Datasheet **ICI**

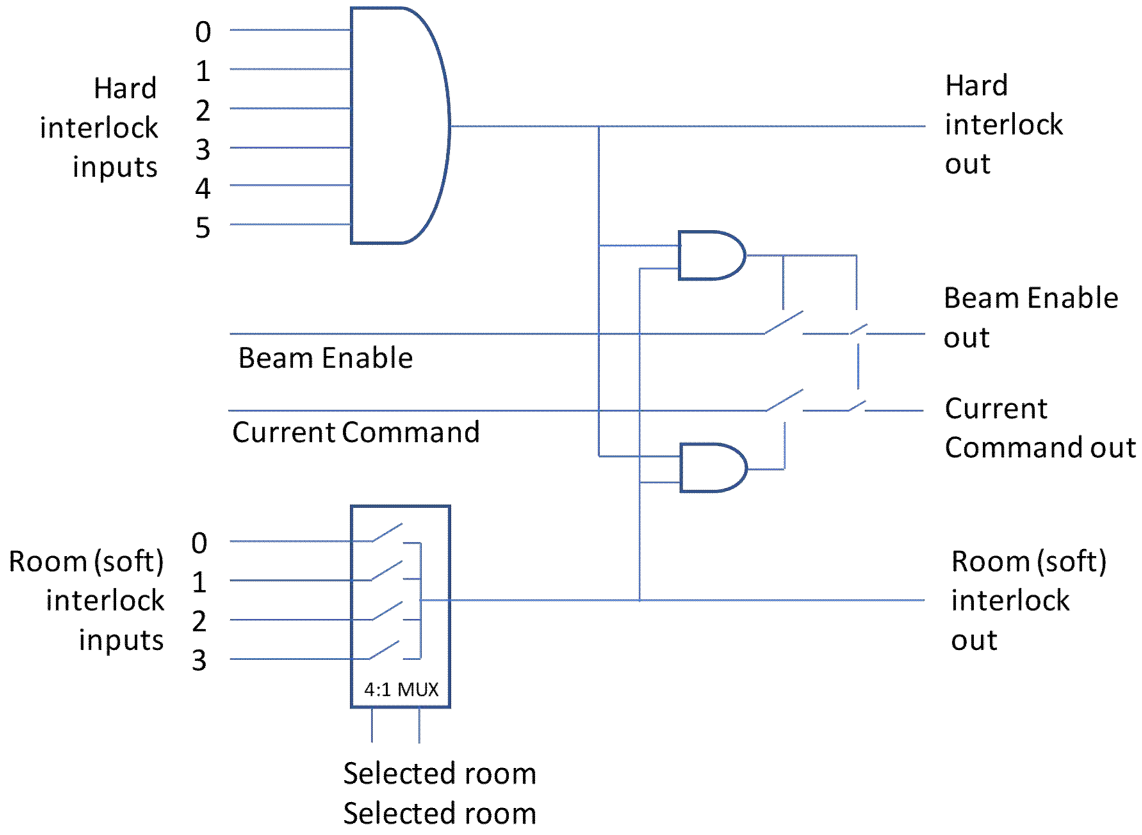
Interlock Control Interface for Particle Therapy Systems

Features

- Interfaces to most particle therapy accelerator types
- Hardware only circuitry
- Safety-rated relays for all critical interlocks
- Fast relays for rapid beam inhibit
- Allows accelerator to receive interlocks from to up to three treatment rooms plus “room 0”
- Multiple ICIs can be combined to increase the number of interlocks
- Suitable for “step and shoot” and continuous scanning beam delivery
- Communication to dose control and room servers via Ethernet for error reporting
- High level of electrical isolation on all signal and communication paths
- Able to interrupt digital and analog control signals for additional interlockking
- Compatible with Pyramid ACI Accelerator Control Interface
- Display showing key configuration and diagnostic information
- Web-browser interface for remote monitoring

Applications	• Connecting interlocks from Pyramid treatment nozzle systems to beam production accelerator systems. • Generic particle therapy accelerator dose interlock interfacing. • In combination with Pyramid ACI to provide a beam control and inter-locking system.
Options	• Integrated sub-system with the accelerator control interface (ACI)

Logic summary



The diagram shows logic for propagation of the the “allow beam” condition. All interlock logic is implemented solely in hardware. Note that redundancy on inputs and outputs not shown on logic summary diagram above.

Six “hard” (non-room centric) inputs, each driving a redundant safety relay pair. All inputs must be good to close hard interlock output. (allow beam)

Four “soft” (room-centric) inputs, each driving redundant opto coupler pair. Input from selected room must be good to close soft interlock output (allow beam). Non-selected room interlock states are masked by redundant MUX pair to allow patient setup and other activities in inactive rooms.

Two control line passthroughs (for example Beam Enable and Current Command) to allow gating of analog and digital control signals by the hard and soft interlocks, plus fast gating by the soft interlock.

Safety relays

Usage	12 for hard interlock inputs (two per input) 4 for interlock outputs (two per output)
Type	IDEC RF1V-4A2B-D24 six pole (4 x n/o, 2 x n/c) safety-rated relay with force-guided contacts.

Hard (non-room centric) interlock inputs	
Number	Six inputs, each comprising a redundant pair of safety relays
Driving signal	24 VDC, 42 mA per input to relay coils.
Voltage source	24 VDC output fused 200 mA available on each channel for optional use as source on each input.
Logic	All inputs must be good (24 V present) to enable output.

Hard interlock output	
Number	One output, comprising a redundant pair of safety relay contacts in series.
Contact rating	6 A maximum at 250 VAC or 30 VDC.
Voltage source	24 VDC output fused 200 mA available on each channel for optional use as source.
Latency	Output opens 10 msec after hard input state goes bad

Soft (room centric) interlock inputs	
Number	Four inputs, each comprising a redundant pair of opto-coupler
Driving signal	24 VDC, 44 mA per input to opto coupler diodes. Voltages down to 5 VDC 10 mA may be used.
Voltage source	24 VDC output fused 200 mA available on each channel for optional use as source on each input.
Logic	Input from selected room must be good (24 V present) to enable output.

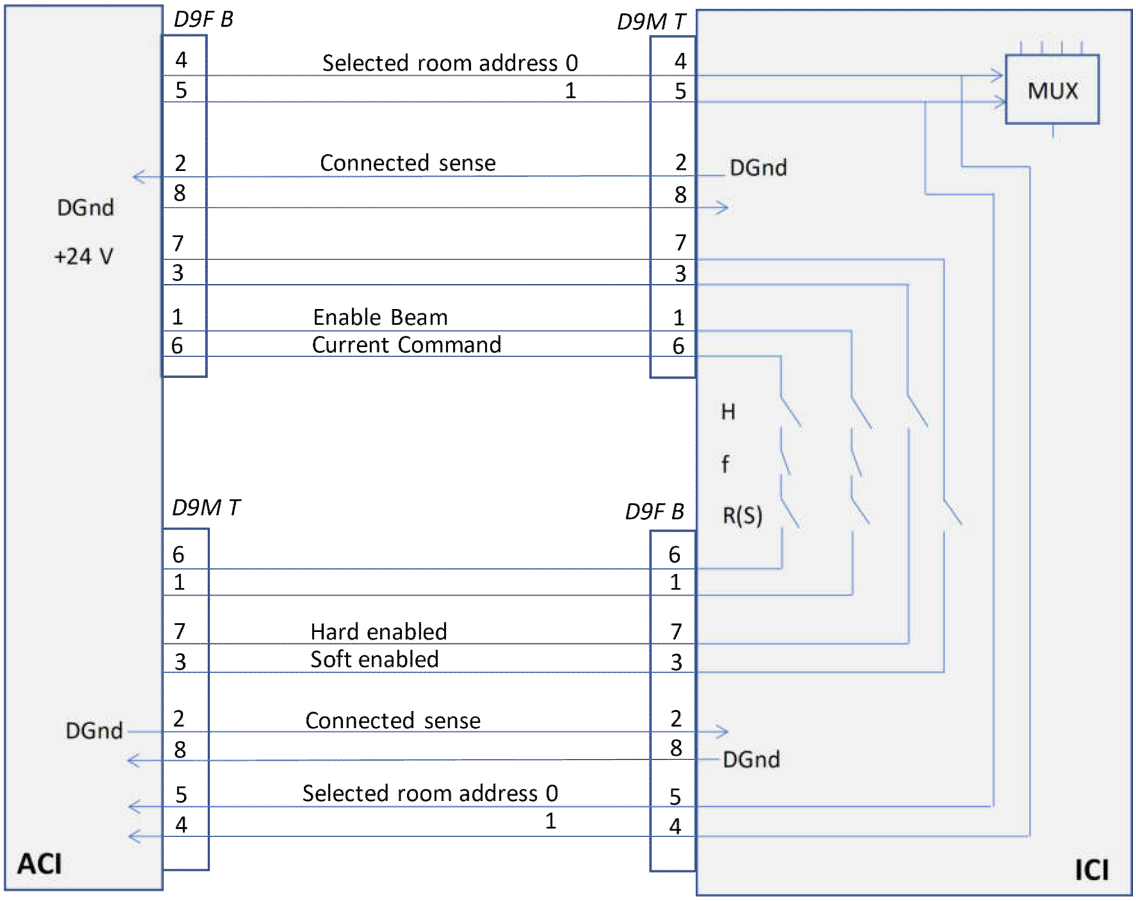
Soft interlock output	
Number	One output, comprising a redundant pair of safety relay contacts in series.
Contact rating	6 A maximum at 250 VAC or 30 VDC.
Voltage source	24 VDC output fused 200 mA available on each channel for optional use as source.
Latency	Output opens 5 msec after soft input state goes bad

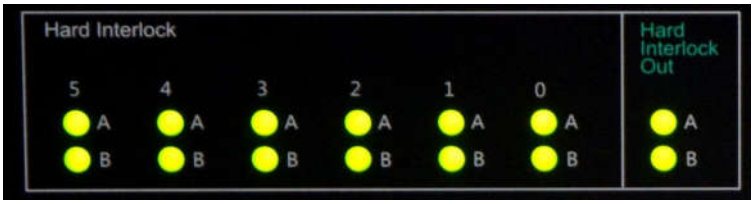
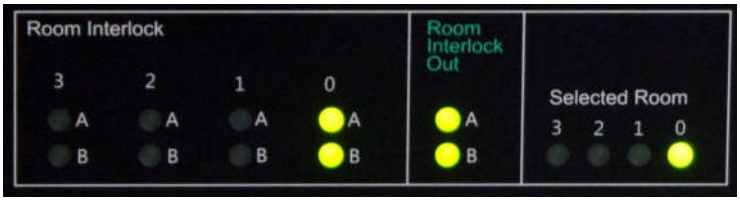
Connecti

Enable R
Transmit 0,1,2,3

Passthrough connection and selected room address

Gated signals	Two signal channels (nominally Beam Enable and Current Command for ACI connection) pass through the hard and soft relay contacts plus a series pair of fast relays.
Latency	Signal through connections interrupted 25 µsec after soft input state goes bad. Signal through connections interrupted 10 msec after hard input state goes bad.
Interlock state communication	One line passes through the hard relay contacts to indicate the hard interlock condition to the ACI or similar connected device. One line passes through the soft relay contacts to indicate the hard interlock condition to the ACI or similar connected device.
Cable connected	ICI (and ACI if used) can sense cables connected if line is pulled down by the other device.
Selected room address	Two input logic bits encode the selected room (0,1,2,3). Opto-coupled inputs suitable for 24 V logic and 5 V logic, 500 ohm input impedance in ICI. Signals are looped back to the ACI (or other sending device).



Connections to supervising computer	
Ethernet	10/100/1000 BaseT TCP/IP Ethernet connection allows monitoring of digital states. Monitor: Hard interlocks in (both redundant relays shown for each input) Soft interlocks in (both redundant relays shown for each input) Hard interlock out (both redundant relays shown) Soft interlock out (both redundant relays shown) Room selected readback bits 0,1 Passthrough connection faults 24 VDC power status The ICI supports a web browser interface that allows these signals to be controlled and monitored remotely.
Processors and OS	
ACI BeagleBone Card	TI Sitara AM335x (ARM Cortex A8) 1 GHz with dual PRU, QNX OS. Performs POST tests of relay function, RAM and flash, memory, battery function, Ethernet connection. ACI is disabled if POST fails.
Displays	
Alphanumeric display	2 x 16 character blue OLED on front panel for device status reporting.
Front panel LEDs	Green LED front panel displays of all hard interlock input and output states showing both relays of redundant pairs (LED illuminated = interlock status good)  Green LED front panel displays of all soft interlock input and output states showing both opto-couplers or relays of redundant pairs(LED illuminated = interlock status good) and selected room (LED illuminated = room is selected) 
Rear panel LEDs	Four green LEDs showing ICI status Power / Initiated / Active / Communications Two LEDs yellow and green on RJ45 connector showing network activity.

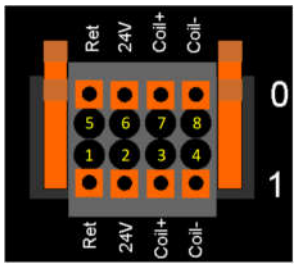
Power	
Input	24(+/- 2) VDC 600 mA typical; 1100 mA PTC fuse for main circuit and 200 mA PTC fuses for cooling fan and power outputs on interlock connectors.
Case	
Format	19” rackmount 1U by 250 mm deep with rear panel cooling fan. See figures for dimensions.
Materials	Steel chassis with Al alloy front panel, polycarbonate decals.
Protection rating	IP43 (protected against solid objects greater than 1mm in size, protected against spraying water)
Weight	3.5 kg (7.7 lb)
Environment	
Operating	10 to 35 C (15 to 25 C recommended), < 70% humidity, non-condensing, shock and short term vibration < 0.2g all axes (1 to 100 Hz). Recommended location is outside radiation area. May be located in a moderate radiation area together with similar electronics, clear of known or expected radiation hot spots. Monitor operation during commissioning and relocate if necessary.
Shipping and storage	-10 to 50 C, < 80% humidity, non-condensing, shock and short term vibration < 1g all axes, 1 to 100 Hz.

Operation	

Connectors

Hard interlock inputs

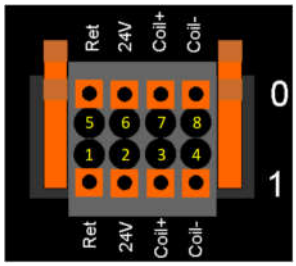
Three rear panel 8 way header 3.5 mm connectors Phoenix Combicon 1787030 for pairs of inputs (0,1) (2,3) (4,5). Mating connectors types Phoenix 1790506 and 1790315 . Spring lock clamping of wire 16 to 24 AWG, 10 mm insulation removed. +24 VDC 200 mA fused supply provided.



1	24 V return	5	24 V return
2	24 VDC fused	6	24 VDC fused
3	Relay coil +ve 1	7	Relay coil +ve 0
4	Relay coil -ve 1	8	Relay coil -ve 0

Room (soft) interlock inputs

Two rear panel 8 way header 3.5 mm connectors Phoenix Combicon 1787030 for inputs (0,1) (2,3). +24 VDC 200 mA fused supply provided.

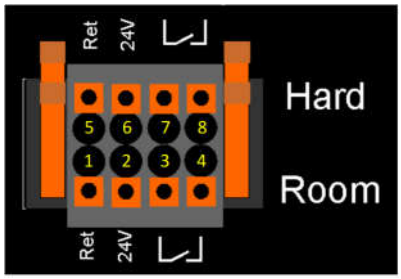


1	24 V return	5	24 V return
2	24 VDC fused	6	24 VDC fused
3	Photodiode 1	7	Photodiode 0
4	Photodiode 1	8	Photodiode 0

The optocoupler photodiodes are bidirectional.

Hard and room interlock outputs

One rear panel 8 way header 3.5 mm connectors Phoenix Combicon 1787030 for hard and room (soft) interlock outputs +24 VDC 200 mA fused supply provided.



1	24 V return	5	24 V return
2	24 VDC fused	6	24 VDC fused
3	Room relay com	7	Hard relay com
4	Room relay n/o	8	Hard relay n/o

Etherne

Connectors (continued)

Beam control signals in (top: from ACI)

DSub 9 pin male, rear panel

1	Beam Enable in	6	Current command in
2	DGnd	7	Soft relay contact in
3	Hard relay contact in	8	Top connect sense
4	Room select bit 0 in	9	DGnd
5	Room select bit 1 in		

Beam control signals out (bottom: to ACI)

DSub 9 pin female, rear panel

1	Gated beam enable out	6	Gated current command out
2	Bottom connect sense	7	Hard relay n/o contact out
3	Soft relay n/o contact out	8	DGnd
4	Room select bit 0 out	9	DGnd
5	Room select bit 1 out		

Power Input

Lemo Redel PXG.M0.2GG.NG. To suit mating connector PAG.M0.2GL type as fitted to Pyramid power supply PSU24-100M-1R.

1	+24 VDC in
2	24 V rtn

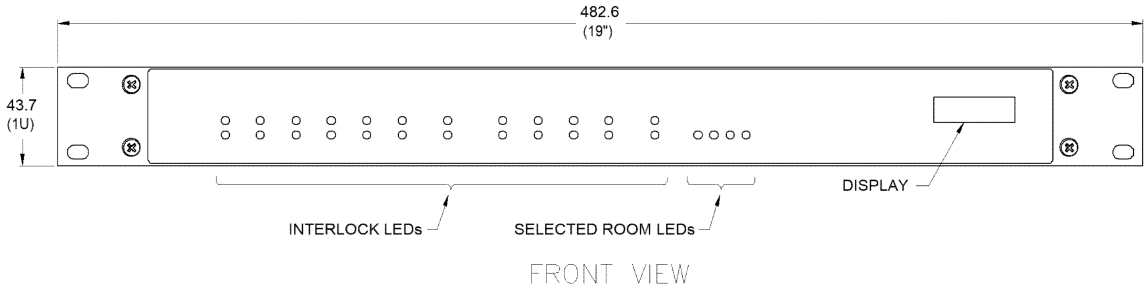
Ground lug

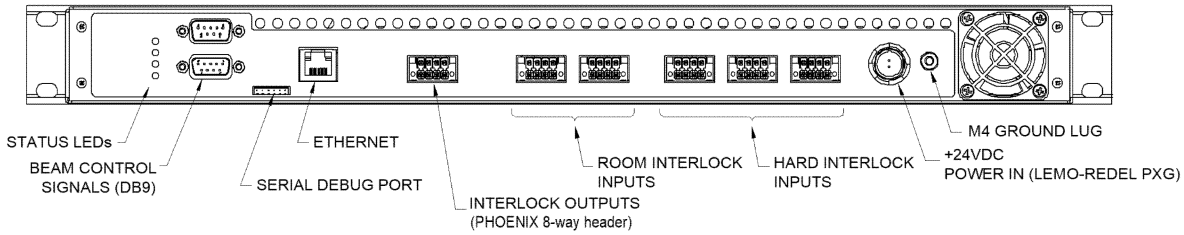
M4 threaded stud.

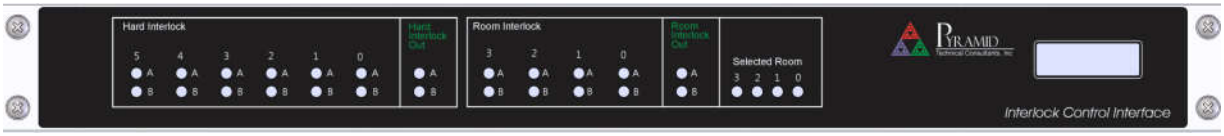
Datasheet

ICI

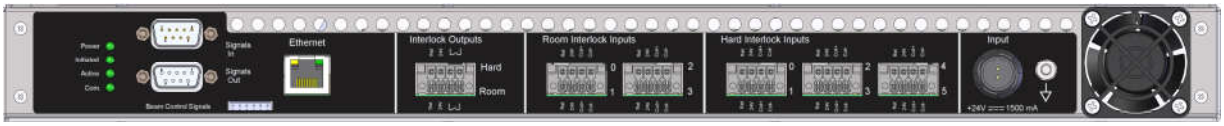
ICI front and rear panels







Front panel artwork

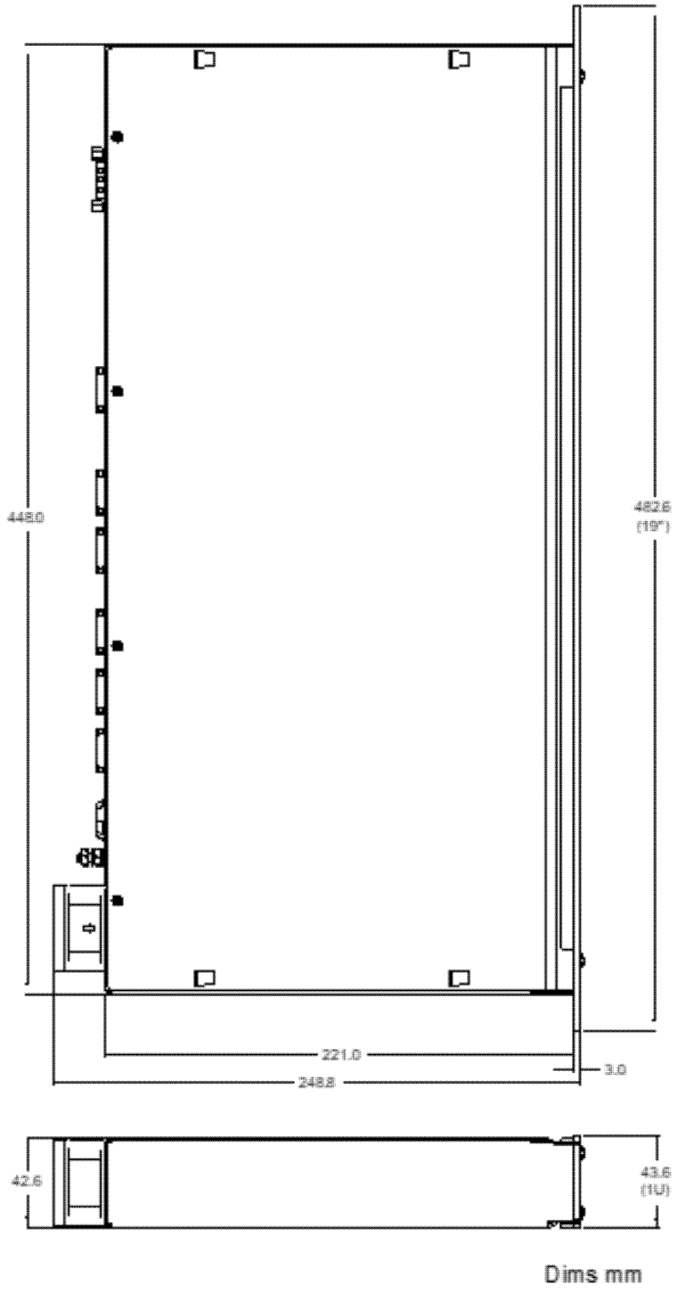


Rear panel artwork

Ordering information

ICI-G	Interlock Control Interface for particle therapy systems. Phoenix mating connectors supplied.

ICI top and side view



Dims mm

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