OPERATIONAL DESCRIPTION

Radio Frequency – In-Vivo Dosimeter
"rf-IVD"

Model 1133

DESIGNED AND MANUFACTURED BY
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1.0 Product Operational Overview

The Sun Nuclear Model 1133 rf-IVD (or wireless IVD) is a system that measures the radiation output of a radioactive substance such as a Co-60 source or a linear accelerator, during the treatment of a patient. Because the radioactive source is located near the middle of the treatment room an RF link makes the movement of personnel, patients and equipment around it safer, i.e. no cables to trip over and no cables to roll carts over.

The system consists of 4 components: Display Module (user interface), Turtle (Communication Hub), Base Station (rf transmitter and receiver), and Detector Pod (rf transmitter and receiver). The Base Station and Detector Pod are identical and are interchangeable through system setup. The diode radiation detectors are connected to the Detector Pod through coaxial BNC connectors.

The radiation therapist connects the radiation detectors (diodes) to the Detector Pod and then positions them on the patient in order to measure the radiation from the accelerator. At this time, the patient is on the treatment couch of the accelerator, already positioned for treatment. The detector pod is battery operated and is positioned within 3 to 10 feet of the beam entrance to the patient. Also at this time, the beam is not on and the rf-IVD is not making a dose measurement.

The therapist then leaves the treatment room that is shielded with approximately 3 feet of concrete and a heavy interlocked door. The patient is restrained on the couch because the treatment plan requires position accuracy to within millimeters, therefore no movement is allowed. Dose measurement is then remotely started on the rf-IVD from the Display Module in the control room and the accelerator beam turned on. A treatment fraction generally lasts for ½ minute or so. When the beam turns off, the rf-IVD is stopped and the dose value is displayed. The rf-IVD display value is recorded or printed on an accessory printer. The therapist then enters the room and removes the detector from the patient.

The recorded rf-IVD measurement is a QA test that verifies the dose output during treatment from the radiation machine. The actual treatment plan is calculated in the Treatment Planning Computer (TPC – not part of the rf-IVD) which uses dosimetry data acquired from a NIST traceable calibrated ion chamber and 3D water phantom. The plan output should also include the "expected" dose at the point of the IVD detector placement. Then the measured IVD dose and the expected TPC dose can be compared for verification. If the expected dose is not verified, the measured dose should not be used to adjust future treatments. Instead, an investigation should be conducted as to why the error occurred. The IVD is calibrated at the institution using the NIST traceable calibrated ion chamber as a standard, the same standard that is used to calibrate the accelerator and the TPC. Therefore, the IVD offers a closed loop QA test of the implementation of the plan.

2.0 RF Transceiver

The RF Transceiver is a completely self-contained hybrid in a 7mm X 10mm, surface-mount, 20-terminal metal can. It operates at 916.5 MHz, +/- 0.2 MHz. The modulation is On/Off Keyed. We are using a baud rate of 4630 bits/sec. The following Acrobat PDF document is the manufacturer’s specification for the hybrid that we are using. Double-click on the icon below to review the manufacturer’s specification.

Acrobat Document

This hybrid is mounted on a two-sided circuit board with a bottom ground plane and a top copper poured ground plane around all of the circuit traces and component mounting pads. There is an 8-pin connector that connects the transceiver to the microcontroller based electrometer board beneath the transceiver’s printed circuit board . The transceiver gets its power, control and data thru the connector from the electrometer board. The transceiver’s power supply Voltage is 3.0V. The power is filtered to keep noise from the electrometer board from getting on the RF output. The two control lines place the transceiver in either transmit mode, receive mode or “Off” mode. There is one transmit line for data to the transceiver and one receive line for data from the transceiver. The RF output track on the printed circuit board from the transceiver hybrid is impedance matched to a 50 Ohm coaxial cable connector. The other end of the coaxial cable is plugged into another 50 Ohm connector that is soldered to the antenna mounting pad. The antenna mounting pad has a “Reverse SMA” connector that is not readily available to the consumer. The ¼ wave helical whip antenna mounts to the “Reverse SMA” connector. The case is an aluminum extrusion with metal end panels.

The system has been tested to meet section 15.249 of Part 15. We are not measuring a patient biometric, i.e. a physical parameter of a human being. We are measuring radiation coming from a radioactive isotope or a particle accelerator. A patient does not have to be present for this equipment to be used.

3.0 Location of Intended Use

The radio frequency communication is only performed in the treatment vault of a hospital, clinic or university. The treatment vault is a shielded room having solid high density steel reinforced concrete walls and ceiling, typically 3 feet thick. The door is an 8 inch thick steel and boron polycarbonate laminate. The treatment vault must be well shielded to protect personnel from very high energy x-rays (20 MV) and is built on the ground floor of the institution. The shielding to prevent high-energy x-rays from leaving the room also prevents RF energy from entering or leaving the room. Refer to the following System Block Diagram.