MANUAL- SAM12

SMALL ARTICLES MONITOR

Thermo Fisher Scientific

SAM12

21st September 2007

Thermo Fisher Scientific
Bath Road, Beenham, Reading, Berkshire. RG7 5PR. England.
Tel: 0118 971 2121 Fax: 0118 971 2835

This manual was produced using *ComponentOne Doc-To-Help*™.

NOTICE

SAM12

NUISANCE ALARMS WHEN MONITORING EQUIPMENT

It may be found that alarms occur when monitoring equipment containing batteries. This is due to the presence of naturally occurring radioactive materials in some batteries; probably Thorium.

To avoid operational difficulties it is therefore recommended that batteries be removed prior to monitoring.

This is not a problem with all batteries, but at this stage it is not possible to identify those which will never exhibit this problem.

WARRANTY AND LIABILITY

THERMO FISHER SCIENTIFIC reserves the right to make changes to this manual and to the equipment described herein without notice. Considerable effort has been made to insure that this manual is free of inaccuracies and omissions. However, THERMO FISHER SCIENTIFIC, makes no warranty of any kind including, but not limited to, any implied warranties of merchantability and fitness for a particular purpose with regard to this manual. THERMO FISHER SCIENTIFIC, assumes no responsibility for, or liability for, errors contained in this manual or for incidental, special, or consequential damages arising out of the furnishing of this manual, or the use of this manual in operating the equipment, or in connection with the performance of the equipment when so operated.

This SAM12 manual is a user guide and must be read in conjunction with the SAM12 Instruction Manual.

IMPORTANT NOTICE

All units produced after the lst January 1996 must by law conform to the rules and regulations governing Electro-magnetic compatibility (EMC). In order to meet the requirements and CE mark the units described in this manual, any maintenance carried out must ensure the correct re-assembly of all parts, especially the earth straps. Furthermore, particular attention should be made to the correct mounting of the mains filter.

WARNING

When monitoring articles, operational procedures should contain warnings regarding inappropriate articles.

These items may include:

- Articles containing liquids
- Articles with significant shielding
- Articles containing large magnets
- Articles with known radioactive content

Articles containing liquids may have different release criteria. Articles of large weight or significant shielding may require different procedures requiring Health Physics intervention. Articles with a magnetic pull of more than four pounds may influence the accuracy of the monitor.

In standard mode, the monitor is unable to differentiate between pre-existing activity and surface contamination of an article. The NBR feature, if used, will partially mitigate for naturally occurring radioactive material.

The SAM12 weighs up to 1.5 tonnes. Only suitable lifting equipment must be used to move the monitor, using the facilities provided. The monitor should only be installed and used on a suitably robust and stable base.

WARNING AGAINST IMPROPER USE

The protection provided by this equipment may be impaired if used in a manner not specified by the manufacture. The user must adhere to all the safety precautions noted overleaf and to individual warnings contained within this manual.

WARNING SYMBOLS:

The following is an explanation of the warning symbols seen on the SAM12. Please read this information before using and/or maintaining this equipment.

As seen on the back of the 5689A Electronics Housing

	**CAUTION:** **Isolate the mains supply and wait one minute before removing this cover.**

As seen on the FHT681 HV Amplifier board screen located inside the 5689A Electronics Housing.

	**CAUTION:** **Isolate HV supply to the printed circuit board before removing cover. With power connected and unit switched on, a max. voltage of +1500V DC with a maximum short circuit power of 825 milli watts is present.**

	**CAUTION:** **Risk of electric shock.**

WEEE COMPLIANCE:

This product is required to comply with the European Union's Waste Electrical & Electronic Equipment (WEEE) Directive 2002/96/EC. It is marked with the following symbol:

Thermo Fisher Scientific has contracted with one or more recycling/disposal companies in each EU Member State, and this product should be disposed of or recycled through them. Further information on Thermo Fisher's compliance with these Directives, the recyclers in your country, and information on Thermo Fisher products which may assist the detection of substances subject to the RoHS Directive are available at www.thermofisher.com/WEEERoHS

Contents

Tables

Figures

Manual Revision History

Issue	Date	Name	Section(s)	Revision comments	Approval
1.0 Draft	14.09.07	C Hills	All	Draft release of SAM12 User Manual for review	M Pottinger
1.0	21.09.07	C Hills	All	First release of SAM12 User Manual	C Ablett

Foreword

Throughout this document the term **“HEALTH PHYSICIST”** (HP) is used extensively. It refers to the Person, Persons or Team responsible for setting up day-to-day running and maintenance of the SAM12. This may be an Instrument Maintenance Engineer, Radiation Safety Officer, local “Competent Person”, Departmental Manager or any other Responsible Person. The **“HEALTH PHYSICIST”** is the highest-level security role, uniquely responsible for setting and maintaining all lower order passwords. The HP would normally be responsible for installing and setting up the SAM12, calibrating for user-defined nuclides, programming operating parameters and verifying correct operation of the instrument.

The term **“TECHNICIAN”** is used to refer to the personnel who normally repair and maintain the instrument in working condition. IMP personnel are designated to this role.

Personnel who are general users of the system and normally carry out routine diagnostic and test functions are allocated to the **“THERMOFISHER”** role.

The term **“USER”** refers to anybody associated with or operating the instrument in any way.

For more information on which menu options are available, see Menu Roles (page 5-5).

Chapter 1 Introduction

Small Articles Monitor

The Small Articles Monitors type SAM12 is designed for monitoring gamma contamination of various items including tools, clothing and personal effects and may also be used for waste. Door switches and a start button are used in conjunction with a back-lit touch-screen LCD, large area coloured lamps and distinctive audible tones, to make controlled monitoring fast and simple.

The outward appearance is similar to that of a safe, with a user control and display panel mounted above the hinged door(s). The electronics is housed in a compartment on top of the instrument for easy maintenance. One or two inch (25mm or 50mm) thick lead shielding, screens the detectors and internal measurement volume from background radiation.

Four, or optionally six, large area plastic scintillation detectors are situated on the top, bottom, left and right and optionally front and back sides of the sensitive volume. Each detector has a separate, independently adjustable High Voltage (HV) supply. Five discriminators are available per detector. This provides adjustable windows for measuring different energy levels. A removable stainless steel liner forms the internal measurement volume. A low density liner is used in the low-energy version.

A Mains power supply charges a 12 volt sealed lead-acid battery to power the instrument and provides at least eight hours operation in the event of mains failure. User definable passwords protect all system parameters, which are accessed through the touch-screen keypad.

The instrument security is protected by the presence of a USB security dongle. In addition to the dongles, User-definable passwords protect all system parameters, which are accessed through the touch-screen LCD.

Operational parameters are user programmable and stored on the instrument's hard drive. In addition, all operational parameters, including calibration and HV Scan data, are backed up on an internal compact flash disk.

The system performs self tests at power-on and at regular intervals during background acquisition. When not actively engaged in monitoring, the system continuously acquires,

analyses and stores background counts for each detector. All counts are corrected to compensate for the "dead-time" of the electronics. In measurement mode, background is automatically subtracted and the result clearly shown by audible and visual indicators. Options include a "Residual Contamination" check which can be performed after an alarm, if required and an "Auto Recount" can be performed if the initial measurement produced an alarm condition. Two-door variants can be programmed to lock after alarms if required.

The standard SAM12 can have the following options in any combination:

4	or	6	Scintillation Counters (C)
1	or	2	Doors (D)
1″ (25mm)	or	2″ (50mm)	Lead (L)

The instrument build standard is therefore identified using the following nomenclature:

SAM12A – *n*C – *n*D – *n*L{-E}

An additional suffix of which signifies the user language may also be used e.g. –E for English speaking or –C for Chinese.

A Low-energy version using a plastic liner is available for detection of low-energy gamma emissions, including those which accompany some primary alpha emitters. Identified by the nomenclature SAM12L – *n*C – *n*D - *n*L

See Specification (page 3-1) for further information.

Note: At the time of printing, neither 1 inch nor low energy versions of the SAM12 are available.

Chapter 2 Description

Main Frame Type 5568A

The Main Frame, type 5568A, is manufactured from a sturdy fabricated steel construction. Mounted on top of the main frame is the Electronics Chassis, containing the Controller Board, Battery and Battery Controller Board, two or three HV and Amplifier Boards, a single Coincidence detector card, user interface connections, user control, keyswitch and LCD display with touch screen.

The inside of the frame is clad on all sides, including the doors, with either 25mm (1") or 50mm (2") of lead to minimise the effect of background radiation.

The scintillation detectors are mounted on the faces and doors of the cabinet. A stainless steel liner fits inside the cabinet to form a sealed cubicle which covers and protects the detectors. A further stainless steel liner covers the lead on the inside of the doors. The outside of the cabinet is clad with stainless steel in-fill panels. The whole cabinet stands on two box sections, mounted one on each side and running front to rear. These box sections provide access for a Fork Lift truck.

Scintillation Detector Type 5569A

Each of the six detectors, type 5569A, is a large area plastic scintillator wrapped in foil and plastic, mounted in an aluminium jacket. A photomultiplier tube is embedded in the plastic. Connection to the dynode chain assembly, type 5462A, mounted on the back of the tube, is via a light-tight gland. A single coaxial cable provides high voltage for the tube and carries the signals to the HV and Amplifier PCB via an MHV connector.

Electronics Chassis Type 5689A

The Electronics Chassis, type 5689A, comprising of a Base Plinth and Top cover, is mounted on top of the Main Frame. Once the Top Cover is removed, four fixings allow the Base Plinth to be detached from the Main Frame to facilitate easy maintenance.

The Electronics Housing contains the Controller Board, Battery Controller PCB, two or three HV and Amplifier PCB's, the mains power supply and the battery. An aperture in the lead allows for cabling to the detectors and a cutaway section in the frame houses the door switch.

Situated on the side of the Electronics Chassis is the Side Control panel. This panel contains connections for the Mains input, ON/OFF key-switch, Network and four USB interfaces.

The Electronics Chassis supports a top-mounted back-lit LCD with touch-screen, an internal loud-speaker, status lamps on both front and rear panels and a large Start button on the front.

Controller Board Type 5670A (5671A)

The Controller Board, type 5670A, is motherboard to an ETX-PM(C) 800mHz Processor.

The ETX assembly contains 256 megabytes of ram and the real time clock.

The motherboard interfaces directly to all other boards and external devices in the system via numerous connectors (not all are being used):

- The application software is retrieved from a 30 gigabyte (minimum) hard disk drive cabled via PL5. The drive also provides non-volatile storage for all data.
- 4 x USB connectors, SK1-4 are routed to the user interface panel on the side of the main chassis
- 4 x isolated relay outputs are available on PL16-19, two which are used to switch the door solenoids.
- 4 x isolated inputs are available on PL24, 27, 28 and 29, two used to sense door status and two used to monitor the status of the door locks
- 1 x network interface SK6 routed to the user interface panel on the side of the main chassis
- 1 x CRT monitor connection on SK7
- 1 x LCD drive on PL6 (or SK1) with backlight driver on PL7
- 1 x RS232 driver for LCD touch screen on PL22
- 1 x POWER connector PL13
- 1 x Loudspeaker connection for sound generator on PL3

Additionally a plug-in assembly, type 5671A, further extends serial communication to X-channel devices via the RS422

protocol as well as providing an I2C bus for driving the LED display(s).

DC-DC Converter Board Type 5675A

A proprietary DC-DC Converter pair produces regulated +5V and ±12V outputs directly from the Battery Controller Board, type 5660A. Power is then distributed to the Controller Board 5670A.

Battery Controller Board Type 5660A

The Battery Controller Board, type 5660A, manages the charging of a 12 volt sealed lead-acid battery. The whole electronics system is powered from the 5660A Board. The 5660A constantly senses the charge/discharge state of the battery and controls the charging voltage accordingly. The charging voltage is temperature compensated by means of a thermistor located on the battery. This helps to maximise the life time of the battery.

A momentary key-switch, located on the side panel, allows power to be switched to the electronics provided the battery voltage is above a safe value (i.e. not discharged), even when mains power is absent. The key-switch needs to be held ON for at least two seconds before the ON state is engaged.

The 5660A continues to monitor the terminal voltage of the battery during battery operation but will signal a shut-down if the battery discharges to a predetermined point, beyond which, it would suffer permanent damage and be difficult to recharge. A miniature fuse protects against over-current conditions.

The application software would normally regulate shut-down. In the event of the software losing control an emergency shut-down is possible by holding the key-switch ON for a minimum of 10 seconds (nominal).

FHT681 Scintillation HV and Amplifier Type 42543-0223

The Scintillation HV and Amplifier Board, type 42543-0223, is a dual channel high voltage generator/scintillation amplifier pair. The HV generators are sub-assemblies (type 42543-0202) which are controlled by DACs (Digital to Analogue Converter) on the main printed circuit board. The HV has a range between 0 and 1400 Volts, with a resolution of about 1 Volt.

The charge pulses arriving along the high voltage cable from the detectors are amplified and each fed to five discriminators

and five associated counters, all controlled by the microprocessor on the main board.

The cards are interrogated via the X-channel bus to retrieve counter values generated every 100ms from a 5 second buffer.

A digital output from each channel is fed to the CCM card, type 42543-0224, such that coincidence on any two detectors can be registered. This allows measurements on Cobalt 60.

FHT681 Coincidence Detector Card Type 42543-0224

The card can support coincidence from 6 detectors via the digital outputs of the HV Amps. By setting relevant summing thresholds on the card, coincidence from two detectors only can be supported.

The cards are set up and interrogated via the X-channel bus.

Visual Indicator LED PCB Type 5672A

This assembly provides the rear (and front optional) visual display necessary to inform the user of progress through the instrument.

Chapter 3 Specification

The standard SAM12 (with stainless-steel liners) is available with three options, in any combination:

- 4 or 6 Scintillation Counters (C)
- 1 or 2 Doors (D)
- 1 or 2 inches (25mm or 50mm) of lead shielding (L)

Therefore, the SAM12 type nomenclature used to identify the build standard is in terms of nC, Nd & nL. The eight variants are:

- SAM12A – 4C – 1D – 1L
- SAM12A – 4C – 1D – 2L
- SAM12A – 4C – 2D – 1L
- SAM12A – 4C – 2D – 2L
- SAM12A – 6C – 1D – 1L
- SAM12A – 6C – 1D – 2L
- SAM12A – 6C – 2D – 1L
- SAM12A – 6C – 2D – 2L

A Low energy Plastic liner (LP) version is available for detecting low-energy gammas, including those which accompany some primary alpha emitters. It is restricted to the variants giving maximum sensitivity and shielding, with a choice of doors:

- SAM12L – 6C – 1D – 2L, and
- SAM12L – 6C – 2D – 2L

A further option is available depending on the character set required by the Windows XP operating system.

- -E Western Europe/North America
- -C Chinese

An upgrade kit (AE0208A) is available to facilitate the detection of the radionuclide ^{60}Co.

Operational Parameters

See Params 1 (page 5-8), Params 2 (page 5-10) and Params 3 (page 5-11) for information regarding the settings and defaults for the Operational Parameters.

Software Options

See Options (page 5-6) for information regarding the settings and defaults for the Software Options.

Vault Options

See Doors (page 5-13) for information regarding the settings and defaults for the Vault and Door Options.

Default Messages

See Messages (page 5-15) for information regarding the settings and defaults for the Software Options.

Background Capability

Background capability is related to alarm threshold and statistical certainty requirements. Background subtraction is included in the measurement routines for the detectors. When the isotope of interest is of low energy level, the energy window can be changed to lower the background count rate thus allowing greater statistical certainty (see Hv Power (page 5-28) and Selection of Detector Operating Parameters (page 9-3)).

The mean background count rate for use in measurement calculations is accumulated from a series of 10 second counts, with a maximum of 10 results stored at any one time. The mean background count rate is therefore based on a 100 second count, which is maintained on a “rolling average” basis.

A significant change in the measured background count rate from the mean will cause the SAM12 to discard the current mean value and restart background monitoring (see Changing Background (page 6-5)).

If, due to heavy use, the SAM12 has been unable to measure background for 15 minutes, a 1 second background count is performed immediately after the current monitoring sequence. If no significant change is detected, the machine will be available for further monitoring. If a change in background is detected, further background measurements are performed until

the SAM12 detects a stable background (see Changes to the Normal Background Monitoring (page 5-49)).

When the mandatory 100 second background count has been accumulated, the monitoring time required to achieve the specified alarm level is calculated. Providing the monitoring time calculated falls within the maximum and minimum limits (see Params 2 (page 5-10)), the instrument will be ready for monitoring. If, however, the monitoring time calculated is greater than the maximum allowed, a “high background” condition exists and monitoring will be inhibited.

A high background condition indicates that the alarm level set and statistical certainties required are not achievable, under the current background conditions. This may be overcome when either the background falls or more suitable operational parameters are entered by the Health Physicist. It is advisable to check for residual contamination if this occurs unexpectedly or persists.

The lower the background field the more sensitive, stable and accurate the measurements will be.

Detectors

Four or Six Detectors

Type:	5569A
Construction:	Large area scintillation counter using a plastic phosphor type BC408 wrapped in foil, plastic and a aluminium jacket.
Thickness:	2.25" (57 mm)
Area:	15" (381 mm) x 15" (381 mm) = 225"sq (145,161 mm^2)
Photomultiplier:	1" (25 mm) extended cathode
Shielding:	1" (25 mm) or 2" (50" mm) of aged lead on all external faces
Energy Response	20 keV upwards (minimum detectable depends on liner material)

Detector HV settings

Operating voltages should normally be set up using the NBR method, although they may also be set up using the Figure of merit (S^2/B shown in figure 9.1) to yield the operating Photomultiplier voltages. These settings are determined and set using the HV Scan feature (Calibration|HV Scan (see HV Scan (page 5-25)). The recommended values, based on the NBR optimization method, can be found in the Calibration certificate for each individual instrument.

Energy Window

This can have all thresholds adjustable under software control:-

Programmable Threshold 1	0 - 4095mV in 1 mV steps
Programmable Threshold 2	0 - 4095mV in 1 mV steps

Programmable Threshold 3	0 - 4095mV in 1 mV steps
Programmable Threshold 4	0 - 4095mV in 1 mV steps
Programmable Threshold 5	0 - 4095mV in 1 mV steps

Control

Instrument ON/OFF operation is via a momentary key-switch on the side panel. Operating any door activates a micro switch and suspends background monitoring. Closing the door indicates a sample is ready to be monitored and initiates a time-out period. If the Start button is pressed within the time-out period, the article is monitored, otherwise background monitoring is resumed. Opening any door during monitoring aborts the measurement. Optional door locks are available and will activate to prevent any contaminated item being removed from the clean door. Data entry and diagnostic functions are accessed through a touch screen but access is password protected.

Displays

LCD The integral back-lit LCD display provided is used in conjunction with the touch-screen for data entry and diagnostic functions. As well as duplicating any front panel LED display, the LCD can also provides comprehensive, user-friendly operational guidance, measurement results and instrument fault messages.

Lamps Five, bright, rear (optional front) panel lamps show the instrument status at all times and give the user clear indication of the measurement result.

FRONT		BACK (2-door only)
Green:	Ready / Clear	Ready / Clear
White:	Recount	Recount
Yellow:	Count	Count
Red:	Alarm	Alarm
Blue:	Out of Service	Out of Service

Charging LED A pulsing white LED on the side panel indicating that the mains is on and charging the battery.

Audible Indications

“Chime”	Measurement with a “CLEAR” result
“Single Beep”	End of a parameter counting sequence.

“Periodic Beeps”	Operator sequence “ERROR”
	Door opened when Background required
	Door open too long
“Rapid Beeps”	Measurement exceeding “ALARM ACTIVITY”
“Siren”	Measurement exceeding “HIGH LEVEL ALARM”
“Warble”	Measurement Aborted

The speaker volume is user adjustable under software control.

Network Communications

An RJ45 connector provides for compliance with ***IEEE 802.11***

USB Ports

A four port USB (version 1.1) hub is available on the side panel for peripheral interfaces (such as memory sticks, dongles, keyboard, mouse, etc.)

Printers

A dot matrix printer is available as an option (A0210A). Contact Thermo Fisher Scientific for the latest model.

Power Requirements

Voltage	-	85 to 264 volts AC
Frequency	-	47 to 63 Hz
Maximum power	-	65 V.A.
Circuit Protection	-	Integral mains fuse in Power supply 250V 2 A

Battery Backup

Battery type:	Sealed lead-acid
Battery capacity:	12 volts 15Ah
Battery support:	typically better than 8 hours
Battery Fuse	5 x 20mm 6.3Amp quick acting.

Dimensions

Overall Dimensions - 5568A + 5689A

Height	46”	(1170 mm) approximately (all versions)
Width	29"	(737 mm) approximately (max for 2-door versions
Depth	36.25"	(921 mm) approximately including door handles, two door unit.
	33.25"	(844 mm) approximately including door handle, (6C-1D-2L)

Dimensions of Measuring Volume

Height	15"	(381 mm)
Width	15"	(381 mm) – 2.34 cubic feet (66 Litres)
Depth	18.3"	(466 mm) – Single door – 2.38cc(68L)
Depth	20.1"	(510 mm) – Double door – 2.60cc(74L)

Weight - with 1" (25 mm) of lead shielding, 4 detectors and one door

SAM12A-4C-1D-1L	770 Kg (1697 LB's) Packed. 670 Kg (1477 LB's) Nett Weight.

Weight - with 2" (50 mm) of lead shielding, 6 detectors and two doors

SAM12A-6C-2D-2L	1480 Kg (3263 LB's) Packed. 1380 Kg (3042 LB's) Nett Weight.

Environmental

Temperature and Humidity

Operational Temperature Range	+0°C to +45°C (32°F to 113°F
Storage Temperature Range	-10°C to +50°C(14°F to 122°F
Humidity Range	up to 95% RH non condensing

NOTE:
USE BELOW +0°C (32°F) IS NOT RECOMMENDED – THE LCD DISPLAY WILL BECOME "SLUGGISH" BELOW THIS TEMPERATURE.
DO NOT STORE ABOVE +60°C (122°F)

Magnetic Shielding

Internal fields – from measured items:

Standard SAM12 'A' variants	Internal magnetic shielding ensures magnetic fields of up to 9000 A/m measured on the surface of the liner will have an effect of less than 5% on the count rate of the adjacent detector.
Low energy SAM12 'L' variants	Internal mu-metal magnetic shielding is **not** fitted in the Low-energy variants to maximise the low energy gamma sensitivity. Thus, the magnetic immunity will be reduced.

For more information regarding SAM12 variants, see Specification (page 3-1.)

External fields – all variants:

Large external magnetic fields may reduce the measured value.

IP rating IP50

Environmental restrictions

- Not for use in flammable or explosive atmospheres
- For installation in “drip-free” locations only
- Do not expose to excessive dust pollution levels

Chapter 4 Unpacking and Installation

Unpacking

After installation of 2-door SAM12, ensure both doors are closed before switch-on.

WARNING: **DUE TO THE LEAD SHIELDING THE SAM12 WEIGHS 1.5 TONS. A FORK-LIFT TRUCK OF SUITABLE LIFTING CAPACITY MUST BE USED TO MOVE AND TRANSPORT THE SAM12 SAFELY, USING THE INTEGRAL FORK-LIFT CHANNELS. WHEELS, SKATES, SKIDS OR SIMILAR DEVICES MUST NOT BE USED TO MOVE THE SAM12.**

PARTICULAR CARE SHOULD BE TAKEN ON GRADIENTS

ENSURE THE INSTALLATION SITE IS SUITABLY ROBUST

DO NOT ATTEMPT TO OPEN DOORS UNTIL THE TRANSIT SUPPORTS HAVE BEEN REMOVED (see Removing Door Transit Supports (page 4-3)**).**

The SAM12 case should contain the following:

- Small Articles Monitor (SAM12)
- 1 or 2 Door Handles
- Combined Operational and Maintenance Manual
- Pack containing ON/OFF keys, Dongle and Screen Cleaner
- Calibration Certificate
- SAM12 Mains power cord (EC countries only)
- Printer with printer cable (Optional)
  Printer Tractor Feed
  Plastic locating tray
- Mounting plinth AE0181B (Optional)

To unpack the SAM12

Remove the top and side packing panels and peel off the polythene wrapping.

The door handle(s), manual, Calibration certificate, Keys, Dongle and Mains power cord are packed inside the measurement cubicle.

The Printer (if supplied) is packed in a separate carton. The printer, printer cable and mains leads are packed inside the measurement cubicle. Retain the packing for these items.

Remove the protective foam from the outer edge of the stainless steel liner and door plate. It may be necessary to remove any traces of adhesive with a suitable solvent cleaner.

The SAM12 should be left on the base pallet until it is at the installation site in order to reduce the risk of damage during transportation. The wooden base is designed to allow easy fork-lift access.

The floor of the installation site should be level, even and suitably robust in order to support the weight of the SAM12.

When at the installation site, remove and retain the plinth mounting bolts and fixings. Lift the SAM12 off its wooden base using the fork lifting channels provided.

CARE MUST BE TAKEN WHEN LIFTING - THE SAM12 WEIGHS 1.5 TONS.

Mechanical installation is described below.

Mechanical Installation

Positioning and Mounting the SAM12

WARNING: **DO NOT ATTEMPT TO OPEN DOORS UNTIL THE TRANSIT SUPPORTS HAVE BEEN REMOVED (see** Removing Door Transit Supports (page 4-3)**).**

The SAM12 is intended for indoor use only, and should not be used where liquids can drip or be spilled onto the lid.

For best possible performance it is suggested that the SAM12 be positioned in the lowest stable background surroundings. High background fields will reduce sensitivity and fluctuating backgrounds may cause false alarms and operational delays during background update periods.

The SAM12 has no specific ventilation requirements.

The SAM12 should be placed on as flat a surface as possible as no means of levelling adjustment is provided on the cabinet. Installation on a slope may affect operation of the door and make opening awkward. Before finally positioning the SAM12, it will be necessary to remove the four M10 transit bolts securing it to the wooden base - **leave the door transit supports in place until the SAM12 is physically installed**.

Retain the four plinth bolts for future use. Use a fork lift of suitable capacity to lift the SAM12 off the wooden base and finally position it.

Ideally the SAM12 should be mounted on a raised "plinth" (base) in order that the door and cubicle are at optimum operating height for users and the LCD display at the optimum viewing angle.

Any such plinth must be flat, suitably robust, mechanically sound, stable and fixed to the floor. The SAM12 should be fixed to the plinth.

A SAM12 mounting plinth is manufactured – associated equipment order code AE0181B. When using this plinth, the SAM12 should be secured to it using the four set of M10 fixing bolts previously removed from the wooden transit base. The mounting plinth (base) should in turn be secured to the floor using the four 12mm diameter mounting holes with suitable fixings. Plinth details are shown on drawing B91208.

Once the SAM12 is correctly positioned, install the optional plastic location tray within the measurement cubicle.

Removing Door Transit Supports

Only remove the door transit supports when the SAM12 is physically installed – to avoid fork lift shock damage.

The SAM12 is shipped with a "Transit Support" located on the underside of each door. The Transit Supports are bolted through the main frame and door frame, to support the door and protect the hinges and latching/locking mechanism from physical damage due to rough transit handling.

Do not attempt to open the door(s) until the Transit Support(s) have been removed.

The Transit Support is secured to the main frame with four M6 Hex head bolts to the latch end of the door frame with one further M6 Hex head bolt on the underside of the door frame at the latch end.

Remove all five fixings before opening the door. Check that the top of the latch cut-out in the doors clears the top of the aluminium catch block by at least 2mm. If this clearance is less than 2mm, transit damage is likely - do not use the SAM12 before contacting Thermo Fisher Scientific or your local agent for further advice. See Door Catch and Lock Replacement and Adjustment (page 11-10) for further information.

The Door Transit Supports are "unique" to each door (they bear the SAM12 Serial No. and "F" for the front door, where applicable) and so should be retained for future use

when transporting the SAM12 over any distance or in situations when rough handling is possible.

Fitting the Door Handle(s)

The SAM12 is shipped with the door handle(s) removed and packed inside the measurement cubicle.

Remove the protective packaging and fix the handle(s) securely to the front left-hand ledge of the door frame using the M6 and M8 hex head bolts and washers supplied – these are shipped screwed into the door frame(s).

Note that the Door Handle (no longer reversible) is deliberately oriented biased "inboard" of the door, such that the main tube is in direct vertical alignment with the Door Latch Lever. (This limits the travel of the latch lever and prevents excessive force damaging the latch. It also makes single hand door operation equally easy for Left-handed and Right-handed users). Previously, incorrect installation resulted in excessive latch wear and premature failure.

Door Operation

Check for smooth operation of the door latching/de-latching mechanism. If any adjustment is necessary, refer to Replacement and Adjustment of (Chrome) Lever Catch (page 11-10) – after the Electrical Installation (page 4-5) is complete.

NOTE: The doors are a fabricated and welded construction which will not be manufactured exactly "square". Some "out of square" deflection will also result from loading the lead, particularly 2" (50mm) models. Additionally, uneven compression of the rubber seal may make the door appear "out of square" or to "sag". Any manufacturing tolerances are allowed for and compensated by the hinge mounting and door catch adjustment during final door Mounting/Assembly.

In-built door catch adjustment of ¼" (6mm) exists to accommodate any movement or wear that may take place - see Door Catch and Lock Replacement and Adjustment (page 11-10)**. Therefore, a door which is, or appears to be, "out of square" is in no way an indication of manufacturing defect or mechanical failure. If a door does not operate correctly consult** Door Catch and Lock Replacement and Adjustment (page 11-10)**.**

The mechanical installation is now complete.

After approximately the first two weeks or 2,000 operations check the door hinge and locking mechanisms for initial

"bedding-in" adjustments as described in Door Locking Mechanism (if fitted) (page 8-1).

Electrical Installation

Before proceeding with the electrical installation, ensure the SAM12 has been mechanically installed as described in Mechanical Installation (page 4-2).

IMPORTANT: ENSURE CORRECT ELECTRICAL SUPPLY AND MAINS CONNECTOR WIRING FOR YOUR MAINS SUPPLY.

Battery State

SAM12 is shipped with the lead-acid battery discharged.

Electrical Installation

The SAM12 is fitted with a 50 VA auto ranging power supply requiring a maximum input power of 65 VA.

DO NOT CONNECT THE MAINS SUPPLY. ENSURE THE KEYSWITCH ON THE REAR PANEL IS SET TO THE OFF POSITION.

A standard IEC mains connector is fitted on the side panel, specified to IEC 320, EN60320. Only mating connectors of the SAM12 standard should be used.

The SAM12 must be connected to a fused outlet capable of being isolated. The isolation switch should be close to the monitor and within reach of the operator.

The IEC power cord must be connected to the electricity supply as follows:

Brown conductor	to	LIVE 'L'	or	Red terminal
Blue conductor	to	NEUTRAL 'N'	or	Black terminal
Green/Yellow conductor	to	EARTH 'E' GROUND	or	Green/Yellow terminal

WARNING: THIS EQUIPMENT MUST AT NO TIME BE OPERATED WITHOUT THE GREEN WIRE CONNECTED TO THE MAINS GROUND.

When all installation work has been carried out, follow the setting up procedure described in Setting Up Procedure (page 9-1).

Printer Installation

Unpack the Printer (if supplied) and locate it as required in the vicinity of the SAM12. Configure the printer as detailed in the manufacturers hand book.

ENSURE the printer is set to the relevant mains setting.

The printer should be used with the USB interface, simply by connecting to the SAM with the USB cable supplied.

Notes on Orientation and Positioning

The large area detectors of the SAM12 make it very sensitive to changes in background. Therefore, it is recommended that the installation site be chosen for background stability and to minimise the effect of statistical fluctuations.

It is recommended that the SAM12 be installed away from active areas to suit both these needs.

If the background field at the installation site is directional it is recommended that the SAM12 be installed so that the back of the Cabinet faces the field source. This orientation should minimise the penetration and scatter of background radiation around the door aperture, although the advantage is small.

After Installation of 2-door SAM12s, ensure both doors are closed before switch-on.

Chapter 5 Operating Instructions

Operational States

There are two operational states for the **SAM12**:

ADMINISTRATOR Mode – this mode allows the instrument to be configured, calibrated and diagnostic checks to be run. Access to this state requires a username and password. See Administrator Mode (page 5-1) for further details.

USER Mode – this mode supports the normal monitoring of samples. Any user can operate the instrument in this state. See User Mode (page 5-45) for further details.

Administrator Mode

Note that communications with the SAM12 is via a touchscreen and this manual has been written primarily giving instructions for the touchscreen commands. It is also possible to use a USB keyboard and mouse to communicate with the SAM12.

Using the Touchscreen Functions

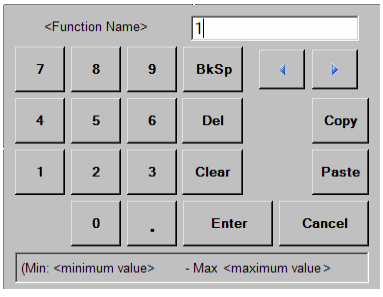
This section describes the methods that are common to all the entry and data viewing operations in the Parameter Mode menus.

When using the touchscreen, directly touch the menu options on the screen when selecting a function.

CAUTION: IT IS ADVISED TO USE A CLEAN FINGER TO TOUCH THE SCREEN. DO NOT USE SHARP OBJECTS ON THE TOUCHSCREEN SUCH AS PENCILS, PENS, SCREWDRIVERS ETC.

Number Functions

When touching the screen in a numerical field, the following number pad appears:

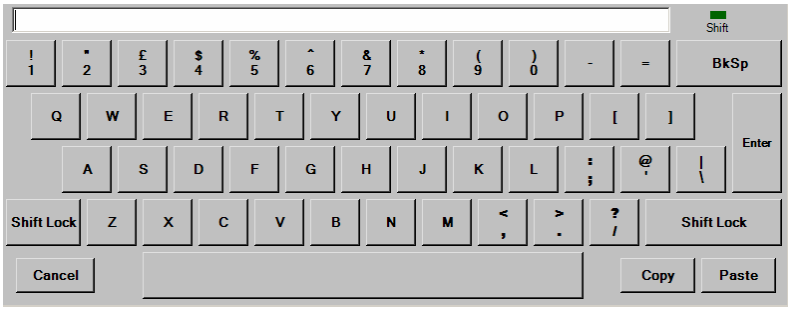


Note that the Function Name, minimum and maximum values are displayed depending on the function selected.

If an illegal value is entered, the value is highlighted in red:

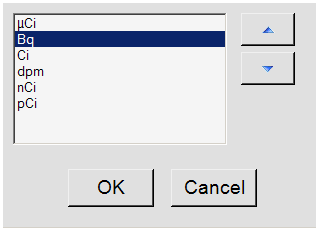
Alpha-numerical Functions

When touching the screen in an alpha-numerical field, the following keyboard appears:



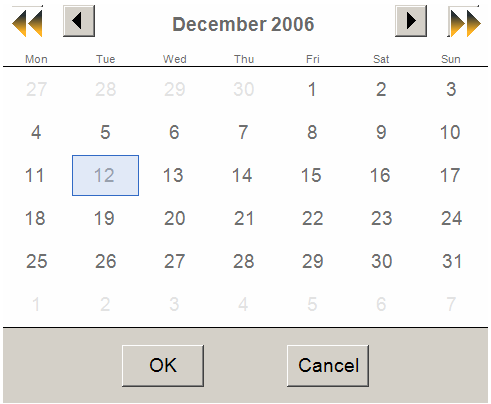
Pre-defined Functions

When touching the screen in a pre-defined field, the following window appears:



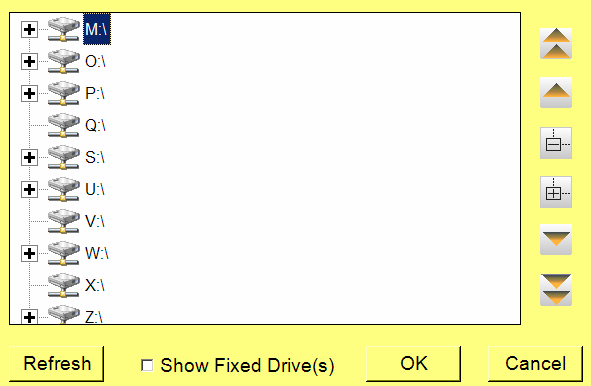
Date Functions

When touching the screen in a date field, the following date selection window appears:



File Location Functions

When touching the screen in a File Location field, the following Drive selection window appears:



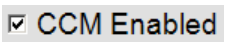
Button Types

The Button types are listed below:

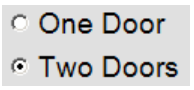
Direction Arrows steps through the menu options

Drop-down lists allows you to select a pre-defined option from the list.

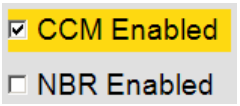
Action button show the process taken when selected.



Tick Boxes show independent options that you can choose to set, or mark. The choice can be toggled on and off by touching on the box.



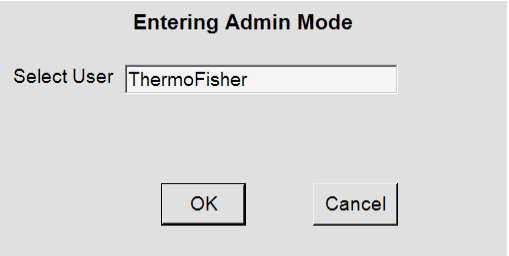
Radio Buttons show mutually exclusive options; choosing one option automatically clears the others. The black dot shows the selected option.



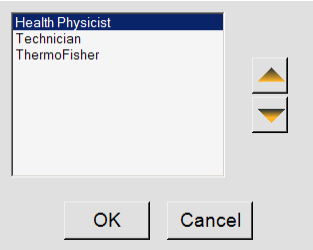
Note that changes made to fields are highlighted until applied or cancelled.

Gaining Access to the Administration Mode

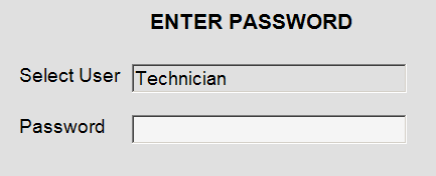
Administration mode is entered by pressing on 'SAM12' in the bottom left-hand corner of the touchscreen when the SAM12 is in Background Checking mode. The Entering Admin Mode window is displayed requesting to select a User:



To select a different user to the one displayed, press the User field of the touchscreen. Select Health Physicist, Technician or ThermoFisher using the Up/Down arrow and select OK. See Foreword (page i) for more information regarding the roles.

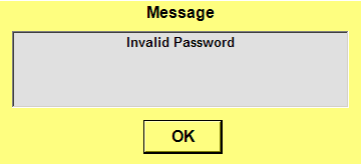


In the Entering Admin Mode window, select OK for the ENTER PASSWORD window (see below) and the Alpha-numeric keyboard to be displayed:



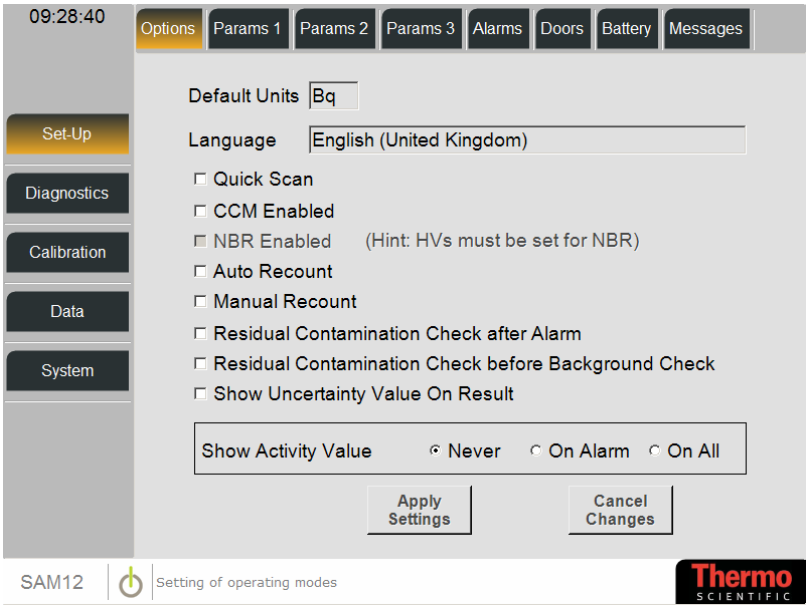
Enter the password using the keyboard and select OK to enter the Administration Mode – note that the Diagnostics – Detector Bar window is initially displayed. The various options available in the Administration Mode are displayed in Menu Roles (page 5-5).

Entering an invalid password will display the following message:



Press OK to re-display the Enter Admin Mode screen.

Moving through the Menus



To move through the menus, select the Main menu option on the left-hand side of the window to display the sub-menus

available. Then select the sub-option from the top. Note that a full list of menu and sub-menu options is displayed in Menu Roles below.

Menu Roles The following options are available depending on the role selected:

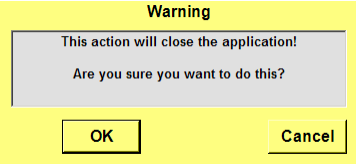
			Role Name		
Main Menu	**Sub-menu**	**See Page**	**Health Physicist**	**Technician**	**Thermo Fisher**
Set-Up	Options	5-6	√		√
	Params1	5-8	√		√
	Params2	5-10	√		√
	Params3	5-11			√
	Alarms	5-12	√		√
	Doors	5-13	√		√
	Battery	5-14			√
	Messages	5-15	√		√
Diagnostics	Detectors Bar	5-16	√	√	√
	Information	5-16	√	√	√
	Timed Counts	5-17	√		√
	Variance Test	5-17	√		√
	Vault	5-18	√	√	√
	Battery Charger	5-19	√		√
Calibration	Efficiencies	5-19	√	√	√
	Cal Check	5-19	√	√	√
	Calibration Selection	5-24	√		√
	HV Scan	5-25	√		√
	Thresholds	5-28			√
	Hv Power	5-28	√	√	√
	Attenuation	5-28	√		√
CCM	Setup	5-30			√
	Information	5-30			√
	Diagnostics	5-31			√
Data	Reports	5-31	√		√
	Archives	5-40	√		√
System	Actions	5-40	√		√
	Setup	5-41	√		√
	Version	5-42	√		√
	Passwords	5-42	√		√

			Role Name		
Main Menu	Sub-menu	See Page	Health Physicist	Technician	Thermo Fisher
	Data Retention	5-42	√		√
	Interfaces	5-43	√		√

Exiting the Administration Mode

To exit Administration mode, press on 'SAM12' in the bottom left-hand corner of the touchscreen. Login to the Administration mode – see Gaining Access to the Administration Mode (page 5-3).

Select the System main menu option and then the Actions sub-menu option. Select the Exit Application button. A warning message is displayed asking for confirmation:



Select OK to exit and Cancel to abandon the exit process. For further information, see Actions (page 5-40).

Upon exiting from the Keypad Parameter Mode, a Residual Contamination check will be enforced if the previous operational state was an Alarm or Residual Contamination condition – see Notes regarding Residual Contamination Check (page 5-60).

Setup Menu

Options

Select Set-Up|Options to customise the SAM12's operation:

Description of options:

Field Name	Description
Default Units	Use the pre-defined window to select a unit from one of the following:

	dpm Bq kBq pCi nCi µCi mCi Ci This changes the displayed activity units for the SAM12. Default: dpm
Language	Use the pre-defined window to select a language. This changes the displayed language for the SAM12.
Quick Scan	This option may be enabled to allow "real-dirty" or "real-clean" to be identified before end of monitoring period. Also see Quick Scan Period in Params 2 (page 5-10). QuickScan is disabled during automatic and manual recounts. *Note that it is not possible to tick Quick Scan and CCM Enabled at the same time.* Default: OFF
CCM Enabled	**If this option is greyed out, then your SAM12 is not configured to use Cobalt Coincidence Monitoring. If you require this utility, please contact Thermo Fisher Scientific for further information.** This option toggles the CCM menu on/off. If the CCM board is installed, tick this option to enable the Cobalt Coincidence Monitoring. See Cobalt Coincidence Monitoring (CCM) (page 6-9). *Note that it is not possible to tick CCM Enabled and Quick Scan at the same time.* Default: OFF
NBR Enabled	*Note that this option is not available until High Voltages are selected during an HV Scan – see HV Scan (page 5-25) for further information.* Tick this option to enable the Natural Background Reduction (NBR). This will enable NBR algorithms to be used to determine the proportion of activity that is due to Naturally Occurring Radioactive Material (NORM). If the presence of NORM is detected, then an estimation of its

	activity shall be made and subtracted from the total activity to give a figure for artificial activity which will be displayed along with the total activity value. Default: OFF	
Auto Recount	Tick this option to enable an automatic recount to be performed before a result if the following is true: *High Level Alarm > measurement > Normal Alarm* Default: OFF	
Manual Recount	Tick this option to allow the user to initiate a recount after a measurement has been completed but before the door is opened and the article is removed. Default: OFF	
Residual Contamination Check after Alarm	Tick this option to enable a Residual Contamination Check to be automatically performed following an Alarm. For further information regarding Residual Contamination Checks, see Residual Contamination Check (page 5-59).	
Residual Contamination Check before Background Check	Tick this option to enable a Residual Contamination Check to be automatically performed before Normal Background Monitoring commences. See Normal Background Monitoring (page 5-49). Default: OFF	
Show Uncertainty Value on Result	*Note that the "Show Uncertainty Value on Result" and "Show Activity Result" option combine to display the information on the result screen.* When this option is ticked, the Uncertainty value is included in the result if the Activity is also displayed. See Monitoring Result (page 5-55) for more information. Default: OFF	
Show Activity Result	Click on one of the radio buttons to select one of the following: Never – the Activity Value will not appear in the result screen On Alarm – the Activity value will only be displayed if an alarm occurs On All – the Activity Result will be displayed for all results. See Monitoring Result (page 5-55) for more information. Default: Never	

Params 1

Select Set-Up|Params1 to customise the first set of Operational Parameters:

Description of options:

Field Name	Description
Low- Background Alarm (cps)	If a background measurement falls below this value (counts per second), a detector failure will occur. Values: 0 to 99,999 cps (0 to disable) Default: 50cps
Gross Changing Background (σ)	This statistical variable is used by SAM12 to determine if a changing background condition exists on all detectors. Values: 0.1 to 7 sigma in 0.1 sigma steps Default: 5 σ
Detector Changing Background (σ)	This statistical variable is used by SAM12 to determine if a changing background condition exists on a single detector. Values: 0.1 to 7 sigma in 0.1 sigma steps Default: 7 σ
Changing Conditions (σ)	This statistical variable is used by SAM12 to determine if a changing measurement condition exists. Values: 0.1 to 7 sigma in 0.1 sigma steps Default: 7 σ
Changing Conditions Period (s)	This is the length of time used by SAM12 to determine if a changing measurement condition exists. Values: 2 to 30 s Default: 3 s
RCC Contamination Threshold (σ)	This is the statistical increase during a Residual Contamination Check compared to the background measurement. Values: 0.1 to 7 sigma in 0.1 sigma steps Default: 7 σ
Calibration Check Accuracy (%)	This is the required accuracy to which the calibration is carried out.
Default Calibration Source	Use the pre-defined window to select a default source. For a list of Sources, see Cal Check (page 5-19). Values: from source database
Calibration Required Interval	This is the number of days since that last calibration date before the unit needs to be calibrated again. See Out of Calibration (page 5-48) to view the

	message displayed on the unit when out of date and Cal Check (page 5-19) for information of the last Calibration Date. Values: 1 to 400 days (0 to disable) Default: 0
Max Clear-Result Display Time (s)	This is the maximum length of time (in seconds) that the Clear result is displayed before reverting to the Ready screen. Values: 0 to 500 s Default: 300 s

For further information regarding these options, contact Thermo Fisher Scientific.

Params 2

Select Set-Up|Params2 to customise the second set of Operational Parameters

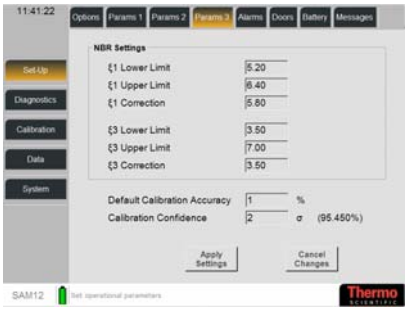
Description of options:

Field Name	Description
Probability of Detection (σ)	This is the probability that exactly one alarm Level of contamination will cause and alarm. For further information, see Description of Parameters Used in Calculations (page 6-2). *Note that the probability is also expressed as a percentage in parentheses* Values: 0 to 10 sigma in 0.1 sigma steps. Default: 1.65 σ
Probability of False Alarm (σ)	This value is the probability that a false alarm will NOT be given during a measurement. This probability is used by SAM12 to determine the monitoring time and the Effective Alarm Level and Minimum Detectable Activity. For further information, see Description of Parameters Used in Calculations (page 6-2). *Note that for simplicity, the Probability of False Alarm is expressed as a percentage in parentheses.* Values: 0 to 10 sigma in 0.1 sigma steps. Default: 3.1 σ
Minimum Monitoring Time (s)	*Note that the Minimum monitoring time must be equal to or be less than Maximum Monitoring Time.* This is the Minimum time for which articles are monitored. This field is used in conjunction with the Maximum Monitoring Time. Values: 3 to 300 s

	Default: 5 s
Maximum Monitoring Time (s)	*Note that the Maximum monitoring time must be equal to or greater than Minimum monitoring time. It must be set to a high enough value to prevent a high background fault.* This is the Maximum time for which articles are monitored. A monitoring time is calculated by the SAM12 to meet the background and the statistical requirements. For given alarm and statistical requirements this parameter will limit the background count-rate allowed. To achieve a fixed monitoring time, set the minimum and maximum monitoring times to the same value. Values: 3 to 300 s Default: 100 s
Measurement Start Timeout (s)	This is the length of time (in seconds) that the user has to press the Start button after closing the door. If the timeout is exceeded, the SAM12 reverts to Normal Background Monitoring. Values: 3 to 360 s Default: 10 s
Quick Scan Period (s)	This is the length of time (in seconds) for the Quick Scan to run (see Options (page 5-6)). Values: 3 to 60 s Default: 10 s
Background Logging Interval (hours)	Select an interval between 1 and 168 hours for the SAM12 to periodically log the background. Select 0 to disable the periodic logging. *Note that each time a mandatory 100 second background is performed the backgrounds for each detector will be logged to the database.* Values: 1 to 168 hours (0 to disable) Default: 0
Measurement Confidence (σ)	The instrument uses this figure to calculate the effective alarm level. It is the number of standard deviations measured against the Alarms (see Alarms (page 5-12)). Values: 0.1 to 7 sigma in 0.1 sigma steps. Default: 2 σ
Out of Service Recovery Interval (mins)	When the unit is Out Of Service (page 5-62), the system automatically clears the error after the Out of Service Recovery Interval has passed. Select 0 to disable the Recovery Interval. Values: 0 to 60 mins Default: 0

Params 3

Select Set-Up|Params3 to customise the third set of Operational Parameters



Description of options:

Field Name	Description
NBR Settings	These are factors used to determine if Naturally Occurring Radioactive Material is present.
Default Calibration Accuracy (%)	This is the default Calibration Accuracy used in the Calibration Check utility - see Cal Check (page 5-19). It is used, along with the background measurement, determines the count time required with the SAM12 is being calibrated. Values: 0.5 to 10% in 0.1% steps Default: 1.00 %
Calibration Confidence (σ)	This factor affects the monitoring time of calibration. Values: 0.1 to 4 sigma in 0.1 sigma steps Default: 2

Note that this section is set by at production and should only be changed in consultation with Thermo Fisher Scientific.

Alarms

Select Set-Up|Alarms to select the Active Calibration Stream and set the alarms:

Description of options:

Field Name	Description
Calibration / Nuclide	Use the direction arrows to change the Calibration type. When the type is correct, select the Make Active button *Note that a description of the Calibration Type is displayed in the field below.*
Normal Alarm (default unit)	This is the detected activity at which SAM12 will indicate an Alarm. Values: 0 to 10,000,000 (Any unit).

	Default: 5000.0 dpm
High Level Alarm (default unit)	This is the detected activity at which SAM12 will indicate an High Level Alarm The Enabled tickbox must be checked for this option to take effect. Values: 0 to 10,000,000 (Any unit). Default: Must be input
CCM Alarm (default unit)	This field is enabled if CCM Enabled is ticked - see Options (page 5-6). This is the detected activity at which SAM12 will indicate a CCM Alarm. Values: 0 to 10,000,000 (Any unit). Default: Must be input
CCM High Level Alarm (default unit)	This field is enabled if CCM Enabled is ticked - see Options (page 5-6). This is the detected activity at which SAM12 will indicate a CCM High Level Alarm. The Enabled tickbox must be checked for this option to take effect. Values: 0 to 10,000,000 (Any unit). Default: Must be input

Doors

Select Set-Up|Doors to select the Number of Doors, whether Locks are fitted and their behaviour

Note that this section is set by at production and should only be changed in consultation with Thermo Fisher Scientific.

Description of options:

Field Name	Description
Number of Doors	Use the Radio buttons to select either One Door or Two Doors. Default: Two
Locks Fitted :	
Front Door	Tick this box if the Front Door has a lock fitted. Also referred to as the "Dirty" door. Default: ON
Rear Door	*Note that this option is only visible if Two Doors is selected in Number of Doors.* Tick this box if the Rear Door has a lock fitted. Also referred to as the "Clean" door

	Default: ON
Lock Behaviour:	
Lock Doors for Measurements	Tick this box if the door(s) are to be locked during a measurement. If the measurement is Clear, both doors are unlocked. Default: ON
Lock doors for Residual Contamination check	Tick this box if the door(s) are to be locked while a Residual Contamination check takes place –see Notes regarding Residual Contamination Check (page 5-60). Default: OFF
Lock Front Door on Alarm	If the SAM12 alarms during a measurement, select one of the following options for whether the front door locks: - Never - High (i.e. locks on High alarms only) - All Alarms (i.e. locks on all alarms) Default: Never

Notes regarding Two-Door SAM12

The two door SAM12 is intended for "barrier" applications and has optional door interlocking to ensure clearance integrity. It operates in the same way as the single door version, except when a CLEAR result is obtained the articles may be removed from the Back (clean) door, as well as the Front (dirty) door.

Battery

Select Set-Up|Battery to configure the Battery Charger

Note that this section is set by at production and should only be changed in consultation with Thermo Fisher Scientific.

Description of options:

Field Name	Description
Discharge Timeout (Secs)	This is the amount of time after the battery discharges to the minimum discharge voltage before the charger turns off the output power. If the charger is already running on battery power, the value of the timeout will not e changed The timer can only be stopped if the mains power is returned
Max. Charge Current	This is the maximum current allowed for charging

(A)	the battery. The charge current is monitored constantly and the PSU output voltage is reduced if this current is exceeded.
Min. Discharge Volume (V)	This is the voltage at which the timer starts, when the battery is being discharged.

Messages

It is possible to amend the Headline(s) and Instructions for the following messages:

- Normal Alarm
- High Level Alarm
- Clear
- Co60 Alarm
- High Co60 Alarm

Select Set-Up|Messages to select a message to configure:

Use the direction arrow to find a Message to configure. Once selected, the text can be updated by pressing on the Headline, Headline 2 and Instruction fields. To save the changes, press Apply Changes.

To set the selected message back to its default setting, press the Set Default button.

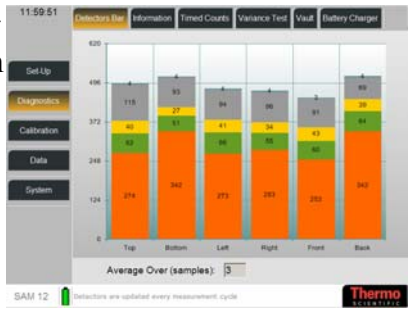
Available Messages:

Message	Headlines and Instructions
Normal Alarm	ALARM - This article is contaminated – Please call HP
High Level Alarm	HIGH ALARM LEVEL - Please call HP
Clear	CLEAR - Please remove article
Co60 Alarm	Co60 ALARM – This article is contaminated
High Co60 Alarm	HIGH Co60 ALARM – Please Call HP

Diagnostics Menu

Detector Bar

Select Diagnostics|Detectors Bar to view the Detectors information



The Detectors are updated every measurement cycle.

Note that the Background Count rate is averaged and updated over the cycle time selected in the Average Over field.

Information

Select Diagnostics|Information to view the current Measurement Information

Description of options:

Field Name	Description
MDA (default unit)	*Note that this is a view only field.* The Minimum Detectable Activity (MDA) is a value derived by the SAM12 and is the smallest activity that can be statistically accurately detected with the current settings and background. The MDA is calculated using the probability of detection, probability of false alarm, monitoring time and the average background etc. Dashes are shown if this value is not available.
Detection Limit (cps)	*Note that this is a view only field.* This is the MDA expressed in counts per second.
Measurement Period (s)	*Note that this is a view only field.* This is the length of time for the sample calculated from the current alarm conditions and background measurement.
Background Rate (cps)	*Note that this is a view only field.* This is the current background rate. The value is set at 0 if a background has not yet been acquired.
Net Effective Alarm Rate (cps)	*Note that this is a view only field.* This is the effective alarm rate calculated using the Normal Alarm setting taking account of current

	alarm conditions and background measurement - see Alarms (page 5-12).

Timed Counts

Select Diagnostics|Timed Counts to view Detectors averaged over a selected specified period. This function allows a count to be made which can be used to ascertain the efficiency and functionality of the SAM12

To toggle between the individual Detector's Thresholds and the Gross Sum of all Detectors views, press the Detectors|Gross Sum button.

To Start the Timed Counts for the Detectors:

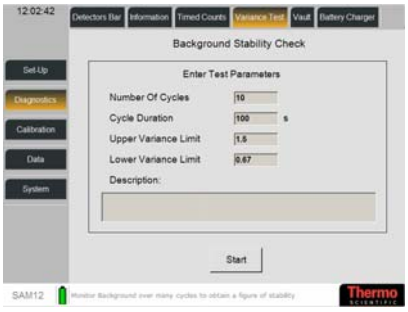
1. Select the number of SAM12 to be averaged by selecting a value in the Average Over field.
2. If you require a Continuous count to be made, tick the Continuous box.
3. Press Start button

To toggle between the Thresholds and Windows display, tick the relevant radio button.

Variance Test

The variance check is a method by which the overall stability of the background can be assessed by running a sequence of background measurements and then assessing the variance of the measured backgrounds over the sequence.

Select Diagnostics|Variance Test to setup the background monitoring over a number of cycles to obtain a figure of stability



Description of options:

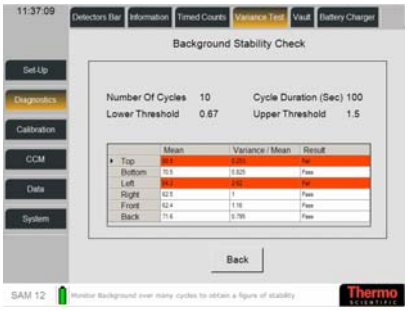
Field Name	Description
Number of Cycles	Enter the number of background measurements to be used in the test.
Cycle Duration (seconds)	Enter the duration of each measurement.
Upper Variance Limit	Enter the Upper Variance Limit for the result.

	Note that this value should initially be set to 1.5.
Lower Variance Limit	Enter the Lower Variance Limit for the result. Note that this value should initially be set to 0.67.
Description	Enter a description of the test.

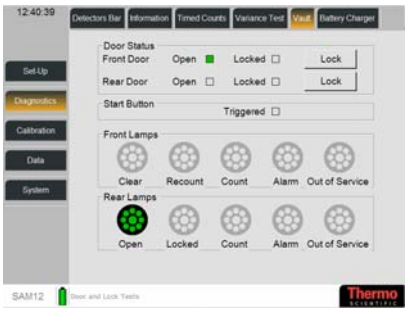
Once the options have been set, press Start for the Background Stability Check to run. A progress window is displayed:

Press Abort button to abandon the check. If the check is left to run, the results are displayed as follows:

Press Back button to return to the Test Parameters window.



Vault Select Diagnostics|Vault to test the Door and Locks

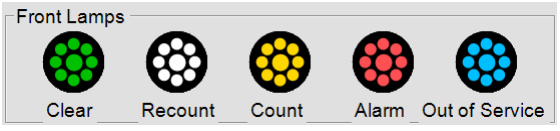


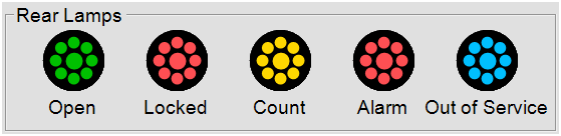
Note that in a one-door SAM12, the Rear Door option is not displayed.

To test the Door Status and Start Button, the display will indicate the door Status and Start Button as follows:

- Front Door Open/Closed and Locked/Unlocked
- Back Door Open/Closed and Locked/Unlocked
- Start Button Pressed/Not Pressed

To test the Front and Rear Lamps, press the lamp icon which will light up and the speaker will beep.





Battery Charger

Select Diagnostics|Battery Charger to view the current status of the battery charger:

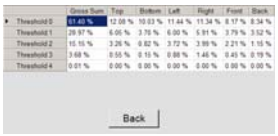
When the mains power is ON, the system charges the battery.

When no mains power is present, the system operates from the battery.

Calibration Menu

Efficiencies

Select Calibration|Efficiencies to view the selected Detector Efficiencies.



Use the direction arrows to select a Calibration. Once selected, press the Details button to view the Gross Sum Efficiency % for the selected Calibration.

The View Active Calibration button automatically displays the active Calibration.

Cal Check

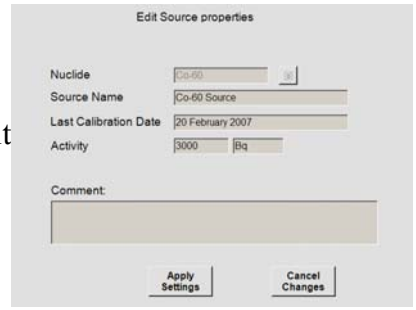
This option allows the user to edit existing Calibration sources and create new ones. There are also functions available to allow the user to check or overwrite the current calibration factor.

Select Calibration|Cal Check to edit the Calibration setting against a selected source and to conduct a calibration check.

The Decay Corrected Activity is displayed on this screen.

Note that the Calibrate button is not available to the Technician role.

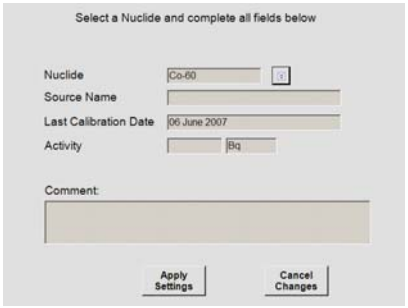
To edit Calibration Source properties, use the direction arrows to select a Calibration Source. Once selected, press Edit button to display the Edit Source properties window:



Description of options:

Field Name	Description
Nuclide	This option is only available when creating a new Calibration Source (see below). This changes the displayed activity units for the SAM12.
Source Name	Enter a Source name.
Last Calibration Date	Select a Calibration Date from the date picker.
Activity	Enter an Activity value. Use the pre-defined window to select a unit from one of the following: • dpm • Bq • kBq • pCi • nCi • µCi • mCi • Ci
Comment	Enter a Comment to describe the Source, if required.

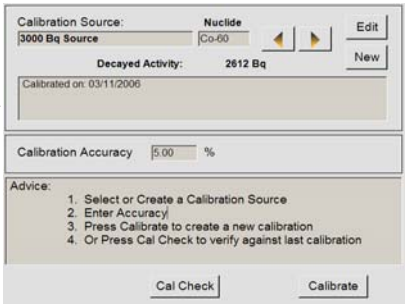
To create a new Calibration Source, press New button to display the Select a Nuclide and complete all fields below window.



Select a pre-defined option from the list provided and enter the required options (see above for Description of options). Select OK to create the new Calibration Source or Cancel to quit without saving.

All calibration results are logged to the database. The "Calibrate" function allows users to overwrite the Calibration factor. The "Cal Check" function informs the user of any discrepancy with the current calibration factor.

To Check the SAM Calibration, select a Calibration Source and Calibration Accuracy. Then press Calibrate button to display the Ready to Start window.

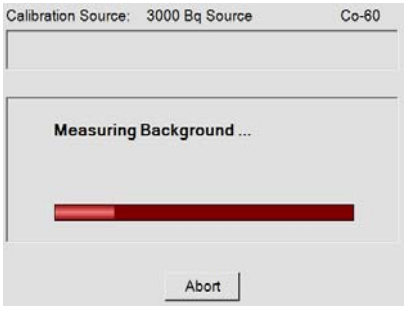


The Calibration Accuracy, along with the background measurement, determines the count time required when the SAM12 is being calibrated.

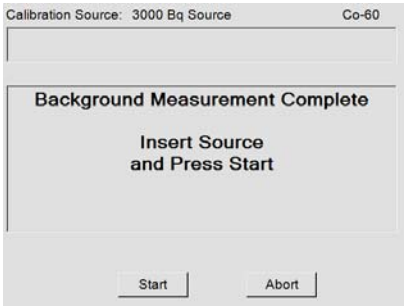
Remove all items from the SAM12 and press the Start button.

Note that the Abort button can be pressed at any time during the process to return to the previous window.

The SAM12 does a one second background measurement which is used in conjunction with the Calibration Accuracy value when calculating the time required for the source count.

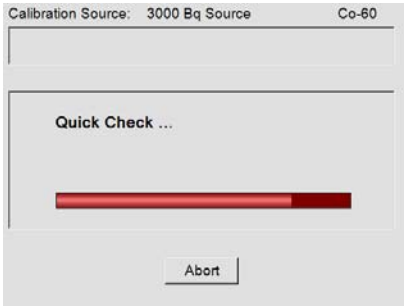


When the Background Measurement is complete, place the source in the SAM12 and press Start.

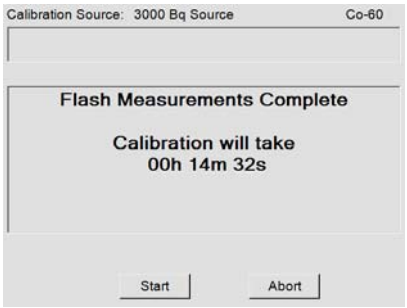


The SAM12 performs a Flash Measurement to calculate the Calibration time.

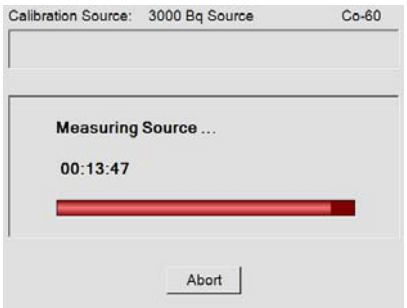
Note that the Calibration time is the sum of the Background and Source measurements. The minimum time is 20 seconds.



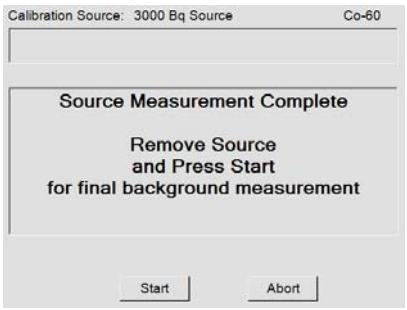
When the Flash Measurements are complete and the Calibration time is displayed, press the Start button.



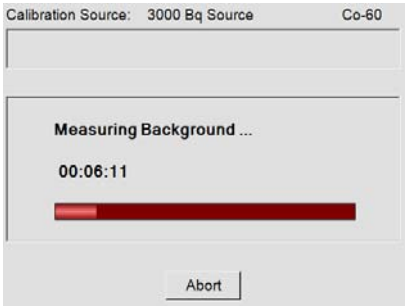
The calculated count time decrements while the source is measured.



When the Source Measurement has been completed, remove the Source and press the Start button for the final background measurement.



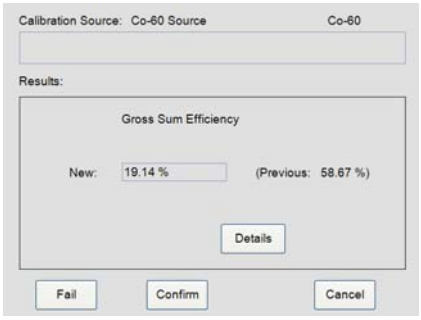
The SAM12 measures the background and the calculated count time decrements



If the calculated efficiency has an illegal value (i.e. no net counts), the efficiency will be set to zero.

If a result is calculated, the new calibration data is displayed.

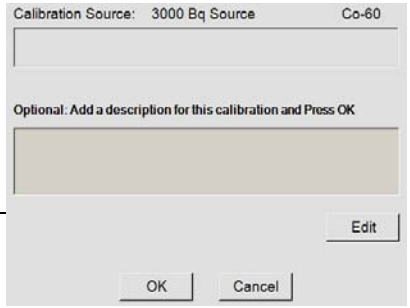
Note that during a Cal Check only an OK button is displayed which returns to the Calibration|Cal Check screen.



Note that the Cancel button will abandon the process.

Press the details button to reveal the detailed results.

If you are satisfied with the result, press the Confirm button to display the Add Description for the Calibration page. Select OK to complete the process.

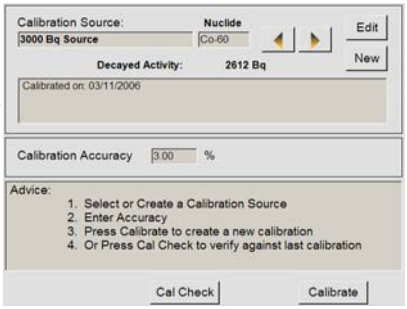


Note that the results are stored in the database and marked as PASS.

If you are NOT satisfied with the result, press the Fail button. The Calibration Source page is re-displayed.

Note that the results are stored in the database and marked as FAIL.

To check the current Calibration, select a Calibration Source and Calibration Accuracy. Then press Cal Check button to display the Ready to Start window.



Remove all items from the SAM12 and press the Start button.

Note that the Abort button can be pressed at any time during the process to return to the previous window.

When the Start button is pressed, the process is similar to that described above in To Check the SAM Calibration (page 5-21).

Description of Error messages:

Error Message	Resolution
Unable to calculate a valid monitoring time	1. There is no source available 2. The source does not have enough activity 3. If a cobalt calibration has been activated and the source is not cobalt60
This is not the default Calibration Source	This is a warning message only

Calibration Selection

Select Calibration|Calibration Selection to view current Calibration and create new customised Calibration

Note that the Active Calibration with its Gross Sum Efficiency % is displayed in the top box.

To change the Active Calibration, use the direction arrows to select a Calibration. Once selected, press Make Active button. The selected Calibration and its Gross Sum Efficiency will be displayed in the top box.

To edit a Calibration Mix, select a Calibration. Press in the Calibration field to edit the Calibration name. In the Calibration Mix section, use the drop-down list to change the Nuclide. Press in the Percentage field to edit the percentage. When complete, press Apply Settings button to save or Cancel button to quit without saving.

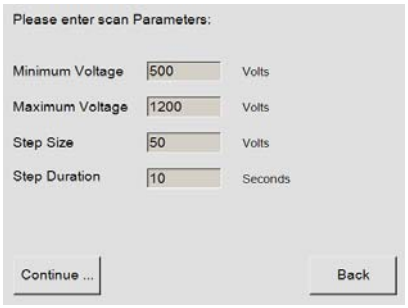
To create a new Calibration Mix, highlight in an empty Calibration Mix window (or an existing Calibration Mix to overwrite) and click on the Create New Mix button. Press in the Calibration field to create a new Calibration name. In the Calibration Mix section, use the drop-down list to add a new Nuclide. Press in the Percentage field to edit the percentage. When complete, press Apply Settings button to save or Cancel button to quit without saving.

To delete an existing Calibration Mix, highlight the Calibration Mix for deletion and press the Delete Mix button.

HV Scan

Select Calibration|HV Scan to view and create HV Scans. It is also possible to set HVs for detector amplifiers. The scan allows repeated counts at an increasing or decreasing HV to be recorded to ascertain detector operating point and efficiency

To start a new HV Scan, press the New HV Scan button to display the Please enter scan Parameters window:



Description of options:

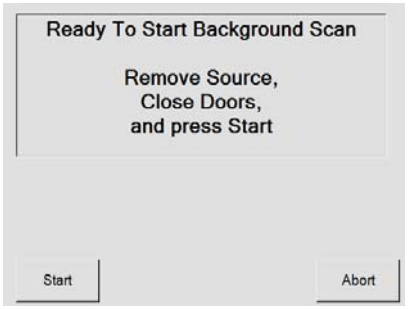
Field Name	Description
Minimum Voltage (Volts)	Enter a minimum voltage.
Maximum Voltage (Volts)	Enter a maximum voltage. *Note that this value should at least be Minimum Voltage + Step Size.*
Step Size (Volts)	Enter a step size for the scan.
Step Duration (seconds)	Enter the length (in seconds) for each step.

Once the above scan parameters have been established, two scans will be made against each amplifier threshold for all

amplifiers at each HV step over the specified integration period:

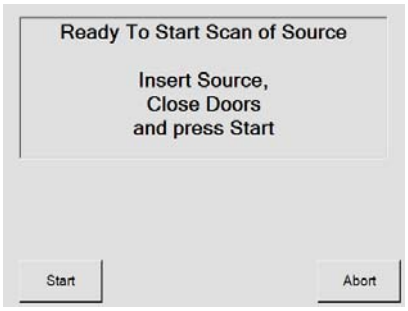
- A background HV Scan
- A source HV Scan

When the options have been entered, press Continue button to display Ready to Start Background Scan window:



Remove any current Source from the SAM12, close the doors and press the Start button. A background HV scan will be performed, recording the counts against **each amplifier threshold** for all amplifiers at each HV step over the specified integration period. A progress window is displayed:

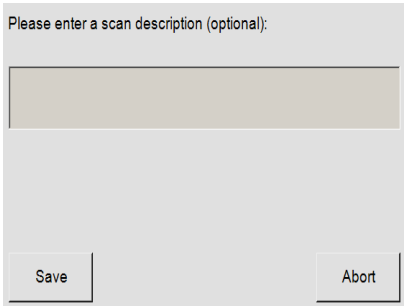
Once the Background Scan is completed, the Ready to Start Scan of Source is displayed:



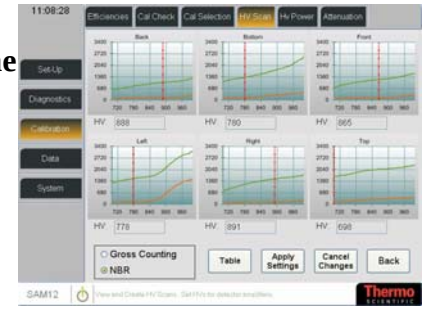
Insert the Source to be scanned into the SAM12, close the doors and press the Start button. A source HV scan will be performed, recording the counts against **each amplifier threshold** for all amplifiers at each HV step over the specified integration period. A progress window is displayed:

Once the Scan is completed, a Save Scan button appears giving the option to save the scan or Abort the process.

To Save the Scan, press Save to display the Please enter a scan description window:



Enter a Scan Description and press Save button to display the Scan results:



Select either Gross Counting or NBR option and Apply Settings to save the Scan.

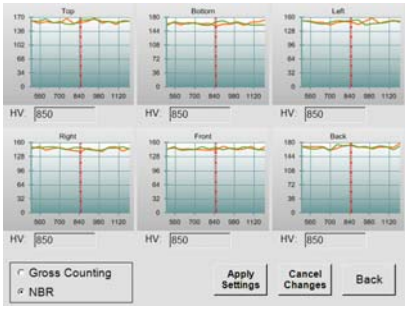
Note that selecting NBR enables the NBR Enabled option in the Options screen (see Options (page 5-6)).

Press Cancel Changes to quit without saving or press Back to return to the Start new scan screen.

To view the HV Scan as a Table, press the Table button to display the scan results:

To view the HV Scan as a Graph, press the Graph button to display the scan results:

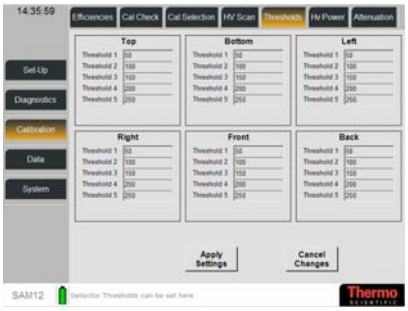
To view the last saved HV Scan, press the Last HV Scan button to display the scan results:



See Performing the HV Scan (page 9-4) for more information regard the HV Scan.

Thresholds

Select Calibration|Thresholds to set the Detector Thresholds:



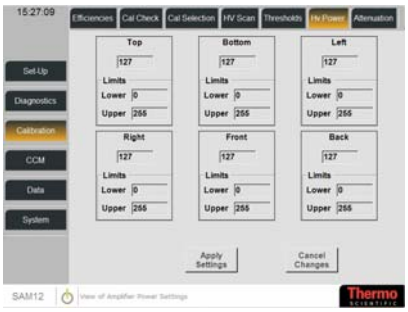
This screen allows the individual voltage of any detector to be viewed and updated.

To change any of the settings, press in the field and update the value. Press Apply Settings button to save or Cancel Changes button to quit without saving.

Note that no threshold value should be set to a voltage that is less than that of the preceding threshold. For example, Threshold 5 must be set greater than or equal to Threshold 4. Failure to follow this advice may invalidate measurements. Please contact Thermo Fisher Scientific before changing threshold values.

Hv Power

Select Calibration|Hv Power to view the Amplifier Power Settings



This screen allows the lower and upper limits for the Hv Power to be viewed and updated. It measure the current being delivered to the Hv Generator.

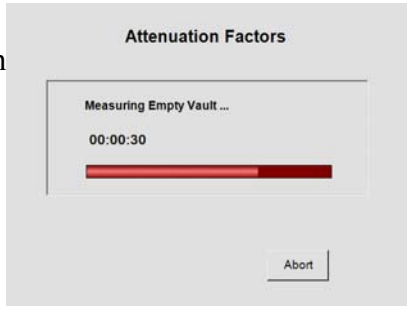
Attenuation

Select Calibration|Attenuation to set a sequence to obtain Attenuation Factors (note that a Phantom object is required for this process):

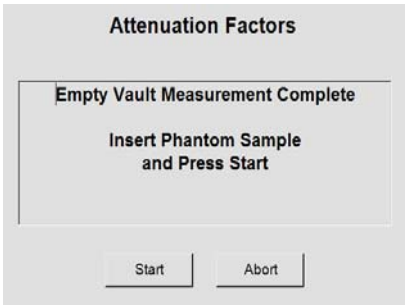
To Calculate New Factors, press Calculate new Factors button to display the Ready to Start window:

Remove all items from the SAM12 and press the Start button to commence measuring the empty vault.

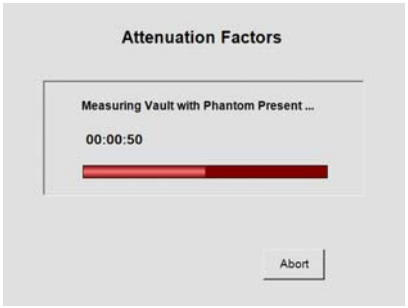
The SAM12 measures the Empty Vault and the calculated count time decrements.

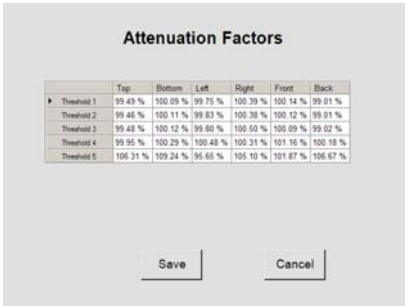


The progress window is displayed until the Empty Vault Measurement Complete window is displayed. Insert the Phantom Sample into the vault and press the Start button to comment measuring the vault with the Phantom present.



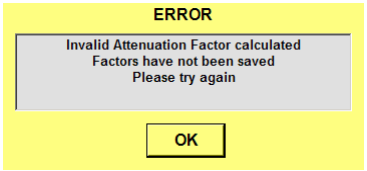
A progress window is displayed until the Attenuation Factors is displayed:





To Save the Attenuation Factors, press the Save button.

If the Attenuation Factors are invalid, the following error message is displayed and it is not possible to save the factors:

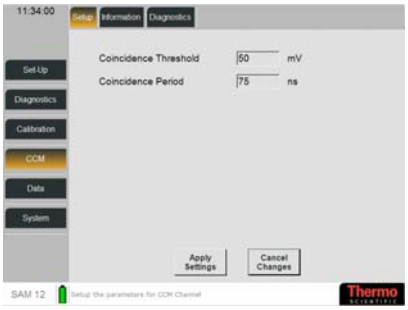


CCM Menu

Note that this menu option is only displayed if the CCM Enabled option is ticked in the Options page - see Options (page 5-6).

CCM Setup

Select CCM|Setup to select the parameters for the CCM Channel



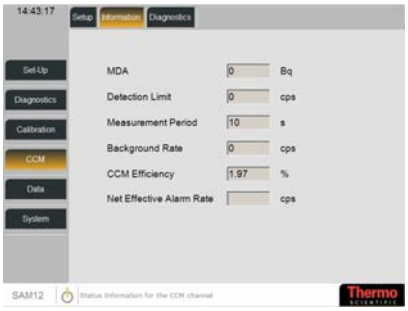
Note that this section is set by at production and should only be changed in consultation with Thermo Fisher Scientific.

Description of options:

Field Name	Description
Coincidence Threshold (mV)	This is the high threshold for summed pulses.
Coincidence Period (ns)	This is an estimate of the Coincidence Period set in nanoseconds.

Information

Select CCM|Information to view the status information for the CCM Channel



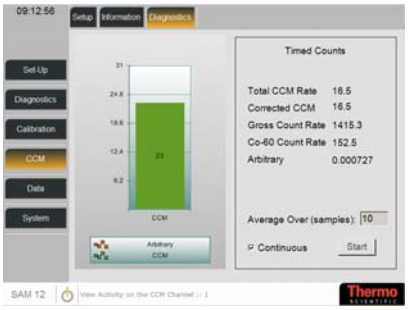
Description of options:

Field Name	Description
MDA (default units)	*Note that this is a view only field.* The Minimum Detectable Activity (MDA) is a value derived by the SAM12 and is the smallest activity that can be statistically accurately detected with the current settings and background. The MDA is calculated using the probability of detection, probability of false alarm, monitoring time and the average background etc. Dashes are shown if this value is not available.
Detection Limit (cps)	*Note that this is a view only field.* This is the MDA expressed in counts per second

	(for the CCM Channel only).
Measurement Period (s)	*Note that this is a view only field.* This is the length of time for the sample calculated from the current alarm conditions and background measurement (for the CCM Channel only).
Background Rate (cps)	*Note that this is a view only field.* This is the current background rate (for the CCM Channel only). The value is set at 0 if a background has not yet been acquired.
CCM Efficiency (%)	*Note that this is a view only field.* This is the Efficiency for the CCM Channel.
Net Effective Alarm Rate (cps)	*Note that this is a view only field.* This is the effective alarm rate for the CCM Channel calculated using the CCM Alarm setting taking account of current alarm conditions and background measurement (see Alarms (page 5-12)).

Diagnostics

Select CCM|Diagnostics to view the activity on the CCM Channel. This function allows a count to be made which can be used to ascertain the efficiency and functionality of the SAM12:



To Start the Timed Counts for the Detectors:

1. Select the number of SAM12 to be averaged by selecting a value in the Average Over field.
2. If you require a Continuous count to be made, tick the Continuous box.
3. Press Start button

Note that the Arbitrary field displays the pulses obtained by random coincidence from non-Cobalt60 source.

Data Menu

Reports

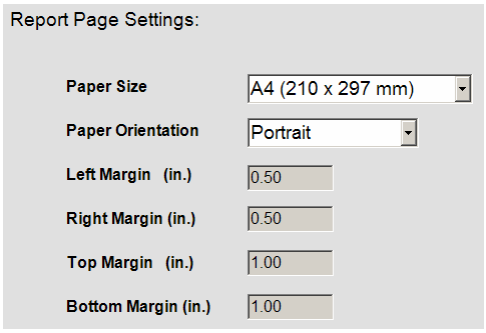
Select Data|Reports to select a Database Report from a pre-defined list:

To run a report, select one from the list and press the Run Report button. The types of Reports available are listed below. Each report displays the following button bar

Report Button Functions

Direction Arrows steps through the report pages

Page Setup display the Report Page settings:



Enter the required settings and press OK

The Print button sends the report to the printer.

The Save button displays the Drive selection window to allow you to select a Drive for the saved report. The report will be saved as an Excel spreadsheet with the following name:

<Report Type><YYMMDDHHMM>.xls

e.g.

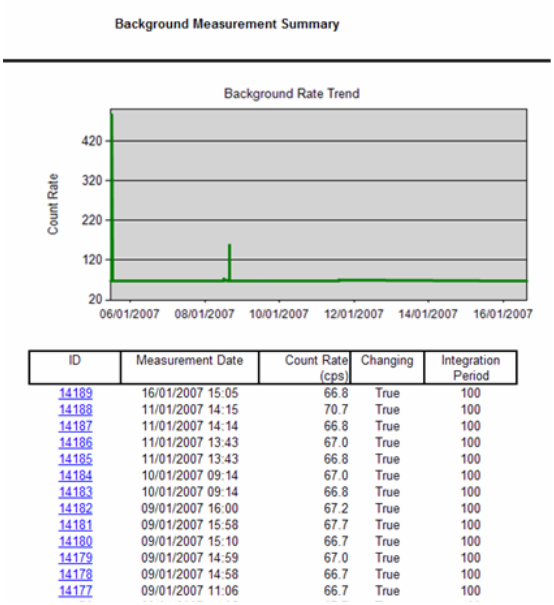
ResultsSummary0612031151.xls

Stop cancels the processing of the report.

Back returns the user to the previous screen.

Background Summary Report

This report shows the Background Rate Trend between the selected Start and End Dates. It is possible to limit the report by Start and End Date.



ID	Measurement Date	Count Rate (cps)	Changing	Integration Period
14189	16/01/2007 15:05	66.8	True	100
14188	11/01/2007 14:15	70.7	True	100
14187	11/01/2007 14:14	66.8	True	100
14186	11/01/2007 13:43	67.0	True	100
14185	11/01/2007 13:43	66.8	True	100
14184	10/01/2007 09:14	67.0	True	100
14183	10/01/2007 09:14	66.8	True	100
14182	09/01/2007 16:00	67.2	True	100
14181	09/01/2007 15:58	67.7	True	100
14180	09/01/2007 15:10	66.7	True	100
14179	09/01/2007 14:59	67.0	True	100
14178	09/01/2007 14:58	66.7	True	100
14177	09/01/2007 11:06	66.7	True	100

Press on one of the ID records to display the Background Measurement Detail for the selected Measurement ID:

Background Measurement Detail

Background ID: 14188 Date/Time: 11/01/2007 14:15

Detector	Threshold	Count Rate (cps)	Integration Period
back	0	75.4	100
back	1	25.4	100
back	2	15.6	100
back	3	10.0	100
back	4	0.6	100
bottom	0	75.0	100
bottom	1	25.0	100
bottom	2	17.1	100
bottom	3	13.0	100
bottom	4	0.7	100
front	0	66.5	100
front	1	28.7	100
front	2	19.6	100
front	3	13.1	100
front	4	0.5	100
left	0	68.0	100
left	1	29.1	100
left	2	19.4	100
left	3	12.9	100
left	4	0.6	100
right	0	66.0	100
right	1	26.4	100
right	2	18.6	100
right	3	13.4	100
right	4	0.5	100
top	0	73.6	100

Calibration History Report

This report lists Calibration History for the SAM12. It is possible to limit the report by Start and End Date, and Full Cal.

Please note that the report below is an example and does not display all the detector information.

Calibration Efficiencies

Calibration ID: 14 Calibration Date: 07/09/2007 12:11:49

Confidence: 2.00

Accuracy: 1.00 % **Full Calibration**

test TSB

	Threshold	Activity Efficiency (%)
GrossSum		
	1	28.42
	2	0.80
	3	0.51
	4	0.00
	5	0.00
back		
	1	5.30
	2	0.14
	3	0.09
	4	0.00
	5	0.00
right		
	1	5.23
	2	0.18
	3	0.11
	4	0.00
	5	0.00
top		
	1	5.72
	2	0.18
	3	0.11
	4	0.00
	5	0.00

Page 1 Of 1

Events Report

This report lists the Event History details between the selected Start and End dates. It is possible to limit the report by Start and End Date.

Event History

Event Time	Description	Additional Info	Category
6/5/2007 2:42:57 PM	Instrument Options Changed		Info
6/5/2007 2:28:05 PM	Active Calibration Changed	CAL_Co-60	Info
6/5/2007 11:39:12 AM	Instrument Parameters Changed		Info
6/5/2007 11:38:23 AM	Changing Background		Info
6/5/2007 11:38:19 AM	Instrument Parameters Changed		Info
6/5/2007 11:34:56 AM	Changing Background		Info
6/5/2007 11:34:46 AM	Changing Background		Info
6/5/2007 11:27:25 AM	Changing Background		Info
6/5/2007 11:21:58 AM	Changing Background		Info
6/5/2007 11:21:45 AM	Changing Background		Info
6/5/2007 11:20:03 AM	Changing Background		Info
6/5/2007 11:08:55 AM	Instrument Options Changed		Info
6/5/2007 11:05:36 AM	Door Violation		Info

HV Scan Report

This report lists the HV Scan details between the selected Start and End dates. It is possible to limit the report by Start and End Date.

HV Scan List

ID	Scan Date	Start HV	End HV	Step HV	Step Period	Description
1	16/10/2006 14:31:11	500	1200	50	10	First scan before calibration has occurred
2	16/10/2006 14:54:45	500	1200	50	10	
3	02/11/2006 13:55:33	500	1200	50	10	
4	02/11/2006 16:35:25	500	1250	50	10	
5	06/11/2006 13:46:31	500	1200	50	10	
6	09/11/2006 16:19:59	500	1200	50	10	
7	14/11/2006 14:29:31	500	1200	50	10	
8	24/11/2006 08:43:49	500	1200	50	10	
9	24/11/2006	500	1200	50	10	

Press on one of the ID records to display the HV Scan Detail for the selected Scan ID:

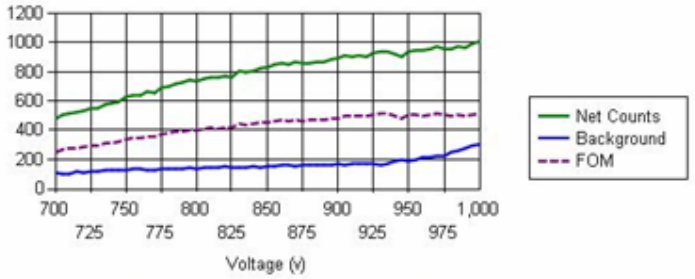
Please note that the report below is an example and does not display all the information.

HV Scan Detail

Scan ID: 20 **Scan Date:** 12/09/2007 11:05:17

Screen dump Scan

Detector: back



Voltage	Background Counts	Source Counts	Net Counts	Figure Of Merit	T1/T2	T2/T4
700	108	588	480	255.7	480.0	1.0
705	105	611	506	272.6	168.7	3.0
710	106	621	515	277.8	-515.0	1.0
715	117	644	527	281.2	527.0	0.5
720	113	649	536	288.1	536.0	1.0
725	118	672	554	297.4	554.0	1.0
730	117	672	555	298.3	277.5	2.0
735	126	706	580	310.4	-193.3	0.8
740	132	720	588	313.3	-294.0	2.0
745	132	731	599	320.0	-149.8	1.3
750	126	760	634	343.8	-317.0	2.0
755	134	774	640	344.4	-320.0	0.7
760	135	777	642	345.2	642.0	1.0
765	132	797	665	360.6	-221.7	1.0
770	131	788	657	356.1	328.5	0.7
885	160	1024	864	473.5	66.5	-6.5
890	166	1036	870	474.6	45.8	-19.0
895	163	1045	882	483.5	25.9	34.0
900	171	1061	890	485.0	24.1	37.0
905	168	1082	914	501.5	16.6	-13.8
910	172	1078	906	494.6	12.4	-24.3
915	172	1082	910	497.2	10.1	-90.0
920	170	1075	905	494.9	7.8	116.0
925	174	1100	926	506.4	6.6	35.0
930	166	1108	942	520.3	5.4	24.9
935	175	1112	937	512.8	5.0	62.3
940	190	1112	922	497.3	4.6	66.3
945	198	1099	901	481.5	4.0	113.0
950	189	1123	934	505.1	3.7	62.5
955	203	1153	950	509.7	3.7	37.0
960	218	1161	943	500.4	3.3	31.9
965	215	1169	954	508.0	3.2	30.2

Instrument Configuration Report

This report lists the current Instrument Configuration settings.

Configuration Settings on

21 December 2006

Configuration Item	Value
Enable Auto Recount on Alarm	True
Background Logging Interval (hours)	0
Calibration Check Accuracy	1
Default Calibration Accuracy (%)	5
Default Calibration Confidence (%)	3
CcmCoincidencePeriod	75
CCM Enabled	True
CCM Fitted	True
Gross Changing Background Sigma	4
Detector Changing Background Sigma	7
Measurement Changing Background Sigma	7
Changing Conditions Check Period	2
DefaultCalibrationSource	
Probability of False Alarm	2.4
Probability of Detection	1.3
Lock Font Door on High Alarm	False
Lock Front Door on Normal Alarm	False
Lock Doors For Measurements	True
Lock Doors for Residual Contamination Check	True
Front Door Lock Fitted	True
Last HV Scan Used NBR	True
Instrument Contaminated	False
Language	en-GB
LockVaultOnAlarm	False
LockVaultOnHighAlarm	False
Low Background Alarm	10
Enable Manual Recount	True
Maximum Monitoring Time (s)	10
Measurement Confidence Sigma	2

Measurement Results Report

This report lists the Activity Results between the selected Start and End dates. It is possible to limit the report by Start and End Dates and by the last n results (note enter 0 for unlimited results):

Activity Results Summary

ID	Measurement Date	Activity (Bq)	Uncertainty (Bq)	Alarmed	Calibration
379	11/01/2007 14:15	3670	53.7	True	CAL_Co-60
378	11/01/2007 14:14	3660	53.4	True	CAL_Co-60
377	11/01/2007 14:14	-0.0977	21.5	False	CAL_Co-60
376	10/01/2007 09:29	-1.24	21.5	False	CAL_Co-60
375	10/01/2007 09:29	4030	78.3	True	CAL_Co-60
374	10/01/2007 09:29	-29.5	29.2	False	CAL_Co-60
373	10/01/2007 09:28	2.12	18.1	False	CAL_Co-60
372	10/01/2007 09:16	8.25	13.6	False	CAL_Co-60
371	09/01/2007 15:37	1820	19.1	True	CAL_Co-60
370	09/01/2007 15:36	1820	19	True	CAL_Co-60

Page 1 Of 1

Press on one of the ID records to display the Activity Results Detail for the selected Results ID:

Activity Results Detail

Results ID: 378

Alarm Zone	Alarm Type	Count Rate (cps)	Alarm Level (cps)	Effective Alarm Level (cps)	Alarmed	Background Rate (cps)	Efficiency (%)
ccm	Normal Alarm	60	8.15	6.97	True	0	2.04
GrossSum	Normal Alarm	2640	921	906	True	395	61
GrossSum	High Alarm	2640	1230	1210	True	395	61

Measurement Results Report

This report lists the Background Variance Test Summary Results between the selected Start and End dates. It is possible to limit the report by Start and End Dates:

Background Variance Test Summary

Test ID	Test Date	Pass / Fail	Lower Limit	Upper Limit	Cycles	Cycle Duration (s)	Description
1	05/06/2007 12:02:59	Fail	0.67	1.5	10	100	

Page 1 Of 1

Press on one of the ID records to display the Background Variance Test Results Detail for the selected Test ID:

Background Variance Test Results Detail

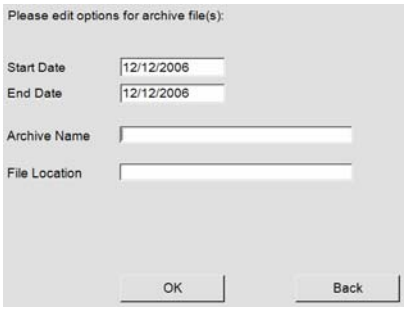
Results ID: 1 Test Date: 05/06/2007 12:02:59

Detector	Pass / Fail	VT	Variance	Mean (cps)
back	Fail	0.5154	10650	207
bottom	Pass	1.421	30000	211
front	Fail	0.6321	11620	184
left	Fail	0.1692	3454	204
right	Pass	0.9519	19030	200
top	Fail	1.83	39760	217

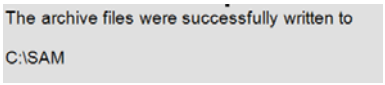
Archives

Select Data|Archives to select an Archive to be saved:

To select archives to be saved, highlight the archive on the screen by pressing individual names or press the Select All button. Press the Save to File button to display the edit options window:



Select a Start / End Date and enter an Archive Name and File Location. Select the OK button to write the archives. A confirmation will be displayed.



System Menu

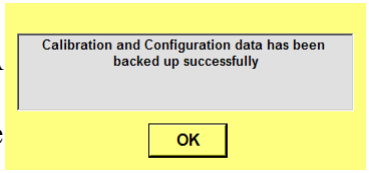
Actions

Select System|Actions to take SAM12 out of Contamination Mode, quit the application or shutdown the system

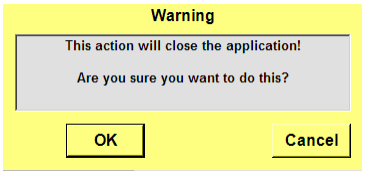
To clear a contamination, press the Contamination Cleared button.

See Params 2 (page 5-10) for information regarding the Out of Service Recovery Interval.

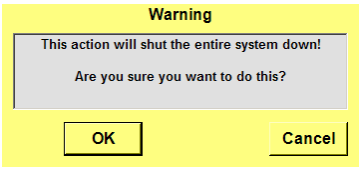
To backup a Calibration, press the Backup Calibration button. A confirmation message will be displayed. Select OK to close the application.



To exit the SAM12 application, press the Exit to Application Login button. A confirmation message will be displayed. Select OK to close the application.



To shutdown the entire system, press the System Shutdown button. A confirmation message will be displayed. Select OK to shut the entire system down.



System Setup

Select System|Setup to set the location, volume, date / time and time zone

To change the Location, enter the location using the alpha-numerical field.

To adjust the volume, move the orange bar to the left to decrease the volume and to the right to increase the volume. To test the volume, press on the loudspeaker icon.

To change the Date, press on the date field and select a date. Note that the format of the date depends on the Language type selected in Options screen - see Options (page 5-6). Select the Apply button to save.

To change the Time, use the Up/Down buttons to change the hours and minutes. Select the Apply button to save.

To change the Time Zone, press on the TimeZone field and select a time zone from the pre-defined list. Select the Apply button to save.

Version

Select System|Version to view the File version information, including the SAM12 Issue and Version numbers

Passwords

Select System|Passwords to change the passwords for the current User Level and levels below

There are three levels of user – Health Physicist, Technician and ThermoFisher. The SAM12 is supplied with unique default passwords for each level - please contact Thermo Fisher Scientific for further information.

To change the Password for a select User, press in the Select User field to display the user roles. Select a User and select OK. Enter a Password and confirm the Password.

Ensure each password level has a unique Password – under no circumstances should all three roles be assigned the same password.

Data Retention

Select System|Data Retention to save the specified data for a set number of months

Enter the length in time (months) for how long each type of data is to be retained. Data is automatically deleted that is older than the specified time. The following data types are displayed:

- Background Data Retention (months)
- Results Data Retention (months)
- Calibration Data Retention (months)

- Cal Check Data Retention (months)
- Event Log Data Retention (months)

Interfaces

Select System|Interfaces to configure an interface to another system

Note that the example given in this description is of a connection to a ViewPoint MultiServer. Other interfaces are possible and the parameters described below may vary according to the interface selected. Please contact Thermo Fisher Scientific regarding your specific interface requirements.

Select the Configure Interface button to view the parameters:

Description of options:

Field Name	Description
Enable	Tick this option to enable the interface to work with the SAM12.
Instrument ID	Enter the Instrument ID using the numerical field
Report Interval (s)	This is the interval in seconds, that the system checks the connection to the interface.
Primary Interface Enable	Tick this option to use the Primary details to connect to the interface (see below).
Primary IP Address	This is the IP address for connection to the interface.
Primary TCP Port	This is the TCP Port for connection to the interface.
Secondary Interface Mode	Use the pre-defined window to select a option from one of the following: Disabled – select this option to not use the Secondary details (see below) Fallback – select this option for the Secondary details to be used if the Primary connection fails Enabled – select this option for the Secondary details to be used
Secondary IP Address	This is the IP address for connection to the interface.

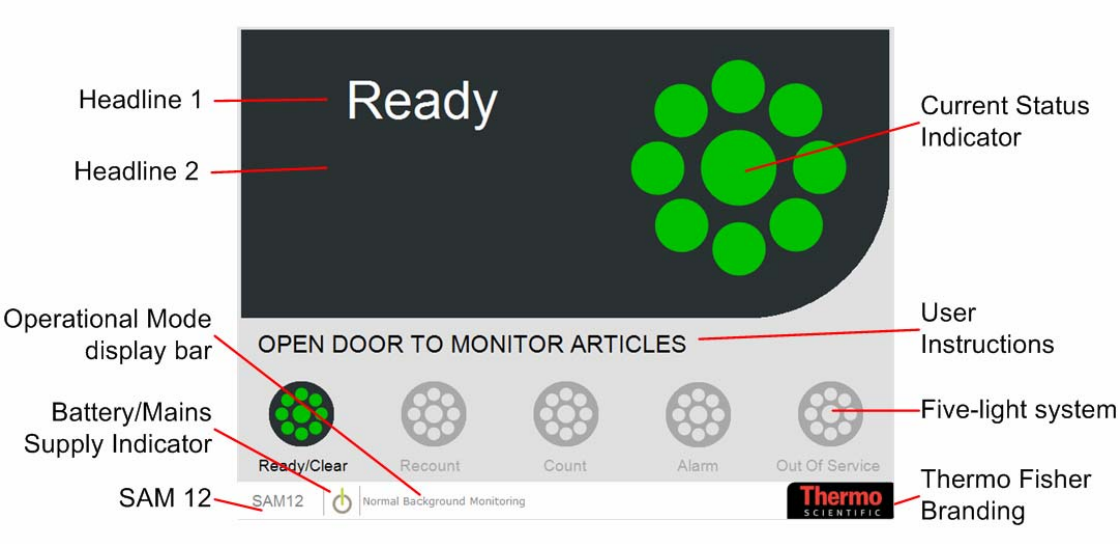
Secondary TCP Port	This is the TCP Port for connection to the interface.
Serial Interface Mode	Use the pre-defined window to select a option from one of the following: Disabled – select this option to not use the Serial details (see below) Fallback – select this option for the Serial details to be used if the Primary and/or Secondary connections fails Enabled – select this option for the Serial details to be used
Serial COM Port	This is the COM Port for connection to the interface.
Serial Baud Rate	This is the Serial Baud Rate for connection to the interface.
Fallback Recovery Interval (s)	This is the interval in seconds, that the system checks whether the standard connection to the interface has been restored during fallback.

User Mode

The basic operation of the SAM12 is as follows:

- Upon power up, system diagnostics are run – see Start Up Checks (page 5-46).
- Upon successful system diagnostics, the SAM12 establishes a new Background – see Establishing a new Background (page 5-48).
- The system enters the Background Monitoring Mode – see Normal Background Monitoring(page 5-49).
- A user places articles to be monitored inside the vault and closes the door – see Door Operations (page 5-51).
- Monitoring starts as a result of the Start button being pressed – see Commence Monitoring (page 5-53).
- Monitoring continues for a period determined by the required confidence levels and the current background.
- Monitoring may be interrupted due to the result of a QuickScan assessment (see Options (page 5-6)), or if a significant change in background conditions is detected during the measurement – see Background Change during Measurement (page 5-54).
- At the end of the Monitoring period, activity is calculated and compared against a set of alarm thresholds. A simple Go/No Go indication is given along with details of the measured activity. If the activity is above the alarm threshold, NBR algorithms are used to attempt to determine the proportion of activity that is due to NORM – see Monitoring Result (page 5-55).
- The user removes the article from the SAM12 - see Remove Articles (page 5-61).

User Screen An example of the SAM12 screen is displayed below:



The SAM12 user screen displays the following:

- Headline 1 and 2, plus current status indicator

  Note that some of these messages are user-definable - see Messages (page 5-15)

- User Instructions

  *Note that some of these messages are user-d*efinable (see Messages (page 5-15)).

- Five-light system which mimics the larger status indicator
- SAM12 – press here to enter Administrator Mode (page 5-1).
- Battery/Mains Supply Indicator (page 5-64)
- Operational Mode display bar – this also gives a description of the selected menu in Administration Mode
- Thermo Fisher Scientific branding

Switch On

Start Up Checks When the SAM12 unit is powered on, the "SYSTEM SELF TESTING" message is displayed.

In this state, diagnostics are run to validate the state of the SAM12 to include:

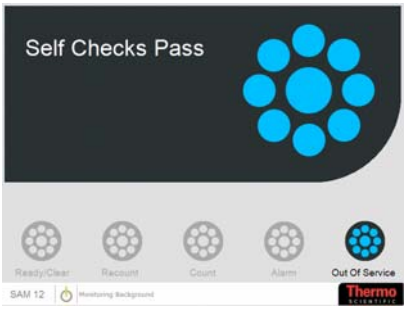
- Instrument Configuration File validation

- XChannel device communication test i.e. checks communication with each peripheral

- Select calibration validity checks, i.e. check efficiency factors are available for all detectors and that at least one valid alarm is set

Database connectivity check, i.e. check that the local database is available.

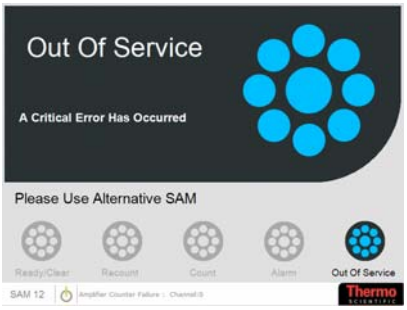
If the System Self Testing passes, the "Self Checks pass" message is displayed for a few seconds.



If the System Self Testing fails, the "Out of Service" message is displayed.

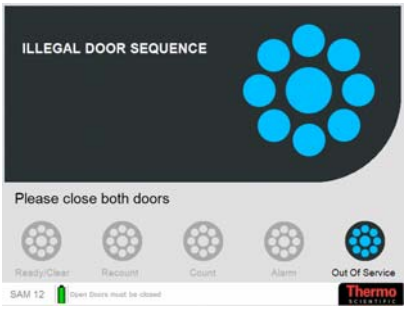
See Critical Error (page 5-62).

See Maintenance and Trouble Shooting (page 11-1) for further information regarding the Self Test Failures messages.



If the door is opened during the start up process, the "ILLEGAL DOOR SEQUENCE" message is displayed. To continue with the process, the door(s) must be shut.

See Doors (page 5-13) for more information.



Out of Calibration

If the Calibration Required Interval option has been exceeded, then the Out of Calibration message is displayed – see Params 1 (page 5-8). To check the Calibration of the unit, see Cal Check (page 5-19).

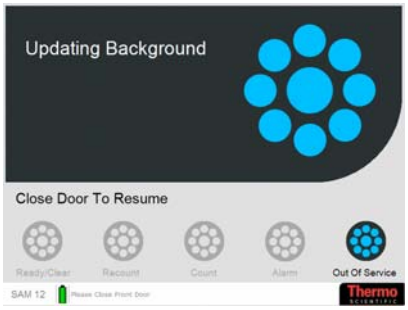
Establishing a new Background

Once the Self Checks have passed, SAM12 will to acquire a new background and the "Updating Background" message is displayed.

See Notes regarding Changing Background (page 5-51) for more information regarding acquiring a background.

When a new Background has been established, the "Ready – OPEN DOOR TO MONITOR ARTICLES" message is displayed. The SAM12 is now ready to start monitoring articles.

If the front door is opened when the SAM12 is establishing a new background, background counting stops, the "Close Door To Resume" message is displayed and an audible alarm will sound. To continue with the process, the door(s) must be shut.



If the back door is opened when the SAM12 is establishing a new background, background counting stops, the "ILLEGAL DOOR SEQUENCE" message is displayed and an audible alarm will sound. To continue with the process, the door must be shut.

See Doors (page 5-13) for more information.

Normal Background Monitoring

This is the normal dormant state of the system. Normal Background Monitoring is continuous until:

1. A door is opened (probably as part of a measurement cycle) – see Door Operations (page 5-51) for more information.

2. A change in background is detected – see Changes to the Normal Background Monitoring (page 5-49) for more information.

3. A high or low background condition is detected - see Notes regarding High Background (page 5-62) for more information.

Notes regarding Normal Background Monitoring

When the SAM12 is not monitoring an article, background is monitored in 10 second periods, each measurement contributing to a “rolling average”, produced over a fixed 100 second period, i.e. 10 measurements. Measurements subsequent to the 10th are added to the results store with the oldest being discarded. In this way, a mean background is stored and constantly updated for each of the detectors - see Background Update (page 6-5) for more information.

These values are summed to give an overall mean Background value for the whole system. Changing or High background conditions can arise from these checks - see Notes regarding Changing Background (page 5-51) and Notes regarding High Background (page 5-62) for more information.

If a 10 second period is interrupted, for example by opening a vault door, the current 10 second average will be discarded.

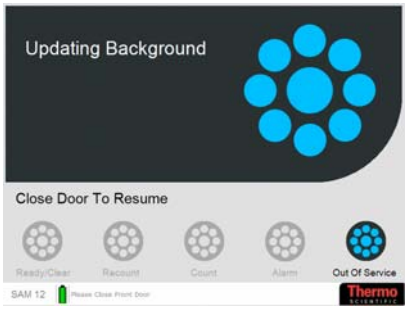
Changes to the Normal Background Monitoring

If a change in the Normal Background Monitoring is detected, SAM12 will acquire a new background and the "Updating Background" message is displayed.

See Notes regarding Changing Background (page 5-51) for more information regarding acquiring a background.

When a new Background has been established, the "Ready – OPEN DOOR TO MONITOR ARTICLES" message is displayed. The SAM12 is now ready to start monitoring articles.

If the front door is opened when the SAM12 is establishing a new background, background counting stops, the "Close Door To Resume" message is displayed and an audible alarm will sound. To continue with the process, the door(s) must be shut.



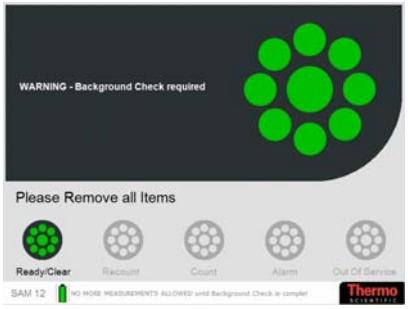
If the back door is opened when the SAM12 is establishing a new background, background counting stops, the "ILLEGAL DOOR SEQUENCE" message is displayed and an audible alarm will sound. To continue with the process, the door must be shut.

See Doors (page 5-13) for more information.

If the Residual Contamination Check before Background Check option is ticked (see Options (page 5-6)), a Residual Contamination Count is performed before a new Normal Background Monitoring commences.

See Notes regarding Residual Contamination Check (page 5-60) for more information.

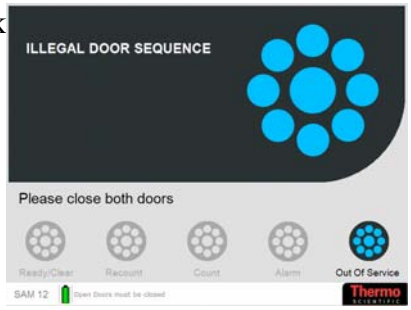
If more than 15 minutes of continuous operation have elapsed since Normal Background Monitoring has commenced, a warning message is displayed to advise the user that a Background Check is required.



In order for the Background Check to be run before

monitoring can re-commence, the door needs to be opened and shut again.

In a two-door SAM12, if the back door is opened during Normal Background Monitoring, the "ILLEGAL DOOR SEQUENCE" message is displayed. To re-establish Normal Background Monitoring, the door(s) must be shut.



See Doors (page 5-13) for more information.

Notes regarding Changing Background

When a changing background has been detected or the instrument does not have a valid background (e.g. at System Startup), the system establishes a new background radiation measurement.

Each 10 second Background count for each detector, is checked against user defined statistical limits for variance from the stored average for that channel. If the count is acceptable it is incorporated into the stored average, otherwise the stored average for all channels is discarded, the blue Alarm lamp will light and “Updating Background - Please Wait” message is displayed while a fresh 100 second Background is accumulated - see Background Update (page 6-5) for more information.

After every successful 10 second Background update period, the minimum monitoring time required to give the required measurement certainty is automatically re-calculated. The calculated monitoring time is rounded-up to the nearest second and used when monitoring articles. If the calculated time is greater than the Maximum Monitoring Time, see Description of Parameters Used in Calculations (page 6-2) and Params 2 (page 5-10) and a “High Background - Out of Use” message will be displayed – see Notes regarding High Background (page 5-62) for more information.

Monitoring

Door Operations

The SAM12 is available with a one or two door option. In a two door SAM12, there is a front door and rear door. In a single door SAM12, only the front door is fitted. See Doors (page 5-13) for more information.

CAUTION: CARE MUST BE TAKEN TO AVOID SWINGING THE DOORS WIDE OPEN WITHOUT

RESTRAINT; IT MAY BE DANGEROUS AND CAUSE DAMAGE TO THE SAM12.

CAUTION: THE DOORS ARE VERY HEAVY AND MUST BE CLOSED WITH REASONABLE CARE, FOR SAFETY REASONS AND TO AVOID UNIT DAMAGE.

See Door Operations (page 5-51) for more information on manually setting up the doors.

With the instrument in the Ready state, displaying "READY – DEPOSIT ARTICLE AND CLOSE DOOR", the door can be opened to commence the monitoring of an article (Note that "Door Open" is displayed in the Operational Mode display bar).

Note that when the door is opened, the background monitoring is suspended.

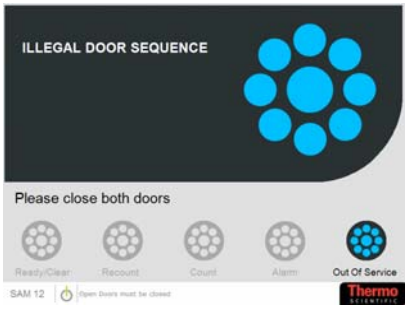
Deposit the article to be monitored in the SAM12 and close the door. (Note that "Door Closed Waiting for Start" is displayed in the Operational Mode display bar).

If the door is not closed within 10 seconds, a repeating alarm shall be sounded.

The "Ready – PUSH START BUTTON TO BEGIN MONITORING" message is displayed.

Notes regarding Illegal Door Operations

The "ILLEGAL DOOR SEQUENCE – Please close both doors" message is displayed under the following circumstances:



- If the back door is opened on a two-door SAM12 when attempting to deposit an article.

- If both doors are opened at the same time on a two-door SAM12.

- If a locked door is forced.

- If the back door is opened on a two-door SAM12 following an ALARM result.

In all cases, the Alarm will sound at full volume until the door(s) are closed.

Following this "ILLEGAL DOOR SEQUENCE" message and the doors have been shut, a Residual Contamination Check will be enforced before normal operation can resume.

See Notes regarding Residual Contamination Check (page 5-60) for more information.

Commence Monitoring

Press the START button to commence monitoring.

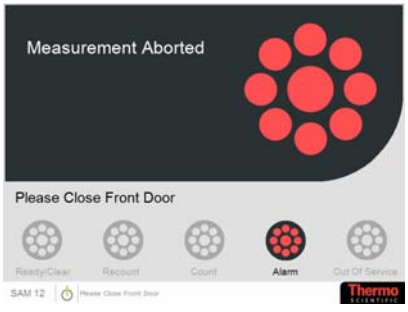
If the START button is not pressed within the Measurement Start Timeout -see Params 2 (page 5-10) for more information - Normal Background Monitoring is resumed and SAM12 returns to the "Ready – Open door to Monitor Articles" message.

See Notes regarding Normal Background Monitoring (page 5-49) for more information.

In this case, to re-start the monitoring of an article, the door needs to be re-opened and shut again.

Once monitoring commences, the SAM12 displays the "Counting" message with an indication of the measurement time remaining.

If the door is opened while the measurement is in progress, audible and visual warnings are given and the measurement is aborted. The "Measurement Aborted – Please Close Front Door" message is displayed.

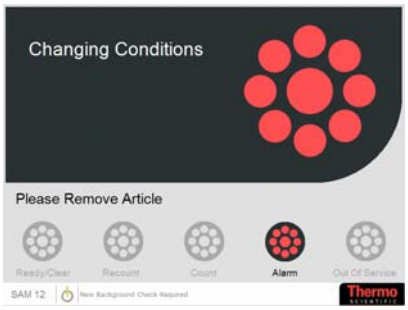


Following this "Measurement Aborted" message, once the Door has been closed, the "Ready – Push Start Button to Begin Recount" message is displayed. If the door is closed and the START button is pressed within the Measurement Start Timeout, the Monitoring proceeds.

If the START button is not pressed within the Measurement Start Timeout, the "Normal Background Monitoring" is resumed and SAM12 displays the "Ready – Open door to Monitor Articles" screen.

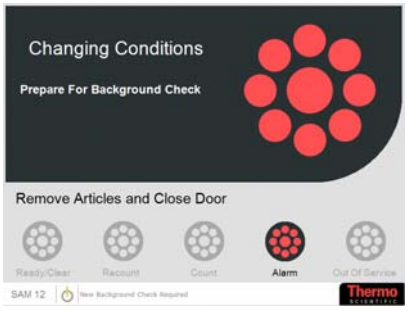
Background Change during Measurement

If the background changes during a measurement, a warning message is displayed stating "Changing Conditions – Please Remove Articles".



A new background check is required before monitoring can resume

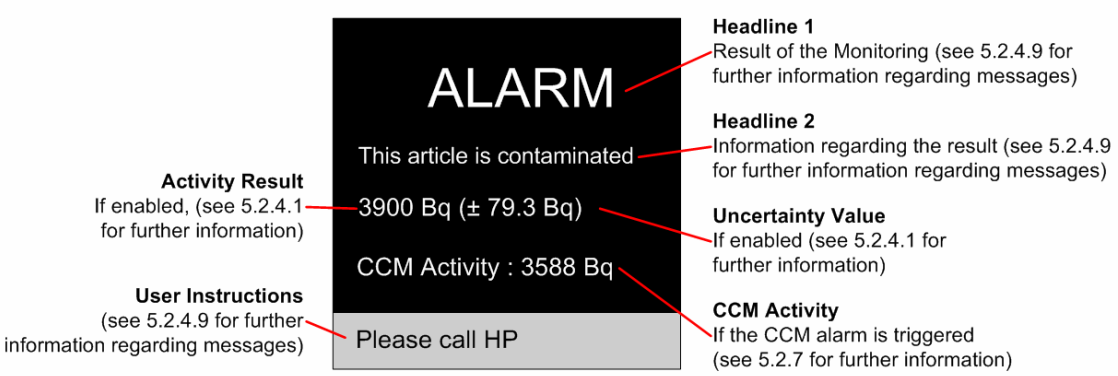
Open the door to remove the article. When the door is closed, the Updating Background window is displayed.



See Notes regarding Changing Background (page 5-51) for more information.

Monitoring Result

An example of the result screen is displayed below:



For more information regarding the options available to display results, see Options (page 5-6) for more information.

CLEAR Result

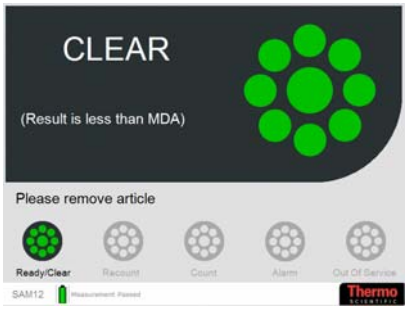
If the measured contamination is below the alarm level or when QuickScan indicates real-clean, the user is informed audibly and visually of the result, with instructions to remove article. The "Clear" message is displayed.

Note that this message is user-definable. See Messages (page 5-15) for more information.

At the end of the measurement sequence, the stored total background count is subtracted from the total measured count to give the net count which is compared with the effective alarm level.

Note that the Uncertainty Value and Activity results are displayed if enabled – see Options (page 5-6) for more information.

Note that if the number of counts is less than Minimum Detectable Activity – see Information (page 5-30) - the Clear result will state that it is less than the MDA.



After a CLEAR result, the user is prompted to remove the measured article. When the door is opened to retrieve the article, the "READY – Deposit Article and Close Door" message is displayed – see Door Operations (page 5-51) to start a new measurement.

CAUTION: THE SAM12 CANNOT DISTINGUISH BETWEEN A GRADUAL BUILD-UP OF CONTAMINATION AND SMALL BACKGROUND CHANGES. THEREFORE, IT IS STRONGLY RECOMMENDED THAT A REGULAR FRISKING PROCEDURE IS ADOPTED AND/OR AN INSPECTION OF THE BACKGROUND REPORT SHOULD INDICATE A BUILD-UP OF ACTIVITY – SEE Reports (PAGE 5-31).

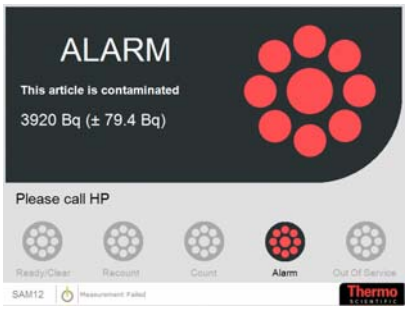
ALARM Result

If the measurement completes but the result is ALARM or when QuickScan indicates real-dirty, the user is informed audibly and visually of the result.

*Note that this mes*sage is user-definable. See Messages (page 5-15) for mor*e information.*

For more information, see Alarms (page 5-12).

Note that the Uncertainty Value and Activity results are displayed if enabled – see Options (page 5-6) for more information.



Recount

If the Manual Recount option is ticked, pressing the START button after a measurement but before the door is opened will initiate a recount. The "Recount – xx Seconds Remaining" message is displayed.

See Options (page 5-6) for more information regarding Manual Recount.

Note that QuickScan is disabled during a recount.

See Options (page 5-6) for more information regarding QuickScan.

If the Auto Recount option is ticked - see Options (page 5-6) for more information - a recount will automatically be performed before a result if the following is true:

High Level Alarm > measurement > Normal Alarm

See Alarms (page 5-12) for more information regarding Alarm settings.

Alarms

Note that in the following section, the Uncertainty Value or Activity Result are not displayed. See Options (page 5-6) for further information regarding the Alarm displays.

If the ordinary alarm level is exceeded, the "Normal Alarm" message will display indicating that the article is contaminated.

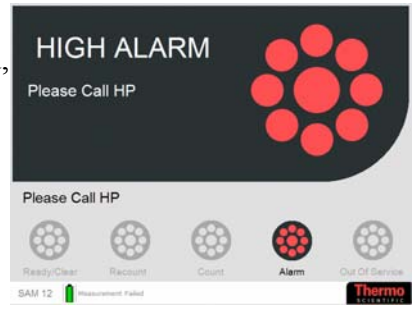
Note that this message is user-definable, see Messages (page 5-15) *for more information.*

Also, an alarm will sound for 3 seconds even if the door is opened.

If the Lock Front Door on Alarm is set to All Alarms, the door will be locked and can only be opened with intervention by an Administrator.

See Doors (page 5-13) for more

information regarding Lock Front Door on Alarm.



If the High Level Alarm - see Alarms (page 5-12) - is exceeded, the "High Level Alarm" message will display.

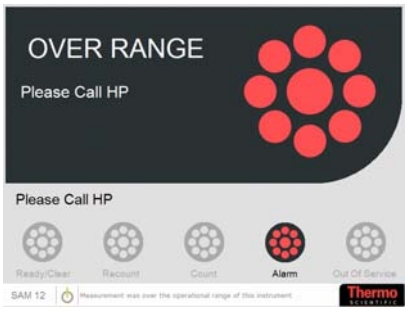
Note that this message is user-definable, see Messages (page 5-15).

If the Lock Front Door on Alarm is set to High or All Alarms, the door will be locked and can only be opened with intervention by an Administrator.

See Doors (page 5-13) for more information regarding Lock Front Door on Alarm.

On a two-door SAM12, the front door will be locked and back door will be unlocked.

Also, a high alarm will sound for 5 seconds.



If the count rate from any detector exceeds 95% of the Amplifier “dead-time” an "Over Range" message is displayed stating that the measurement was over the operational range of the instrument.

If the CCM board is installed and the CCM option - see Options (page 5-6) - is selected, when the CCM alarm – see Alarms (page 5-12) - is exceeded, the "Co60 ALARM" message is displayed.

Note that this message is user-definable, see Messages (page 5-15) for further information.

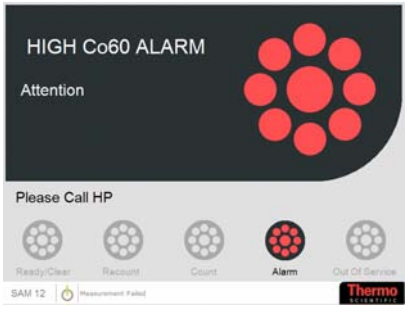
Also, an alarm will sound for 3 seconds even if the door is opened.

If the Lock Front Door on Alarm is set to All Alarms, the door will be locked and can only be opened

with intervention by an Administrator.

See Doors (page 5-13) for more information regarding Lock Front Door on Alarm.

If the CCM board is installed and the CCM option (see Options (page 5-6)) is selected, when the High Level CCM Alarm (see Alarms (page 5-12)) is exceeded, the "High Co60 Alarm" message will display.



Note that this message is user-definable, see Messages (page 5-15) for further information.

If the Lock Front Door on Alarm is set to High or All Alarms, the door will be locked and can only be opened with intervention by an Administrator.

See Doors (page 5-13) for more information regarding Lock Front Door on Alarm.

On a two-door SAM12, the front door will be locked and back door will be unlocked.

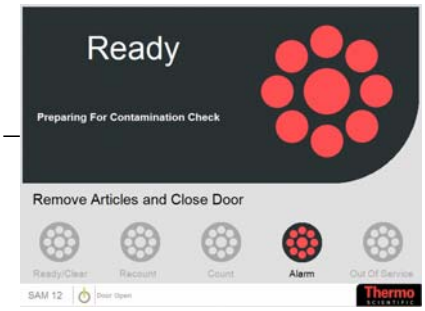
Also, a high alarm will sound for 5 seconds.

If the Lock Front Door On Alarm option is set to 'Never', the door can be opened and the Articles removed (see Remove Articles (page 5-61)).

See Doors (page 5-13) for more information regarding Lock Front Door on Alarm.

Residual Contamination Check

Following an alarm, if the Residual Contamination Check after Alarm option is ticked (see Options (page 5-6)), the "Ready – Preparing for Contamination Check" message is displayed.



After the contaminated article is removed and the Door is closed, the Residual Contamination Count is performed.

See Notes regarding Residual

Contamination Check (page 5-60) for more information.

Notes regarding Residual Contamination Check

The Residual Contamination Check is run under the following circumstances:

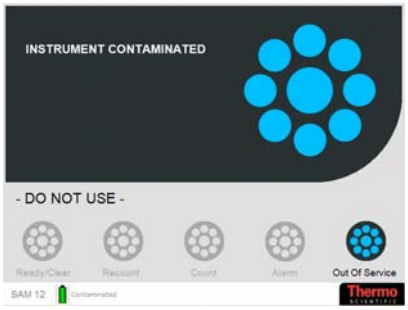
- Following any door violation.

- If the Residual Contamination Check before Background Check option is set - see Options (page 5-6).

- If Residual Contamination Check after Alarm option is set - see Options (page 5-6).

The Residual Contamination Check will verify that the current background count rate does not exceed the Background Count Rate before the alarm, by a statistically significant amount. If no contamination is found, the "Ready – OPEN DOOR TO MONITOR ARTICLES" message is displayed and the SAM12 reverts to Background mode.

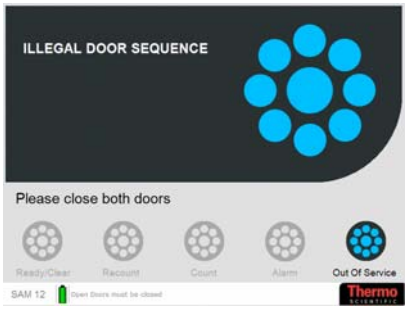
However, if residual contamination is detected or the count rate from any detector exceeds 95% of the Amplifier “dead-time”, then an Instrument Contaminated state exists. The "INSTRUMENT CONTAMINATED – DO NOT USE" message is displayed (see Instrument Contaminated (page 5-61) for more information).



Note that if the Door Locked options are ticked, the door(s) are locked while the Instrument is Contaminated.

See Doors (page 5-13) for more information regarding Lock Front Door on Alarm.

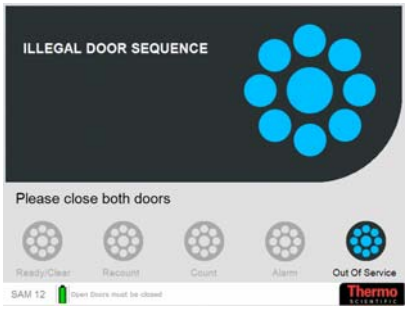
If a door is opened during the Residual Contamination Check, the "ILLEGAL DOOR SEQUENCE – Please close both doors" message is displayed.



Once closed, the Residual Contamination Count recommences.

Instrument Contaminated

If the Instrument is contaminated, it is not possible to open the doors. Intervention by an Administrator is necessary to clear the contamination.



See Actions (page 5-40) for more information regarding clearing the Contamination

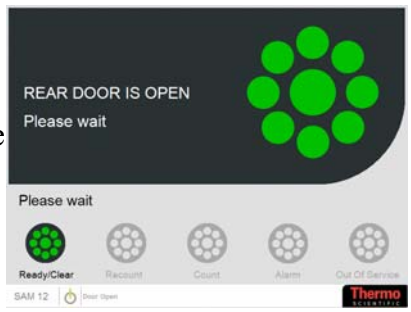
Once the contamination has been cleared, and User Mode is re-instated, the SAM12 performs the System Self Testing – see Start Up Checks (page 5-46).

Remove Articles

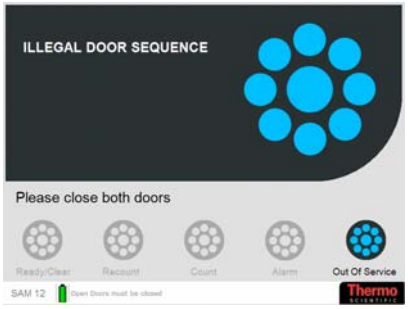
Two-door SAM12

In a two-door SAM12, open the front door to remove a clean or dirty Article – the "READY – DEPOSIT ARTICLE AND CLOSE DOOR" message is displayed – see Door Operations (page 5-51). The SAM12 is now ready to monitor another article.

On a two-door SAM12, if the Rear Door is opened to remove a clean article, the "REAR DOOR IS OPEN – Please Wait" message is displayed. Closing the door displays the "Ready" message.



On a two-door SAM12, if the Rear Door is opened to remove a dirty article, the "ILLEGAL DOOR SEQUENCE" message is displayed. Closing the door causes a Residual Contamination Check to be run.



See Notes regarding Illegal Door Operations (page 5-52).

One-door SAM12

In a one-door SAM12, open the door to remove the Article – the "READY – DEPOSIT ARTICLE AND CLOSE DOOR" message is displayed - see Door Operations (page 5-51). The SAM12 is now ready to monitor another article.

Out Of Service

Critical Error

If an error occurs during the establishment of a new background, the "Out of Service" message is displayed (note that the reason for the error may be displayed in the message bar at the bottom of the screen).

To clear this error, the state must be cleared in the Administration Mode (or will clear automatically when the Out of Service Recovery Interval is passed, see Params 2 (page 5-10) for more information).

See Actions (page 5-40) for more information regarding clearing the Critical Error.

Temporary Error

If High or Low Background occurs, the "Out of Service" message is displayed.

Note that this Temporary Error message is recoverable.

Notes regarding High Background

The "Out Of Service – Temporary Error has Occurred" if High Background conditions exist.

"Out of Service – High Background Conditions" message is displayed when the background activity prevents discrimination of the alarm level with the required confidence, in the Maximum Monitoring Time allowed - see Params 2 (page 5-10). If the count rate from any detector exceeds 95% of the

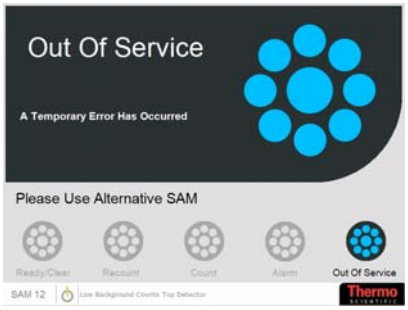
Amplifier “dead-time”, a High Background fault condition will also be enforced. Monitoring of articles cannot be performed unless one or more of the following occurs:

1. The background activity drops sufficiently for the current alarm level to be detected, or,
2. The Health Physicist modifies one or more of the following parameters:
   - Increases the maximum monitoring time - see Params 2 (page 5-10).
   - Relaxes the Probability of Detection - see Params 2 (page 5-10).
   - Relaxes the Probability of False Alarm - see Params 2 (page 5-10).
   - Raises the Normal Alarm level - see Alarms (page 5-12).

Minimum Detectable Activity (MDA) and High Background Criterion (page 6-7) describes how the SAM12 decides if a high background condition exists.

Notes regarding Low Background

The "Out Of Service – Temporary Error has Occurred" if Low Background conditions exist.



“Out of Service – Low Background Counts Top Detector” message is displayed when the count rate in the gross counts window over the 10 second background check period on any single detector falls below the threshold. It will remain in this state until the background count rate once again exceeds the threshold on all detectors.

Battery/Mains Supply Indicator

On the main screen, an icon is displayed on the bottom edge of the screen which indicates whether the SAM12 is running on battery or mains supply as follows:

Indicates that the SAM12 is running on battery.

See Battery Charger (page 5-19) for more information regarding Battery Status including remaining battery life.

This icon indicates that the SAM12 is running on mains supply.

Switch Off

Only an Administrator is able to exit the SAM12 application – see Actions.

Chapter 6 Technical Description - Physics

Performance Characteristics

Introduction

The apparatus is designed to measure a wide variety of personal articles and equipment for contamination so that they may be removed safely from the active area or from the site. Other potential uses include determining the gross contamination of waste materials to determine their suitability for public disposal or for further processing such as burial or incineration.

To achieve a good degree of measurement certainty, a high uniformity of response throughout the sample is desirable. This is achieved by surrounding the sample on all sides, by large area detectors. Since the main requirement is to quickly prove the absence of contamination, rather than to identify which radio nuclides are present, large area Scintillation detectors, having high gamma sensitivity, are the most robust, low maintenance and cost effective solution.

The main problem with very large area gamma sensitive detectors is the high sensitivity to background radiation. This effect is minimised by shielding the detectors on all six faces with 1" or 2" of lead. Low energy variants are fitted with an additional 2 mm Copper shield to absorb the secondary x-rays produced by gamma's absorbed by the lead.

An attenuation factor facility exists to compensate for stable directional background influences and for shielding effects of known waste containers.

The background is measured accurately, by monitoring over a long period. This is achieved by taking a series of 10 second background counts and averaging over 100 seconds. The background count is updated with a new count every 10 seconds to maintain a "rolling average". Statistical checks on each background value guard against sudden changes. The average count is stored and used for background subtraction.

Software facilitates automatic calculation of monitoring time and programmable probabilities of False Alarm and Detection, Alarm levels and Efficiency Correction factors. A facility known as Quickscan, when enabled, will identify whether the article is either clearly clean or contaminated within a time period very much shorter than the evaluated "worst case" monitoring time. Five user definable discriminator thresholds are available which allow the rejection of interfering high

energy photons from cosmic radiation and consequently improve MDA of selected radionuclide contaminants. In addition, these discriminators may be used to identify the presence of Naturally Occurring Radioactive Material (NORM), using the Natural Background Reduction (NBR); and ^{60}Co using Cobalt Coincidence Monitoring (CCM). Thus any article can be monitored accurately with known statistical certainty often in a few seconds.

Spatial Response

The article could be placed randomly anywhere inside the measurement volume and not precisely in the geometric centre. Additionally, a point source may be positioned anywhere on or within the article itself. Therefore the sensitivity at the extremities and uniformity of response throughout the measurement volume, in all planes, are of interest. The detectors are large, and arranged such that high sensitivity is maintained throughout the measurement volume, almost perfect 4π coverage being attained by six detector variants (see Figure 1 (page 6-14) to Figure 10 (page 6-18)).

A full type test report is available from Thermo Fisher Scientific on request.

Explanation of the Operational Calculations

Introduction

It is a requirement to measure contamination on personal articles as quickly and accurately as possible. Optimum detection efficiencies are required, with minimum statistical error in giving alarm indications. Measurement of contamination is dependent on ambient background level. Accuracy of measurement of both background and contamination is dependent on respective background and contamination monitoring times, self absorption and also on chosen probability of false alarm and probabilities of detection.

This section summarises the calculations employed by the CPU in determining whether the parameters selected by the user allow the monitor to operate correctly. The section then shows the criteria used to determine whether an alarm has occurred during a measuring sequence.

Description of Parameters Used in Calculations

The parameters used in the calculations are summarised and abbreviated as follows:

t_B **Background Update Time (seconds)** is the time over which the average background counts have been accumulated, this is a fixed 100 second rolling average in the SAM. Background measurements can only occur when the door is shut.

B_{sum} **Total Average Background Count Rate (cps)** is the sum of the mean background of all the detectors, measured over the background update time (t_B). This is a fixed 100 second rolling average in the SAM. See Notes regarding Normal Background Monitoring (page 5-49).

B_{eff} **Effective Background while Monitoring (cps)** is the sum of the mean background of all the detectors, Bsum, corrected for the effect of attenuation.

T_{cal} **Calculated Monitoring Time (seconds)** is the minimum time required to perform a measurement according to the calculation in Calculation of the Monitoring Time (Tcal) (page 6-6). The specified alarm level must be achieved with the required certainty in the Monitoring Time, which will depend upon a number of user programmable variables, as well as the Background.

T_{mon} **Actual Monitoring Time (seconds)** is the actual time for which Articles are monitored. The calculated monitoring time (Tcal) is first rounded up to the nearest whole second. It is then compared with the user programmed Minimum Monitoring Time (Tmin) and if Tcal < Tmin then Tmon is forced to be Tmin, otherwise Tmon = Tcal. If Tmon > Tmax then a high background condition exists and normal monitoring is not possible (see Calculation of the Monitoring Time (Tcal) (page 6-6)).

T_{min} **Minimum Monitoring Time (seconds)** is the Minimum Time for which articles are monitored, regardless of the calculated Monitoring Time, see explanations of Tcal and Tmon above. The Minimum Monitoring Time is set from in Params 2 (page 5-10).

T_{max} **Maximum Monitoring Time (seconds)** is the maximum time for which articles are monitored, regardless of the calculated Monitoring Time, see explanations of Tcal and Tmon above. The Maximum Monitoring Time is set in Params 2 (page 5-10).

C_{Act} **Contamination Alarm Level (variable unit)** is the activity level at which the user requires the alarm to be triggered. The alarm level is set in Alarms (page 5-12) and the units, e.g. dpm, Bq, nCi, may be selected in Options (page 5-6).

C_{cps} **Contamination Alarm Count-rate (cps)** is the count-rate at which the user requires the alarm to be triggered. It is equivalent to the Contamination Alarm Level set by the user modified by the system Efficiency Correction Factor (E).

C_{effect} **Effective Alarm Count rate (cps)** is the effective net count rate at which the SAM normal alarm is triggered. The Contamination Alarm Count rate is modified to take account of the monitoring time, background statistical fluctuation and user programmed Probability of Detection. This ensures the Alarm set point reflects the measurement certainty required. The current Effective Alarm count rate may be viewed in Information (page 5-16). The Ceffect calculation is detailed in Contamination Alarm (page 6-8).

F **Probability of False Alarm (σ)** is the probability that a false alarm does not occur during a measuring sequence. The value of F in terms of sigma is set in Params 2 (page 5-10), where the associated probability is shown alongside in parentheses. The value is usually set as high as possible, so that false alarms do not occur, e.g. one false alarm in a hundred measurements is a probability of 99% (2.4 σ), see Table 3- Probability - Sigma and % (page 6-12).

P **Probability of Detection (σ)** is the probability that exactly one Alarm Level of contamination will cause an alarm. The value of P in terms of sigma is set in Params 2 (page 5-10), where the associated probability is shown alongside in parenthesis. The minimum allowable probability is 50% (zero sigma). Increasingly higher probabilities become increasingly subject to other parameters, particularly background level. The interrelationship will be discussed in the Calculation stages.

E **Efficiency Correction Factor** is the system efficiency (summed efficiency for all detectors) to the nuclide (Enuc) or mixture of nuclides (Emix) being monitored. E is given by the contamination count rate in a given time and divided by the activity. E is determined by calibrating with a known radionuclide source, as detailed in Calibration for Other Nuclides (page 10-3).

A — **Attenuation Factor** is an allowance for attenuation of a directional background field by articles being measured. Values of A can be determined for each detector by following the test procedure in Attenuation (page 5-28).

DL — **Detection limit** or Minimum Detectable Count Rate (cps)

MAct — **Minimum Detectable Activity (variable unit)** is the minimum Activity the system can detect within the calculated monitoring time. It is very dependent on the user programmed False Alarm rate and the prevailing background conditions and thus will continuously vary. The current Minimum Detectable Activity (MDA) may be viewed in Information (page 5-16) in the units specified in on the Options sub-menu (see Options (page 5-6)). The MDA calculation is detailed in Minimum Detectable Activity (MDA) and High Background Criterion (page 6-7).

RAct — **Activity of Contamination (variable unit)**

Background Update

While the SAM12 is not occupied, background is monitored in 10 second periods, each measurement contributing to a "rolling average", produced over a fixed 100 second period: i.e. 10 measurements. Measurements subsequent to the 10th are added to the results store with the oldest being discarded. In this way a mean background is stored and constantly updated for each of the four detectors. These four mean values are summed to give an overall mean Background value for the whole system.

Changing Background

In relatively stable background conditions, 100 second "rolling average" accumulates an accurate background count. It is, however, slow to respond to sudden background disturbance and drift, making it is necessary to screen each count before incorporating it into the rolling average. Consequently to guard against inaccurate measurements and false alarms, the SAM reads and checks the counts from each detector every second. A changing background conditions exists if either of the following conditions are true:-

Any one detector count shows a Mσ change from the stored average for that channel:

$$\left|\left[B_{av} - C_a\right]\right| \geq \mathrm{M}\sqrt{B_{av}}$$

where B_{av} is the rolling average for any one detector.

C_a is the counts registered in the last one second background update.

M is the Detector Changing Background variable (see Params 1 (page 5-8)). The default value for M is 7. It is not recommended that M should be set below 4.0σ.

All four or six detector counts show a Nσ change from their relevant stored averages in the same direction:

$$\left|\left[B_{av} - C_a\right]\right| \geq N\sqrt{B_{av}}$$

where B_{av} is the rolling average for any one detector.

C_a is the counts registered in the last one second background update.

N is the Gross Changing Background variable (see Params 1 (page 5-8)). It is not recommended that N should be set below 3.0σ.

The former expression detects gross changes in any single channel, while the latter guards against significant drift in all channels.

Calculation of the Monitoring Time (T_{cal})

After every successful 10 second background update, the average background for each channel is updated. The four or six average backgrounds are then summed and a new monitoring time is re-calculated as follows:

$$C_{cps} = C_{Act}.E.Z_{Act}$$

where Act is one of the units below

Z_{Act} is the corresponding multiplier

Units	Unit Multiplier Z_{Act}
Bq	1
kBq	1000
Dpm	0.01666
pCi	0.037
nCi	37
µCi	3.7E4
mCi	3.7E7
Ci	3.7E10

T_{cal} found by solving:

$$C_{cps} = F\sqrt{\frac{B_{eff}}{t_B} + \frac{B_{eff}}{T_{cal}}} + P\sqrt{\frac{B_{eff}}{t_B} + \frac{B_{eff} + C_{cps}}{T_{cal}}} + \frac{1}{4}(F+P)^2\left(\frac{1}{t_B} + \frac{1}{T_{cal}}\right)$$

In practice, the software solves this expression using a numerical substitution for T_{cal} and iterative binary search technique. The value of T_{cal} which provides the solution is then

rounded up to the nearest whole second and compared to the user programmed minimum and maximum monitoring times.

The actual monitoring time (T_{mon}) used when monitoring is then set according to the following criteria:

$T_{mon} = T_{cal}$ when $T_{cal} > T_{min}$

$T_{mon} = T_{min}$ when $T_{cal} \leq T_{min}$

If $T_{cal} > T_{max}$ then a high background condition exists and monitoring is not possible. See Notes regarding High Background (page 5-62).

Minimum Detectable Activity (MDA) and High Background Criterion

Once a mean background count rate has been calculated, the SAM will be ready to monitor articles, and the Minimum Detectable Count Rate, also referred to as the detection limit (DL) is found by solving the following formula for DL:

Therefore $M_{Act} = \frac{DL}{Z_{Act}.E}$,

$$DL = F\sqrt{\frac{B_{eff}}{t_B} + \frac{B_{eff}}{T_{mon}}} + P\sqrt{\frac{B_{eff}}{t_B} + \frac{B_{eff} + DL}{T_{mon}}} + \frac{1}{4}(F+P)^2\left(\frac{1}{t_B} + \frac{1}{T_{mon}}\right)$$

where Act is the activity unit

m Detectable Activity and Detection Limit may be viewed on the Information sub-menu (see Information (page 5-16)) and will be displayed in the units selected in the Options PAGE (see Options (page 5-6)).

NOTE:
MDA may differ from the Alarm level because:
Tmon is rounded up
Tmin may take effect

Changing Conditions

During the monitoring cycle, the monitoring time is subdivided into timeslices. Each sum of the count rates on all detectors in a slice is compared to the average count rate in the cycle up to that point.

Changing Conditions exist where the following formula is satisfied:

$$\left|\left[C_{av} - C_{sl}\right]\right| \geq N_{sl}\sqrt{C_{av}}$$

where C_{av} is the rolling average count rate within the monitoring cycle, up to the point of the check.

C_{sl} is the counts registered in the last time slice

N_{sl} is the Changing Conditions variable (see Params 1 (page 5-8)). It is not recommended that N_{sl} should be set below 3.0σ.

The first Changing Conditions check will take place after $2T_{sl}$ and then after every second within the monitoring cycle.

where T_{sl} is the Changing Conditions period (time slice) variable (see Params 1 (page 5-8)).

Contamination Alarm

After monitoring an article for the prescribed monitoring time (T_{mon}), the effective contamination alarm level (C_{effect}) is calculated as follows:

$$C_{effect} = C_{cps} - P\sqrt{\left(B_{eff}\left(\frac{1}{t_B}+\frac{1}{T_{MON}}\right)+\frac{C_{cps}}{T_{MON}}\right)}$$

The total system background count rate B_{eff} is then subtracted from the total system gross contamination count rate (C_{gross}), and the remaining (net) contamination count rate compared with the alarm level. So an alarm condition exists if:

$$\left(C_{gross} - B_{eff}\right) \geq C_{effect}$$

Calculation of Activity and Uncertainty

The system will display both the activity of contamination on/in the article, and its associated uncertainty. Both of these options may be enabled from the Options sub-menu (see Options (page 5-6)). The Activity may be displayed after any measurement, as long as the evaluated activity is greater than the MDA.

The activity is calculated using the following formula:

$$R_{Act} = Z_{Act}.\frac{C_{gross} - B_{eff}}{E_{mix}}$$

where R_{Act} refers to the activity in the selected unit.

le nuclide mix, $E_{mix} = E_{nuc}$. However where the user has created a mix with multiple nuclides:

$$E_{mix} = \sum E_{nuc}.P_{nuc}$$

where E_{nuc} is the efficiency of the system to a specific nuclide

P_{nuc} is the proportion of the specific nuclide within the total mix.

The uncertainty of the activity measurement is calculated as follows:

$$\frac{R_{Act}.N_{conf}}{E_{mix}}\sqrt{\left(\frac{B_{eff}}{t_B}+\frac{C_{gross}}{T_{mon}}\right)}$$

where N_{conf} is the number of confidence levels.

Quickscan

Quickscan is a method used to identify, within the monitoring time T_{mon}, whether the article is either "clearly" contaminated or clear, referred to as "real-dirty" or "real-clean". Quickscan is enabled on the Options sub-menu (see Options (page 5-6)). It is only activated when $T_{mon}>T_{min}$

The Quickscan period T_Q is the time period after the beginning of the monitoring cycle, at which the first time slice check is undertaken. Subsequently further Quickscan checks will be undertaken at periods that are integer multiples of T_Q e.g. $2T_Q$, $3T_Q$, until the end of the monitoring period. The Quickscan period is set on the Params 2 sub-menu (see Params 2 (page 5-10)).

If the Quickscan formula (refer to Thermo Fisher) is satisfied at any of the Quickscan checks, then the monitoring cycle will terminate, with the appropriate clean or contaminated indication.

Natural Background Reduction (NBR)

After a measurement resulting in an alarm, an NBR check may be undertaken, if enabled on the Options sub-menu (see Options (page 5-6)).

For details of the NBR assessment, please contact Thermo Fisher Scientific.

Cobalt Coincidence Monitoring (CCM)

A specific assessment of ^{60}Co contamination may be undertaken, if enabled on the Options sub-menu (see Options (page 5-6)). Further an alarm may be triggered specifically for ^{60}Co, although in most situations this alarm is unlikely to trigger before the Normal alarm.

The method of assessment of background count rates and contamination level, applies to the CCM channel in the same way as for the sum of all detectors (gross sum channel) described in this section. However both the background count rate B_{CCMsum} and the efficiency E_{CCM}, are considerably lower than for the gross sum channel.

For details of the CCM assessment, please contact Thermo Fisher Scientific.

Residual Contamination Level

After a measurement resulting in an Alarm condition, a Residual Contamination Count (RCC) may be taken, if enabled on the Options sub-menu (see Options (page 5-6)). A count equal to the monitoring time (T_{mon}) is enforced.

Residual Contamination is assumed to exist where the following formula is satisfied:

$$\left(C_{RCC} - B_{sum}\right) \geq N_{RCC}\sqrt{\left(\frac{B_{sum}}{T_{MON}}\right)}$$

where C_{RCC} is the average count rate during the Residual Contamination Count period.

N_{RCC} is the RCC threshold variable (see Params 1 (page 5-8)).

The default setting for N_{RCC} is 7.0σ and should never be set to a less that the sum of the probabilities of detection and false alarm (P+F).

In the event of residual contamination being detected, the SAM will enter an "Out of Service" state and monitoring will not be possible (see Notes regarding Residual Contamination Check (page 5-60)). The doors will lock if the option is fitted. Intervention by a password holder will be required to terminate the fault status (see Instrument Contaminated (page 5-61)).

Automatic Calculation of Calibration Monitoring Time

The Calibration technique (see Calibration Menu (page 5-19)) uses flash (10 second) background and source counts to automatically calculate the count time for the user. The Calibration Accuracy and the associated confidence level is set in Params 3 menu (see Params 3 (page 5-11)).

The count confidence level has a default setting of 3σ (99.7%) which is a generally accepted Confidence level that produces acceptable count times.

Then Calibration Count Time,

where N_{conf} = 3 (Count Confidence Level of 99.7%)

n = Flash source + background Count (cps)

b = Flash Background Count (cps)

A = Calibration Accuracy (ratio e.g. 5% = 0.05)

The calculated count time is rounded up to the nearest whole second and T is limited to 10,000 seconds.

$$T = N_{conf}^2 \frac{\left(n + \sqrt{nb}\right)}{A^2\left(n-b\right)^2}\left(Sec's\right)$$

Note that when CCM (see CCM Menu (page 5-30)) is installed, during a ^{60}Co calibration, both the CCM channel and all the detectors are calibrated at the same time. This may lead to slightly extended counting times due to the lower CCM channel efficiency.

Isotope gamma efficiencies

The following data were obtained during type testing in a stable 7-10 µR/h (0.07-0.1 µSv/h) Background using pant-sources in

free space, (i.e. un-attenuated). The detectors were optimised for each Isotope in the geometric centre of the measurement cubicle.

Efficiencies are quoted "Centre" (geometric centre of Measurement Volume).

and 3 inches (centre of Measurement Volume 3" from floor)

Nominal Value quoted with maximum spread in brackets. Door configuration has a small, usually insignificant, effect on 6 detector efficiencies.

SAM12A – Standard Stainless Steel Liners

Table 1 Standard SAM12 Standard Stainless Steel Liners

Variant	Total Bgnd (typ)	^{60}Co (1.2 MeV)		^{137}Cs (662 keV)		^{137}Ba (356 keV)	
	10µR/h 0.1 µSv/h	3 inches	Centre	3 inches	Centre	3 inches	Centre
4C-XD-1L	350 cps	45% (40-48)	40% (36-44)	17% (16-20)	16% (15-19)	28% (26-31)	26% (24-28)
6C-2D-1L	550 cps	57% (55-59)	53% (51-55)	24% (22-26)	23% (21-25)	38% (36-40)	36% (34-38)
6C-1D-2L	350 cps	61% (58-65)	58% (56-60)	26% (24-28)	25% (23-27)	—	—

Low Energy Variants

Low Energy Variants have 6 detectors, 2 inches (50 mm) lead shielding and an additional 2mm Copper X-ray absorber. (***Note**: mu-metal magnetic shielding is removed for maximum sensitivity).*

Table 2 Low Variant SAM12 Energy Variants

	Total Bgnd	^{241}Am (59 keV)	
		3 inches	Centre
SAM12LP – 6C-1D-2L (Plastic Liners)	1000 cps	13½% (12-15)	13% (12-15)
SAM12LA – 6C-1D-2L (Aluminium Liners)	1000 cps	9%	9%

		(8-10)	(8-10)

A full Type Test Report is available from Thermo Fisher Scientific on request.

Typical ^{60}Co detection performance

Detection of 5,000 DPM (83 Bq) ^{60}Co.

Typical performance in 10 μR/hr (0.1 μSv/hr) Background.

< 1 False Alarm in 1000 Measurements (all figures typical)

Measurement Confidence	SAM11 Model	^{60}Co Eff.	Typical Background	Monitoring Time
99% (2.4σ)	6C-2L	61%	350 cps	4.5s
	6C-1L	61%	550 cps	7.1s
	4C-1L	45%	350 cps	8.5
95% (1.65σ)	6C-2L	61%	350 cps	3.3s
	6C-1L	61%	550 cps	5.2s
	4C-1L	45%	350 cps	6.1s
90% (1.3σ)	6C-2L	61%	350 cps	2.8s
	6C-1L	61%	550 cps	4.4s
	4C-1L	45%	350 cps	5.2s

A full Type Test Report is available from Thermo Fisher Scientific on request.

Probability – Sigma and %

Table 3- Probability - Sigma and %

Sigma	Probability
0.0	50.00%
0.1	53.98%
0.2	57.93%
0.3	61.79%
0.4	65.54%
0.5	69.15%
0.6	72.57%
0.7	75.80%
0.8	78.81%
0.9	81.59%
1.0	84.13%
1.1	86.43%
1.2	88.49%
1.3	90.32%
1.4	91.92%
1.5	93.32%
1.6	94.52%
1.7	95.54%

Sigma	Probability
1.8	96.41%
1.9	97.13%
2.0	97.72%
2.1	98.21%
2.2	98.61%
2.3	98.93%
2.4	99.18%
2.5	99.38%
2.6	99.53%
2.7	99.65%
2.8	99.74%
2.9	99.81%
3.0	99.87%
3.1	99.90%
3.2	99.93%
3.3	99.95%
3.4	99.966%
3.5	99.977%
3.6	99.984%
3.7	99.989%
3.8	99.993%
3.9	99.995%
4.0	99.997%

This probability refers to either the Probability of Detection or the Probability of NOT triggering a False Alarm. These probabilities are calculated and displayed in Params 2 (page 5-10)**.**

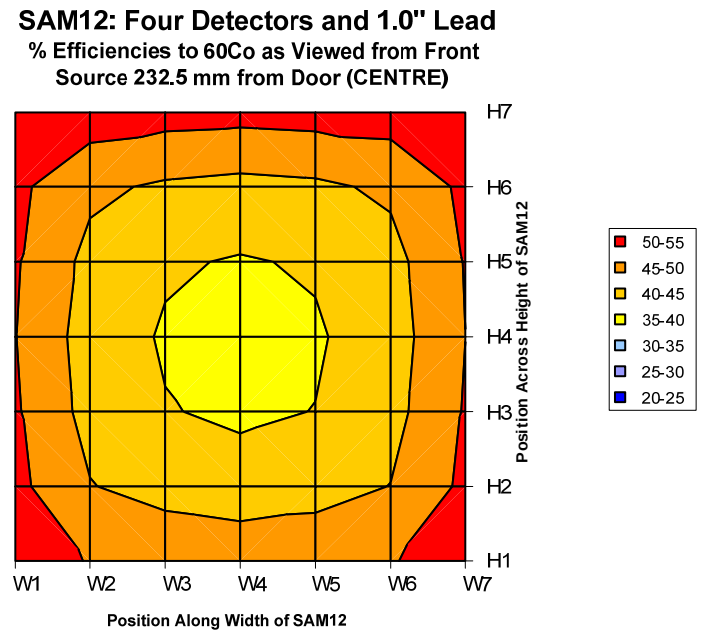


Figure 1 - Front Spatial Response

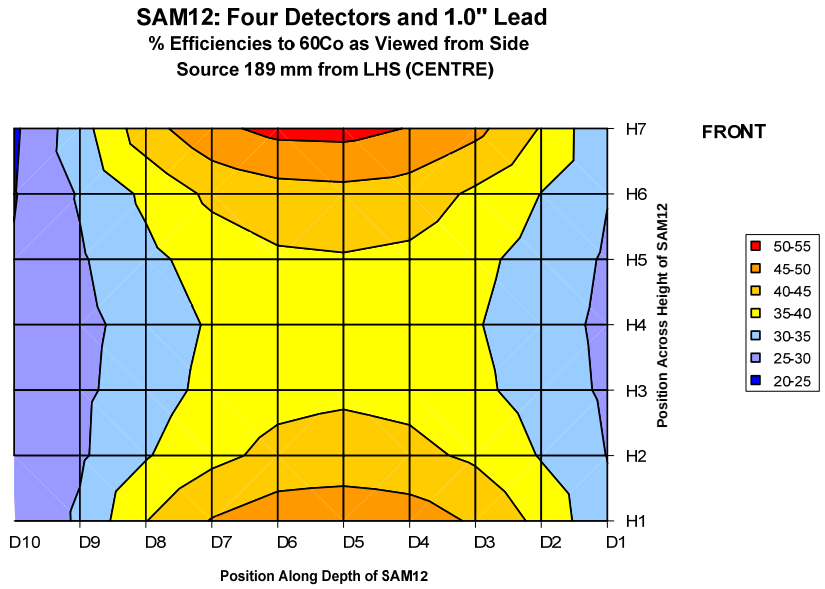


Figure 2 - Side Spatial Response

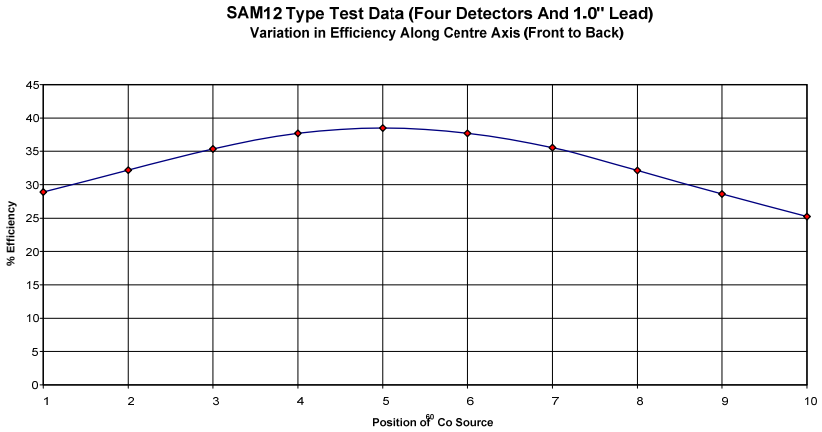


Figure 3 - Efficiency variation along Central Axis (Front to Back) SAM12A 4C-2D-1L

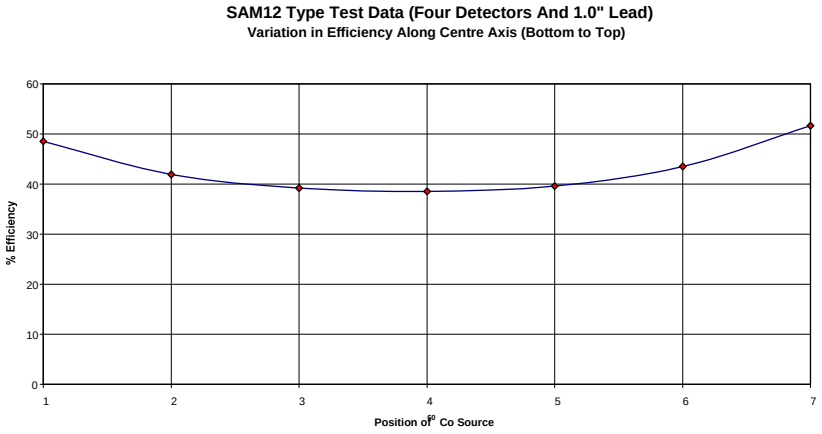


Figure 4 - Efficiency Variation along Central Axis (Bottom to Top) SAM12A 4C-2D-1L

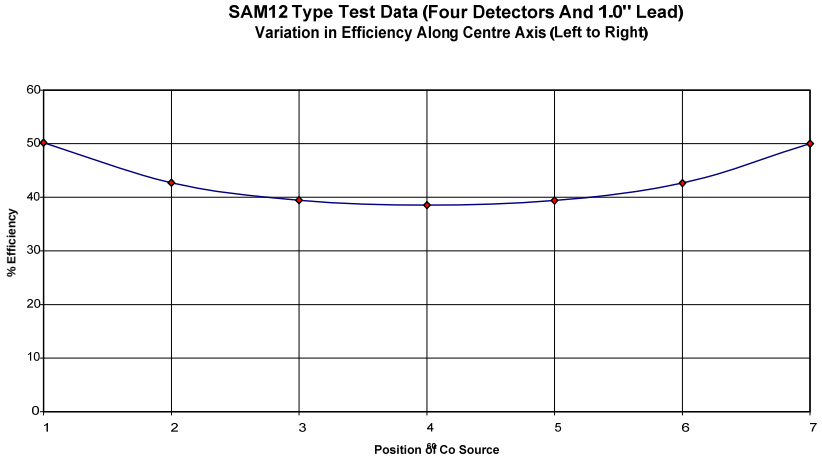


Figure 5 - Efficiency Variation along Central Axis (Left to Right) SAM12A 4C-2D-1L

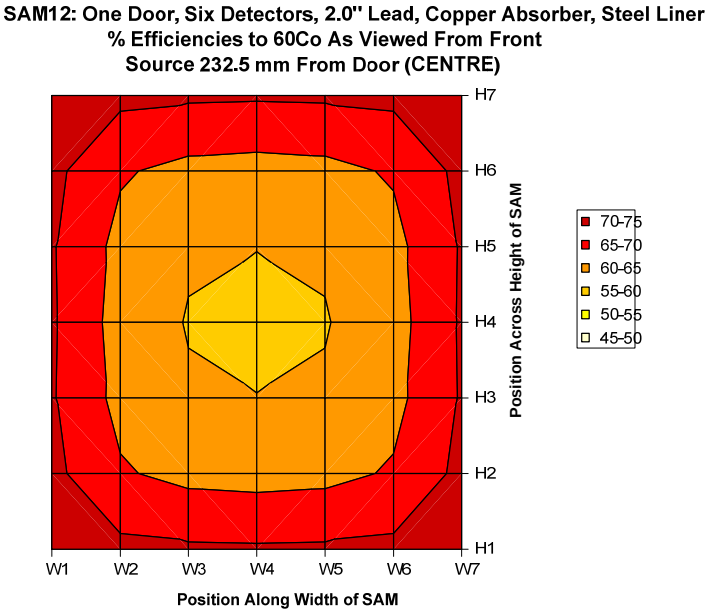


Figure 6 - Front Spatial Response - SAM12A 6C-1D-2L

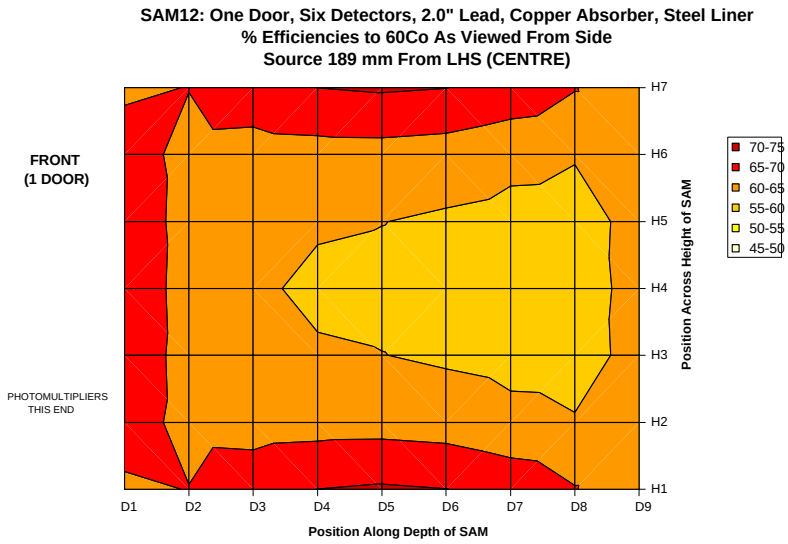


Figure 7 - Side Spatial Response - SAM12A 6C-1D-2L

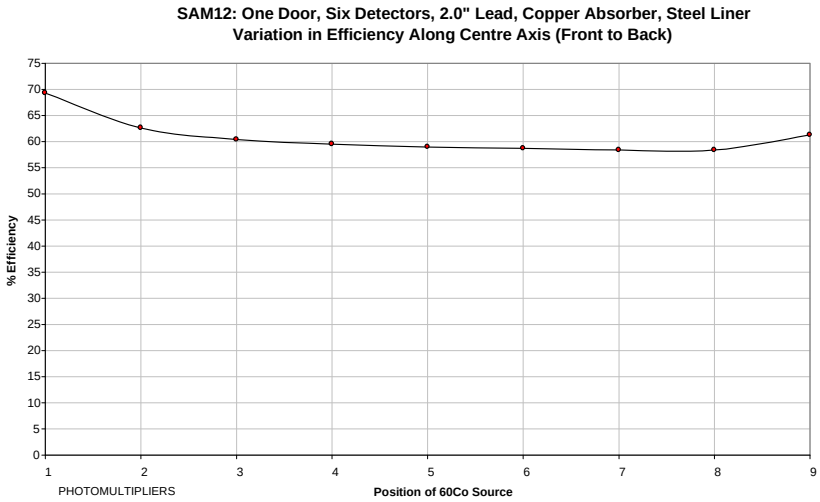


Figure 8 - Variation along Central Axis (Front to Back) - SAM12A 6C-1D-2L

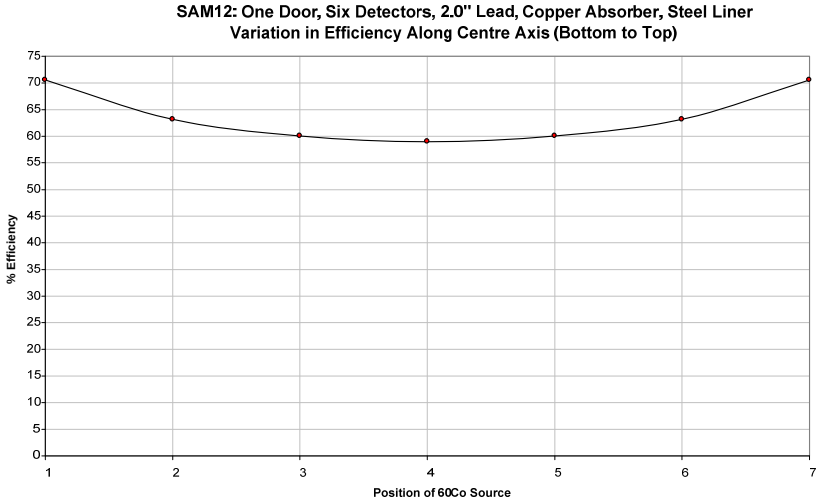


Figure 9 - Variation along Central Axis (Bottom to Top) - SAM12A 6C-1D-2L

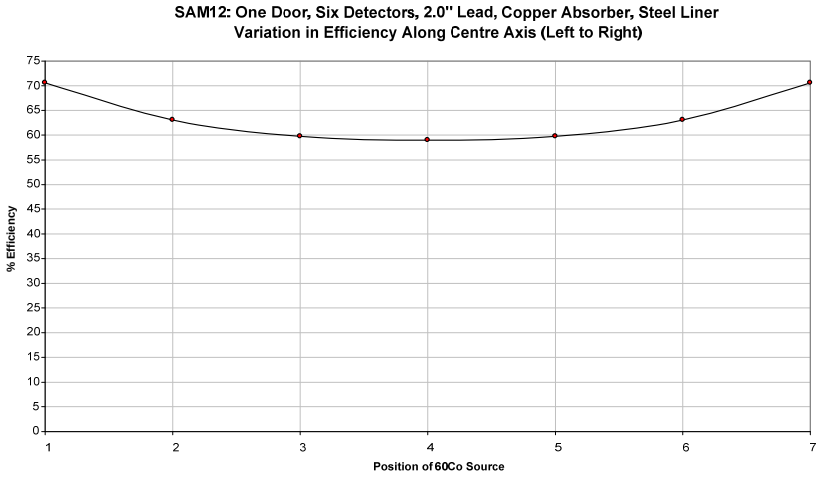


Figure 10 - Variation along Central Axis (Left to Right) - SAM12A 6C-1D-2L

Chapter 7 Technical Description - Circuitry

Description (page 2-1) provides a general background to the following description and should be read before proceeding.

Introduction

This section deals with the operation and function of all the major electronic assemblies which comprise the SAM12. Description of all assemblies is restricted to general operation and specification since detailed circuit operation may be the subject of design confidentiality.

Controller Board - Type 5670A

The Controller Board, Type 5670A, is detailed in assembly drawing E91885/A . This comprises all the interface buffers and connections necessary to communicate between all peripherals and the proprietary on-board plug-in ETX processor.

ETX Processor

The ETX unit plugs into the motherboard using connectors SK2, SK5, SK9 and SK12.

The assembly has the following facilities used by the system:

1. 800Mhz Pentium-M processor.
2. 256 megabytes of RAM.
3. Dual RS232 Serial communication interface.
4. Real time clock.
5. This is supported by an off-board Lithium battery. The RTC provides microprocessor access to year, month, day, hour, minute, seconds. It also provides several interrupt periods from one year down to 0.01 seconds
6. Quad USB hub Type 1
7. Single Ethernet interface
8. LCD and CRT drivers
9. Dual IDE ports
10. ISA 8-bit I/O expansion
11. Flash Card interface
12. Audio synthesizer

PL30 Header for Non Volatile Memory (CF)

LK8 - Write protect facility

LK7 - Define as Master option

1 Giga-Byte minimum capacity

PL5 44 pin Primary IDE port for 2.5" disks

Power connector PL26

PL25 40 pin Primary IDE port for 3.5" disks

Power connector PL26

PL4 40 pin Secondary IDE port for CD Roms

Power connector PL23

IC9 Programmable I/O Device

IC9 is a Programmable Logic Device (PLD) providing the following:

1. A "4 x 4" keyboard interface
2. I/O expansion bus to PL15
3. Control of 4 independent change-over contacts on PL16, 17, 18 & 19
4. 4 x optically isolated sense inputs on PL24, 27, 28 & 29
5. A windows type Key bleep on PL21
6. A watchdog output via TR1 in parallel with the on board reset switch S1

IC6 and IC8 Buffer

IC6 & IC8 provide for RS232 voltage levels on PL8 & PL9:

Label	Connection PL8/9	Function
TXD	5	Transmit Data
RX-EXT	3	Receive Data
DTR	7	Data Terminal Ready
RTS	4	Ready to Send
DCD	1	Data Carrier Detected
CTS	6	Clear to Send
RI	8	
DSR	2	Data Set Ready

IC1 Sound Amplifier

IC1 provides for a loud-speaker drive on PL3 from the on board (ETX) sound signal generator.

IC2 & IC3 USB power controllers

Provides for two independent power sources with current limiting for USB peripherals

IC5 LCD Power and Control

IC4 EEPROM

Not used

Display facilities

SK7 VGA/ CRT display interface

SK1 LCD & Touch Screen display interface compatible with 5663A

Inputs

Summary of the controller board inputs:

Input	Connection	Function
IP1	PL24	Door Switch (dirty)
IP2	PL27	Solenoid Status (dirty)
IP3	PL28	Door Switch (clean)
IP4	PL29	Solenoid Status (clean)
IP5	PL20	Start Button

Outputs

Summary of the controller board outputs:

Output	Connection	Function
OUT1	PL16	Door Interlock Magnet (dirty)
OUT2	PL17	Door Interlock Magnet (clean)
OUT3	PL18	Not Used
OUT4	PL19	Not Used

Battery Controller Board Type 5660A

Battery Controller Board, type 5660A, is shown on assembly diagram C91799/A. This is an X-channel device which enables the operating system to monitor the charging process and remotely shut down the load.

Introduction

The Battery Controller Board, type 5660A, controls the DC voltage output of a power converter unit (PL4) between the range +11.2 V to +15.6 V in order to maintain the integrity of the +12 V 15 Ah Lead Acid Battery (PL3), over the operating temperature range (temperature sensor on PL1).

The 5660A has the ability to switch the load (PL6) ON/OFF as directed by the operator, whilst continuing to charge the

battery. Current and voltage monitoring (IC100/101) and control circuitry (IC4) always ensure sufficient power is made available to power the SAM12 (even when the battery is exhausted) from the primary power source.

The transfer to battery is automatic. However the load will be removed when the battery terminal voltage falls bellow +10.5 V. This circuit is required to prevent the battery being damaged by being deeply discharged. Hysteresis is built in to this circuit to prevent oscillations. It does not allow the battery to re-connect as soon as its terminal voltage recovers slightly as a result of having the load removed from its terminals.

The user is signalled the pending shut-down in order that any data can be saved.

A key switch is connected to the 5660A for manually switching the power ON/OFF to the load.

Keyswitch operation

The key-switch performs two operations.

Primarily it allows the instrument to be switched ON if either the mains supply exists or the battery contains sufficient charge, or both. This is achieved by turning the key clockwise for at least 2 seconds.

Secondly, the instrument can be switched OFF should the operating software fail to carry out the “Shut-down” task by holding the key clockwise for at least 10 seconds.

FHT681 42543-0223 & 42543-0224

For more information regarding the Scintillation HV and Amplifier Board, see FHT681 Scintillation HV and Amplifier Type 42543-0223 (page 2-3).

For more information regarding the CCM Board, see FHT681 Coincidence Detector Card Type 42543-0224 (page 2-4).

Scintillation HV & Amplifier

The Dual-Channel Scintillation HV and Amplifier board provides the high voltages for two scintillation detectors. It also receives charge pulses from two detectors, amplifies them and discriminates between five energy levels. Independent counter values (five for each channel) are generated every 100ms and stored in a 5 second buffer. In addition to that, 1s values are built from the 100ms values. All these values can be polled from the serial interface.

The HV sections are designed to provide independently adjustable polarising voltages for two scintillation detectors with working voltage ranges between 500V to 1400V.

The setting of high voltages and thresholds is done via the serial interface.

The 1st,3rd and 4th counters for each channel form Cobalt coincidence pulses which are available on OUT1 & 2 connectors.

HV & Amplifier Connections

The card has six connectors.

The scintillation detectors are connected via MHV connectors on PMT1 & 2.

Coincident outputs are on BNC connectors OUT1 & 2.

X15 & X16: These connectors provide power supplies to the board and RS485 terminations:

X15 & X16	SIGNAL
1	EARTH
2	0V
3	RX-
4	TX-
5	Signal Ground
6	TX+
7	+5V
8	RX+
9	+5V

Coincidence detector

Used in conjunction with PCB 42543-0223, this assembly allows measuring the coincidence counting rate of up to 6 detectors. The number of coincidences can be determined through setting the threshold no.1.

Coincidence Detector connections

The board has six connectors.

Coincident inputs are on BNC connectors “IN” 1-6.

X15 & X16: These connectors provide power supplies to the board and RS485 terminations:

X15 & X16	SIGNAL
1	EARTH
2	0V
3	RX-
4	TX-
5	Signal Ground
6	TX+
7	+5V
8	RX+
9	+5V

Mains Power Supply Module

The mains power supply is a proprietary high-frequency switched mode 50 Watt converter. The power module can accept a mains input of 85 V to 264 V, 47 Hz to 63 Hz, the output is between 12 and 15 V at 3.5 A. The actual output voltage is controlled by the 5660A.

The power supply is capable of charging the battery at a maximum rate of 3.3 A, up to +40°C. This module contains AC Mains and dangerous DC switching voltages. It should not be operated with the protective cover removed or the mains ground (earth) conductor disconnected. It is not user serviceable and should be returned to Thermo Fisher’s Service department for repair.

LCD Display and Controller I/F & Backlight Inverter Module

The LCD module is fitted with an integral Cold Cathode Fluorescent (CCFL) back-light. The back-light is driven from a proprietary inverter, mounted in a small screened box within the display. The inverter generates dangerous high voltages and RF interference frequencies and should not be operated outside the box or with the display lid removed.

The LCD is controlled via a proprietary serial interface device also mounted in a small screened box within the display.

Neither the display or the back-light inverter or the controller are user serviceable and should be returned to Thermo Fisher's Service department for repair.

General Electromagnetic Compatibility (EMD) Considerations

The overall construction is designed to minimise the effects of mains and airborne interference and emissions.

It is, therefore, vital that the construction standard is maintained at all times, particularly when replacing parts and during servicing.

Earthing is particularly important for continued EMC (and Safety) performance. 'Hard' earthing of the mains inlet/filter assembly and LCD display tail, the FHT681 HV/Amplifier screening can and the frame earth are particularly important. Refer to the relevant Servicing instructions in Routine Checks (page 8-1) for details.

The instrument should only be operated with all earthing connections securely made and all screening covers fitted.

Chapter 8 Routine Checks

This section describes the routine checks required to ensure the correct operation of the SAM12. Most mechanical and electronic failures, if they occur, will become apparent during normal operation and do not require checking. Therefore, they are not included in this section.

Mechanical Checks

Door Locking Mechanism (if fitted)

Once a month, or during source checks, check the operation of the door lock, if the option is fitted. To do this, perform a measurement with a source known to give alarms. When the alarm occurs, check the door is locked and remains locked, after the Residual Contamination Check if the option is selected. Enter a valid password in the normal way (see Gaining Access to the Administration Mode (page 5-3)) and check the door unlocks. For the two door SAM12 with door locks, opening one door will lock the other.

Alternatively the locks can be exercised individually (see Vault (page 5-18) for more information).

SAM12 Mounting Arrangement

During calibration, or more frequently if required, check any mechanical structure on which the SAM12 may be mounted. Since the SAM12 with especially with 2" of lead shielding is very heavy, any mounting arrangement should be inspected for signs of deterioration, instability or any other factor which may affect safety of operation or maintenance. If any such defect is suspected, the SAM12 should be withdrawn from service and safely removed using a suitable forklift and the integral fork lifting facilities provided. The mounting should be repaired and made safe before replacing the SAM12.

See Door Lubrication (page 11-10) for details regarding lubrication of the knuckles of the door hinge.

Other Mechanical Checks

Any other mechanical faults should, if they occur, become apparent during normal monitoring operation.

Electrical Checks

Battery Charge state

During calibration, check the general condition of the battery. To do this, turn the SAM12 key-switch on the rear panel to the ON position and remove the mains power cord. Remove the top cover and connect a suitable Voltmeter, set to the DC volts range, directly across the battery terminals. Check the "load" battery voltage is greater than 12 volts (assuming the battery has previously been charged). If the battery voltage is low, consult Troubleshooting (page 10-4). Replace the top cover.

Alternatively the battery voltage and load can be monitored (see Battery (page 5-14) for further information).

NOTE: Only qualified personnel should operate the SAM12 with the mains connected and the cover removed. Make sure all the warnings given at the front of this manual are heeded.

Display Checks

During calibration, ensure all lamps are operational (see Vault (page 5-18) for further information).

It may be necessary at some time (due to replacement of Touch Screen or Touch Controller) to re-calibrate the touch screen. This is an Administration function and the facility would be accessed outside of the application program.

EMC & Safety Earthing Checks

Periodically, and after Servicing, check all Earth connections are fitted and tight to ensure continued EMC performance and User Safety. These checks should include the screws securing the mains inlet/filter assembly to the rear panel, all connections to the central earth point (CEP), and the connection to the Main Frame.

Also check that all screening covers are fitted and all fixings tightly secured.

Periodic Source Checks

During calibration, after repairs, or once a year, the detection efficiency of the SAM12 should be checked using a Calibration check as described in Cal Check (page 5-19). To perform these checks, small area sources of the nuclides that the SAM12 is required to detect should be used. A stable background is essential for an accurate result. The calibration check will be performed to an accuracy defined by Calibration Check Accuracy (%) (see Params 1 (page 5-8)). The overall Efficiency calibration factor should be within ±10% of the existing programmed value.

Should the results be outside these limits, the SAM12 operational parameters require revision (see Setting Up Procedure (page 9-1)). Calibration procedures are described in Calibration Procedure (page 10-1).

Carry out a regular source check after a 100 sec background update.

Regular Source checks

Daily or weekly source checks are advisable, using a Calibration check as described in Cal Check (page 5-19).

The check source is placed in the calibration position, usually 3 inches from the bottom of the measuring volume.

The alarm response should be 2 out of 3 or greater than the probability of detection for a “one alarm level” source.

Cleaning Instructions

WARNING: Ensure the mains supply is isolated before cleaning.

The display can be wiped clean with a dry cloth. Smudges may require the application of the Screen cleaner provided when the instrument was delivered.

The cubical should be cleaned using a mild detergent.

Make sure the equipment is completely dry before re-connecting the supply.

Chapter 9 Setting Up Procedure

Initial Setting Up for Use

General

After the initial installation and before switching on the SAM, read Operating Instructions (page 5-1). Ensure the door(s) are properly closed. Connect the mains lead to the SAM12 and turn the keyswitch clockwise until the unit switches on (a click is heard after about 1-2 seconds) and then release it (see Keyswitch operation (page 7-4)).

Initialisation

The SAM12 will power up and load up the Windows XP operating system, followed by the SAM12 application. During this time, the *Thermo Scientific* banner will be displayed (see below).

Once the application has loaded, the application will initialise (see Start Up Checks (page 5-46)). The system will automatically pass into the User Mode. In this mode, the user will not have access to any operational parameters. In order to set up the instrument the user requires a security dongle, which should be placed in the USB port of the SAM12. When this dongle is in place, the touch screen is activated, and the user will have access to the Administrator Mode (page 5-1).

Setting Passwords

There are three user levels:(Technician, Health Physicist and Thermo Fisher). The lowest level is *Technician* and allows the user to view some parameters and undertake calibration checks. The *Health Physicist* level gives access to all parameters that are used for calibration and setup of the instrument. The top level *Thermo Fisher* is reserved for the expert user since it gives access to specialised calibrations settings that fundamentally affect the performance of the instrument, and should only be set at the Thermo Fisher factory or by a Service

engineer. The menu options that are available to each user levels are summarised in Menu Roles (page 5-5).

Passwords (page 5-42) shows how the user may change the password. Both the *Thermo Fisher* and the *Health Physicist* passwords protect the security of the operational Parameters and hence the integrity of the measurement. Therefore these passwords should remain confidential; their use restricted and above all should not be readily obvious to potential "hackers".

Each user level should have a unique password and under no circumstances should all three levels be assigned the same password.

Setting the Operational Parameters

2-Door Locking Configuration

For 2-door SAMs, it is essential that the door locking options are correctly configured before monitoring operation is allowed. Doors (page 5-13) describes the method for setting the doors correctly.

At this point, it is strongly recommended that the following User Programmable Operational Parameters are checked and reset by the Health Physicist before allowing normal monitoring to proceed.

Low Background Alarm
Gross changing background
Detector changing background
Changing Conditions
Changing Conditions period
Calibration Required Interval

See Set-Up|Params 1 (page 5-8) for more information.

Probability of Detection
Probability of False Alarm
Minimum Monitoring Time
Maximum Monitoring Time
Measurement Confidence
Quick Scan Period

See Set-Up|Params 2 (page 5-10) for more information.

Set-Up/Alarms
Calibration stream
Normal Alarm

See Set-Up|Alarms (page 5-12) for more information.

Resetting the above Parameters will guarantee the integrity of measurements. It is also important to reset the time and data (see CCM Setup (page 5-30)) since these are used when check the calibration due dates, and also by the Data option.

A listing of all the parameters is available by selecting Instrument Configuration Report (page 5-38). This report should be either printed or saved to USB memory stick, when the instrument is first set up, and when significant changes of configuration are undertaken.

The SAM12 will be delivered optimised with a valid HV Scan and optimum operating voltages stored. The exception being the upgrade kit, where the SAM12 electronics needs to be matched to the existing detectors. If the HV Scan needs to undertaken for any reason, follow the procedure described in HV Scan (page 5-25).

The SAM12 will be delivered calibrated to both ^{137}Cs and ^{60}Co. However if the user wishes to undertake a calibration check, or to recalibrate, follow the procedure described in Cal Check (page 5-19). Whenever the operating voltage on a detector is changed, the instrument must be recalibrated.

The details of the current and previous calibrations are stored to a backup compact flash. These backups take place automatically after every calibration, and when requested by the User. It is recommended that the backup is undertaken after every voltage scan and calibration. This backup may be retrieved if for any reason the hard drive on the instrument needs replacement.

Selection of Detector Operating Parameters

The following sections assume that the instrument is set to the factory defaults.

Detector HV Selection

The Test and Performance Certificate supplied with each instrument lists the recommended High Voltage settings for each detector for the optimum detection. HV Scan (page 5-25) describes the setting of the detector HVs.

If, however, it is required to ascertain the optimum operating voltages by measurement, e.g. due to new detectors, the procedure described in Derivation of the Optimum Operating Voltage (page 9-4) should be followed. Calibration for other nuclides and nuclide mixes is described in Calibration Procedure (page 10-1).

Derivation of the Optimum Operating Voltage

Calibration Source Activity

The SAM12 is designed to detect activities down to release levels and otherwise 'as low reasonably achievable'. However, the SAM12 is also very linear in response, so a wide range of source activities may be used for set-up and calibration. Depending upon energy / detector efficiency, source activity should ideally be in the 100 nCi (3.7 kBq) to 11 µCi (400 kBq) range, and in any case not more than 20 µCi (740 kBq). Long count times will be required for small sources to maintain statistical accuracy against adverse background influences.

The calibration of the SAM12 to ^{60}Co when CCM is installed, requires a longer counting time than would be required if CCM was not installed. The reason being that CCM mode has a lower efficiency than the standard "gross counting" mode, typically 1% for a 6 detector instrument. Therefore it is recommended that a ^{60}Co source of activity in excess of 40 kBq be used to undertake the CCM calibration. Note that the CCM calibration is undertaken at the same time as the standard ^{60}Co calibration.

Performing the HV Scan

NOTE: For all the measurements performed below, the door(s) should be fully closed in order to minimise the effect of background fluctuations. All counts read from the detectors are corrected to compensate for the amplifier "dead time".

With the SAM12 and surrounding area free of sources, enter the Administrator Mode (page 5-1) as 'Health Physicist'. From the function tabs on the left side of the screen select the 'Calibration' option. Then from the tabs along the top of the screen select 'HV Scan'. There will be a choice between performing a 'New Scan' and viewing the 'Last Scan'. Press the 'New Scan' button.

The new screen allows for the setting of the scan parameters Start, Stop and Step voltages as well as the counting time. The recommended values for these parameters are;

Start	=	500 volts
Stop	=	1200 volts
Step	=	5 volts
Time	=	10 seconds

NOTE: Short voltage steps are required in order to make the location of the optimum operating voltage easier. Using the recommended values, this process will take approximately one hour to complete.

Once there parameters have been set and the 'Start' button has been pressed. A series of onscreen instructions are displayed to step the user through the scan process.

NOTE: The scan can be aborted at any time by pressing the 'Abort' button. The scan is performed on all detectors simultaneously.

The first step is to perform a background scan. This is followed by a scan with a ^{137}Cs source, placed as near the centre of the vault as possible. On completion of the scan the users is given the option of saving the data by pressing the 'Save Scan' button. This data, along with its description, can be retrieved via the 'Data' tab (see HV Scan Report (page 5-36)). Once the 'Save' button has been pressed, the display changes to show graphs of the scans.

Determining the operating voltage for mid-high energy nuclides

There are two methods for determining the optimum operating voltage depending on whether the NBR and CCM features will be used, or whether the voltages will be set the "classic" way by reviewing the Figure of Merit at each voltage setting. The recommended method is that which allows the use of NBR and CCM, which typically will also provide an operating voltage which satisfies the Figure of Merit criteria.

NBR method

When the graphs are displayed, select the 'NBR' option, and then press the respective graph for a detector which will expand it to fill the screen. The optimum operating voltage is that which has a T1/T2 ratio of between 30 and 35. In order to find this press the 'Table' button and the data will be displayed. From the table, identify the operating voltage that has the correct T1/T2. If you have to interpolate between two voltages, assume a linear change. Enter this value into the 'HV Setting' box and then press the 'Back' button.

The value below the graph will now have a **Gold** background to it. This background colour highlights that the value has been changed, but not yet saved. When all operating voltages have been set, press the 'Apply Settings' button to save these values.

NOTE: The 'Back' button **must** be pressed in order to access the other functions.

Figure of Merit (FOM) method

NOTE: The following procedure tends to be iterative in nature and included as a guide only. Different operational requirements and background conditions may necessitate a different choice of operating point. The final choice should be at the discretion of the senior Health Physicist.

The Objectives are to:

- Obtain consistent detector efficiencies, particularly between opposite pairs, and
- Obtain good overall system efficiency, and
- Obtain low average background count and minimal spread between detectors

When the graphs are displayed, select the 'Gross Counting' option, and then press the respective graph for a detector which will expand it to fill the screen. Pressing 'Table' will show the actual FOM and S^2/B values – note that S^2/B is proportional to FOM and is included for those users who prefer this quantity.

For mid and high energies, an FOM 'peak' is usually evident from the data. Determine the maximum value of FOM for each detector - **as a starting point**. If no clear peak is visible or several peaks exist, select a starting FOM value corresponding to a background value (B) similar to that of the other detectors. Select the detector operating point as follows:

1. The background count for each detector does not exceed the following:

	Typical	Maximum
1 inch (25 mm)	10 cps/µR/h 1000 cps/µSv/h	15 cps/µR/h 1500 cps/µSv/h
2 inches (50 mm)	6 cps/µR/h 600 cps/µSv/h	10 cps/µR/h 1000 cps/µSv/h

2. Each background count does not differ by more than 30% from the mean value of all detectors.
3. Calculate the Mean Source Counts (Sm) for all detectors. The value of the net source counts (S) for each detector does not differ by more than 15% from the mean value of (S) for all top, bottom, left and right detectors and by no more than 25% for front and rear detectors (if fitted).

If any detector exceeds any of these limits, alter the relevant HV by 10 V and check the FOM is not significantly different than the original. A total adjustment of 75 V is permissible.

This is a rough guide and individual circumstances may demand wider variations.

If and when the background and source values are satisfactory, calculate the detector efficiencies from the net source counts (S) and source activity, at the chosen HV setting. Calculate the overall system efficiency, which should be within the range below:

SAM12 No. detectors	^{60}Co (1.2 MeV) Centre	^{137}Cs (662 keV) Centre
4C	40% (36-44)	16% (15-19)
6C	58% (53-63)	28% (23-33)

The above table includes variations for 1 and 2 door versions and is independent of lead shielding.

4 Detector Systems: Individual detector efficiencies should be an approximately equal proportion of the Total System efficiency, (i.e. approx 10% each for ^{60}Co).

If one of an opposite pair of detectors is high, and the other is low, then the source is probably off centre.

6 Detector Systems: Individual top, bottom, left & right efficiencies should be approximately equal.

The front and back detectors will be slightly lower efficiency than the other four detectors due to geometric effects – if the source is in geometric centre of volume.

If the overall system efficiency or any individual detector efficiency is too low (or too high), consider the source values at the next HV step - review the background Criteria in Tests (1) & (2) and the Source Criteria in Test (3). Repeat this process if necessary.

NOTE: The Minimum Detectable Activity (MDA) is proportional to the square root of the Background – lower background improves (reduces) the MDA. Therefore 'Squeezing' a few extra source counts at the expense of a significant background increase, will be detrimental.

Variance Testing

When the system has been set-up, a background stability test, usually referred to as a variance test, should be performed. This is a test to measure the deviation of the distribution of background from a perfect Gaussian distribution. This is equivalent to a Chi-squared test.

See Variance Test (page 5-17) for further information regarding how to set up the variance test. The variance test result is the

variance of the counts recorded in each cycle, divided by the mean count in all the cycles. The upper and lower variance limits have defaults of 1.5 and 0.67. The default values are based on a recommended number of counting cycles of 25 and a cycle period of 25 s. If the number of cycles or the counting period is increased above these values, then the spread of values is lower, and the limits may be reduced. Refer to Figure 11 (page 9-9) for typical limits.

Setting the NBR parameters

The NBR feature is effectively a pair of filters which examine the ratio of pulse rates above different pulse height thresholds. Since the ratios from NORM, and typical man-made radiation are well known, then a degree of compensation is possible when NORM is present.

See Params 3 (page 5-11) to view the setting of the NBR parameters. This should only be undertaken by an expert user, and this menu is only available at the Thermo Fisher level (see Menu Roles (page 5-5) for more information).

These parameters may be fine tined based on the NORM present on the users site. However it is recommended that the user receives specific training from Thermo Fisher Scientific, since incorrect setting of these parameters may result in some samples being incorrectly identified as NORM.

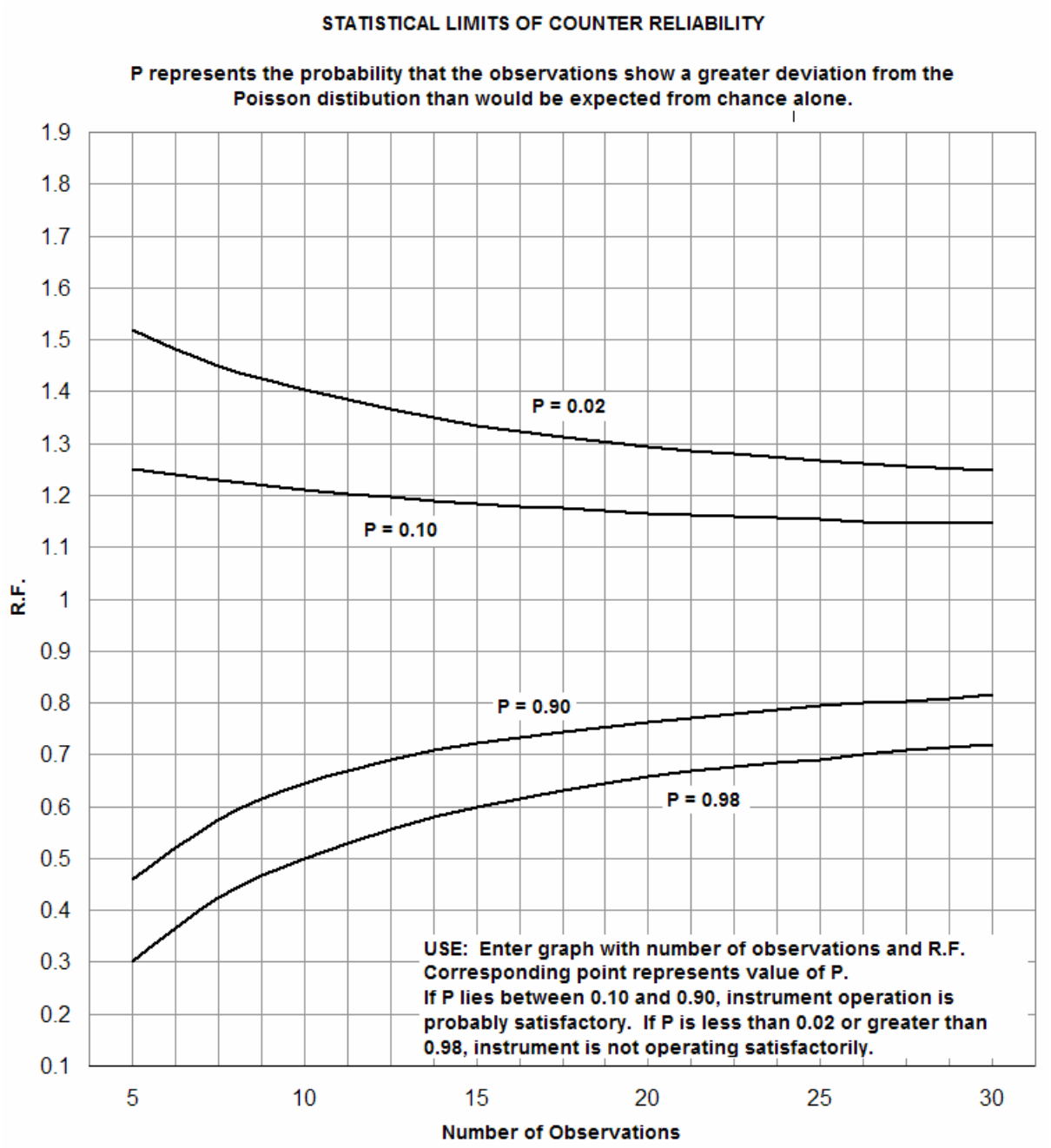


Figure 11 Statistical Limits of Counter Reliability

Chapter 10 Calibration Procedure

This section deals in detail with primary system calibration. It includes background, source and efficiency checks on individual detectors to check detector balance as well as overall system efficiency. Primary system calibration by the Health Physicist is only usually necessary on initial installation and on a periodic audit basis. More frequent overall system calibration checks can be quickly carried out by Technician user level using the "Cal Check" facility (see Cal Check (page 5-19)). For more information regarding the user roles, see Foreword (page i) and Menu Roles (page 5-5).

Note: Throughout this section examples are given in Bq. However, by first selecting nCi's from the Options Menu (see Options (page 5-6)) as the operating units, all values may be entered in these units. Of course the equations remain unchanged, though care must be taken to ensure that the units are consistent.

Calibration Validity

The SAM is capable of undertaking a calibration validity check. This check will evaluate the number of days between the last valid (PASS) calibration check. If this number of days exceeds the maximum acceptable recalibration interval, then the SAM will put itself "Out of Service" (see Out of Service (page 5-62)).

To define the period between calibrations checks, set the "Calibration Required Interval" parameter in Params 1 (page 5-8).

If the user "Fails" the calibration check, then this is not treated as a calibration, and is disregarded when assessing whether the SAM is within its recalibration interval.

Equipment Required

1. A small radioactive source of known nuclide and activity, which is found within typical contamination to be monitored. The SAM is designed to detect activities down to release levels, as well as quantify significantly larger activities, up to in excess of 130 µCi (5 MBq).

Since the SAM has a very linear response to activity, any source of activity between 100 nCi (3.7 kBq) to 10 µCi (370 kBq) range may be used. When CCM is enabled, the 60Co source used for calibration should have an activity in excess of 5 µCi (185 kBq) in order to minimise the calibration time. Long count times will be required for small sources to maintain statistical accuracy against adverse background influences.

2. A source holder, to securely retain the source for positioning within the cubicle.
3. A generic USB printer, (e.g. Epson LX300)

Preparation for Calibration

First the user must enter the Calibration Menu (page 5-19). Select HV Scan (page 5-25) and check the detector HV's are set correctly for the Calibrating isotope. If these are not known, they must be determined as described in Detector HV Selection (page 9-3) before proceeding with the calibration. The SAM12 is then ready for calibration.

Calibration

Ensure the background is stable, the door is closed and any calibration sources are well away from the SAM12 (at least 8 feet).

1. Ensure the door is shut and the unit is on and ready.
2. Login to the Administration mode, using the Health Physicist role (see Gaining Access to the Administration Mode (page 5-3)).

See Cal Check (page 5-19) for more information.

To check the calibration, the *Cal Check* button is selected. This does not allow the calibration factor to be changed, but a comparison is made between the old and new factor.

To recalibrate the instrument, i.e. adjust the calibration factor for a particular nuclide, the *Calibrate* button is selected.

The calibration process should be repeated for a number of nuclides that would be found in typical contamination. As a minimum, a calibration to both ^{137}Cs and ^{60}Co should be undertaken. The ^{137}Cs calibration is essential when the NBR facility is used; the ^{60}Co calibration is essential when CCM is required.

Notes: Ensure that each source is at least 8 feet away from the SAM during the background measurement.

At the end of the calibration, the user is prompted to PASS or FAIL the calibration. If the result does not appear to be correct – see below for reference values – it may be appropriate to FAIL (or Cancel) the calibration.

SAM12A No. detectors	^{60}Co (1.2 MeV)		^{137}Cs (662 keV)		^{137}Ba (356 keV)		CCM
	3 inches	Centre	3 inches	Centre	3 inches	Centre	Centre
4C	42% (40-44)	38% (36-40)	17% (16-20)	16% (15-19)	28% (26-31)	26% (24-28)	0.4%
6C	57% (55-59)	53% (51-55)	24% (22-26)	23% (21-25)	38% (36-40)	36% (34-38)	1.1%

See Specification (page 3-1) for more information regarding the various SAM12 types.

NOTES: If the efficiency is very different from the expected value and the background is stable, perform an HV scan (see Performing the HV Scan (page 9-4)) and repeat this procedure.

The Instrument Configuration Report (See Reports (page 5-31)) will provide a hard copy of the set-up and calibration results.

Calibration for Other Nuclides

See HV Scan (page 5-25) for more information.

Efficiency factors for other nuclides and mixtures of nuclides can be defined in a similar manner to that for ^{60}Co described in Preparation for Calibration (page 10-2.)Before calculating efficiency factors for new nuclides, it would be advisable to verify those for ^{60}Co and / or ^{137}Cs, ensuring that the SAM's detectors are functioning correctly.

If low energy nuclides need to be monitored such as ^{57}Co, then it may be necessary to undertake an HV scan for that particular nuclide. Follow the procedure described in Performing the HV Scan (page 9-4), specifically for the Figure of Merit method (see Figure of Merit (FOM) method (page 9-5)), in order to find the best operating voltage.

If NBR is required, then the voltage must always be optimised using the method described .in NBR method (page 9-5).

Calibration mixes

The SAM12 will allow "calibration streams" to be set, which will include a number nuclides and their associated percentage in the mix. The SAM12 will take account of the respective efficiency of the nuclide and the percentage, to evaluate the overall efficiency of the SAM12 to the mix. Note that even when the SAM is calibrated to a single nuclide, such as ^{137}Cs, this is still treated as a single nuclide stream. Only those nuclides to which the SAM12 has been calibrated, may be included in the mix.

Calibration Selection (page 5-24) shows how to create the mix for a new calibration stream.

It is not essential that the percentage of all the nuclides entered adds up to 100 %. In this situation, the SAM12 will assume the unidentified percentage is due to undetectable nuclides, such as ^{55}Fe, and adjust the overall percentage efficiency to the mix appropriately.

Troubleshooting

If Background Values Vary by More Than 30%

CHECK IMMEDIATE AREA AROUND SAM12 FOR A LOCAL SOURCE OR DIRECTIONAL BACKGROUND FIELD "SHINE".

The background operating voltage may be adjusted in steps of 25 V for a particular detector in order to increase or decrease the background response to be more consistent with the other detectors.

HOWEVER ANY ADJUSTMENT OF THE VOLTAGE WILL INVALIDATE THE CCM AND NBR MODES, WHICH MUST BE SET USING THE METHOD DESCRIBED IN Selection of Detector Operating Parameters (page 9-3).

If Nuclide Count-Rate Outside Required Value

If only one of the detectors is outside the required value, change the relevant HV setting as described in the previous section.

AGAIN, ANY ADJUSTMENT OF THE VOLTAGE WILL INVALIDATE THE CCM AND NBR MODES, WHICH MUST BE SET USING THE METHOD DESCRIBED IN Selection of Detector Operating Parameters (page 9-3).

Significant deviations form the expected efficiency indicate a faulty detection assembly, and remedial action should be taken.

Chapter 11 Maintenance and Trouble Shooting

Fault Messages

The fault messages produced whilst in the application are directly controlled by the software written by Thermo Fisher Scientific whereas errors reported from the motherboard Bios or the Window's operating system will be supplier dependent.

Power-up Screens

On switching ON the screen will remain blank for several seconds whilst the Bios carries out basic checks on the motherboard. The screen will eventually show scripting which details the progress of these initial tests. Should a fault be found the process will halt with the fault/error detailed. This should be recorded and reported to Thermo Fisher Scientific's service department. The equipment cannot be used until the fault is removed.

It must be noted that a failure of the LCD backlight module will leave the display blank even though "boot-up" is taking place correctly.

In a normal boot-up the Bios' sequence of tests will be followed by loading the operating system from the disk drive, signalled by the Thermo Fisher Scientific log screen. Any failure here will result in a "blue" screen. Again you will need to contact Thermo Fisher Scientific's service department if this does occur.

Finally the application software will be loaded and the SAM12 User screen will be displayed.

Self Test Screens

The application is entered with tests to verify the detection components are working correctly. Should a failure occur during these initial checks then the "Out of Service" message will appear on the message bar and one of the following will be displayed on the message bar:

1. Unable to set detector alarms
2. Database Offline
3. Unable to Configure Detector Subsystem
4. Invalid Language Setting
5. Default Calibration has no Alarms

6. Configured Error
7. Failed to Retrieve Sound Data From Database
8. No Default Calibration Selected
9. X-Channel Failure
10. X-Channel Failure Accessing Node {0}, ID {1}

Device Error Messages

If one of these messages occurs, a fault with a peripheral device is indicated. Normal operation of the SAM12 can be continued when action has been taken to rectify or circumvent the problem.

PRINTER NOT ACCEPTING DATA - The printer refused to accept data for over ten seconds. This may be due to the printer being disconnected, off-line or turned off. Check the printer and the connection to the SAM12 (see Network Communications (page 3-5)).

Operational Self Tests

Whilst the SAM12 is in Background Checking mode, certain aspects of the instrument's operation are tested repeatedly. If a fault is detected, the SAM12 will display the appropriate message as follows:

1. Amplifier Failure
2. Amplifier Counter Failure
3. Amplifier Counter Overflow
4. Amplifier HV Over Current
5. Amplifier HV Over Voltage
6. Amplifier HV Under Current
7. Amplifier HV Under Voltage
8. Amplifier Dead Time Saturation
9. Amplifier EEPROM failure
10. Front Lamp Control Failure
11. Rear Lamp Control Failure
12. X-Channel Failure
13. X-Channel Failure Node {0}

The fault messages produced whilst in the application will, typically, result in the "OUT of SERVICE" and "Critical Error" messages being displayed. Reference to OUT OF SERVICE (page 5-62) may assist to clear this fault and allow continued operation

An extreme failure may result in the Window's "blue" screen halting further activity. This will require rebooting the

software. However, continued occurrence of this fault would suggest a serious problem that needs reporting to Thermo Fisher Scientific's service department.

Servicing of the Electronics Chassis - Type 5689A

The Electronics Chassis contains the Power Supply module, battery, Charger PCB, Controller board and four HV and Amplifier Pcb's. Mounted on the front panel are the LCD Display and inverter, loudspeaker, keypad, start button and indicator lamps.

NOTE: AS A MATTER OF GENERAL ELECTRICAL SAFETY AND FOR CONTINUED EMC PERFORMANCE, ANY EARTH TAGS, WIRES, CONNECTORS OR COVERS REMOVED FROM ANY PART OF THE SAM12 IN THE COURSE OF SERVICING, MUST BE REFITTED. CARE SHOULD BE TAKEN AT ALL TIMES NOT TO SHORT THE BATTERY TERMINALS.

Removal of the Top Cover

CAUTION: SWITCH OFF THE MAINS SUPPLY TO THE SAM12 AND WAIT 1 MINUTE AFTER SWITCHING DOWN THE SAM12 BEFORE REMOVING THE TOP COVER.

To gain access to the 5689A Electronics Chassis components the Top Cover must be removed. To do this remove the 2 screws securing the top cover to the Electronics chassis. Lift the top cover clear of the Electronics chassis.

Removal of the Electronics Chassis from the Main Frame

When carrying out major Servicing work on the 5689A Electronics Chassis, it may be advantageous to remove it from the SAM12. The chassis is quickly and easily removed from the main frame as follows and since the assembly is complete, stand-alone testing is also possible. Remove the top cover as described in Removal of the Top Cover (page 11-3). Disconnect the detector coaxial connectors from the HV and Amplifier pcbs. Disconnect the door micro switch and locking gear cables (if fitted). Remove the protective cover from the HV & Amplifier pcbs. Release the four bolts securing the Electronics chassis to the Main Frame. The Electronics Chassis is now free and may be lifted clear of the Main Frame.

CAUTION: THE ELECTRONICS CHASSIS TYPE 5689A WEIGHS ABOUT 45 LBs (20KG) SO CARE IS REQUIRED WHEN LIFTING IT OFF THE MAIN FRAME.

When refitting the 5689A Electronics Chassis in the Main Frame, ensure:

- All four fixing bolts are fitted and tightened.
- The HV & Amplifier boards are covered with the protective lid.
- The detector cables are correctly terminated with their respective amplifiers.
- All earth Connections are securely fitted.
- The top cover is fitted and all fixings are tight.

These requirements are mandatory and necessary for continued EMC performance and user safety.

Removal and Replacement of the Power Supply

IMPORTANT: BEFORE ANY WORK STARTS ENSURE THAT THE MAINS SUPPLY IS DISCONNECTED FROM THE SAM12 AND THE SAM12 IS POWERED OFF.

The mains power supply for the SAM12 is mounted at the rear of the electronics chassis on the left hand side.

Having first disconnected the mains supply and removed the cover from the Electronics chassis as described in Removal of the Top Cover (page 11-3), deflect the restraining plastic on the PSU to one side to release the module from the aluminium bracket supporting the 5660A. Unplug PL4 from the 5660A and gently ease the PSU and cable from under the bracket. Remove the two wires connected to the mains filter and disconnect the earth cable from the Central Earth Point. Finally, remove the wires from the PSU connecting with plug PL4.

The Power Supply module contains dangerous high switching voltages and is not user serviceable. It should be returned to Thermo-Fisher Scientific's service department for repair or replacement.

Power Supply Replacement

Ensure the correct type of replacement power supply is used (See Recommended Spares List (page 12-1)). Replacement of the Power Supply is the reverse of the removal procedure. If the Power Supply is thought to be faulty it should be replaced with an identical unit (See Recommended Spares List (page 12-1)). Replace the connections ensuring all the clamping screws are tight and all GROUND/EARTH connections are made.

Adjustment of PSU

There is no PSU adjustment

Battery - Removal and Replacement

CARE SHOULD BE TAKEN AT ALL TIMES NOT TO SHORT THE BATTERY TERMINALS

The battery is a sealed lead/acid jelly type construction and does not require regular maintenance. If however, it requires replacement, proceed as follows:

Switch off the power, switch off the SAM12 and remove the top cover as described in Removal of the Top Cover (page 11-3). Disconnect the thermistor assembly from the negative BLACK terminal marked - first, taking care not to short it to the + terminal. Disconnect the red wire from the positive RED + terminal taking care not to short it to the - terminal. Remove the holding bracket by undoing the two mounting screws and then remove the battery. Dispose of it safely as required. The battery should be replaced only with one of a similar type or operation of the SAM12 may be impaired.

When refitting the battery, make sure the mounting bracket is be properly secured. Reconnect the red wire to the RED + terminal first.

ENSURE THAT ANY PROTECTIVE SAFETY BOOT IS REFITTED CORRECTLY OVER THE RED + POSITIVE BATTERY TERMINAL.

Reconnect the thermistor card to the BLACK - terminal last. Failure to do this may impair charging control and may lead to premature battery failure.

The battery contains hazardous substances; please take care to dispose of the old battery in accordance with your local regulations – in Europe Directive 2006/66/EC.

Battery Controller Board Type 5660A - Removal and Replacement

Switch off the power and remove the top cover as described in Removal of the Top Cover (page 11-3). The charger PCB is situated on the left hand side of the Electronics Chassis immediately over the power supply. Before attempting to remove the 5660A Charger board, ensure the mains supply is disconnected and the SAM is switched OFF . Disconnect the Battery cable from the 5660A board at PL3. Disconnect the other cables, remove the four screws and washers securing the PCB to its mounting spacers. The PCB is now free to be removed from the Electronics chassis.

Replacement of the Charger PCB

Replacement of the charger PCB is the reverse of the removal procedure (PL3 last). Should the Charger PCB be thought to be faulty it should be replaced with an identical unit (See Recommended Spares List (page 12-1)).

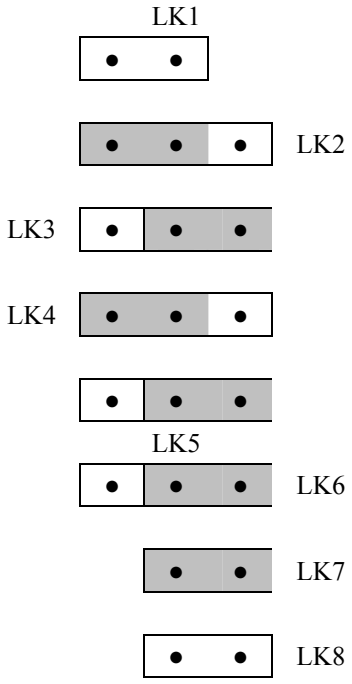
Controller Board type 5670A - Removal and Replacement

Switch off the power, power down the SAM12 and remove the top cover as described in Removal of the Top Cover (page 11-3). The 5670A Controller board is situated in the front centre of the Electronics Chassis, adjacent with the loudspeaker. Before attempting to remove the Controller board, ensure the power cable is removed from PL13. To remove the PCB, first disconnect all the cables around the periphery of the board. Remove the two screws retaining the PCB to its mounting spacers. The PCB is now free to be removed from the Electronics chassis.

Replacement of the Controller board

Replacement of the Controller PCB is the reverse of the removal procedure. Should the Controller thought to be faulty it should be replaced with an identical unit (See Recommended Spares List (page 12-1)).

Set the Link and Switches as follows:



FHT681 cards - Removal and Replacement

WARNING: THE HV & AMPLIFIER PCB'S GENERATE DANGEROUS HIGH DC VOLTAGES. EXERCISE CAUTION WHEN SERVICING, ALWAYS ALLOW THE HV TO DISCHARGE BEFORE COMMENCING WORK.

Switch off the power and remove the top cover as described in Removal of the Top Cover (page 11-3)

The FHT681 cards (4 maximum) are mounted vertically in line on the right hand side of the electronic chassis. They are

protected beneath a metal shield which can be removed by undoing 4 screws in the top of the cover.
From left to right the cards are organised as:

- Coincidence detector (1 only)
- HV and Amplifier for detectors TOP & BOTTOM
  Amp 1
- HV and Amplifier for detectors LEFT & RIGHT
  Amp 2
- HV and Amplifier for detectors FRONT & BACK
  Amp 3

Before attempting to remove any FHT681 board, switch the SAM12 OFF and wait 1 minute for the HV to discharge before beginning work.

The board mountings are identical. To remove any PCB, first disconnect the 9-way Dee, then release the MHV coax detector connector and the BNC coincidence cable for the HV and amps card or the 9-way Dee and the mating BNC connectors for the Coincidence card. Carefully prise each pcb from it's mounting spacers.

Replacement of the FHT681 PCB's

Replacement of any of the boards is the reverse of the removal procedure. Ensure the colour coded detector cables are matched to the correct amplifier connector PMT1 or PMT2:

- **LEFT** is Orange /PMT1 **RIGHT** is Yellow / PMT2
- **FRONT** is Red / PMT1 **BACK** is Violet / PMT2
- **TOP** is Green / PMT1**BOTTOM** is Blue / PMT2

It is not important which coincidence port is connected to which amplifier output.

What is important is the identity of the card and the detectors connected to it!

If any Board is thought to be faulty it should be returned to Thermo Fisher Scientific's service department for repair.

NOTE: All cards MUST be linked using the cables originally supplied

Removing & Replacing the Mains Inlet/Filter Assembly

In the event of this part requiring replacement, it must be replaced with a unit of identical type. When re-connecting the mains wiring, ensure the mains inlet earth connection is made securely to the Central Earth Point (CEP). These requirements

are mandatory and necessary for continued EMC performance and user safety.

LCD Display, Touch Screen, Touch Controller & Backlight Inverter - Removal and Replacement

WARNING: The Backlight Inverter generates dangerous high voltages. Exercise caution when servicing, always allow the HV to discharge before commencing work. Do not remove the Inverter from its protective screening enclosure.

Refer to assembly drawing D92053/A for details.

Switch off the power .Before attempting to remove the Display and Inverter, ensure the SAM12 is OFF. Remove the ten "allen" screws from the rear of the display housing and gently pull the front bezel assembly away from the main housing and lay flat onto the top cover. Take care not to strain the three cables attached. If necessary pull through more cable to ease working on the assembly.

The controller and inverter cards are accessed by removing the protection covers on the rear of the Display assembly. Take care in removing the connecting cables.

Both the Touch Controller module and the Back-light Inverter are propriety items and are not user serviceable. They should be returned to Thermo Fisher Scientific's service department for repair or replacement.

Four screws attach the LCD shield to the front bezel. On removal the LCD and shield can be lifted from the bezel and touch screen, itself sitting in a recess of the plastic bezel. The touch screen is not fixed to the bezel.

Another four screws hold the aluminium shield to the LCD, via spacers.

Replacement of the LCD Display, Touch Screen, Touch Controller and Backlight Inverter

Replacement of the LCD Display, Touch Screen, Touch Controller and Back-light Inverter is the reverse of the removal procedure. Should any item be thought faulty they should be replaced with an identical unit (See Recommended Spares List (page 12-1)).

It is necessary to take special care in handling the Touch Screen and LCD, to keep all faces free of dirt and finger marks!

Front/Rear Panel LED's - Removal & Replacement

Disconnection and removal of these items are obvious. The LED's are propriety items and therefore are not user serviceable. They should be replaced with identical parts as detailed in Recommended Spares List (page 12-1).

Start Switch, Keyswitch and Loudspeaker - Removal & Replacement

These items are unlikely to fail or need regular servicing. However, in the event of failure, their removal and replacement is obvious. See Recommended Spares List (page 12-1) for component details.

WARNING: Unplug the mains lead and disconnect the battery to avoid the SAM12 switching on inadvertently as the start switch connector is unplugged.

Detector Removal and Replacement

NOTE: The detectors are light sensitive and, because of this, are contained in a light-tight enclosure. Care must be exercised at all times not to damage the enclosure as subsequent damage to the photomultiplier tube may result due to light leaks.

Removal

Disconnect the mains supply. Ensure the key-switch on the rear panel is in the OFF position.

Open the door and remove the screws retaining the stainless steel cubicle Liner to the Main Cabinet frame.

Removing the Stainless Steel Liner from the Cabinet to exposes the detectors.

Undo the wing-nuts that hold the detectors in place and slide the detector to the rear of the SAM12.

When space allows disconnect the detector coaxial cable.

The detectors are held in place by 4 lugs, when the detector is free of the lugs it may be lifted out.

TAKE CARE THAT THE DETECTOR DOES NOT FALL!!

Detector Replacement

Replacement of the Detectors follows the removal procedure in reverse. Again care must be exercised not to break the light-tight seals.

Once the detectors are in place, refit the stainless steel liner.

Setting up Replacement Detectors for Use

Replacement detectors or detectors with replacement PMT's will need to be set for optimum performance with the Isotopes of interest. Before determining HV's, the Single Channel Analyser Thresholds must be reset to their default settings or erroneous results will be obtained (see Thresholds (page 5-28)). Once this is done, select the detector operating point using the HV scan procedure detailed in Selection of Detector Operating Parameters (page 9-3).

Door Lubrication

Periodically, or as required, lubricate the knuckles of the door hinge. Any proprietary lubricant may be used, e.g. WD40, PTFE, petroleum distillates or light oils etc.

Door Catch and Lock Replacement and Adjustment

Correct operation and adjustment of the door catch, sensing and locking mechanisms is vital for trouble-free operation.

Replacement and Adjustment of (Chrome) Lever Catch

Replacement Door Lever Catch set (part #200895JF) includes the Catch Plate and Strike Block. The (chrome) Strike Block supplied in a new set should ***not*** be used – it should be replaced with the original (or replacement) stainless steel Strike block (to Drg. B39278).

1. To replace the Door Lever Catch, undo M4 x 10mm long countersunk screws securing the outer door cover in 6 positions, and remove cover.
2. Open door and undo M5 x 35mm long countersunk screws securing lever catch to door bracket in 3 positions (for version with 50mm lead and a counter fitted to door, the M5 screws are secured with M5 crinkle washers and M5 nuts).
3. Replace and secure Lever Catch and before fully closing door, check that top of Catch Plate is positioned approximately 3mm above top of Lever Catch (when viewed from the front) – adjust vertical position of Catch Plate on the Main Frame if required.

   (Further vertical adjustment of the Door Lever Catch is available by way of the slotted holes in the Lever Catch *mounting plate*, located inside the hollow door frame section. Slacken the three M4 Nuts securing the mounting plate to the inside of the door section and adjust the Lever Latch as required.)

Note: If it is necessary to replace the stainless steel Strike Block, undo 8-32 UNC grubscrew and unscrew strike block from (chrome) Catch Plate. Replace stainless steel Strike Block and adjust its position until shoulder of block protrudes 2 to 3mm from boss on Catch Plate and secure with 8-32 UNC grubscrew.

4. Carefully close door and check that catch Strike Block just clears inside edge of Lever Catch – if necessary adjust horizontal position of the (aluminium) catch block.

Note: It is permissible to file a small chamfer on the outer strike end edge of the stainless steel Strike Block to just achieve a running clearance, if necessary.

5. Check that door is secured in closed position and that a very small clearance (less than 0.2mm) exists between door and stop block. If necessary, adjust the thickness of catch shim (by adding or removing 0.05/0.1mm laminates) to obtain the correct clearance.
6. Replace and secure door cover.

Adjustment for Two Door Units:

1. Open door and note vertical position of catch Strike Block. Remove Strike Block and add a 1mm catch shim, or alternatively undo 8-32 UNC grubscrew until block is free to rotate, unscrew block one turn and secure in position with 8-32 UNC grubscrew, remove 0.4mm of laminates from existing catch shim.
2. Replace catch Strike Block and secure in vertical position noted earlier.
3. Close door, push start switch, pull and release door catch handle. Open opposite door and check that the door with the new catch has not been released. If further adjustment is required, add shim in increments of 0.1mm.

Replacement Door Stop Block

4. Open door and remove existing stop block using a 25mm wide wood chisel. Scrape off any traces of adhesive from frame.
5. Undo the M4 x 10mm long countersunk screws securing the main liner in 8 positions and remove the liner.
6. Undo the M4 x 10mm long countersunk screws securing the switch assembly in 2 positions (to prevent accidental damage to switch during adjustment procedure).
7. Carefully close the door and measure gap between door and frame (dimension A). Measure the thickness of door stop and add 0.25mm (dimension B). Adjust the thickness of catch shim (by adding or removing 0.05/0.1mm laminates) to equal the difference between dimensions A and B. If the required catch shim thickness cannot be obtained, then the position of the

catch strike block must be adjusted by one turn (1.6mm) and the procedure repeated.

8. Apply Dow Corning primer 1204 to rear (surface without edge chamfers) of stop block and mating surface of frame and allow 2 hours to dry. Apply Dow Corning RTV 3145 adhesive to rear of stop block and position stop block on frame 3mm below and 2.5mm to the left of the RH edge of solenoid/catch block. Close Door and allow Adhesive to cure for 12 hours before opening Door. ***Note:*** *Adhesive may take up to 72 hours to fully cure.*
9. Measure the gap between door and stop block and adjust thickness of catch shim until gap is less than 0.2mm.
10. For units with one door, secure switch assembly to the frame and close door. For units with two doors, check switch operation as detailed in Section 11.4.3.
11. Replace and secure main liner.

Trouble Shooting

This Section covers a number of possible operational problems, their likely causes and possible remedial action.

WARNING: EXERCISE EXTREME CAUTION WHEN SERVICING.
There are dangerous mains voltages around the power supply module and very dangerous high voltages on the HV and amplifier boards. High voltage also exists on the LCD backlight and in the inverter enclosure. The 12 v battery stores considerable energy, so care should be taken not TO short the terminals. Please read the cautionary notes in Servicing of the Electronics Chassis - Type 5689A (page 11-3).

Normal Start-up (Boot-up) Operation

In general a successful start, or “boot up” when the SAM12 key-switch is turned ON is indicated by:

- a series of “System Self Test” display messages
- a series of lamp tests , each accompanied by a “beep” tone
- a series of internal (invisible) self tests.
- a single chime “ding-dong” on satisfactory completion.

Unit “dead” (will not boot up) & charging LED is OFF

If the display remains blank and unlit, no lamps are lit and no sound is heard (assuming the volume has not been turned off) it would indicate that the SAM12 is “dead”.

LED OFF - indicates the AC mains supply is OFF and instrument cannot run off the battery.

1. Check the fuse on the 5660A charger PCB, FS1.
2. If the fuse is intact, the battery is probably discharged. Check the voltage at PL4 on the charger PCB. If it is below 11.2 volts, the battery is discharged and the charging supply must be restored before further operation is possible.

Restoring the AC mains/charging supply - should light the LED and allow the system to run while charging the battery.

1. Check the AC mains power cord is connected.
2. Check the fuse in the mains adapter (if fitted).
3. Check the power supply is receiving the mains supply.
4. Check the power supply output on 5660/PL4 (temporarily remove from pcb to check) - no output indicates the internal fuse has blown and the power supply should be replaced (see Removal and Replacement of the Power Supply (page 11-4).
5. Check the output on PL3 of the 5660A charger PCB - it should be greater than +12.5 volts.

Unit “dead” (will not boot up) & charging LED is ON

LED ON - indicates the AC mains supply is ON and should be powering the instrument while charging the battery.

1. Retry switching the unit ON.
2. Check the fuse on the 5660A charger PCB, FS1.
3. Check the battery voltage is greater than 12.5 volts.
4. Check there is battery volts on OUTPUT connector PL6. If no output is observed on PL6 a fault on the Charger PCB is indicated and it should be replaced as detailed in Section 11.2.5.
5. Check the power connections from the 5566A Charger PCB to the 5565A Controller board.
6. Check the regulated +12 V, -12 V & +5 V outputs from the DC-DC converter module 5675A. The DC-DC module is not user serviceable and if faulty the Converter board should be replaced as described in Controller Board type 5670A - Removal and Replacement (page 11-6).

7. Switch unit OFF and replace the Controller board as described in Controller Board type 5670A - Removal and Replacement (page 11-6).
8. If the SAM12 is still dead after changing the Controller board, contact Thermo-Fisher Service department for further help.

Starts-up but Display is "Blank" & Fails Self Tests (no chimes)

If the SAM12 starts but fails to chime ("ding-dong") within 60 seconds of being switched ON, then it has not successfully completed the power-on Self Tests and a fault is indicated. Observe the LCD display, if a fault message is displayed refer to subsequent subsections. If, however, the display is blank or the message is unintelligible, it is likely the Controller board has a serious fault and the microprocessor has I/O problems or has crashed. Replace the Controller board as described in Controller Board type 5670A - Removal and Replacement (page 11-6).

Will not run & displays "Out Of Service – Low Background Counts"

The blue FAULT lamp is lit (see Fault Messages (page 11-1)for an explanation of the fault messages). The Self Tests have detected the background count from the detector channel is below the Low Background Alarm value set in Params 1 (page 5-8). Proceed as follows:

1. Enter a valid password and Setup|Params 1. Check that the Low Background Alarm is not set to an unreasonably high value for the prevailing background condition.
2. Select Calibration|HV Scan and check the HV settings for each channel are correct.
3. Check the cable connections between the Controller board and the HV & Amplifier pcbs.
4. Having performed checks 1 to 3 above, select Diagnostics|Detectors Bar, perform a 10 second count and check the faulty channel/s and note the counts.

Zero counts in a channel usually implies a complete failure in either the detector assembly or HV/Amplifier PCB. A few counts suggests either reduced detector efficiency or threshold problems in the HV/Amplifier.

1. Swap the faulty detector MHV connection from the relevant HV/Amplifier to that of a working channel. Perform a further 10 second count and note the counts in each channel.
2. If the fault moves with the detector into a previously working channel, the fault is in the detector assembly

and should be replaced as defined in FHT681 cards - Removal and Replacement (page 11-6).

3. If the fault remains with the original HV/Amplifier channel, the fault is in the HV & Amplifier PCB and this should be replaced as defined in FHT681 cards - Removal and Replacement (page 11-6).

Will Not Run & Displays "Out Of Service – High Background Conditions"

This condition occurs when the Background activity prevents the SAM12 from discriminating the pre-set alarm level with the required confidence within the Maximum Monitoring Time allowed (see Params 1 (page 5-8)). Enter a valid password and proceed as follows:

1. Select Setup|Params 2 and check the Maximum Monitoring Time is set to a reasonable value. Adjust it upward if necessary.
2. Select Setup|Alarms and check the Normal Alarm level is set to a reasonable value. Adjust it upward if necessary.
3. Select Setup|Params 2 and check the Probability of False Alarm is set to a reasonable value. Reduce it if necessary.
4. Select Setup|Params 2 and check the Probability of Detection is set to a reasonable value. Reduce it if necessary.
5. Select Calibration|HV Scan and check the High Voltage settings of ALL six detector channels are correct.
6. Select Setup|Params 2 and set a 10 second Minimum Monitoring Time. Check the counts in all four detector channels are reasonable for the expected ambient background level using Diagnostics|Detector Bars.
7. If a single channel shows a background count significantly greater than the other detectors, a noisy channel or a light leak is likely. Proceed as follows:
   - Swap the faulty detector MHV connection from the relevant HV/Amplifier to that of a working channel. Perform a further 10 second count and note the counts in each channel. *(N.B. Bear in mind the different operating voltages).*
   - If the fault moves with the detector into a previously working channel, the fault is in the detector assembly and should be replaced as defined in Removal (page 11-9).
8. If the fault remains with the original HV/Amplifier channel, the fault is in the HV and Amplifier PCB and this should be replaced as defined in FHT681 cards -

Removal and Replacement (page 11-6) channels show a background count significantly greater than that expected, the SAM12 is experiencing an elevated background. Proceed as follows:

- Check the area immediately around the SAM12 for sources of any possible contamination.
- Measure the ambient background level with a suitable survey monitor. If the background is high, it must be reduced or the SAM12 moved for normal monitoring operation to resume.

IF THIS CONDITION PERSISTS and the background and measurement limits seem to be reasonable, 'frisk' inside the monitor cubicle for a possible build-up of contamination.

Fails Lamp or LED Tests

A power-on Self Test lights each lamp & LED in turn. If any lamp or LED fails to light in sequence (except the charging LED), proceed as follows - using "Diagnostics/Vault" to re-test lamps as required:

1. Check the connections to the lamp assemblies and to the Controller board.
2. Any device failure will need a replacement board.
3. If there are two lamp assemblies and neither are functioning then a fault on the Controller board is indicated and it should be replaced as described Controller Board type 5670A - Removal and Replacement (page 11-6).

Fails Loudspeaker Test

A power-on self Test produces a "beep" tone as each lamp is tested and a single chime "ding-dong" upon satisfactory completion. If no sound is heard, proceed as follows:

1. Enter a valid password and select System|Setup, and increase the volume (as described in Setup (page **Error! Bookmark not defined.**)). The speaker should produce a series of "beeps" which gradually get louder or quieter when the volume control is dragged.
2. If no sound is heard, check the speaker connection to the Controller board.
3. Since the speaker is unlikely to have failed, a fault on the Controller board is indicated and it should be replaced as described in Controller Board type 5670A - Removal and Replacement (page 11-6).

Fails the LCD Display Test

A power-on self Test switches on the back-light and produces series of "Self Test Messages" as each lamp is tested. If the

back-light fails, see Display Backlight Failure (page 11-17). If the display fails to show any message, or is totally "blacked out" proceed as follows:

1. Check the multi-cable connections from the display to PL6 & PL7 on the Controller board.
2. If check 1 above has not revealed the problem, a fault in the LCD module or Controller board is indicated.
3. Temporarily connect a spare LCD module to the Controller board PL6 & PL7 (the back-light is required).

If the message becomes visible, the fault is in the LCD display module. This is not user serviceable and should be replaced (with the back-light) as described in LCD Display, Touch Screen, Touch Controller & Backlight Inverter - Removal and Replacement (page 11-8)

If no message appears, the fault is in the Controller board, which should be replaced as described in Controller Board type 5670A - Removal and Replacement (page 11-6).

Display Backlight Failure

A power-on self Test switches on the back-light and produces a series of "Self Test Messages" as each lamp is tested. If the back-light fails to light, proceed as follows:

1. Check the cabling from the back-light inverter enclosure to PL7 on the Controller board.
2. Check that 5 volts appears across the pins of PL7 when the back-light should be on. If 5 volts is apparent then a fault in the LCD or back-light inverter is indicated. These items are not user serviceable and should be replaced as described I, LCD Display, Touch Screen, Touch Controller & Backlight Inverter - Removal and Replacement (page 11-8) is absent across the pins of PL7, a fault on the Controller board is indicated and it should be replaced as described in Controller Board type 5670A - Removal and Replacement (page 11-6).

Will Not Accept Valid Passwords

If the SAM12 starts and runs but will not accept a valid password, a fault is indicated either in the LCD Touch-pad or the Controller board. Proceed to LCD Keypad Inoperative or Not Aligned (page 11-17).

LCD Keypad Inoperative or Not Aligned

If the SAM12 Starts and runs but will not respond to password entry or returns incorrect characters on the LCD display, a fault is likely in the Controller board or possibly the keypad. Proceed as follows:

1. Check the cable connections between the Touch screen keypad and the Controller board.
2. Temporarily plug a spare LCD assembly into the control board. If this solves the problem the original Touch-pad is faulty and should be replaced as described in LCD Display, Touch Screen, Touch Controller & Backlight Inverter - Removal and Replacement (page 11-8)
3. The fault is likely to be in the Controller board which should be replaced as described in Replacement of the Controller board (page 11-6).

Will not Enter Background Mode

If, after power-up, or after exiting from the main menu, the SAM12 displays "Cannot Measure Background - Please Close the Door", a fault with the door switch system is likely. Proceed as follows:

1. Check that the door switch is working correctly by selecting "Diagnostics/Vault". The switch is situated in the left hand vertical box section of the main frame and is operated by closing the door. Replace any switches if necessary.
2. Check the continuity of the cable connecting the door switch(s) to the Controller board.

Table 4 - Summary of the Controller Board Inputs

Input	Connection	Function
IP1	PL24	Door Switch (dirty)
IP2	PL27	Solenoid Status (dirty)
IP3	PL28	Door Switch (clean)
IP4	PL29	Solenoid Status (clean)
IP5	PL20	Start Button

Replace the Controller board as described in Controller Board type 5670A - Removal and Replacement (page 11-6) if the switches are working correctly.

Locked in Background Mode

If the SAM12 has acquired a valid set of background readings, but will not enter measurement mode when a sample is entered and the Start switch is operated, proceed as follows:

1. Check that the Start switch is working correctly by using "Diagnostics/Vault". The switch is situated in the left hand side of the front panel. Replace if necessary.

2. Check the continuity of the cable connecting the Start switch to PL20 on the Controller board. Replace if necessary.
3. Restart the instrument. If the fault persists replace the Controller board as described in Controller Board type 5670A - Removal and Replacement (page 11-6).

Locked in Measurement Mode

If the SAM12 becomes stuck in a monitoring cycle with the display showing “Count Time Remaining xx seconds” it is likely that microprocessor has crashed. Power down and check again. Continual crashing may indicate that the Controller board needs replacing as described in Controller Board type 5670A - Removal and Replacement (page 11-6) possible that the hard disk may have suffered some damage in this area of the program. If the problem persists even after changing the Controller board a new disk should be considered.

USB Output Data is Corrupted

If USB data output from the SAM12 to a serial printer, or external computer, contains spurious characters, or is corrupted in any way, check the following possible causes:

1. If no output whatsoever is received, check the data cable connections (see Displays (page 3-4)).
2. If a USB printer is involved, perform a printer self-test, to determine whether the printer itself is at fault.

Chapter 12 Spares List

Recommended Spares List

The following spares are recommended on the basis that first-line service is best performed by changing modules.

CONTROLLER BOARD	5670A
ETX Processor	702695PE
SECURITY DONGLE	A92169/A
BATTERY CONTROLLER BOARD	5660A
HV & AMPLIFIER BOARD	FHT681 425430223
CCM BOARD	FHT681 425430224
LOUDSPEAKER	91603/A
START SWITCH	701829KG
DOOR SWITCH	406859KG
TOUCH SCREEN	702633ND
TOUCH-SCREEN CONTROLLER	702632ND
DYNODE CHAIN	A3-54040

Spares List

	ETX CONTROLLER BOARD	5670A
	ETX Processor	702695PE
	DUAL CHANNEL RS422 BOARD	5671A
	5-WAY LED CLUSTER	5672A
	BATTERY CONTROLLER BOARD	5660A
	BATTERY TEMPERATURE SENSOR	5659B
	HV & AMPLIFIER BOARD	FHT681 42543-0223
	CCM BOARD	FHT681 42543-0224
SAM 12 only	SCINTILLATION DETECTOR	5569A
LAM12 only	SCINTILLATION DETECTOR	TYPE 5390B
	DC-DC CONVERTER BOARD	5675A
	LOUDSPEAKER	B91603/A
	DOOR SWITCH	406859KG
	PWR MODULE AC/DC	702473KJ
	12.1” LCD	702548ND
	BACKLIGHT INVERTER	702549ND
	IC/MEM SDRAM 256MB	702627PD
	TOUCH-SCREEN CONTROLLER	702632ND
	TOUCH SCREEN	702633ND
	KEYSWITCH	702663KG
	START SWITCH	701829KG

Drawings List (by Assembly)

SAM 12 only		SAM12 FAMILY TREE	C92049
		DYNODE CHAIN - General Assy	A3/54040
	42543-0223	HV & AMPLIFIER BOARD - General Assy	42543/0223
	42543-0224	CCM BOARD - General Assy	42543/0224
	5659B	TEMPERATURE SENSOR BRD - General Assy	C91794/A
	5660A	BATTERY CONTROLLER BRD - General Assy	C91799/A
	5670A	ETX CONTROLLER BOARD - General Assy	E91885/A
	5671A	DUAL CHANNEL R2422 BOARD - General Assy	C91929/A
	5672A	5-WAY LED CLUSTER - General Assy	D91956/A
	5675A	DC-DC CONVERTER BOARD - General Assy	C91965/A
SAM 12 only		SAM12 OUTLINE DRAWING (1 DOOR)	TBA
SAM 12 only		SAM12 OUTLINE DRAWING (2 DOOR)	TBA
SAM 12 only		SAM12 INTERCONNECTION DIAGRAM	E92033
LAM 12 only		LAM12 Outline View	E91453

Drawings List (Letter and Numerical Order)

	42543-0223	HV & AMPLIFIER BOARD - General Assy	42543/0223
	42543-0224	CCM BOARD - General Assy	42543/0224
		DYNODE CHAIN - General Assy	A3/54040
	5659B	TEMPERATURE SENSOR BRD - General Assy	C91794/A
	5660A	BATTERY CONTROLLER BRD - General Assy	C91799/A
	5671A	DUAL CHANNEL R2422 BOARD - General Assy	C91929/A
	5675A	DC-DC CONVERTER BOARD - General Assy	C91965/A
SAM 12 only		SAM12 FAMILY TREE	C92049
	5672A	5-WAY LED CLUSTER - General Assy	D91956/A
	5670A	ETX CONTROLLER BOARD - General Assy	E91885/A
SAM 12 only		SAM12 INTERCONNECTION DIAGRAM	E92033
SAM 12 only		SAM12 OUTLINE DRAWING (1 DOOR)	TBA
SAM 12 only		SAM12 OUTLINE DRAWING (2 DOOR)	TBA
LAM 12 only		LAM12 Outline View	E91453

Accessories List

SECURITY DONGLE	A92169/A
CCM OPTION	
PLINTH	
WASTE PHANTOM	details on request
CHECK SOURCES	details on request
SOURCE RODS	details on request

Glossary

µCi	micro-curie
A	Attenuation Factor or amps
Beff	Effective Background while Monitoring
Bq	Becquerel
Bsum	Total Average Background Count Rate
C	Counter(s)
CAct	Contamination Alarm Level
CCM	Cobalt Coincidence Monitoring
Ccps	Contamination Alarm Count-rate
Ceffect	Effective Alarm Count rate
Ci	Curie
CPM	Counts per minute
D	Door(s)
DL	Detection limit
dpm	Disintegrations per minute
E	Efficiency Correction Factor
F	Probability of False Alarm
FOM	Figure of Merit
Health Physicist	Person, Persons or Team responsible for setting up day-to-day running and maintenance of the SAM12
HP	*Health Physicist*
HV	High Voltage
kBq	kiloBecquerel
L	Lead
LCD	Liquid Crystal Display
LED	Light Emitting Diode
MAct	Minimum Detectable Activity
mCi	Milli Curie
MDA	Minimum Detectable Activity
NBR	Natural Background Reduction

nCi	nanocurie
NORM	Naturally Occurring Radioactive Material
P	Probability of Detection
PCB	Printed Circuit Board
pCi	picocurie
Quickscan	Method used to identify, within the monitoring time (see Tmon), whether the article is either “clearly” contaminated or clear, referred to as “real-dirty” or “real-clean”
RAct	Activity of Contamination
RCC	Residual Contamination Count
SAM	Small Article Monitor
Technician	Personnel who normally repair and maintain the instrument in working condition
tB	Background Update Time
Tcal	Calculated Monitoring Time
ThermoFisher	Personnel who are general users of the system and normally carry out routine diagnostic and test functions
Tmax	Maximum Monitoring Time
Tmin	Minimum Monitoring Time
Tmon	Actual Monitoring Time
User	Anyone associated with or operating the instrument.
V	voltage

Index

M

N

O

P

R

S

T

U

V