Elekta

iCom Interface Information

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ELEKTA

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Related documents

Elekta does not supply all the documents that we refer to in this document with the equipment. Elekta reserves the right to make the decision on which of the documents we supply with the equipment.

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TECHNICAL HELP

Contact your local Elekta representative for technical help

Field Change Order (FCO) record

When you receive an FCO, Elekta recommends that you:

- Put the FCO in the related section of this document
- Complete the FCO Record with:
  - The FCO number.
  - The date you added the FCO.
  - Your signature.
- Use the information in your procedures.

FCO number	Date	Signature

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List of figures and tables

1 General safety and regulatory information

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1.1 Introduction

This chapter gives the general safety and regulatory information about Elekta.

Configurations

This document gives the information for all configurations of the equipment. It is possible that you do not have a license for all configurations available.

Examples

If the examples in this document refer to patients, physicists, or hospitals by name, then they are not the names of real persons or hospitals. If an example uses the name of a real person or hospital, it is accidental.

1.2 Function of this document

The function of this document is to provide an overview of the iCom external interface that is available on Elekta linear accelerators. It describes the iCom interface for Integrity™ R1.1, R1.2, R2.0, R2.1, R3.0, R3.1 and R3.2 control systems. Other references are available upon request from Elekta.

Clinical User
A Clinical User is a Qualified Person who uses the linear accelerator, and its accessories, for the treatment of patients. A Clinical User is trained in the safe, clinical operation of the digital accelerator. Such a treatment **must be** therapeutic only.

Service User
A Service User is a Qualified Person who is trained to do the maintenance tasks on the linear accelerator and its accessories. A Service User operates the linear accelerator, and its accessories, to do the tests, adjustments, and repairs to the equipment. Such operation **must not** be therapeutic.

All users

Before you operate the equipment, Elekta recommends that you read, understand, and obey all the:

- Warnings
- Cautions
- Notes
- Release notes
- Safety labels and markings
- FCOs

Elekta recommends that you:

- Read carefully the information in the Safety section of this chapter.
- Keep this document with the equipment, which lets you easily refer to it.

1.3 Intended audience

This document is intended for use by developers of treatment planning systems, record and verify (R&V) systems and other external interfaces to Elekta linear accelerators.

1.4 Compliance

The design of the equipment is in compliance with applicable international standards for safety.

Contact Elekta Limited for more information on applicable international and IEC safety standards.

1.5 Training

Different countries have different regulations for training. Make sure that you have the necessary training before you operate, or do work on the equipment. Make sure that your training is in compliance with the laws and regulations of the jurisdiction in which the equipment is installed.

1.6 Safety

Elekta recommends that:

- All users obey the precautions in this section
- That you examine the warnings, cautions and notes in this document and use them in your local Work Instructions.

1.6.1 Important safety instructions

It is important to install, operate, and do the maintenance correctly on all medical electrical equipment. This is most important for safety related items. For your safety and the safety of the patients, Elekta recommends that you read, understand and obey all:

- Warnings, cautions and notes in this document and related documents.
- Warnings, cautions and safety markings on the equipment and the accessories of the equipment.
- Instructions and information in the Safety section of this document and related documents.

1.7 Text formats

This is the convention for the text formats that you can find in this document.

Text Format	Definition
Bold	The text that shows on a VDU screen Button labels Screen (window) labels File names Sequential selections Important information
SMALL CAPS	Signal names
`courier`	Denotes text to be entered by the user, or paths

1.8 Conventions

This is the convention for terms that you can find in this document.

Term	Convention
Authorized Person	A person who is given the authority to do the work on the equipment by the authority that controls the equipment.
Qualified Person	A person that is recognized by a competent authority to have the necessary knowledge and training to do specified tasks.

1.9 Conventions for the directions of the linear accelerator

Figure 1.1 gives the conventions that Elekta uses to refer to the directions of the linear accelerator in the treatment room. The conventions are applicable only when the patient is in the head first *(anatomical supine)* position on the treatment table.

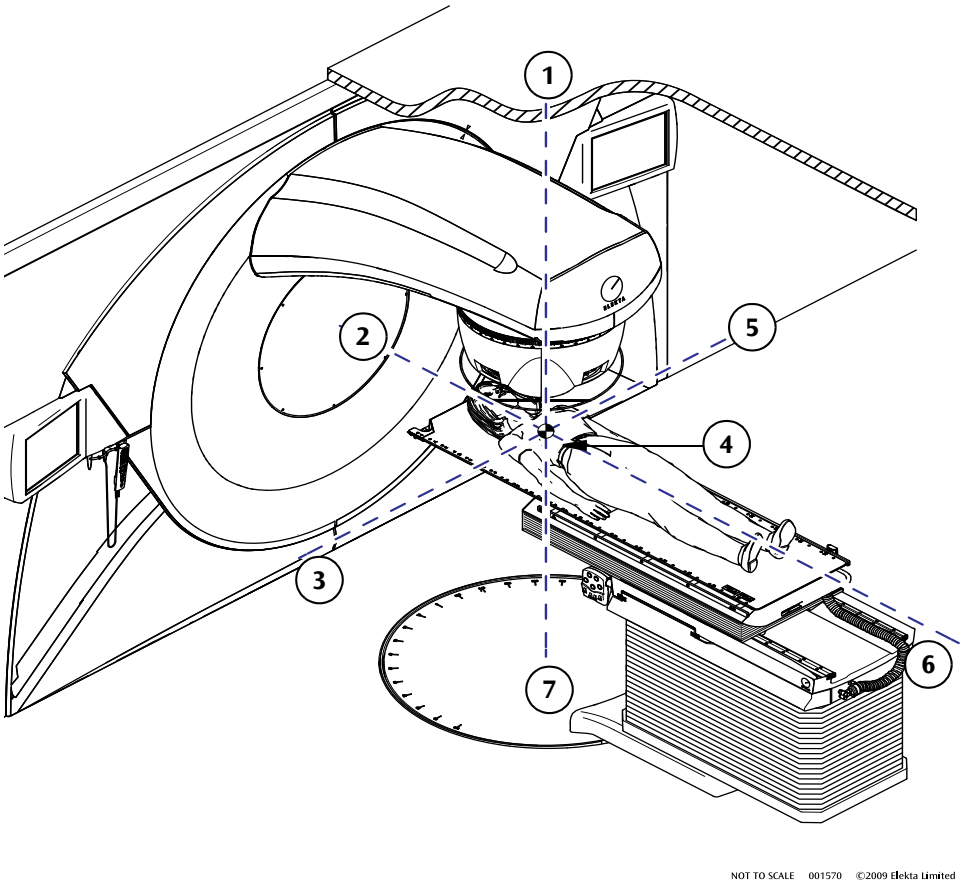

Figure 1.1 Conventions for the directions of the linear accelerator

(1) Treatment room ceiling (top) *(anatomical anterior)*
(2) Linear accelerator gun (G-end) *(anatomical superior)*
(3) Linear accelerator A-side *(anatomical right)*
(4) Machine isocenter
(5) Linear accelerator B-side *(anatomical left)*
(6) Linear accelerator target (T-end) *(anatomical inferior)*
(7) Treatment room floor (bottom) *(anatomical posterior)*

Note: *The A and B positions in* **Figure 1.1** *are correct with the gantry at 0° only. The A and B positions rotate with the gantry. Therefore, with the gantry rotated 180°, A and B are opposite.*

1.10 Abbreviations and acronyms

These are the conventions for the abbreviations and acronyms that you can find in this document.

Acronyn	Definition
ASU	Assisted Set-Up
API	Application Programming Interface
BLD	Beam Limiting Device
CAT	Customer Acceptance Test
CC	Counter Clockwise
CD	Compact Disk
CW	Clockwise
DICOM	Digital Imaging and Communications in Medicine
DLG	Dynamic Leaf Guide
DLL	Dynamic Link Library
DMLC	Dynamic Micro Multileaf Collimator
DVD	Digital Video Disk
IEC	International Electrotechnical Commission
EMC	Electromagnetic Compatibility
FFF	Flattening Filter Free
HDRE	High Dose-Rate Electron
ID	Identification
IMAT	Intensity Modulated Arc Therapy
IMRT	Intensity Modulated Radiation Therapy
IP	Internet Protocol
LAN	Local Area Network
MeV	Mega Electron Volt
MLC	Multi-Leaf Collimator
MU	Monitor Unit
NRT	Non Real Time
NSS	Network Security Solution
PC	Personal Computer
PRF	Pulse Repetition Frequency
R&V	Record and Verify

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RT	Real Time
TCP/IP	Transmission Control Protocol/Internet Protocol
TCS	Treatment Control System
VMAT	Volumetric Modulated Arc Therapy

2 Overview of iCom

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2.1 The iCom interface

iCom is the Elekta network communications protocol for the control and monitoring of a linear accelerator by an external system. The interface has two elements:

- iCom-Vx
- iCom-Fx

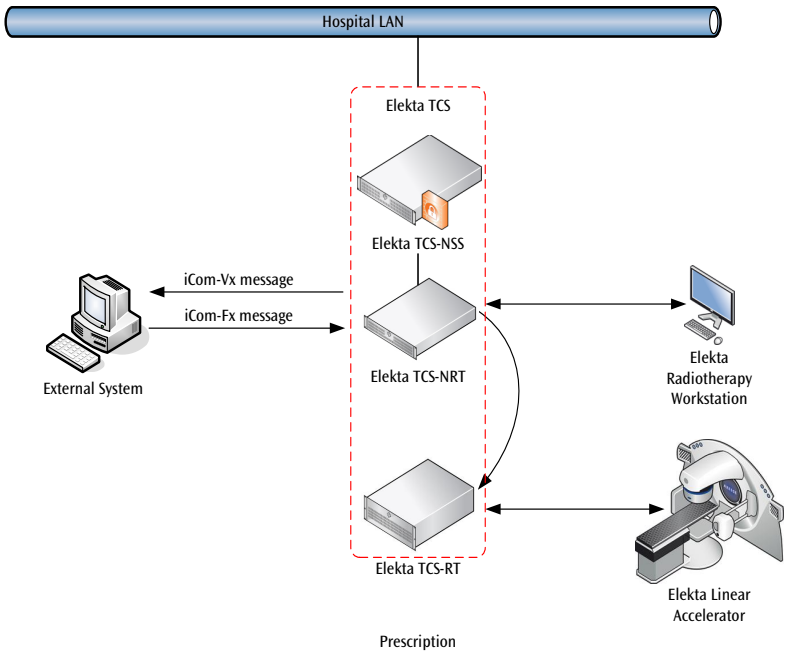

Figure 2.1 Overview of iCom

32-bit dynamic link library (DLL) routines are used to interface with iCom.

- Version 12.09 of the iCom DLL is used with Integrity™ R1.1, R1.2, R2.0, R2.1. Version 12.09 can be linked to Windows® XP applications.

Version 13.0.0 of the iCom DLL is used with Integrity™ R3.1 and R3.2 Version 13.0.0 can be linked to Windows® XP and Windows® 7 applications.

The network security solution (NSS) provides a firewall, routing and storage.

2.1.1 Elekta treatment control system

To understand how the iCom interface works with the Integrity™ TCS, it is necessary to understand the TCS architecture. The TCS is divided into two subsystems (see **Figure 2.2**).

- TCS-RT - the real time computer which runs the linear accelerator control system software.
- TCS-NRT - the non real time Windows® computer which runs the user interface and the prescription preparation software.

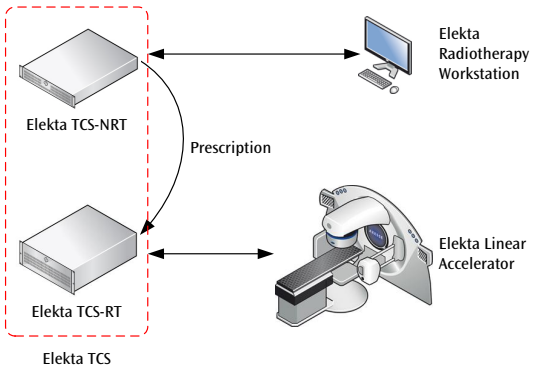

Figure 2.2 TCS subsystems

The external system interfaces with the linear accelerator via the TCS-NRT computer. This approach isolates the TCS-RT from the external system. The external system does not need to know how to control the linear accelerator, only how to specify a treatment.

Note: *Irrespective of the mechanism used to set up a field for treatment, the TCS is always active. It controls and monitors the operation of the linear accelerator. An external system cannot bypass the TCS.*

When an external system is connected to the linear accelerator, there are two modes of communication:

- iCom-Vx - the external system works as a record and verify (R&V) system with the standard linear accelerator functionality.
- iCom-Fx with iCom-Vx - the external system provides a complete prescription preparation and R&V system.

When the Integrity™ TCS is in **Clinical** mode and **Receive External Prescription** is selected, you cannot change prescription information directly through the TCS user interface. To run a prescription in Clinical mode, an external R&V system must be connected to the TCS. The R&V system must transmit the prescription information to the TCS with iCom-Fx and monitor with iCom-Vx.

2.1.2 iCom-Vx

iCom-Vx allows up to four external systems to monitor the current **Prescribed**, **Set** and **Run** parameter values of the linear accelerator in real time. If you use iCom-Fx, then you only have three iCom-Vx available for other functions. An R&V system is necessary but will use the iCom-Fx and one of the iCom-Vx connection. The values that can be monitored include actual geometric positions and patient information.

- iCom-Vx is primarily intended for use with iCom-Fx to allow an external R&V system to verify that the prescription is correct prior to treatment, and to record the treatment when delivered.
- iCom-Vx can also be used as a stand-alone function, for instance as part of a department logging facility.

Treatment parameter values are transmitted from the TCS:

- prior to treatment delivery to enable external verification;
- at treatment termination to enable external recording.

Certain linear accelerator events such as treatment **Start**, **Interrupt** and **Terminate** in treatment mode are also transmitted.

The external system can connect to the TCS at any time to receive iCom-Vx messages.

2.1.3 iCom-Fx overview

iCom-Fx enables an external system to transmit a treatment prescription to the TCS.

The treatment prescription is transmitted to the TCS when requested by the TCS user. The prescription is integrity-checked prior to treatment delivery.

When the TCS is set to receive an external prescription via iCom-Fx, it disables manual entry or alteration of any prescription settings.

The external system can connect to the TCS only when the TCS is in **Clinical** mode and the **Receive External Prescription** button is selected. iCom-Fx communication is not available when the TCS is in **Service** Mode.

iCom-Fx cannot be used in isolation. It can be used only in conjunction with iCom-Vx.

2.1.4 iCom-Fx with iCom-Vx

When used together, iCom-Fx and iCom-Vx allow an external system to:

- Remotely prepare a treatment prescription.
- Transmit the treatment prescription to the TCS when requested.
- Receive confirmation from the TCS that the prescription is correctly set up before treatment begins.
- Monitor treatment progress.
- Record the treatment when delivered.
- Optionally, terminate the treatment via the external terminate interlock function.

For treatment, there must be a one-to-one relationship between an external system and the TCS. At the start of treatment, the external system communicating via iCom-Vx and iCom-Fx must be connected to the same TCS as the external system termination mechanism (if fitted).

2.2 iCom communication

2.2.1 iCom-Vx communication

iCom-Vx initialization occurs when the TCS is powered up. The external system can connect to the TCS at any time to receive iCom-Vx messages. There can be up to four, concurrent iCom-Vx connections at any time.

To receive data via iCom-Vx, the external system must attach to the iCom-Vx network socket. The TCS responds to this connection by initiating transfer of an iCom-Vx message.

The format of the iCom-Vx message is pre-determined by a system data file and provides the external system with a comprehensive range of information. The type of message and the linear accelerator machine state are encoded into the iCom-Vx message header. The external system filters the messages to extract only the information it requires. See **Chapter 4** and **Appendix C** for information on message content.

During patient setup in the linear accelerator **Preparatory** state, iCom-Vx data is transmitted at a rate of approximately one message per second. When radiation commences, the data rate is increased to approximately four times a second if a dynamic therapy license is applied. Otherwise the data rate is increased to approximately two times a second. In addition to the timer driven reporting, other events will cause iCom-Vx to send data immediately which will be the changes in the Linac state or a change in a control point number (Sequence ID). The control system is only polled at a frequency of 4Hz so there is no gauarantee that every Sequence ID of a beam will be reported. This makes sure that the external recording device can accurately monitor the delivery of all treatments. When the Linac is in an Uninitialized state (Powered down), an empty message is sent every 30 seconds to maintain the link. During all non-therapy based functions, the data rate is reduced to approximately one message every five seconds to maintain the link. Exact timings depend on the network performance and the processing speed of the computers.

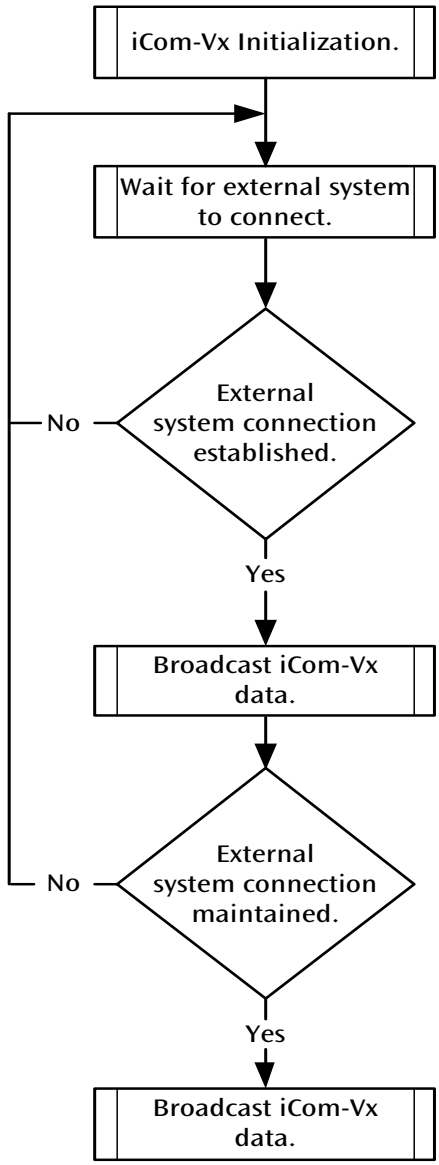

Figure 2.3 iCom-Vx state transition

2.2.2 iCom-Fx communication

iCom-Fx initialization occurs when an authorized user selects the **Receive External Prescription** mode on the TCS. This places the TCS into slave mode, where it waits for the external system to connect and transmit an iCom-Fx message.

The external system connects to the TCS only when the TCS is in **Clinical** mode. iCom-Fx communication is not available in Service mode.

If the connection to the external system is lost, then the TCS returns to the **Wait for External System to Connect** state. Any currently-selected treatment settings are cleared if they have not been delivered.

The format of the iCom-Fx message is based on the control point format proposed in the DICOM-RT data model. With this protocol, it is possible to specify fields using all the treatment techniques available on the linear accelerator. In addition, the protocol is designed to support the full dynamic capabilities of the linear accelerator.

iCom-Fx has a minimum set of mandatory parameters that must be provided in order for treatment to commence. The parameters include radiation type, energy, Monitor Units (MUs) and wedge position. For all other parameters, entry is optional. For a linear accelerator whose beam limiting device (BLD) is a multileaf collimator (MLC), the external system must also specify values defining the X and Y field size and offset, plus the accessory number, if appropriate.

The treatment data is extracted from the iCom-Fx message by the TCS. The TCS then validates the received prescription settings against a set of pre-determined parameters (see **Section 4.3.2**) to make sure that the field can be safely treated before preparing the linear accelerator for treatment. These settings cannot be altered on the TCS.

The linear accelerator Assisted Set-Up (ASU) facility can then be used to set the machine parameters.

When the linear accelerator has the correct settings, the external system must send a **CONFIRM SETTINGS** message to instruct the machine to enter the **Ready to Start** state. Treatment commences only when you press the **Start** key on the function keypad.

If a new treatment message is received, any current data is discarded and the new parameters are used to set up the linear accelerator. During radiation, or if the TCS is not in iCom-Fx mode, receipt of a new message results in an error response being sent to the external system.

The iCom-Vx data must be read by the external system at each control point to verify that the settings are correct and to record the treatment when delivered. If incorrect, the external system can terminate the treatment if the external terminate interlock is present.

The external system can use the external terminate interlock function to terminate radiation at any time.

When treatment has started, the TCS treats a beam to its termination. Disconnection of the external system does not terminate the treatment while it is in progress. Disconnection clears the current beam if not yet started and/or raises an inhibit to prevent delivery from commencing. If iCom-Vx disconnection occurs, iCom-Fx automatically disconnects.

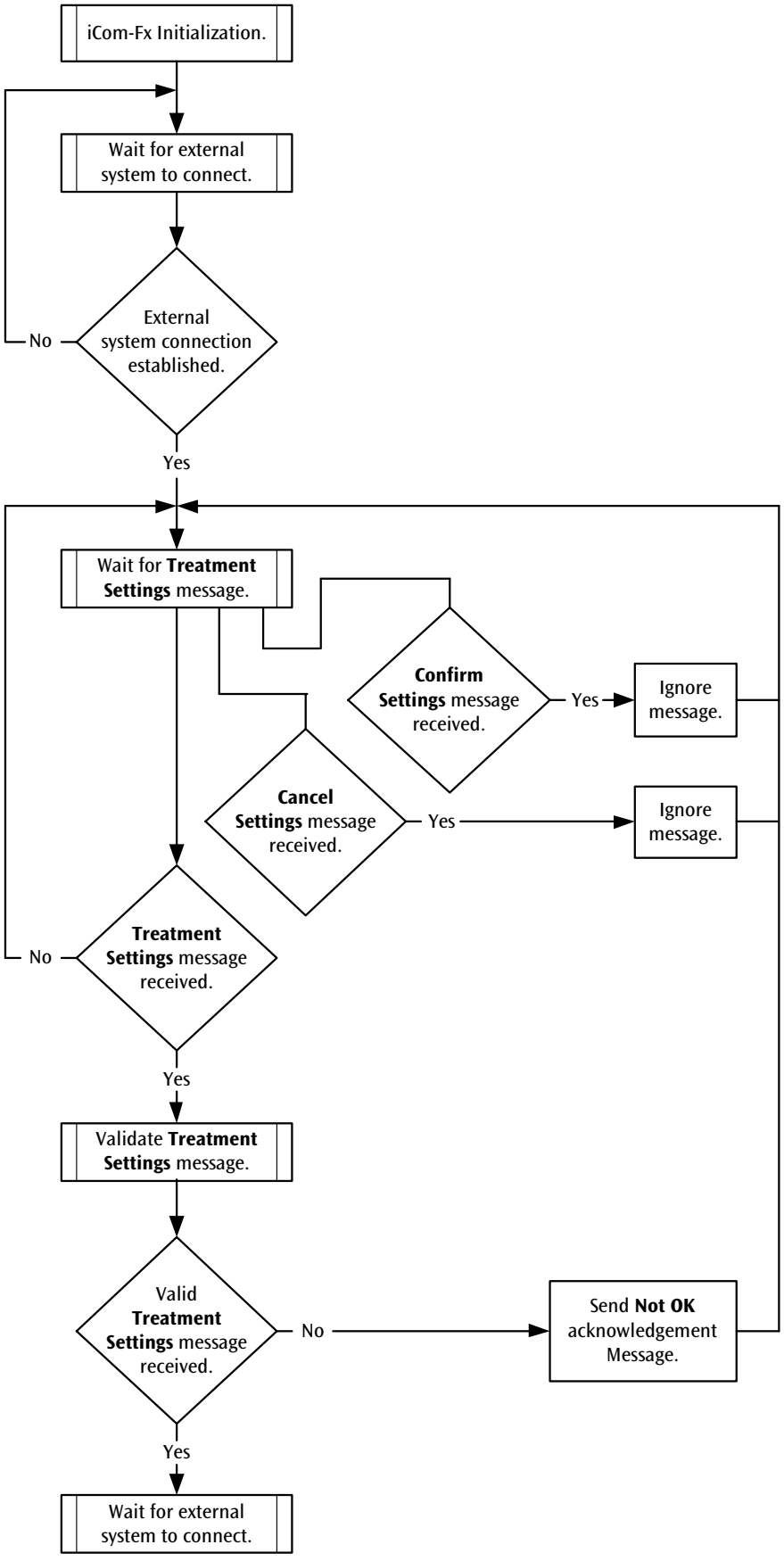

Figure 2.4 iCom-Fx state transition

2.2.3 iCom-Fx with iCom-Vx communication

Figure 2.5 shows the messages that pass between the external system and the TCS of the linear accelerator when using iCom-Fx with iCom-Vx in normal operation.

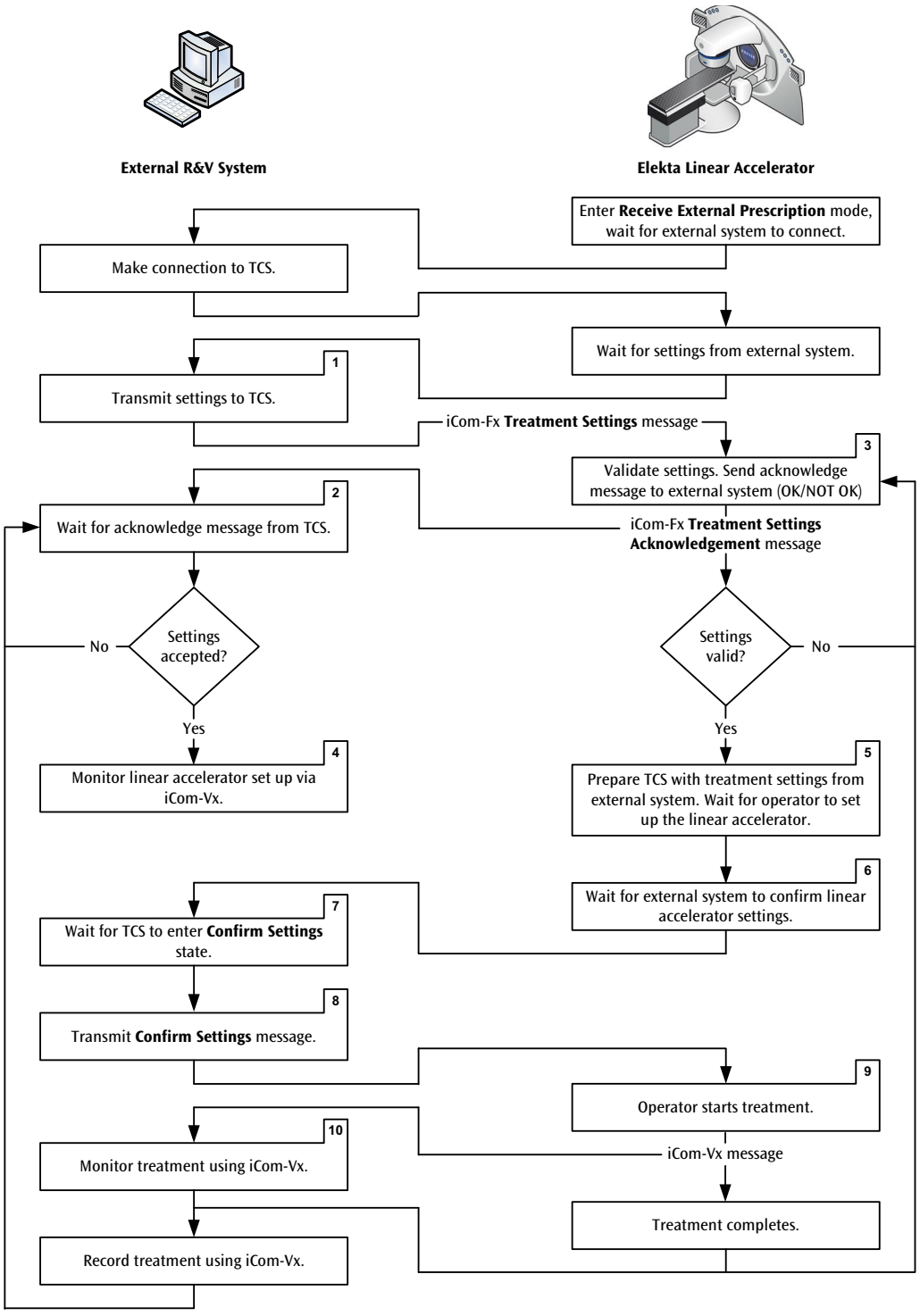

Figure 2.5 iCom-Fx with iCom-Vx communication

1 When the TCS is in **Receive External Prescription** mode, it accepts a connection from an external system. The user is prohibited from entering any prescription details at the TCS.

2 The TCS waits for the external system to transmit the iCom-Fx treatment settings message.

3 These settings are validated by the TCS and an acknowledgement message is returned to the external system. If the validation checks fail, then the acknowledgement message contains an error code that identifies the reason for failure.

4 If the settings are valid, they are passed to the TCS-RT. You can then set up the machine ready for treatment.

5 During treatment setup, the linear accelerator continuously transmits the current state and settings using iCom-Vx (see **Chapter 4.2.2**).

6 The external system waits for iCom-Vx to change to **Confirm Settings**.

7 When the linear accelerator is set up (that is, has only the **Confirm Settings** inhibit and **Desktop Not Ready** inhibit on the TCS), iCom-Vx changes state to **Confirm Settings**.

8 The external system transmits the **CONFIRM SETTINGS** message to the TCS.

9 The **Settings Not Confirmed** inhibit is seen on the TCS. This **Settings Not Confirmed** inhibit is removed by the external system sending the **CONFIRM SETTINGS** message to the TCS.

10 On receipt of the **CONFIRM SETTINGS** message the **Settings Not Confirmed** inhibit is removed from the TCS. The linear accelerator enters the **Ready to Start** state and the user can begin treatment by pressing **Start**. If the linear accelerator reaches the **Ready to Start** state and the user leaves the TCS untouched for a period of five minutes, the **Settings Not Confirmed** inhibit is seen on the TCS.

11 Once treatment starts, the external system can monitor and record the treatment when it completes. If the external system needs to terminate treatment, it can do so by asserting the external terminate interlock.

12 Subsequent to the **CONFIRM SETTINGS** message, if the external system needs to inhibit treatment it is able to in one of three ways:

- Transmitting an **UNCONFIRM SETTINGS** message.
- Transmitting a **CONFIRM SETTINGS** message (which toggles this state).
- Asserting the external terminate interlock (see **Section 2.3.1**).

13 When treatment has finished, the linear accelerator returns to the **Wait for Settings from External System** state.

Note: *When the external terminate interlock is active, the linear accelerator cannot achieve the* **Ready to Start** *state and cannot transmit the* **CONFIRM SETTINGS** *iCom-Vx message.*

Tolerance checking

The external R&V system must confirm that the actual values at each control point are within an acceptable tolerance of the prescribed values. See **Chapter 4.3.4** for a description of control points.

Depending on the R&V system used, the initial setup tolerances are checked in the R&V system software. The TCS provides in-treatment tolerance checking. The iCom tolerance table is used to check the tolerance of the actual values. See **Appendix A** for information on tolerances. If the values are not within required tolerances, the TCS can terminate the treatment. The R&V system can only initiate treatment termination if the external terminate (optional) interlock is present.

See the documentation for the R&V system for further information.

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2.3 External termination (optional)

The external terminate function gives an external system an opportunity to inhibit and/or terminate treatment on the linear accelerator.

The external terminate interlock circuit may already be in use. It is the responsibility of the user to make sure that any existing use of external terminate is not disturbed.

2.3.1 External terminate interlock circuit

On PreciseBEAM™ System a connection to the external terminate interlock circuit is available from TS73E in the Linear AcceleratorClient Interface Terminal Board (CITB).

On Elekta Compact™ a connection to the external terminate interlock circuit is available from BJ5948. 123 in the linear accelerator main control cabinet backpanel (MCCB).

The MOSAIQ® R &V system does not use this interface any more.

1 An open connection causes termination during irradiation or interrupted states and inhibits the transition from **Preparatory** to **Ready to Start** state at all other times (see **Figure 2.6**).

External Terminate (item 30) within the TCS provides the status of the external terminate interlock:

i30 ECG_Ext_terminate 30
'Ext. term 230'
External_termination input.

TRUE (odd) = External_terminate
FALSE (even) = Not_set

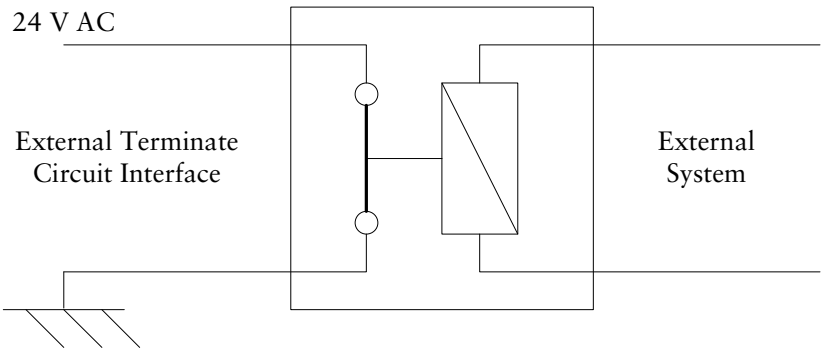

Figure 2.6 External terminate interlock

2.3.1.1 Relay/switch contact requirements

The external terminate circuit connection consists of a 10 kΩ pull-up resistor fed from a 15 V DC supply. This input is pulled down by the relay contacts provided by the external system.

The current rating of the external relay must be greater than 1.5 mA. Any low power switching relay with a contact rating in the order of 0.5 A (or greater) and a contact resistance of less than 500 mΩ is adequate.

For further details, see the *Digital Accelerator Corrective Maintenance Manual* and the *Digital Accelerator System Diagrams*.

3 iCom installation and use

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3.1 iCom installation

3.1.1 Pre-checks

Do these machine pre-checks:

1 Start the digital accelerator.

2 In **Clinical** mode, deliver a selection of prescriptions at various energies. Make sure that the digital accelerator terminates correctly after every delivery.

3 Make sure that all screen displays work correctly.

3.1.2 iCom dynamic link library

iCom uses Transmission Control Protocol/Internet Protocol (TCP/IP) for communications between the external system and the digital accelerator.

32-bit dynamic link library (DLL) routines are used to interface with iCom.

- Version 12.09 of the iCom DLL is used with Integrity™ R1.1, R2.0, R2.1. Version 12.09 can be linked to Windows® XP applications.

Version 13.0.0 of the iCom DLL is used with Integrity™ R3.1 and R3.2. Version 13.0.0 can be linked to Windows® XP and Windows® 7 applications.

The library routines are divided into three categories:

- Applicable to iCom-Vx
- Applicable to iCom-Fx
- Applicable to both iCom-Fx and iCom-Vx.

The specification of the routines is described in the following sections.

3.1.3 iCom DLL installation configurations

The DLL and supporting files are described in the **README.txt** file located on the iCom installation CD. The **README.txt** file explains how and where the files should be used. This file also contains the latest information relating to the use of the iCom library software and additional tips not included in this document.

3.1.4 Installation instructions

1 Put the iCom installation CD in the CD/DVD drive of the PC. The setup program starts automatically. Alternatively, open **setup.exe** on the CD.
The **Elekta iCom Setup** dialog box appears (see Figure 3.1).

Note: *If a previous version of iCom has been detected, the install process stops. You must uninstall the previous version of iCom before continuing. Use 'Add/Remove Programs' in the Windows® Control Panel.*

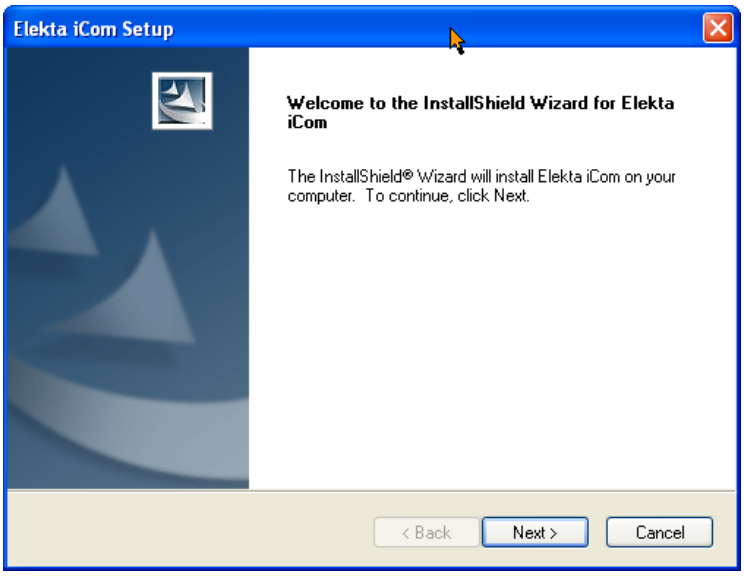


Figure 3.1 Elekta iCom Setup dialog box—Welcome

2 Click **Next** to continue.
The **Elekta iCom Setup** dialog box shows **Choose Destination Location**.

3 Click **Browse** to select a directory in which to install the iCom DLL, or accept the default.

4 Click **Next** to continue.
The **Elekta iCom Setup** dialog box shows **Choose Destination Location**.

Note: *You can install the iCom DLL in any directory that you prefer. The installation process adds that directory to the path.*

5 Click **Browse** to select a directory in which to install the support files, or accept the default.

6 Click **Next** to continue.

7 Select **Do not install iCom API files**, or accept the default **Install iCom API files**.

8 Click **Next**.
The **Elekta iCom Setup** dialog box shows **Start Copying Files**.

Note: *By default, the LIB and the API files required for development are installed. They are installed into the directory selected in step 3 and 5.*

9 Check that the settings in the **Current Settings** box are correct.

10 Click **Next**.

11 When installation is complete, click **Finish** to exit the setup program.

3.1.5 Installation process in conjunction with other installations

iCom installation can be invoked by the installation of a third party system. In this event, the installation process completes automatically.

The iCom DLL can be installed as part of another installation process for an external system. The **setup.exe** file supplied on the CD can be run with the **/s** extension for a silent installation. The options are configured by the **setup.iss** file, which can be edited to supply the options required. For more details, see the **setup.iss** file supplied on the CD.

Note: *If the iCom files are copied directly from the CD, Version 12.06 and above require that Microsoft®.Net runtime libraries are installed as well. This is done by running the appropriate Microsoft 'dotnetfxN.exe' where N is the .Net version.*

3.2 Using the iCom interface

3.2.1 Receiving External Prescriptions on the digital accelerator

To use the iCom-Fx functionality:

1 Put the digital accelerator into Clinical mode.

2 Click the **Receive External Prescription** primary function button.

Table 3.1 Button for treatment delivery

Receive External Prescription		Open **Receive External Prescription**

Note: *It is not possible to receive external prescriptions in Service mode.*

An external system can be connected after the TCS has been launched, in order to receive iCom-Vx data at any time. The link is available whenever Windows® has been launched on the TCS, regardless of the state of the machine. iCom-Vx data is available in Service mode or Clinical mode.

3.3 iCom Customer Acceptance Test

This section explains how to use the iCom Customer Acceptance Test (iCom CAT) program as part of the post installation checks to verify that the system is operating correctly, and that connection between the external R&V system and the accelerator is functioning.

The iCom CAT program is supplied on the iCom installation CD. Installation instructions can be found in **Section 3.1.4** of this manual.

Note: *The screen images included can appear in a different format, depending on the operating system running on the PC. The displays shown are applicable to Windows® XP.*

3.3.1 iCom CAT prerequisites

The following are mandatory:

- PC running Windows® 7.
- TCP/IP device driver installed
- An ethernet link from the PC to the TCS:
  - If the link is via an ethernet hub or switch, a standard ethernet patch cable is required.
  - If the link is not via an ethernet hub or switch, a standard ethernet crossover cable is required.

Before you start the iCom CAT program, make sure that the TCS is in **Receive External Prescription** mode (see Figure 3.2 and Figure 3.3).

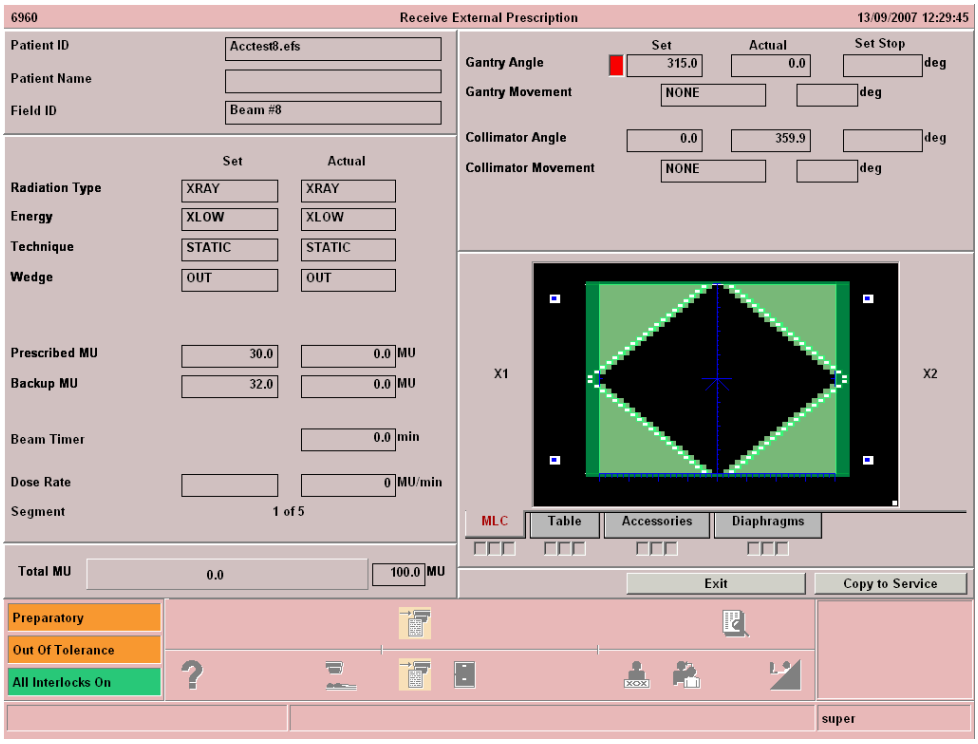


Figure 3.2 Receive External Prescription window for non-dynamic field

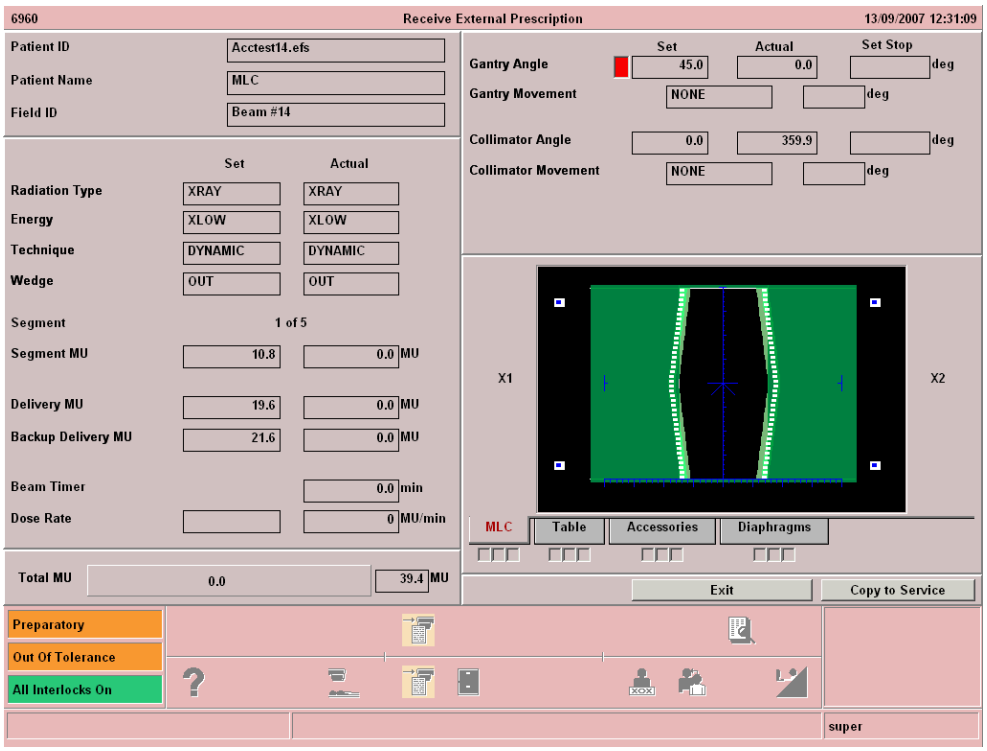


Figure 3.3 Receive External Prescription window for dynamic fields

3.3.2 Starting the iCom CAT program

1 Open **iComCAT.exe** in Windows® Explorer, or use the **Run** command on the **Start** menu.

2 In the **Server Connections** dialog box, type the **Server IP Address** and the **Linac ID** of the digital accelerator in the applicable boxes (see **Figure 3.4**).

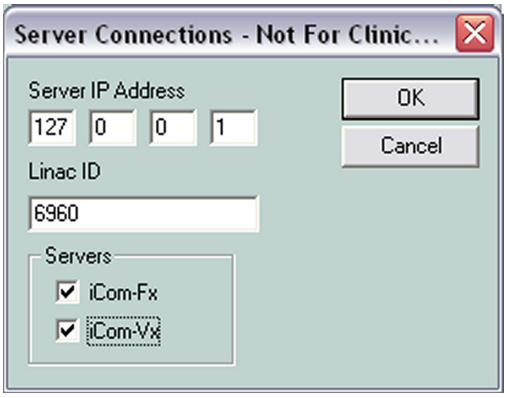


Figure 3.4 Server Connections dialog box

Note: *The* **Server IP Address** *is given by the hospital client network administrator. The* **Linac ID** *(for example 6960) must be the same as that given to the digital accelerator in the* **Linac Customization** *program.*

3 Make sure that the **iCom-Fx** and **iCom-Vx** check boxes in the **Servers** area are selected.

4 Click **OK.** The main **iCom CAT** window opens (see **Figure 3.5**).

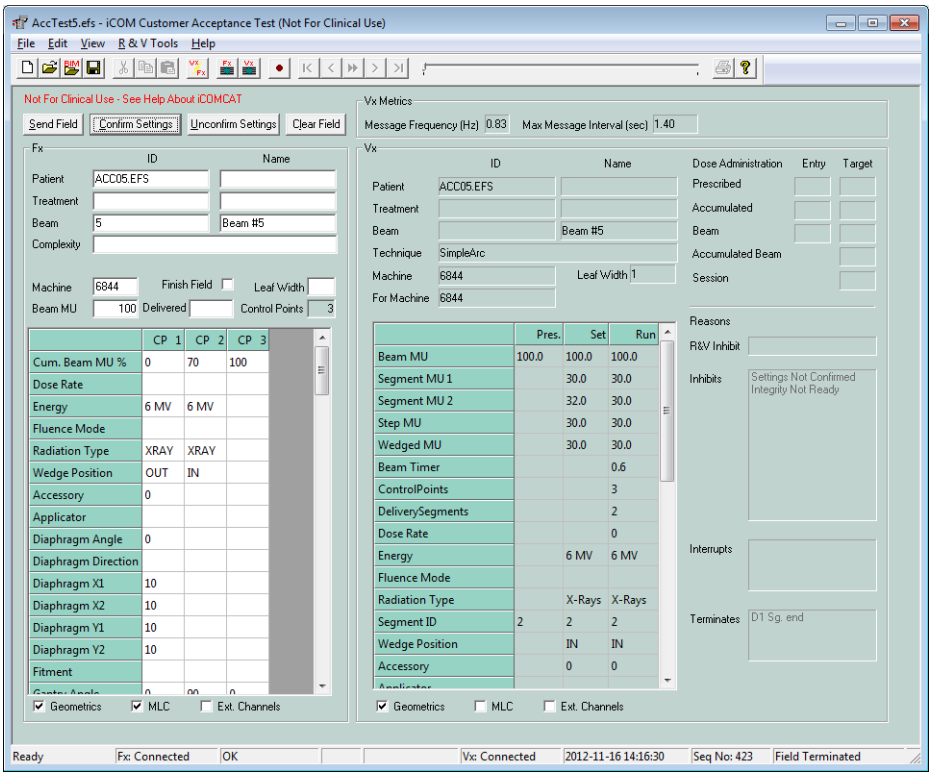
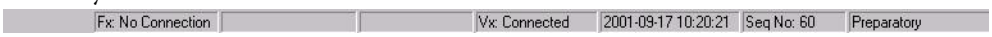


Figure 3.5 iCom CAT window

3.3.3 Establish a network connection

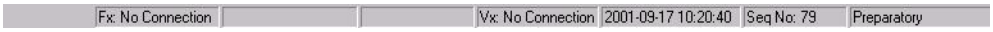
If a network connection is made with the digital accelerator, the iCom status bar of the **iCom-CAT** window shows one of these:

- If only the iCom-Vx connection is made:



- If the iCom-Fx and iCom-Vx connections are made:

If no network connection with the digital accelerator is made, the iCom status bar of the **iCom-CAT** window shows:



Note: *If you fail to make a network connection, refer to the Integrity™ Software Installation and Upgrade Manual.*

3.3.4 iCom-Fx test

Field settings are sent to the digital accelerator in the **Fx** area of the **iCom CAT** window.

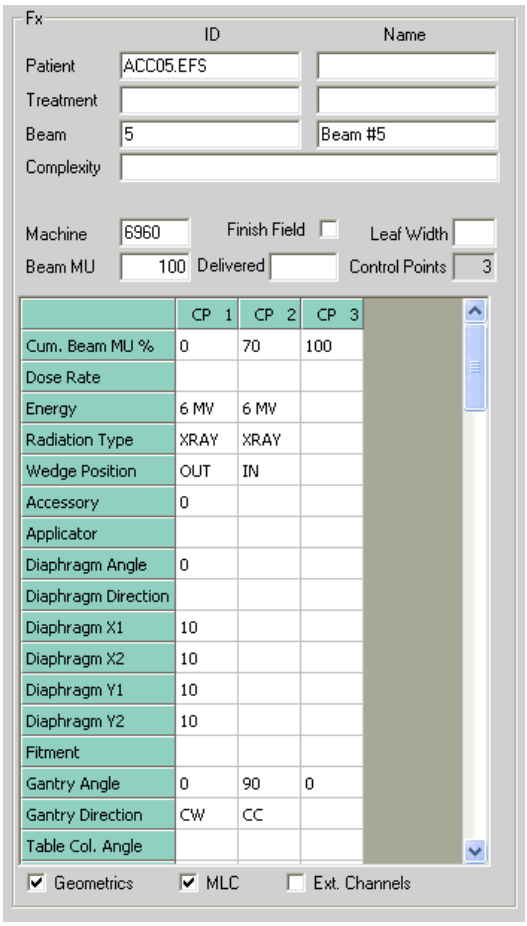


Figure 3.6 iCom-Fx area of iCom CAT window

A number of prepared prescription files are supplied on the iCom installation CD. To open the prescription files, follow this procedure:

1 On the **File** menu, select **Open**.

2 Open the **iCom\Test Harness** directory on the CD drive.

The available files are shown in **Figure 3.7**.
The description of each file is listed in **Table 3.2**.

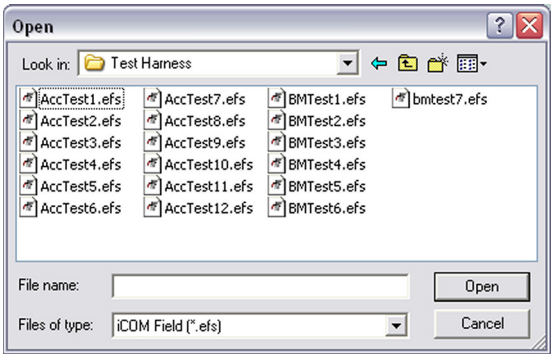


Figure 3.7 Prepared prescription files

Table 3.2 List of prepared prescriptions

Filename	Description
AccTest1.efs	Single segment, X-ray, static.
AccTest2.efs	Dual segment, X-ray, static.
AccTest3.efs	Single segment, electron, static.
AccTest4.efs	Single segment, X-ray arc (0° to 90°).
AccTest5.efs	Dual segment, X-ray arc (0° to 90° and 90° to 0°).
AccTest6.efs	Single segment, X-ray, static, multi-leaf collimator.
AccTest7.efs[1]	Five segment, X-ray, step-and-shoot, wedged with gantry moving.
AccTest8.efs[1]	Five segment, X-ray, step-and-shoot, diaphragm and multi-leaf collimator moving.
AccTest9.efs[1]	114 segment, X-ray, dynamic, multi-leaf collimator moving. *Note: This field will fail when licensed for step-and-shoot only and is included as an example only.*
AccTest10.efs[1 2]	10 segment high dose rate electron therapy (HDRE).
AccTest11.efs[1]	Five segment, X-ray, step-and-shoot, multi-leaf collimator, diaphragm and gantry moving.
AccTest12.efs[1]	255 segment, X-ray, step-and-shoot, multi-leaf collimator moving.
AccTest13.efs[1]	One segment, Intensity Modulated Radiation Therapy (IMRT) treatment. *Note: This field will fail when licensed for step-and-shoot only and is included as an example only.*

AccTest14.efs	A three segment dynamic MLC (DMLC) beam, a PreciseBEAM™ Dynamic licence is necessary.
AccTest15.efs	A single segment DMLC beam, only the leaves and diaphragms move during radiation. Requires a PreciseBEAM™ Dynamic licence.
AccTest16.efs	A single segment rotational DMLC (R-DMLC) beam, both the leaves and gantry move during radiation. Requires a Precise-BEAM™ Dynamic Arc licence.
AccTest17.efs	A single segment enhanced rotational (ER-DMLC) beam, both the leaves and gantry move during radiation, has an uneven dose distribution between arcs. Requires a PreciseBEAM™ VMAT licence.
AglTest01_Static_Open.efs	Single segment, X-ray, static, 40x40 MLC (w/ corner limits)
AglTest02_Static_Small.efs	Single segment, X-ray, static, Small offset MLC.
AglTest03_Static_Wedged.efs	Single segment, X-ray, static, wedge IN.
AglTest04_Dual_Wedged.efs	Dual segment, X-ray, static, wedge IN then OUT.
AglTest05_Arc.efs	Single segment, X-ray, arc.
AglTest06_Arc_Wedge.efs	Dual segment, X-ray, arc, wedge IN then OUT.
AglTest07_Wedged_OUT_IN.efs	Dual segment, X-ray, static, wedge OUT then IN.
AglTest08_StepNShoot.efs	3 segment, X-ray, step-and-shoot, MLC and gantry Moving.
AglTest09_Mixed_NRG.efs	3 segment, X-ray, step-and-shoot, MLC and gantry Moving, 2 different energies.
AglTest10_StepNShoot_N_Segs.efs	5 segment, X-ray, step-and-shoot, MLC and gantry Moving.
AglTest11_SkipNScan.efs	3 segment, X-ray, skip-and-scan, MLC and gantry Moving (in move only), 2 radiating arcs.
AglTest12_DMLC_1_Seg.efs	1 segment of 3 (radiating) steps, X-ray, Dynamic-MLC, mixed leaves and diaphragms moving.
AglTest13_R_DMLC_IMAT_1_Seg.efs	1 segment of 3 (radiating) steps, X-ray, Rotational Dynamic-MLC, gantry and mixed leaves and diaphragms moving.
AglTest14_DMLC_2_Segs.efs	2 segments of 2 & 1 (radiating) steps respectively, X-ray, Dynamic-MLC, mixed leaves and diaphragms moving.
AglTest15_R_DMLC_IMAT_2_Segs.efs	2 segments of 2 & 1 (radiating) steps respectively, X-ray, Rotational Dynamic-MLC, gantry and mixed leaves and diaphragms moving.

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AglTest16_RV_DMLC_IMAT_2_Segs.efs	2 segments each of 2 (radiating) steps, X-ray, Rotational Dynamic-MLC with variable Dose-rate, head and mixed leaves and diaphragms moving.
AglTest17_RV_DMLC_IMAT_2_Segs_Ex.efs	2 segments each of 2 (radiating) steps, X-ray, Rotational Dynamic-MLC with variable Dose-rate, head, gantry and mixed leaves and diaphragms moving.
AglTest18_StepNShoot_Leaf_DLG_Extent.efs	3 segment, X-ray, step-and-shoot, MLC and gantry Moving, with Y2 then Y1 DLGs at max extention.
AglTest19_DMLC_Leaf_DLG_Extent.efs	Single segment, X-ray, Dynamic-MLC, MLC and diaphragms Moving, with Y2 then Y1 DLGs at max extention.
AglTest21_Dyn_Interdigitation.efs	Single segment, X-ray, Dynamic-MLC, with leaves moving to & from interdigitated & closed positions.
AglTest22_Dyn_Interdig_with_DLGs.efs	Single segment, X-ray, Dynamic-MLC, with leaves moving to & from interdigitated & closed positions whilst DLGs are moving.
AglTest23_Dyn_Closed_Moving.efs	Single segment, X-ray, Dynamic-MLC, with moving closed leaves and DLGs maintaing a stationary apperture.
AglTest24_Dyn_Closed_Moving2.efs	Single segment, X-ray, Dynamic-MLC, with moving closed leaves and DLGs with a fixed size, moving apperture.
BMTest1.efs[1]	Five segment step-and-shoot Beam Modulator™ field with leaf movement only, dual-aperture field.
BMTest2.efs	Simple static dual-aperture Beam Modulator™ field.
BMTest3.efs	Simple static dual-aperture Beam Modulator™ field.
BMTest4.efs	Simple static dual-aperture Beam Modulator™ field.
BMTest5.efs[1]	254 segment step-and-shoot Beam Modulator™ field with leaf movement only, dual-aperture field.
BMTest6.efs	Simple static dual-aperture Beam Modulator™ field.
BMTest7.efs	Electron field, 6 cm × 6 cm square applicator, Beam Modulator™.
BMTest8.efs	A single segment DMLC beam, only the leaves and move during radiation. Requires a PreciseBEAM™ Dynamic licence.
BMTest9.efs	A single segment R-DMLC beam, both the leaves and gantry move during radiation. Requires a PreciseBEAM™ Dynamic Arc licence.
BMTest10.efs	A single segment ER-PreciseBEAM™ Dynamic beam, both the leaves and gantry move during radiation, has an uneven dose distribution between arcs. Requires a PreciseBEAM™ VMAT licence.
BMTest1.efs[1]	Five segment step-and-shoot Beam Modulator™ field with leaf movement only, dual-aperture field.
BMTest2.efs	Simple static dual-aperture Beam Modulator™ field.

BMTest3.efs	Simple static dual-aperture Beam Modulator™ field.
BMTest4.efs	Simple static dual-aperture Beam Modulator™ field.
BMTest5.efs[1]	254 segment step-and-shoot Beam Modulator™ field with leaf movement only, dual-aperture field.
BMTest6.efs	Simple static dual-aperture Beam Modulator™ field.
BMTest7.efs	Electron field, 6 cm × 6 cm square applicator, Beam Modulator™.
BMTest8.efs	A single segment DMLC beam, only the leaves and move during radiation. Requires a PreciseBEAM™ Dynamic licence.
BMTest9.efs	A single segment R-DMLC beam, both the leaves and gantry move during radiation. Requires a PreciseBEAM™ Dynamic Arc licence.
BMTest10.efs	A single segment ER-PreciseBEAM™ Dynamic beam, both the leaves and gantry move during radiation, has an uneven dose distribution between arcs. Requires a PreciseBEAM™ VMAT licence.
CheckRg_BM_Open.efs	Beam Modulator™ open exposure
CheckRg_BM_Ref.efs	Beam Modulator™ reference exposure
CheckRg_MLC_Open.efs	MLCi/MLCi2 open exposure
CheckRg_MLC_Ref.efs	MLCi/MLCi2 reference exposure

The default parameters for the file selected appear in the **Fx** area in the iCom CAT window (see **Figure 3.6**).

Note: *Make sure that the correct energy is selected in the* **Energy** *box to agree with one of the energies available on the digital accelerator.*

Note: *The digital accelerator must be in* **Receive External Prescription** *state to accept the settings. If not, an Fx connection is not made.*

3 Click **Send Field** to send the prescription settings to the digital accelerator.

For the settings to be accepted, the **Radiation Type**, **Energy**, **Wedge Position** and applicator field parameters from the prescription must agree with those configured on the digital accelerator. This comparison is case-sensitive.

Figure 3.8 shows the iCom status bar in situations where a mismatch occurs.

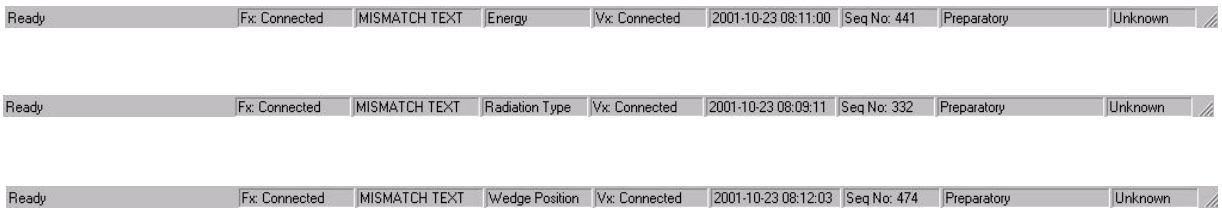

Figure 3.8 The iCom status bar displaying possible situations for parameters mismatches

If the prescription parameters do not agree with those on the digital accelerator, correct the values of the prescription in the **Fx** area of the **iCom CAT** window. The correct format for text entries are in **Table 3.3**.

Table 3.3 Correct format for text entries

Parameter	Example of format
Machine name	xxxx (for example, Linear3)
Radiation types	ELECTRON X-Rays
Energies	4 MeV 6 MV
Wedge	IN OUT

Note: *The text entries are case-sensitive.*

3.3.5 iCom-Vx test

The **Vx** area of the **iCom CAT** window shows the current settings at the digital accelerator (see Figure 3.9). When iCom-Vx operates but the digital accelerator does not radiate, the **Message Count, Seq Number** and **Time** in the iCom status bar are updated after one second.

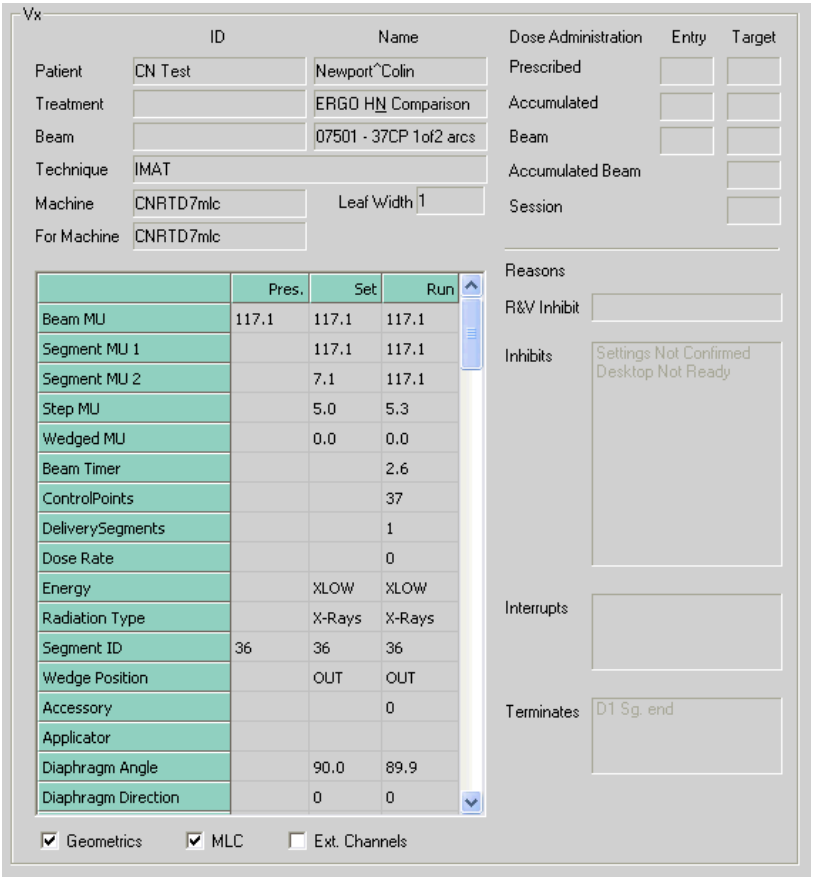

Figure 3.9 iCom-Vx area of iCom CAT window

3.3.6 MLC test

To view representations of the field shape, continue as follows:

1 On the **View** menu, select **MLC:Fx** or **MLC:Vx**.

The **MLC:Fx** or **MLC:Vx** window appears (see **Figure 3.10**).

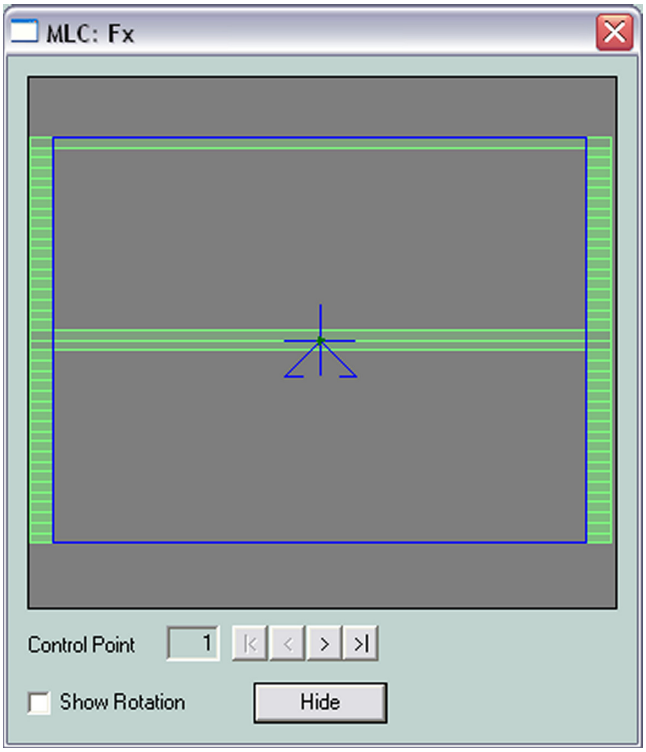

Figure 3.10 MLC:Fx window

3.3.7 Example treatment test

This section explains how to deliver a sample treatment on the digital accelerator using the iCom CAT program.

Note: *The procedure that follows is not for clinical use.*

1 Start **iCom CAT** as shown in **Section 3.3.2**.

2 Select a prepared prescription file (see **Figure 3.11**).

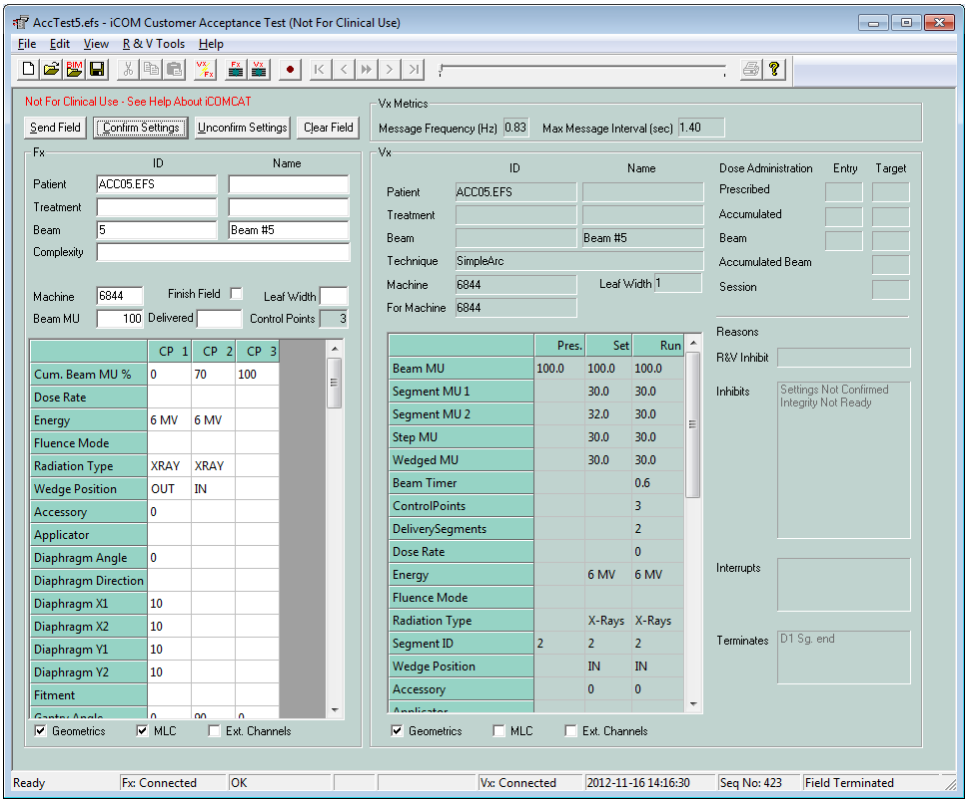

Figure 3.11 iCom CAT window - prepared prescription file

3 Edit the text as necessary.

4 Click **Send Field**.

5 Set up the digital accelerator as necessary.

6 Click **Confirm Settings**.

The digital accelerator goes into the **Ready to Start** state (see **Figure 3.12**).

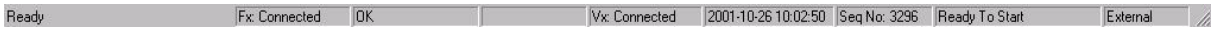

Figure 3.12 iCom status bar—Ready to Start

7 Press the **Start** key on the function keypad.

8 Monitor treatment progress on the **Vx** area in the **iCom CAT** window.

9 At the end of the treatment, click **Clear Field** to remove the treatment settings from the digital accelerator.

Note: *The iCom CAT will be signed off in the Digital Accelerator Customer Acceptance Tests manual.*

3.4 Corrective maintenance

3.4.1 Troubleshooting

If you can not make a network connection from the iCom PC to the TCS, check that the digital accelerator is in the correct state to receive a network connection. The state is shown on the main TCS display.

If it is not, follow this procedure:

1 Start the digital accelerator.

2 Log on to Clinical mode.

3 Open **Receive External Prescription** for the iCom-Fx and iCom-Vx connections.

Note: *If an iCom-Vx only connection is required, log on to Service mode and launch DSB or DQB instead. You can verify the installation of the software option by using the* **Linac Options** *tab in the* **Configuration Utility**. *If two of the iCom options are not available, enter the applicable software license key.*

4 Check that there is a network connection between the iCom PC and the TCS.

5 Run the TELNET network test tool from the PC.
Type: **telnet 192.168.30.2:22.**

If there is a connection to the TCS, a response is given as follows:

c:\>telnet 192.168.30.2 22

SSH-1.99_Open SSH_3.9p1

If there is no connection, the following response is given:

c:\>telnet 192.168.30.2 22

Connecting to 192.168.30.2. Could not open connection to the host, on port 22:Connect failed.

Note: *External system equipment that is found to be faulty is the responsibility of the appropriate third party.*

3.4.2 Diagnostics

To aid integration, diagnostic messages can be logged. Configure the level of diagnostic messages logging for iCom Fx and iCom Vx on the **iCom** page of the **Configuration Utility**.

Diagnostics can be performed on a working TCS. Level 1 & 2 diagnostics can be used on a clinical system. Levels 3, 4 & 5 must only be used on a non clinical system, as they require the system to be unlocked. This is so that dbWin32 can be installed and run on the TCS during treatment to capture output.

The levels of diagnostic messages logging are:

1 No logging.

2 Errors and warnings with timing—logged to event log.

3 Message contents—logged to standard debug output.

4 Message grammar—logged to standard debug output.

5 All logging—logged to standard debug output.

Messages for level **2** can be viewed in the Windows® Event Viewer (Event Viewer can be found in the Windows® Control Panel under Administrative Tools).

Messages for levels **3**, **4** and **5** can be viewed with **dbwin32. (dbwin32** is a freeware tool that captures the console and debug information from running applications).

3.4.3 iCom logging

iCom logging is controlled by the **iComClient.dll** which resides on the external R&V PC. The **iComClient.dll** can log the interactions between the external systems and the iCom interface.

Log files are stored in the **C:\iComLog** directory. This new **C:\iComLog** directory must be created on the **C:** drive of the third party external system workstation. The directory contains the last eight days of log files. After eight days, the log files are deleted if they have not been accessed. Log files are deleted only on start up of the **iComClient.dll**.

The **iComLog.ini** file must be copied here so that the logging can be configured. Each individual function can be logged. To stop the logging for a particular function place a # at the beginning of the appropriate line in the **iComLog.ini** file.

Switching On/Off the logging with a 32-bit Windows® installation

The logging is switched on at the R&V PC with the following registry key:

[**HKEY_LOCAL_MACHINE\SOFTWARE\Elekta Oncology Systems Ltd\RTD\iCom**]

LoggingLevel = dword:00000001

Setting this value back to 0 switches off the logging.

The following registry files are provided to switch on/off the logging:

- Double-click **iComLoggingOn.reg** to switch on the logging. This adds the logging key to the registry.
- Double-click **iComLoggingOff.reg** to switch of the logging. This removes the logging key from the registry.

Switching On/Off the logging with a 64-bit Windows® installation

The logging is switched on at the R&V PC with the following registry key:

[HKEY_LOCAL_MACHINE\SOFTWARE\Wow6432Node\Elekta Oncology Systems Ltd\RTD\iCom]

LoggingLevel = dword:00000001

Setting this value back to 0 switches off the logging.

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4 iCom implementation

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4.1 iCom implementation

4.1.1 Implementation considerations

This section contains information that should be carefully considered by the designer of the external system iCom interface.

What is a complete set of treatment settings?

Since the prescription is stored on an external system, the digital accelerator does not know what is a complete field specification. Therefore, it is possible for an external system to fail to transmit a key prescription parameter (for example, omit the fact that a shadow tray is to be fitted) and for this omission not to be detected at the digital accelerator. The external system must make sure that all prescribed parameters are transmitted via iCom-Fx and verify, via iCom-Vx, that all parameters have been received at the digital accelerator.

Machine specific calibration data

It is possible for treatment settings to be transmitted via iCom-Fx where the parameters are complete and consistent, but are defining a field which cannot be treated at the digital accelerator (due to individual capabilities/characteristics of each digital accelerator). In this event, the digital accelerator control subsystem rejects the field at treatment time with an appropriate inhibit set.

The circumstances under which this could arise are:

- **Arc/Dose incompatible**
  The angle through which the gantry is to rotate is too large in relation to the prescribed monitor units. As an example, if the gantry is to rotate from −90° to +90°, but only 5 monitor units (MU) have been prescribed, the dose rate required to achieve the arc may not be available and would be rejected.
- **Energy compatibility**
  When moving a prescription from one digital accelerator to another, the external system needs to take account of the compatibility of one digital accelerator with the next. This is of particular importance when the prescribed energy is available on one digital accelerator, but not on another. The external system may have to alter the prescription parameters (for example, prescribed monitor units) to achieve the same treatment on different digital accelerators.
- **Prescribed vs. Set values**
  An integral safety feature of the digital accelerator is that the actual digital accelerator settings being used for treatment are displayed on the TCS next to the prescribed value. This has been implemented in order for the operator to perform a simple visual check to make sure the digital accelerator is set as prescribed.

  This important safety feature should be taken into account when designing an external R&V system.
- **Network failure**
  If the network link to the digital accelerator fails, the iCom-Vx data is not received by the external system. It is the responsibility of the external system to handle the effect of the network failure. The design of the external system must take into account such an eventuality.

  This is of particular importance should the failure occur during treatment. The digital accelerator shall take no action regarding the treatment in progress.
- **Integration tests**
  When there is more than one digital accelerator connected on a network, it is essential to make sure that both iCom connections (Vx and Fx) are made to the same digital accelerator. Integration testing of the external system with the required digital accelerator is essential.

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It should be noted that, when an external system is integrated with the digital accelerator using the iCom interface, it is the responsibility of the system integrator to perform integration tests. This is of particular importance when accepting the system after installation and after maintenance.

Minimum leaf separation (Agility™ only)

WARNING 4.1

There is a minimum leaf separation gap between opposite leaves when prescribed as closed. If you do not account for this in treatment plans, it can cause clinical mistreatment.

There must be a prescribed value for the minimum separation between two opposite leaves and their adjacent leaves to prevent collisions. The minimum leaf gap is 1 mm between leaf tips. This is measured at the leafbank. For specific minimum leaf gaps refer to the applicable product data. The minimum leaf gap measurement at isocentre is dependent on the treatment planning system. For more information refer to the treatment planning system documentation.

This fixed separation is used in all conditions, regardless of offset or gantry angle, to prevent leaf collisions.

Beam Modulator™

WARNING 4.2

If a pair of leaves have prescribed values which are closed in the 16x21 field limits, the result will be leakage radiation between the leaves. You must account for this in the treatment plan. If you ignore this warning it can cause clinical mistreatment.

The above warning is specific for the Beam Modulator™. The Beam Modulator™ has a fixed field limit of 16x21 as it has no diaphragms, where as the Agility™ has one set of orthoganal diaphragms, the leaf seperation is only an issue for leaves exposed by the diaphragms, and hence on Agility™ is variable.

An optical system is used to detect actual leaf positions. A ×2 focal length lens is used to enlarge the image and so compensate for the narrower leaves.

4.2 Responsibilities of the external system

Connection to an external system could cause unidentified risks to the patient, operator and machine. This section contains information that should be carefully considered by the designer of the external system iCom interface. In particular, it is the responsibility of the external system to:

- Make sure that all necessary values are included in the iCom-Fx message that defines the intended treatment field.
- Set the required positions of the diaphragms and MLC leaf positions. Note that the digital accelerator does not carry out a check on the relative positions of the leaves and diaphragms and uses the supplied positions if they are physically achievable. To comply with IEC requirements, diaphragms must be set to provide the minimum size radiation field surrounding the intended radiation field defined by the MLC leaves.
- Make sure that data sent to the digital accelerator is in the correct format and valid. Do not rely on Elekta® digital accelerators to detect and reject all invalid values.
- Correctly handle responses from the digital accelerator which indicate that the iCom-Fx treatment definition has been rejected. The whole message is rejected by iCom-Fx.

- Handle all communication between the external system and the digital accelerator.
- Detect that the network connection to the digital accelerator has failed and to take whatever action is deemed appropriate by the developer of the external system.
- Warn the user when communication with the digital accelerator has failed.
- Check that there is a one-to-one relationship between the external system and the digital accelerator, in particular that the Linac ID being reported in the iCom-Vx message matches that supplied in the iCom-Fx message.
- Make sure that, in the event of communication failure during treatment delivery, the clinical user of the external system takes responsibility for defining the remaining dose to deliver. In particular, the external system must not imply to the user that the total dose delivered matches the last reported value prior to network communication failure.
- Make sure that message numbers are checked so that missing messages are detected and handled accordingly.
- Make it clear to the user that tolerance checking is not performed by the TCS on unprescribed parameters from the point after settings have been confirmed to the start of radiation. That it is possible in this condition to confirm settings, then adjust the unprescribed values and start radiation.
- Incorporate security mechanisms (for example, passwords) to prevent use of the external system by inappropriate person(s).
- Make sure that no message is sent to the digital accelerator across iCom-Fx during treatment.

It is also the responsibility of the supplier of the external system to:

- Make sure that validation and integration of the system is undertaken.
- Carry out end-to-end checks using iCom-Fx and iCom-Vx to confirm that communication is with the intended digital accelerator prior to clinical use.
- Make sure that, in the event of an abnormal field termination, the external system:

  Records the delivered dose.

  Determines if or when a **Finish Field** is to be created.

  Chooses whether to create a **Finish Field** or delegate the creation of the **Finish Field** to the TCS.

  Since the TCS has no record or knowledge of any prior deliveries of the field, the external system must supply the correct field and/or delivery information when delivering an external **Finish Field** or creating a **Finish Field**.

- Make sure that, when a **Finish Field** is delivered using the iCom protocol of the TCS, the external system supplies the correct original field (that is, the field that previously failed to complete normally) and correct amount of successfully delivered MU.

Note: *When multiple* **Finish Fields** *are required to complete the delivery of any given beam, the MU supplied for each successive* **Finish Field** *is the cumulative total of MU delivered so far for that beam. This includes the initial (failed) delivery and any earlier* **Finish Fields**.

4.2.1 iCom-Vx default data set

The data transmitted by iCom-Vx is described in **Table 4.1**.

Table 4.1 Data transmitted by iCom-Vx

Tag ID[1]	Tag name	Part(s)
	Generic Tags	
7001, 0001	Machine Name	Prescribed[2]
7001, 0002	Patient ID	Prescribed[2]
7001, 0003	Patient Name	Prescribed[2]
7001, 0005	Treatment Name	Prescribed[2]
7001, 0007	Beam Name	Prescribed[2]
7001, 000C	Technique ID	Prescribed[2]
7001, 000D	For Machine	Prescribed[2]
7001, 0008	Segment ID	Prescribed, Set, Run
5001, 0002	Radiation type	Prescribed, Set, Run
5001, 0003	Energy	Prescribed, Set, Run
5001, 0004	Wedge Position	Prescribed, Set, Run
7001, 0009	Monitor Units 1	Prescribed, Set, Run
7001, 000A	Monitor Units 2	Prescribed, Set, Run
5001, 0005	Beam Timer	Prescribed, Set, Run
5001, 0001	Beam Monitor Units	Prescribed, Set, Run
5001, 0009	Collimator X1	Prescribed, Set, Run
5001, 000A	Collimator X2	Prescribed, Set, Run
5001, 000B	Collimator Y1[3]	Prescribed, Set, Run
5001, 000C	Collimator Y2[3]	Prescribed, Set, Run
5001, 0015	Fieldsize X	Prescribed, Set, Run
5001, 0016	Fieldsize Y	Prescribed, Set, Run
5001, 0016	Fieldsize Y	Prescribed, Set, Run
5001, 0017	Offset X	Prescribed, Set, Run
5001, 0018	Offset Y	Prescribed, Set, Run
5001, 0007	Gantry Angle	Prescribed, Set, Run
5002, 0007	Gantry Stop Angle	Prescribed, Set, Run
5001, 0008	Collimator Angle	Prescribed, Set, Run
5001, 0010	Table Height	Prescribed, Set, Run
5001, 0011	Table Rotation	Prescribed, Set, Run
5001, 0012	Table Lateral	Prescribed, Set, Run
5001, 0013	Table Longitudinal	Prescribed, Set, Run
5001, 0014	Table Isoc Rotation	Prescribed, Set, Run

Table 4.1 Data transmitted by iCom-Vx

Tag ID[1]	Tag name	Part(s)
5001, 000D	Electron Applicator Code	Prescribed, Set, Run
5001, 000E	Electron Accessory Fitment	Prescribed, Set, Run
5001, 000F	Accessory number	Prescribed, Set, Run
5001, 0028	Wedged Beam Monitor Units	Run
5001, 0050	Inhibit Reason 1	Run[2]
5001, 0051	Inhibit Reason 2	Run[2]
5001, 0052	Interrupt Reason	Run[2]
5001, 0053	Terminate Reason	Run[2]
7001, 0050	R&V inhibit	Run[2]
7002, 0006	Leaf Width	Run[2]
7002, 0002	Control Point Count	Run
7002, 0008	Delivery Segment Count	Run
7002, 000B	Step Monitor Units	Prescribed, Set, Run
5001, 0006	Dose Rate Set	Prescribed, Set, Run
7001, 0038	Beam Timer	Prescribed, Set, Run
5001, 0019	Gantry Direction	Prescribed, Set, Run
5002, 0008	Collimator Stop Angle	Prescribed, Set, Run
5001, 00BB	Collimator Direction	Prescribed, Set, Run
	MLCi/MLCi2 Tags	
5001, 0101	MLCi/MLCi2 Y1 leaf 01	Set, Run
5001, 0102	MLCi/MLCi2 Y1 leaf 02	Set, Run
	to	
5001, 0127	MLCi/MLCi2 Y1 leaf 39	Set, Run
5001, 0128	MLCi/MLCi2 Y1 leaf 40	Set, Run
5001, 0201	MLCi/MLCi2 Y2 leaf 01	Set, Run
5001, 0202	MLCi/MLCi2 Y2 leaf 02	Set, Run
	to	
5001, 0227	MLCi/MLCi2 Y2 leaf 39	Set, Run
5001, 0228	MLCi/MLCi2 Y2 leaf 40	Set, Run
	Agility™ Tags (1 to 40 and 41 to 80)	
5001, 0101	Agility™ Y1 leaf 01	Set, Run
5001, 0102	Agility™ Y1 leaf 02	Set, Run
	to	
5001, 0149	Agility™ Y1 leaf 79	Set, Run
5001, 0150	Agility™ Y1 leaf 80	Set, Run
5001, 0201	Agility™ Y2 leaf 01	Set, Run

Table 4.1 Data transmitted by iCom-Vx

Tag ID[1]	Tag name	Part(s)
5001, 0202	Agility™ Y2 leaf 02	Set, Run
	to	
5001, 0249	Agility™ Y2 leaf 79	Set, Run
5001, 0250	Agility™ Y2 leaf 80	Set, Run
	Integrity™ R3.1 or higher Tags	
7002, 0010	Fluence mode[4]	Prescribed, Set, Run

1 Tag IDs are in hexidecimal format.
2 These items have only one part - the part transmitted is an internal representation.
3 For Agility™, these tags MUST be specified at fixed positions 20 and 20 for X-rays. They are used to specify the Y applicator size for Electron treatment.
4 Fluence mode (Integrity™ R3.1 or higher).

4.2.2 iCom-Vx states

Each iCom-Vx state indicates the value of the state element of the iCom-Vx message. Events occur instantly and usually once only, whilst states are continuous. Events are shaded in this table.

Table 4.2 shows which values (prescribed, set or run) are broadcast by iCom-Vx with each state.

All values are broadcast for events and for the first message after a transition to a **RADIATION** state. After this first message, only the run values are broadcast for **RADIATION** states.

Table 4.2 iCom-Vx states

	iCom-Vx state	Description	Prescribed	Set	Run
0	UNKNOWN or INVALID STATE	The connection between iCom-Vx and the digital accelerator TCS has failed in this state. No message is sent until the connection is restored.	✓	✓	✓
1	PREPARATORY	This state indicates that the digital accelerator is not yet set for treatment, but will accept fields.	✓	✓	✓
2	CONFIRM SETTINGS	This state indicates that the TCS has verified the current treatment settings and awaits user/external system confirmation that treatment may begin.	✓	✓	✓
3	READY TO START	This state indicates that the user/external system has confirmed that treatment may begin but has not yet started treatment.	✓	✓	✓
4	SEGMENT START	This event indicates treatment has started. The iCom-Vx message contains the digital accelerator settings as they were at the start of the segment.	✓	✓	✓
5	SEGMENT IRRADIATE	This state indicates that treatment is in progress.			✓
6	SEGMENT INTERRUPT	This event indicates that treatment has been interrupted. The iCom-Vx message contains the digital accelerator settings as they were when treatment was interrupted.	✓	✓	✓
7	SEGMENT INTERRUPTED	This state indicates that treatment has interrupted — it remains until treatment restarts or terminates.			✓
8	SEGMENT RESTART	This event indicates that treatment has restarted after interruption. The iCom-Vx message contains the digital accelerator settings as they were when the treatment was restarted.	✓	✓	✓
9	SEGMENT TERMINATE	This event indicates that segment has completed (normally or abnormally). The iCom-Vx message contains the digital accelerator settings as they were at the moment of segment termination. This event is not set for the final segment.	✓	✓	✓
10	SEGMENT PAUSE	This state indicates the digital accelerator has paused while switching segments. This state occurs before each segment is irradiated.			✓
11	FIELD TERMINATE	This event indicates that the *final* segment in a field has completed or that the field has terminated abnormally. The iCom-Vx message contains the digital accelerator settings as they were at the moment of termination.	✓	✓	✓

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Table 4.2 iCom-Vx states

	iCom-Vx state	Description	Prescribed	Set	Run
12	TERMINATE CHECKING	This state indicates that the digital accelerator is processing the field termination checks.			✓
13	FIELD TERMINATED	This state indicates that treatment has terminated, that is the termination checks have completed. This state remains until a new field is selected for treatment[1].			✓
14	MOVE ONLY	This state indicates a move-only segment is in progress. There is no MU being delivered and geometric movement is taking place.			✓

1 When FFF energies are used, a small dose may overrun up to 0.3 MUs in the reported value for Beam MUs at termination. This difference in the value is not cumulative. This is expected system behaviour and does not need sign off by the MOSAIQ® user.

Note: *If the* **START** *key is not pressed within five minutes of the* **CONFIRM SETTINGS** *message then: i) the digital accelerator state is returned to* **PREPARATORY** *and ii) the state transition back to* **WAIT FOR CONFIRM SETTINGS MESSAGE** *is made.*

Table 4.3 below shows the state changes and events occurring during typical treatments.

Table 4.3 State changes

Normal treatment of single segment beam	Normal treatment of dual-segment beam	Interrupt then complete a single segment beam
PREPARATORY	PREPARATORY	PREPARATORY
READY TO START	READY TO START	READY TO START
SEGMENT PAUSE	SEGMENT PAUSE	SEGMENT PAUSE
SEGMENT START (event)	SEGMENT START (event)	SEGMENT START (event)
SEGMENT IRRADIATE	SEGMENT IRRADIATE	SEGMENT IRRADIATE
FIELD TERMINATE (event)	SEGMENT TERMINATE (event)	SEGMENT INTERRUPT (event)
TERMINATE CHECKING	SEGMENT PAUSE	SEGMENT INTERRUPTED
FIELD TERMINATED	SEGMENT START (event)	SEGMENT RESTART (event)
PREPARATORY	SEGMENT IRRADIATE	SEGMENT IRRADIATE
	FIELD TERMINATE (event)	FIELD TERMINATE (event)
	TERMINATE CHECKING	TERMINATE CHECKING
	FIELD TERMINATED	FIELD TERMINATED
	PREPARATORY	PREPARATORY

4.3 iCom-Fx messages

This section describes how the iCom-Fx interface operates on the digital accelerator. See **Figure 2.4**.

iCom-Fx initialization occurs when the operator selects the **Receive External Prescription** mode on the digital accelerator.

If at any time the connection to the external system is lost, then the system returns to the **Wait for External System to Connect** state. Any currently selected treatment settings are cleared if they have not yet been treated.

4.3.1 iCom-Fx treatment field specification

This section specifies the structure of an iCom-Fx treatment field. A full specification of the elements within the structure is given in **Appendix C**.

There are two elements to the iCom-Fx treatment field specification:

- The header (see **Table 4.4**).
- The control points (see **Table 4.5**).

Note: *The mandatory items in **Table 4.4** and **Table 4.5** are highlighted.*

Table 4.4 Header items for the iCom-Fx treatment field specification

Parameter	Description	Mandatory under condition
Machine Name	The user-defined name identifying the digital accelerator to be used for the field delivery	
Patient ID	The unique identifier of the patient record	
Patient Name	The name of the patient	
Treatment Name	The treatment volume name (see Note 1)	
Beam Name	A description of the field (see Note 2)	
Field Complexity	The field technique	If option is set in iCom tab of Configuration Tool. For Dynamic or Intensity Modulated Arc Therapy (IMAT) beams.
Beam Monitor Units	The beam MU value for the field	
Leaf Width	Field prescribed for machine with specified leaf width	Must be set to value = 0.5 for Agility™.
		0.4 for Beam Modulator™. 1.0 or blank for MLCi and MLCi2

Note: 1 *The Treatment Name tag is used by iViewC™ and iViewGT™ as one of the identifiers to store the image. Although the Treatment Name tag is optional, if the tag is not supplied, iViewC™ and iViewGT™ creates a Treatment Name from the patient ID, which creates problems later if the image data is exported.*

Note: 2 *Although the Beam Name tag is optional, if this tag or the Beam ID (older Javelin tag) is not supplied when integrated with the iViewGT™ or iViewC™ system, no images are stored. This is because the iView™ system uses Beam Name to identify the image. If the Beam Name is not specified and Beam ID is specified, then iCom-Fx copies Beam ID to Beam Name.*

Note: 3 *Although the Patient ID, Patient Name and Beam Name are not mandatory, if they are not supplied, the field is checked each time it is downloaded. To take advantage of quicker beams, subsequent load times, the tag and ID must be supplied.*

Table 4.5 Control point items for the iCom-Fx treatment field specification

Parameter	Description	Mandatory under condition
Cumulative Beam MU Percentage	Specifies the cumulative percentage of the beam MU which is to have been delivered when the control point takes effect	
Radiation Type	The modality of the control point	
Energy	The user-defined energy name	
Fluence Mode[4]	The fluence shaping is standard mode or FFF	For X-ray fields, where the energy name is one of the FFF energies.
Wedge Position	The wedge position, in or out	
Beam Timer	The backup time (in minutes) that radiation can be on	
Dose Rate Set	The nominal dose rate to be used for the control point	
Gantry Angle	The angle of the gantry	When field complexity is greater than simple[1]
Gantry Rotation Direction	The gantry rotation direction when looking towards the digital accelerator from the isocenter	When gantry angle is specified
Collimator Angle	The angle of the collimator	When field complexity is greater than simple[1]
Collimator Rotation Direction	When looking from the beam source towards the isocenter	If dynamic collimator movement is prescribed
Collimator X1/X2	The position of the X1 and X2 diaphragms[2]	Mandatory for X-ray fields.
		For all electron fields to define the applicator field size

Table 4.5 Control point items for the iCom-Fx treatment field specification

Parameter	Description	Mandatory under condition
Collimator Y1/Y2	The position of the Y1 and Y2 diaphragms[2]	Mandatory, prescribe at fixed 20 cm position for X-ray fields.
		For all electron fields to define the applicator field size
Collimator Leaves: MLCi/MLCi2 - 40 and for Agility™ - 80	The position of the MLCi and MLCi2 leaves, defines the leaf shape[3]	The leaf shape is mandatory for X-Ray fields. It must not be specified for Electron fields.
Electron Applicator Code	The electron applicator type	Radiation type is electron
Electron Accessory Fitment	The electron accessory number	Radiation type is electron
Accessory Number	The X-ray accessory number	
Table Rotation Non-isocentre	The Precise Table rotation angle	
Table Height	The Precise Table height	
Table Lateral	The Precise Table lateral position	
Table Longitudinal	The Precise Table longitudinal position	
Table Isoc Rot	The isocentric Precise Table rotation angle	

1 Only the first control point is mandatory if the value does not change throughout the field.
2 For Agility™, these tags must be specified at fixed positions 20 and 20 for X-rays.
3 When a leaf shape is specified, ALL leaves must be specified.
4 Fluence mode (Integrity™ R3.1 or higher).

4.3.2 iCom-Fx treatment field types

The section explains the different field types used by iCom-Fx and defines the complexity of the tags.

Simple

Simple Static:

- Two control points. No gantry movement during irradiation. No leaf movement, diaphragm movement, table movement or collimator rotation during irradiation.
- Three control points as above but wedge position can change between segments. There must be radiation in both segments.

Simple Arc:

- Two control points. Gantry movement only during irradiation.
- Three control points. Gantry and wedge movement only during irradiation. The gantry finishes where it started.

StepNShoot:

- Move-only segments may be included. No movement during irradiation. Segments can be in any order (do not have to alternate move-only and radiating segments). The following parameters can be changed in a move-only segment: gantry angle, collimator angle, diaphragms, energy, fluence mode, wedge position and dose rate.

SkipNScan:

- Radiating arc(s) and move-only segments. No collimator, leaf or diaphragm movement during irradiation.

Dynamic:

- Leaf or diaphragm movement during irradiation. No collimator or gantry movement during irradiation.

IMAT:

- Collimator rotation, gantry rotation and leaf/diaphragm movement during irradiation.

4.3.3 Finish Fields created by the TCS

iCom, in conjunction with Integrity™, offers a feature whereby the external system instructs the TCS to create a **Finish Field** for a specified beam that previously failed to complete normally. The external system determines if and when to use this feature. A **Finish Field** created this way is entirely under the control of the external system.

Note: *The external system can choose to generate its own* **Finish Field** *instead and not make use of this feature.*

Note: *When multiple* **Finish Fields** *are required to complete the delivery of any given beam, the MU supplied for each successive* **Finish Field** *is the cumulative total of MU delivered so far for that beam. This includes the initial (failed) delivery and any earlier* **Finish Fields**.

The original beam and the number of MU successfully delivered so far is sent to the TCS. Tag 7002, 0009 flags if a **Finish Field** has been created (see **Appendix C**). Tag 7002, 0007 lists the number of MU that have been successfully delivered (see **Appendix C**). Both these tags must be present for a **Finish Field** to be valid.

Based on the delivered MU information, the TCS determines the step in which delivery terminated. Control points prior to this step are discarded since these have been successfully delivered. If the step in which delivery terminated contains any movements (for example, gantry/collimator rotation, leaf or diaphragm movement), the TCS generates a new start position for the remainder of the step. A constant linear movement of all moving parameters with respect to the delivered MU is assumed.

If the remaining MU to deliver in the current step does not result in a valid delivery segment, the start point is moved to the beginning of the next step that results in a valid delivery segment. Consequently, the total MU deliverable in the **Finish Field** can be less than that originally specified. A difference of up to 0.9 MU is acceptable. If the difference is greater than 0.9 MU, the TCS generates an error in the external system and disables the beam for delivery.

The **Finish Field** is validated in exactly the same way as the original field. When the **Finish Field** has passed all such validation, the beam is sent to the TCS-RT. The external system verifies that the resulting **Finish Field** is correct for delivery and confirms the settings on the digital accelerator, similarly to normal field delivery.

Note: *The TCS does not record the generated* **Finish Field**. *The external system records the delivery.*

4.3.4 Control points

A control point defines the treatment settings at the start, during and end of the beam (see **Figure 4.1**).

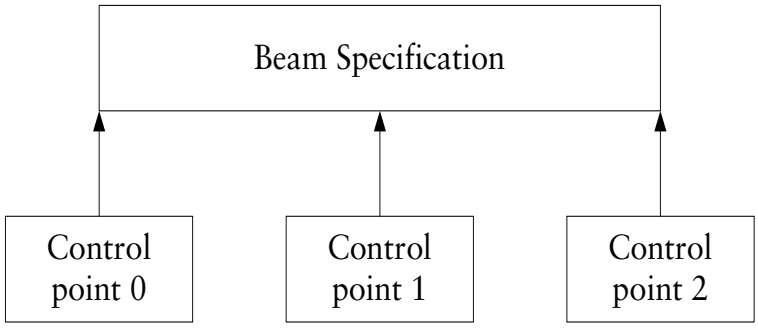

Figure 4.1 Control points

Control points can be used to specify the start conditions of segments (see control points 0 and 1 in **Figure 4.2**) and at the end of the final segment (see control point 2 in **Figure 4.2**). When control points are used in this manner, consistency between the stop and start values at intersegment boundaries is achieved.

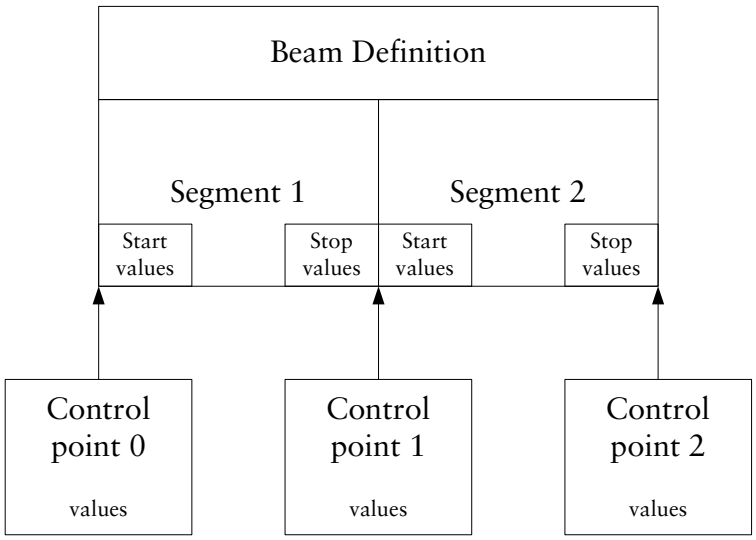

Figure 4.2 Control point overview

The number of control points in a beam specification is indicated by the **Number of Control Points** parameter. Each control point is identified by the **Control Point Index** parameter. Both of these parameters are calculated automatically for use with iCom - the external system must not supply them.

4.3.4.1 Control point rules

This section lists the rules which apply to the specification of control points using iCom on the digital accelerator.

General rules

The maximum number of control points is 256 for all non-dynamic fields.

The maximum number of control points is 1000 for all dynamic fields. These control points can be incorporated into 255 or less delivery segments.

The cumulative beam MU percentage must be specified in all control points.

The following parameters must be specified in all control points (except the final control point where they are optional):

- Radiation type
- Energy
- Fluence mode (X-rays only) for Agility™ only.
- Wedge position (X-rays only).

Any entered values must not have more decimal places than are defined for the parameter.

Cumulative beam MU percentage

The method for calculating the MU value for a segment is selectable from the **iCom** tabbed page in the **Configuration Utility** window.

- The first, independent, method is for simple static and simple arc treatments only.
- The second, independent, method is used for complex fields and can be used for simple fields, which can be configured from the iCom customization page.
- The third method is the dependent method for calculating segment MU. This is the default method.

Simple fields

The cumulative beam MU percentage must be 0% for the first control point, between 0.1% and 99.9% for any intermediate control points, and 100% for the final control point.

The cumulative MU values delivered at a given control point can be calculated using the following expressions:

The first segment:

$$\text{Beam MU} \times \frac{\text{Cumulative beam MU percentage}}{100}$$

This value is then rounded to the nearest 1 MU.

Note: *The decimal remainder is rounded down if equal to or less than 0.5 MU.*
The decimal remainder is rounded up if equal to or greater than 0.5 MU.

The optional second segment:

$$\text{Prescribed field MU - First segments MU value}$$

iCom-Fx in this configuration operates to integer MU values for each segment. Therefore, a rounding error can be introduced when specifying a cumulative beam MU percentage. iCom-Fx guarantees that 100% of the prescribed dose is delivered, although the sub-division per segment may not be exactly as prescribed.

For example, if 79 MU is required with 37% wedged and 63% unwedged, the actual required MU values are:

Wedged: 37% of 79 MU = 29.23 MU. Unwedged: 79 MU – 29 MU = 50 MU

iCom-Fx rounds the first segment to the nearest whole number, thus prescribing 29 MU wedged, 50 MU unwedged.

Note: *The worst case error is 0.5* MU *for the first segment.*

Complex fields and configured simple fields

The second method requires that percentage MU is specified to two decimal places. This method can be used for simple static and simple arc treatments but must be configured on the TCS **Configuration** icon, iCom customization page.

The cumulative beam MU percentage must be 0% for the first control point, between 0.01% and 99.99% for the intermediate control points and 100% for the final control point.

The segment MU is calculated using the following expression:

$$\frac{\text{(Percent in CPn+1 - Percent in CP) * Beam MU}}{100}$$

This value is rounded to the nearest 0.1 MU.

If a segment MU is less than 0.9 MU, then the field is rejected. Segments of 0.9 MU are set to 1 MU.

This method differs from the simple fields method in the following ways:

- The calculated segments MU, when totalled up, may not match the prescribed beam MU.
- The segment MU is calculated independently of any previous segment value.

Note: *The worst case for rounding is 0.05 MU for segments calculated as greater than 1 MU and 0.15 MU for segments rounded from 0.85 MU to 0.9 MU and then to 1 MU. Therefore, the prescribed total dose may differ from the reported prescribed total dose by:*

(0.05 x Number of calculated segments greater than 1 MU)
+
(0.15 x Number of segments set to 0.9 MU)

Dependent method

The third, dependent, method takes into account the previously accumulated rounded MU. This is to match the accumulated dose to the accumulated percentage of the beam at that point. This is then rounded to the nearest 0.1 MU. This means that the total prescribed beam MU will always equal the calculated beam MU +/– 0.1 MU.

The actual MU for a segment is calculated with the following formula:

(Percent in CP * Beam MU/100) - Accumulated Total

Discrete vs. linear data types

The following parameters are discrete type parameters. This means the value of the parameters is fixed throughout the delivery of the control point, changing only at the following control point boundaries:

- Energy
- Fluence mode (Agility™ only)
- Wedge position
- Accessories and applicators.

All other parameters are linear type parameters. This means the values change linearly throughout delivery of the segment.

Radiation type, energy and wedge

1 When the radiation type is electrons, then an electron applicator code and electron accessory fitment must be supplied.

2 When radiation type is X-rays, an electron applicator code and electron accessory fitment must be omitted.

3 When radiation type is X-rays and the energy is the check radiograph energy, then the electron applicator code and electron accessory fitment must not be supplied but the applicator may be fitted at time of treatment.

4 When energy type is check radiograph, only single exposure check films are accepted and the following are cross-validated:

- The calculated MU does not exceed the customizable maximum check-film MU
- The gantry angle must be the same for each control point
- Diaphragm positions are specified
- Wedge is not specified as IN.

5 If the wedge position is in, the maximum fieldsize that can be treated is 30 cm × 40 cm (fieldsize X by fieldsize Y). This limit is defined by the size of the wedge.

Geometric parameters

1 All applicable geometric parameters must be specified at control point level.

2 Geometric parameters may be specified once at the first control point if they do not change at any point in the field (see notes for **Collimators X1/X2** and **Collimators Y1/Y2** in Appendix C).

3 All geometric parameters that change at any control point of a given beam must be specified explicitly at all control points, including those preceding the change, excluding leaf positions.

4 All dynamic movements occur linearly between control points with respect to dose delivered.

5 No geometric movement is allowed during a radiating segment of step-and-shoot IMRT fields.

6 The minimum diaphragm separation is 0.5 cm on Asymmetric and MLCi/MLCi2 machines.

7 Collimator angle, gantry angle and diaphragm positions are mandatory when the field is complex and is on an Asymmetric or MLCi/MLCi2 machine, that is has a field complexity greater than simple.

Concatenation

Integrity™ concatenates together adjacent prescribed segments to form delivery segments. It tries to concatenate as many prescribed segments as possible, and only puts in a segment break if:

- The gantry and/or collimator rotation change direction.
- The wedge position changes.
- The fluence mode of the beam changes.
- The energy of the beam changes.
- There is a non–radiating segment, with no movement (null).
- There is a non–radiating segment, with digital accelerator movement (gantry or BLD rotation).
- The delivery segment reaches 1000 MU.

The only geometric parameters that may be changed during a prescribed radiation segment are the leaves, diaphragms, gantry rotation, and collimator rotation.

Control point structure

The diagrams in Figure 4.3 to Figure 4.6 show the difference between the prescribed field and the field that is delivered for both dynamic therapy and IMAT.

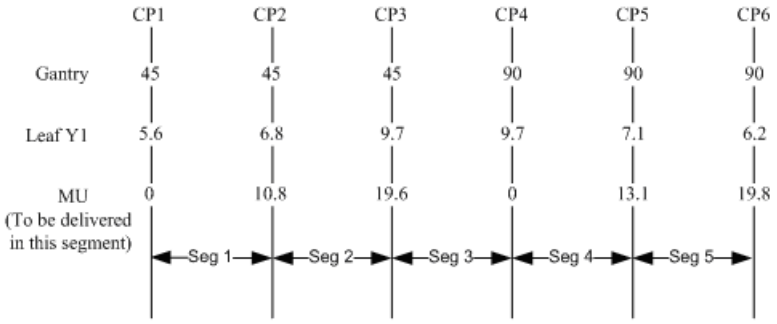

Figure 4.3 Dynamic field with control points and prescribed segments

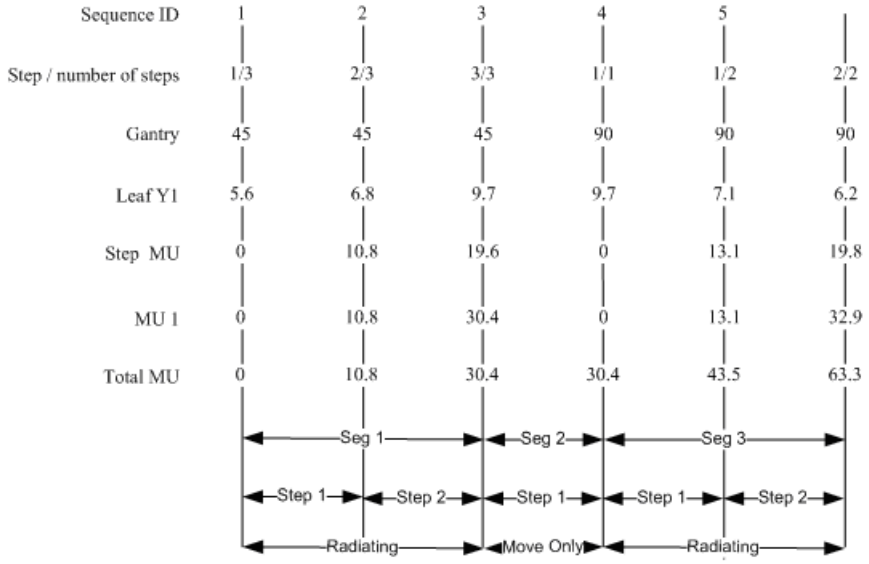

Figure 4.4 Dynamic field with control points and delivery segments

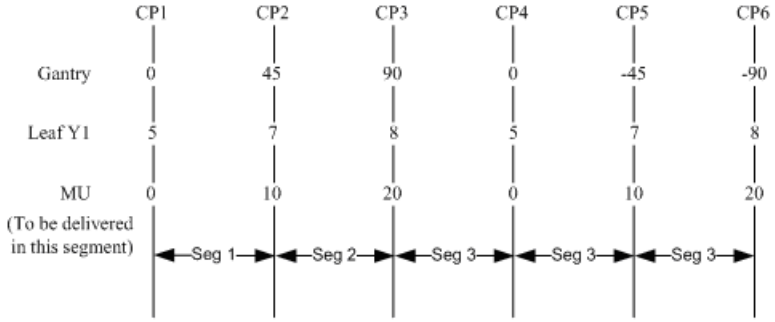

Figure 4.5 IMAT field with control points and prescribed segments

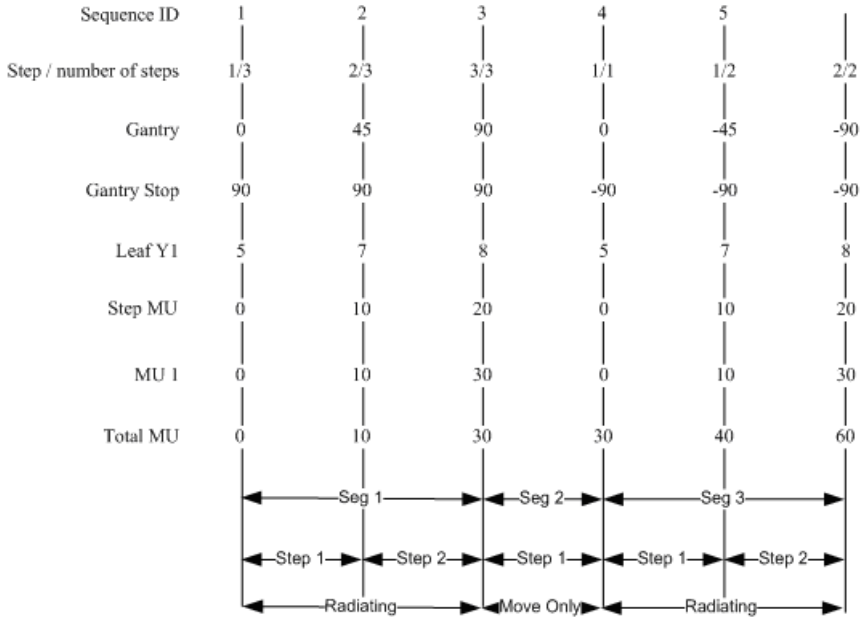

Figure 4.6 IMAT field with control points and delivery segments

4.3.5 Agility™ field specification

Refer to the *Agility™ Treatment Planning Information*.

4.3.5.1 MLCi/MLCi2 field specification

This section lists the constraints imposed by the TCS on the MLCi/MLCi2 leaf settings supplied by an external system using iCom-Fx.

MLCi/MLCi2 leaf settings vs. backup diaphragm settings

When an MLCi/MLCi2 field is specified, there are two sets of field defining parameters:

- The actual MLCi/MLCi2 leaf positions

The backup diaphragm positions.These sets of parameters must be consistent. An example is shown in **Figure 4.7**.

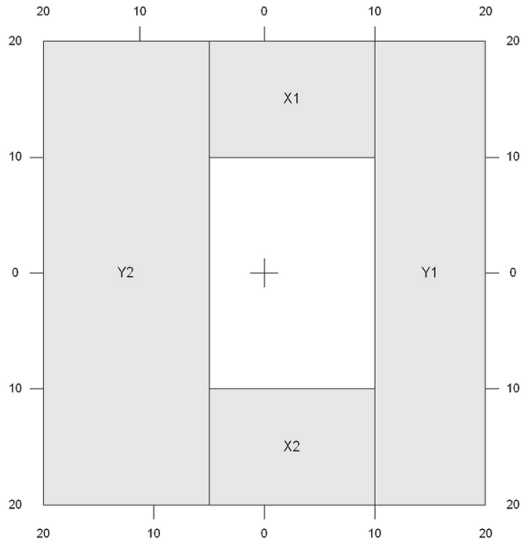

Figure 4.7 MLCi/MLCi2 field defining parameters

The backup diaphragms are set as follows:

X1 = 10 cm X2 = 10 cm Y1 = 10 cm Y2 = 5 cm

When MLCi/MLCi2 leaves are supplied, the field changes to that shown in **Figure 4.8**.

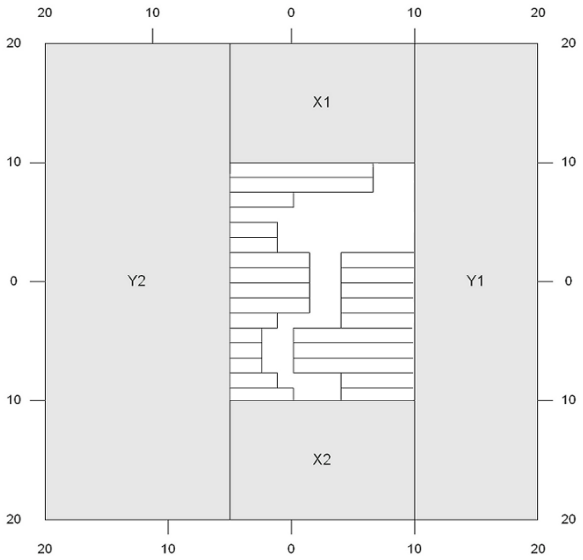

Figure 4.8 Field when MLCi/MLCi2 leaves are supplied

- All leaves within the X fieldsize must be specified.
- Leaves may be specified outside the X fieldsize and will be reported back through iCom-Vx.
- Any specified leaf pairs must form a contiguous block.
- For Desktop Pro™ and Integrity™, when Y1 and Y2 are not specified, iCom-Fx can calculate the diaphragm positions from the trailing leaf positions. The trailing leaf will be selected from the leaves within the X diaphragms. This is to give the smallest possible field size for the MLCi/MLCi2 shape. By default, this behavior has been switched off and can be switched on via the **iCom** tabbed page in **Configuration Utility** window.

4.3.6 Examples of beam specifications using control points

This section shows how treatment fields can be specified using the control point notation.

X-Ray treatments for Agility™ & Beam Modulator™ must have the MLC shape defined. On Agility™ Diaphragms Y1/Y2 must be 20.0 & 20.0 (at the 1st Control point) and on Beam Modulator™ both sets of diaphragms may be omitted, but if specified must match the fixed diaphragms 8/8 & 10.5/10.5.

Electron treatments (for all heads) the MLC Shape must not be defined, and the diaphragms are used to specify the applicator size (irrespective of physical diaphragms), and the diaphragm values must yield a zero offset. The Accessory (type) and Fitment are mandatory, and the Wedge must be OUT.

Static delivery

Single segment: 150 MU, unwedged.

Table 4.6 Control points, static delivery

Parameters	Control Point 1	Control Point 2
Treatment machine name	Elekta Synergy	
Beam ID	14	

Table 4.6 Control points, static delivery

Parameters	Control Point 1	Control Point 2
Beam MU	150	
Number of control points	2	
Field complexity	Simple	
Control point index	0	1
Radiation type	X-Rays	
Energy	6 MV	
Wedge	OUT	
Cumulative MU	0	100
Diaphragm X1	7.2	
Diaphragm X2	7.2	
Diaphragm Y1	20.0	
Diaphragm Y2	20.0	
Gantry angle	0	
Gantry rotation	None	
Collimator angle	45	

Arc delivery

Single segment: 150 MU, unwedged, gantry rotating from 0 to 45°.

Table 4.7 Control points, arc delivery

Parameters	Control Point 1	Control Point 2
Treatment machine name	Elekta Synergy	
Beam ID	14	
Beam MU	150	
Number of control points	2	
Field complexity	Simple	
Control point index	0	1
Radiation type	X-Rays	
Energy	6 MV	
Wedge	OUT	
Cumulative MU	0	100
Diaphragm X1	7.2	
Diaphragm X2	7.2	
Diaphragm Y1	20.0	
Diaphragm Y2	20.0	
Gantry angle	0	45
Gantry rotation	CW	
Collimator angle	45	

Table 4.8 Applicator

Parameters	Control Point 1	Control Point 2
Treatment machine name	Elekta Synergy	
Beam ID	<TBD>	
Beam MU	100	
Number of control points	2	
Field complexity	Simple	
Control point index	0	1
Radiation type	ELECTRON	ELECTRON
Energy	10 MV	10 MV
Applicator	Rect.	
Fitment	1	
Wedge	OUT	OUT
Cumulative MU	0	100
Diaphragm X1	3	
Diaphragm X2	3	

Parameters	Control Point 1	Control Point 2
Diaphragm Y1	3	
Diaphragm Y2	3	
Gantry angle	0	45
Gantry rotation	CW	
Collimator angle	0	

Irregular shape Agility™ delivery

Single segment: 100 MU, unwedged, with leaf shape.

Table 4.9 Control points, irregular shape MLC delivery

Parameters	Control point 1	Control point 2
Treatment machine name	Elekta Synergy	
Beam ID	14	
Beam MU	100	
Number of control points	2	
Field complexity	Simple	
Control point index	0	1
Radiation type	X-Rays	
Energy	6 MV	
Wedge	OUT	
Cumulative MU	0	100
Diaphragm X1	7	
Diaphragm X2	7	
Diaphragm Y1	20.0	
Diaphragm Y2	20.0	
Gantry angle	0	
Gantry rotation	None	
Collimator angle	45	
Y1:34[1]	12.0	
Y1:35[1]	11.8	
Y1:36[1]	10.0	
Y1:37[1]	9.0	
Y1:38[1]	8.2	
Y1:39[1]	7.7	
Y1:40[1]	8.2	
Y1:41[1]	8.5	
Y1:42[1]	10.0	
Y1:43[1]	10.0	
Y1:44[1]	9.3	
Y1:45[1]	9.0	
Y1:46[1]	8.7	
Y1:47[1]	6.2	

1 For Agility™, ALL leaves must be specified.

StepNShoot irregular shape Agility™ delivery

Segment 1: Radiating 50 MU.

Segment 2: Move only segment moving Y diaphragms from 5 cm to 9 cm, leaves moved from backup positions to shape and rotating diaphragms from –90° to 0°.

Segment 3: Radiating 25 MU.

Segment 4: Move only segment moving rotating diaphragms from 0° to 90° and opening up leaf shape.

Segment 5: Radiating 25 MU.

Table 4.10 Control points, step-and-shoot irregular shape Agility™ delivery

	Control points					
Parameters	**1**	**2**	**3**	**4**	**5**	**6**
Treatment machine name	Elekta Synergy					
Beam ID	14					
Beam MU	100					
Number of control points	6					
Field complexity	StepNShoot					
Control point index	0	1	2	3	4	5
Radiation type	X-Rays	X-Rays	X-Rays	X-Rays	X-Rays	X-Rays
Energy	6 MV	6 MV	6 MV	6 MV	6 MV	6 MV
Wedge	OUT	OUT	OUT	OUT	OUT	OUT
Cumulative MU	0	50	50	75	75	100
Gantry	0	0	0	0	0	0
Collimator angle	–90	–90	0	0	90	90
Diaphragm X1	5	5	5	5	5	5
Diaphragm X2	5	5	5	5	5	5
Diaphragm Y1	5	5	9	9	9	9
Diaphragm Y2	5	5	9	9	9	9
Y1:35	5	5	5	5	9	9
Y1:36	5	5	5	5	8	8
Y1:37	5	5	6	6	7	7
Y1:38	5	5	7	7	6	6
Y1:39	5	5	8	8	5	5
Y1:40	5	5	9	9	5	5
Y1:41	5	5	8	8	5	5
Y1:42	5	5	7	7	6	6
Y1:43	5	5	6	6	7	7
Y1:44	5	5	5	5	8	8
Y1:45	5	5	5	5	9	9

Table 4.10 Control points, step-and-shoot irregular shape Agility™ delivery

	Control points					
Parameters	**1**	**2**	**3**	**4**	**5**	**6**
Y2:35	5	5	5	5	9	9
Y2:36	5	5	5	5	8	8
Y2:37	5	5	6	6	7	7
Y2:38	5	5	7	7	6	6
Y2:39	5	5	8	8	5	5
Y2:40	5	5	9	9	5	5
Y2:41	5	5	8	8	5	5
Y2:42	5	5	7	7	6	6
Y2:43	5	5	6	6	7	7
Y2:44	5	5	5	5	8	8
Y2:45	5	5	5	5	9	9
Y1:44	5	5	5	5	8	8
Y1:45	5	5	5	5	9	9
Y2:35	5	5	5	5	9	9
Y2:36	5	5	5	5	8	8
Y2:37	5	5	6	6	7	7

Dynamic delivery of two equally weighted segments

Note: *This field is for illustration purposes only. Radiating while moving geometric parameters is not currently supported in iCom.*

Segment 1: 75 MU, wedge in, gantry rotates from 0° to 45°, collimator is static.

Segment 2: 75 MU, wedge in, gantry is static, collimator rotates from 120° to 90°.

Table 4.11 Control points, dynamic delivery of two equally weighted segments

Parameters	Control points		
	1	2	3
Treatment machine name	Elekta Synergy		
Beam ID	14		
Beam MU	150		
Number of control points	3		
Field complexity	Dynamic		
Control point index	0	1	
Radiation type	X-Rays	X-Rays	X-Rays
Energy	6 MV	6 MV	6 MV
Wedge	OUT	OUT	OUT
Cumulative MU	0	50	100
Diaphragm X1	7.2		
Diaphragm X2	7.2		
Diaphragm Y1	12.3		
Diaphragm Y2	4.6		
Gantry angle	0	45	45
Gantry rotation	CW	None	
Collimator angle	120	120	90
Collimator rotation	None	CC	

Dynamic delivery of two unequally weighted segments with a step change in gantry angle

Note: *This field is for illustration purposes only. Radiating while moving geometric parameters is not currently supported in iCom.*

Segment 1: 4 MU, wedge in, gantry rotates from 0° to 45°, collimator rotates from 45° to 120°.

Segment 2: No MU, that is move only segment, gantry rotates from 45° to 90°.

Segment 3: 105 MU, unwedged, gantry rotates from 90° to 180°.

Table 4.12 Control points, dynamic delivery of two equally weighted segments with step change

Parameters	Control points			
	1	2	3	4
Treatment machine name	Elekta Synergy			
Beam ID	14			
Beam MU	150			
Number of control points	4			
Field complexity	Dynamic			
Control point index	0	1		
Radiation type	X-Rays	X-Rays	X-Rays	
Energy	6 MV	6 MV	6 MV	
Wedge	IN	OUT	OUT	
Cumulative MU	0	30	30	100
Diaphragm X1	7.2			
Diaphragm X2	7.2			
Diaphragm Y1	20.0			
Diaphragm Y2	20.0			
Gantry angle	0	45	90	180
Gantry rotation	CW	CW	CW	
Collimator angle	120	45	45	45
Collimator rotation	CC	None	None	

4.4 Summary of iCom data types and error codes

The data types used in the function calls are defined in **iComAPI.h**.This is located in the folder where iCom was installed. A summary is given here:

Table 4.13 iCom data types

```
typedef LONG ICOMHandle;
typedef LONG ICOMMsgHandle;
typedef LONG ICOMResult;
typedef DWORD ICOM_TAG;
```

The error codes returned by the functions calls are defined in **iComAPI.h**. A summary is given in **Table 4.14**.

Table 4.14 iCom error codes

Data type	Error code
#define ICOM_RESULT_OK	1
#define INVALID_CONNECTION_HANDLE	–2
#define INVALID_MESSAGE_HANDLE	–3
#define TIMEOUT_ERROR	–4
#define CONNECTION_IN_PROGRESS	–5
#define NOT_CONNECTED	–6
#define INVALID_CONTROL_POINT_VALUE	–7
#define DUPLICATE_ITEM	–8
#define MISSING_CONTROL_POINT	–9
#define INVALID_PROTOCOL_VERSION	–10
#define TOO_MANY_TAGS	–11
#define CONNECTION_FAILED	–12
#define SEND_IN_PROGRESS	–13[1]
#define INVALID_TAG	–14[1]

1 This error code is only for an iCom-Fx connection - not iCom-Vx.

See **Appendix C** for a full listing of error codes.

4.5 Dynamic IMRT

It is possible to extend the use of control points to include support for IMRT dynamic type fields. An IMRT dynamic field may allow the MLC leaves to move dynamically during irradiation. This section describes how an IMRT field can be prescribed using the **Receive External Prescription** protocol.

Example

The IMRT field comprises a number of control points in which the MLC leaves are prescribed to be in different positions throughout the duration of the beam. The position of each MLC leaf is specified in each control point.

An example of an intensity modulated field specified using the control point notation follows:

Note: *In the example, assume the prescribed Beam MU = 200.*

At the start of irradiation (Cumulative Beam MU% = 0), the leaves must be at the positions prescribed in control point index 0.

After 50 MU (Cumulative Beam MU% = 25) the leaves must be at the positions prescribed in control point index 1.

After 150 MU (Cumulative Beam MU% = 75) the leaves must be at the positions prescribed in control point index 2.

At completion of the beam 200 MU (Cumulative Beam MU% = 25) the leaves must be at the positions prescribed in control point index 3.

The leaves are assumed to move linearly with respect to dose delivered between successive control points. The number of control points can vary between two (minimum) and 1000 (maximum).

As with step-and-shoot fields, dynamic IMRT fields require that, if a leaf position is specified at one control point of a radiating segment, it is also specified at the other control point. Note that segment MU values are calculated to a resolution of 0.1 MU, therefore the cumulative beam MU% has a resolution of two decimal places.

Table 4.15 gives an example of an IMRT field specified using iCom-Fx.

Table 4.15 IMRT field example

	Control points			
Parameters	**1**	**2**	**3**	**4**
Treatment machine name	Elekta Synergy			
Beam ID	14			
Beam MU	200			
Number of control points	4			
Field complexity	Dynamic			
Control point index	0	1	2	3
Radiation type	X-Rays	X-Rays	X-Rays	X-Rays
Energy	6 MV	6 MV	6 MV	6 MV
Wedge	OUT	OUT	OUT	OUT
Cumulative MU	0	25	75	100
Gantry angle	0	0	0	0
Collimator angle	45			
Diaphragm X1	10			
Diaphragm X2	10			
Diaphragm Y1	20			
Diaphragm Y2	20			
Y1:11	20.00	19.00	18.00	17.00
Y1:12	18.00	17.00	15.00	15.00
Y1:13	16.00	15.00	12.00	13.00
Y1:14	14.00	13.00	8.00	11.00
Y1:15	12.00	11.00	5.00	9.00
Y1:16	10.00	9.00	2.00	11.00
Y1:17	8.00	7.00	–1.00	13.00
Y1:18	6.00	5.00	–4.00	15.00
Y1:19	4.00	3.00	0.00	16.00
Y1:20	2.00	1.00	4.00	17.00
Y1:21	0.00	–1.00	8.00	16.00
Y1:22	–2.00	–3.00	12.00	15.00
Y1:23	–4.00	–5.00	16.00	14.00
Y1:24	–6.00	–7.00	20.00	13.00
Y1:25	–4.00	–5.00	17.00	12.00
Y1:26	–2.00	–3.00	14.00	11.00
Y1:27	0.00	–1.00	11.00	10.00

Table 4.15 IMRT field example

	Control points			
Parameters	**1**	**2**	**3**	**4**
Y1:28	2.00	1.00	8.00	9.00
Y1:29	4.00	3.00	5.00	8.00
Y2:11	6.00	5.00	0.00	1.00
Y2:12	8.00	7.00	3.00	2.00
Y2:13	10.00	9.00	6.00	3.00
Y2:14	12.00	11.00	9.00	4.00
Y2:15	14.00	13.00	12.00	5.00
Y2:16	16.00	15.00	15.00	6.00
Y2:17	18.00	17.00	18.00	7.00
Y2:18	20.00	15.00	19.00	8.00
Y2:19	18.00	13.00	18.00	9.00
Y2:20	16.00	11.00	17.00	10.00
Y2:21	14.00	9.00	16.00	11.00
Y2:22	12.00	11.00	15.00	12.00
Y2:23	10.00	13.00	14.00	13.00
Y2:24	8.00	14.00	13.00	14.00
Y2:25	6.00	15.00	12.00	15.00
Y2:26	4.00	16.00	11.00	16.00
Y2:27	2.00	17.00	10.00	17.00
Y2:28	0.00	18.00	9.00	18.00
Y2:29	−2.00	19.00	8.00	19.00

Appendix A Tolerances

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A.1 Tolerance values

The tolerance values that are used when the field is treating are shown in **Table A.1**.

Table A.1 Tolerances for static and dynamic therapy

	Static tolerance	**Dynamic tolerance**	
Gantry angle	0.5°	3.0°	
Collimator angle	0.5°	3.0°	
Table Vertical	Half dynamic tolerance	4 cm	
Table Lateral	Half dynamic tolerance	2 cm	
Table Longitudinal	Half dynamic tolerance	2 cm	
Isocentric Rotation	Half dynamic tolerance	6.0°	
MLC Diaphragm X1	1 mm	1 mm	
MLC Diaphragm X2	1 mm	1 mm	
MLC Diaphragm Y1	1 mm	1 mm	
MLC Diaphragm Y2	1 mm	1 mm	
		Normal dose rate	Low dose rate
MLC Leaf	1 mm	1 mm	2 mm

These are the current tolerance values on the date of publication and may change in the future.

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Appendix B Library routines

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B.1 Shared iCom-Fx and iCom-Vx library routines

This section describes the syntax of the shared iCom-Fx/iCom-Vx library routines that are available.

iComGetConnectionState

This function call checks the connection state of the iCom-Fx or iCom-Vx server.

```
ICOMResult iComGetConnectionState (ICOMHandle hICOM);
```

Input Parameter

- **`hICOM`**
  A handle that identifies the iCom-Fx or iCom-Vx data socket to be checked for connection status.

Return Value

- **`ICOMResult`**
  A value that indicates the status of the connection.

Table B.1 Return values for the function iComGetConnectionState

Status result	Value	Explanation
ICOM_RESULT_OK	1	The connection has started and is okay.
INVALID_CONNECTION_HANDLE	−2	The **`hICOM`** parameter is not a valid connection handle.
CONNECTION_IN_PROGRESS	−5	A previous connection attempt has not yet completed.
NOT_CONNECTED	−6	The network link to the digital accelerator TCS does not exist (due to network failure).
CONNECTION_FAILED	−12	The connection with the digital accelerator TCS has failed. A new connection must be established.

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Description

This routine allows the server connection state to be monitored separately, rather than using other iCom library routines return codes. For example:

```
#include "iComAPI.h"
#define TEN_SECONDS 10000
ICOMHandle hICOM= iComFXConnect("6912",TEN_SECONDS, "LA1" );
if ( hICOM > 0)
{
     /* Connection established, begin an iCom-Fx message */
     ICOMMsgHandle hICOMMsg = iComBeginMessage( hICOM );
     if( hICOMMsg > 0)
     {
        /* Message created OK. Now Fill it up */
        :
       ICOMResult hConStatus = iComGetConnectionState( hICOMMsg );
        if (hConStatus > 0)
        {
           /* Connection Status okay. Send message */
           ICOMResult hRespMsg = iComSendMessage( hICOMMsg );
           if(hRespMsg > 0 )
           {
              /* Reply received from SL */
              /* Get Error Tag and Error Code from message */
           }
        }
    }
    iComDisconnect( hICOM );
}
```

iComDisconnect

Breaks a network connection to the TCS data socket. This function is available to both iCom-Vx and iCom-Fx.

```
ICOMResult iComDisconnect( ICOMHandle hICOM );
```

Input Parameter

- **hICOM**
  A handle that identifies the iCom connection.

Return Value

- **ICOMResult**
  A value that indicates whether the disconnection was successful.

Table B.2 Return values for the function iComDisconnect

Status result	Value	Explanation
ICOM_RESULT_OK	1	Function call completed successfully.
INVALID_CONNECTION_HANDLE	−2	The handle supplied is not a valid connection.

Description

The data socket used for communications with the TCS is deleted, enabling other clients to connect.

When the iCom-Vx connection is broken, a record is made in the TCS log files. If the connection is intentionally broken by the client, a record will not be logged.

Any previously transmitted iCom-Fx data is cleared from the TCS. Do not call if currently waiting for a message on the same connection.

For example (iCom-Fx):

```
#include "iComAPI.h"
#define TEN_SECONDS 10000
ICOMHandle hICOM = iComFXConnect( "6912",TEN_SECONDS,"LA1" );
/* Linac customized machine name */
if( hICOM > 0 )
{
   /* Connection established */
   :
   :
   /* Now disconnect connection */
   ICOMResult iComResult = iComDisconnect( hICOM );
   if( iComResult != ICOM_RESULT_OK )
   {
      /* The disconnect has failed */
   }
}
```


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For example (iCom-Vx):

```
#include "iComAPI.h"
#define TEN_SECONDS 10000
ICOMHandle hICOM  = iComVXConnect( "6912", TEN_SECONDS );
if( hICOM > 0 )
{
    /* Connection established */
    :
    :
    /* Now disconnect connection */
    ICOMResult iComResult = iComDisconnect( hICOM );
    if( iComResult != ICOM_RESULT_OK )
    {
       /* The disconnect has failed */
    }
}
```

iComDeleteMessage

Deletes an iCom message. This function is used by iCom-Vx and iCom-Fx.

```
ICOMResult iComDeleteMessage( ICOMMsgHandle hICOMMsg );
```

Input Parameter

- **`hICOMMsg`**
  A handle that identifies an iCom message.

Return Value

- **`ICOMResult`**
  A value that indicates the status of the function call.

Table B.3 Return values for the function iComDeleteMessage

Status result	Value	Explanation
ICOM_RESULT_OK	1	The function call completed successfully.
INVALID_MESSAGE _HANDLE	-3	The handle supplied is not a valid message handle.

Description

When an iCom-Vx message has been processed, it should be deleted in order to free the resources used. When constructing an iCom-Fx message, this function call can be used to delete the message after it is used.

Note: **`iComSendMessage`** *guarantees to delete its message parameters.*

For example:

```
#include "iComAPI.h"
#define TEN_SECONDS 10000
#define FIFTY_MILLI_SECONDS 50
ICOMHandle hICOM  = iComVXConnect( "6912", TEN_SECONDS );
if( hICOM > 0 )
{
    /* Connection established */
    ICOMMsgHandle hICOMMsg = iComWaitForMessage( hICOM,
       FIFTY_MILLI_SECONDS );
    if(  hICOMMsg > 0 )
    {
       /* Message Received, process it */
       :
       :
       /* Now delete the message */
       if( iComDeleteMessage( hICOMMsg ) == ICOM_RESULT_OK )
       {
           /* Message deleted OK */
       }
    }
    /* Now disconnect connection */
    iComDisconnect( hICOM );
}
```


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B.2 iCom-Vx library routines

This section describes the syntax of the library routines relevant to the use of iCom-Vx.

iComVXConnect

Establishes a network connection to the TCS iCom-Vx data socket.

```
ICOMHandle iComVXConnect(LPCSTR pszHost, ULONG ulTimeout);
```

Input Parameters

- **pszHost**
  A pointer to a null-terminated string defining either the IP address or the alias name of the TCS defined in the host file of the system.
- **ulTimeout**
  A **ULONG** integer that specifies the length of time (in milliseconds) to wait for a connection. A timeout less than 500 will result in a timeout of 500 ms.

Return Value

If successful then a handle to the connected socket which the TCS will use for iCom-Vx data transfers is returned. If unsuccessful then the handle value will be:

Table B.4 Return values for the function iComVxConnect

Status result	Value	Explanation
TIMEOUT_ERROR	−4	No connection has been established with the TCS within the specified timeout period.
CONNECTION_IN_PROGRESS	−5	A previous connection attempt has not yet completed.
CONNECTION_FAILED	−12	The connection with the TCS has failed. A new connection will need to be established.

Description

iCom-Vx data is broadcast from the TCS to a TCP/IP socket on the external system. The socket is created by this function call. A handle to the iCom connection is returned. Subsequent iCom-Vx function calls use the handle created by this function call. For example:

```
#include "iComAPI.h"
#define TEN_SECONDS 10000

   char* pszHostName= "6912"; /* 6912 is the alias for the
   Linac I/P address */
   ULONG iTimeout= TEN_SECONDS;
   ICOMHandle hICOM= iComVXConnect( pszHostName, iTimeout );

   if( hICOM <= 0)
   {
       /* Connection not established */
   }
```

iComWaitForMessage

This waits to receive a message from the TCS.

```
ICOMMsgHandle iComWaitForMessage( ICOMHandle hICOM,nTimeout );
```

Input Parameters

- **`hICOM`**
  A handle identifies the TCS data socket.
- **`nTimeout`**
  A **`ULONG`** integer that specifies the length of time (in milliseconds) to wait for an iCom message. A value of 0 indicates that the calling task shall wait forever.

Return Value

If successful, the handle to the received iCom message is returned.
If unsuccessful, the message handle will contain:

Table B.5 Return values for the function iComWaitForMessage

Status result	Value	Explanation
INVALID_CONNECTION_HANDLE	−2	The handle supplied is not a valid connection or another application thread has previously closed the connection.
TIMEOUT_ERROR	−4	The time-out period expired before a message was received.
INVALID_PROTOCOL_VERSION	−10	The wrong version of the DLL is being used with the TCS.
CONNECTION_FAILED	−12	The connection with the TCS has failed. A new connection will need to be established.

Description

An iCom message transmitted by the TCS is received. A handle to the message is returned. The iCom-Vx protocol contains a watchdog message, which guarantees that a message will be received by the iCom DLL at least every 5 seconds while a connection is open. This message is used by the DLL to detect if the connection established with the TCS is still open. If no message is received within 10 s, the socket is marked as failed. The next call to **`iComWaitForMessage`** will return **`CONNECTION_FAILED`** in such a circumstance. The connection will be automatically deleted.

Note: *While servicing this connection, no other calls to the DLL for connection handle should be made, including* **`iComDisconnect`**.

For example:

```
#include "iComAPI.h"
#define TEN_SECONDS 10000
#define FIFTY_MILLI_SECONDS 50
ICOMHandle hICOM = iComVXConnect( "6912", TEN_SECONDS );


if( hICOM > 0 )
{
       /* Connection established */
       :
       :
       ICOMMsgHandle hICOMMsg = iComWaitForMessage( hICOM,
          FIFTY_MILLI_SECONDS );
       if(  hICOMMsg > 0 )
       {
         /* Message Received, process it */
         :
         iComDeleteMessage( hICOMMsg );
       }
       else if( hICOMMsg == INVALID_PROTOCOL_VERSION )
       {
         /* iComDLL does not support protocol sent from Linac */
       }

       /* Now disconnect connection */
       ICOMResult iComResult = iComDisconnect( hICOM );
       if( iComResult != ICOM_RESULT_OK )
       {
         /* The disconnect has failed */
       }
   }
```

iComGetFirstTagValue

This gets the value of the first tag from an iCom-Vx message. See **Section 4.2.1** for an explanation of tags.

This method can be called with a *null* value to get the buffer size to be allocated for the requested value.

```
ICOMResult iComGetFirstTagValue( ICOMMsgHandle hICOMMsg,
ICOM_TAG* pTag, char* pPart, char* pBuff );
```

Input Parameter

- **hICOMMsg**
  A handle which identifies the TCS iCom-Vx message.

Output Parameters

- **pTag**
  A pointer to an **ICOM_TAG** allocated by the calling application.
- **pPart**
  A pointer to a byte that identifies the TCS 'part', allocated by the calling application.
- **pBuff**
  A pointer to a null-terminated string containing the value of the item tag. The calling procedure must allocate a buffer capable of receiving the value.
  If a *null pointer* is passed, the returned **iComResult** will contain the length of the buffer to be allocated, excluding the null termination for strings.

Return Value

- **iComResult**
  A value that indicates the status of the function call.

Table B.6 Return values for the function iComGetFirstTagValue

Status result	Value	Explanation
	0	This indicates that there are no tags in the message.
ICOM_RESULT_OK	1	The function call completed successfully.
INVALID_MESSAGE_HANDLE	–3	The handle supplied is not a valid message handle.

Description

Each item or tag in the iCom-Vx message is identified by a group and element (see **Appendix A** for a full list of the tags). The first tag in an iCom-Vx message can be decoded using this function call.

The TCS part is one of: '**P**' (prescribed), '**S**'(set), or '**R**' (run).

The value of an item is encoded as a decimal string. For example '27', '–6.8', '6 MV' and 'OUT' are all valid item tag values.

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The size of the buffer can be extracted by calling this function once with a null pointer for the **pBuff** input parameter. The return value will be the size of the buffer required to allocate the value.

For example:

```
#include "iComAPI.h"
#define TEN_SECONDS 10000
#define FIFTY_MILLI_SECONDS 50

ICOMHandle hICOM = iComVXConnect( "6912", TEN_SECONDS );

   if( hICOM > 0 )
   {
       /* Connection established */
       :
       :
       ICOMMsgHandle hICOMMsg = iComWaitForMessage( hICOM,
          FIFTY_MILLI_SECONDS );
       if(  hICOMMsg > 0 )
       {
           /* Message Received, process it */
           ICOMResult iResult = 0;
           ICOM_TAG   iTag;
           char       chPart;
           char       achValue[255];

           iResult  = iComGetFirstTagValue(hICOMMsg,
                                           &iTag,
                                           &chPart,
                                           achValue );
           while( iResult == ICOM_RESULT_OK )
           {
              /* Data in iTag, chPart & achValue */
              :
              /* Get next value */
              iResult  = iComGetNextTagValue(hICOMMsg,
                                             &iTag,
                                             &chPart,
                                              achValue );
           }
           :
           iComDeleteMessage( hICOMMsg );
       }
       /* Now disconnect connection */
       iComDisconnect( hICOM );
   }
```

iComGetNextTagValue

This gets the value of the next tag from an iCom-Vx message. This method can be called with a null value to get the buffer size to be allocated for the requested value.

```
ICOMResult iComGetNextTagValue( ICOMMsgHandle hICOMMsg,
ICOM_TAG* pTag, pPart, pBuff );
```

Input Parameter

- **hICOMMsg**
  A handle which identifies the TCS iCom-Vx message.

Output Parameters

- **pTag**
  A pointer to an **ICOM_TAG** allocated by the calling application.
- **pPart**
  A pointer to a byte identifying the TCS 'part', allocated by the calling application.
- **pBuff**
  A pointer to a null-terminated string containing the value of the item tag. The calling procedure must allocate a buffer capable of receiving the value.

If a null pointer is passed in, the returned **ICOMResult** will contain the length of the buffer to be allocated, excluding the null termination for strings.

Return Value

- **iComResult**
  A value that indicates the status of the function call:

Table B.7 Return values for the function iComGetNextTagValue

Status result	Value	Explanation
	0	This indicates that there are no tags in the message.
ICOM_RESULT_OK	1	The function call completed successfully.
INVALID_MESSAGE_HANDLE	–3	The handle supplied is not a valid message handle.

Description

Each item, or tag, in the iCom-Vx message is identified by a group and element (see **Appendix A** for a full list of the tags).

The first tag in an iCom-Vx message must be requested using the **iComGetFirstTagValue** function call. Subsequent tags can be decoded using this function call.

The TCS part is one of: '**P**' (prescribed), '**S**'(set) or '**R**' (run).

The value of an item is encoded as a decimal string. For example, '27', '–6.8' '6 MV' and 'OUT' are all valid item tag values (see example for **iComGetFirstTagValue**).

The size of the buffer can be extracted by calling this function once with a null pointer for the **pBuff** input parameter. The return value will be the size of the buffer required to allocate the value.

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iComGetTagValue

Returns the requested tag value for the specified tag ID and part. This method can be called with a *null* value to get the buffer size to be allocated for the requested value.

```
ICOMResult iComGetTagValue( IComMsgHandle hICOMMsg,ICOM_TAG
Tag, pPart, pBuff);
```

Input Parameters

- **hICOMMsg**
  A handle which identifies the TCS iCom-Vx message.

Tag

An **ICOM_TAG** which identifies the tag value to be returned from the message.

pPart

A pointer to a null-terminated string defining the part of the tag to be returned from the message.

Output Parameters

pBuff

A pointer to a null-terminated string containing the value of the item tag. The calling procedure must allocate a buffer capable of receiving the value. If a *null pointer* is passed in, the returned **ICOMResult** will contain the length of the buffer to be allocated, excluding the null termination for strings.

Return Value

ICOMResult

If the **pBuff** parameter is a *null* pointer, the **ICOMResult** will return the buffer size. If unsuccessful, then the **ICOMResult** will be a negative number as follows:

Table B.8 Null return value for the function iComGetTagValue

Status result	Value	Explanation
INVALID_MESSAGE_HANDLE	−3	The handle supplied is not a valid message handle.

If the **pBuff** is a *valid* pointer, the **ICOMResult** will indicate the status of the function call:

Table B.9 Return values for the function iComGetTagValue

Status result	Value	Explanation
ICOM_RESULT_OK	1	The function call completed successfully.
INVALID_MESSAGE_HANDLE	−3	The handle supplied is not a valid message handle.
INVALID_TAG	−14	

Description

Each item or tag in the iCom-Vx message is identified by a group and element (see **Appendix A** for a full list of the tags).

The TCS part is one of: '**P**' (prescribed), '**S**'(set) or '**R**' (run).

The value of an item is encoded as a decimal string. For example, '27', '-6.8' '6 MV' and 'OUT' are all valid item tag values.

The size of the buffer can be extracted by calling this function once with a null pointer for the **pBuff** input parameter. The return value will be the size of the buffer required to allocate the value.

Due to a limitation with the iCom interface, it's not possible to get the individual tag values, via the message **iComGetNextTagValue**, for the following tags:

MLC leaf 5001 0101 to 5001 00B8

Inhibit reasons 5001 0050 to 5001 005D

Interrupt reason 1 5001 0052

Interrupt reason 2 5001 005E

Interrupt reason 3 5001 0070

Interrupt reason 4 5001 0071

Terminate reason 1 5001 0053

Terminate reason 2 5001 005F

Terminate reason 3 5001 0080

Terminate reason 4 5001 0081

External channels 5001 0020 to 5001 0026

For example:

```
#include "iComAPI.h"
#define TEN_SECONDS 10000
#define FIFTY_MILLI_SECONDS 50

ICOMHandle hICOM= iComVXConnect( "6912",TEN_SECONDS );

if( hICOM >0)

{
   /* Connection established */
   ICOMMsgHandle hICOMMsg =
      ICOMWaitForMessage(hICOM,FIFTY_MILLI_SECONDS);
   if( hICOMMsg > 0)
   {
      /* Message Received, process it */
      ICOMResult  iSize = 0;
      ICOMResult  iResult = 0;
      ICOM_TAG    iTag = ICOM_PATIENT_NAME;
      char*       pchPartRun = "R";

      //Get size of buffer first.
      iSize = iComGetTagValue(hICOMMsg,
                                    iTag,
                                    pchPartRun,
                                    NULL);
```

```
            //Error check
            if( iSize > 0)
            {
               //Use size to allocate buffer
               char* achValue = new char[iSize+1];
               iResult = iComGetTagValue(hICOMMsg,
                                         iTag,
                                         pchPartRun,
                                         achValue);
                  delete [] achValue;
            }
               iComDeleteMessage( hICOMMsg );
         }
         /* Now disconnect connection */
         iComDisconnect( hICOM );
      }
```

iComGetState

This gets the value of the digital accelerator machine state from an iCom-Vx message.

```
short iComGetState( ICOMMsgHandle hICOMMsg );
```

Input Parameter

- **`hICOMMsg`**
  A handle which identifies the TCS iCom-Vx message.

Return Value

A **`short`** integer containing the digital accelerator machine state.

Table B.10 Return values for the function iComGetState

Status result	Value	Explanation
	1	PREPARATORY
	2	CONFIRM SETTINGS
	3	READY TO START
	4	SEGMENT START
	5	SEGMENT IRRADIATE
	6	SEGMENT INTERRUPT
	7	SEGMENT INTERRUPTED
	8	SEGMENT RESTART
	9	SEGMENT TERMINATE
	10	SEGMENT PAUSE
	11	FIELD TERMINATE
	12	TERMINATE CHECKING
	13	FIELD TERMINATED
	14	MOVE ONLY
INVALID_MESSAGE_HANDLE	–3	The handle supplied is not a valid message handle.

Description

Each iCom-Vx message contains information about the current state of the digital accelerator. In an unknown or invalid state there is loss of communication between Vx and the TCS, In this event, no messages are sent although the connection remains valid. This function call extracts the state from the message.

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For example:

```
#include "iComAPI.h"
#define TEN_SECONDS 10000
#define FIFTY_MILLI_SECONDS 50

ICOMHandle hICOM = iComVXConnect( "6912", TEN_SECONDS );

if( hICOM > 0 )
{
    /* Connection established */

    ICOMMsgHandle hICOMMsg = iComWaitForMessage(hICOM,
       FIFTY_MILLI_SECONDS);
    if(  hICOMMsg > 0 )
    {
        /* Message Received,  process it */
        short sState = iComGetState( hICOMMsg );
        if( sState != INVALID_MESSAGE_HANDLE )
        {
            /*Valid State Received*/
        }
        iComDeleteMessage( hICOMMsg );
    }
    /* Now disconnect connection */
    iComDisconnect( hICOM );
}
```

iComGetDate and iComGetTime

Extract the date and time from an iCom-Vx message. This method can be called with a null value to get the buffer size to be allocated for the requested value.

```
ICOMResult iComGetDate( ICOMMsgHandle hICOMMsg, pszDate);
ICOMResult iComGetTime( ICOMMsgHandle hICOMMsg, pszTime);
```

Input Parameter

- **hICOMMsg**
  A handle which identifies the TCS iCom-Vx message.

Output Parameter

- **pszDate** (**or pszTime**)
  A pointer to a null-terminated string into which the date (or time) will be placed. The calling procedure must allocate a buffer capable of receiving the value. If a *null* pointer is passed in the **ICOMResult**, it will contain the length of the buffer to be allocated, excluding the null termination for strings.Return Value
- **ICOMResult**
  A value indicating the status of the function call:

Table B.11 Return values for the functions iComGetDate and iComGetTime

Status result	Value	Explanation
ICOM_RESULT_OK	1	The function call completed successfully.
INVALID_MESSAGE_HANDLE	–3	The handle supplied is not a valid message handle.

Description

Each iCom-Vx message contains the date and time. These function calls extract the date and time from the message. The size of the buffer can be extracted by calling the function once with a null pointer for the **pszDate** (or **pszTime**) output parameter. The return value being the size of the buffer required to allocate the value.

The date is in the format **ccyy-mm-dd** for example, **1995-12-25**.

The time is in the format **hh:mm:ss** for example, **16:20:34**.

For example:

```
#include "iComAPI.h"
#define FIFTY_MILLI_SECONDS 50

/* Connection previously established with handle hICOM */

ICOMMsgHandle hICOMMsg = iComWaitForMessage( hICOM,
   FIFTY_MILLI_SECONDS );

if( hICOMMsg > 0 )

{

   char szDate[30];
   char szTime[30];
   /* Message Received,  process it */
   if(( iComGetDate( hICOMMsg, szDate ) == ICOM_RESULT_OK )
      &&( iComGetTime( hICOMMsg, szTime ) == ICOM_RESULT_OK ))
```


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```
        {
            /* Valid Date & Time received */
        }
        iComDeleteMessage( hICOMMsg );
    }
```

iComGetFunction

Extracts the current digital accelerator function mode from an iCom-Vx message.

```
short iComGetFunction( ICOMMsgHandle hICOMMsg );
```

Input Parameter

- **hICOMMsg**
  A handle which identifies the TCS iCom-Vx message.

Return Value

A **short** integer containing the current function.

Table B.12 Return values for the function iComGetFunction

Status result	Value	Explanation
	–1	Unknown mode.
	1	Premium Therapy Treatment.
	3	Premium Check Radiograph.
	5	Premium Finish Field.
	8	Standard Therapy Treatment.
	9	Receive External Prescription.
	10	Service mode.
INVALID_MESSAGE_HANDLE	–3	The handle supplied is not a valid message handle.

Description

Each iCom-Vx message contains information about which function the digital accelerator is currently operating in. This function call extracts the mode from the message.

For example:

```
#include "iComAPI.h"
#define FIFTY_MILLI_SECONDS 50

/* Connection previously established with handle hICOM */

ICOMMsgHandle hICOMMsg = iComWaitForMessage( hICOM,
   FIFTY_MILLI_SECONDS );
if(  hICOMMsg > 0 )
{
    /* Message Received,  process it */
    short sFunction = iComGetFunction( hICOMMsg );
    if( sFunction != INVALID_MESSAGE_HANDLE )
    {
        /* Valid Function */
    }
    iComDeleteMessage( hICOMMsg );
}
```


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iComGetSeqNumber

This extracts the current sequence number from an iCom-Vx message.

```
long iComGetSeqNumber( ICOMMsgHandle hICOMMsg );
```

Input Parameter

- **hICOMMsg**
  A handle which identifies the TCS iCom-Vx message.

Return Value

A **long** integer containing the sequence number which can also be an error code.

Table B.13 Return values for the function iComGetSeqNumber

Status result	Value	Explanation
INVALID_MESSAGE_HANDLE	−3	The handle supplied is not a valid message handle.

Description

Each iCom-Vx message contains a unique sequence number. This function call extracts the sequence number from the message.

The sequence number can be used to determine whether messages have been missed. The range values in the **sequence number** should be 0 to 65535 (**unsigned short**), with the negative values representing error codes. Due to a known error, the return value for this function actually returns a **sign extended short** ranging from -32768 to 32767, hence the error codes are masked. In order to work around this, please use another function to test the validity of the message and then cast the result of this function to **unsigned short** to yield the correct sequence number (see example below).

Note: *The sequence number rolls over from its maximum count 65535 back to 0, which should not be considered as an error.*

For example:

```
#include "iComAPI.h"
#define FIFTY_MILLI_SECONDS 50
/* Connection previously established with handle hICOM */
ICOMMsgHandle hICOMMsg = iComWaitForMessage(hICOM,
FIFTY_MILLI_SECONDS);
if( hICOMMsg > 0 )
{
 /* Message Received, process it */
 if (iComGetFunction(hICOMMsg) != INVALID_MESSAGE_HANDLE)
{
/* Convert Sequence Number to 'unsigned short' range 0..65535 */
long sSeqNumber = iComGetSeqNumber( hICOMMsg );
unsigned short uSeqNumber = static_cast<unsigned
short>(sSeqNumber);
/* use uSeqNumber */
}
```

```
iComDeleteMessage( hICOMMsg );
}
```

B.3 iCom-Fx library routines

This section describes the syntax of the library routines relevant to the use of iCom-Fx.

iComFXConnect

This establishes a network connection to the TCS iCom-Fx data socket.

```
ICOMHandle iComFXConnect( pszHost, unsigned long ulTimeout,
pszMachineName );
```

Input Parameters

- **`pszHost`**
  A pointer to a null-terminated string defining either the IP address or the alias name of the TCS.
- **`ulTimeout`**
  An unsigned long integer specifying the length of time (in milliseconds) to wait for a connection. The minimum value is 500 ms, therefore setting a value <500 ms will result in a timeout of 500 ms.
- **`pszMachineName`**
  A pointer to a null-terminated string that is the digital accelerator customized machine name. The machine name supplied here is used in the subsequent treatment settings, CONFIRM SETTINGS, and CANCEL SETTINGS messages.

Return Value

If successful, the returned value is a handle to the connected socket which the TCS will use for iCom-Fx data transfers. If unsuccessful then:

Table B.14 Return values for the function iComFXConnect

Status result	Value	Explanation
TIMEOUT_ERROR	−4	The connection is not established within the timeout period.
CONNECTION_IN_PROGRESS	−5	

Description

iCom-Fx communicates with the TCS via a TCP/IP socket on the external system. The socket is created by this function call. A handle to the connected socket is returned. Subsequent iCom-Fx function calls use the handle created by this function call.

Note: *If more than one digital accelerator is available on the network then unplanned treatment can result if the wrong digital accelerator is selected. It is the responsibility of external system designers to make sure this does not happen.*

For example:

```
#include "iComAPI.h"
#define TEN_SECONDS 10000

   char* pszHostName= "6912"; /* 6912 is the alias for the
      Linac I/P address */

   char* pszMachineName = "LA1"; /* LA1 is the Linac
      customized machine name */


   ICOMHandle hICOM= iComFXConnect( pszHostName, TEN_SECONDS,
      pszMachineName );


   if( hICOM < 0)
   {
       /* Connection not established */
   }
```

iComBeginMessage

This creates an iCom-Fx treatment message.

```
ICOMMsgHandle iComBeginMessage( ICOMHandle hICOM );
```

Input Parameter

- **hICOM**
  A handle which identifies the TCS iCom-Fx data socket.

Return Value

If successful, the returned value is a message handle which is to be used for the subsequent treatment settings. If unsuccessful then:

Table B.15 Return values for the function iComBeginMessage

Status result	Value	Explanation
INVALID_CONNECTION_HANDLE	−2	The handle supplied is not a valid connection.

Description

This function call creates a message handle. The treatment settings message is populated by adding data to this message handle.

For example:

```
#include "iComAPI.h"
#define TEN_SECONDS 10000
ICOMHandle hICOM = iComFXConnect("6912",TEN_SECONDS,"LA1");
if( hICOM > 0)
{
   /* Connection established, begin an iCom-Fx message */
   ICOMMsgHandle hICOMMsg = iComBeginMessage( hICOM );
   if( hICOMMsg > 0)
   {

      /* Message created OK. Now Fill it up */
      :
      :
      ICOMMsgHandle hRespMsg = iComSendMessage( hICOMMsg );
      if( hRespMsg > 0 )
      {
         /* Reply received from Linac */
         /* Get Error Tag and Error Code from message */
         :
         iComDeleteMessage( hRespMsg );
      }
   }
   iComDisconnect( hICOM );
}
```

iComInsertTagVal

Adds an item tag to an existing iCom-Fx treatments settings message.

```
ICOMResult iComInsertTagVal( ICOMMsgHandle hICOMMsg,
                             ICOM_TAG Tag,
                             LPCSTR pVal,
                             USHORT nCntrlPointNum );
```

Input Parameters

- **`hICOMMsg`**
  A handle which identifies a TCS iCom-Fx message.
- **`Tag`**
  An **`ICOM_TAG`** which identifies the tag to be added to the message.
- **`pVal`**
  A pointer to a null-terminated string which contains the value to be added to the message.
- **`nCntrlPointNum`**
  A **`USHORT`** integer which indicates to which control point the tag is to be added. 0 indicates the tags *before the first control point* (that is, field level). 1 indicates control point 0, 2 indicates control point 1 etc.

Return Value

- **`ICOMResult`**
  A value indicating the status of the function call:

Table B.16 Return values for the function iComInsertTagVal

Status result	Value	Explanation
ICOM_RESULT_OK	1	The function call completed successfully.
INVALID_MESSAGE_HANDLE	–3	The passed parameter, message handle, is invalid.
INVALID_CONTROL_POINT_NUM	–7	The **`nCntrlPointNum`** parameter is out of range. The tag is ignored.
DUPLICATE_ITEM	–8	The tag already exists in the control point. The tag is ignored.

Description

This function call adds an item tag to an existing iCom-Fx treatment settings message.

Note: *The machine name tag (7001 0001) does not need to be entered into the iCom-Fx message using this function. The machine supplied as the* **pszMachineName** *parameter in the* **iComFXConnect** *call is automatically used.*

For example:

```
#include "iComAPI.h"
#define TEN_SECONDS 10000
ICOMHandle hICOM = iComFXConnect("6912",TEN_SECONDS,"LA1");
if( hICOM > 0)
{
   /* Connection established, begin an iCom-Fx message */
   ICOMMsgHandle hICOMMsg = iComBeginMessage( hICOM );
   if( hICOMMsg > 0)
   {
      /* Message created OK. Now Fill it up */
      ICOMResult iRes = iComInsertTagVal( hICOMMsg,
         ICOM_GANTRY_ANGLE,"90", 1 );
      if( iRes != ICOM_RESULT_OK )
      {
         /*Tag not added */
      }
      /* Add rest of tags */
      :
      :
      ICOMMsgHandle hRespMsg = iComSendMessage( hICOMMsg );
      if(hRespMsg > 0 )
      {
         /* Reply received from Linac */
         /* Get Error Tag and Error Code from message */
         ICOM_TAG iTag;
         short sErrCode = iComGetErrorCode(hRespMsg);
         iRes = iComGetErrorTag( hRespMsg, &iTag );
         if((sErrCode > 0) && (iRes == ICOM_RESULT_OK ))
         {
            /* Retrieved Error Code and associated Tag */
         }
         :
         iComDeleteMessage( hRespMsg );
      }
   }
   iComDisconnect( hICOM );
}
```

iComSendMessage

This sends an iCom-Fx treatments settings message to the TCS.

```
ICOMMsgHandle iComSendMessage( ICOMMsgHandle hICOMMsg );
```

Input Parameter

- **`hICOMMsg`**
  A handle which identifies the iCom-Fx message to be sent to the TCS.

Return Value

If successful, the returned value is the message handle which contains the validation message returned by the TCS. If unsuccessful then:

Table B.17 Return values for the function iComSendMessage

Status result	Value	Explanation
INVALID_CONNECTION_HANDLE	−2	The Fx connection is invalid.
INVALID_MESSAGE _HANDLE	−3	The passed parameter, message handle, is invalid.
TIMEOUT_ERROR	−4	There is no response from the TCS.
NOT_CONNECTED	−6	The network link to the TCS does not exist (due to a network failure).
MISSING_CONTROL_POINT	−9	There is a gap in the control point spec (for example, control points 1 and 3 have been specified, control point 2 has not).
INVALID_PROTOCOL_VERSION	−10	

In all failure cases the message is deleted.

Description

This function call sends an iCom-Fx treatment settings message to the TCS and returns a message handle of the response message from the TCS.

The message identified by the **`ICOMMsgHandle`** parameter supplied to this call is deleted. The message handle returned from the call must be deleted by the calling task.

A time-out will occur on this API call, if no acknowledgement has been received from the TCS within the allowed time period. This time period depends upon the number of control points in the field being sent. This ranges from 40 seconds for 1 or 2 control points to a few minutes for more complex fields.

iComSendMessageEx

Extended version of **`iComSendMessage`**. This is a non-blocking call to send the iCom-Fx treatment settings message to the TCS.

```
ICOMResult iComSendMessageEx (ICOMMsgHandle hICOMMsg);
```

Input Parameter

- **`hICOMMsg`**
  A handle which identifies the TCS iCom-Fx message to be sent to the TCS.

Return Value

- **`ICOMResult`**
  A value indicating the status of the function call:

Table B.18 Return values for the function iComSendMessageEx

Status result	Value	Explanation
ICOM_RESULT_OK	1	The function call completed successfully.
INVALID_CONNECTION_HANDLE	-2	The handle supplied is not a valid connection.
INVALID_MESSAGE_HANDLE	-3	The passed parameter, message handle, is invalid.
NOT_CONNECTED	-6	The network link to the TCS does not exist (due to a network failure).
MISSING_CONTROL_POINT	-9	There is a gap in the control point spec (for example, control points 1 and 3 have been specified, control point 2 has not).
INVALID_PROTOCOL_VERSION	-10	

Description

This function call sends an iCom-Fx treatment settings message to the TCS. This method is non-blocking. The client must get the return message from the **`iComWaitForMessage`** method then use this for extracting the message error code and tag. If using this method, the client must implement time-outs.

iComGetErrorCode

Extracts the error code from an iCom-Fx treatments settings acknowledgement message.

```
short iComGetErrorCode( ICOMMsgHandle hICOMMsg );
```

Input Parameter

- **`hICOMMsg`**
  A handle which identifies the iCom-Fx message received from the TCS.

Return Value

A **`short`** integer which contains the error code. Possible error codes are summarized in **Table B.19** and explained in greater detail in **Appendix C**.

Description

This function call extracts the error code from an iCom-Fx treatments settings acknowledgement message (see ***iComInsertTagVal*** for an example).

Table B.19 Return values for the function iComGetErrorCode (possible error codes)

	Code	Meaning
0	OK	Settings accepted by TCS.
1	NOT SUPPORTED	Tag(s) supplied are not supported by the current digital accelerator.
2	UNDER SPECIFIED	Mandatory tag(s) are missing.
3	OVER SPECIFIED	A tag is specified more than once in a control point.
4	OUTSIDE RANGE	The value is outside the digital accelerator customized range.
5	INCONSISTENCY	Tags supplied are inconsistent with one another.
6	MISMATCH TEXT	A text was specified but no matching text exists on the digital accelerator.
7	PROTOCOL ERROR	Invalid tag group/element/part/value.
8	NOT READY	The digital accelerator is in a state in which it cannot receive settings.
9	WRONG MACHINE	The settings are not for the current machine.
10	CHECKSUM ERROR	The checksum verification has failed
11	VERSION ERROR	An incorrect version of the iCom DLL is being used.
12	NOT LICENSED	The field is not treatable due to incorrect licence options.
–3	INVALID_MESSAGE_HANDLE	The handle supplied is not a valid message handle.

iComGetErrorTag

Extracts the error tag from an iCom-Fx treatment settings acknowledgement message.

```
ICOMResult iComGetErrorTag( ICOMMsgHandle hICOMMsg, ICOM_TAG* pTag
);
```

Input Parameter

- **`hICOMMsg`**
  A handle which identifies the iCom-Fx message received from the TCS.

Output Parameter

- **`pTag`**
  A pointer to an **`ICOM_TAG`** which will receive the error tag.

Return Value

- **`ICOMResult`**
  A value which indicates the status of the function call:

Table B.20 Return values for the function iComGetErrorTag

Status result	Value	Explanation
ICOM_RESULT_OK	1	The function call completed successfully.
INVALID_MESSAGE _HANDLE	–3	The **`hICOMMsg`** parameter is not a valid message handle.

Description

This function call extracts the error tag from an iCom-Fx treatments settings acknowledgement message (see ***iComInsertTagVal*** for an example).

iComGetErrorControlPoint

This function call will extract the control point number for the error that was reported.

```
ICOMResult iComGetErrorControlPoint (ICOMMsgHandle hICOMMsg );
```

Input Parameter

- **hICOMMsg**
  A handle which identifies the iCom-Fx message received from Fx.

Return Value

If successful, the returned value is the control point number for which the error has been reported.

Table B.21 Return values for the function iComGetErrorControlPoint

Status result	Value	Explanation
INVALID_MESSAGE_HANDLE	–3	The **hICOM** parameter is not a valid connection handle.

Description

This routine allows the extraction of the control point number, if there are errors reported from the Fx treatment message just sent.

For example:

```
#include "iComAPI.h"
#define TEN_SECONDS 10000
ICOMHandle hICOM= iComFXConnect("6912",TEN_SECONDS, "LA1" );
if ( hICOM > 0)
{
   /* Connection established, begin an iCom-Fx message */
   ICOMMsgHandle hICOMMsg = iComBeginMessage( hICOM );
   if( hICOMMsg > 0)
   {
      /* Message created OK. Now Fill it up */
      :
      ICOMResult hConStatus = iComGetConnectionStatus(hICOMMsg );
      if (hConStatus > 0)
      {
         /* Connection Status okay. Send message */
         ICOMMsgHandle hRespMsg = iComSendMessage( hICOMMsg );
         if(hRespMsg > 0 )
         {
            /* Reply received from SL */
            /* Get Error Tag and Error Code from message */
            ICOMResult  iRes;
            iRes = iComGetErrorControlPoint(hRespMsg );
            iComDeleteMessage( hRespMsg );
         }
      }
   }
   iComDisconnect( hICOM );
}
```

iComSendCancel

This function call clears the last sent treatment settings from the TCS.

```
ICOMResult iComSendCancel ( ICOMHandle hICOM );
```

Input Parameter

- **`hICOM`**
  A handle which identifies the TCS iCom-Fx data socket.

Return Value

- **`ICOMResult`**
  A value which indicates the status of the function call:

Table B.22 Return values for the function iComSendCancel

Status result	Value	Explanation
ICOM_RESULT_OK	1	The function call completed successfully.
INVALID_CONNECTION_HANDLE	–2	The **`hICOM`** parameter is not a valid connection handle.
NOT_CONNECTED	–6	The network link to the TCS is broken (due to a network failure).

Description

`iComSendCancel` can be used up to and including **Ready to Start** state. If it is used after the **Start** key is pressed (that is, during treatment) then it is ignored.

This message should be used to clear the just delivered treatment settings from the TCS after termination.

For example:

```
#include "iComAPI.h"
#define TEN_SECONDS 10000
ICOMHandle hICOM = iComFXConnect("6912",TEN_SECONDS,"LA1");
if( hICOM > 0)
{
   /* Connection established */
   :
   :
   /* Prescription previously sent with iComSendMessage */
   /* Now wish to cancel settings previously set up.
   ICOMResult iResult = iComSendCancel( hICOM );
   if( iResult == ICOM_RESULT_OK )
   {
      /* The settings have been cleared on the Linac */
   }
   iComDisconnect( hICOM );
}
```

iComSendConfirm

This function call enables treatment to begin at the digital accelerator.

```
ICOMResult iComSendConfirm( ICOMHandle hICOM );
```

Input Parameter

- **`hICOM`**
  A handle which identifies the TCS iCom-Fx data socket.

Return Value

- **`ICOMResult`**
  A value which indicates the status of the function call:

Table B.23 Return values for the function iComSendConfirm

Status result	Value	Explanation
ICOM_RESULT_OK	1	The function call completed successfully.
INVALID_CONNECTION_HANDLE	–2	The **`hICOM`** parameter is not a valid connection handle.
NOT_CONNECTED	–6	The network link to the TCS is broken (due to a network failure).

Description

The external system should use iCom-Vx to monitor the state of the digital accelerator to see when it is in the **Confirm Settings** state. When this state is reported this function call causes a message to be sent from the external system to the TCS to remove the **Settings Not Confirmed** inhibit, thereby permitting treatment to start.

This function call does not start treatment. The user must press the **<Start>** key.

`iComSendConfirm` behaves as a toggle mechanism. If the **Settings Not Confirmed** inhibit is not set, then it is set by sending the **CONFIRM SETTINGS** message. This inhibits treatment again.

Note: *The new* **`iComSendConfirmEx`** *should be used in preference to this method for new implementations.*

For example:

```
#include "iComAPI.h"
#define TEN_SECONDS 10000
ICOMHandle hICOM = iComFXConnect("6912",TEN_SECONDS,"LA1");
if( hICOM > 0)
{
   /* Connection established */
   :
   :
   /* Prescription previously sent with iComSendMessage */
   /* Now wish to confirm settings previously set up.
   ICOMResult iResult = iComSendConfirm( hICOM );
   if( iResult == ICOM_RESULT_OK )
   {
      /* Settings have been confirmed on the Linac */
      /* Treatment may begin */
   }
   iComDisconnect( hICOM );
}
```

iComSendConfirmEx

This function call enables treatment to begin at the digital accelerator.

```
ICOMResult iComSendConfirmEx(ICOMHandle hICOM, int bConfirm);
```

Input Parameters

- **`hICOM`**
  A handle which identifies the TCS iCom-Fx data socket.
- **`bConfirm`**
  An integer which, if equal to 1, will *confirm* settings, or if equal to 0 will *unconfirm* settings.

Return Value

- **`ICOMResult`**
  A value which indicates the status of the function call:

Table B.24 Return values for the function iComSendConfirmEx

Status result	Value	Explanation
ICOM_RESULT_OK	1	The function call completed successfully.
INVALID_CONNECTION_HANDLE	–2	The **`hICOM`** parameter is not a valid connection handle.
NOT_CONNECTED	–6	The network link to the TCS is broken (due to a network failure).
INVALID_PROTOCOL_VERSION	–10	If the user is using protocol 3 or less.

Description

The external system should use iCom-Vx to monitor the state of the digital accelerator to see when it is in **Confirm Settings** state. When this state is reported, this function call causes a message to be sent from the external system to the TCS to remove the **Settings not Confirmed** inhibit thereby permitting treatment to start.

This function call does not start treatment. This user must press the **Start** key.

This function differs from **`iComSendConfirm`** in that it is not a toggle action, but the parameter **`bConfirm`** is the state of the confirm message that is to be sent. This should be used in preference to **`iComSendConfirm`**.

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Appendix C Tags summary and error codes

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C.1 Tags

Table C.1 Tags

iCom-Vx	iCom-Fx	Items	Tag (Hex)	Linac item ID
		Group IDs		
		Linac	5001	–
		Linac stop items	5002	–
		Linac R&V	7001	–
		Others	7002	–
		Generic Tags		
x	✓	Generic error reporting	0000, 0000	
✓✓	✓✓	Machine name	7001, 0001	–
✓✓	✓	Leaf width	7002, 0006	–
✓✓	✓	Patient ID	7001, 0002	–
✓✓	✓	Patient name	7001, 0003	–
✓✓	✓	Treatment name	7001, 0005	–
		Prescription Target Dose	7001, 0018	
		Prescription Entry Dose	7001, 002F	
✓✓	✓	Phase name	3001, 1002	–
✓✓	✓	Beam name	7001, 0007	–
✓✓	✓✓	Beam monitor units	5001, 0001	33
✓✓	✓✓	Radiation type	5001, 0002	31
✓✓	✓✓	Energy	5001, 0003	32
✓✓	✓✓	Fluence mode (Integrity™ R3.1 only)	7002, 0010	
x	✓✓	Cumulative beam MU percentage	7002, 0004	–
		Control Point Id	7002,0003	
		Checksum	7002,00FF	
x	✓	Field complexity	7002, 0005	–
✓✓	✓✓	Wedge position	5001, 0004	39
✓✓	✓	Segment timer	5001, 0005	37/367
✓	✓	Dose rate set	5001, 0006	43
✓✓	✓	Gantry rot. direction	5001, 0019	–
✓✓	✓	Gantry angle	5001, 0007	70
✓✓	✓	Collimator angle	5001, 0008	75
✓✓	✓	Collimator X1	5001, 0009	80
✓✓	✓	Collimator X2	5001, 000A	85
✓✓	✓	Collimator Y1	5001, 000B	90

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Table C.1 Tags

iCom-Vx	iCom-Fx	Items	Tag (Hex)	Linac item ID
✓✓	✓	Collimator Y2	5001, 000C	95
✓✓	✓	Electron applicator code	5001, 000D	40
✓✓	✓	Electron accessory fitment	5001, 000E	41
✓✓	✓	Accessory number	5001, 000F	42
✓✓	✓	Table height	5001, 0010	125
✓✓	✓	Table rotation	5001, 0011	130
✓✓	✓	Table lateral	5001, 0012	120
✓✓	✓	Table longitudinal	5001, 0013	115
✓✓	✓	Table isoc. rot.	5001, 0014	110
✓✓	x	Fieldsize X	5001, 0015	592
✓✓	x	Fieldsize Y	5001, 0016	593
✓✓	x	Offset X	5001, 0017	594
✓✓	x	Offset Y	5001, 0018	595
✓✓	x	Wedged beam monitor units	5001, 0028	–
✓✓	x	Gantry stop angle	5002, 0007	71
✓	x	Collimator stop angle	5002, 0008	76
✓	x	Collimator X1 stop	5002, 0009	81
✓	x	Collimator X2 stop	5002, 000A	86
✓	x	Collimator Y1 stop	5002, 000B	91
✓	x	Collimator Y2 stop	5002, 000C	96
✓	x	Table height stop	5002, 0010	126
✓	x	Table rotation stop	5002, 0011	131
✓	x	Table lateral stop	5002, 0012	121
✓	x	Table longitudinal stop	5002, 0013	116
✓	x	Table isoc. rot. stop	5002, 0014	111
✓	x	External channel 1 to External channel 7	5001, 0020 to 5001, 0026	–
		Digital accelerator status		
✓✓	x	Inhibit reason 1	5001, 0050	46
✓✓	x	Inhibit reason 2	5001, 0051	47
✓✓	x	Interrupt reason	5001, 0052	58
✓✓	x	Terminate reason	5001, 0053	62
✓✓	x	R&V inhibit	7001, 0050	-
		Integrity™ R1.1 Tags		
✓✓	✓	Collimator rotation direction	5001, 00BB	N/A

Table C.1 Tags

iCom-Vx	iCom-Fx	Items	Tag (Hex)	Linac item ID
x	✓	Table motion	5001, 00BC	N/A
✓✓	x	Control point count	7002, 0002	N/A
x	x	Delivered monitor units	7002, 0007	N/A
✓✓	x	Delivery segment count	7002, 0008	N/A
x	✓	Finish Field indicator	7002, 0009	N/A
✓	✓	Deliver now indicator (deprecated)	7002, 000A	N/A
✓	x	Step MU	7002, 000B	N/A
		Collimator MLCi/MLCi2 Tags		
✓✓	✓	MLC leaf Y1 01	5001, 0101	701
✓✓	✓	MLC leaf Y1 02 to	5001, 0102	702
✓✓	✓	MLC leaf Y1 39	5001, 0127	739
✓✓	✓	MLC leaf Y1 40	5001, 0128	740
✓✓	✓	MLC leaf Y2 01	5001, 0201	741
✓✓	✓	MLC leaf Y2 02 to	5001, 0202	742
✓✓	✓	MLC leaf Y2 39	5001, 0227	779
✓✓	✓	MLC leaf Y2 40	5001, 0228	780
		Beam limiting device	5001,00B8	
		MLC Leaf shape	5001,00B9	
		Beam Id	7001, 0006	
✓✓	x	Segment ID	7001, 0008	-
✓✓	x	Monitor unit 1	7001, 0009	35
✓✓	x	Monitor unit 2	7001, 000A	36
✓✓	x	Tolerance table	7001, 000B	-
✓✓	x	Template name	7001, 000C	-
✓✓	x	For machine	7001, 000D	-
		Collimator Agility™ (1 to 40 and 41 to 80)		
✓✓	✓	MLC leaf Y1 01	5001, 0101	701
✓✓	✓	MLC leaf Y1 02 to	5001, 0102	702
✓✓	✓	MLC leaf Y1 79	5001, 0149	739
✓✓	✓	MLC leaf Y1 80	5001, 0150	740
✓✓	✓	MLC leaf Y2 01	5001, 0201	741
✓✓	✓	MLC leaf Y2 02 to	5001, 0202	742
✓✓	✓	MLC leaf Y2 79	5001, 0249	779
✓✓	✓	MLC leaf Y2 80	5001, 0250	780

General Notes:

The data set transmitted via iCom-Vx is controlled by a configuration file, but there is an option to have a non standard configuration file setup by Elekta so that the data set can be customized to suit the clients individual needs. The customized data set is arranged through the 'specials' process for which a charge may be made. The standard data set is defined in iCom-Vx default data set.

For iCom-Vx:

x = tag is not applicable for iCom-Vx.

✓ = tag may be broadcast via iCom-Vx but not in the standard data set.

✓✓ = tag included in the default data set.

For iCom-Fx:

x = tag is not applicable for iCom-Fx.

✓ = tag is optional. It may be supplied in the treatment settings message.

✓✓ = tag is mandatory. It must be supplied in the treatment settings message.

C.2 Error Codes

Table C.2 Error codes

	Error codes	Meaning
0	OK	Settings accepted by the TCS.
1	NOT SUPPORTED	Tag(s) supplied are not supported by the current digital accelerator.
2	UNDER SPECIFIED	Mandatory tag(s) are missing.
3	OVER SPECIFIED	A tag is specified more than once in a control point or has been specified for too many decimal places.
4	OUTSIDE RANGE	The value is outside the digital accelerator customized range.
5	INCONSISTENCY	Tags supplied are inconsistent with one another.
6	MISMATCH TEXT	A text was specified but no matching text exists on the digital accelerator.
7	PROTOCOL ERROR	Invalid tag group/element/part/value.
8	NOT READY	The digital accelerator is in a state in which it cannot receive settings.
9	WRONG MACHINE	The settings are not for the current machine.
10	CHECKSUM ERROR	The checksum verification has failed.
11	VERSION ERROR	An incorrect version of the iCom DLL is being used.
12	NOT LICENSED	The field is not treatable due to incorrect licence options.

C.3 Description of tags

This section contains a full definition of the tags available. Tags are identified by a hexadecimal tag number. This number is split into a 4-digit group number and a 4-digit ID. For example, the tag number for the **Generic error reporting** tag is 0000 0000.

Note: *All tag IDs are in hexadecimal unless otherwise stated.*

0000 0000 Generic error reporting (Optional)

iCom-Fx description: This tag is used for error reporting only.

iCom-Fx error code:

0004 OUTSIDE RANGE	Range check failed.
0007 PROTOCOL ERROR	Unable to determine message type. Using newer version of dll with older server. A confirm message has been sent but the message contents are not as expected.
0008 NOT READY	The field could not be processed due to another one being loaded or the digital accelerator is not in the correct state.
0011 VERSION ERROR	Protocol version used by dll not the same as the server.
0012 LICENSE ERROR	Not licensed for the field type requested.

5001 0001 Beam Monitor Units (Mandatory)

Type:	Number, real to one decimal place.
Valid values:	Range: 0 to 32000.
Use:	iCom-Vx and iCom-Fx.
iCom-Fx description:	This tag is used to set the beam monitor unit value for the current beam.
iCom-Vx description:	This tag is used to report the beam monitor unit value of the current beam selected at the digital accelerator. When FFF energies are used, a small dose may overrun up to 0.3 MUs in the reported value for Beam MUs at termination. This difference in the value is not cumulative. This is expected system behaviour and does not need sign off by the MOSAIQ® user.

iCom-Fx error codes:

0003 OVERSPECIFIED	1 MU rounding for simple fields is configured and the fields has decimal places prescribed.
0004 OUTSIDE RANGE	The value specified is outside the digital accelerator customized range (Item 33). If more than one segment is indicated, then the range of each segment monitor unit must be less than or equal to 1000. For example, if beam monitor units is set to 1500 and two segments of 750 MU are prescribed then there is no problem. But if the segments are 1200 MU and 300 MU then the range check will fail.

Table C.3 Customized beam paraeters, valid range

Beam MU = 1500	CP 0	CP 1	CP 2	
Beam cum MU%	0	50	100	OK
Beam cum MU%	0	80	20	Not OK

	The energy is check radiograph and the total beam MU is greater than the customizable maximum allowable checkfilm value.
0007 PROTOCOL ERROR	The value specified is not of the correct value (that is, no conversion algorithm found for tag).

5001 0002 Radiation Type (Mandatory)

Type:	Text (1 to 9 characters).
Valid values:	The value must match the digital accelerator customized texts for the radiation type item (Item 31).
Use:	iCom-Vx and iCom-Fx.
iCom-Fx description:	This tag is used to set the radiation type of the current control point. This tag must be specified in all control points, except for the final one.
iCom-Vx description:	This tag is used to report the radiation type of the current segment selected at the digital accelerator.

iCom-Fx error codes:

0001 NOT SUPPORTED	Arc therapy has been prescribed for a machine that does not support arc therapy. The value in a control point is different from the first control point (that is, not permitted to change radiation types in a single beam).

Table C.4 Valid control point values

Nr control pts = 3	CP 0	CP 1	CP 2	
Radiation type	X-rays	X-rays	X-rays	OK
Radiation type	X-rays	X-rays		OK
Radiation type	X-rays	Electrons		Not OK
Radiation type	X-rays	X-rays	Electrons	Not OK

0002 UNDER SPECIFIED	The mandatory radiation type tag is not supplied.
0005 INCONSISTENCY	An electron radiation type is specified, but MLC leaves are also specified. More than two control points have been prescribed for a check film.
0006 MISMATCH TEXT	The value does not match the digital accelerator text. More than 1 dp has been specified.

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5001 0003 Energy (Mandatory)

Type:	Text (1 to 9 characters).
Valid values:	The value must match the digital accelerator customized texts for the energy item (Item 32).
Use:	iCom-Vx and iCom-Fx.
iCom-Fx description:	This tag is used to set the energy of the current control point. This tag must be specified in all control points, except for the final one.
iCom-Vx description:	This tag is used to report the energy of the current segment selected at the digital accelerator.

iCom-Fx error codes:

0001 NOT SUPPORTED	The value is for an electron energy, but an X-ray radiation type specified, or vice versa. X-Ray field but not an X-Ray Cal Block- internal Fx error. An electron field has be specified but an X-Ray energy has been set. The value of an electron energy in control point *x* is different from control point *x-1* (that is, not permitted to change electron energy in a single beam).

Table C.5 Valid control point values

Nr Control Pts = 3	CP 0	CP 1	CP 2	
Energy	x low	x low	x low	OK
Energy	x low	x low		OK
Energy	x low	x high		OK
Energy	x low	x low	x high	Not OK
Nr control pts = 2	CP 0	CP 1		
Energy	4 MeV			OK
Energy	4 MeV	4 MeV		OK
Energy	4 MeV	6 MeV		Not OK

0002 UNDER SPECIFIED	The mandatory energy tag is not supplied.
0005 INCONSISTENCY	The value in the final control point is different from the previous control point.
0006 MISMATCH TEXT	The value does not match the digital accelerator text.
0012 NOT LICENSED	HDRE is only available for machines with the appropriate license.

7002 0010 Fluence Mode (Mandatory if the fluence mode is FFF)

Type:	Text (1 to 7 characters).
Valid values:	STD or FFF
Use:	iCom-Vx and iCom-Fx.
iCom-Fx description:	Use this tag to set the fluence mode of the active control point. This tag must be specified in all control points other than the final control point.
iCom-Vx description:	This tag is used to report the fluence mode of the selected active segment of the digital accelerator.

iCom-Fx error codes:

0001 NOT SUPPORTED	The value is for the energy that is not supported. An electron field is specified and an X-ray fluence mode is set.

Table C.6 Valid control point values

Nr Control Pts = 3	CP 0	CP 1	CP2	
Fluence mode	STD	STD	STD	OK
Fluence mode	STD	STD		OK
Fluence mode	STD	FFF		OK
Fluence mode	STD	STD	FFF	Not OK

0002 UNDER SPECIFIED	The fluence mode tag is not supplied when the energy name maps to a FFF energy.
0005 INCONSISTENCY	The value in the final control point is different from the previous control point. The field specifies a check film energy and prescribes a FFF fluence mode. The field gives electrons and fluence mode.
0006 MISMATCH TEXT	The value does not match the digital accelerator text.
0012 NOT LICENSED	The FFF is only available for machines with the applicable license.

5001 0004 Wedge Position (Mandatory for X-rays)

Type:	Text (1 to 6 characters).
Valid values:	The value must match the digital accelerator customized texts for the wedge item (Item 39).
Use:	iCom-Vx and iCom-Fx.
iCom-Fx description:	This tag is used to set the wedge position for the current control point. This tag must be specified in all control points, except for the final one. It must be IN or OUT.
iCom-Vx description:	This tag is used to report the wedge position of the current segment selected at the digital accelerator. It can be reported as IN, OUT or MOVING.

iCom-Fx error codes:

0001 NOT SUPPORTED	The value in the final control point is different from the previous control point.

Table C.7 Valid control point values

Nr Control Pts = 3	CP 0	CP 1	CP 2	
Wedge position	IN	OUT		OK
Wedge position	IN	OUT	OUT	OK
Wedge position	IN	IN	OUT	Not OK

0002 UNDER SPECIFIED	The mandatory wedge tag is not supplied.
0005 INCONSISTENCY	The wedge tag is not supplied for an X-ray beam.
	The value is set to IN for an electron beam.
	Wedge is set to IN for a checkfilm.
0006 MISMATCH TEXT	The value does not match the digital accelerator text.

5001 0005 Segment Timer (Optional)

Type:	Number, real to one decimal place.
Valid values:	0.1 to 300.0 minutes (for iCom-Vx).
	0.1 to 300.0 minutes (for iCom-Fx).
Use:	iCom-Vx and iCom-Fx.
iCom-Fx description:	This tag is used to set the segment timer for the current control point (Item 37).
	For Integrity™ R1.1 and later the segment timer is ignored by iCom-Fx.

Note: *In order to comply with IEC 6061-2-1 clause 29.1.2 in iCom mode, the external system must display the segment timer value, permit the user to enter a segment time and the external system documentation shall explain that entry is optional and, if entered, how to calculate a timer value.*

iCom-Vx description:	This tag is used to report the segment timer of the current segment selected at the digital accelerator (Item 367).
	For Integrity™ R1.1 and later iCom-Vx does not report the value of the segment timer to the external system.

iCom-Fx error codes:

0004 OUTSIDE RANGE	The value specified is outside the digital accelerator customized range (Item 37).
0007 PROTOCOL ERROR	The value specified is not of the correct type.

5001 0006 Dose Rate Set (Optional)

Type:	Number, integer.
Valid values:	Range: 1 MU to 2800 MU per minute. (This range can be customized locally at the digital accelerator).
Use:	iCom-Vx and iCom-Fx.
iCom-Fx description:	This tag is used to set the dose rate for the current control point. For a given beam energy the dose rate can be varied by altering the pulse repetition frequency (PRF). The dose rate tag provides a method of specifying the desired nominal dose rate. If dose rate is omitted the default nominal dose rate for the given energy will be used (normally the highest available setting). If the dose rate is specified, the PRF automatically adjusts so that the resulted dose rate is the nearest available dose rate less than or equal to the requested value. If CVDR is not available (not licensed or non dynamic treatment) the range of PRF settings is not continuous; 7 dose rates are available with the highest as the nominal dose rate for the energy, and each lower dose rate as half of the next higher rate; if the nominal dose rate is 400, the available rates are: 6, 12, 25, 50, 100, 200 or 400 MU/min. When CVDR is used, there are 255 equally spaced dose rates, with the highest as the nominal dose rate. **Integrity** In Integrity™ R1.1 and later the system selects the available Dose Rate that is equal-to or less-than the User specified Dose-Rate. This means in the example above that the system selects Dose-Rate 109 MU/min. It is therefore important that if the user wants to irradiate at maximum Dose-Rate then they specify a Dose-Rate greater-than or equal-to the Maximum Available Dose Rate. If no dose rate is specified in a prescription, Integrity™ R1.1 and later automatically delivers the maximum available dose rate.
iCom-Vx description:	This tag is used to report the dose rate of the current segment selected at the digital accelerator.

iCom-Fx error codes:

0002 UNDER SPECIFIED	The tag has previously been set and is now unprescribed.
0004 OUTSIDE RANGE	The value specified is outside the digital accelerator customized range (Item 43).
0007 PROTOCOL ERROR	The value specified is not of the correct type.

5001 0007 Gantry Angle (Optional)

Type:	Number, real to one decimal place.
Valid values:	Range: –179.9° to +180.0° (This range can be customized locally at the digital accelerator.)
Use:	iCom-Vx and Fx.
iCom-Fx description:	This tag is used to set the gantry angle at the start of the current control point. When this tag is used, the gantry rotation direction tag (5001 0019) is mandatory.
iCom-Vx description:	This tag is used to report the gantry angle of the current segment selected at the digital accelerator.

iCom-Fx error codes:

0001 NOT SUPPORTED	The gantry is to rotate through an arc not supported on the digital accelerator.

Table C.8 Valid control point values

Nr control pts = 3	CP 0	CP 1	CP 2	
Gantry angle	0.0	45.0	0.0	OK
Gantry angle	0.0	45.0	60.0	OK
Gantry angle	0.0	45.0	-45.0	OK
Gantry angle		45.0	90.0	Not OK
Gantry angle	0.0		45.0	Not OK

0002 UNDER SPECIFIED	A value has been specified for a control point other than control point zero but not for all control points. Tag has previously been set and is now unprescribed. Gantry movement has been set and is now unprescribed. Must be specified for complex fields. Gantry movement has been specified but no gantry angle specified.
0003 OVER SPECIFIED	The number of decimal places supplied is greater than what is defined for the gantry.
0004 OUTSIDE RANGE	The value specified is outside the digital accelerator customized range (Item 70).
0007 PROTOCOL ERROR	The value specified is not of the correct type.

5001 0008 Collimator Angle

Type: Number, real to one decimal place.

Valid values: Range: -179.9° to +180.0°
(This range can be customized locally at the digital accelerator.)

Use: iCom-Vx and iCom-Fx.

iCom-Fx description: This tag is used to set the collimator angle at the start of the current control point. The mechanical limits of the collimator do not allow rotation through 180.0°. This means that collimator rotation direction is implied.

If the collimator angle at the beginning of the segment is greater than the collimator angle at the end of the segment, the rotation will be counterclockwise.

If the collimator angle at the beginning of the segment is less than the collimator angle at the end of the segment, the rotation will be clockwise.

For Integrity™ R1.1 and later the collimator rotation direction is mandatory for PreciseBEAM™ VMAT fields, if there is prescribed collimator movement during radiation. Otherwise for backwards compatibility, the digital accelerator will choose the direction that will not go through 180°.

Table C.9 Valid control point values

Tag	CP1	CP2	
Collimator angle	−179.9	+180	OK
Collimator rotation	CC		
Collimator angle	+180	−179.9	OK
Collimator rotation	CW		
Collimator angle	90	−90	Not OK
Collimator rotation	CW		
Collimator angle	0	45	Not OK
Collimator rotation	CW		

iCom-Vx description: This tag is used to report the collimator angle of the current segment selected at the digital accelerator.

iCom-Fx error codes:

0001 NOT SUPPORTED — The values specified indicate that a dynamic movement is required.

The value specified is not of the correct type.

The collimator is to rotate through an arc not supported on the digital accelerator.

0002 UNDER SPECIFIED	A value has been specified for a control point other than control point zero, but not for all control points (see gantry angle description). Collimator angle must be specified for a complex field.
0004 OUTSIDE RANGE	The value specified is outside the digital accelerator customized range (Item 75).

5001 0009
5001 000A

Collimator X1/X2

Type:	Number, real to two decimal places.
Valid values:	Range:
	X-ray fields: -12 cm to 20 cm for Agility™.
	0 cm to 20 cm for Asymmetric and MLCi/MLCi2 machines (this range can be customized locally at the digital accelerator); 8 cm on a Beam Modulator™.Electron fields: Any valid applicator size for all BLD.
Use:	iCom-Vx and iCom-Fx.
iCom-Fx description:	This tag is used to set the position of the X1/X2 collimator at the start of the current control point.
	For electron fields on all BLD, the tag is used to specify the field size of the applicator.
iCom-Vx description:	This tag is used to report the position of the X1/X2 collimator of the current segment selected at the digital accelerator. In the case of electron fields, the values reported back are the calibrated positions for the applicator fitted. The nominal field size will be reported back on the field size and offset tags.

iCom error codes:

0001 NOT SUPPORTED	The values specified indicate that a dynamic movement is required.
0002 UNDER SPECIFIED	The value is omitted when it must be supplied.
	A value has been specified for a control point other than control point zero, but not for all control points (see gantry angle description).
	This must be specified for complex fields if calculate diaphragm positions is switched off.
	Diaphragm must be specified for a check film.
	Not consistently specified.
0004 OUTSIDE RANGE	The value specified is outside the digital accelerator customized range (Items 80 and 85).
	The value specified indicates that a wedge fieldsize is too large.

Note: *If the field size is invalid, both tags are considered to be incorrect, but only one error will be reported which will always be the X1 tag even if the X2 tag is outside of range*

0005 INCONSISTENCY	A value has been specified for a control point other than control point zero, but not for all control points (see gantry angle description).
0007 PROTOCOL ERROR	The value specified is not of the correct type.

5001 000B
5001 000C

Collimator Y1/Y2

Type:	Number, real to two decimal places.
Valid values:	Range:
	X-ray fields: Fixed, must be 20 cm for Agility™. 10.5 cm or blank on a Beam Modulator™.
	X-ray fields: -12.5 cm to +20 cm (this range can be customized locally at the digital accelerator) on MLCi/MLCi2.
	Electron fields: Any valid applicator size for all BLD.
Use:	iCom-Vx and iCom-Fx.
iCom-Fx description:	This tag is used to set the position of theY1/Y2 collimator at the start of the current control point.
	The default behavior of iCom is to reject fields that have no Y diagrams specified. However, there is an IEC requirement to use the smallest possible field size for a given MLC shape. iCom-Fx may be configured to calculate the Y collimator if no value is specified for any control point. The configuration of this behavior is found on the iCom tab of the configuration tool.
	Regardless of the setting for calculation of collimators, if the first control point value is specified, this value will be copied to all other control points.
	For electron fields on all BLD, the tag is used to specify the field size of the applicator.
iCom-Vx description:	This tag is used to report the position of the Y1/Y2 collimator of the current segment selected at the digital accelerator. In the case of electron fields, the values reported back are the calibrated positions for the applicator fitted. The nominal field size will be reported back on the field size and offset tags.

iCom error codes:

0001 NOT SUPPORTED	The values specified indicate that a dynamic movement is required.
0002 UNDER SPECIFIED	The value is omitted when it must be supplied.
	Not consistently specified.
	Must be specified for complex fields if calculate diaphragm positions is switched off.
0004 OUTSIDE RANGE	The value specified is outside the digital accelerator customized range (Items 90 and 95).

Note: *If the field size is invalid both tags are considered to be incorrect. Only one error will be reported in this case and that will always be the Y1 tag even if the Y2 tag is outside of range.*

0005 INCONSISTENCY	A value has been specified for a control point other than control point zero but not for all control points (see gantry angle description).
0007 PROTOCOL ERROR	The value specified is not of the correct type.

5001 000D Electron Applicator Code (Mandatory for electrons)

Type:	Text.
Valid values:	The value must match the digital accelerator customized texts for the electron applicator item (Item 40).
Use:	iCom-Vx and iCom-Fx.
iCom-Fx description:	This tag is used to set the value of the accessory number at the start of the current control point.
iCom-Vx description:	This tag is used to report the value of the electron applicator of the current segment selected at the digital accelerator.

iCom-Fx error codes:

0002 UNDER SPECIFIED	Not specified in CP1. Needs to be specified for the last control point. Not specified in electron field.
0004 OUTSIDE RANGE	Not a valid applicator ID.
0005 INCONSISTENCY	The electron applicator tag changes across control points or is specified for an X-ray field.
0006 MISMATCH TEXT	The value does not match the digital accelerator text. The applicator is not recognized as valid for this machine.

5001 000E Electron Accessory Fitment (Mandatory for electrons)

Type:	Number, integer.
Valid values:	Range: 1 to 14 (iCom-Fx). 0 to 15 (iCom-Vx), value of 15 indicates an error condition.
Use:	iCom-Vx and iCom-Fx.
iCom-Fx description:	This tag is used to set the value of the electron accessory fitment at the start of the current control point.
iCom-Vx description:	This tag is used to report the value of the electron accessory fitment of the current segment selected at the digital accelerator.

iCom-Fx error codes

0001 NOT SUPPORTED	Do not allow dynamic movement of this parameter.
0002 UNDER SPECIFIED	The electron accessory fitment tag is not supplied for an electron beam.
	Needs to be specified for the last control point.
	Tag has previously been set and is now unprescribed.
	First control point not specified.
0004 OUTSIDE RANGE	The value specified is outside the digital accelerator customized range (Item 41).
	The collimators specified are not correct for this fitment.
0005 INCONSISTENCY	The electron accessory fitment tag is supplied for an X-ray field.
	Tag has previously been set and is now unprescribed.
0007 PROTOCOL ERROR	The value specified is not of the correct type.

5001 000F Accessory Number (Optional)

Type:	Number, integer.
Valid values:	Range: 0 to 127 (iCom-Fx). 0 to 127 (iCom-Vx), value of 128 indicates an error condition.
Use:	iCom-Vx and iCom-Fx.
iCom-Fx description:	This tag is used to set the value of the shadow tray at the start of the current control point.
iCom-Vx description:	This tag is used to report the value of the shadow tray of the current segment selected at the digital accelerator.

iCom error codes:

0001 NOT SUPPORTED	The shadow tray can not change from one segment to another.
0002 UNDER SPECIFIED	The accessory has previously been specified and is now not specified.
0004 OUTSIDE RANGE	The value specified is outside the digital accelerator customized range (Item 42).

0005 INCONSISTENCY	The accessory number tag is supplied for an electron beam. The field specifies a check film energy and an accessory has been prescribed.
0007 PROTOCOL ERROR	The value specified is not of the correct type.

5001 0010 Table Height (Optional)

Type:	Number, real to one decimal place.
Valid values:	Range: –52 cm to +83 cm. (This range can be customized locally at the digital accelerator.)
Use:	iCom-Vx and iCom-Fx.
iCom-Fx description:	This tag is used to set the height of the table relative to the isocenter at the start of the current control point.
iCom-Vx description:	This tag is used to report the height of the table relative to the isocenter of the current segment selected at the digital accelerator.

iCom error codes:

0001 NOT SUPPORTED	The values specified indicate that a dynamic movement is required.
0002 UNDER SPECIFIED	Not specified and/or not in earlier control points.
0004 OUTSIDE RANGE	The value specified is outside the digital accelerator customized range (Item 125).
0007 PROTOCOL ERROR	The value specified is not of the correct type.

5001 0011 Table Rotation (Optional)

Type:	Number, integer.
Valid values:	Range: –179° to +180° (This range can be customized locally at the digital accelerator.)
Use:	iCom-Vx and iCom-Fx.
iCom-Fx description:	This tag is used to set the non-isocentric table rotation angle at the start of the current control point.
iCom-Vx description:	This tag is used to report the non-isocentric table rotation angle of the current segment selected at the digital accelerator.

iCom error codes:

0001 NOT SUPPORTED	The values specified indicate that a dynamic movement is required.
0002 UNDER SPECIFIED	Not specified and/or not in earlier control points
0004 OUTSIDE RANGE	The value specified is outside the digital accelerator customized range (Item 130).
0007 PROTOCOL ERROR	The value specified is not of the correct type.

5001 0012 Table Lateral (Optional)

Type:	Number, real to one decimal place.
Valid values:	Range: –25 cm to +25 cm. (This range can be customized locally at the digital accelerator.)
Use:	iCom-Vx and iCom-Fx.
iCom-Fx description:	This tag is used to set the lateral position of the table at the start of the current control point.
iCom-Vx description:	This tag is used to report the lateral position of the table of the current segment selected at the digital accelerator.

iCom error codes:

0001 NOT SUPPORTED	The values specified indicate that a dynamic movement is required.
0002 UNDER SPECIFIED	Not specified and/or not in earlier control points.
0004 OUTSIDE RANGE	The value specified is outside the digital accelerator customized range (Item 120).
0007 PROTOCOL ERROR	The value specified is not of the correct type.

5001 0013 Table Longitudinal (Optional)

Type:	Number, real to one decimal place.
Valid values:	Range: 0 cm to +100 cm. (This range can be customized locally at the digital accelerator.)
Use:	iCom-Vx and iCom-Fx.
iCom-Fx description:	This tag is used to set the longitudinal position of the table at the start of the current control point.
iCom-Vx description:	This tag is used to report the longitudinal position of the table of the current segment selected at the digital accelerator.

iCom error codes:

0001 NOT SUPPORTED	The values specified indicate that a dynamic movement is required.
0002 UNDER SPECIFIED	Not specified and/or not in earlier control points.
0004 OUTSIDE RANGE	The value specified is outside the digital accelerator customized range (Item 115).
0007 PROTOCOL ERROR	The value specified is not of the correct type.

5001 0014 **Table Isocentric Rotation (Optional)**

Type:	Number, integer.
Valid values:	Range: −135° to +135° (This range may be customized locally at the digital accelerator.)
Use:	iCom-Vx and iCom-Fx.
iCom-Fx description:	This tag is used to set the isocentric table rotation angle at the start of the current control point.
iCom-Vx description:	This tag is used to report the isocentric table rotation angle of the current segment selected at the digital accelerator.

iCom error codes:

0001 NOT SUPPORTED	The values specified indicate that a dynamic movement is required.
0002 UNDER SPECIFIED	Not specified and/or not in earlier control points.
0004 OUTSIDE RANGE	The value specified is outside the digital accelerator customized range (Item 110).
0007 PROTOCOL ERROR	The value specified is not of the correct type.

5001 0015 **Fieldsize X/Y**
5001 0016

Type:	Number, real to two decimal places.
Valid values:	Range: 0 cm to +40 cm.
Use:	iCom-Vx only.
iCom-Vx description:	These tags are used to report the Fieldsize X/Y of the current segment selected at the digital accelerator. During electron treatments, these are the nominal values of the fieldsize and offset, not the calibrated positions which can be calculated from the collimator X1/X2 Y1/Y2 positions.

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5001 0017
5001 0018

Offset X/Y

Type:	Number, real to two decimal places.
Valid values:	Range: –16.25 cm to +16.25 cm.
Use:	iCom-Vx only.
iCom-Vx description:	These tags are used to report the Field Offset X/Y of the current segment selected at the digital accelerator. During electron treatments, these are the nominal values of the fieldsize and offset, not the calibrated positions which can be calculated from the collimator X1/X2 Y1/Y2 positions.

5001 0019 **Gantry Rotation Direction**

Type:	Enumerated.	
Valid values:	None	No rotation
	CW	Clockwise rotation
	CC	Counterclockwise rotation
Use:	iCom-Fx and iCom-Vx.	
iCom-Fx description:	This tag is used to set the gantry direction of rotation for the current control point. It is mandatory whenever the gantry angle tag is used. The tag must not be set for the final control point.	
iCom-Vx description:	Reports back gantry movement.	

iCom-Fx error codes

0002 UNDER SPECIFIED	This tag is not specified when a gantry angle is specified. Must be specified for complex field (CP). Attribute now being set whereas earlier CP were not.
0004 OUTSIDE RANGE	The value specified is outside the digital accelerator customized range.

Table C.10 Valid control point values

Nr Control Pts = 3	CP 0	CP 1	CP 2	
Gantry angle Gantry rotation	0 CW	45 CC	0	OK
Gantry angle Gantry rotation	0 CW	45 CW	60	OK
Gantry angle Gantry rotation	0 None	0 CC	-45	OK
Gantry angle Gantry rotation	0 CC	45 CW	90	Not OK
Gantry angle Gantry rotation	0 CW	45 CW	45	Not OK
Gantry angle Gantry rotation	0 CW	45 None	45	OK

0005 INCONSISTENCY	Movement has been detected in a check film.
0006 MISMATCH TEXT	The value does not match the digital accelerator text that is, could not convert string to display mode language.
0007 PROTOCOL ERROR	The value specified is not one of the enumerated values.

5001 0020 to 5001 0026 **External Channels 1-7 (Optional)**

Type:	Digital - number, integer. Analogue - number, real. (Decimal places depend on calibration on channel.)
Valid values:	Digital 0 to 127. Analogue 0 to 4095.
Use:	iCom-Vx only.
iCom-Vx description:	This tag is used to report back the values from the external channels. Channels 1 to 5 are analogue and channels 6 and 7 are digital. For a more detailed description of the use of external channels, please see the *External Channels Manual*.

5001 0028 **Wedged Beam Monitor Units (Optional)**

Type:	Number, real to one decimal place.
Valid values:	Range: 0 to 32000.
Use:	iCom-Vx only.
iCom-Vx description:	This tag is used to report the accumulated number of MU that has been given with the physical autowedge in the beam. When FFF energies are used, a small dose may overrun up to 0.3 MUs in the reported value for Beam MUs at termination. This difference in the value is not cumulative. This is expected system behaviour and does not need sign off by the MOSAIQ® user.

5001 0050
5001 005D

Inhibit Reason

Tag ID:	Hexadecimal
Inhibit reason 1	5001 0050
to	
Inhibit reason 12	5001 005D

Type:	Text (1 to 14 ASCII characters).
Valid values:	Digital accelerator customized text for Items 46 to 57 inclusive.
Use:	iCom-Vx only.
iCom-Vx description:	These tags are used to report the digital accelerator items which are inhibiting treatment. Examples of items which may inhibit are ROOM DOORS & FAULT RESET REQUIRED.

5001 0052
5001 005E
5001 0070
5001 0071

Interrupt Reason

Tag ID:	Hexadecimal
Interrupt reason 1	5001 0052
Interrupt reason 2	5001 005E
Interrupt reason 3	5001 0070
Interrupt reason 4	5001 0071

Type:	Text (1 to 14 ASCII characters).
Valid values:	Digital accelerator customized text for Items 58 to 61 inclusive.
Use:	iCom-Vx only.
iCom-Vx description:	This tag is used to report the digital accelerator item which caused treatment to be interrupted.

5001 0053
5001 005F
5001 0080
5001 0081

Terminate Reason

Tag ID:	Hexadecimal
Terminate reason 1	5001 0053
Terminate reason 2	5001 005F
Terminate reason 3	5001 0080
Terminate reason 4	5001 0081

Type:	Text (1 to 14 ASCII characters).
Valid values:	Digital accelerator customized text for Items 62 to 65 inclusive.
Use:	iCom-Vx only.
iCom-Vx description:	This tag is used to report the digital accelerator item which caused a treatment to terminate. In the TCS the finished field will not be created on the TCS, if the TCS is in **Receive External Prescription** mode. This is done by the external R&V system. If the communication link between the TCS and the external systems fails, the external system must not assume the last received MU value was the total delivered value.

The TCS will not create a **Finish Field** when in modes (other than **Receive External Prescription**) on the following termination codes:

Table C.11 Termination codes

Termination Code	Termination code descriptions
2	TCS/MLC link failure.
366	Significant difference between MU1 and MU2.
367	The backup timer was reached.
451	The backup MU was reached.
189 511 461 506 456	Ion Chamber voltage fail.
9112	MLC link failure.

Note that a **Finish Field** will not be created under the following conditions:

- If the entire field delivery has only 1 MU left.
- If the backup timer has been set and there is insufficient time to deliver the remainder of the field.

If Integrity™ is in Receive External Prescription mode. It is then the responsibility of the external system to decide if one needs to be created.

5001 00B8 Beam Limiting Device

Type:	N/A error reporting only.
Valid values:	N/A error reporting only.
Use:	iCom-Fx.
iCom-Fx description:	This tag is only used for generic errors that occur with the MLC shape.

iCom error codes:

0001 NOT SUPPORTED	Sending leaves to a machine with Asymmetric diaphragms.

5001 00B9 MLC Leaf shape

Type:	N/A error reporting only.
Valid values:	N/A error reporting only.
Use:	iCom-Fx.
iCom-Fx description:	This tag is only used for generic errors that occur with the MLC shape.

iCom error codes:

0002 UNDER SPECIFIED	No leaf shape has been specified for an X-Ray beam. Note: All individual (missing) leaf errors are reported against the specific leaves. Individual leaf errors are not reported against this generic MLC Shape tag.
0004 OUTSIDE RANGE	Outside range.
0005 INCONSISTENCY	Control point requires a leaf shape.

5001 00BB Collimator Rot. direction

Type:	Enumeration
Valid values:	None - no rotation CW - clockwise rotation CC - counterclockwise rotation
Use:	iCom-Fx & iCom-Vx

Description for iCom-Fx

This tag is used to set the collimator rotation direction for the current control point. Any resultant movement of collimator between control points can not pass through 180°. for example, sweep is restricted to range –179.9, –90, +90, +180. The rotation is defined as that viewed from the radiation source towards the isocenter.

The tag must not be set for the final control point.

For Integrity™ R1.1 and later the collimator rotation direction is mandatory for PreciseBEAM™ VMAT fields, if there is prescribed collimator movement during radiation. Otherwise for backwards compatibility, the digital accelerator will choose the direction that will not go through 180°. If specified at any control point other than the 1st, it must be specified at all control points (except the last).

Description for iCom-Vx

Reports back the collimator movement.

iCom-Fx error codes

0002 UNDER SPECIFIED	Must be specified when the collimator (BLD) angle changes during radiation.
0005 INCONSISTENCY	Value is inconsistent with the collimator angle specified.

Table C.12 Valid control point values

Tag	CP1	CP2	CP3	
Collimator angle	0	45	0	OK
Collimator rotation	CC	CW		
Collimator angle	0	45	60	OK
Collimator rotation	CC	CC	CC	
Collimator angle	0	0	–45	OK
Collimator rotation	None	CW		
Collimator angle	0	45	45	Not OK
Collimator rotation	CC	CC		
Collimator angle	0	45	45	Not OK
Collimator rotation	None	None		

0006 MISMATCH TEXT	The value specified is not one of the enumerated values.

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5001 00BC **Table motion**

Type:	N/A error reporting only.
Valid values:	N/A error reporting only.
Use:	iCom-Fx only.
iCom-Fx description:	This tag is only used for generic errors that occur on the patient support system (table).

iCom-Fx error codes

0012 LICENSE ERROR	Unsupported table motion during radiation detected.

5001 0101 0102 to 5001 0227/ 0228 - 5001 0101 0102 to 5001 0249/0250 **MLC Leaf Y1 01/02 to Y2 39/40 - Agility™ Leaf Y1 01/02 to Y2 79/80**

Type:	Number, real to two decimal places.
Valid values:	Range: –15 cm to +20 cm for Agility™.
Use:	iCom-Vx and iCom-Fx.
iCom-Fx description:	These tags are used to set the position of the MLC leaves at the start of the current control point. For Agility™, the corner leaf limits must be prescribed (see the *Agility™ Treatment Planning Information for detail information*). For Integrity™ R1.2 and R2.1, the corner leaf limits apply to MLCi/MLCi2, 40 leaf pairs (1-4 and 37-40). There are no corner leaf restrictions for Beam Modulator™.
iCom-Vx description:	Integrity™ R1.1 and later sends all leaf values.

5002 0007
5002 0008

Gantry/Collimator Stop Angle

Type:	Number, real to one decimal place.
Valid values:	Range: –179.9° to +180°
Use:	iCom-Vx only.
iCom-Vx description:	These tags are used to report the stop angle of the gantry and collimator of the current segment selected at the digital accelerator.

5002 0009
5002 000A

Collimator X1 and X2 Stop

Type:	Number, real to two decimal places.
Valid values:	Range: –12 cm to +20 cm for Agility™. 0 cm to +20 cm for other head types.
Use:	iCom-Vx only.
iCom-Vx description:	These tags are used to report the stop position of the X1 and X2 collimators of the current segment selected at the digital accelerator.

5002 000B
5002 000C

Collimator Y1 and Y2 Stop

Type:	Number, real to two decimal places.
Valid values:	Range: Fixed, must be 20 cm for Agility™. -12.5 cm to +20 cm for other head types.
Use:	iCom-Vx only.
iCom-Vx description:	These tags are used to report the stop position of the Y1 and Y2 collimators of the current segment selected at the digital accelerator.

5002 0010

Table Height Stop

Type:	Number, real to one decimal place.
Valid values:	Range: –52 cm to +83 cm.
Use:	iCom-Vx only.
iCom-Vx description:	This tag is used to report the stop position of the table height of the current segment selected at the digital accelerator.

5002 0011

Table Rotation Stop

Type:	Number, integer.
Valid values:	Range: –179° to +180°
Use:	iCom-Vx only.
iCom-Vx description:	This tag is used to report the stop angle non-isocentric table rotation of the current segment selected at the digital accelerator.

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5002 0012 Table Lateral Stop

Type:	Number, real to one decimal place.
Valid values:	Range: –25 cm to +25 cm.
Use:	iCom-Vx only.
iCom-Vx description:	This tag is used to report the lateral stop position of the table of the current segment selected at the digital accelerator.

5002 0013 Table Longitudinal Stop

Type:	Number, real to one decimal place.
Valid values:	Range: 0 cm to +100 cm.
Use:	iCom-Vx only.
iCom-Vx description:	This tag is used to report the longitudinal stop position of the table of the current segment selected at the digital accelerator.

5002 0014 Table Isocentric Rotation Stop

Type:	Number, integer.
Valid values:	Range: –135° to +135°
Use:	iCom-Vx only.
iCom-Vx description:	This tag is used to report the stop angle of the isocentric table rotation of the current segment selected at the digital accelerator.

7001 0001 Machine Name (Mandatory)

Type:	Text (1 to 10 ASCII characters).
Valid values:	The digital accelerator machine name as defined by the digital accelerator customization application.
Use:	iCom-Vx and iCom-Fx.
description:	This tag identifies the digital accelerator to which the external system is connected.

iCom-Fx error codes

0002 UNDER SPECIFIED	The mandatory machine name tag is not specified.
0009 WRONG MACHINE	The value does not match the name of the machine receiving the settings.

7001 0002 Patient ID (Optional)

Type:	Text (null terminated).
Valid values:	All ASCII characters except control characters in range (0x00 – 0x1F or 0x7F). The maximum length of this tag is 64 characters.
Use:	iCom-Vx and iCom-Fx.
iCom-Fx description:	This tag identifies the patient record on the system.
iCom-Vx description:	The size of the string, without the null termination, can be retrieved by calling **`iComGetTagValue`** or **`iComGetNextTagValue`** with a *null* pointer passed on **`pBuff`**. See library routine descriptions for details.

iCom-Fx error codes

0004 OUTSIDE RANGE	The value is outside of valid character range.
0006 MISMATCH TEXT	Internal Fx error.

7001 0003 Patient Name (Optional)

Type:	Text (null terminated).
Valid values:	All ASCII characters except control characters in range (0x00 – 0x1F or 0x7F). The maximum length of this tag is 64 characters.
Use:	iCom-Vx and iCom-Fx.
iCom-Fx description:	This tag contains the patient name.

iCom-Fx error codes

iCom-Vx description:	The size of the string, without the null termination, can be retrieved by calling **`iComGetTagValue`** or **`iComGetNextTagValue`** with a *null* pointer passed on **`pBuff`**. See library routine descriptions for details.
0004 OUTSIDE RANGE	The value is outside of valid character range.
0006 MISMATCH TEXT	Internal Fx error.

7001 0005 Treatment Name (Optional)

Type:	Text (null terminated).
Valid values:	All ASCII characters except control characters in range (0x00 - 0x1F or 0x7F). The maximum length of this tag is 64 characters.
Use:	iCom-Vx and iCom-Fx.
description:	This tag is the name of the current treatment ID. The size of the string, without the null termination, can be retrieved by calling **`iComGetTagValue`** or **`iComGetNextTagValue`** with a *null* pointer passed on **`pBuff`**. See library routine descriptions for details.

iCom-Fx error codes

0004 OUTSIDE RANGE	The value is outside of valid character range.

Note: *Although the Treatment Name tag is optional, if it is not supplied when interpreted with the iViewGT™ system, the tag is used by iViewGT™ as one of the identifiers to store the image. If the tag is not supplied, iViewGT™ creates a Treatment Name from the patient ID, which creates problems later if the image data is exported.*

7001 0006 Beam Id (Optional)

Type:	Number, integer.
Valid values:	Range: 0 to 2147483647. Values greater than 2147483647 are accepted but the maximum value is 2147483647.
Use:	iCom-Fx only.
iCom-Fx description:	This tag is the name of the current treatment ID for older Javelin systems. On Desktop Pro™ R6.0 systems, this tag must not be set to a value greater than 32767, otherwise this will stop the beam from treating. On later Integrity™ systems, if the tag is greater than 32767 the value resets to zero. This does not stop the beam and you can continue with the treatment.
iCom-Vx description:	If the Beam Name (Tag 7001 0007) is not specified and the Beam ID is specified, then the Beam ID is copied to the Beam Name. The Beam Name then contains, as a string, an integer in range 0 to 2147483647.

iCom-Fx error codes

0004 OUTSIDE RANGE	The value is outside of valid character range.
0007 PROTOCAL ERROR	The value is not of the correct type.

7001 0007 Beam Name (Optional)

Type:	Text (null terminated).
Valid values:	All ASCII characters except control characters in range (0x00 - 0x1F or 0x7F). The maximum length of this tag is 64 characters.
Use:	iCom-Vx and iCom-Fx.
iCom-Fx description:	This tag is the name of the current beam ID.
iCom-Vx description:	The size of the string, without the null termination, can be retrieved by calling **`iComGetTagValue`** or **`iComGetNextTagValue`** with a *null* pointer passed on **`pBuff`**. See library routine descriptions for details.

iCom-Fx error codes

0004 OUTSIDE RANGE	The value is outside of valid character range.
0006 MISMATCH TEXT	The value does not match the digital accelerator text.

Note: *Although this tag is optional, if neither this tag nor Beam ID (older Javelin tag) is supplied when integrated with the iViewGT™ system, no images will be stored. This is due to the iViewGT™ system using the Beam Name to identify the image. If Beam Name is not specified and Beam ID is, then iCom-Fx will copy Beam ID to Beam Name.*

7001 0008 Segment ID

Type:	Number, integer.
Valid values:	Range: 1 to 256 for a valid field. (–32767) if no field is currently selected.
Use:	iCom-Vx only.
iCom-Vx description:	This tag is used to report the ID of the current segment selected at the digital accelerator.

7001 0009 Monitor Units 1

Type:	Number, real to one decimal place.
Valid values:	Range: 0 to 1000 0 for move-only segments
Use:	iCom-Vx only.
iCom-Vx description:	This tag is used to report the value of the segment monitor unit item of the current segment selected at the digital accelerator. When FFF energies are used, a small dose may overrun up to 0.3 MUs in the reported value for Segment MUs at termination. This difference in the value is not cumulative. This is expected behaviour and does not need signoff by the MOSAIQ® user.

7001 000A Monitor Units 2

Type:	Number, real to one decimal place.
Valid values:	Range: 0 to 1010 0 for move-only segments
Use:	iCom-Vx only.
iCom-Vx description:	This tag is used to report the value of the backup segment monitor unit item of the current segment selected at the digital accelerator.

7001 000B Tolerance Table

Type:	Text, at least one character.
Valid values:	ASCII characters.
Use:	iCom-Vx only.
iCom-Vx description:	This tag is used to report the value of the tolerance table item of the current field selected at the digital accelerator.

7001 000C Template Name

Type:	Text, at least one character.
Valid values:	ASCII characters.

Use:	iCom-Vx only.
iCom-Vx description:	This tag is used to report the name of the template of the current field selected at the digital accelerator.

7001 000D **For Machine**

Type:	Text (1 to 10 ASCII characters).
Valid values:	A digital accelerator machine name as defined by the Linac Customization application.
Use:	iCom-Vx only.
iCom-Vx description:	This tag is used to report the value of the 'for machine' item of the current beam selected at the digital accelerator. The 'for machine' item specifies which digital accelerator the currently selected beam was prescribed to be treated.

7001 0038 **Beam Timer**

Type:	Number, real to one decimal place.
Valid values:	0.1 min to 131 min.
Use:	iCom-Vx only. the beam timer is supplied to the third party system, it can be displayed to meet IEC.
iCom-Vx description:	This tag replaces the segment timer tag for iCom-Vx. The beam timer tag is computed internally and is not prescribed, therefore it is invalid for iCom-Fx.

Note: *In order to comply with IEC 60601-2-1 clause 29.1.2 in iCom mode, the external system must display the beam timer value.*

7001 0050 R&V Inhibit

Type:	Text (1 to 14 ASCII characters).
Valid values:	Not applicable.
Use:	iCom-Vx only.
iCom-Vx description:	This tag is used to report the digital accelerator verification item which is inhibiting treatment of the current beam. Examples of items which can inhibit are PRESCRIPTION INCOMPLETE and OVERRIDE REQUIRED.

7002 0002 Control point count

Type:	Integer.
Valid values:	2 to 1000.
Use:	iCom-Vx only.
iCom-Vx description:	Reports back how many control points are in the current field.

7002 0003 Control point index

Type:	Text (1 to 14 ASCII characters).
Valid values:	Not applicable.
Use:	Internal iCom-Fx only.
iCom-Fx description:	This tag is generated by iCom-Fx and should not be set by the user.

7002 0004 Cumulative Beam MU% (Mandatory)

Type:	Number, real to one or two decimal places.
Valid values:	Range: 0 to 100 The resolution of this tag can be configured for simple static or simple arc fields to one tenth of a percent (default setting) or one hundredth of a percent. Complex fields can be specified to an arbitrary number of decimal places.
Use:	iCom-Fx only.
iCom-Fx description:	This tag is used to set the percentage of the beam monitor units which are to be delivered before control point in which the tag is specified takes effect. An arbitrary number of decimal places is accepted. This is necessary to support very large doses that can arise.

iCom error codes:

0002 UNDER SPECIFIED	The mandatory Cumulative Beam MU Percentage tag is not specified.

0003 OVER SPECIFIED	The number of decimal places supplied is greater than defined for the percentage MU. A simple field has been sent but rounding has been switched to whole MU and decimal places have been specified.
0004 OUTSIDE RANGE	The calculated MU was less than 1 MU for a radiating segment. The percentage value is not between 0% and 100%.
0005 INCONSISTENCY	Value is non-zero for the first control point. Value is not 100 for the final control point, or 100 for any other control point. Value for control point *x* is less than the value for control point *x-1*.

Note: *A field will be rejected if a move only segment is prescribed for the last segment.*

Table C.13 Valid control point values

Nr control pts = 2	CP 0	CP 1	CP 2	
Cum beam MU%	0.0	100.0		OK
Cum beam MU%	10.0	100.0		Not OK
Cum beam MU%	0.0	45.0		Not OK

Nr control pts = 3	CP 0	CP 1	CP 2	
Cum beam MU%	0.0	45.0	100.0	OK
Cum beam MU%	0.0	0.0	100.0	OK
Cum beam MU%	0.0	100.0	100.0	OK

0007 PROTOCOL ERROR	The value specified is not of the correct value.

7002 0005 Field Complexity (Optional)

Type:	String.
Valid values:	Simple. StepNShoot.
Use:	iCom-Fx only.
iCom-Fx description:	This tag is used to define the complexity of the field. If omitted it will default to value Simple. A description of field complexity is given in **Section 4.3.1**.

iCom error codes:

0005 INCONSISTENCY	Fx server has derived a different complexity from the sent value.
0006 MISMATCH_TEXT	The value does not match one of the valid values.
0007 PROTOCOL ERROR	The value specified is not of the correct type that is, the incorrect type for the parameter has been set.

7002 0006 Leaf Width (optional)

Type:	Number, real to 1 decimal place.
Valid values:	0.5 cm – Agility™.
Use:	iCom-Fx and iCom-Vx.
description:	iCom-Fx: Checks the prescription against the leaf width of the connected machine. This is a field level tag and only needs to be specified once in the field. It is mandatory if connected to a Beam Modulator™. iCom-Vx: Reports back the configuration of the connected machine.

iCom error codes:

0001 NOT SUPPORTED	The value specified does not match the configuration of the machine to which it is connected.
0002 UNDER SPECIFIED	The tag and value were not specified.
0003 OVER SPECIFIED	Too many decimal places specified.
0004 OUTSIDE RANGE	The value is not within the valid range.
0007 PROTOCOL ERROR	The value specified is not of the correct type.

7002 0007 Delivered monitor units

Type:	number, real to one decimal place.
Valid values:	0.1 – Value of total field MU minus one.
Use:	iCom-Fx only.
iCom-Fx description:	This tag is used when delivering a Finish Field, to specify the number of monitor units (MU) of the original beam that were successfully delivered. It is then used to determine the segment in which the original beam terminated, and to compute the remaining MU to be delivered. The new start positions are computed from the start/stop positions of the terminating segment, and the number of MU delivered in that segment, derived from this tag value, assuming a constant linear movement.

Note: *The number of delivered MU is a cumulative total of MU delivered for the beam so far, if multiple finish fields are required.*

iCom-Fx error codes

0002 UNDER SPECIFIED	Delivered monitor units not specified, when Finish Field indicator is specified.
0003 OVER SPECIFIED	The number of decimal places supplied is greater than what is defined for delivered monitor units.
0004 OUTSIDE RANGE	The delivered monitor units is larger that the original fields beam monitor units or less than 0.1MU.
0005 INCONSISTENCY	Delivered monitor units specified, when Finish Field indicator is not specified.

7002 0008 Delivery segment count

Type:	Integer.
Valid values:	1 to 255.
Use:	iCom-Vx only.
iCom-Vx description:	Reports back how many delivery segments are in the current delivery field. That is, the number of deliverable segments that remain after adjacent prescribed segments have been concatenated to minimize beam off states.

7002 0009 Finish Field indicator

Type:	Text.
Valid values:	TRUE or FALSE.
Use:	iCom-Fx only.
iCom-Fx description:	Mandatory if delivered monitor units is specified, and vice versa. The value must be either TRUE or FALSE, if the tag is not present the indicator is FALSE. This tag is added as a safety feature to prevent the inadvertent calculation and delivery of a Finish Field.

iCom-Fx error codes

0002 UNDER SPECIFIED	Finish Field indicator not specified, when delivered monitor units is specified.
0005 INCONSISTENCY	Finish Field Indicator specified, when delivered monitor units is not specified.
0006 MISMATCH TEXT	The value is neither TRUE or FALSE.

7002 000A Deliver now indicator (Deprecated)

Note: *Retained for compatibility with MOSAIQ® version 1.4. All Finish Fields are 'Deliver Now'.*

Type:	Text.
Valid values:	TRUE or FALSE.
Use:	iCom-Fx only.
iCom-Fx description:	This tag allows the generation of the move-only positioning step at the beginning of a Finish Field to be suppressed. The value must be either TRUE or FALSE. If the tag is not present the indicator is TRUE, and a move-only step will be generated. This tag is added to support deliver now behavior whereby the digital accelerator is already positioned at (or near) the new start position.

iCom-Fx error codes

0005 INCONSISTENCY	Deliver now indicator specified, when not a Finish Field.
0006 MISMATCH TEXT	The value is neither TRUE or FALSE.
0007 PROTOCOL ERROR	The value is FALSE.

7002 000B Step MU

Type:	Number, real to one decimal place.
Valid values:	0.1 to 1000.
Use:	iCom-Vx only.
iCom-Vx description:	This tag is used when monitoring dynamic fields to show the prescribed segments MU value, unlike the MU1 value which will show the delivery segments dose.

7002 00FF CHECKSUM

Type:	N/A error reporting only.
Valid values:	N/A error reporting only.
Use:	iCom-Fx.
iCom-Fx description:	Internal iCom tag used to confirm message consistency and to make sure data has not been corrupted in transfer. This tag should not be set.

iCom error codes:

0010 CHECKSUM ERROR	Internal check for data corruption has failed. The data has been corrupted in transfer.

List of warnings and cautions

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