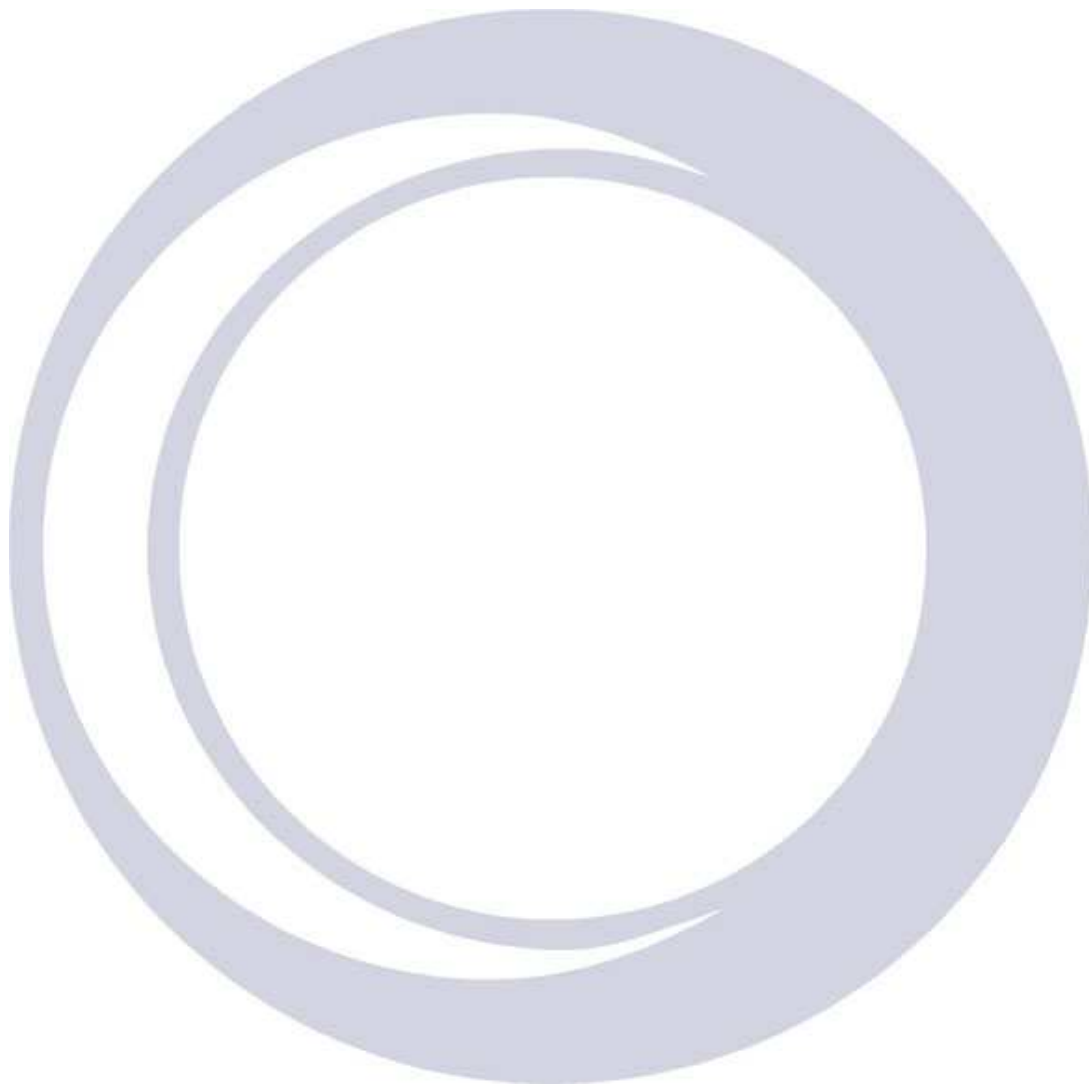


Field Control Software

Project: 39370 Scheuermann

Software Guide

Revision 1 March 2011



The Business of Science[®]



Copyright

© Copyright 2011 Oxford Instruments NanoScience, a trading name of Oxford Instruments Superconductivity Ltd. All rights reserved.

You may make hard copies of this manual for your organisation's internal use in connection with the system with which it was supplied, provided that the integrity of the manual is maintained and this copyright notice is reproduced.

Other than as permitted above, you may not reproduce or transmit any part of this document, electronically or mechanically without the prior written permission of Oxford Instruments NanoScience.

Disclaimer

Oxford Instruments' policy is one of continued improvement. The Company reserves the right to alter without notice the specification, design or conditions of supply of any of its products or services. Although every effort has been made to ensure that the information in this manual is accurate and up to date, errors may occur. Oxford Instruments NanoScience shall have no liability arising from the use of or reliance by any party on the contents of this manual and, to the fullest extent permitted by law, excludes all liability for loss or damages howsoever caused.

Trademarks

The Oxford Instruments Logo, Heliox, Kelvinox, Oxford Instruments Direct and Cryofree are trademarks or registered trademarks of Oxford Instruments plc or its subsidiaries. The use of our trademarks is strictly controlled and monitored and any unauthorised use is forbidden. Other trademarks and registered trademarks not listed above may be used in this manual.

LabVIEW is a registered trademark of the National Instruments Corporation in the United States and/or other countries

Technical and Customer Support

Contact details for Technical and Customer Support:
helpdesk.nanoscience@oxinst.com

Oxford Instruments NanoScience

Tubney Wood, Abingdon, Oxon, OX13 5QX, England
Tel: +44 (0)1865 393 200
Fax: +44 (0)1865 393 333
E-mail: nanoscience@oxinst.co.uk
www.oxford-instruments.com

Contents

Safety Issues 5

 Safety symbols used in this manual 5

 Disclaimer 5

 Warnings 5

1 Introduction 6

2 Installing the Software 7

3 Getting Started/Configuring the Instruments 8

4 Overview of the software design 17

5 Field Control State Machine 21

6 Troubleshooting 30

Welcome

Thank you for choosing your equipment from Oxford Instruments, a company dedicated to providing world-class products and customer support. Our highly trained teams are available to help you with all your queries relating to your order, delivery or technical issues.

As an Oxford Instruments customer, you have access to a worldwide service and support package providing telephone and on-site technical and repair services. In the unlikely event that your product should require repair, our technicians will initiate service under the terms of your Oxford Instruments warranty.

At Oxford Instruments we know that your expectations are at the highest level. We aim to meet and exceed those expectations in the service that we provide, and in the quality you will see when you use Oxford Instruments equipment.

We are delighted you selected Oxford Instruments as your supplier and wish you success with your new equipment.

Jim Hutchins, Managing Director, Oxford Instruments NanoScience

Safety Issues

Before you attempt to install or operate the Field Control software, please make sure that you are aware of all safety precautions listed in this document together with the warnings and cautions set out in the separate instrument manuals. If the software is supplied with a superconducting magnet system, you should also read the safety precautions listed in the manuals supplied for the magnet system components.

Safety procedures are vital to prevent

- Serious injury or death
- Serious damage to the equipment.

Cryogenic systems are potentially hazardous and you must take precautions to ensure your own safety, particularly if you are writing your own system control routines.

The general safety precautions required when working with cryogenic systems and superconducting magnets are given in the *Safety Matters* booklet that will have accompanied your Oxford cryogenic system.

Safety symbols used in this manual

Symbols are used in this manual to draw your attention to safety procedures that you must follow to protect yourself or the equipment. There are two types of hazard symbol used in this manual:



Warning: The warning triangle highlights dangers which may cause injury or, in extreme circumstances, death. Warnings and cautions must be followed to ensure your own safety.



Caution: The general caution symbol highlights actions that you must take to prevent damage to the equipment. The action is explained in the text.

Disclaimer

Oxford Instruments cannot accept responsibility for damage to the system caused by failure to observe the correct procedures laid down in this manual and the other manuals supplied with the system. The warranty may be affected if the system is misused, or the recommendations in the manuals are not followed.

Warnings

Warnings and cautions must be followed to ensure your own safety.

1 Introduction

This guide covers the following aspects of the software developed for project 39370 Scheuermann to set the magnet field:

- software installation
- getting started/establishing communication with the instruments
- design of key parts of the software (eg the Field Control State Machine)
- trouble-shooting

Configuration and Operation of the software are described in the project 39370 Superconducting Magnet System “Operator’s Handbook”.

Please note that the software was developed within a PC Windows XP/LabVIEW 2009 environment. If additional support is required for the general operation or programming of LabVIEW, please contact National Instruments at www.ni.com/labview/.

2 Installing the Software

A CD containing an installer for the Field Control application (FieldControl.exe) and a .zip file containing the software source code have been supplied.

2.1 Installing the application

Browse the files on the CD to find ... \Field Control Installer \setup.exe

Run setup.exe

The default installation directory for FieldControl.exe is:

c:\Program Files\FieldControl

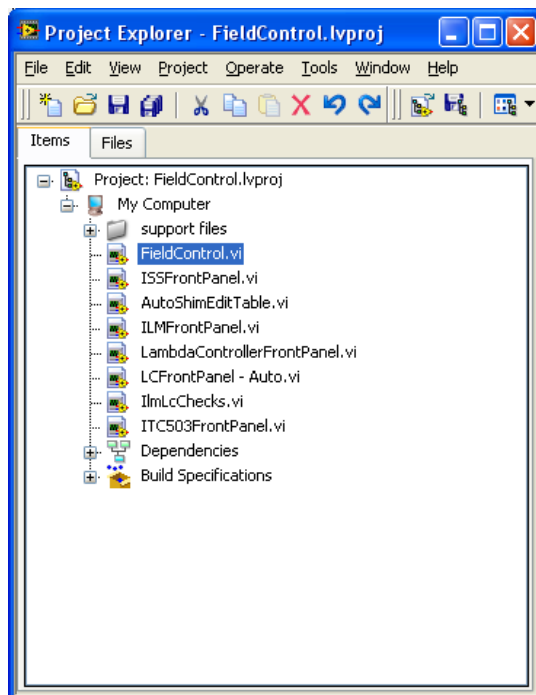
In addition to FieldControl, the installer will install LabVIEW Run-time 2009.

2.2 LabVIEW source code

Browse the files on the CD to find "Field Control LabVIEW Source.zip"

Preserve the folder hierarchy when extracting the files.

To open the source code, start LabVIEW (version 2009 or newer) and open project file "FieldControl.lvproj". The top level VI is "FieldControl.vi". See section 4 for a description of the code.



2.3 LabVIEW Options

LabVIEW Environment option, "Automatically close VISA sessions" must be OFF (unchecked). (Tools | Options, then select the "Environment" category).

2.4 Post Installation

The CD contains project specific information. After installation you should keep the original installation CD in a safe place.

3 Getting Started/Configuring the Instruments

3.1 Instrument Communication

3.1.1 Serial Ports

Communications with Oxford Instruments' instruments is best performed over an RS232 serial link. A USB–serial converter can be used. (Please be aware that some USB–Serial converters may lose data, eg we have observed data losses when using Prolific. Also, the Prolific USB–serial driver, in combination with NI–VISA versions newer than NI–VISA 4.2, may cause system crash.) We have used a “Brainbox” USB–serial converter successfully, and USB–serial converters purchased from NI should also work. The Oxford Instruments ISOBUS system allows many instruments to be connected to a single serial port with each instrument having a unique ISOBUS address (ISOBUS address is simply a number between 0 and 9).

3.1.2 GPIB

We currently support GPIB cards from National Instruments only. If you are using GPIB communication then it is important that you choose a GPIB card compatible with LabVIEW, the operating system you are using, and that LabVIEW itself is installed with the correct options. Please consult National Instruments or the LabVIEW user manuals for details if necessary. Please ensure that the GPIB driver from National Instruments is installed, configured correctly and the computer operating system recognises the card.

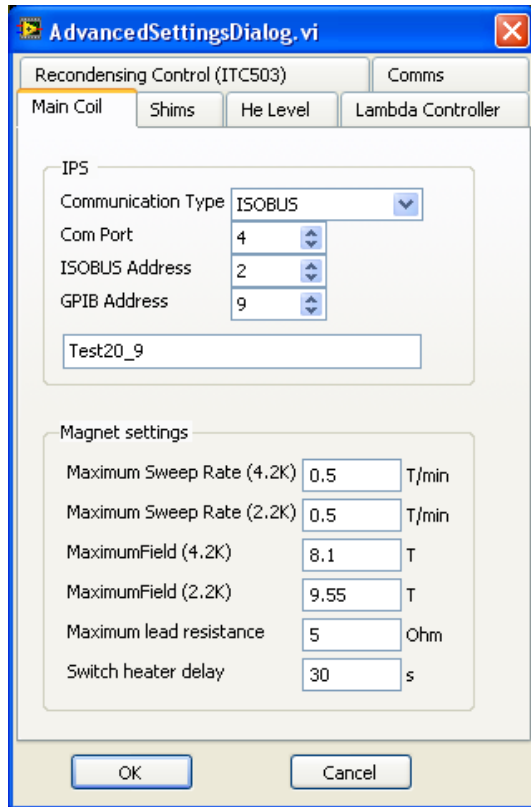


This manual does not contain safety information for the instruments or systems that this software can be used to control. For this information, please refer to individual instrument manuals and system documentation.

3.2 Software

To start the Field Control software, run “Field Control.exe”.

Each instrument requires configuration within the software before communication can begin. The configuration includes the instrument remote communication parameters, a device name and type, along with possible system control parameters. This information is entered using the “Advanced Settings Dialog” which opens automatically the first time Field Control is run, or if the previous Field Control run terminated with a communication error.



Once Field Control is running, the AdvancedSettingsDialog is accessed via the “Advanced settings” tab.



The setup information is stored in initialization files tesltron.ini (IPS, ILM, LC and ITC) and iss.ini (ISS). These should be edited using the AdvancedSettingsDialog VI. **It is not recommended to edit these files by hand as the text is not always easy to interpret.**

For each of the instruments follow the instructions given in section **Error! Reference source not found.**

3.3 Communication Principles

To remote control/monitor Oxford Instruments electronic devices eg ITC, IPS, ILM ... there are some simple steps that must be followed.

- 1) Decide on the method of communication for the instrument eg RS232, GPIB, ISOBUS or GATEWAY and use the appropriate cabling.

- 2) Find or assign an address to the instrument in question (ie ISOBUS or GPIB addresses).
- 3) Enter the communication parameters into the software on the PC for the instrument in question.
- 4) Start the software driver for the instrument.

RS232 communication is also known as serial communication and requires a single cable between the COM port of your computer and the instrument. For this method of communication, you only need identify the COM port on your computer. If your PC does not have a COM port, you can use a USB-serial converter.

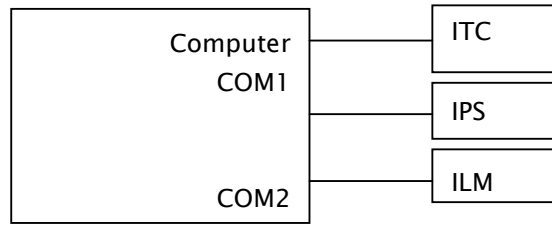
ISOBUS is similar to RS232 and uses a unique ISOBUS cable made by Oxford Instruments. This ISOBUS cable allows a single COM port on the computer to be connected to multiple Oxford Instruments electronic devices in a daisy chain manner. One adapter (master) connects to the computer COM port and the other adapters (slaves) connect to the back of the electronic devices (RS232 connector). Each instrument has an ISOBUS address that is stored in the instrument memory and this ISOBUS address must be unique to each instrument connected to the ISOBUS cable. Communication to each device is then achieved by knowing the ISOBUS address of each instrument in question and the computer COM port the master plug is connected to.

GPIB communication is a well known method of controlling hardware. This requires a GPIB card (we only support GPIB cards from National Instruments) to be installed in a computer (with the necessary driver software installed), a GPIB cable and the GPIB interface to be fitted to the electronics in question. One end of the GPIB cable is connected to the GPIB card of the computer and the other to the back of the device. For multiple control of devices, another cable can then be connected in a daisy chain manner to another device. For this method of communication, you require the GPIB address of each instrument.

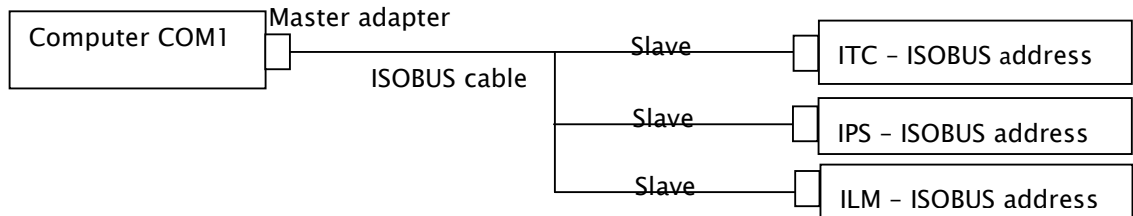
GATEWAY communication to devices is a combination of GPIB and ISOBUS technology. The computer is connected via GPIB (described above) to an instrument (known as the GATEWAY instrument). A small adapter (called a GATEWAY adapter) is then connected to the RS232 port of the GATEWAY instrument. The ISOBUS cable master adapter subsequently connects to this GATEWAY adapter and the other slave connectors of the ISOBUS cable connected to other instruments RS232 connectors (on the back of each instrument). With GATEWAY devices, the command is sent to the GATEWAY instrument via GPIB. However, the command is then relayed to the other instruments on the ISOBUS cable. For this method of communication you require the GPIB address of the GATEWAY instrument and the ISOBUS address of the instrument connected to ISOBUS cable.

Examples of these communication methods are shown on the next page.

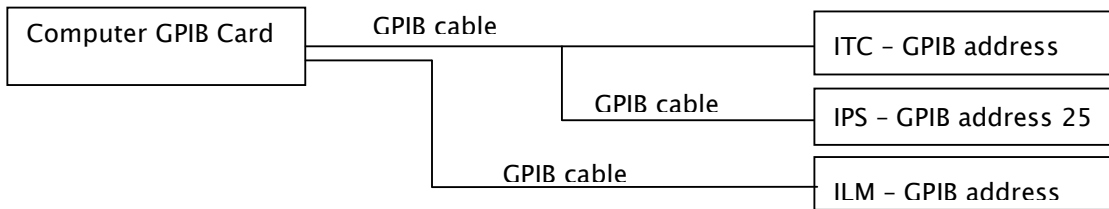
RS232 Communication



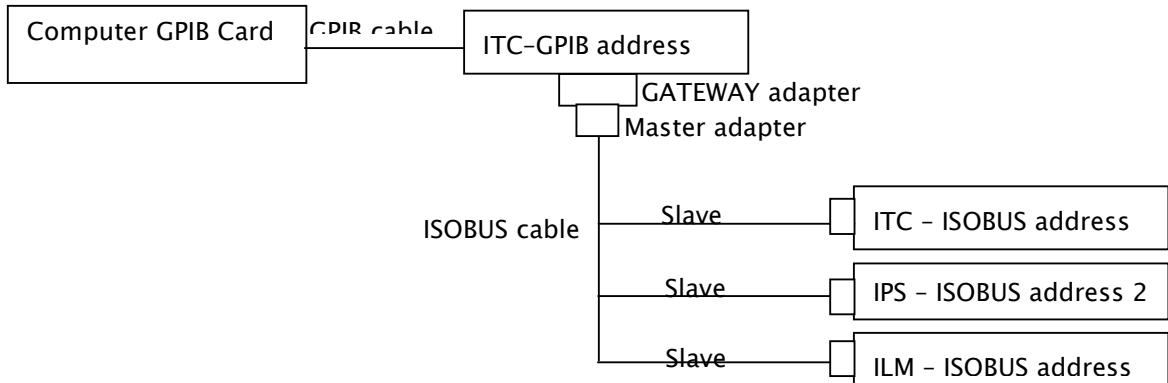
ISOBUS Communication



GPIB Communication



GATEWAY Communication

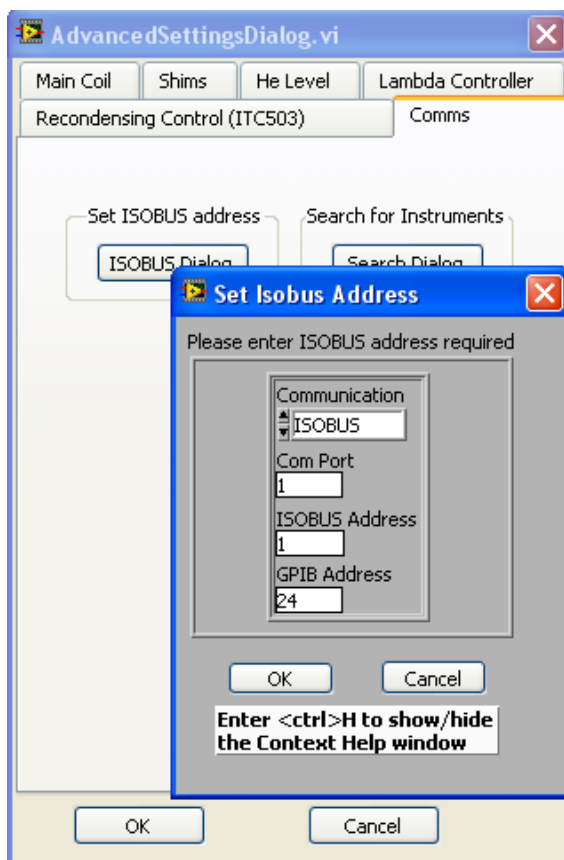


3.4 Communications Parameters

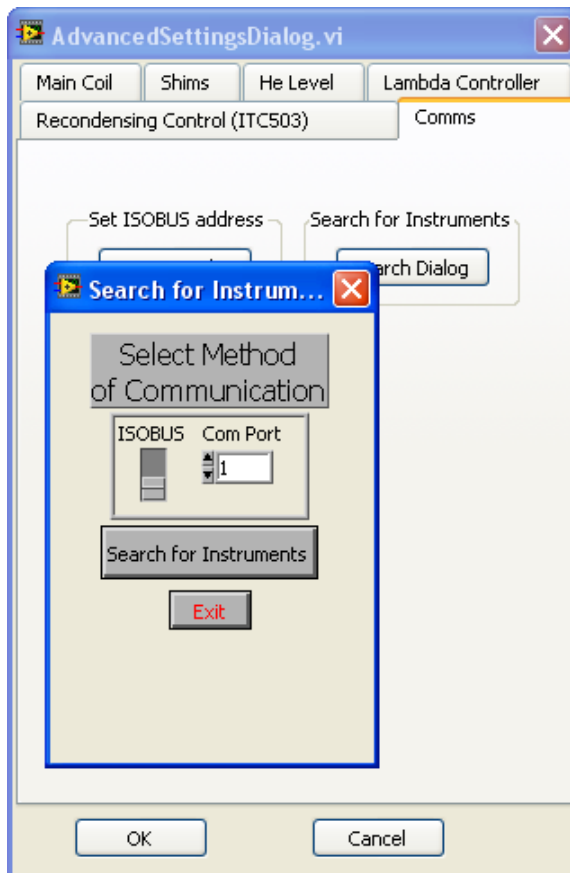
The type of communication link must be specified, and in the case of multi-instrument buses eg ISOBUS or GPIB, uniquely identify all instruments that are sharing the link.

To uniquely identify each instrument the software must know how and where to communicate with the instrument in question. This requires two steps.

- 1) The first step is to identify or set the address of the instrument. The two addresses in question are called the ISOBUS address and the GPIB address. The ISOBUS address can only be set using software (using Set ISOBUS Address, see 4.4.1). The GPIB address can only be set by entering the Test procedures for the instrument in question (please consult the instrument manual). Please select unique ISOBUS or GPIB addresses for each instrument (instruments with the same address will result in corrupt communication and data errors).



- 2) Alternatively there is a tool which searches for instruments connected to your PC. Run the VI called "Search for Instruments.vi". Select the method of communication and search for instruments. This small utility will report the addresses of any device connected to the PC. If "Device conflict" appears, it implies that there are two instruments connected that have the same address. The address of one of the devices should be altered in this case. Please take note of the addresses of the instruments detected as you will require the information for the setup dialogs of the instruments.



- 3) Once the addresses of the instruments are known, the software communication parameters within the computer LabVIEW software must be set to the same values as the instruments. These parameters are entered via the AdvancedSettingsDialog. At this point this is simply a software configuration, and does not affect the instrument itself.

Table 1 lists the different interface configurations and the values of the different interface parameters for each. Non-zero addresses are examples only and can be any unique number. Table 2 indicates the default ISOBUS addresses for our instruments.

3.4.1 To Set the ISOBUS address of an Instrument.

Each of Oxford Instruments electronic devices eg IPS, ITC, ILM... have an internal ISOBUS address (similar to a GPIB address). The ISOBUS address is simply a number between 1 and 9 and must be unique to each device ie to each IPS, ITC, ILM etc. It can only be set using software commands. In order to use a computer to control many devices from a single COM/RS232/Serial port of a computer, you can use an ISOBUS cable along with the ISOBUS addresses of all the instruments.

To assign an ISOBUS address to a device, please select “Set ISOBUS address” on the AdvancedSettingsDialog. This will open a LabVIEW VI called SetISOBUSAddress.VI. Enter the required values for the communication parameters. Select OK and follow the instructions.



Note: please ensure that no other instruments connected to the ISOBUS cable are turned on, otherwise the software will attempt to set all the instruments connected to the ISOBUS cable to the same ISOBUS address.



Instrument Interface	COM Port	ISOBUS	GPIB
Direct serial link to computer. Communication : RS232	No of com port used.	-1	N/A
ISOBUS directly to computer. Communication : ISOBUS	No of com port used.	Enter the ISOBUS address of the instrument.	N/A
ISOBUS which is connected via a gateway instrument Communication : GATEWAY	N/A	Enter the ISOBUS address of the instrument	GPIB address of the gateway instrument
GPIB only. Communication : GPIB	N/A	0 There is no need to set the ISOBUS address in the instrument to 0 however as the firmware will only respond to ISOBUS 0 when interfaced via GPIB	GPIB address of instrument
Instrument is a gateway instrument. (GPIB to computer and Gateway unit to ISOBUS) Communication : GPIB	N/A	0 There is no need to set the ISOBUS address in the instrument to 0 however as the firmware will only respond to ISOBUS 0 when interfaced via GPIB	GPIB address of instrument

Table 1 Possible interface configurations and the associated communication to be entered in Setup Dialog VI's. N/A stands for "Not applicable" in which case the value is not used .

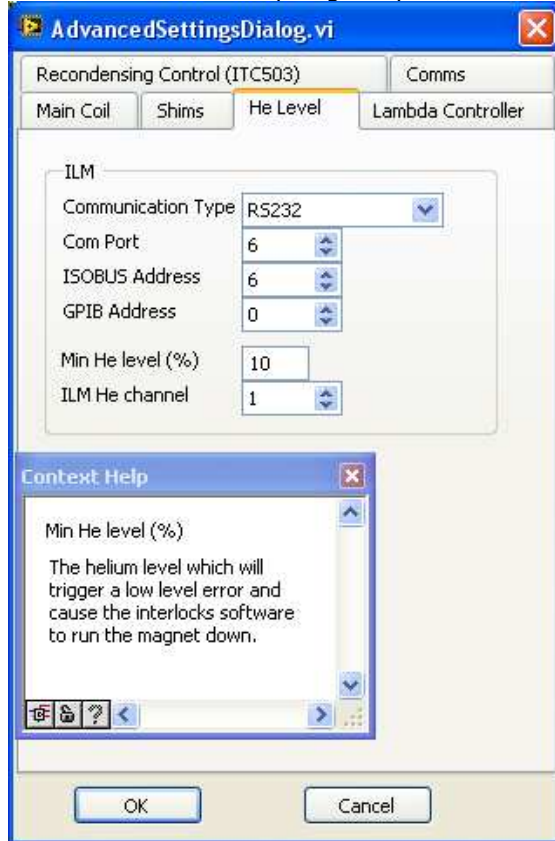
Instrument	Address
ITC502/503	1
PS120/IPS120	2
Lambda controller	3
SMC4	4
IGH	5
ILM200	6
ISS10	7

Table 2 Default ISOBUS addresses

3.5 Instrument Specific Software Configuration

Instructions for configuring the remaining settings on the AdvancedSettingsDialog (eg Switch heater delay) are given in the 39370 Operators Handbook.

There is also on-line help to guide you (CTRL H).



3.6 Running Field Control

Click the OK button to save settings and Field Control will start.

If the communication settings are correct, the s/w will start to communicate with the IPS and other instruments.

If there is a communication problem the software can be aborted. Re-start Field Control to re-open the AdvancedSettingsDialog and correct the communication parameters.

Instructions for setting field etc are given in the 39370 Operators Handbook.

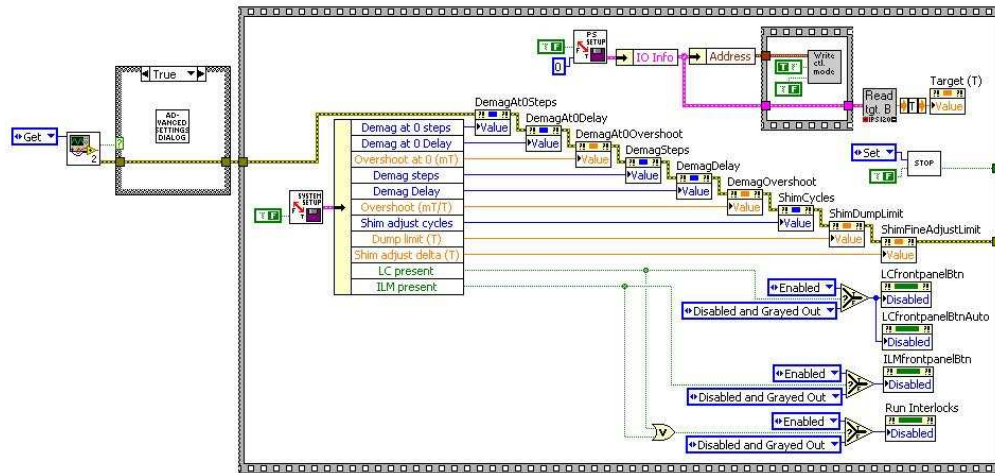
4 Overview of the software design

The Field Control software consists of a top level application and other, instrument specific, applications that are launched from the top level one.

The Top Level application is FieldControl.vi

The block diagram of FieldControl.vi has 3 distinct sections:

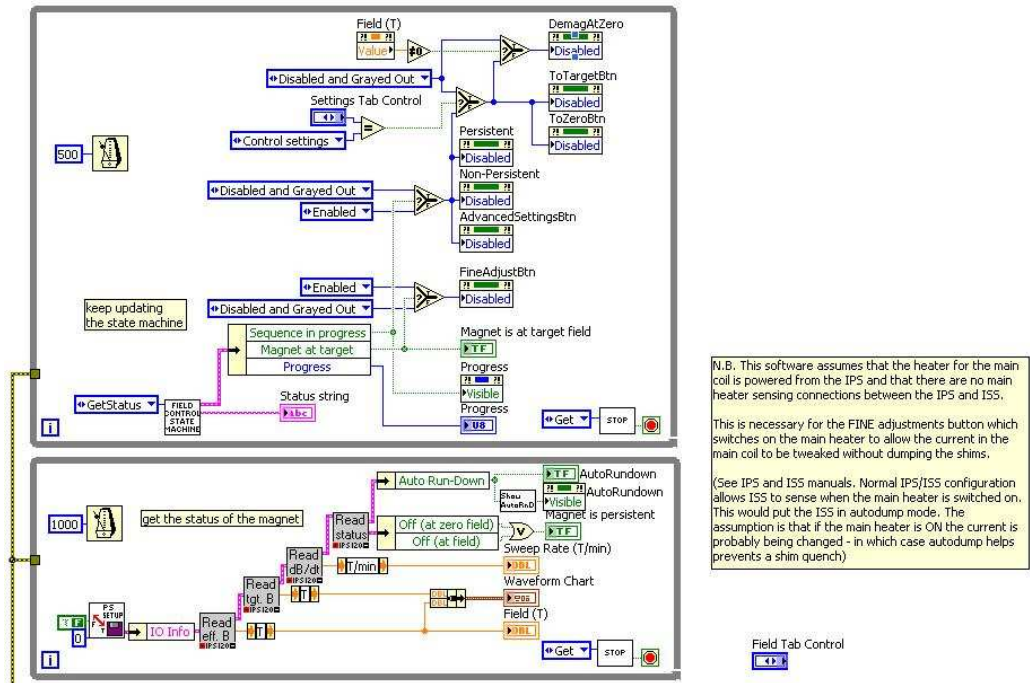
- 1) Initialisation



FieldControlIniFile.vi is the first VI to be called. This VI reads, from FieldControl.ini, the “Configure?” key that was saved the last time the software ran.

If it’s “true” then the software opens AdvancedSettingsDialog.vi so that the system can be configured. When the user closes AdvancedSettingsDialog.vi, the software initialises the FieldControl.vi front panel and then launches the rest of the program.

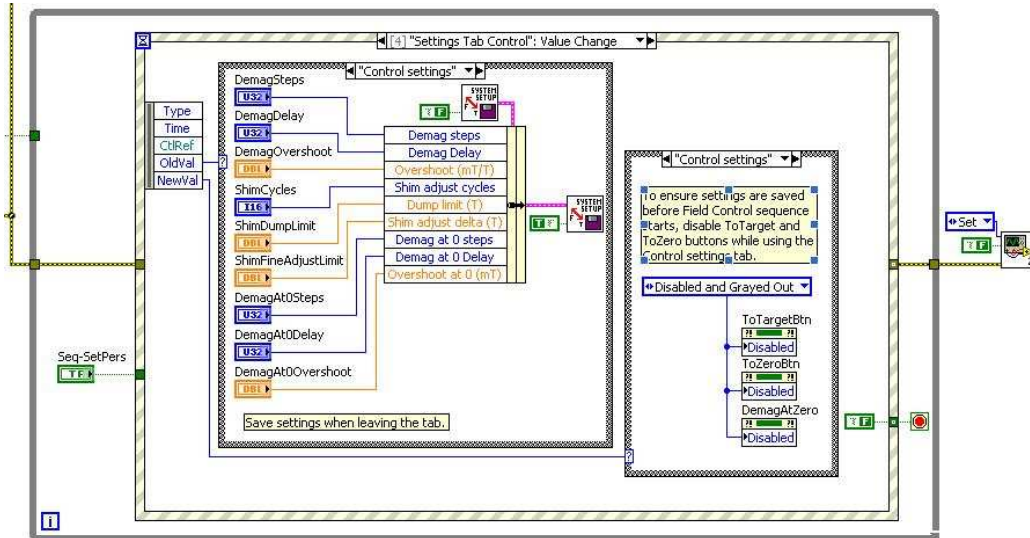
2) Update front panel status



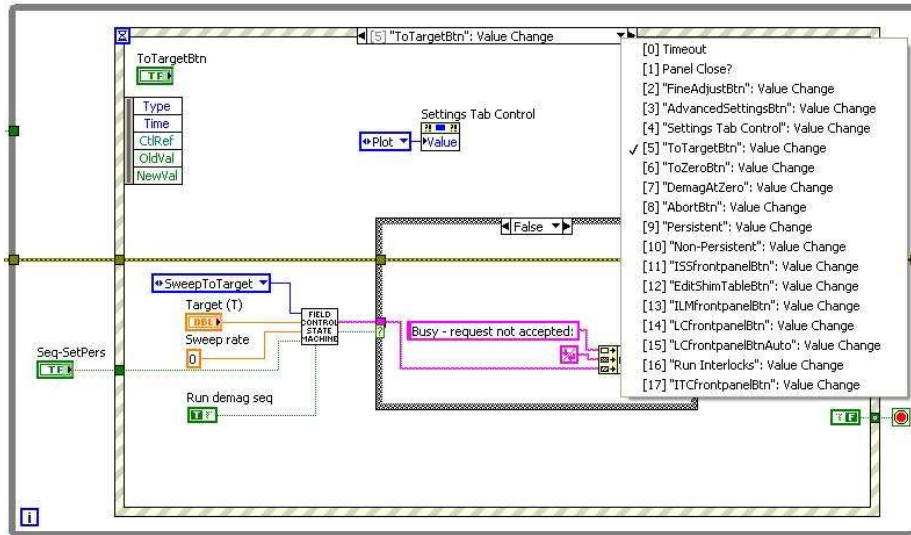
This section of FieldControl.vi is divided into 2 loops. The upper loop calls FieldControlStateMachine.vi (see section 5) twice a second to get the status of the system and update the state of any *sequence* that is in progress. This section also updates the enabled/disabled status of some front panel buttons whose statuses depend on whether or not a *sequence* is in progress.

The lower loop runs at a slower rate and is used to update the front panel “Field” etc indicators and the plot. If desired, the code in this loop could be included in the upper loop and this loop could be removed.

3) Handle User Events



This section handles several types of event:



- a) Start a sequence: Someone clicks on one of the “To Target”, “To Zero”, “Abort”, “Demag at Zero”, “Persistent” or “Non-persistent” buttons. (*Event structure options [5] to [10] in the screen shot above.*)

Each of these actions involves a call to FieldControlStateMachine.vi

See section 5 for further details.

Option in event structure	Button	Action
[5]	ToTargetBtn	Calls FieldControlStateMachine.vi with Actions=SweepToTarget
[6]	ToZeroBtn	Calls FieldControlStateMachine.vi with Actions=SweepToZero
[7]	DemagAtZero	Calls FieldControlStateMachine.vi with Actions=DemagAtZero
[8]	AbortBtn	Calls AbortSequence.vi, which calls FieldControlStateMachine.vi with Actions=Abort
[9]	Persistent	Calls ToPersistentDialog.vi, which calls FieldControlStateMachine.vi with Actions=ToPersistent
[10]	Non-Persistent	Calls ToNonpersistentDialog.vi, which calls FieldControlStateMachine.vi with Actions=ToNonpersistent

- b) User closes the Field Control window to exit the application (*Option [1] in the screen shot above*)
- c) User selects a different tab. Leaving the “Control Settings” tab prompts the s/w to save the settings on that tab. (*Option [4] above.*)
- d) Fine adjustment button clicked – this opens a dialog so that the main coil field can be adjusted by the user. (*Option [2] above.*)
- e) Advanced Settings – this opens the Advanced Settings dialog. (*Option [3] above.*)
- f) Launch one of the other control Vis:

Option in event structure	Button	VI that is launched.
[16]	Run Interlocks	A VI (IlmLcChecks.vi) that monitors temperature (via the Lambda Controller) and the He level (as monitored by the ILM) and either warns of low He or high temperature or prompts FieldControlStateMachine.vi to run down the magnet if it detects a problem.

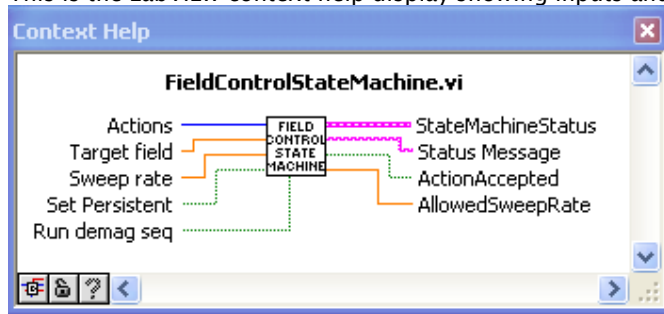
Option in event structure	Button	VI that is launched.
[1 1]	ISSfrontpanelBtn	The Shim power supply front panel VI (ISSFrontPanel.vi)
[1 2]	EditShimTableBtn	A VI for editing the shim current settings table (AutoShimEditTable.vi)
[1 3]	ILMfrontpanelBtn	The Helium level meter front panel VI (ILMFrontPanel.vi)
[1 4]	LCfrontpanelBtn	The Lambda Controller front panel VI (LambdaControllerFrontPanel.vi)
[1 5]	LCfrontpanelBtnAuto	A VI used for Lambda Controller automatic control (LCFrontPanel - Auto.vi)
[1 7]	ITCfrontpanelBtn	The ITC front panel, used to communicate with the instrument that controls re-condensing. (ITC503FrontPanel.vi)

5 Field Control State Machine

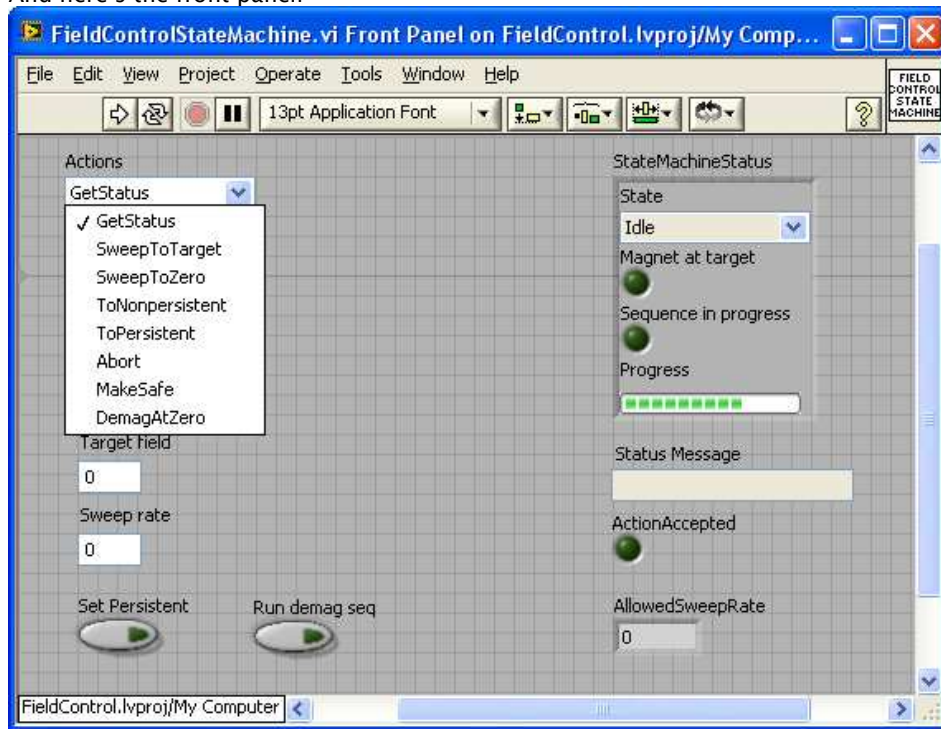
5.1 FieldControlStateMachine.vi

The core of the Field Control application is FieldControlStateMachine.vi. This piece of code contains the *sequences* to sweep the magnet coils to target field or zero, make the main coil persistent or non-persistent, and abort a sequence.

This is the LabVIEW context help display showing inputs and outputs:

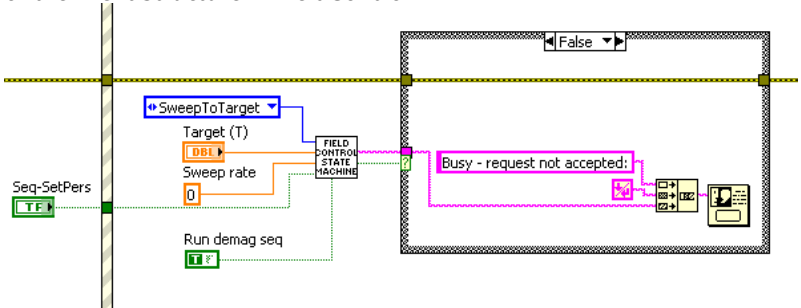


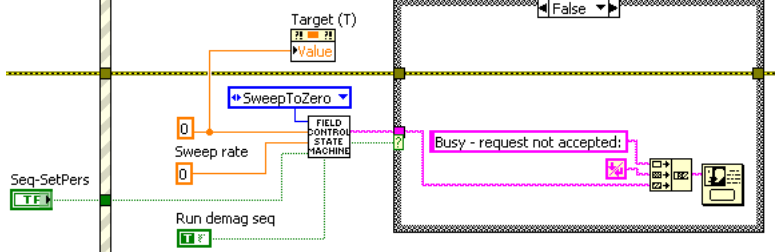
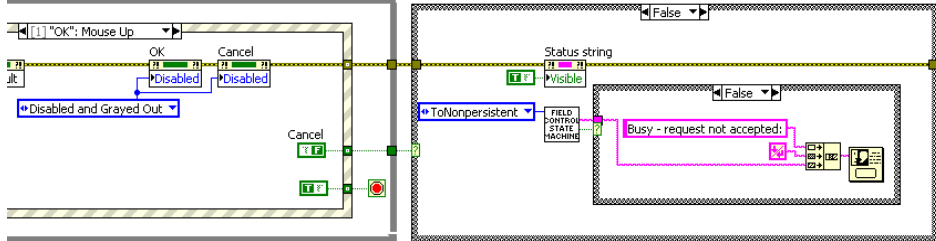
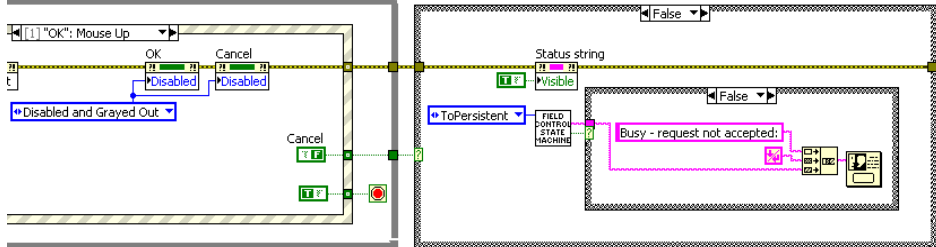
And here's the front panel:

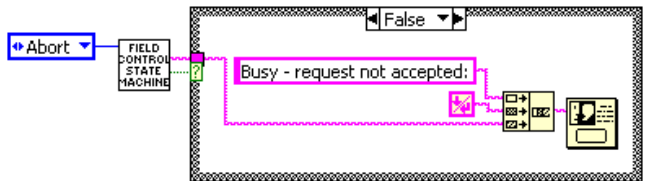
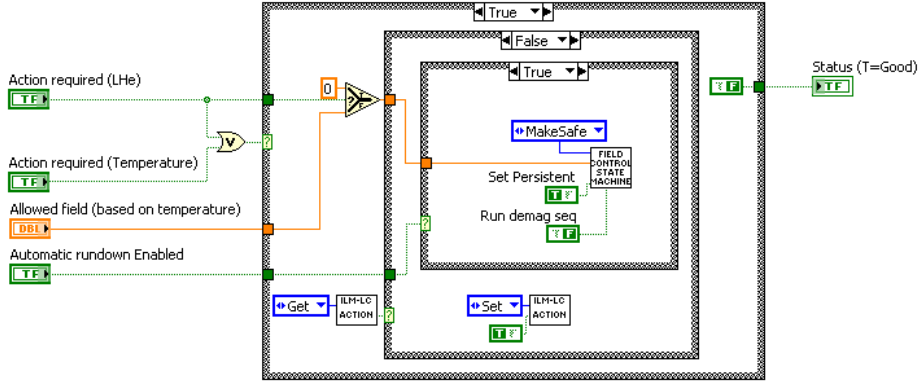


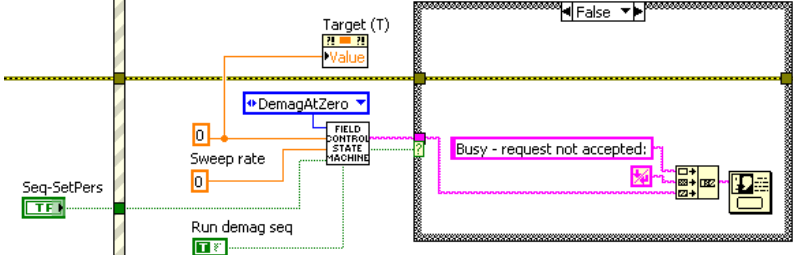
Description of the Actions and when each of them is used:

"Actions"	Other inputs, what happens and how/where it's called within the Field Control app.
GetStatus	<p>Other inputs: None required</p> <p>What happens: If a sequence is in progress, the status of the sequence will be updated by a call to SetFieldSequence.vi. Otherwise, nothing happens.</p>

<p>“Actions”</p>	<p>Other inputs, what happens and how/where it’s called within the Field Control app.</p>
	<p>How/Where it’s called: Every 500 ms from “update front panel status” loop of FieldControl.vi (see Section 4, item 2) above)</p>
<p>SweepToTarget</p>	<p>Other inputs: “Target Field” If “Sweep rate” = 0 then the s/w uses the settings defined on the AdvancedSettingsDialog, Main Coil tab. “Set Persistent” T or F to specify whether or not to make the magnet persistent at the end of the sequence. “Run demag sequence” T or F for whether or not to include demag</p> <p>What happens: Assuming no other sequence is in progress (State=Idle), sets State=SweepingToTarget and calls SetFieldSequence.vi with appropriate parameters to start a sweep to target. Otherwise, updates the state of the pre-existing sequence.</p> <p>How/Where it’s called: As a result of user click on “To Target” button, which is handled by option [5] of the Event Structure in FieldControl.vi</p> 
<p>SweepToZero</p>	<p>Other inputs: If “Sweep rate” = 0 then the s/w uses the settings defined on the AdvancedSettingsDialog, Main Coil tab. “Set Persistent” T or F to specify whether or not to make the magnet persistent at the end of the sequence. “Run demag sequence” T or F for whether or not to include demag</p> <p>What happens: Assuming no other sequence is in progress (State=Idle), sets State=SweepingToZero and calls SetFieldSequence.vi with appropriate parameters to start a sweep to zero. Otherwise, updates the state of the pre-existing sequence.</p> <p>How/Where it’s called: As a result of user click on “To Zero” button, which is handled by option [6] of the Event Structure in FieldControl.vi</p>

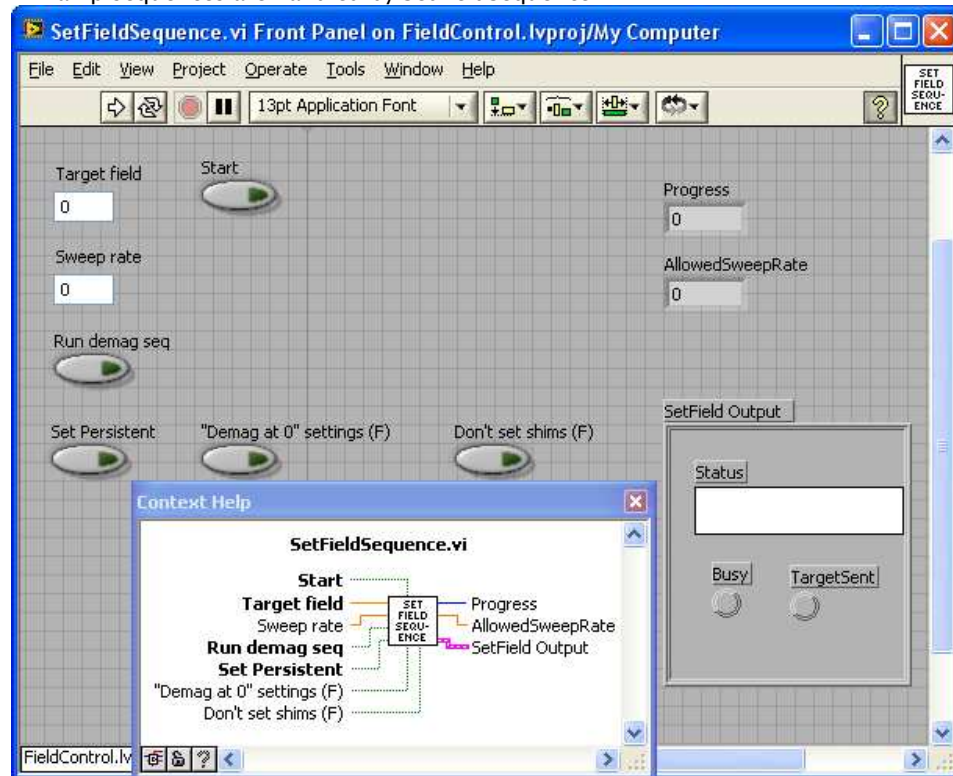
"Actions"	Other inputs, what happens and how/where it's called within the Field Control app.
	
<p>ToNonPersistent</p>	<p>Other inputs: None required</p> <p>What happens: Assuming no sequence is in progress (State=Idle), calls SetNonpersistent.vi, and finally sets State=Idle. Otherwise, updates the state of the pre-existing sequence.</p> <p>How/Where it's called: When users clicks on "Non-Persistent" button (which is handled by option [10] of the Event Structure in FieldControl.vi), ToNonpersistentDialog.vi is called. This, in turn, calls FieldControlStateMachine.vi Below is an extract from ToNonpersistentDialog.vi:</p> 
<p>ToPersistent</p>	<p>Other inputs: None required</p> <p>What happens: Assuming no sequence is in progress (State=Idle), calls SetPersistent.vi, and finally sets State=Idle. Otherwise, updates the state of the pre-existing sequence.</p> <p>How/Where it's called: When users clicks on "Persistent" button (which is handled by option [9] of the Event Structure in FieldControl.vi), ToPersistentDialog.vi is called. This, in turn, calls FieldControlStateMachine.vi Below is an extract from ToPersistent.vi:</p> 
<p>Abort</p>	<p>Other inputs: None required</p> <p>What happens:</p>

<p>“Actions”</p>	<p>Other inputs, what happens and how/where it’s called within the Field Control app.</p> <p>Assuming any sequence other than MakeSafe is in progress, calls WriteActivity.vi to put the IPS into HOLD state, and finally sets State=Idle. Otherwise, updates the state of the pre-existing (MakeSafe) sequence.</p> <p>How/Where it’s called:</p> <p>When users clicks on “Abort” button (which is handled by option [8] of the Event Structure in FieldControl.vi), AbortSequence.vi is called. This, in turn, calls FieldControlStateMachine.vi</p> <p>Below is the block diagram of AbortSequence.vi:</p> 
<p>MakeSafe</p>	<p>Other inputs:</p> <p>“Target Field” (MakeSafe may simply reduce field magnitude)</p> <p>“Sweep rate” = 0 so s/w uses the settings defined on the AdvancedSettingsDialog, Main Coil tab.</p> <p>“Set Persistent” T or F to specify whether or not to make the magnet persistent at the end of the sequence.</p> <p>“Run demag sequence” T or F for whether or not to include demag</p> <p>What happens:</p> <p>Assuming MakeSafe is not already in progress (State ≠ MakingSafe), sets State=MakingSafe and calls SetFieldSequence.vi with appropriate parameters to start a sweep to zero.</p> <p>Otherwise, updates the state of the pre-existing MakeSafe sequence.</p> <p>How/Where it’s called:</p> <p>If the user clicks on the “Run Interlocks” button (which is handled by option [16] of the Event Structure in FieldControl.vi), IlmLcChecks.vi will be launched. While IlmLcChecks.vi is running, the MakeSafe sequence can be run as a result of over-temperature or LHe under-level condition and subsequent call to IlmLcAction.vi. Below is the block diagram of IlmLcAction.vi:</p> 
<p>DemagAtZero</p>	<p>Other inputs:</p> <p>If “Sweep rate” = 0 then the s/w uses the settings defined on the AdvancedSettingsDialog, Main Coil tab.</p> <p>“Set Persistent” T or F to specify whether or not to make the magnet persistent at the end of the sequence.</p>

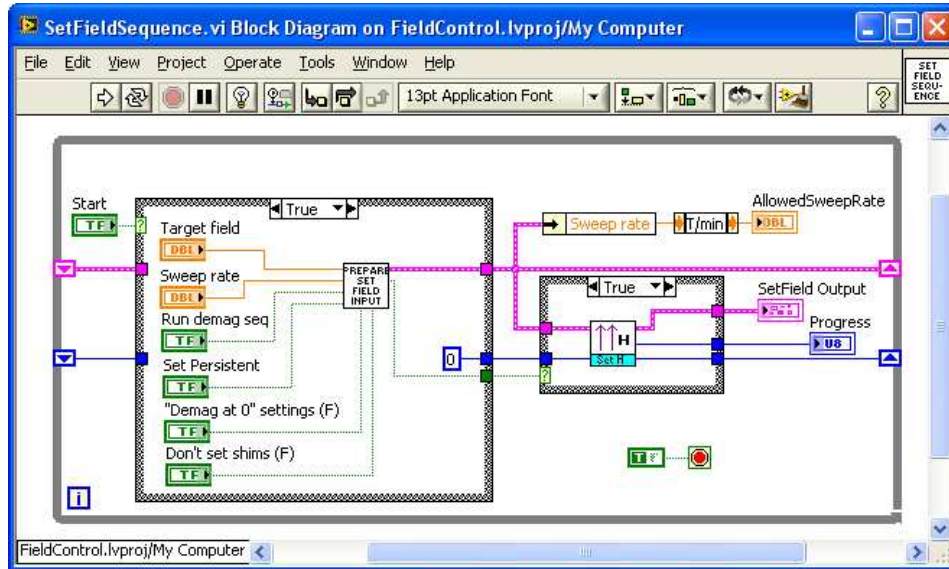
"Actions"	Other inputs, what happens and how/where it's called within the Field Control app.
	<p>"Run demag sequence" T or F for whether or not to include demag</p> <p>What happens: Assuming no other sequence is in progress (State=Idle), sets State=DemagnetisingAtZero and calls SetFieldSequence.vi with appropriate parameters to start a sweep to zero, including demagnetisation. Otherwise, updates the state of the pre-existing sequence.</p> <p>How/Where it's called: As a result of user click on "Demag at Zero" button, which is handled by option [7] of the Event Structure in FieldControl.vi</p> 

5.2 SetFieldSequence.vi

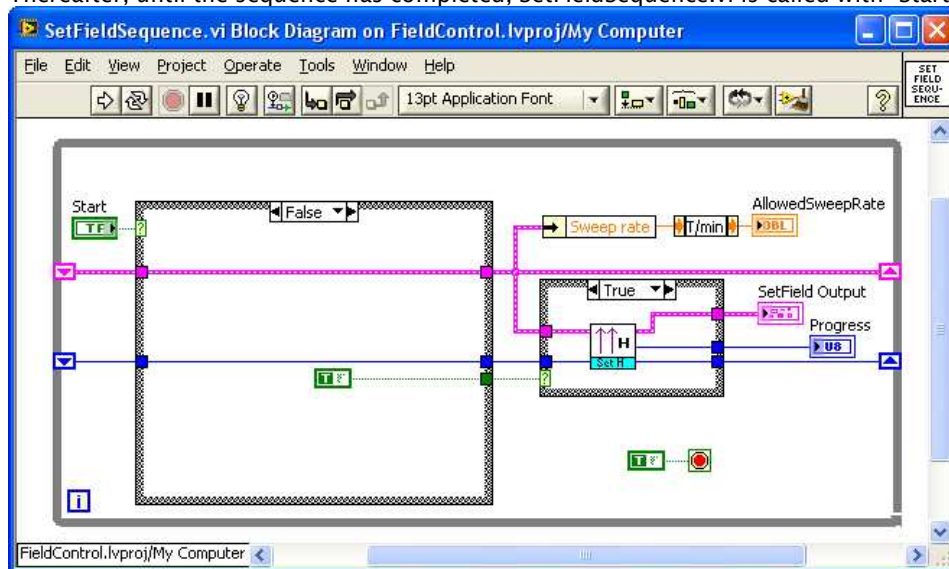
All ramp sequences are handled by SetFieldSequence.vi



When starting a sequence, SetFieldSequence.vi is called with the "Start" input set to **true**, which means sequence settings will be initialised and a new sequence will be started.



Thereafter, until the sequence has completed, SetFieldSequence.vi is called with “Start” set to **false**.

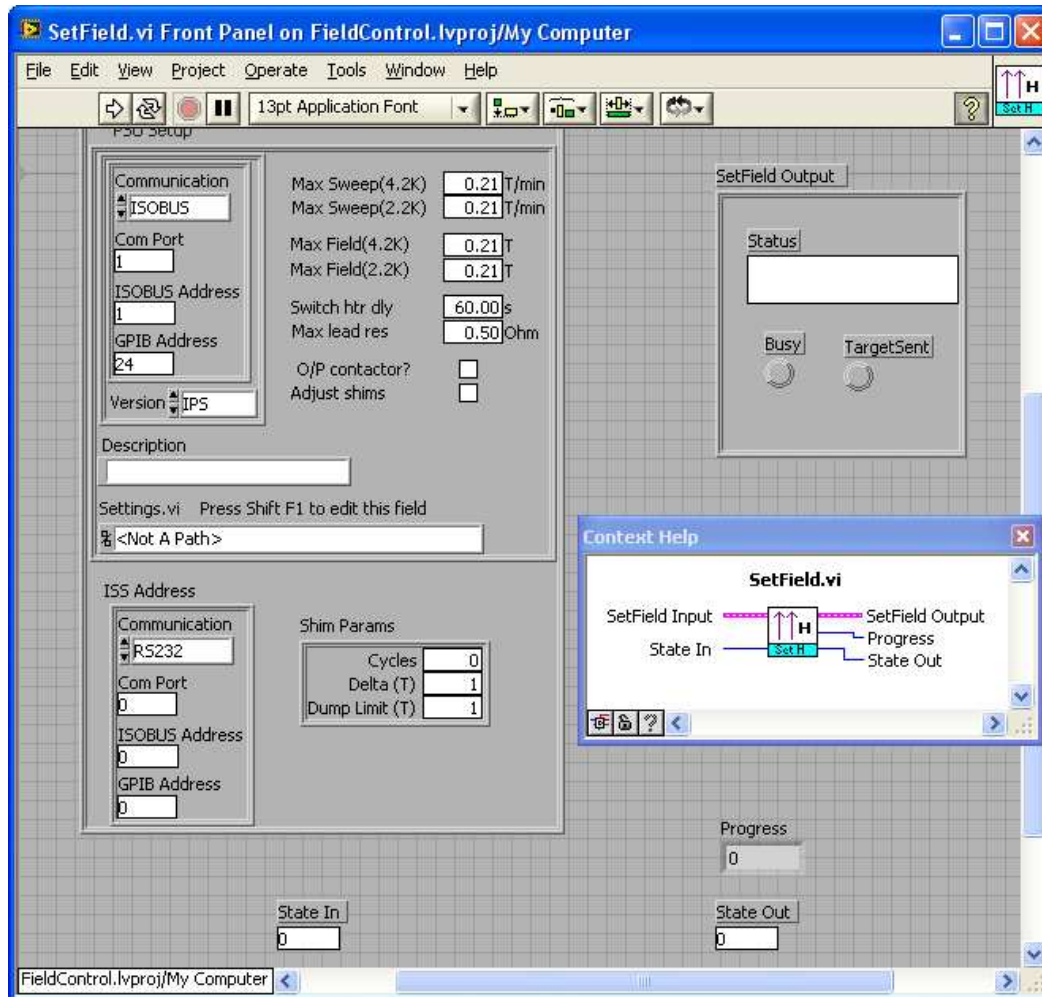


5.3 SetField.vi

SetField.vi contains the sequence for ramping a magnet system to a particular field.

The first states of SetField.vi all deal with getting the IPS and ISS to a known state so that the rest of the sequence can run. This is necessary because:

- 1) there's no knowing what happened before FieldControl.exe started.
- 2) When the s/w aborts a sequence it puts the IPS into HOLD state. Apart from that, the software does not change the state of the IPS and ISS and no record is kept of how far the sequence had progressed; so, again, there's no knowing the state of the IPS and ISS.

**Initial conditions:**

1. Magnet in any state (non-persistent or persistent, at field or zero)
2. Shims in any state (at field or zero)

Actions:

1. If field > nT then ramp shims to zero
If field < nT then dump the current stored in the shims.
2. Start ISS auto-dump. (Command P1 followed by H1)
3. If necessary, make the magnet non-persistent (ie ramp up leads, switch on heater, wait).
4. Ramp magnet PSU to the new current *using demagnetisation sequence if selected.*
5. Stop ISS auto-dump. (Command P1 followed by H0)
6. Make the magnet persistent (switch off the heater, wait (?)s, and ramp leads to zero)
7. Calculate the shim current values (from a supplied table).
8. Apply the shim currents
9. Repeat application of the shim current *n* more times (*n* is a user-specified value, and will be <4).

Demagnetisation sequence:**Notes:**

- Need to restrict the maximum field to (upper limit - H).
- The s/w needs to allow for +ve and -ve fields.
- The s/w needs to allow for different maximum fields depending on magnet temperature.

Parameters required:

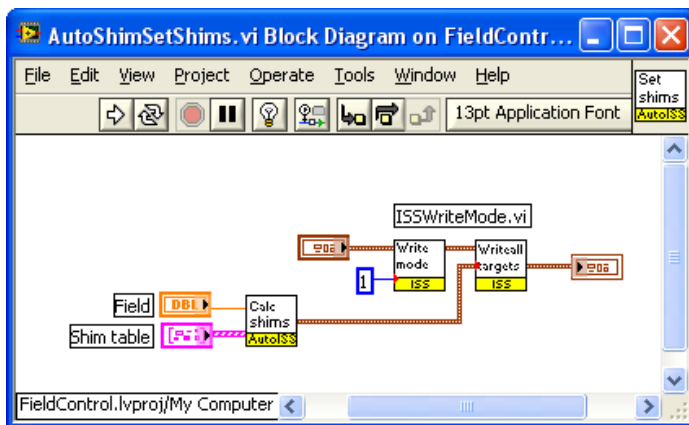
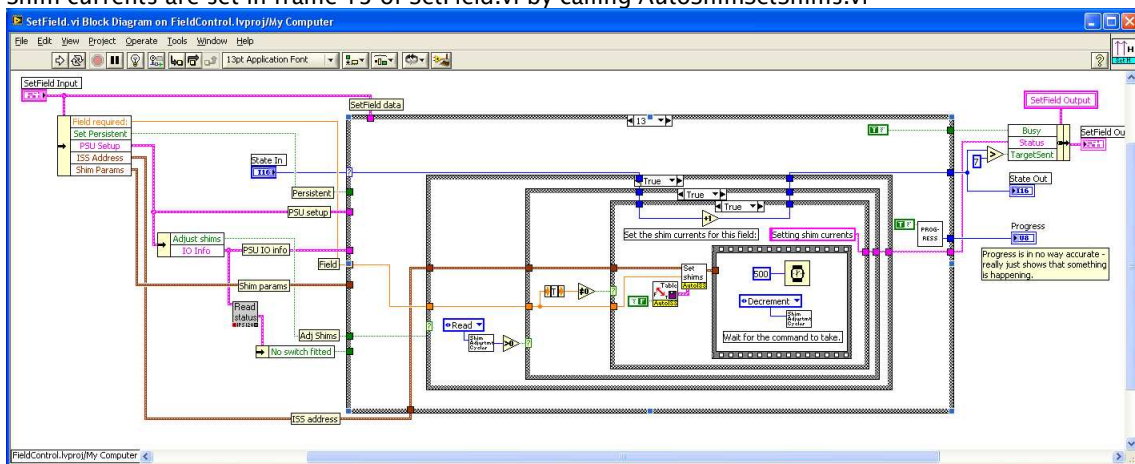
- Overshoot (H)
- Ramprate (will remain constant throughout the sequence)
- Number of steps (always odd)
- Delay

Sequence:

- H=Overshoot
- If (field < present field) then H = -H
- Loop for I = 1, Number of steps
 - Ramp to (field+H)
 - Wait Delay
 - $H = 0.707 * H * (-1)$
- Endloop
- Ramp to field

5.4 Calculation of shim currents

Shim currents are set in frame 13 of SetField.vi by calling AutoShimSetShims.vi

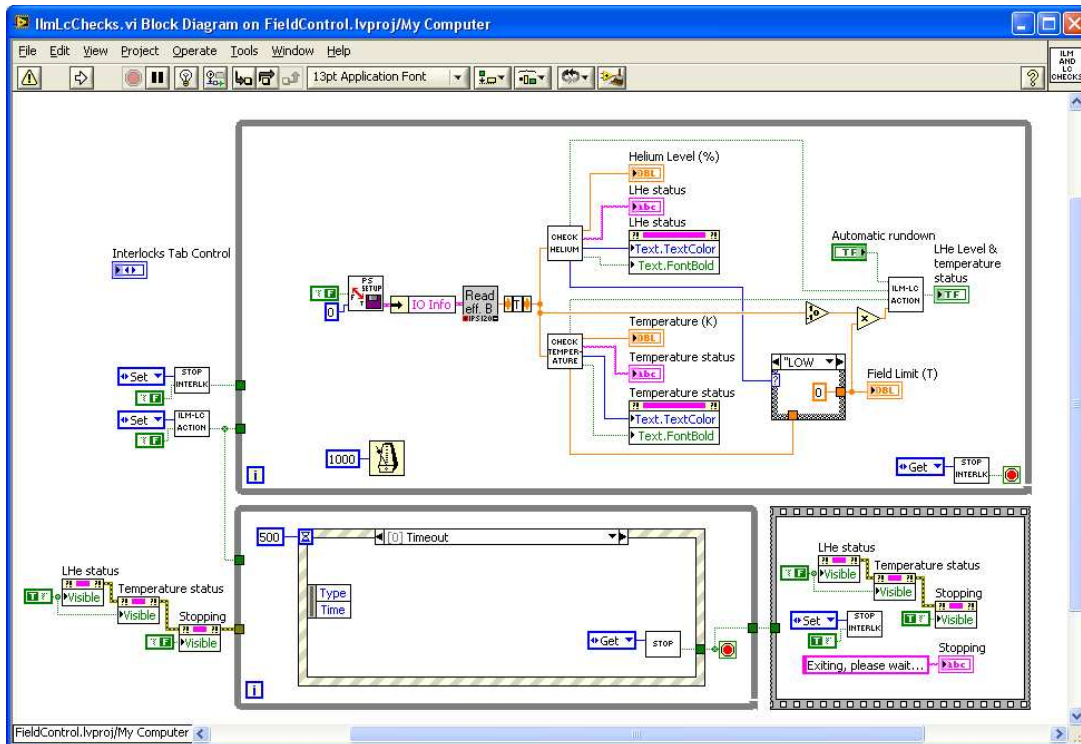
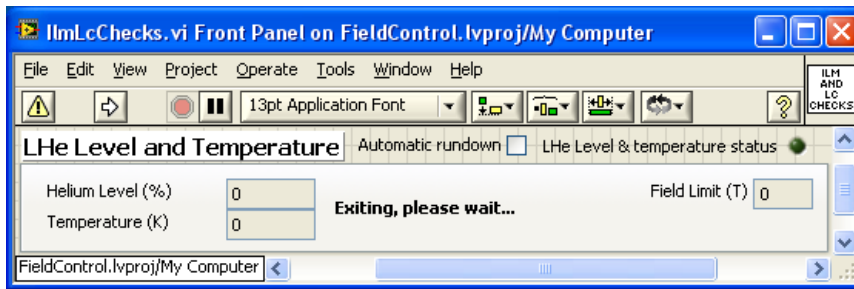


AutoShimSetShims.vi calls AutoShimCalculateShims.vi to calculate the required shim currents. Given the target Field and the Shim table (which consists of a list of magnet Fields and shims currents used at each of those Fields), the software calculates, using linear interpolation, shim currents to correspond with the target Field. Add more lines to the Shim table to cope with non-linear relationship between Field and shim currents.

5.5 IlmLcChecks.vi

IlmLcChecks.vi monitors the LC and ILM, checking magnet temperature and LHe level, and calculating the resulting maximum permitted magnet field. If the actual magnet field is greater than the permitted level, the software will either display a warning dialog box or automatically reduce the magnet field by running the MakeSafe sequence (see above 5.1).

The “Automatic rundown” checkbox determines whether the software displays a warning dialog box or runs the MakeSafe sequence.



6 Troubleshooting

This section lists some common problems and their solutions. If these do not enable you to resolve your difficulties, please contact Oxford Instruments.

VI 'Hangs'

There is probably a communications problem due to the cable or communication parameters entered for the instrument – see section 6.1. If the problem does not appear to be communications-related, try re-installing the software.

Unable to close a VI

You may encounter this problem if running the software source code within the LabVIEW development environment:

Some VIs are dialog boxes that are launched from a higher level VI, and automatically disappear once they have finished executing. If you load these directly, you may not be able to close them from the menu. To get rid of them, first switch to edit mode by pressing `CTRL-M` and you will then be able to close them in the normal way.

ISOBUS timeouts

If you press a button on a real instrument front panel while Field Control is trying to communicate with it, the request from the software will be rejected. After a few seconds, if you do not release the button, a dialog box is shown. Release the button and press Continue.

Intermittent communications errors

This can happen if the com port has been incorrectly initialised, in particular if only one stop bit is being used. This can manifest itself either as timeouts even though the instruments are not being interfered with, or Command Rejected errors. All the higher level VIs automatically perform correct initialisation of the com port, but if you load and run a lower level VI directly, or if you have written your own, then it is possible to get into this situation. You must exit and re-start LabVIEW in order to reinitialise the port.

6.1 Isolating communications problems

Assuming you are using the software source code, this section gives a step-by-step guide to isolating and fixing some of the more common communications problems.

1. If the VI is a high level one, such as Field Control, proceed from step 2 with each of the component instruments (temperature controller, magnet power supply etc.).
 2. Disconnect all instruments from their communications lines, except for the one under scrutiny. In the case of Gateway networks however, you must always have the Gateway instrument switched on in order to talk to a slave instrument.
 3. Switch the target (and Gateway) instrument off briefly, and then on again. Make a note of GPIB and ISOBUS addresses if they appear during startup.
 4. Load and run the instrument front panel.
 5. If the instrument front panel runs, then move on to the next instrument and repeat from step 2.
 6. If the instrument front panel does not run, quit and restart LabVIEW and Windows. This is to ensure that any com ports initialised incorrectly are cleared before investigating further.
-

-
7. Load the VI called BusCommand.VI from the BUS.LLB library. This provides a quick and easy method of checking a particular instrument with different configurations.
 - a) Enter the communications parameters for the instrument directly into the left-hand panel on the VI, and enter a capital 'V' into the command section. Run the VI.
 - b) If the VI runs properly, a version message from the instrument will appear in the Reply field. This indicates that the parameters are correct and that the instrument is correctly connected and set up.
 - c) If you have a simple ISOBUS system, enter an ISOBUS address of -1, this will cause the command to be sent out as if without any addressing prefix. If the instrument responds, the problem is with addressing.
 - d) If you have a Gateway instrument then use an ISOBUS address of 0. Disconnect the Gateway Adapter from the instrument so that the computer is only talking to the Gateway instrument. Once you establish communication to the Gateway instrument you will have to use SetISOBUSAddress.VI to set the ISOBUS address of the other instruments to non-zero values before attempting to talk to them using BusCommand.VI.
 - e) If you experience problems talking through the Gateway adapter you can attempt to talk to each instrument individually using its' serial ports and a 25-way pin to pin ribbon cable to a serial port on the computer.
 - f) If you are using GPIB to talk to the instrument, check you are using the right GPIB address.
 - g) Try swapping cables (GPIB systems) or serial plugs (ISOBUS/Gateway systems) on the target instrument and re-running the BusCommand VI. If you can make the instrument respond in this way then the problem is clearly with the cabling.
 - h) Load and run the SetupDialog for the instrument. Check the settings correspond to those in the BusCommand VI. Adjust the setup if necessary.
 - i) If all the individual instrument Front Panels work, but a higher level VI does not, then make sure that the instruments have unique ISOBUS and GPIB addresses.
 - j) As a last resort, try re-installing the software, before contacting Oxford Instruments.

6.2 GPIB Problems

The majority of GPIB problems occur due to incorrect set-up of the driver in the computer.

We recommend the use of PCI-GPIB boards.

Always use the latest version of the driver. If any diagnostic tests are provided with the driver software for the board then use them.

Oxford Instruments' VIs do not use DMA transfer or interrupt level processing. It is recommended that DMA transfer is turned off and the IRQ setting set to 'None'.