



SAFETY INTERLOCK CABLE

(Voltech Part Number 250-022)

Installation Guide

Voltech Instruments Inc.

11637 Kelly Road
Suite 306
Fort Myers, FL 33908, USA
Tel: +1 239 437 0494
Fax: +1 239 3841
sales@voltech.com

Voltech Instruments Ltd.

148 Sixth Street
Harwell International Business Centre
Didcot, Oxon OX11 0RA, U.K.
Tel: +44 (0) 1235 834555
Fax: +44 (0) 1235 835016
sales@voltech.co.uk

Voltech Instruments are committed to a policy of continuous product development. Hence, product specification and the information given in this manual are subject to change without notice.

No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form, or by any means electronic, mechanical photocopying, recording or otherwise without prior written permission of Voltech Instruments.

© 2004 Voltech Instruments. All rights reserved.

Microsoft, Windows and the Windows logo are either registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries.

Voltech Part Number: 98-078, Issue 1, December 2004.



DANGER OF ELECTRIC SHOCK

Only qualified personnel should install this equipment, after reading and understanding this user manual. If in doubt, consult your supplier.



RISQUE D'ELECTROCUTION

L'installation de cet équipement ne doit être confiée qu'à un personnel qualifié ayant lu et compris le présent manuel d'utilisation. Dans le doute, s'adresser au fournisseur.



GEFAHR VON ELEKTRISCHEM SCHOCK

Nur entsprechend ausgebildetes Personal ist berechtigt, diese Ausrüstung nach dem Lesen und Verständnis dieses Anwendungshandbuches zu installieren. Falls Sie Zweifel haben sollten, wenden Sie sich bitte an Ihren Lieferanten.



RISCHIO DI SCARICHE ELETTRICHE

Solo personale qualificato può installare questo strumento, dopo la lettura e la comprensione di questo manuale. Se esistono dubbi consultate il vostro rivenditore.

Contents

SAFETY INTERLOCK CABLE	1-1
1 INTRODUCTION	1-1
1.1. <i>Introduction</i>	1-2
1.2. <i>Recommended Infra-Red (IR) Safety System</i>	1-3
2 DESCRIPTION	2-1
2.1. <i>General Description</i>	2-2
2.2. <i>Principle of Operation</i>	2-3
2.2.1. <i>Yellow and blue</i>	2-3
2.2.2. <i>Black Link</i>	2-3
2.2.3. <i>Red and White</i>	2-3
2.2.4. <i>Green and Black</i>	2-3
2.3. <i>Cable Schematic</i>	2-4
3 INSTALLING THE IR SAFETY SYSTEM	3-1
3.1. <i>Positioning the Light Curtain</i>	3-2
3.2. <i>Important - Operator Safety</i>	3-4
3.3. <i>Important Note - The Safety Enclosure</i>	3-4
3.4. <i>Connecting the Safety Interlock Cable to a Banner Light Curtain</i>	3-5
4 TESTING THE SAFETY SYSTEM	4-1
4.1. <i>Recommended Daily Check</i>	4-2
4.2. <i>Quick Check – Complete System</i>	4-2
5 OPERATING THE AT3600 WITH THE IR SAFETY SYSTEM	5-1
5.1. <i>AT3600 Messages</i>	5-2
6 CONSTRUCTING SAFE FIXTURES	6-1

1 INTRODUCTION

Thank you for choosing to use this Voltech product. If you experience any difficulty during installation or use of the safety interlock cable or are unsure of any of its features or abilities, please do not hesitate to contact either your local supplier or a Voltech main service centre as listed inside the front cover.

1.1. INTRODUCTION

Many of the tests available with the AT series testers are capable of generating dangerously high voltages, which could cause operator injury unless proper safety precautions are taken.

With this in mind, the rear panel of the AT3600 and some AT accessories have been designed with a safety interlock connector, which is described in the user manual of those products.

Unless the three safety interlock signals on this connector are properly made, the tester will not generate any dangerous voltages.

It is possible for you to use your tester without connecting the safety interlocks; but you will then be restricted to only 'low voltage' tests. If you wish to make full use of your tester and use any test that can generate high voltages, including

- Magnetizing Current
- Open Circuit Voltage
- Insulation Resistance
- Hi-Pot (DC)
- Wattage
- Hi-Pot (AC)
- Surge Stress Test

then you **must** have a safety system operating the safety interlocks.

Note: Dangerous voltages may also be produced when testing transformers and inductors in the presence of a dc bias current.

Sudden removal of the dc current will generate high voltages across the part under test.

The details of any particular safety system installation could vary depending on where the tester is being used. In a robotic production line, for example, the tester could be located in an enclosed area, and the safety switches could be mounted in the door.

With manual production, the safety system could be based on a physical barrier, for example, a 'lid' fitted with safety interlock switches. However, the requirement to open and close such a barrier

will give a slower speed of test, and often the reduced production throughput that follows from this may not be acceptable.

1.2. RECOMMENDED INFRA-RED (IR) SAFETY SYSTEM.

For optimum safety, ease of use and test speed, Voltech recommends the use of a safety light curtain with the AT3600 and other Voltech products that can generate dangerous voltages during routine production testing. This provides a 'light curtain' of infrared beams positioned in front of the tester.

Once the operator has placed a transformer on the test fixture, and removed his or her hand, the light curtain can signal that the situation is safe within a few tens of milliseconds. However, if the operator tries to touch the transformer during program execution, the safety system will open the safety interlocks (also within a few tens of milliseconds), so that the tests with dangerously high voltages will not be run.

The Safety Interlock Cable is an accessory that makes connection between the AT3600 and a safety light curtain as safe and easy as possible. The cable has been optimised for use with the 'Banner' safety light curtain described below, but safety light curtains from other manufacturers may also be suitable.

To construct a complete safety system you will need:

- Voltech AT3600 Safety Interlock Cable
- Banner 'Micro-Screen' safety light curtain
 - 1 off USCD-1T2 Metal Box Controller
 - 1 off USE2424YI Yellow Emitter 610mm high with 150mm to 9m range.
 - 1 off USR2424YI Yellow Receiver 610mm high with 150mm to 9m range.
Source: www.banner.com
- Methods to restrict access to the back of the working area

NOTE: The Banner part numbers were correct in 2004. You are strongly advised to consult with your safety system supplier before making purchase decisions. Similar safety systems are available from many other manufacturers and may be suitable.

2 DESCRIPTION

2.1. GENERAL DESCRIPTION

The Safety Interlock Cable is a robust and convenient way of connecting the AT3600 and other Voltech products to a safety interlock system. Although other safety systems may be suitable, the cable has been optimised for direct and quick connection to the Banner product described in the previous chapter.



Length	1.75 metres
Construction	High-quality shielded cable and terminations.
AT3600 Termination	Slimline 9-way d-type plug
Safety System Termination	Color-coded wires with bootlace ferrules. 20mm cable gland to secure the cable to the light curtain control box case.
Voltech Part Number	77-041

2.2. PRINCIPLE OF OPERATION

The cable carries 3 pairs of color-coded wires. Each pair must be linked together by the safety system before the AT3600 will operate a high voltage test. If any one of the three pairs becomes un-linked during a test, the AT3600 very quickly switches off any high voltage that is being produced.

There are three pairs of wires in order to provide the multiple redundancy required by various international safety standards.

2.2.1. Yellow and blue.

The primary control (MPCE) elements of the AT3600. The primary generator power is passed through the yellow and blue leads. The contacts used to connect yellow to blue must be rated 230V ac, 4A or more.

2.2.2. Black Link

This link may be used to series two primary control relays of the safety system. This provides protection against one of the MPCE relays of the safety system locking in a closed position.

2.2.3. Red and White

This is the secondary control element (MSCE) of the AT3600. If this pair is open-circuited, prime power will also be removed from the AT3600 high power generator. This action is independent of the MPCE above and thus provides fail-safe operation of the complete safety system.

A 6k8 resistor is fitted in series with this pair, as required by the AT3600's electrical control system.

2.2.4. Green and Black

This is a monitoring pair, used by the AT3600 to confirm the status of the safety system.

2.3. CABLE SCHEMATIC.

Function	AT3600 9-pin d-type		Safety Light Curtain	Connection to safety system.
Primary power to the high voltage generators is passed through pins 3 and 7	3	—	Yellow	Main power- breaking relays (Final Switching Device) of the safety system. The black link is used to series 2 relays, if present.
	7	—	Blue	
	No Connection	[Black	
	No Connection		Black	
Secondary control logic.	5	—	Green	Monitoring or auxiliary relay.
	6	—	Black	
Secondary switching device. (A 6k8 resistor is fitted in series with pin 2).	2	—	Red	Secondary Control Element.
	9	—	White	
Screen	Screen		No Connection	

3 INSTALLING THE IR SAFETY SYSTEM

3.1. POSITIONING THE LIGHT CURTAIN

The light curtain should be positioned in front of the tester, extending well beyond the width of the tester so that the operator is not impeded when he/she has to load and unload the transformer under test.

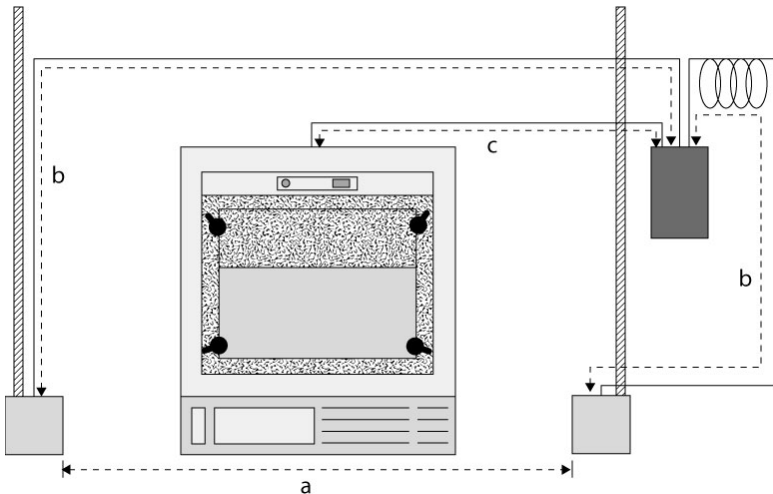
The interconnection between each of the modules is via simple multi-way cables, which are easy for you to install.

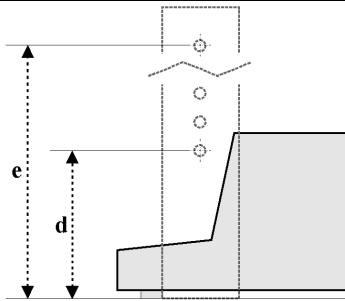
Finally the AT Safety Interlock cable connects between the BANNER control box and the AT Safety Interlock socket.

This document gives an overview of the Micro Screen functions when used with the AT3600. In particular it describes how to connect the cable to the BANNER control box.

The user must refer to the BANNER documentation for details of assembly and operation of the Micro Screen.

The following shows a suggested installation.





The dimensions are as follows

- | | | |
|----|--|--------------------------------------|
| a. | Width of the light curtain | 1.8m to 2.0m |
| b. | Banner cable length from control box to vertical columns | 2m |
| c. | Voltech cable length from control box to tester | 1.5m |
| d. | Lowest beam in light curtain | 60mm minimum above the work surface |
| e. | Highest beam in light curtain | 630mm maximum above the work surface |
| f. | Maximum object resolution | 18mm |

The two vertical columns are equipped with suitable mounting brackets, making it easy for you to secure them to the work surface in the correct positions either side of the AT series tester.

The length of the cables is sufficient to allow you to position the control box outside the safety enclosure either under or on top of the work surface.

3.2. IMPORTANT - OPERATOR SAFETY

It is the responsibility of the user's organization to ensure that the AT3600 and its associated safety systems are installed, maintained, and operated in accordance with all safety guidance and legislation that may be in force locally. The BANNER Micro Screen (light curtain) will provide only part of the complete safety function that is required. The AT3600 and light curtain must be installed by a designated, qualified safety person who will conduct an overall assessment of the risks involved and provide operator training, safety notices, and further safety equipment as well as install the AT3600 and light curtain in accordance with local regulations.

When conducting a risk assessment and providing operator training and notices, it should be noted that the first safety feature of the AT3600 is the yellow indicating light on its front panel. This light will be lit when the AT3600 is running a test and may be generating dangerous voltages. (External indicating devices can also be used to show that the AT3600 is in a hazardous condition. See the 'Remote Port' description in the AT3600 user manual.) The operator should not attempt to touch the part under test or enter the safety enclosure when the yellow light is illuminated. The light curtain then provides supplementary safety protection against accidental entry into the safety enclosure by the operator.

3.3. IMPORTANT NOTE - THE SAFETY ENCLOSURE

Clearly, any safety system should be thought of providing a total 'safety enclosure' which prevents access from all sides to the dangerous voltages on the transformer under test. It is also clear that the infrared safety system can only provide one side of this safety enclosure - that which faces the operator.

If there is a danger that an operator or any other person could touch the transformer under test from either the side or the rear of the tester, then you must also take steps to prevent this, either by installing suitable physical barriers, or for example, by positioning the tester in the corner of the room so that existing walls prevent access to the transformer from the side and rear. The two vertical columns of the IR safety system would then normally be placed touching the physical barriers, which form the side-walls of the safety enclosure. Additionally, it should be noted that highest beam in the light curtain of the IR safety system is approximately 600mm above the work surface. If there is any danger that the operator could reach over this height, or could touch the transformer under test from above, then further precautions should be taken to provide physical barriers to guard against this.

3.4. CONNECTING THE SAFETY INTERLOCK CABLE TO A BANNER LIGHT CURTAIN

The free end of the Safety Interlock cable is already prepared for wiring to the BANNER USCD-1T2 control box.

Caution :

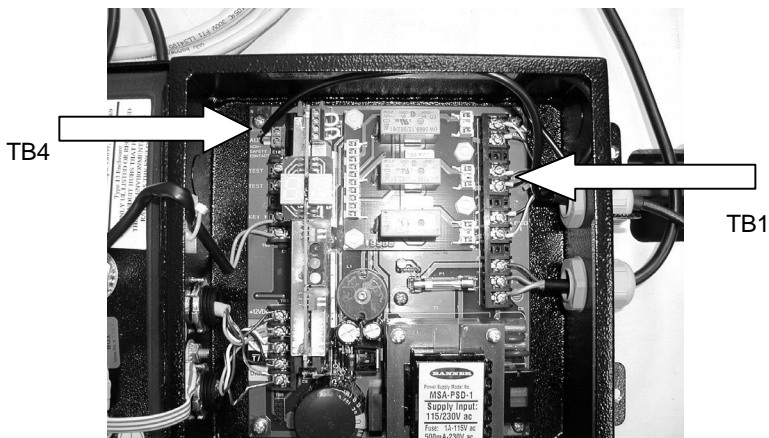
- **Ensure that the light curtain and the AT3600 is disconnected from the supply before opening the control box.**
- **Consult the user manual supplied with the light curtain for up-to-date information.**

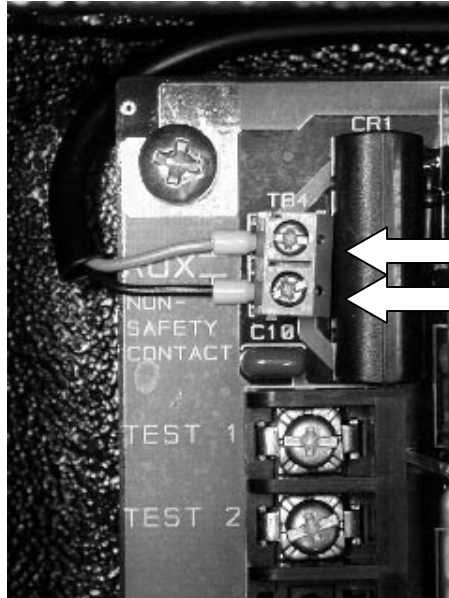
1. Remove the lid from the control box.
2. Identify the terminal block TB1 and TB4 inside the control box.
3. Remove the lock nut from the cable gland on the cable and feed the wires through a convenient knockout panel on the control box. E.g. next to TB1.
4. Replace the lock nut over the wires and secure the cable gland in place.

INSTALLATION

5. Secure the color-coded wires according to the diagrams below.
6. Replace the lid on the control box.
7. Connect the d-type connector to the AT3600's interlock port.
8. Position the AT3600, light curtain beams, control box and cables as described previously.
9. Apply power to the light curtain control box and follow the manufacturer's instructions for test and use.
10. Apply power to the AT3600 and test the safety system as described in the next chapter.

Terminal block	Label	Connect wire colour...	To terminal...
TB4	AUX	Green	a
TB4	AUX	Black	b
TB1	SSD	White	a
TB1	SSD	Red	b
TB1	FSD2	Blue	a
TB1	FSD2	Black	b
TB1	FSD1	Black	a
TB1	FSD1	Yellow	b

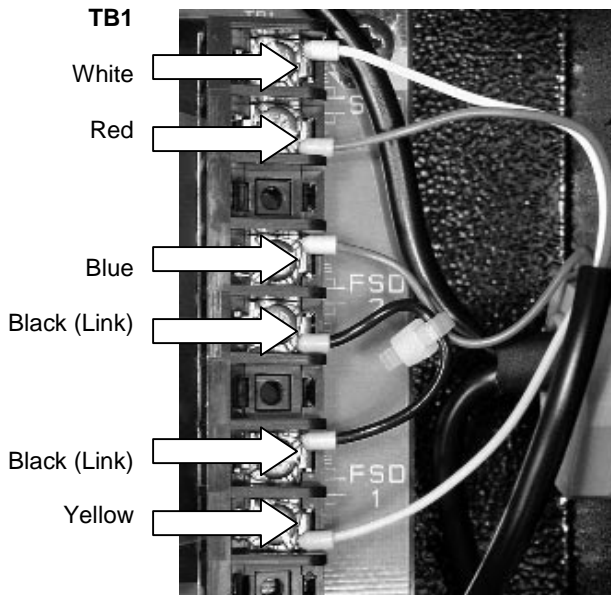




TB4

Green

Black



TB1

White

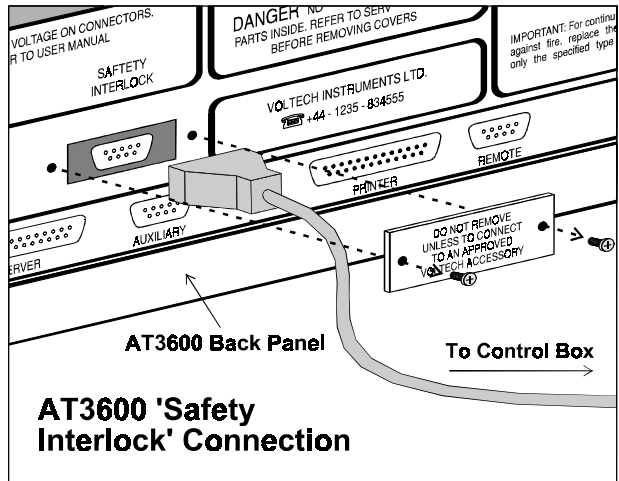
Red

Blue

Black (Link)

Black (Link)

Yellow



4 TESTING THE SAFETY SYSTEM

4.1. RECOMMENDED DAILY CHECK

Testing the safety system, which may include checking any physical barriers in the total safety enclosure surrounding the tester, should be supervised by your designated, qualified person responsible for operator safety.

Please refer to the documentation of your safety system for installation and routine testing.

Check the Voltech Safety interlock cable for damage as part of the overall inspection of the system.

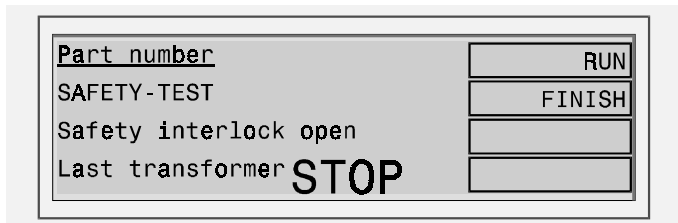
4.2. QUICK CHECK – COMPLETE SYSTEM

A quick check of the total system may be performed at any time by using one of your existing test programs, provided that it contains a high-voltage test.

To perform a quick system check:

Run a program containing a high-voltage test. E.g. HPAC

Watch the front panel of the AT3600 and, when the high-voltage test (HPAC) is running (for HPAC, you will see the test voltage displayed), carefully break the beam without touching the tester. You should see the following display:



If any part of the operation is not correct, or if you suspect that the safety system is not operating properly for any reason, stop working and carry out detailed checks as described in this and the safety system manuals.

5 OPERATING THE AT3600 WITH THE IR SAFETY SYSTEM

5.1. AT3600 MESSAGES

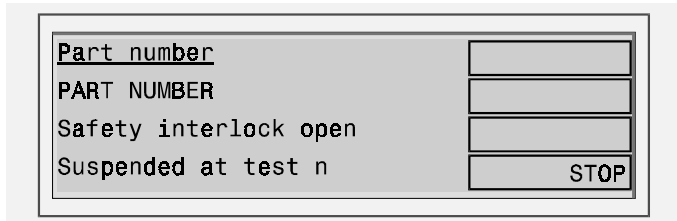
The tester has four distinct points in its operation when it may check the condition of the safety interlock:

1. Running a high voltage test during program execution
2. Performing the fixture compensation for a high voltage test within a program
3. Running a high voltage test in measure mode
4. Performing the fixture compensation prior to running a high voltage test in measure mode

As indicated in the previous section entitled 'Testing the Safety System', the safety checks are made both before and during the measurement.

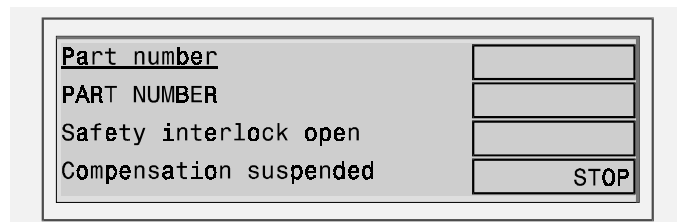
If the safety system indicates that the light curtain is broken before the start of the measurement, the tester will display one of four 'suspended' messages on the front panel, depending on which of the four operations listed above you were trying to perform:

(a)

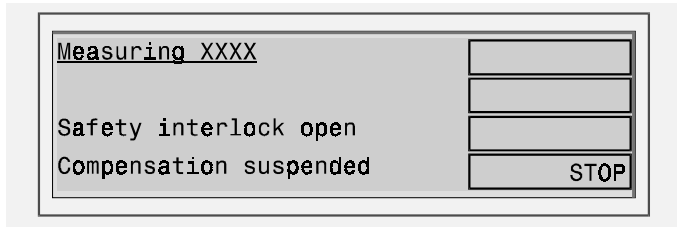


Where 'n' is the number of the test with the dangerous source.

(b)



(c)



(d)

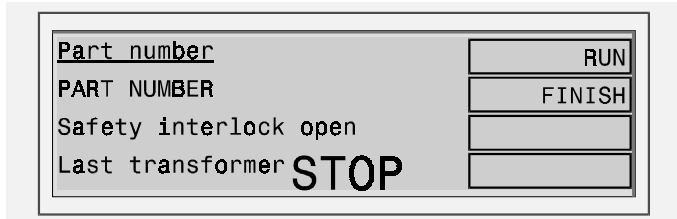


Where 'XXXX' is the appropriate test mnemonic.

Operation will remain suspended at this point until the safety system indicates that it is safe to proceed, after which test execution will carry on as normal. If you do not wish to continue from this point, pressing the STOP soft-key will halt the test execution and return the display to the appropriate higher level menu selection.

If the light curtain is broken after the measurement has started, then the test will be stopped, and the high voltage source shut down. The front panel of the tester will show a message containing the word 'STOP', again with the exact text varying depending upon the operation that you were trying to perform. Examples are as follows:

(a)



(b)

<u>Part number</u>	RUN
PART NUMBER	FINISH
Safety interlock open	
Last transformer STOP	

(c)

<u>Measurement</u>	EXECUTE
STOP	MEASURE
Safety interlock open	PROGRAM
	SELF - TEST

(d)

<u>Measure XXXX</u>	
Safety interlock open	
Compensation STOP	ABORT

There is no way that the measurement can be recovered from this point. For program execution, this means that the entire program has to be re-run from the first test; and for measure mode, the test has to be re-entered. In the case of fixture compensation, either the compensation for the entire program must be re-run, or (in measure mode) the compensation for the required test.

Note that during the normal operation of changing transformers, the indicator on the slave column can show a red light. This merely indicates that the light curtain has been broken; it should automatically reset and return to the green indicator when the operator removes their hand.

When program execution has finished, and the front panel LED changes to either red (fail) or green (pass), then it is safe for the operator to change to the next transformer to be tested.

6 CONSTRUCTING SAFE FIXTURES

As described in the previous section, when the light curtain of the safety system is broken, the tester will stop the execution of a high voltage test, and remove the dangerous voltages, to protect the operator from the dangers of electric shock.

This may sound a simple operation, but in fact it is not. Firstly, there has to be a certain amount of signal processing within the vertical columns to detect that the IR beams have been broken; secondly, the control box has to signal this to the tester; and thirdly, the tester has to ramp-down the test source. This final operation has to be done carefully, because if there is current flowing through the inductance of a winding and it is suddenly switched off, rather than creating a safe situation, it could produce a dangerously high 'back emf'.

Clearly this means that, after the light curtain has been broken, there has to be a finite amount of time to switch off and safely ramp down the potentially dangerous voltage. With the IR Safety System, this time could be as long as 50msec.

This time has to be born in mind when you are designing your test fixtures. It is essential that any high voltage point on the transformer under test is set far enough back from the light curtain so that it cannot be touched by the operators hand within 75msec of breaking the beams.

Note that the high voltage points on the transformer could include the body or core (as well as terminals) if your program contains Hi Pot tests for core isolation.

The normally assumed value for the speed of an operator's hand is 2m/sec. This speed implies that the distance from the beams of the light curtain to the dangerous point on the transformer should be at least 150mm.



