO OTHER HUBS AS NEEDED. DO NOT USE THE "X8" PORT IN THIS CASE.
5. ANY ONE CABLE SHOULD NOT EXCEED 325'. FOR LONGER RUNS USE ANOTHER HUB AS A REPEATER.
6. THE MAXIMUM NUMBER OF HUBS THAT SHOULD BE CONNECTED IN SERIES IS FOUR (ONE IN THE CONSOLE; THREE IN THE CHAMBERS. SEE THE MANUAL TEXT FOR DETAILS.)
7. AN OPTIONAL PUNCH DOWN BLOCK CAN BE USED TO TERMINATE THE MAIN CABLE END(S).
8. ALL DATA CABLES ARE "CAT 5" (10BASE-T) WITH RJ-45 CONNECTORS (TERMINATED STRAIGHT THRU).

198007 3-5-02 RWJ REVISED 3-9-05

FIGURE 4

MAIN (CPU) CARD CAGE



SEE FIGURE 6 FOR DETAILS OF WIRING TO THESE CARDS

FOOT PRINT: 14 3/8" X 5 1/2"
MTG. HOLES: 13 3/4" X 4 3/16"
HEIGHT: 8.0"

FIGURE 5

198008

ICS MAIN CARD CAGE WIRING DETAILS

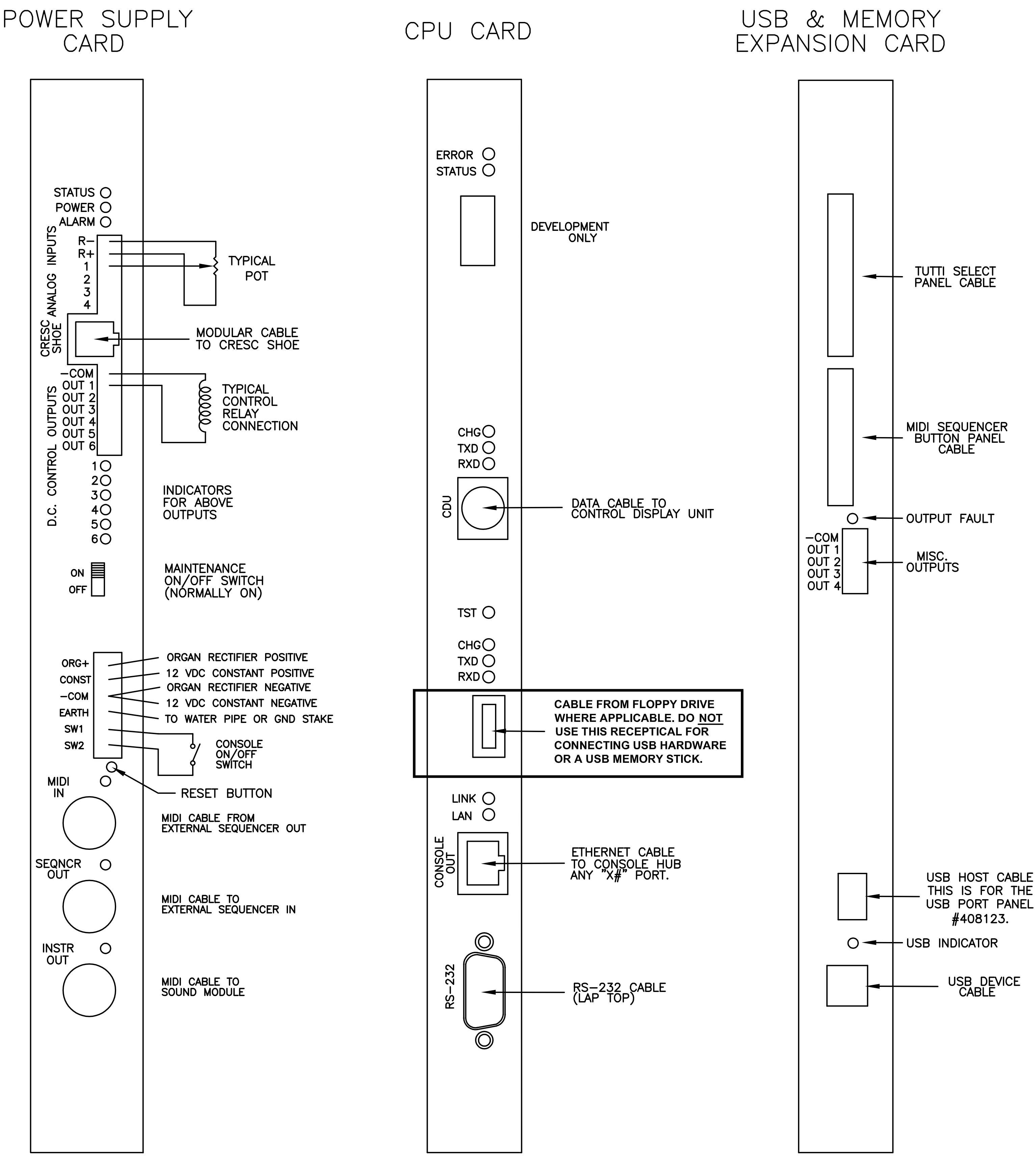


FIGURE 6 198009 REVISED 08/05 KWH

USING A CONSOLE AC CONTROL SYSTEM TO PROVIDE SWITCHED OUTLETS

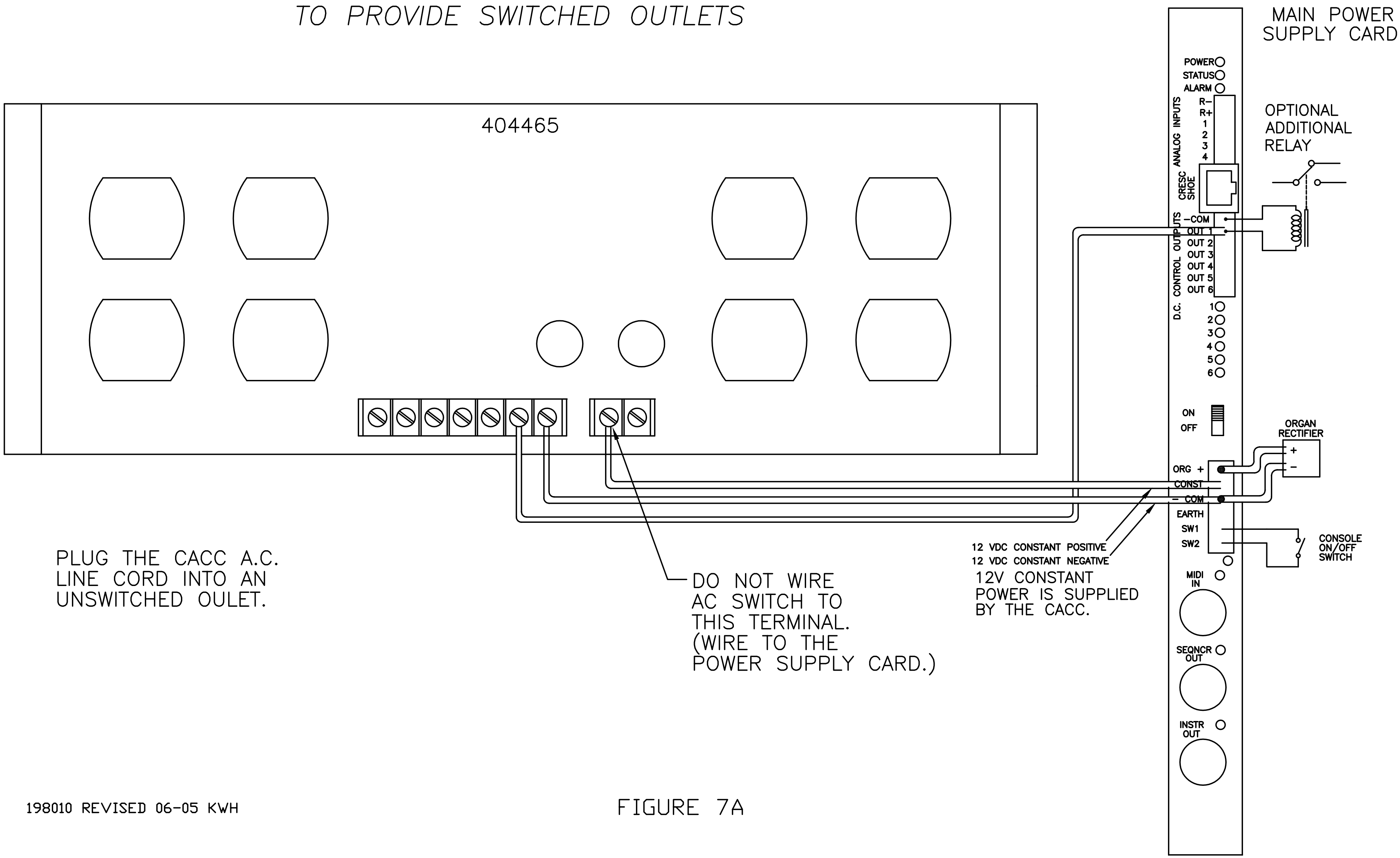


FIGURE 7A

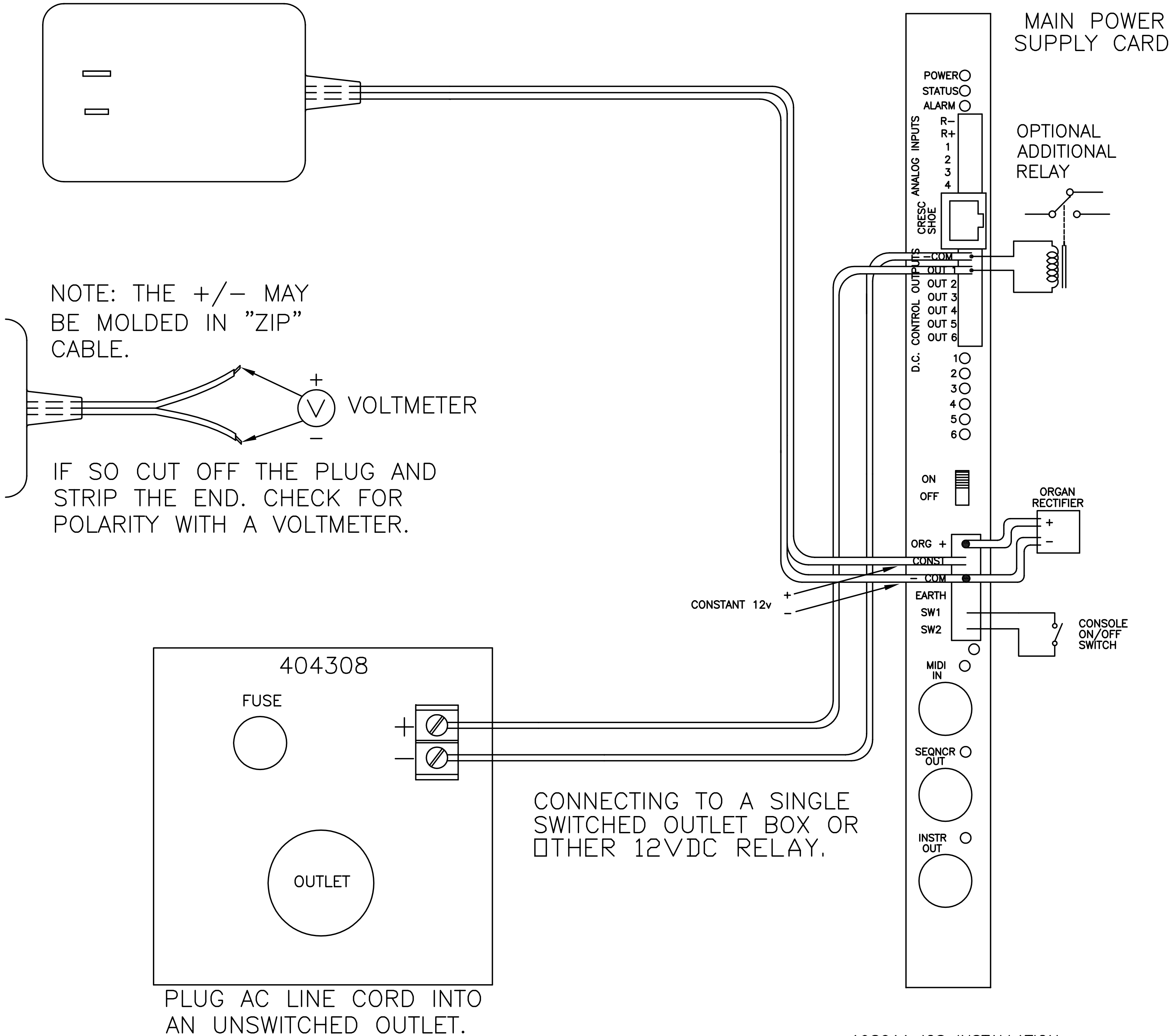


FIGURE 7B

198011 ICS INSTALLATION
REVISED 09-03 KWH

SATELLITE CARD CAGE

LEFT TO RIGHT	LED USAGE DESCRIPTION
1	LINK STATUS
2	LAN STATUS
3	1st SATELLITE CARD STATUS
4	1ST SATELLITE CARD CHANGED DATA
5	2nd SATELLITE CARD STATUS
6	2nd SATELLITE CARD CHANGED DATA
7	3rd SATELLITE CARD STATUS
8	3rd SATELLITE CARD CHANGED DATA
9	4th SATELLITE CARD STATUS
10	4th SATELLITE CARD CHANGED DATA
11	5th SATELLITE CARD STATUS
12	5th SATELLITE CARD CHANGED DATA
13	6th SATELLITE CARD STATUS
14	6th SATELLITE CARD CHANGED DATA
15	SATELLITE uC. STATUS
16	FUSE/DRIVER FAULT

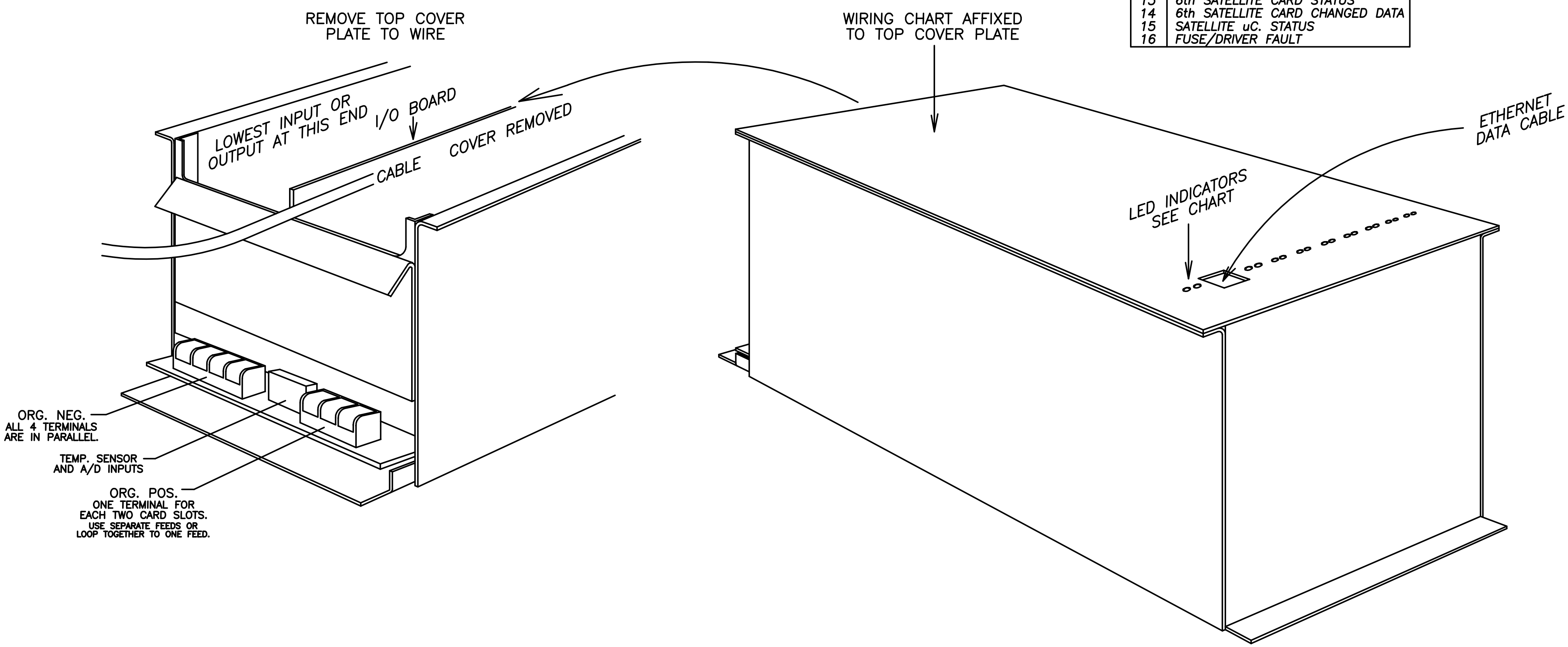
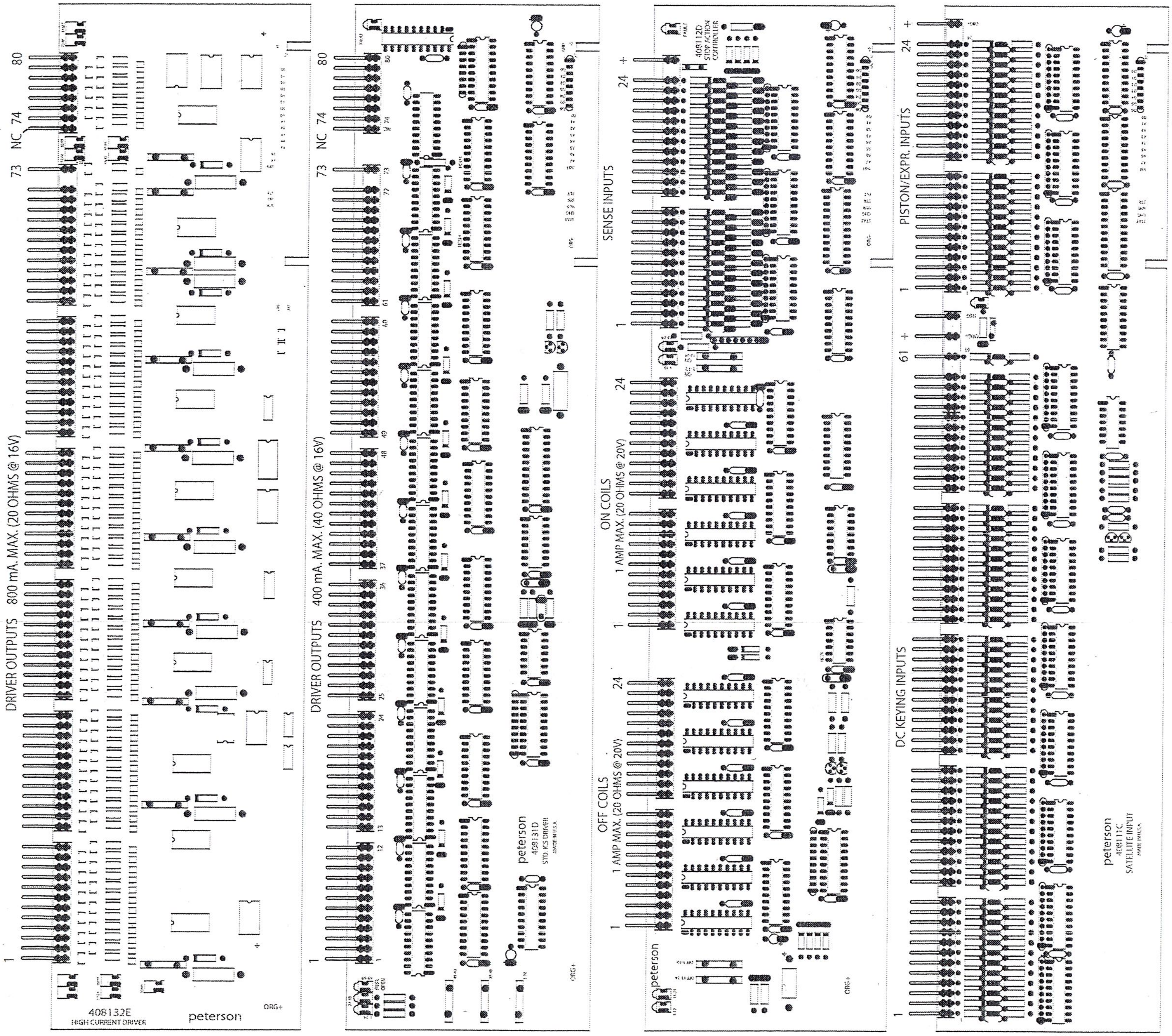


FIGURE 8

198012 ICS INSTALLATION
3-7-02 RWJ



408132 HIGH CURRENT DRIVER

408131 STANDARD DRIVER

408112 STOP CONTROLLER

408111 SATELLITE INPUT

FIGURE 9

FIG9ICS 5-18-05 RWJ

SATELLITE MICRO CARD
408110

CAGE ADDRESS DIP SWITCH
SHOWN WITH ADDRESS 10000000
THIS IS A BINARY ADDRESS THAT IS NORMALLY SET AT THE FACTORY SHOULD IT BE NECESSARY TO SWAP OR CHANGE THIS BOARD BE SURE TO MATCH THE SWITCH SETTING TO THE BOARD OR LABEL ON THE CAGE.

ETHERNET CABLE

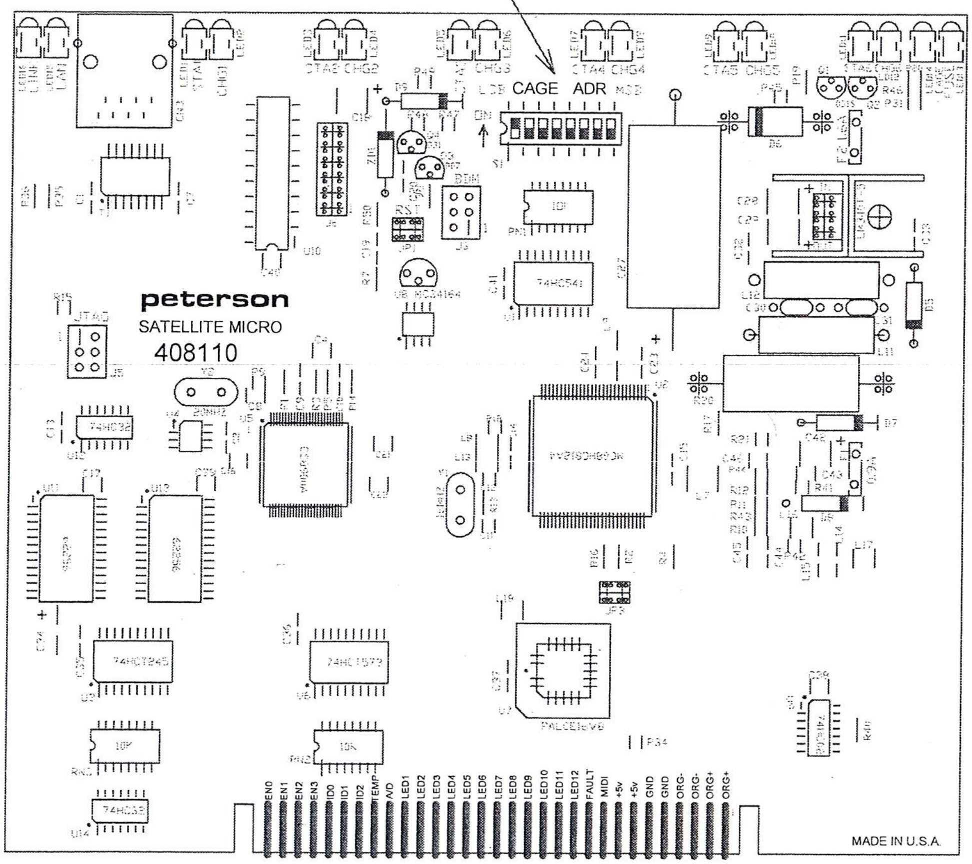
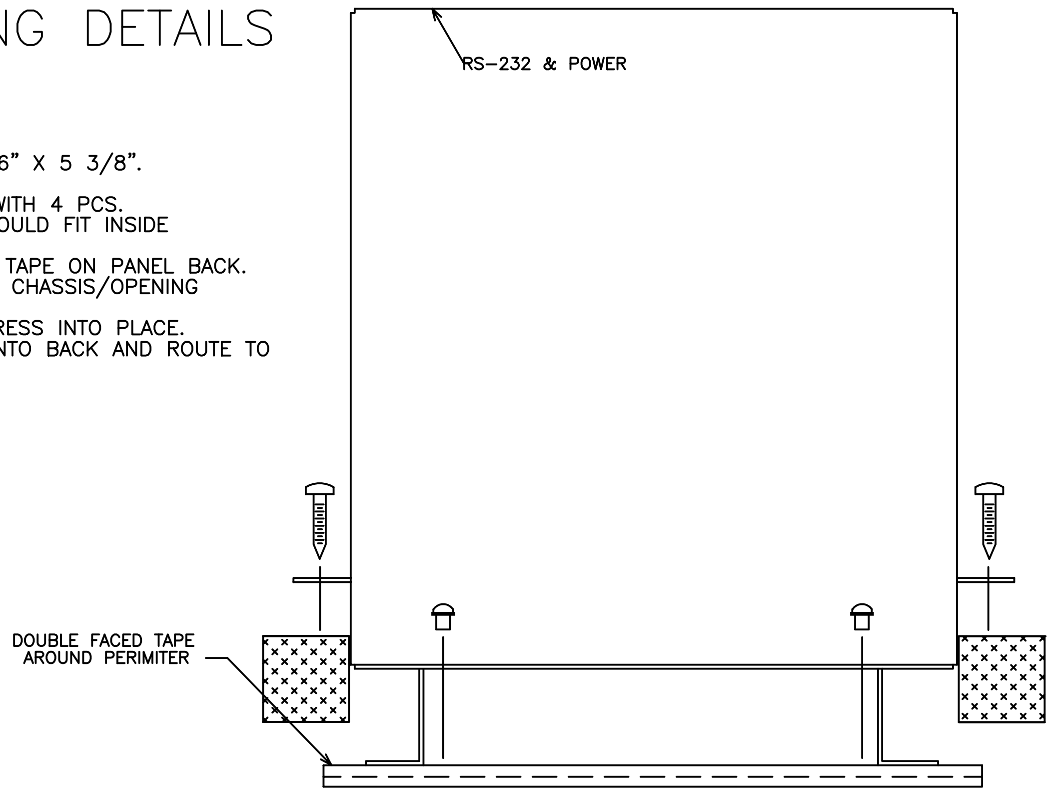
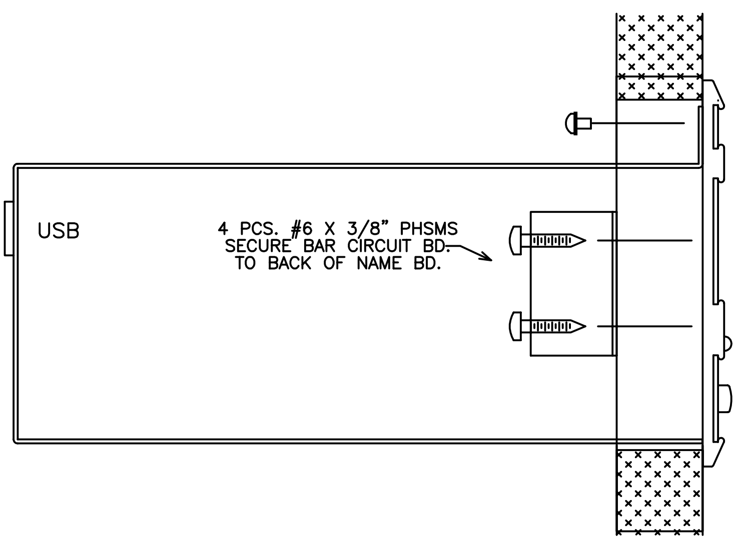


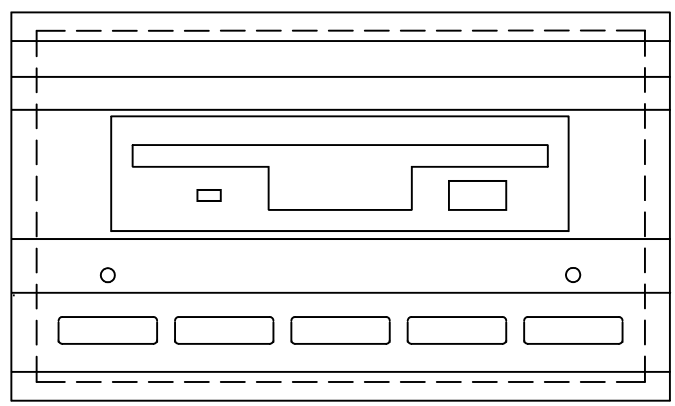
FIGURE 10

FLOPPY MOUNTING DETAILS

1. CUT OPENING IN NAME BOARD 3 1/16" X 5 3/8".
   NOTE: 5 3/4" REQUIRED BEHIND.
2. MOUNT COVER CHASSIS FROM BACK WITH 4 PCS. #6-32 X 3/8" SCREWS. CHASSIS SHOULD FIT INSIDE OPENING AND BE SELF ALIGNING.
3. REMOVE FACING FROM DOUBLE SIDED TAPE ON PANEL BACK.
4. INSERT FLOPPY DRIVE ASSEMBLY INTO CHASSIS/OPENING FROM FRONT.
5. TAKE CARE TO ALIGN PANEL, THEN PRESS INTO PLACE.
6. PLUG THE USB DATA/POWER CABLE INTO BACK AND ROUTE TO MAIN CAGE.







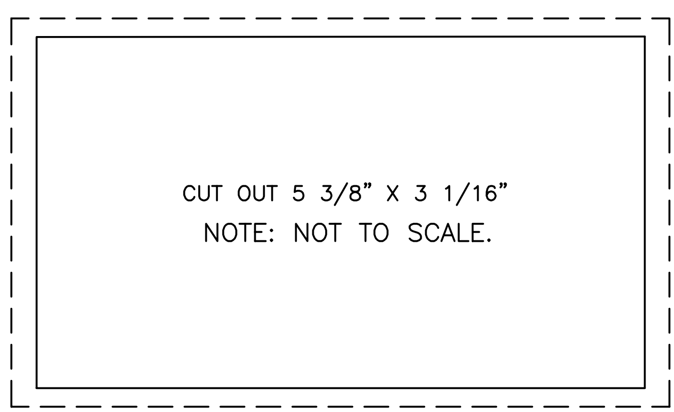
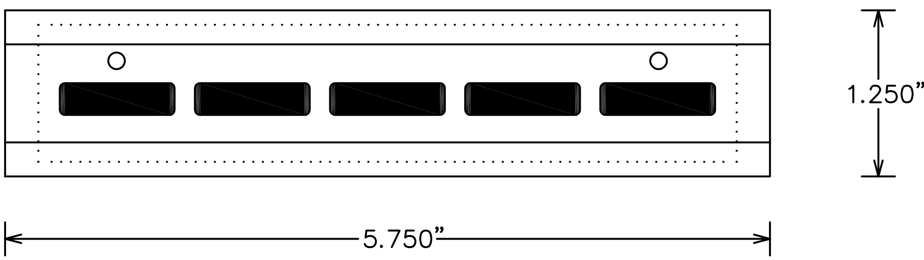
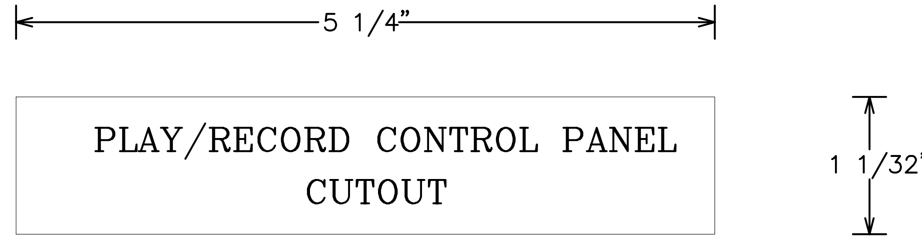


FIGURE 11

PLAY/RECORD CONTROL PANEL





USB PORT