

Control and Charge Monitoring Unit for Particle Therapy Treatment Control Rooms



Features

- Designed to meet the requirements of IEC 60601-2-64:2014.
- Non-volatile charge recorder (> 30 minutes duration)
- Keyswitch access for preparing and enabling irradiation
- Illuminated physical switches to start and pause irradiation
- Audible signal for dose being delivered plus audio output signal
- Latching emergency stop button with direct connection to rear panel connector
- Relay to stop irradiation if total dose exceeds target plus allowed tolerance
- 7" color LCD touch screen for real-time display of dose delivered, dose target and system state
- Built-in self-diagnostics
- Automatic irradiation stop if internal failure detected
- Checks that critical cable connections are made
- Ethernet connectivity to compatible dosimetry and session management systems
- Maintains a record of pencil beam spot number when used with compatible dosimetry systems

Applications	<ul style="list-style-type: none">• Particle therapy treatment control.• Independent redundant non-volatile charge recording.• Independent overdose interlocking.
Options	<ul style="list-style-type: none">• Panel mounting kit• TTL, fiber optic or fast negative-going charge pulse input• TTL or fiber optic gate inputs



Specifications

Charge recording

Signal type	Selectable from: - TTL pulses - Fiber optic 640 nm pulses The dosimetry system that the CM100 works with defines the quantum of dose that corresponds to one pulse.
Maximum pulse rate	2 MHz
Dose per pulse	Configurable from 1e-5 to 1.0 MU recorded per pulse received
Counting scheme	Upwards from zero to set dose
Count limit	Automatic interlock if count reaches configurable limit, typically 120% of set dose.
Counter depth	64 bits
Data retention and display	Data recorded to flash memory card. CM100 display and function maintained for greater than 20 minutes after power loss using built-in re-chargeable battery pack.

Gating

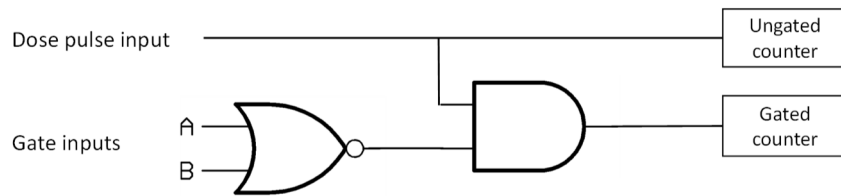
Two inhibit inputs to allow charge monitoring into a gated counter channel to be temporarily disabled, for example if the beam is known to be absent by other means and any apparent dose would be spurious.

An example is to prevent counting apparent dose from an imaging X-ray shot when the particle beam is known to be blocked by a beam stop.

A parallel non-gated charge monitoring counter remains active.

Gate inputs purchase option select from:

- TTL pulses
- Fiber optic 640 nm pulses



Audio

Output	Internal speaker, adjustable volume (muting not allowed) and parallel audio line output jack.
Sound	Selectable "tick" or "beep". Audio frequency of beep option selectable.
Scaling	Configurable pulse rate to audio tick rate mapping from 1e6 to 1e2 pulses per tick.
Source	Ungated channel



Specifications (continued)**Beam disable**

Pause	Safety-rated relay (Tyco SR4) with mechanically-guided contacts and sensing of welded contacts. Normally open contacts. Relay closed if pause button not pressed, CM100 is in BEAM ON state with no errors.
Overflow	Safety-rated relay (Tyco SR4) with mechanically-guided contacts and sensing of welded contacts. Normally open contacts. Relay closed if Max MU threshold is not exceeded, CM100 is in READY or BEAM ON state with no errors.
EMO	Mechanically-latching emergency off switch contacts connect directly to rear panel connector. Contacts open when switch depressed.

Processor

Type	TI Sitara AM335x (ARM Cortex A8) 1 GHz with dual PRU.
Operating system	Debian Linux.
Watchdog	Relays open (hardware action) and forced processor reset if watchdog is not tickled every msec.

Self-test

Automated self-test (POST)	Automated tests of relay function, RAM and flash memory, battery function, Ethernet connection. System operation prohibited if POST fails.
Other tests	Tests with user prompts for button function, emergency off, audio function, keyswitch function, touchscreen function, fiber-optic signalling.

Connectivity

Ethernet	Ethernet 10/100/1000 Mbps. Auto MDIX. Embedded EPICS channel access server allows client software to monitor and control device function.
USB	USB port for device setup and diagnostics (qualified service technician access). Connecting to the USB port creates a virtual network to a host system and appears at static IP address 192.168.7.2.
Dosimetry system	Direct fiber-optic communications channel to compatible pencil beam scanning scan and dose control systems to allow CM100 to record spot number and system state. The connection is not mandatory; the CM100 will function in respects aside from spot number tracking if it is not present.
Other devices	Fiber-optic communications to devices including magnetic field monitors (H20 device), power supply interfaces (M10, M40 devices) in normal or snooping mode for optional recording of data associated with beam scanning.



Specifications (continued)**Audio**

Configuration	Audio line output in parallel to the internal speaker (connecting to jack does not disable internal speaker)
Level	2 V rms max

Power

Power input	24 V (+/- 2V) DC, 1000 mA typ, 1500 mA max.
Battery backup	<p>Operation of device including user interface continues for not less than 20 minutes if power is removed.</p> <p>Alert if battery pack is missing, low performance or not in good condition.</p> <p>Battery pack type: AA Portable Power Corp 10566/ PR-CU-R485 16 V 1500 mAh (5 x Powerizer LiFePO4 18650 3.2V V 1500 mAh) with TI BQ24630 charge controller.</p> <p>> 1000 cycle life, battery pack factory replaceable.</p>

Case

Configuration	Desk-mounting console. See figures for dimensions
Protection rating	IP34 (proof against splashed liquid).
Weight	4.5 kg (10.0 lb)

Environment

Intended location	Particle therapy treatment rooms (one CM100 per room)
Operating environment	10 to 35 C (15 to 25 C recommended) , < 70% humidity, non-condensing, vibration < 0.2g all axes (1 to 100 Hz)
Shipping and storage environment	-10 to 50 C, < 80% humidity, non-condensing, vibration < 1g all axes, 1 to 100 Hz



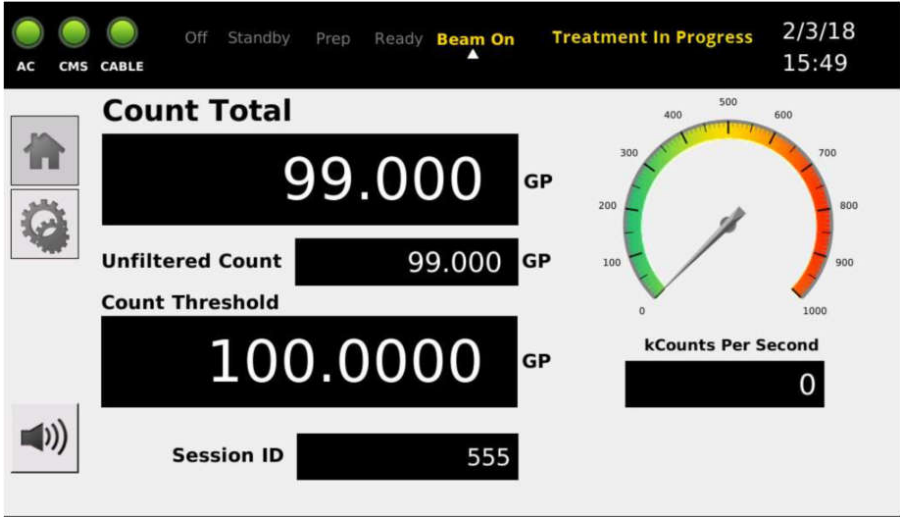
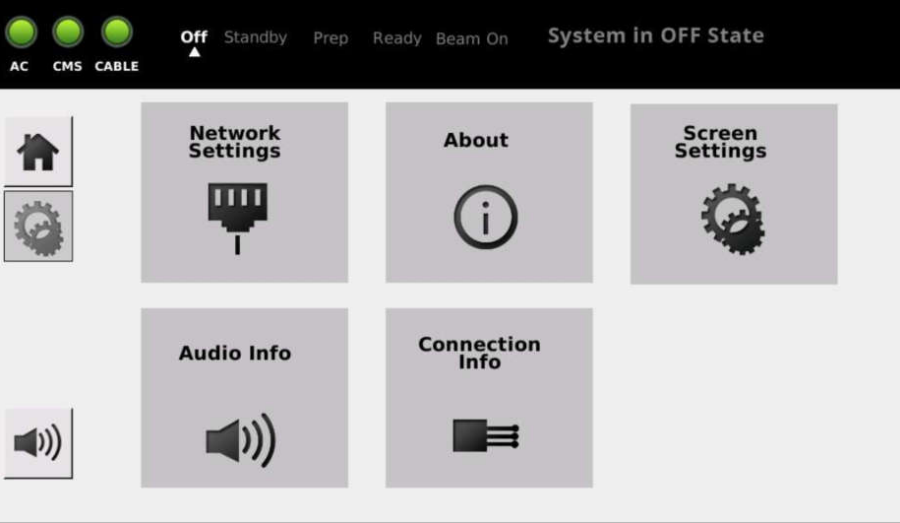
Controls



Keyswitch	Three-position switch with key retention. Positions correspond to stages in an irradiation as defined in IEC 60601-2-64: Off / Prepare / Treat. Backlit labels indicate PREP and TREAT conditions. Key can only be removed in OFF position.
Emergency Stop	Locking push switch with visual indication of actuation.
Start	Pushbutton with green illuminated bezel indicating availability to start or resume irradiation.
Pause	Pushbutton with blue illuminated bezel indicating availability to pause irradiation.
User interface	1024 by 768 backlit color LCD capacitive touch screen, 7" (17.8 cm) diagonal
Access rights	Clinical controls or service controls only enabled when authorization codes are received from a host system via Ethernet command.
Processor reset	Rear panel push-button.

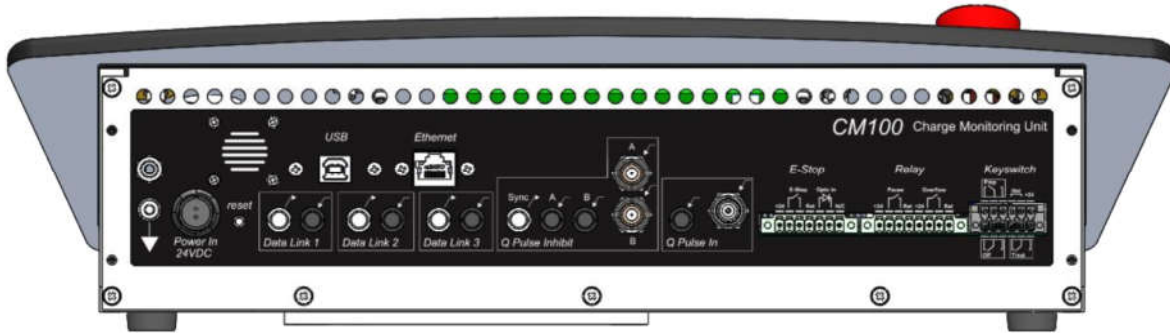


Display

Clinical display	
Access	Screen is locked (read only) during irradiations
Key features	<ul style="list-style-type: none"> - Current monitor units (MU) or giga-protons (GP) - Target MU or GP - Dose rate - Session ID - Status
Example	
Service display	
Key features	Access to configuration options (access rights required, settings, self-test functions and data log).
Example	



Signals and connections

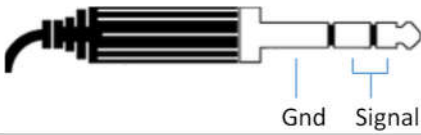


Connector details listed below are from right to left for view above

<p>Keyswitch</p>	<p>Phoenix 1787056 12-position 3.5 mm. Locking mating connector Phoenix 1790331 (supplied). Changeover (SPDT) indication of keyswitch state to remote devices. Position 1: Off Position 2: Prepare Position 3: Treat (direct connection)</p> <table border="1"> <tr> <td>1</td> <td>Key position 1 n/c</td> <td>7</td> <td>Key position 2 n/c</td> </tr> <tr> <td>2</td> <td>Key position 1 com</td> <td>8</td> <td>Key position 2 com</td> </tr> <tr> <td>3</td> <td>Key position 1 n/o</td> <td>9</td> <td>Key position 2 n/o</td> </tr> <tr> <td>4</td> <td>Key position 3 n/c</td> <td>10</td> <td>24 V rtn</td> </tr> <tr> <td>5</td> <td>Key position 3 com</td> <td>11</td> <td>24 V rtn</td> </tr> <tr> <td>6</td> <td>Key position 3 n/o</td> <td>12</td> <td>+24 VDC out</td> </tr> </table>	1	Key position 1 n/c	7	Key position 2 n/c	2	Key position 1 com	8	Key position 2 com	3	Key position 1 n/o	9	Key position 2 n/o	4	Key position 3 n/c	10	24 V rtn	5	Key position 3 com	11	24 V rtn	6	Key position 3 n/o	12	+24 VDC out
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<p>Relay</p>	<p>Phoenix 1827923 8-position 3.81 mm. Locking mating connector Phoenix 1851290 (supplied). Contact closure indication of pause state and counter exceeded limit state.</p> <table border="1"> <tr> <td>1</td> <td>+24 VDC out</td> <td>5</td> <td>+24 VDC out</td> </tr> <tr> <td>2</td> <td>Pause relay contact</td> <td>6</td> <td>Count limit relay contact</td> </tr> <tr> <td>3</td> <td>Pause relay contact</td> <td>7</td> <td>Count limit relay contact</td> </tr> <tr> <td>4</td> <td>24 V rtn</td> <td>8</td> <td>24 V rtn</td> </tr> </table>	1	+24 VDC out	5	+24 VDC out	2	Pause relay contact	6	Count limit relay contact	3	Pause relay contact	7	Count limit relay contact	4	24 V rtn	8	24 V rtn								
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<p>Emergency stop</p>	<p>Phoenix 1827910 7-position 3.81 mm. Locking mating connector Phoenix 1851287 (supplied). Emergency off switch contacts. Opto-coupled digital input.</p> <table border="1"> <tr> <td>1</td> <td>+24 VDC out</td> <td>5</td> <td>Opto input anode (1 kΩ)</td> </tr> <tr> <td>2</td> <td>Switch contact</td> <td>6</td> <td>Opto input cathode (1 kΩ)</td> </tr> <tr> <td>3</td> <td>Switch contact</td> <td>7</td> <td>n/c</td> </tr> <tr> <td>4</td> <td>24 V rtn</td> <td></td> <td></td> </tr> </table>	1	+24 VDC out	5	Opto input anode (1 kΩ)	2	Switch contact	6	Opto input cathode (1 kΩ)	3	Switch contact	7	n/c	4	24 V rtn										
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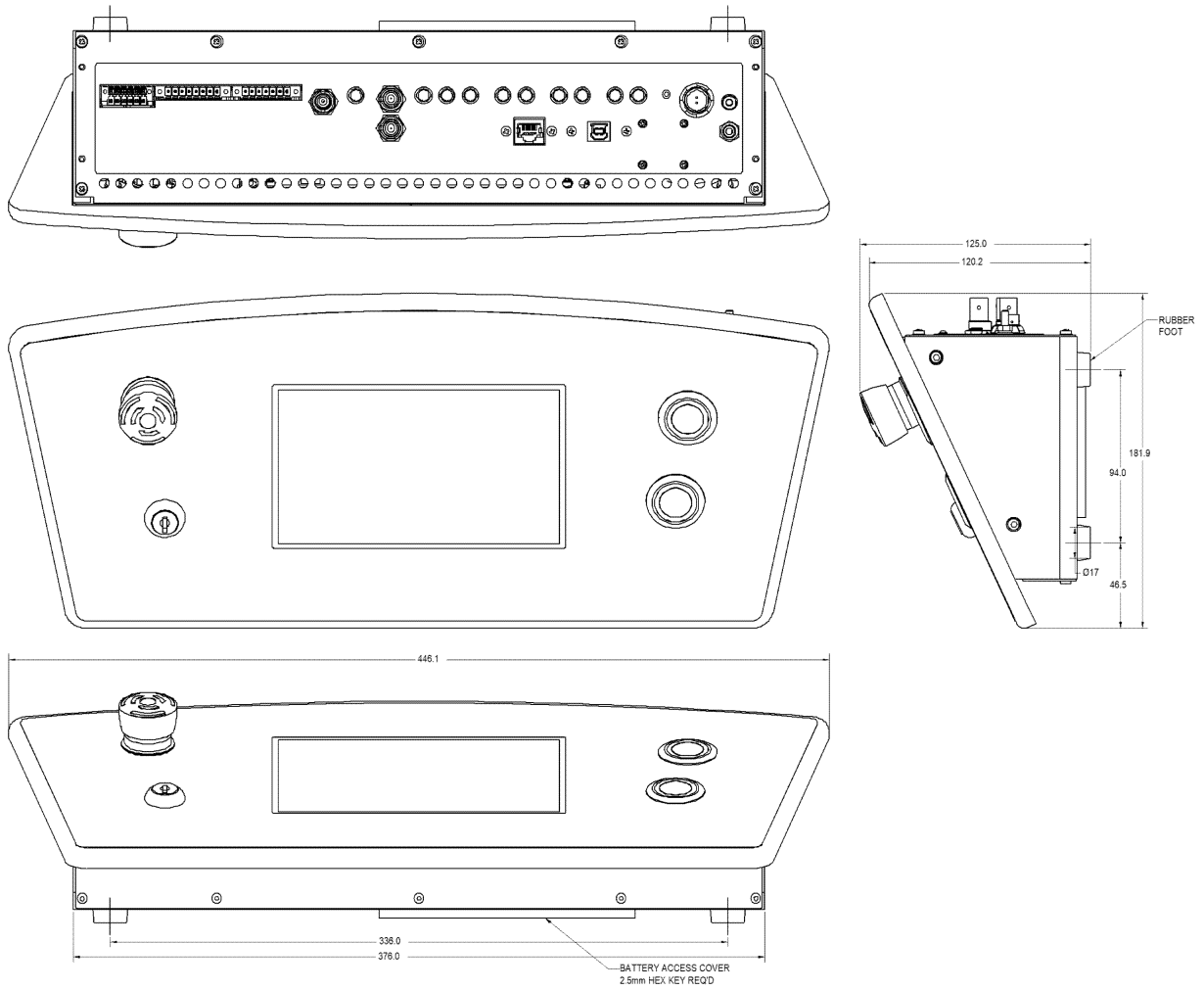


Connectors (continued)

<p>Charge pulse input</p>	<p>BNC female and HFBR-2515 ST bayonet fiber optic receiver. Automatic detection of disconnected cable. Build-time options for pulse input:</p> <ul style="list-style-type: none"> - TTL level pulses via BNC input - fast negative-going NIM pulses via BNC input - optical pulses via fiber optic input 				
<p>Charge pulse count inhibit inputs</p>	<p>Two BNC female and two HFBR-2515 ST bayonet fiber optic receiver. Build-time options for A and B pulse inhibit inputs for the filtered charge count:</p> <ul style="list-style-type: none"> - TTL levels via BNC inputs - optical levels via fiber optic input 				
<p>Synch output.</p>	<p>HFBR-1515 ST bayonet fiber optic transmitter (640 nm light). External system synchronisation (future option)</p>				
<p>Data links</p>	<p>Three fiber optic receiver/transmitter pairs (HFBR-2525, HFBR-151 ST bayonets) . Serial communication channels Link 1: optional transfer of spot number and related data from compatible scan/dose systems. Links 2,3: optional communication with other compatible devices such as magnetic field monitors, power supply monitors.</p>				
<p>Ethernet</p>	<p>RJ-45 standard Ethernet connector. Communication with system controller for transfer of dose target and general control and readback. Standalone operation of the CM100 is also possible, with dose targets input by an authorized clinical user.</p>				
<p>USB</p>	<p>Type B receptacle. Diagnostic port. Factory configuration and service work by trained staff only.</p>				
<p>Power input</p>	<p>Lemo Redel PXG</p> <table border="1"> <tr> <td>1</td> <td>+24 VDC in</td> </tr> <tr> <td>2</td> <td>24 V rtn</td> </tr> </table>	1	+24 VDC in	2	24 V rtn
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2	24 V rtn				
<p>Audio out</p>	<p>3.5 mm audio jack. Mating connector:</p> 				
<p>Ground lug</p>	<p>M4 threaded stud</p>				



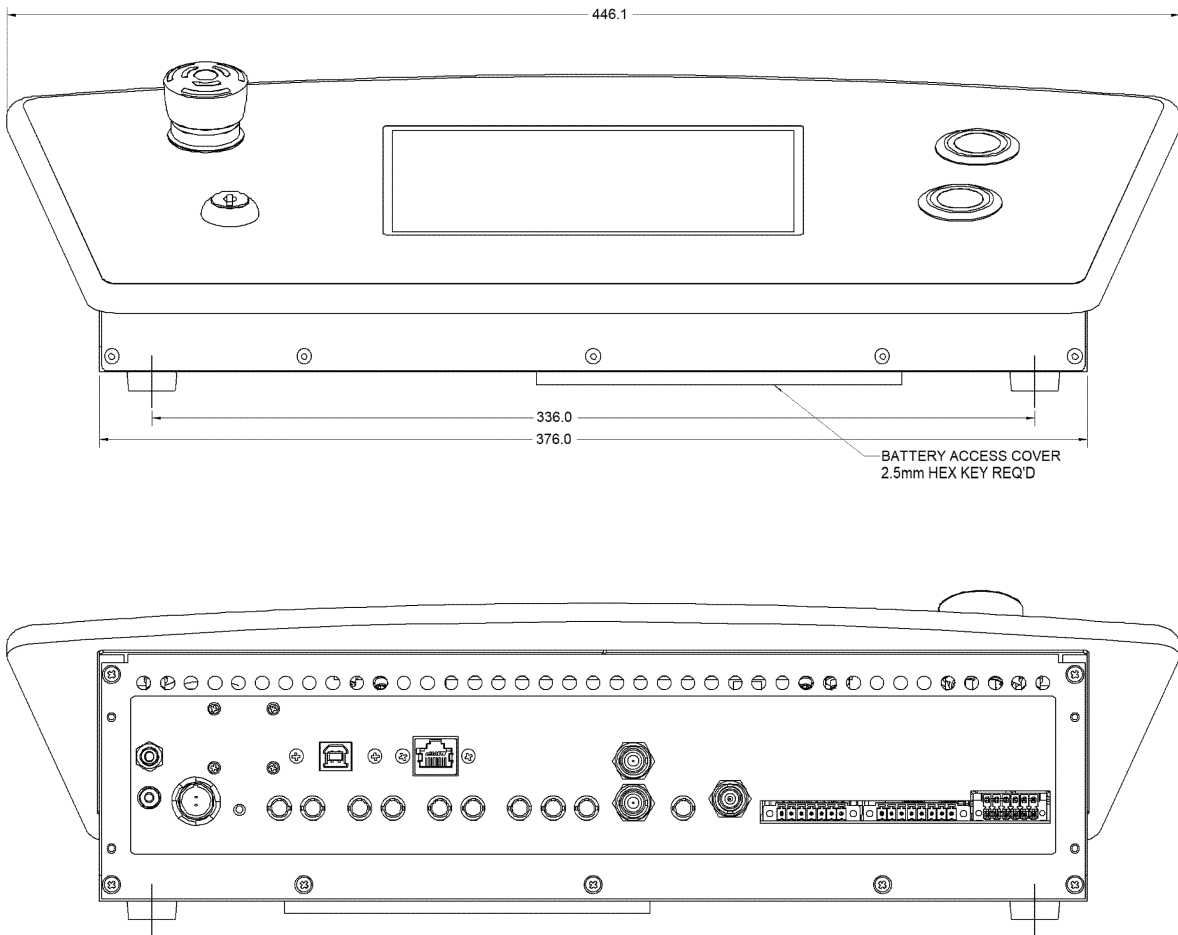
Dimensions



Dims mm



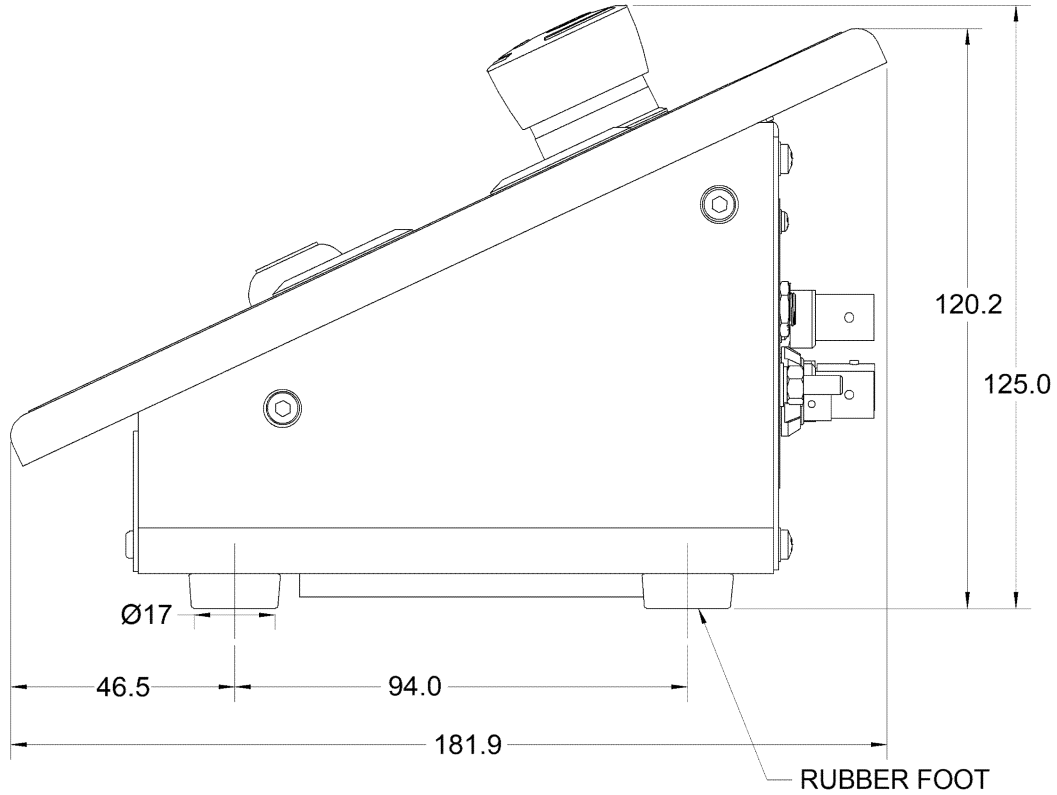
Dimensions—Front and Rear Views



Dims mm



Dimensions — Side View



Dims mm

Ordering information

CM100	Control and Charge Monitoring Unit for particle therapy treatment control rooms.
-QN / -QO	Charge pulse type options (default is TTL level pulses on BNC input): - configured to count fast negative-going pulses on BNC input / - configured to count optical pulses on ST fiber optic input.
-GO	Gate signal type (default is TTL logic levels on BNC gate inputs A and B): - configured to respond to optical logic level on ST fiber optic gate inputs A and B.
-PM	6U panel mounting kit for standard 19" rack

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All trademarks and names acknowledged.

CM100_DS_180607

