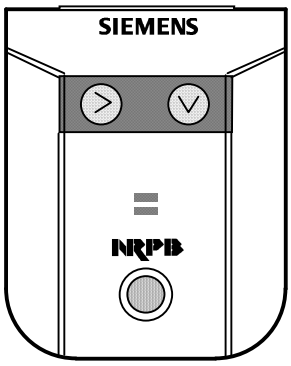
SIEMENS

ELECTRONIC PERSONAL DOSEMETER

TECHNICAL HANDBOOK

(WB & SK Version)
EPD Software Version 8



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GLOSSARY

$\dot{W}B$	WB dose rate
$\dot{S}K$	SK dose rate

/h	Per hour
dBA	Decibels. A weighted scale (sound intensity)
EEPROM	Electrically Erasable Programmable ROM
EPD	Electronic Personal Dosemeter
EPDS	Electronic Personal Dosimetry System
eV	Electron Volt
HEX	Hexadecimal
Hp	Hp(10) - Penetrating individual dose equivalent at a depth of 10mm of tissue. Displayed as WB on the EPD
WB	Wholebody individual dose equivalent at a depth of 10mm of tissue (equivalent to Hp(10))
Hs	Hs(0.07) - Superfidial individual dose equivalent at a depth of 0.07mm of tissue. Displayed as SK on the EPD
SK	Skin individual dose equivalent at a depth of 0.07mm of tissue (equivalent to Hs(0.07))
ICRU	International Commission on Radiation Units
ID	Identification
LCD	Liquid Crystal Display
LED	Light Emitting Diode
m	milli ($x10^{-3}$)
NRPB	National Radiological Protection Board - the legal authority on radiation in the UK
PCB	Printed Circuit Board
pc	Personal Computer
PIN	The structure of a PIN diode, Positive-Intrinsic-Negative
RAM	Random Access Memory
Sv	Sievert
T	Tesla
TLD	Thermoluminescent Device
°C	Degrees Celsius
Dose	The accumulated dose to which alarm thresholds apply, intended for tactical dose monitoring (eg. per day, per week, per shift etc)
Total Dose	Intended to be a secure record of the total accumulated dose received since Dosemeter issue - alarms do not apply to total dose.
Toggle	Switching from one state to another
µ	micro ($x10^{-6}$)

1. INTRODUCTION

1.1 Overview

The Electronic Personal Dosemeter (EPD) has been developed in the UK in collaboration with the National Radiological Protection Board (NRPB) with the aim of improving Dosimetry practice.

A substantial investment in new micro-circuit and high energy battery technology has resulted in a very compact unit which has the reliability and integrity to meet the very high confidence levels required for legal Dosimetry data collection.

It is a highly sophisticated device sensitive to gamma and X-rays (photons), and beta radiation (energetic electrons) in the following energy range.

gamma, X-rays	20 keV	to	6 MeV
beta radiation	250 keV	to	1.5 MeV

The advantages of the EPD over traditional film and TLD systems include

- instant dose and dose rate readout
- emulates common Personal Alarming Dosemeter functions
- measures and calculates directly the ICRU quantities, $Hp_{(10)}$ and $Hs_{(0.07)}$ as defined in ICRU publication 39(1985), (identified here as WB and SK respectively).
- greatly reduced processing costs
- dose resolution down to 1µSv

The radiation is detected by three silicon diode detectors sensitive to the different types and energies of radiation. Their outputs are combined to give the dose equivalents WB (wholebody dose - individual dose equivalent at a depth of 10mm of tissue) and SK (skin dose - individual dose equivalent at a depth of 0.07mm of tissue).

The Dosemeter calculates the accumulated dose and the dose rate for both wholebody and skin dose. These can be displayed on the Dosemeter LCD.

Dose data is saved to secure memory every 15 minutes to minimise data loss on battery or other failure.

Visible and Audible alarms are given if either the accumulated dose or dose rates exceed programmable threshold levels. Alarms apply to Dose only, Total Dose is intended as a record of total accumulated dose over a known period.

1.2 About This Manual

This is the Technical Manual (WB &SK Version) for the Siemens Electronic Personal Dosemeter operating with Version 8 Software and where the parameters Hp and Hs are displayed to the user as WB and SK respectively.

The Dosemeter is designed to be used either in stand-alone mode or as part of a system. If part of a system then the EPD will be used in conjunction with a reader unit which will interface to a variety of software systems.

If the EPD is being used in isolation from a Reader, some of the information given here will not apply.

Two models of the EPD are available, EPD-1 and EPD-2. The EPD-2 model has an additional feature over the standard EPD-1 in that dose is able to be reset via the EPD buttons.

This manual covers both EPD-1 and EPD-2 features. Where a feature is EPD-2 specific this restriction is noted in the text.

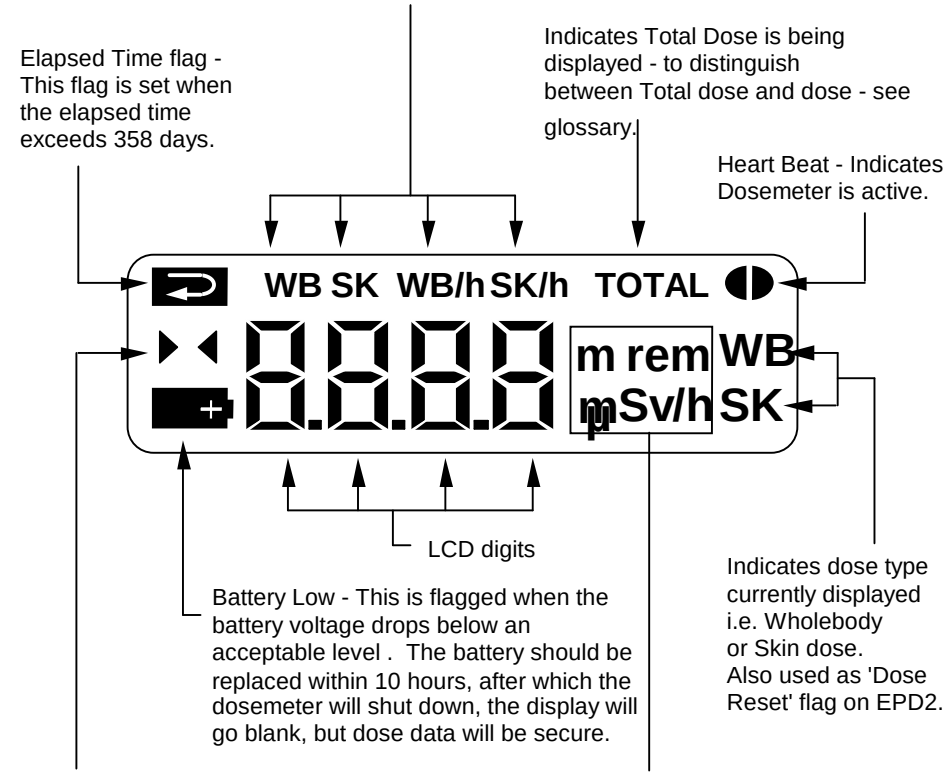
The manual deals with Sieverts throughout. To convert to Rem multiply by 100.

Where the displayed parameters are discussed WB and SK are the annotations used. Where the internal parameters are discussed Hp and Hs are used.

2. USER INSTRUCTIONS

2.1 LCD Display

Dose and other information is conveyed to the user via a custom designed LCD.



Indicates display is showing alarm thresholds or that 'Dose Reset' mode has been selected on EPD2.

Indicates display is showing ID high digits

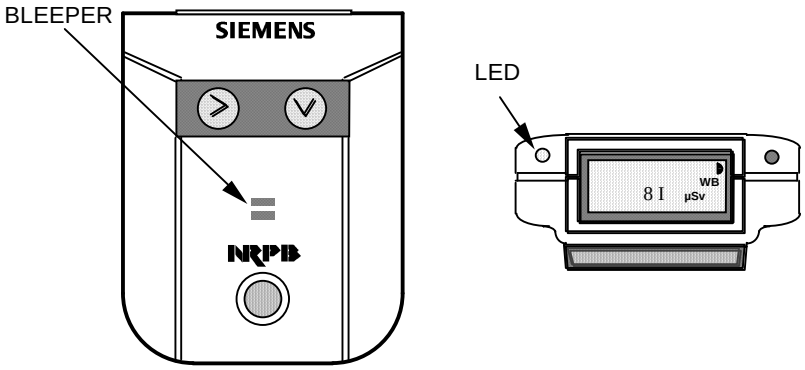
Indicates display is showing ID low digits

These also indicate 1st and 2nd WB Alarm thresholds in Dual WB Alarm mode. See sections 2.4.3 and 3.4.1 for details.

Units of dose and dose rate currently displayed. Note programmable option to use either Sieverts or rem.

2.2 Audible And Visible Alarms

The bleeper and LED activate together when certain conditions occur. The LED is red and the bleeper sounds at 2kHz with an intensity of typically 80 dBA at 30 cm.



The mode in which the alarms operate depends on the condition that arises.

CONDITION	ALARM MODE
Accumulated Dose Alarm	———————— Continuous
Dose Rate Alarm	– – – – – – Fast intermittent
EPD Failure	— — — — — — Slow intermittent
Over-range Alarm	———————— Continuous and flashing LCD display

The nature of any alarm is shown on the LCD display by an alarm flag (see section 2.5) or, in the case of an over-range alarm, by a flashing LCD display.

2.3 Button Operation

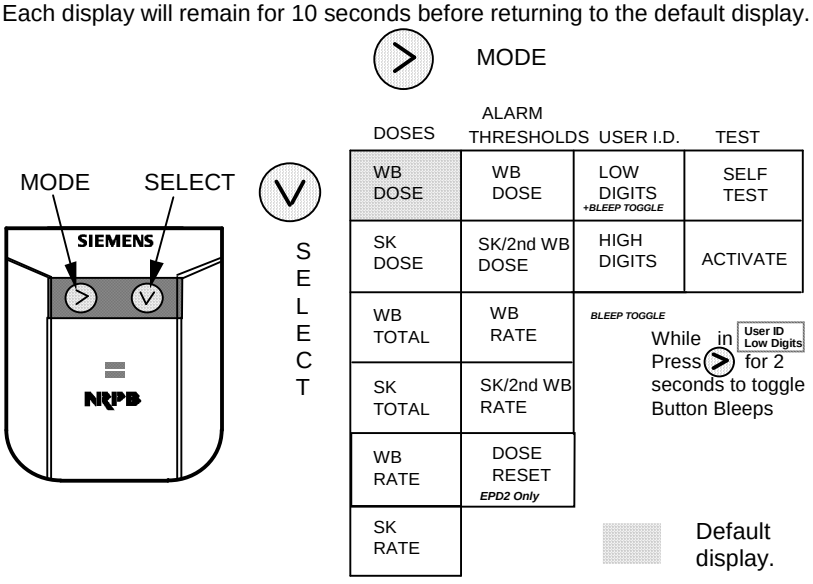
The different display types available on the Dosemeter are selected by use of the two rubber control buttons.

The two function buttons are - a button represented by a horizontal arrow and a button represented by a vertical arrow. (> & v)

The MODE button selects one of the four modes :

- Doses - Dose and Dose Rate Information
- Alarm Thresholds (and Dose Reset on EPD-2 only)
- User ID (and Button Bleep Toggle)
- Test - select and activate confidence test

Each display will remain for 10 seconds before returning to the default display.



Hold > for more than 2 Seconds to mute Dose, Rate or Over-range Alarm if muting enabled.

Press > or v to cancel confidence test.

Mode and Select options form a 4 x 8 matrix - each display being controlled by a bit in the EPD inhibit table (InhibitTab) parameter (see section 3.4). Those displays not shown are used by Siemens for test purposes. If all displays are

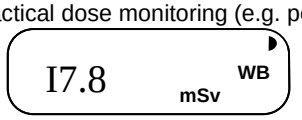
inhibited then the EPD automatically selects Mode 3 Select 7 which is a blank display with half moons operating and alarms operational.

2.4 Operation and Indications

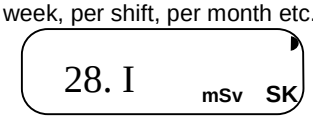
2.4.1 DOSE AND DOSE RATE DISPLAYS

WB AND SK DOSE

This mode displays the wholebody WB and skin SK dose. These are used for tactical dose monitoring (e.g. per day, per week, per shift, per month etc.).



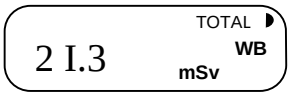
OR



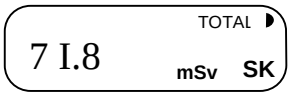
DISPLAY RANGE: WB 0µSv - 16.77Sv (auto ranging)
SK 0µSv - 16.77Sv (auto ranging)

WB AND SK TOTAL DOSE

This mode displays the TOTAL wholebody WB and skin SK dose. This is a legal or secure record of the total dose received since the EPD was issued.



OR

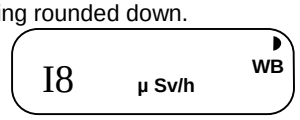


DISPLAY RANGE: WB 0µSv - 16.77Sv (auto ranging)
SK 0µSv - 16.77Sv (auto ranging)

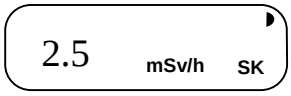
WB AND SK DOSE RATE

This mode displays the current WB or SK dose rates.

This displays only the first two significant figures of the dose rate, the reading being rounded down.



OR



DISPLAY RANGE: $\dot{W}B$ 0µSv/h - 16.0Sv/h (auto ranging)
$\dot{S}K$ 0µSv/h - 10.0Sv/h (auto ranging)

• These are *display* ranges. For details on actual measurement ranges and their accuracy refer to Appendix A.

Over-range is indicated with a continuous alarm and a flashing LCD display - see section 2.5.5.

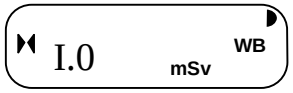
2.4.2 WB AND SK ALARM THRESHOLD DISPLAYS

The Dosemeter can act as a personal alarming Dosemeter with alarm 'on' thresholds for accumulated dose alarms, and alarm 'on' and 'off' thresholds for dose rate alarms.

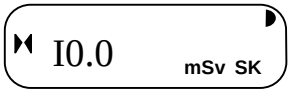
'On' and 'Off' alarm thresholds allow hysteresis for dose rate alarms, see section 2.5.3 .

These modes show on the display the current settings for the alarm 'on' thresholds. However, the alarm 'off' thresholds for the rate alarms are NOT viewable on the display.

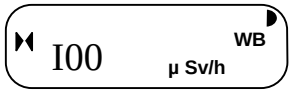
e.g. a threshold setting for WB dose



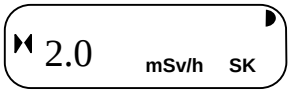
e.g. a threshold setting for SK dose



e.g. a threshold setting for WB rate



e.g. a threshold setting for SK rate



See section 2.5 for alarm settings.

2.4.3 DUAL WB ALARMS

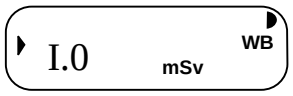
It is possible to configure the EPD to alarm at two levels of WB dose or rate. In this mode the EPD still monitors and records SK dose and rate, but the SK alarm thresholds operate on the current WB values. See section 3.4.1 for details on Dual WB Alarm configuration.

When the first WB alarm operates the audible and visual alarms will operate (if enabled) and the appropriate WB or WB/h flag will appear on the LCD. When the second WB alarm operates the audible and visual alarms will operate (if enabled) and the LCD flag will stay on.

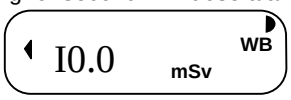
As the second WB alarms use the SK threshold values, the range and resolution is the same as for the SK thresholds. Any muting control over SK alarms will operate on the second WB alarms in dual WB alarm mode.

The Thresholds are indicated by ► and ◄ for first WB and second WB respectively.

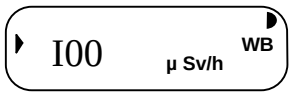
e.g. a threshold
setting for first WB dose alarm



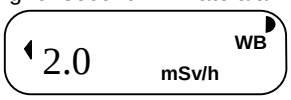
e.g. a threshold
setting for second WB dose alarm



e.g. a threshold
setting for first WB rate alarm



e.g. a threshold
setting for second WB rate alarm

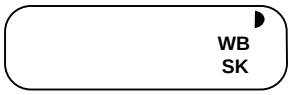


Although the dual alarms are referred to as first WB and second WB the EPD will operate correctly even if the second WB alarm thresholds are set lower than the first WB thresholds.

2.4.4 DOSE RESET (EPD-2 only)

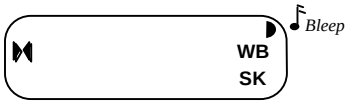
On the EPD-2 model a Dose Reset facility is available to clear the dose using the control buttons on the EPD. This EPD-2 feature may be enabled or disabled by entering the correct code in the Inhibit Table (see section 3.4.2).

If the reset function is enabled it is accessible as the next "SELECT" function under the Alarm Thresholds and the display is shown as blank except for the WB and SK symbols. Any alarm flags are also displayed along with the heartbeat.



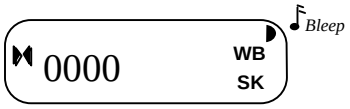
Operation is in three stages as follows:

- **Select the function** by pressing the buttons (see section 2.3).
- **Perform the request** by holding down the mode button ⊛ for more than 2 seconds, until the unit bleeps and the two arrows appear on the left hand side of the display.



Release the mode button.

- **Confirm the request** within 10 seconds by holding down the mode button ⊛ again for a further 2 seconds or more. The unit will bleep and the digits '0000' will be displayed.



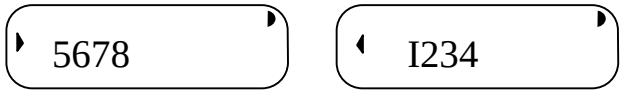
Release the mode button. (If the mode button continues to be held down then the unit will bleep every 2 seconds reminding the operator to release the button.) The EPD will return to its default display.

Both WB and SK dose values are now zeroed. The *TOTAL* dose values have not been affected.

2.4.5 USER IDENTIFICATION

The User ID is an 8 digit number shown on two displays - the LOW 4 digits and the HIGH 4 digits.

e.g. a user code 12345678



LOW DIGITS HIGH DIGITS

It is possible to display the same User ID from two different sets of EPD parameters - see section 3.4.2. This allows Button Bleep Toggle to be enabled/disabled and also allows the order in which the low and high digits are displayed to be changed.

2.4.6 BUTTON BLEEP TOGGLE

Every time an EPD button is pressed the unit bleeps. This feature may be toggled 'on' and 'off' from the buttons or from a reader unit.

When the EPD first powers up the Button Bleep is enabled. The bleep feature may simply be toggled 'off' and 'on' by holding down the mode button ⊛ while the unit is displaying the User ID Low Digits.

Operation is as follows:

- Select the User ID low digits (mode 2, Select 0 only) by pressing the buttons (see section 2.3).
- Perform the request by holding down the mode button ⊛ for more than 2 seconds, until the unit bleeps.
- Release the mode button.

The unit has now toggled its button bleep state.

2.4.7 CONFIDENCE TEST MODE

The EPD has the facility to run a confidence test. This is activated by one press of the SELECT Ⓥ button when the following display is shown.

The confidence test is inhibited at dose rates exceeding 32µSv/h $\dot{W}B$ or 320µSv/h $\dot{S}K$, since dose can not be accumulated during the test.

The confidence test performs the following tasks:

a) Exercises all the display segments.

b) Exercises the alarms - visible and audible.

c) Active RAM test.

d) Test each detector amplifier and counter chain.

Tests (c) and (d) will not be performed more than twice every 15 minutes (i.e. the confidence test will run but without these tests).

Tests (c) and (d) will not be performed should the dose rate have reached or exceeded 32µSv/h after test (b).

2.5 Dose And Dose Rate Alarms

To emulate the function of a personal alarming Dosemeter, the EPD will alarm under certain programmable accumulated dose and dose rate conditions.

All the alarms are checked and updated every 2 seconds except at low dose rates where this period increases to a maximum of 14 seconds for dose rates.

The Dosemeter alarms are as follows:

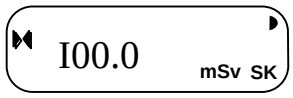
Fast intermittent	- - - - - - - - - - - -	dose rate alarms
Continuous	————————	dose/over-range alarms

2.5.1 ACCUMULATED DOSE ALARMS

The accumulated dose alarm thresholds can be set within the following range:

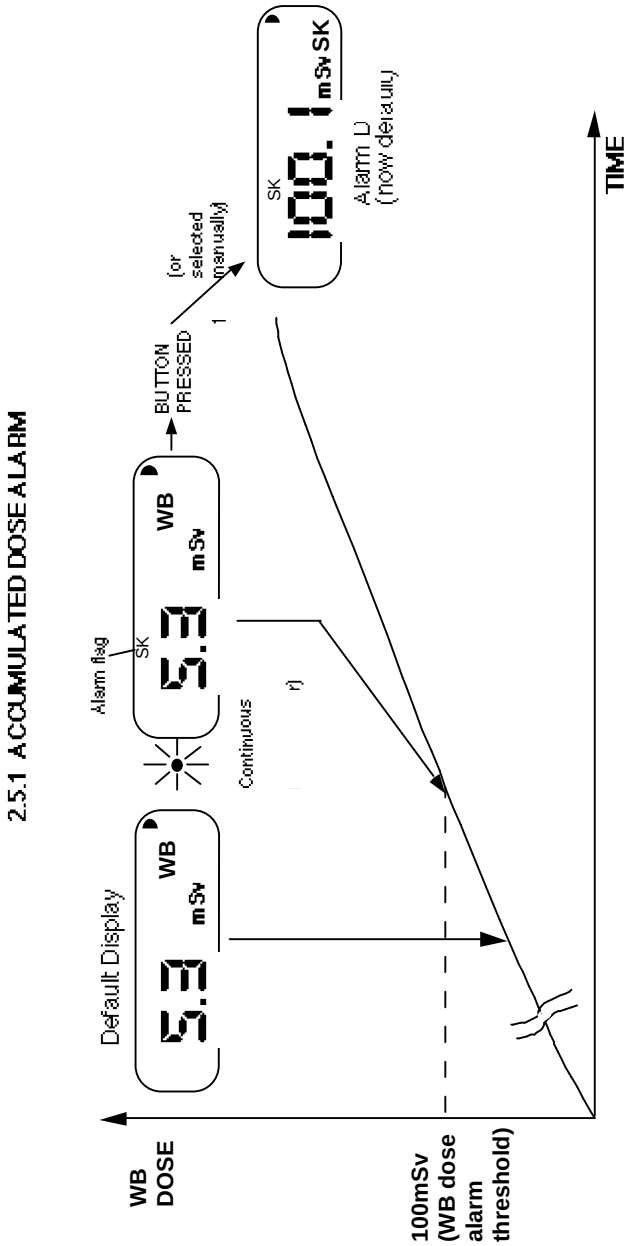
WB	0µSv	-	655.35mSv	in steps of 10µSv
SK	0µSv	-	6.5535Sv	in steps of 100µSv
Second WB	0µSv	-	6.5535Sv	in steps of 100µSv

The four most significant digits of the alarm thresholds can be viewed on the LCD using the function buttons as described before. These displays are characterised by the ⋈ symbol for WB and SK alarms, or ► and ◄ for dual WB alarms.

e.g. 

When the dose equals or exceeds the dose threshold, the LED will illuminate, the bleeper will sound continuously, and the alarm flag will be displayed. The next time a button is pressed the alarm screen becomes the default screen and so the Dosemeter goes to this alarm display after 10 seconds (or before if the user selects this screen manually). This display remains the default display until an alarm of higher priority (see Section 2.5.4) is activated.

An example is shown on the following page.

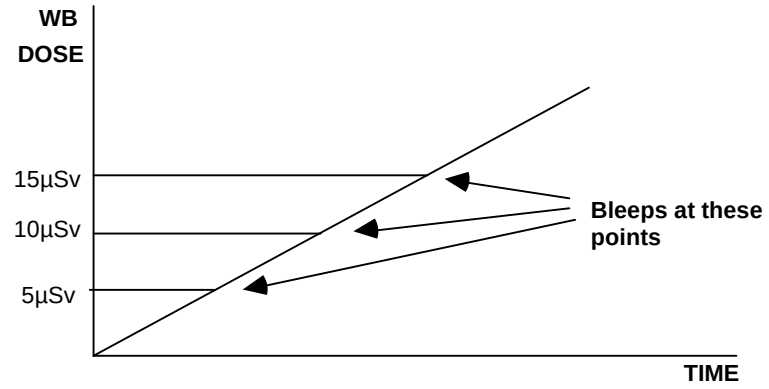


The audible alarm may be muted by depressing the mode button for more than 2 seconds (unless this alarm mute is inhibited). In order to preserve battery life, the EPD can be configured to automatically mute after 8 minutes.

2.5.2 WHOLEBODY DOSE ACCUMULATION WARNING

In addition to the alarm thresholds, the unit can be set up to give a warning bleep at every programmable increment in WB, wholebody dose. This increment can be set between 1 µSv and 15 µSv, or disabled by setting the increment to 0 . The maximum bleep rate is once every two seconds.

e.g. with the increment set to 5µSv



2.5.3 DOSE RATE ALARMS

The dose rate alarm thresholds can be set within the following range: See section 3.4.3.

$\dot{W}B$	Range 1: 0µSv/h to 32767µSv/h in 1µSv/h steps Range 2: 0µSv/h to 1023mSv/h in 1mSv/h steps
$\dot{S}K$	Range 1: 0µSv/h to 327.67mSv/h in 10µSv/h steps Range 2: 0µSv/h to 10230mSv/h in 10mSv/h steps
Second $\dot{W}B$	Range 1: 0µSv/h to 327.67mSv/h in 10µSv/h steps Range 2: 0µSv/h to 10230mSv/h in 10mSv/h steps

Recommended Settings:

$\dot{W}B$			$\dot{S}K$		
From:	To:	Steps:	From:	To:	Steps:
7µSv/h	99µSv/h	1µSv/h	100µSv/h	990µSv/h	10µSv/h
100µSv/h	990µSv/h	10µSv/h	1mSv/h	9.9mSv/h	0.1mSv/h
1mSv/h	9.9mSv/h	0.1mSv/h	10mSv/h	99mSv/h	1mSv/h
10mSv/h	99mSv/h	1mSv/h	100mSv/h	990mSv/h	10mSv/h
100mSv/h	990mSv/h	10mSv/h	1.0Sv/h	10.0Sv/h	0.1Sv/h
1Sv/h					

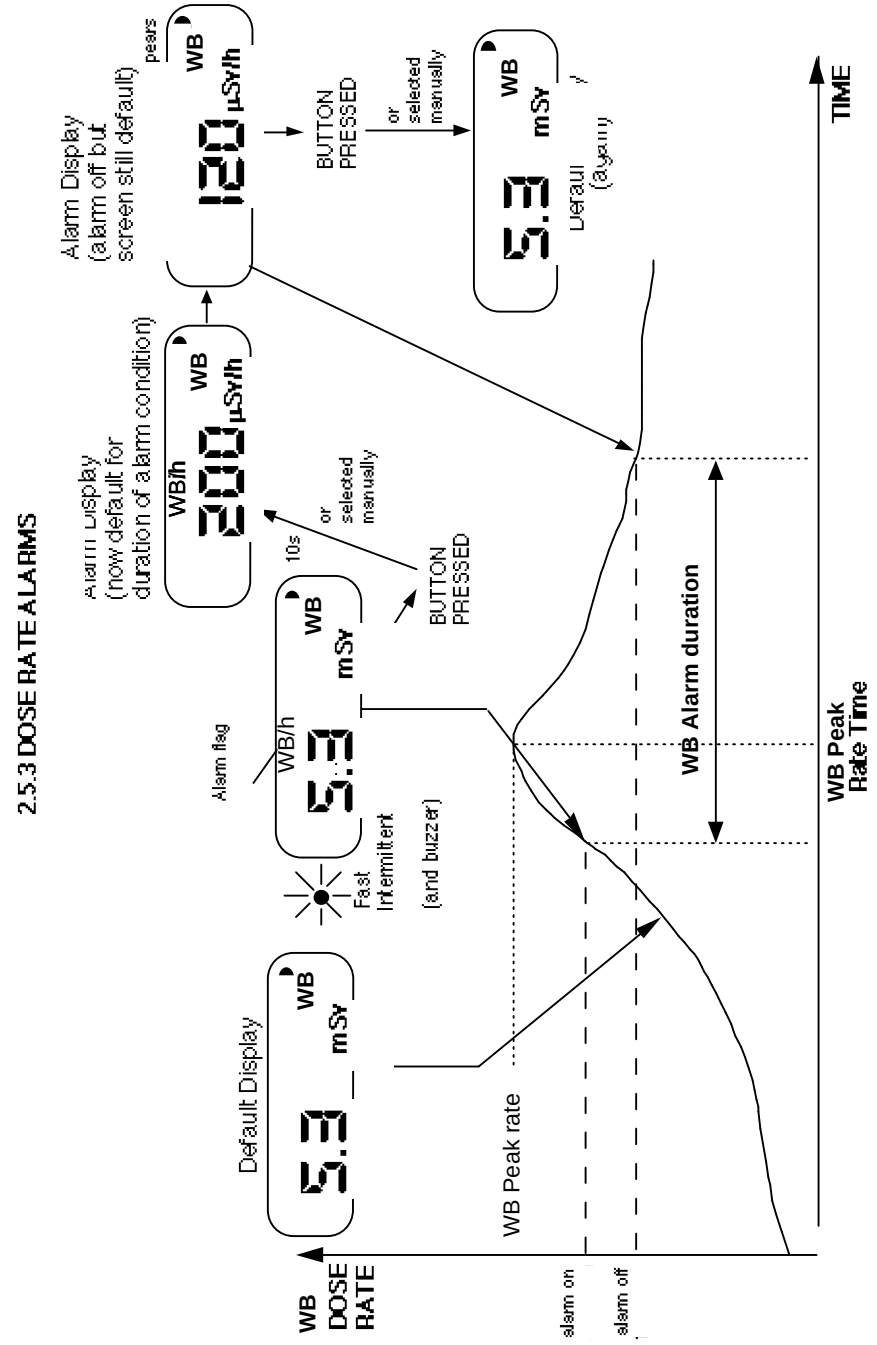
As the EPD only displays two most significant digits of rate alarms it is recommended that only values to that resolution are used when setting alarm thresholds. Also the minimum recommended alarm thresholds are 7µSv/h $\dot{W}B$ and 100µSv/h $\dot{S}K$ to prevent excessive false alarms due to statistical noise.

The thresholds can be viewed on the LCD in the same way as the accumulated dose alarm thresholds (see Section 2.5.1).

The rate alarms can be made to work with hysteresis, i.e. the alarm 'off' threshold is lower than the alarm 'on' threshold. The alarm 'off' thresholds can be set up within the same ranges as the alarm 'on' thresholds. However, to avoid confusion only the alarm 'on' thresholds can be viewed on the Dosemeter LCD.

As the dose rate rises above both the alarm 'on' AND alarm 'off' threshold the LED will flash and the bleeper sound at the fast intermittent rate. The alarm is self cancelling when the dose rate falls below the alarm 'off' threshold.

An example is shown on the following page.


2.5.3 DOSE RATE ALARMS
WB DOSE RATE
TIME
Default Display
WB
mSv
5.3
Alarm flag
WB/h
Fast Intermittent
(and buzzer)
BUTTON PRESSED
10s
or selected manually
Alarm Display (now default for duration of alarm condition)
WB/h
200 µSv/h
Alarm Display (alarm off but screen still default)
120 µSv/h
BUTTON PRESSED
or selected manually
WB Peak rate
WB Alarm duration
WB Peak Rate Time
alarm on
alarm off

The audible alarm may be muted by depressing the mode button for more than 2 seconds (unless this alarm mute has been inhibited). In order to preserve battery life, the EPD can be configured to automatically mute alarms after 8 minutes .

The peak dose rates measured are recorded for both wholebody and skin dose rates along with the times at which these rates occurred (to a resolution of 4 seconds) The period over which the wholebody dose rate alarm is active is also recorded (to a resolution of 2 seconds). This feature is not available for skin dose rate.

2.5.4 ALARM PRIORITIES

If more than one alarm condition is present then the default display is set with the following priorities:

1	Wholebody Dose Rate	$\dot{WB}$
2	Skin Dose Rate	$\dot{SK}$
3	Wholebody Dose	WB
4	Skin Dose	SK

If dual WB alarms are enabled then the second WB alarms would replace the SK alarms in the above table of priorities.

2.5.5 OVER-RANGE INDICATION

If a rate alarm exceeds 1Sv/h $\dot{WB}$ or 10Sv/h $\dot{SK}$, or if a dose store attempts to increment above full scale (16,777,215µSv), then a continuous alarm occurs and the LCD display flashes every two seconds.

This alarm can be muted by pressing the Mode button for 2 seconds.

Note: EPD will alarm again after muting should over-range conditions re-occur.

2.5.6 DISPLAY UNITS

The Dosemeter LCD can be configured to display values in either Sieverts or Rem, selected via the Disp/Mut.En parameter - see section 3.4.1.

2.5.7 ALARM MUTING

The Dosemeter can be configured to automatically mute alarms after 8 minutes and/or to allow alarms to be muted by pressing the Mode button for two seconds. It is also possible to configure the Dosemeter such that the LED and buzzer do not operate at all during alarm conditions.

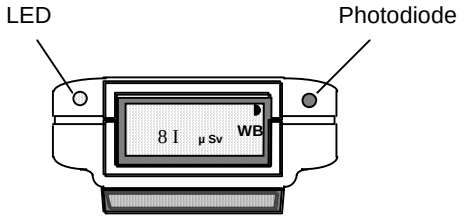
These muting functions are controlled by the AlarmMut.En parameter (see section 3.4.1) and do not effect the operation of the LCD alarm flags.

3. DOSEMETER FUNCTIONAL CONTROL

3.1 Communicating With The Dosemeter

3.1.1 OPTICAL INTERFACE

Communication with the Dosemeter can be achieved optically by way of the LED and Photodiode.



Communication with the Dosemeter will normally be through a Reader acting as an interface between the Dosemeter and the various Siemens software systems available.

The range of Siemens software allows authority control over EPD configuration changes.

3.1.2 HIGH DOSE RATES

During communication at high dose rates, dose accumulation continues but dose rate is not calculated.

During communications, the Dosemeter will correctly accrue dose up to a maximum of 8mSv per communication period. A typical communication period may be 10 seconds, this would mean that the EPD would measure dose correctly up to 2.8Sv/h.

If the Dosemeter has been subject to less than approximately 8mSv WB of dose during the communication period, the dose will be correctly incremented, however if it has been subject to more than 8mSv of dose during the communication period the dose accumulated will be some value between 0 and 8mSv.

3.1.3 DISPLAY DEFAULT

After communication, the Dosemeter will show the default display - depending on which displays are inhibited by the inhibit table parameter - see section 3.4.2.

3.1.4 DOSE RATE

Dose rate is not calculated during communications with the Dosemeter and is reset for normal operation on completion of the communication.

3.1.5 TIME-OUT

There is a 20 second time-out from the last communication after which the Dosemeter reverts to normal operation.

3.2 Issuing A Dosemeter

In order to issue a Dosemeter (ie. assign it to a person), the Dosemeter is provided with a 16 character Wearers Name and an 8 digit decimal numerical Wearer I.D. The numerical ID is viewable on the Dosemeter.

These are stored in the Dosemeter as follows:

Wearer_Name	A_N_Other	(up to 16 characters)
Wearer_ID	00003456	8 figures

A non issued Dosemeter will have Wearer_ID = FFFFFFFF
A newly issued Dosemeter should also have the following:

- All dose data cleared
- All counters cleared
- Alarm thresholds set to the desired levels
- No failure detected
- The physical impact count cleared
- Elapsed time less than 358 days

The Dosemeter also has a unique PCB serial number placed in the EEPROM during manufacture. This parameter is known as the Dosemeter ID and cannot be altered, but can be read using a reader system.

System software will normally record the Dosemeter ID of each issued unit.

3.3 Dosemeter Data

3.3.1 DOSE DATA

These parameters can be cleared using a reader system (subject to authority).

The accumulated doses displayed on the LCD (in Decimal) are stored in 6 digit HEX numbers to a resolution of 1µSv. The LCD display auto ranges and only shows the four most significant digits. The full resolution value may be read by communicating with the EPD.

Name: HPTotalDose
HSTotalDose
HP.Dose

HS.Dose

The SK and WB peak dose rates and the times at which these peak rates occur are recorded. The numbers recorded are the Elapsed Time parameters:

Name: ElapsedTime in 15 minute intervals from 0 to FFFF (wrap-around)
ElapsedMins in 1 minute intervals from 0 to 14
ElapsedSecs in 2 second intervals from 0 to 29

Peak dose rates are stored to 2 second resolution, this resolution is lost on loss of power - 15 minute resolution restored on power-up.

Name: HPPkDsRate
HSPkDsRate
HPPkDR.Time
HPPkDR.Mins
HPPkDR.Secs
HSPkDR.Time
HSPkDR.Mins
HSPkDR.Secs

The number of two second intervals over which the WB dose rate alarm has been active is stored in a 4 digit HEX number.

Name: HPAlarm.dur

If an EPD-2 unit is being used then the short term dose reset feature is available (see section 2.4.4). The operation clears WB and SK Dose, total dose values are not affected. This feature is controlled by setting the correct bit in the inhibit table.

3.3.2 COUNTERS

The total number of counts received from each detector is accumulated and stored in four separate counters. Each counter contains the counts on each of the respective channels - hard gamma channel, soft gamma channel, beta channel, and beta compensating channel.

Name: Hard.Gamma
Soft.Gamma
Beta.Counts
Compensated

3.3.3 POWER UP COUNT

The number of times the Dosemeter has been powered up is stored in a 1 digit HEX number.

Name: Entry.Cntr

This parameter wraps round (i.e. when its maximum value of 15 is exceeded, it returns to 0).

3.3.4 DOSEMETER IMPACT DETECTION (IMPACT COUNT)

The Dosemeter has on board a piezo detector which signals to the processor when physical impact is detected. When the processor receives a signal a special processing routine may be adopted for a 4 second period. The Dosemeter stores the number of 4 second intervals over which special processing has taken place. This is known as the impact count, has a maximum value of 16777215 and is stored as a 6 digit HEX number.

Name: Impacts

NOTE: If the impact detector causes a 4 second special processing period 11 times in succession, then the Dosemeter will display FLF9 (see section 4). This is true except in doserates above approximately 5mSv/h when counts due to impacts become insignificant relative to radiation counts. The FLF9 failure mode may be enabled and disabled via comms - see section 3.6.

3.3.5 ELAPSED TIME

The number of 15 minute intervals, since the last time this parameter was reset, during which the Dosemeter has been active is stored in a 4 digit HEX number. When this value reaches 8640 HEX - 358 days - the Elapsed Time flag will be displayed.

Name: ElapsedTime

This parameter 'wraps around' and returns to zero after 15 minutes at its maximum value (approx. 22 months).

3.3.6 NON FAULTY BLOCKS

The Dosemeter logs dose data in a circular buffer, the Non Faulty Block field indicates how many store locations are still available for logging. This parameter is read only.

Name: NonFaultyBlocks

The maximum is 5 Non Faulty Blocks, the normal operating minimum is 2 Non Faulty Blocks.

3.3.7 DOSE STORE

Both SK and WB dose information is stored as a dose profile, the intervals between entries in the dose profile is adjustable between 1 and 255 minutes by setting the Minutes Between Dose Stores parameter.

Name: Minutes Between Dose Stores

The EPD stores WB dose and SK dose as a continuous circular store in EEPROM. If the interval between stores is changed, then a timestamp is inserted

into the store and an additional store is recorded. Up to 212 storage locations are provided.

3.4 Control Over Dosemeter Functionality

3.4.1 ALARM MUTE DISABLE AND DISPLAY TYPE

An 8 bit number controls the following functions:

- Display Sieverts or Rem
- Dual WB Alarms
- Automatic Muting of audible alarm
- Inhibit Automatic Eight Minute Mute of audible alarm
- Control Over Separate WB and SK Alarms

Name: Disp/Mut.En

Format:

x	x	x	x	x	x	x	x
Bit 7	6	5	4	3	2	1	0

x = variable

Bit 0: WB dose alarm mute enable: 0 = disable; 1 = enable
Bit 1: SK dose alarm mute enable: 0 = disable; 1 = enable
Bit 2: WB rate alarm mute enable: 0 = disable; 1 = enable
Bit 3: SK rate alarm mute enable: 0 = disable; 1 = enable
Bit 4: Display type: 0 = Sievert; 1 = Rem
Bit 5: Dual WB alarms: 0 = normal; 1 = dual WB mode
Bit 6: Automatic mute: 0 = normal; 1 = automatically mute
Bit 7: Eight minute mute: 0 = normal; 1 = Inhibit 8 minute mute

If muting is not enabled for an alarm, that alarm will continue until the condition clears.

3.4.2 DISPLAY INHIBIT CODES

The Dosemeter can be set up such that it only displays certain facilities. The displays that are not shown are called "inhibited". This is controlled by a 32 bit binary number entered into the Dosemeter via the InhibitTab parameter.

Name: InhibitTab

Format:

x	x	x	x	1	1	x	x	x	x	x	x	1	1	#	1
Bit 31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16

x	x	x	x	1	1	1	1	1	1	x	x	x	1	1	1
Bit 15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

KEY:

1	Must set this bit to 1
x	Bit may be set to 0 or 1
#	If an EPD-1 is being used then this bit has no effect

If an EPD-2 is being used then this bit may be set to 0 or 1

Each bit controls whether a particular display is inhibited or uninhibited:
1 = inhibit; 0 = enable

The inhibit table corresponds to the 4x8 matrix formed by the Mode and Select buttons as follows:

Mode ∅	0		1		2		3	
Select ¬	Doses	Bit No	Alarms	Bit No	User ID	Bit No	Test	Bit No
0	WB Dose	28	WB Dose	20	Low ID (Bleep)	12	Test	4
1	SK Dose	29	SK Dose	21	High ID	13	Activate	5
2	WB Total	30	WB Rate	22	Low ID	14	Hard	6
3	SK Total	31	SK Rate	23	High ID	15	Soft	7
4	WB Rate	24	Impact Count	16	Low ID	8	Beta	0
5	SK Rate	25	Dose Reset	17	High ID	9	Beta Comp	1
6	Blank	26	Blank	18	Low ID	10	Blank	2
7	Blank	27	Blank	19	High ID	11	Blank	3

Shaded areas are used by Siemens for test purposes, they must be set to '1' in the inhibit table and they are not selectable as displays.

To prevent continuous confidence testing, to disable the test inhibit both 'Activate' and 'Test'.

3.4.3 DOSE AND DOSE RATE ALARM THRESHOLDS

Dosemeter alarm thresholds can be set up for accumulated dose and dose rate for both wholebody and skin dose.

Name:
- HPRateAl.on
- HPRateAloff
- HSRateAl.on — This becomes 2nd WB in Dual WB mode
- HSRateAloff — This becomes 2nd WB in Dual WB mode
- HPDoseAl.Th
- HSDoseAl.Th — This becomes 2nd WB in Dual WB mode (See section 2.4.3)

The dose rate alarm thresholds can be set over 2 ranges using the second range with the top bit set as follows:

$\dot{W}B$ Range 1: 0µSv/h to 32767µSv/h in 1µSv/h steps
(HPRateAl = 0 to 32767)

Range 2: 0µSv/h to 1023mSv/h in 1mSv/h steps
(HPRateAl = 32768 to 33791)

$\dot{S}K$ Range 1: 0µSv/h to 327.67mSv/h in 10µSv/h steps
(HSRateAl = 0 to 327670)

Range 2: 0µSv/h to 10230mSv/h in 10mSv/h steps
(HSRateAl = 327680 to 337910)

3.4.4 WHOLEBODY DOSE ACCUMULATION WARNING

The Dosemeter can be set such that the buzzer bleeps once at certain increments of wholebody dose.

Name: BleepEnable

The value of bleep can be set between '1' and 'F' (15) indicating a bleep after every increment of WB dose between 1µSv and 15µSv. Setting the parameter to '0' disables the function - see section 2.5.2.

3.4.5 BUTTON BLEEP CONTROL

The button bleep can be toggled on and off by setting a parameter via a reader.

Name: BtnBleep

0 = Bleep; 1 = No Bleep

This function can be toggled via buttons on the EPD (see section 2.4.6) regardless of the status of this parameter.

3.4.6 FREE FORMAT NUMBER

The Dosemeter has available two free format HEX numbers:

Name: FreeFormat1 (2 digit HEX)
FreeFormat2 (8 digit HEX)

These parameters are used for control purposes by some Siemens EPD software systems.

3.5 Calibration Data

3.5.1 CALIBRATION CONSTANTS

The calibration constants are set during calibration.

Name : HP.rate.gain (HP_dg)
HS.rate.gain (HS_dg)
Pen.SG.factor (KSY)
Beta.comp.factor (KLY)
Gamma/Beta.sens (KA)
Sup.SG.factor (KSC)
Pen.gamma.sens. (KY)
Beta.sens (KB)

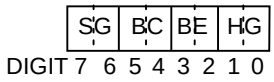
These parameters are used to enable the 4 channels to be combined in the correct manner to give correct values of skin and wholebody dose.

3.5.2 DETECTOR THRESHOLDS

The threshold level for each channel is the level above which a pulse is acknowledged. The threshold level for each of the 4 channels is set during calibration, the user has no write access to these values.

Name: SG.BC.BE.HG

The parameters are displayed in an 8 digit HEX number in the following format:



SG - soft gamma threshold digits 7 & 6
BC - beta compensating threshold digits 5 & 4
BE - beta threshold digits 3 & 2
HG - hard gamma threshold digits 1 & 0

3.6 Summary of Dosemeter Parameters

Calibration:

Parameter		ID	Min	Max	Units
Hp.rate.gain	(hp_dg)	502	128	4095	
Hs.rate.gain	(hs_dg)	503	128	4095	
Pen.SG.factor	(ksy)	504	128	4095	
Beta.comp.factor	(kly)	505	128	4095	
Gamma/Beta.sens	(ka)	506	128	4095	
Sup.SG.factor	(ksc)	507	128	4095	
Pen.gamma.sens	(ky)	508	128	4095	
Beta.sens	(kb)	509	128	4095	
Timer.y1		50A	0	255	
Timer.b1		50B	0	255	
Timer.b2		50C	0	255	
SG.BC.BE.HG		531	0	FFFFFFFF	

Identity:

Parameter	ID	Min	Max	Units
Free Format1	547	0	FF	
Free Format2	548	0	FFFFFFFF	
Wearer_Name	521	String - Up to 16 characters		
Wearer_ID	522	0	FFFFFFFF	

Alarm Thresholds:

Parameter		ID	Min	Max	Units
HpRateAlon	0 to 32767µSv/h	513	0	32767	1µSv/h
	0 to 1023mSv/h		32768	33791	1mSv/h
HpRateAloff	0 to 32767µSv/h	514	0	32767	1µSv/h
	0 to 1023mSv/h		32768	33791	1mSv/h
HsRateAlon	0 to 327.67mSv/h	515	0	32767	10µSv/h
	0 to 10230mSV/h		32768	33791	10mSv/h
HsRateAloff	0 to 327.67mSv/h	516	0	32767	10µSv/h
	0 to 10230mSV/h		32768	33791	10mSv/h
HpDoseAl.Th		517	0	65535	10µSv
HsDoseAl.Th		518	0	65535	100µSv

Status:

Parameter	ID	Min	Max	Units
Fail Code	534	0	FF	
Impacts	535	0	16777215	4 Seconds
Non Faulty Blocks	536	0	5	
EPD ID		0	16777215	
Software Version		0	255	
Log.Status	541			
Param.BlkSt	542			
Entry.Cntr	543	0	F (wraps)	
Unit.Status	545	0	FFFF	
ElapsedTime	546	0	FFFF (wraps)	15 Mins
ElapsedMins	590	0	14	Minutes
Elapsed2Secs	591	0	29	2 Seconds

Dose, Dose Rate and Counter Results:

Parameter	ID	Min	Max	Units
HpAlarm.dur	544	0	65535	2 secs
HpTotalDose	551	0	16777215	µSv
HsTotalDose	552	0	16777215	µSv
Hp.Dose	553	0	16777215	µSv
Hs.Dose	554	0	16777215	µSv
HpPkDsRate	555	0	16777215	µSv/h
HsPkDsRate	556	0	16777215	10µSv/h
HpPkDR.TIme	557	0	65535	15 mins
HsPkDR.Time	558	0	65535	15 mins
HpPkDR.Mins	592	0	14	Mins
HpPkDR.Secs	593	0	29	2 Secs
HsPkDR.Mins	595	0	14	Mins
HsPkDR.Secs	594	0	29	2 Secs
Hard.Gamma	561	0	4294967295	Counts
Soft.Gamma	562	0	4294967295	Counts
Beta.Counts	563	0	4294967295	Counts
Compensated	564	0	4294967295	Counts

Dose Storage:

Parameter	ID	Min	Max	Units
Mins between Dose Stores (stored value)	573	1	255	Mins
Mins Between Dose Stores (current value)	596	0	255	Mins
Minutes since last store	597	0	255	Mins
Minutes to next store	598	0	255	Mins
Address of next Dose Store	599	0	FF	
Page of next Dose Store	600	1	5	

EPD Control:

Parameter	ID	Min	Max	Units
Bleep Control	511	Bit 0: 0 = Bleep; 1 = No Bleep		
Bleep Enable	512	0	15	µSv
Inhibit.Tab	532	0	FFFFFFFF	
Disp/Mute.En Bit 0: Enable WB dose alarm mute Bit 1: Enable SK dose alarm mute Bit 2: Enable WB rate alarm mute Bit 3: Enable SK rate alarm mute Bit 4: 0 = Sieverts; 1 = Rems Bit 5: Dual WB Alarms Bit 6: Auto Mute Bit 7: Inhibit 8 min mute	533	0	FF	
Not used	571			
Dose Clear	572	Bit 4: 1 = Enable; 0 = Disable		
Enable FLF9	574	Bit 7: 1 = Enable; 0 = Disable		
Spare	575			
Spare	576			
Spare	577			
Spare	578			
Spare	579			
Spare	580			
Spare	581			
Spare	582			
Spare	583			
Spare	584			
Spare	585			
Spare	586			
Spare	587			

4. FAILURE MODES AND FAULT DIAGNOSTICS

4.1 Dosemeter Faults

Faults can be identified as follows:

Fault:	See section:
'FLxx' on display	4.2
Non zero number in fail code parameter (accessed using reader)	4.2
Non FFFF Unit Status (accessed using reader)	4.3
Other Fault	4.4

An EPD fault is usually indicated by a visual and audible alarm, the LCD giving an indication of the nature of the fault.

Alarm rate : —— —— —— —— slow intermittent rate

To preserve the life of the EPD battery the alarm is self muting after 20 seconds.

4.2 Display and Fail Codes

The following table shows the fault codes which are displayed and their corresponding internal fail codes for software detected errors in the Dosemeter. In the event of a fault, the relevant Recovery Procedure should be followed.

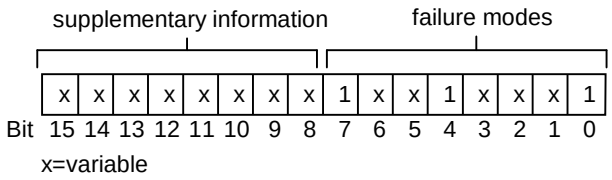
LCD Display	Hex Fail Code	Error	Recovery Procedure No.
FL01 to FL09	01 to 09	Software Errors - arithmetic	1
FL0t	0C	Possible EMC or static	1
FL1	1B	Self Test Error	2
FL11, 12, 16, 19,1E	11, 12, 16, 19, 1A	Self Test Errors	1
FL13	13	No counts detected on Hard Gamma Channel in 7 hrs	3
FL14	14	No counts detected on Soft Gamma Channel in 23hrs	3
FL15	15	No counts detected on Beta channel in 52 hrs	3
FL17	17	Un-recoverable Self Test Error	4
FL20 to FL38	20 to 38	Software Errors - detector counts	1
FL4, 42, 4E, 4t	4B, 42, 4A, 4C	Software Errors - executive	2
FL43, 47	43, 47	Software Errors - executive	1
FAIL	44	Break in Communication Link during comms.	5
FL50 to FL58	50 to 58	Software Errors - service	1
FL5F	5F	Software Errors - service	1
FL6, 60, 68, 6t	6B, 60, 68, 6C	EEPROM Access Errors	2
FL65, 66, 67, 6E, 6L, 6F	65, 66, 67, 6A, 6E, 6F	EEPROM Access Errors	1
FL70, 75, 7E	70, 75, 7A	EEPROM Access Errors	2
FL71 to 74, FL76 to 79	71 to 74, 76 to 79	EEPROM Access Errors	1
FL81 to FL88	81 to 88	Display Errors	1
FL90 to FL97	90 to 97	Software Errors - task Entry	1
FLF9	F9	Continued Physical Impact Detection	6
NORMAL (Failure only detected via reader)	61, 62	Non-critical fault - reduced number of log-blocks	7

4.3 Unit Status

The unit status is a 16 bit binary number stored in the Dosemeter giving an indication of the current status of the Dosemeter. It can be used in conjunction with the fail code to indicate the cause of any fault within the Dosemeter.

Name: Unit.Status

Format: The unit status is held in the Dosemeter in the following format



Each bit acts as a flag to a particular fault i.e. it is set to 0 if a fault of that type has been detected, and is set to 1 otherwise. Bits 0 to 7 give information on which fault mode the Dosemeter has fallen into, while bits 8 to 15 give supplementary information.

Unit Status Examples (in HEX):

- F7FF Low Battery (flag will be on LCD).
- FBFF Elapsed time greater than 358 days (flag will be on LCD).
- FFDF An FLF9 has occurred (physical abuse).

The following table describes the meaning of each bit.

	BIT	TYPE OF FAULT	Recovery Procedure No.
FAULT MODES	0	Reserved for future use. Set to 1	
	1	Communication link broken during communication session	5
	2	Dose calculation halt- communication still possible	2
	3	Fatal Error	1
	4	Reserved for future use. Set to 1	
	5	More than 11 consecutive impact detection's	6
	6	Non critical fault	7
	7	Reserved for future use. Set to 1	
SUPPLIMENTARY INFORMATION	8	Partial EEPROM failure- still usable	
	9	Data logging cannot occur	
	10	Elapsed time exceeds 358 days	
	11	Battery voltage low	
	12	Software stack overflow	
	13	Detector failure	
	14	Registers overflowed	
	15	Fault not otherwise indicated	

e.g. if bit 11 was set to 0, that would indicate that the battery voltage was low.

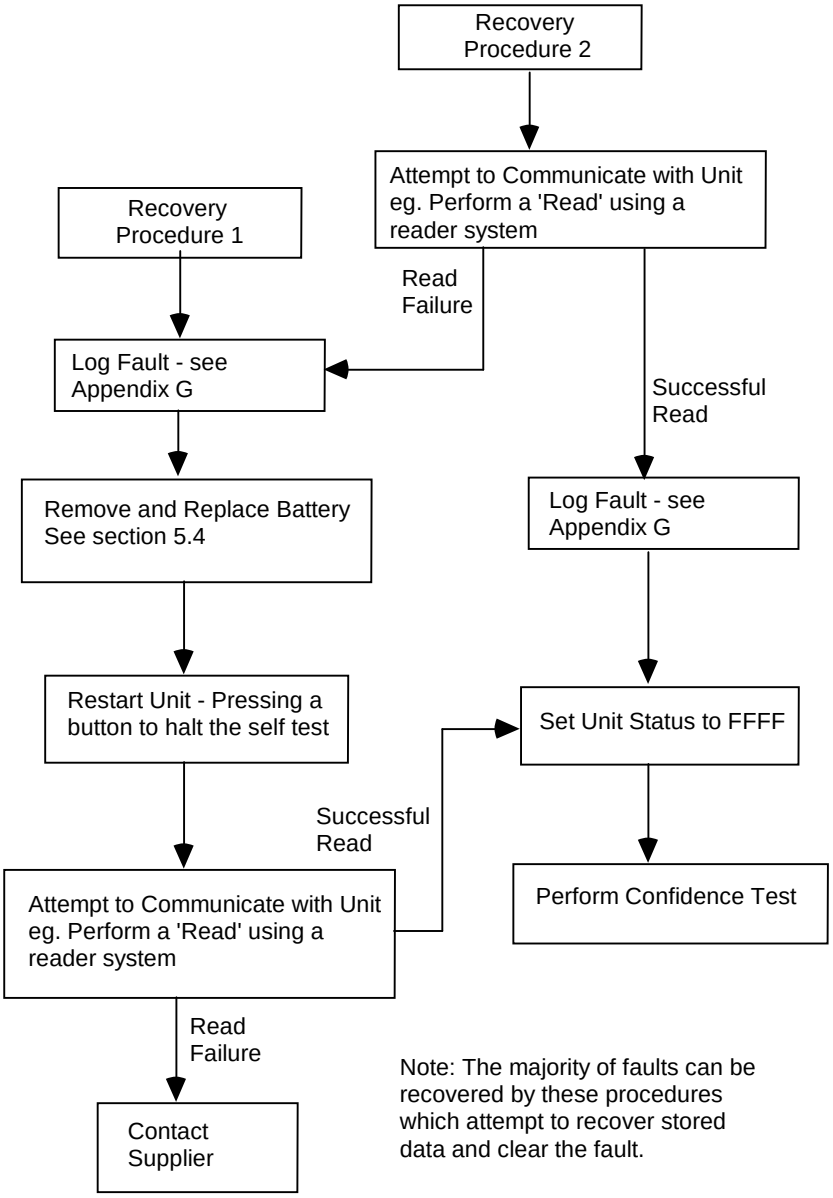
4.4 Other Dosemeter Faults

It may be possible for the Dosemeter to fail without producing or displaying a Fail Code or causing an alarm. This section explains what actions should be taken in the event of such a fault occurring.

Symptom	Likely Cause	Action
Blank Screen Nothing displayed on the LCD, not even 'Heart Beat' indication	Battery Failure	Attempt to communicate with the EPD to prove diagnosis. Remove old and Insert new battery and restart unit- see section 5.4. Communicate with unit to access stored data.
Static Screen 'Heart Beat' indication not flashing	2 second timer error	Attempt to communicate with the EPD. Replace battery and restart unit- see section 5.4. Communicate with unit to access stored data. If there is still no 'Heart Beat' contact supplier.
Faulty Button Operation No response to button(s)	Hardware fault	Communicate with unit to access stored data. Contact supplier.
Un-mutable Alarm Cannot mute alarm using buttons	Muting Disabled see section 3.4.1	Communicate with EPD. Clear alarm conditions. Enable muting if required.
Faulty Buzzer No Audible alarm during Confidence Test	Hardware fault	Contact supplier.
Faulty Display Segment missing on LCD display	Hardware fault	Contact supplier.
Spurious Alarming Unit alarms for no apparent reason	Over-range Alarm caused by background counts	Reset Dose and/or Total Dose from their maximum values. Set unit status to FFFF.
Spurious SK alarms	Perforated Beta window	Contact supplier

4.5 Recovery Procedures

4.5.1 RECOVERY PROCEDURES 1 AND 2



4.5.2 RECOVERY PROCEDURE 3

1. Follow Recovery Procedure 1.
2. Check the performance of the unit against a known source eg Siemens Irradiator Unit.
3. If Dosemeter fails performance test return the unit to supplier.

Note:

No counts failures could be caused by operating in a very low background condition or by a detector failure, therefore, Siemens recommend that the Dosemeter be functionally tested against a known source following a recovery from this failure.

For the Dosemeter to function correctly each channel must receive a minimum of 1 count in the period indicated (7 hrs for hard gamma, 23 hrs for soft gamma and 52 hrs for the beta channel), hence this fault will occur and re-occur in an environment with very low or no background radiation.

4.5.3 RECOVERY PROCEDURE 4

1. Communicate with the unit to recover dose information.
2. Log the fault - see Appendix G
3. Return the unit to supplier.

Note:

This is an unrecoverable Self-Test Error, however communication with the unit is still possible.

4.5.4 RECOVERY PROCEDURE 5

1. Ensure that last write was successful
2. Re - write parameters if necessary
3. Any properly terminated communication clears ‘FAIL’
4. Perform a confidence test

Note:

This fault condition indicates that the EPD has been written to but has timed-out (20 seconds) before receiving a valid link terminate. The possible causes for this would be:
a) EPD removed from reader during communication cycle
b) Reader software failed to send a command for 20 seconds

4.5.5 RECOVERY PROCEDURE 6

1. Log the fault - see Appendix G and note the users name
2. Set the unit status to FFFF
3. Clear the impact counter (optional)
4. Perform a confidence test

Note:

This is a short term fault caused by continued Dosemeter impact detection, sometimes due to the way the unit is being worn or the type of job being performed by the User. The fault is self clearing when the abuse stops, however, the unit status and the number of impacts recorded are not reset automatically.

If an EPD persistently shows this fault and it cannot be attributed to the way the unit is being used, return the unit to the supplier

4.5.6 RECOVERY PROCEDURE 7

1. Log the fault - see Appendix G
2. No further action is necessary

Note:

This is a non-critical fault with no operational effect on the Dosemeter. The fault is only detected via a reader by observing the unit status and fail code parameters.
This fault is caused by normal ageing of the unit and will result in reduced spare storage capacity.

5. CALIBRATION AND MAINTENANCE

5.1 Calibration

The EPD is calibrated by a highly sophisticated automatic system consisting of several radioactive sources. The EPD is not expected to go out of calibration during its working life.

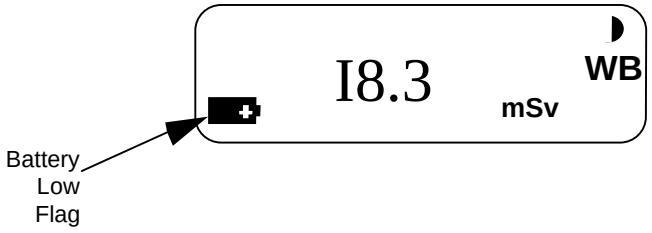
During calibration the calibration constants are set, and the threshold levels for each of the four channels are set. The threshold levels determine the minimum pulse size that can be considered a "count". The calibration constants ensure that the channels are combined in the correct fashion to give correct dose readings.

5.2 The EPD Battery

The EPD battery uses Lithium Thionyl Chloride technology* and is custom designed for use with the Dosemeter .

A Battery change is necessary every 12 months and/or when the battery low flag is displayed indicating the battery voltage has dropped to below an acceptable level.

It is only to be changed by a competent technician.



*Siemens can also provide an option for using 3 x AAA batteries.

5.3 LITHIUM BATTERY WARNING

WARNING

Battery Storage
Batteries in storage should be kept in an isolated, dry, well ventilated and cool environment, and not exposed to direct sunlight. Temperatures should preferably be maintained below +30°C and definitely not allowed to exceed +70°C. Each battery must be contained in a self sealing polythene bag or equivalent. Ensure that the terminals are protected from short circuit.

Normal Use
The Lithium battery is a high energy design and as such must be treated with respect. Battery contents are potentially toxic, flammable and explosive.

The following instructions apply:-

- Do not allow batteries to be short circuited.
- Do not attempt to recharge batteries.
- Do not open, puncture, crush or tamper with the battery.
- Do not allow the EPD or battery to be used or stored in temperatures exceeding +70°C.
- Do not expose the batteries to direct sunlight.
- Follow the instructions below if battery damage or leakage occurs, or if a battery starts to heat up. Do not allow electrolyte to contact the skin or eyes.
- Do not leave a battery in the EPD with the EPD display blank, i.e. with the EPD in the not started state. To do so causes the battery to be drained at several times the normal rate and will therefore unnecessarily reduce battery life.

Dealing with damaged or leaking batteries, or batteries that are heating up
The battery has a safety vent to allow a controlled release of electrolyte in the event of damage, abuse or fire. If an EPD has been damaged in any way which could affect the battery, care must be exercised when replacing the battery which may have vented into the EPD case.

Do not expose a leaking battery or the contents of a battery to water.

Leakage of electrolyte from the battery can normally be detected by the smell of sulphur dioxide and/or the presence of electrolyte solutes. In this event the battery should be electrically disconnected from the EPD using protective clothing, gloves and goggles. It should then be placed in a self-sealing polythene bag or equivalent and disposed of in the correct manner (see below). Wash with copious amounts of water if the electrolyte comes in contact with the skin and seek medical advice if it comes in contact with the eyes.

Disposal
Check local, regional or national regulations for any special requirements for the disposal of Lithium batteries. Normally batteries can be disposed of in a secured landfill. DO NOT DISPOSE OF IN A FIRE. Do not dispose of in a normal household or domestic waste system.

Batteries awaiting disposal should be stored safely as described under ***Battery Storage*** above. Do not store batteries without insulating the terminals.

Air Transport
This battery has passed the tests referenced in IATA (1995-1996) Packing Instruction 903 Special Provision A45 Part 9. The battery therefore meets parts 7,8,9 and 10 and is regarded as non-dangerous goods.

The battery may therefore be shipped in its normal packing by passenger or cargo aircraft.

5.4 Battery Replacement

When the battery low flag is displayed on the LCD, the battery should be replaced within 10 hours to avoid Dosemeter shut down.

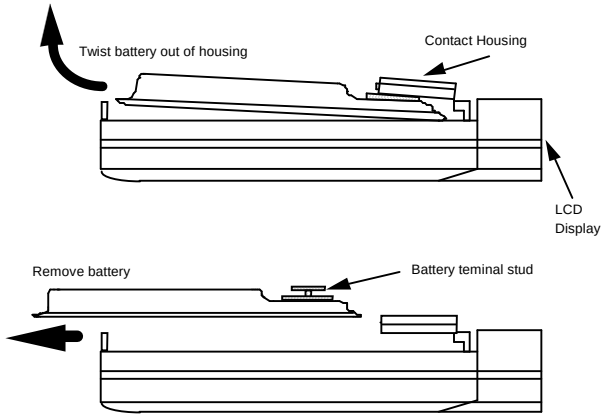
If the battery is not replaced within 10 hours of the battery low flag being displayed, the Dosemeter will shut down, the display will go blank, but dose data will be secure. The EPD shutdown can occur at any time from 10 hours to approximately 14 days following the display of the battery low flag.

Under no circumstances leave a battery in a Dosemeter which has shut down, or is not active for any reason.

Lithium Battery Option:
If the Dosemeter has been damaged in any way which could affect the battery, care must be exercised when replacing the battery which may have vented into the EPD case and caused the Dosemeter to become pressurised. See WARNING on the previous page.

Unscrew the battery cover. If, when the battery cover is removed, the battery appears to have vented or there is a smell of sulphur dioxide and / or the presence of electrolyte solutes, see WARNING on the previous page. Otherwise proceed as follows:

Remove the battery by holding the Dosemeter by the LCD display end of the Dosemeter, with the battery uppermost. Twist the battery away from the contact housing, supporting the contact housing with first finger and thumb. See the following diagram.



BATTERY REMOVAL

The old battery should be disposed of in accordance with the instructions given under the Warning on page 37.

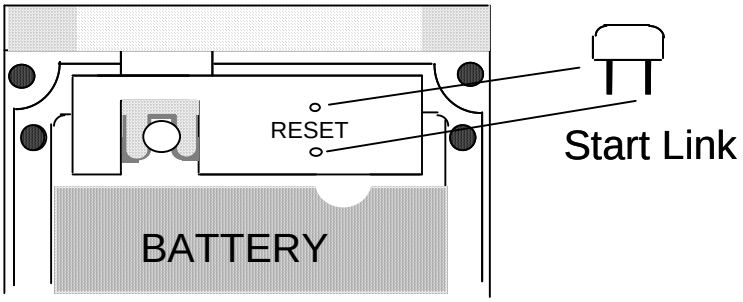
The new battery should be checked for leakage and mechanical damage prior to being removed from its polythene bag. Check the date of manufacture (D.O.M) stamp. Lithium batteries have a shelf life of 10 years, but will lose up to 10% capacity in this period.

Insert the battery into the contact housing as shown in the diagram overleaf. Care must be exercised when fitting the battery. Ensure that the contacts are correctly located on the battery terminal and that the battery contact housing is held securely to prevent breakage. Using firm pressure ensure that the battery is fully located in the contact housing. There should be less than 1mm gap at the top of the contact assembly between the battery stud and the back of this contact (see diagram overleaf). **Always restart the EPD immediately.**

3 x AAA Battery Option:
Unscrew battery cover, remove and replace batteries ensuring correct battery terminal contact, restart Dosemeter before replacing cover.

5.4.1 STARTING THE DOSEMETER

Insert the starting link and observe the display, which, within two seconds, will start to display all the LCD segments and exercise the LED and buzzer.



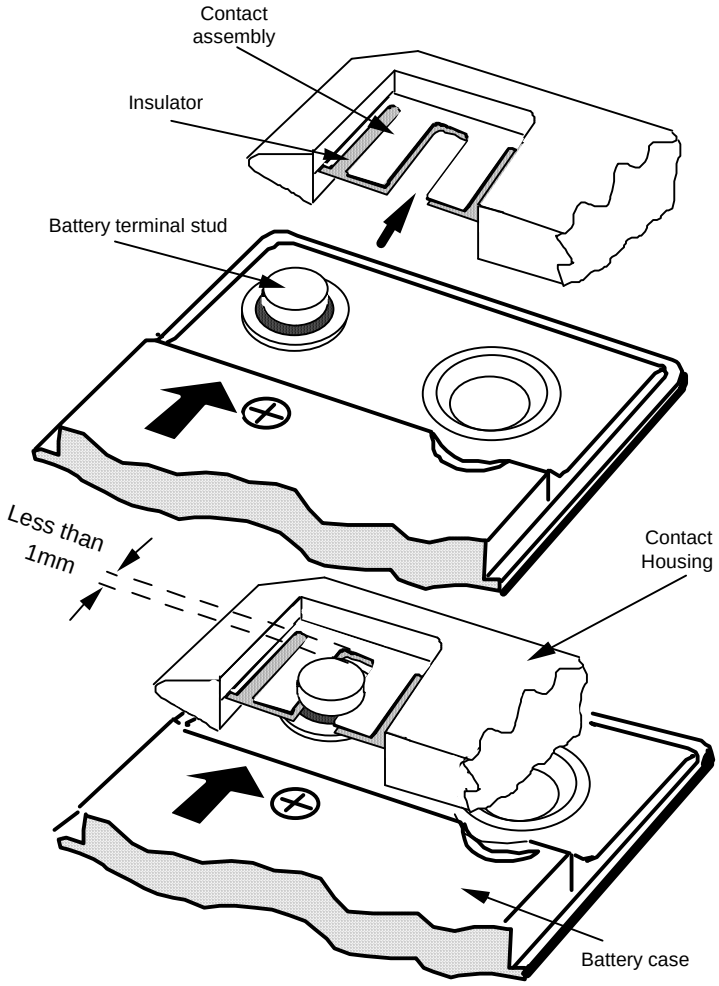
If the display does not appear check that the battery has been fitted correctly. If the battery feels warm remove it immediately as it may have been short circuited. This battery should be replaced in the Polythene bag from where it came and allowed to cool in a safe place.

When the LCD has been seen to display all the segments, the battery cover can be replaced on the Dosemeter using the screws provided.

When closing the battery cover do not use excessive force. This will not be necessary if the battery is correctly positioned (see diagram overleaf), and the rubber seal around the battery compartment is correctly in place. Insert the pocket clip just before final closure and insertion of the two screws.

Do not leave a battery in a Dosemeter which has failed to start.

Less than 15 minutes of dose data will be lost by powering down the Dosemeter (i.e. removing the battery), changing the battery, and restarting it.



BATTERY REPLACEMENT

Appendix A. Radiological Specifications

All radiological responses at +20°C

Dose Ranges

WB	Display	0µSv to 16.77 Sv	(auto ranging)
	Store	0µSv to 16.777215 Sv	resolution 1 µSv
SK	Display	0µSv to 16.77 Sv	(auto ranging)
	Store	0µSv to 16.777215 Sv	resolution 1 µSv

Alarm Thresholds:

WB	Display	0µSv/h to 655.3mSv	(auto ranging)
	Set/Store	0µSv/h to 655.35mSv	resolution 10µSv
SK	Display	0µSv/h to 6.553Sv	(auto ranging)
	Set/Store	0µSv/h to 6.5535Sv	resolution 100µSv

Dose Rate Ranges

$\dot{W}B$	Display	0µSv/h to 16.0 Sv/h (auto ranging)	
		resolution 2 significant digits, zeroing the rest.	
	Peak Store	0µSv/h to 16.777215Sv/h	
		resolution 1µSv/h	
$\dot{S}K$	Display	0µSv/h to 10.0 Sv/h (auto ranging)	
		resolution 2 significant digits, zeroing the rest.	
	Peak Store	0µSv/h to 167.77215Sv/h	
		resolution 10µSv/h	

Note: $\dot{W}B$ display over-ranges at 1.0Sv/h but continues to display above this limit. $\dot{S}K$ display is limited to and over-ranges at 10Sv/h.

Alarm Thresholds:

$\dot{W}B$	Display	0µSv/h to 1.0Sv/h	(auto ranging)
	Set/Store	0µSv/h to 32767µSv/h	resolution 1µSv/h
		0µSv/h to 1023mSv/h	resolution 1mSv/h
$\dot{S}K$	Display	0µSv/h to 10.0Sv/h (auto ranging)	
or 2nd $\dot{W}B$	Set/Store	0µSv/h to 327.67µSv/h	resolution 10µSv/h
		0µSv/h to 10230mSv/h	resolution 10mSv/h

Linearity of response with dose rate

WB	^{137}Cs	0 Sv/h to 0.5Sv/h	±10%
		0.5Sv/h to 1Sv/h	±20%
		1 Sv/h to 2 Sv/h	±30%
		2 Sv/h to 4 Sv/h	±50%
		4 Sv/h to 50 Sv/h	continues to accumulate dose at a rate greater than 4 Sv/h
SK	$^{90}Sr/^{90}Y$	0µSv/h to 1Sv/h	±20%
		1 Sv/h to 50 Sv/h	continues to accumulate dose at a rate greater than 1 Sv/h

Repeatability

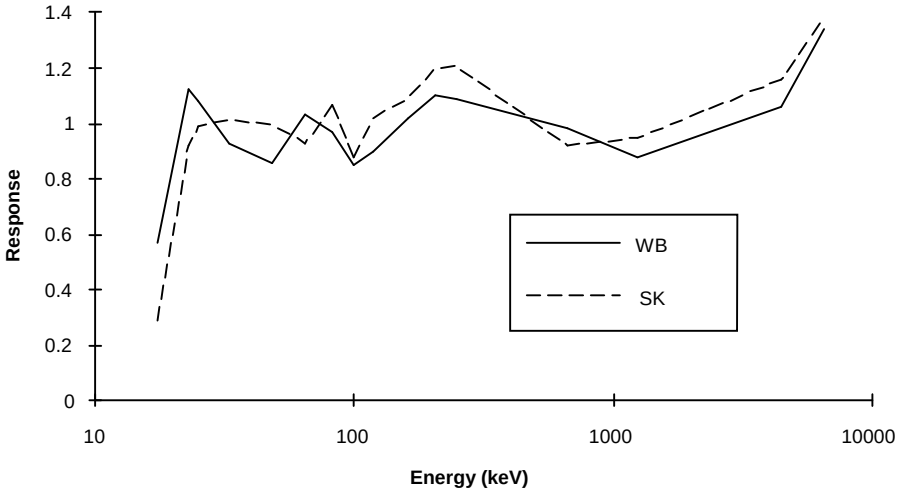
Better than ±5 % for 100µSv WB dose at 5mSv/h

Calibration Accuracy

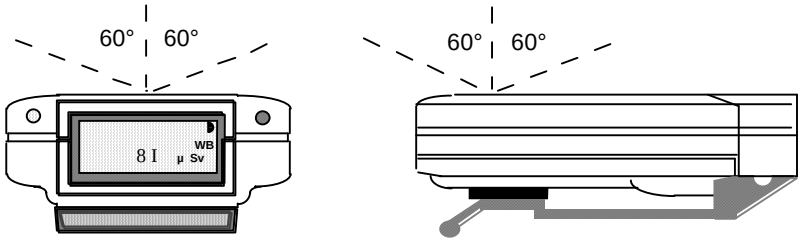
WB	^{137}Cs	100 µSv at 5 mSv/h ±10 %
SK	$^{90}Sr/^{90}Y$	100 µSv at 5 mSv/h ±20 %

Energy Response

Typical WB & SK response.



Combined angular and Energy response



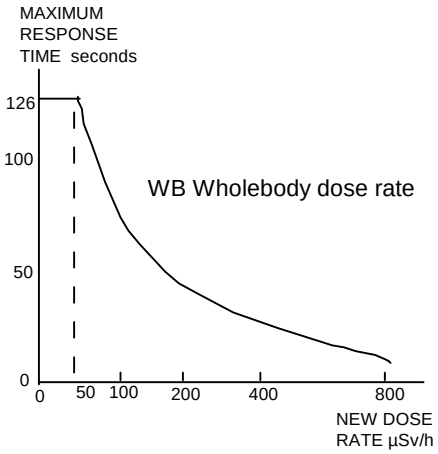
WB	Photons	20keV - 1.5 MeV 1.5MeV - 10MeV	Accuracy ± 30% Accuracy ± 50%
SK	Averaged Beta Energy	250keV - 1.5MeV	Accuracy ± 30%

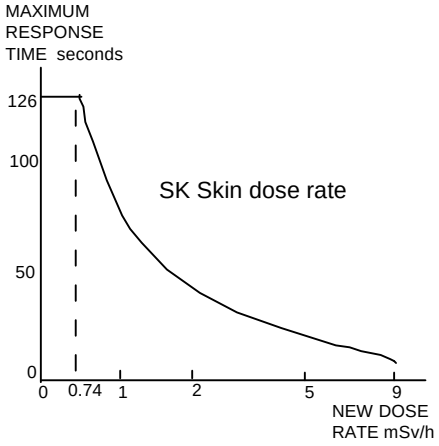
Neutron Response
Less than 2 % of true neutron dose.

Radon Response
No significant response to alpha emissions of radon and its progeny.

Dose Rate Response Times
Due to dose rate averaging, the Dosemeter has a finite response time to changes in dose rate.

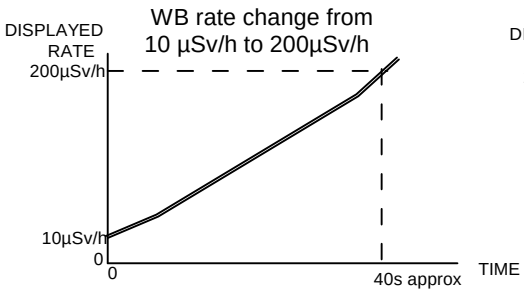
These graphs show the maximum time the Dosemeter will typically take to respond fully to new rates. Precise response times depend on detector sensitivities, and hence on the calibration parameters for the Dosemeter. They will also be affected by statistical variations, particularly at low dose rates. The Dosemeter response times do not in any way depend on the previous dose rate.

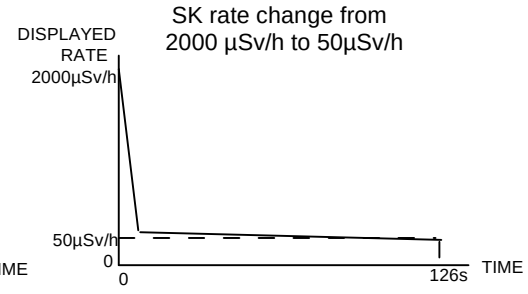




e.g. if the WB rate changes to 50 µSv/h, the maximum time the Dosemeter takes to respond fully to this change is 126 seconds. The calculated rate changes roughly linearly towards the correct rate over this time period except when a large fall in rate is seen. In this case the response is rapid at first, before becoming roughly linear.

Typical examples of how the displayed dose rate changes following a step change in dose rate


WB rate change from
10 µSv/h to 200µSv/h
DISPLAYED
RATE
200µSv/h
10µSv/h
0
0
40s approx
TIME


SK rate change from
2000 µSv/h to 50µSv/h
DISPLAYED
RATE
2000µSv/h
50µSv/h
0
0
126s
TIME

Appendix B. Environmental Specifications

Temperature and Humidity Range

- Operating Temperature Range -10°C to +40°C.
- Humidity up to 90% RH non condensing
  (tested in accordance with IEC 45B(Secretariat)107 Draft April 1992).
- Storage Temperature -25°C to +70°C.

Over the Operating Temperature and Humidity Range specified above:

- A Dosemeter's response to background radiation will not increase by more than 0.2µSv/h from its measured performance at 20°C.
- A Dosemeter's response to ^{137}Cs at 7.5µSv/h will not vary by more than ±20% from its measured performance at 20°C.

Appendix C. Electromagnetic Compatibility

Standard Unit

The Dosemeter will perform within 10% of its normal response in the following:

Electric Field	E=25 V/m	10kHz	to	250kHz RMS	Carrier Wave Only
	E=50 V/m	250kHz	to	1 GHz RMS	Carrier Wave Only
	E=5 V/m	100kHz	to	1GHz RMS	AM 80% sine
Magnetic Field	H=60 A/m	50Hz	to	60Hz RMS	
	H=4.0 A/m	10kHz	to	1MHz RMS	
	B=10mT	Static			
Electro-Static Discharge	6kV @ 2mJ				

Radar - Owing to the sensitivity of the circuitry of the device, the Standard EPD is not suitable for use at establishments where high power radar may be in use. (e.g. airports, dockyards. mobile phones, security article detectors, microwave ovens etc.).

EMC Enhanced Unit

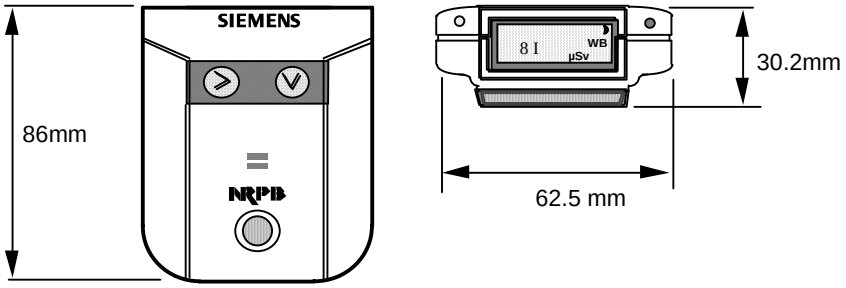
The Dosemeter will perform within 10% of its normal response in the following:

Electric Field	E=100V/m	10kHz	to	2GHz RMS	Carrier Wave Only
	E=100V/m	10kHz	to	1 GHz pk	AM 80% 1kHz to 15kHz
	E=50V/m	1GHz	to	1.5GHz pk	
	E=100V/m	1.5GHz	to	2GHz pk	
	E=100V/m	500MHz	to	700MHz pk	Pulse Modulation 100%
	E=10V/m	700MHz	to	3GHz pk	PRF: 100Hz to 10kHz
	E=70V/m	3GHz	to	8GHz pk	Width: 20ns to 100µs
Magnetic Field	H=60 A/m	50Hz	to	60Hz RMS	
	H=4.0 A/m	10kHz	to	1MHz RMS	
	B=10mT	Static			
Electro-Static Discharge	6kV @ 2mJ				

Appendix D. Mechanical And Miscellaneous Specifications

Impact
A special detector will trigger special processing to take place to counteract the effect of physical impact.

Dimensions



Weight
The unit weighs approx. 170g

Case
Magnesium Alloy with polyester coating
Colours: yellow, grey, olive drab (military green)
Designed to facilitate decontamination (see Appendix F).

Battery Connection
Push-clip

Battery Type
Lithium Thionyl Chloride 5 Ah
3 x AAA batteries*

Battery Life
Typically 12 months (2500 hours*) in continuous operation at an average dose rate of 5µSv/h with the alarm sounding less than 20 hours per year.

*AAA battery operated Dosemeter

Operation
Two rubber push buttons

Display

Custom 7 segment 4 digit Liquid Crystal Display

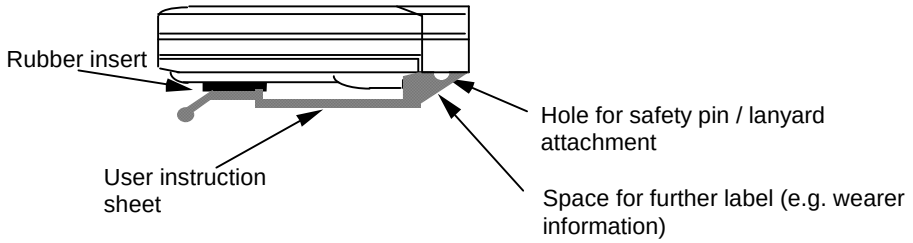
Beta Window
Aluminised polyimide film.

Alarm sounder
2kHz, typically 80 dBA at 30cm, fully sealed.

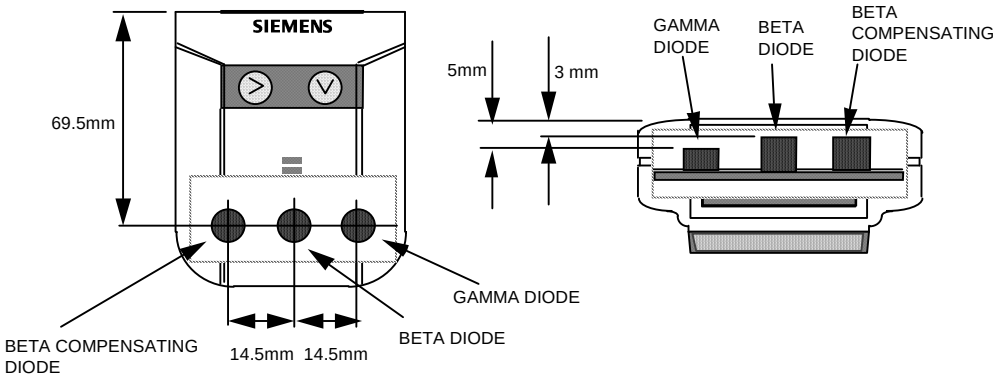
Three sounding modes	continuous	————————
	slow intermittent	— — — — — — —
	fast intermittent	– – – – – – – – – –

These are sounded during the confidence test

Clip
High impact plastic - renewable

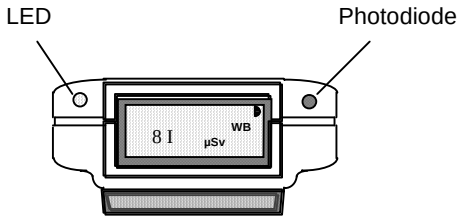


Detectors
Multiple silicon PIN diodes



Appendix E. Communication Link

The EPD communicates optically to a special Reader unit which may be connected to a PC running Siemens EPD software. It does this via an LED and a photodiode.



The Reader to EPD optical link operates at 900 - 1000 nm (infra - red)
The EPD to Reader optical link operates at 600 - 700 nm (visible red)

The optical link is capable of running at two different transmission speeds

Slow 128 bits / sec

Fast 3906.25 bits / sec

The Reader unit receptacle ensures that correct alignment is achieved and that excess ambient light does not affect reliable operation even in well illuminated environments.

A unique communication protocol is used to restrict tampering.

Appendix F. Cleaning and Decontamination

The EPD should be cleaned by wiping it over periodically with a cloth lightly dampened with a solution of water and up to 5% of a neutral water based detergent.

Do not use solvents or other cleaners.

If radiological deposits are present the unit should be decontaminated by carefully wiping it over using a disposable cloth or tissue dampened with a detergent solution as described above, or alternatively by using a disposable 'sticky wipe rag'. The unit should afterwards be checked with a sensitive radiation monitor to ensure satisfactory decontamination has been achieved.

Appendix G. Fault Log Sheet

DATE	TIME	EPD ID	UNIT STATUS	FAIL CODE LCD | HEX	DESCRIPTION OF FAULT	CORRECTIVE ACTION

Appendix H. Manufacturers Details

MANUFACTURER'S ADDRESS

Siemens Environmental Systems Limited
Sopers Lane
Poole
Dorset BH17 7ER
United Kingdom

TECHNICAL SUPPORT TELEPHONE NUMBER

(01202) 782779 International: + 44 1202 782779

Fax:
(01202) 782335 International: + 44 1202 782335

SALES TELEPHONE NUMBER

(01202) 782374 International: + 44 1202 782374
(01202) 782780 International: + 44 1202 782780

Fax:
(01202) 782335 International: + 44 1202 782335

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