FWT-100 RADIACHROMIC READER SYSTEM

User's Manual

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INTRODUCTION

The FWT-100 Radiachromic Reader is a computer controlled densitometer designed to read FWT-60-00 Radiachromic Detectors. The complete reader system consists of a computer (IBM PC\XT\AT compatible), the reader head, an ADC card for the computer, a cable to connect the head to the card, and software.

HARDWARE INSTALLATION

Dedicated Computer

We recommend that you use a dedicated computer for the Model 100. We have found that users who network, run multiple programs, or use inexpensive computers often have poor results with the Model 100. If you do have problems, stop multitasking, shut down all concurrent programs, remove the network connection, remove excess hardware and/or try a better quality computer.

ADC Board

Before installing the ADC board in the computer you need to note the base address of the board. If you have other expansion cards in the computer you should also check that the base address does not conflict with the address of the other cards. If necessary, the base address may be altered by changing the DIP switch on the ADC card.

To determine the base address of the card examine the DIP switch settings and the numbers printed on the printed circuit board (not the numbers on the DIP switch housing). Table 1 gives the decimal and hexadecimal values and the position of each switch. The card is originally set up with an address of 0x300.

Note the base address of the card so that this may be specified in the configuration file for the software. Since computers vary in style you should consult your systems manual for details on installing an expansion card in your computer.

Most installations are as follows:

First make sure that the computer is turned off and unplugged. Next open the case to allow access to the expansion slots. Choose an appropriate empty slot for the card. Remove the retaining bracket, being careful not to drop the screw in the computer. Firmly insert the card in the slot and screw the bracket to the chassis. Replace the case.

Connecting the Head to the Card

Before connecting the head to the card you should make sure that the computer is turned off. Connect either end of the supplied cable to the card and the other end to the reader head (the two ends are interchangeable). Securely fasten them by tightening the screws on the connectors.

The base address of the ADC card may be changed to provide a range of selections to the user. The default setting is hexadecimal 300, equivalent to decimal 768, which has switches 3 and 4 off and switches 5-9 on.

Table 1 - FWT-300 Computer ADC Card Base Address Selection
NOTE: Addresses 000 to 0FF hex used by internal I/O

Address		DIP Switch Settings						
Dec	Hex	9	8	7	6	5	4	3
256	100	on	on	on	on	on	off	on
264	108	off	on	on	on	on	off	on
272	110	on	off	on	on	on	off	on
280	118	off	off	on	on	on	off	on
288	120	on	on	off	on	on	off	on
296	128	off	on	off	on	on	off	on
304	130	on	off	off	on	on	off	on
312	138	off	off	off	on	on	off	on
320	140	on	on	on	off	on	off	on
328	148	off	on	on	off	on	off	on
336	150	on	off	on	off	on	off	on
344	158	off	off	on	off	on	off	on
352	160	on	on	off	off	on	off	on
360	168	off	on	off	off	on	off	on
368	170	on	off	off	off	on	off	on
376	178	off	off	off	off	on	off	on
384	180	on	on	on	on	off	off	on
392	188	off	on	on	on	off	off	on
400	190	on	off	on	on	off	off	on
408	198	off	off	on	on	off	off	on
416	1A0	on	on	off	on	off	off	on
424	1A8	off	on	off	on	off	off	on
432	1B0	on	off	off	on	off	off	on
440	1B8	off	off	off	on	off	off	on
448	1C0	on	on	on	off	off	off	on
456	1C8	off	on	on	off	off	off	on
464	1D0	on	off	on	off	off	off	on
472	1D8	off	off	on	off	off	off	on
480	1E0	on	on	off	off	off	off	on
488	1E8	off	on	off	off	off	off	on
496	1F0	on	off	off	off	off	off	on
504	1F8	off	off	off	off	off	off	on
512	200	Do not use - Reserved for system						
520	208	Do not use - Reserved for system						
528	210	on	off	on	on	on	on	off
536	218	off	off	on	on	on	on	off
544	220	on	on	off	on	on	on	off
552	228	off	on	off	on	on	on	off
560	230	on	off	off	on	on	on	off
568	238	off	off	off	on	on	on	off
576	240	on	on	on	off	on	on	off
584	248	off	on	on	off	on	on	off
592	250	on	off	on	off	on	on	off
600	258	off	off	on	off	on	on	off
608	260	on	on	off	off	on	on	off
616	268	off	on	off	off	on	on	off

Address		DIP Switch Settings						
Dec	Hex	9	8	7	6	5	4	3
624	270	on	off	off	off	on	on	off
632	278	Do not use - Reserved for system						
640	280	on	on	on	on	off	on	off
648	288	off	on	on	on	off	on	off
656	290	on	off	on	on	off	on	off
664	298	off	off	on	on	off	on	off
672	2A0	on	on	off	on	off	on	off
680	2A8	off	on	off	on	off	on	off
688	2B0	on	off	off	on	off	on	off
696	2B8	off	off	off	on	off	on	off
704	2C0	on	on	on	off	off	on	off
712	2C8	off	on	on	off	off	on	off
720	2D0	on	off	on	off	off	on	off
728	2D8	off	off	on	off	off	on	off
736	2E0	on	on	off	off	off	on	off
744	2E8	off	on	off	off	off	on	off
752	2F0	on	off	off	off	off	on	off
760	2F8	Do not use - Reserved for system						
768	300 DEFAULT SETTING	on	on	on	on	on	off	off
776	308	off	on	on	on	on	off	off
784	310	on	off	on	on	on	off	off
792	318	off	off	on	on	on	off	off
800	320	Do not use - Reserved for system						
808	328	Do not use - Reserved for system						
816	330	on	off	off	on	on	off	off
824	338	off	off	off	on	on	off	off
832	340	on	on	on	off	on	off	off
840	348	off	on	on	off	on	off	off
848	350	on	off	on	off	on	off	off
856	358	off	off	on	off	on	off	off
864	360	on	on	off	off	on	off	off
872	368	off	on	off	off	on	off	off
880	370	on	off	off	off	on	off	off
888	378	Do not use - Reserved for system						
896	380	on	on	on	on	off	off	off
904	388	off	on	on	on	off	off	off
912	390	on	off	on	on	off	off	off
920	398	off	off	on	on	off	off	off
928	3A0	on	on	off	on	off	off	off
936	3A8	off	on	off	on	off	off	off
944	3B0	Do not use - Reserved for system						
952	3B8	Do not use - Reserved for system						
960	3C0	on	on	on	off	off	off	off
968	3C8	off	on	on	off	off	off	off
976	3D0	on	off	on	off	off	off	off
984	3D8	off	off	on	off	off	off	off
992	3E0	on	on	off	off	off	off	off
1000	3E8	Do not use - Reserved for system						
1008	3F0	Do not use - Reserved for system						
1016	3F8	Do not use - Reserved for system						

Lamp Replacement

The FWT-100 comes with a lamp installed and one spare lamp taped to the inside of the lamp access cover. When the lamp burns out or becomes too dim you should replace it. To replace the lamp first remove the access cover by unscrewing the black thumb screw on the back of the reader head. Remove the access cover and, from the bottom of the reader, unscrew the black thumb screw which holds the lamp in place. Disconnect the lamp from the circuit board by pulling the connector off the board. Remove the lamp and discard it. Insert the new lamp into the holder as far as it will go and tighten the thumb screw just enough to prevent the lamp from moving. Do not overtighten the screw or you may damage the lamp's housing. Attach the lamp's connector to the circuit board. Replace the access cover.

Holders

The FWT-100 comes with two holders, the film holder and the neutral density filter holder, which has a wider slot than the film holder. To remove a holder unscrew the thumb-screw. A spring will push the holder up as you unscrew the screw. You may need to apply a little downward force on the body of the holder to ease pressure. To insert a holder, drop it into the slot and press it down while screwing the screw in. Make sure that the thumb screw is securely fastened and that the holder is even with the block surrounding it. If it is not secured down completely the computer will not be able to detect accurately whether there is film present in the holder. Both of these holders may be taken apart to clean the inside of the holder.

Software Installation

As with most software it is recommended that you make a backup copy of the original disk and store the original in a safe place. Use the DOS DISKCOPY command to make a backup copy. Follow the instructions for DISKCOPY in your DOS manual to make the copy.

The next step is to make a working copy of the program. The working copy may be on a floppy disk or in a directory on a hard disk. It should contain these three files: FWT100.EXE, FWT100.CFG and FWT100.CAL. The first is the executable program, which may be placed in the current directory or in a directory included in the PATH environment variable. The second is the configuration file and the last is calibration information which will calculate absorbed dose based on net optical density and thickness of the radiachromic detector. These two files should be in the directory from which you start the program.

NOTE: The supplied FWT100.CAL file is only a sample to show how such a file is set up (see below for details of how this file is set up). It should NOT be used for determining actual absorbed dose.

CONFIGURATION FILE FWT100.CFG:

The configuration file FWT100.CFG is an ASCII text file. It should be modified using an ASCII text editor or the ASCII mode (sometimes called non-document mode) of a word-processing program. This file contains the default values of many parameters used by the program. The following describes the data included in this file and the order in which the data should be specified.

Port Batch StartId Thk NormThk Wl UseDefBkg MeasurePost Prec

The parameters are:

Port - Hexadecimal base address for the ADC card.
Batch - Batch number of the film; this determines which calibration curve will be used to assign a dose.
StartId - ID for the first dosimeter.
Thk - Average thickness of the film being used.
NormThk - The thickness to which net optical densities are normalized.
Wl - Starting wavelength. Specify 600 or 510.
UseDefBkg - Non-zero integer if the default bkg should be used for the detectors.
MeasurePost - Non-zero integer if the post-irradiation optical density is to be measured.
Prec - An integer value greater than or equal to 0 indicating how many decimal places should be used in reporting doses.

The entries must be separated by at least one space and the parameters may be on more than one line. The Batch and StartingId parameters are alphanumeric strings. They may contain any sequence of printable characters (spaces excluded) and may have up to 10 characters each.

EXAMPLE: The sample configuration file contains the line:

300 8W9 001 47.5 50.8 600 0 1 2

This indicates that the ADC board is at address 300 (hexadecimal), which is the factory setting. The current film is from batch 8W9 and the first dosimeter's number is 001. The average thickness of the film currently being used is 47.5 microns and is being normalized to 50.8 micron film

(the calibration data was normalized to 2 mil = 50.8 micron film). The program will start measuring on the 600 nm wavelength and will not use the default background. It will measure post irradiation optical densities and will report doses to two decimal places, such as 2.48.

CALIBRATION FILE FWT100.CAL:

The calibration file FWT100.CAL is also an ASCII text file and should be modified using an ASCII text editor or the non-document mode of a word-processor. This file contains information pertaining to the calibration curve you develop for the film. See below for the data included in this file and Table 2 for an explanation of the type of curves you can specify for the calibration. Each line of the calibration file should have the following parameters:

Wl CalibId Batch Bkg Min Max Eqn p_0 p_1 p_2 p_3 p_4 p_5

where

Wl - Wavelength to which this calibration applies.
CalibId - Calibration identification.
Batch - Batch to which this calibration applies.
Bkg - Default background optical density.
Min - Minimum normalized specific optical density to which this calibration applies.
Max - Maximum normalized specific optical density to which this calibration applies.
Eqn - Type of equation the calibration uses (see Table 2). This is a single character.
$p_0 ... p_1$ *- The six parameters of the calibration curve. Note that all six parameters must be specified even if the curve takes less than six parameters (such as the power series).*

EXAMPLE: The sample FWT100.CAL file contains the data:

510 Sample 8W9 .055 .03 2.0 3 .05 .482 .2 2.27 .4 5.32
600 Sample 8W9 .060 .03 2.0 3 .3 .338 .8 1.06 1.5 2.22

This indicates that there are two calibrations, one for 510 nm and the other for 600 nm, and that both are called Sample and are for batch 8W9. The default background for the 510 wavelength is 0.055 and for the 600 wavelength is 0.060. The calibration for both wavelengths is considered good for normalized specific optical densities in the range 0.03 to 2.0 and both use 3-point Lagrangian interpolation. The remaining six numbers on both lines are the six parameters. For the 3-point Lagrangian interpolation these parameters represent three (SOD, dose) points of the calibration curve.

Equation type	Single character	Algebraic Representation
Power Series	L	$p0 * SOD^{p1}$ NOTE: the parameters are typically determined from a linear regression of log(SOD) vs. log(dose)
Polynomial	P	$p0 + p1 * SOD + p2 * SOD^2 + ... + p5 * SOD^5$
Exponential	E	p0 * exp(p1 * SOD)
Interpolation (Linear)	I	$p1 + \frac{SOD - p0}{p2 - p0}(p3-p1)$, where (p0, p1) = first (SOD, dose) pair, and (p2, p3) = second (SOD, dose) pair
3-point Lagrangian Interpolation	3	$\frac{(SOD-p2)(SOD-p4)}{(p0-p2)(p0-p4)} p1 + \frac{(SOD-p0)(SOD-p4)}{(p2-p0)(p2-p4)} p3 + \frac{(SOD-p0)(SOD-p2)}{(p4-p0)(p4-p2)} p5$ where (p0, p1), (p2, p3) and (p4, p5) are three (SOD, dose) pairs

In these equations, SOD refers to the specific optical density of the detector. p0...p5 refer to parameters of the equation as they are to be specified in the calibration file FWT100.CAL.

RUNNING THE FWT100 PROGRAM:

To run the FWT100 program the executable file FWT100.EXE must be in the current directory or in a directory specified in the path command. The configuration file FWT100.CFG must be in the current directory. The calibration file FWT100.CAL should be in the current directory; if it is not, the program will still run but it will not assign doses. To start the program type FWT100 from the DOS prompt. There are several command line options which may specified to override the default values and the values in the configuration file. These options include the following:

-istart_id Sets the starting id for the detectors.
-xaddress Hexadecimal address of the ADC card.
-daddress Decimal address of the ADC card.
-b Measure the background of the detectors.
-p Measure the post-irradiation optical density.
-tthk Set the default film thickness to thk.
-wwl Set the starting wavelength to wl (510 or 600).
-f Turns off film present detection.

The leading '-' and first letter are the command line switches. If the switch takes a parameter (such as thk) it should immediately follow the first letter; there should not be a space between the switch character and the parameter.

The software is menu driven with some options having hotkeys. The options are listed below, grouped by the main menu category. To activate one of the main menus simply press the first letter of the desired menu (e.g. 'F' for the file menu). Options within a menu are typically chosen by pressing the highlighted letter of that option or by moving the selection bar to the option and pressing the ENTER key.

FILE Menu

Load - Loads a previously saved file. After loading a file you are queried about what type of readings to take.

Save - Saves a file to disk.

Change Dir - Allows you to change the current working drive and/or directory.

Print Data - Prints the data to a file or to the printer. The default file is PRN which should direct the data to the printer.

OS Shell - Shells from the program to DOS while keeping the program and data loaded.

Quit - Exit the program.

EDIT Menu

Opens up an editing window for the current dosimeter (the entry tagged on the left side of the screen by an inverse video '>'). See Table 3 for a list of commands used in editing.

Table 3 - Input field Editing Keys

KEY	ACTION
Left Arrow	cursor left
Right Arrow	cursor right
Up Arrow	cursor up
Down Arrow	cursor down
<Ctrl> Left Arrow	word left
<Ctrl> Right Arrow	word right
Tab	field right
Shift Tab	field left
Enter	process field
<Ctrl> Enter	process all fields
Decimal (.)	move to the right side of decimal point
Home	beginning of field
End	end of line /end of field
<Ctrl> Home	beginning of first field
<Ctrl> End	end of last field
Ins	tggle field insert mode
Del	delete character left
Backspace	delete character left
<Ctrl> R	restores field to original contenet
<Ctrl> T	delete word right
<Ctrl> U	delete to end of field
<Ctrl> Y	delete to end of last field
Esc	abort data entry

OPTIONS Menu

Neutral Density Filter Check - This option guides you through an optical density check using the FWT-160 standard neutral density filter set. The results of this check are displayed on the screen as well as being appended to the file FILTERS.LOG in ASCII format.

Readings - Lets you specify the type of readings to be done.

These include:

Background Readings - For reading background OD.

Normal Final Readings - For reading the post-irradiation OD of the Radiachromic Detectors. Choosing this option will also open a window requesting whether the background should be assigned a default value. If a calibration exists for the proper batch then a dose will be calculated after the OD is read.

Calibration Final Readings - Takes the post-irradiation OD for a calibration set. This will prevent the program from calculating a dose for the dosimeter.

SETUP Menu

Zero Reader - The program automaticallly zeroes on a regular basis, so this option should rarely be needed. It is provided for the instance where zero drift may occur without detection (e.g. when in one of the menus or in the DOS shell for an extended period of time). This will zero the reader on the current wavelength. This

option should be chosen only when the film holder is empty. This may be activated by pressing 'Z' when reading optical densities.

Wavelength - This option lets you choose either the 510 nm or the 600 nm wavelength for measuring optical densities. This may be activated by pressing 'W' when reading optical densities.

Accepting an OD Reading

The optical density reading is automatically accepted after about two seconds, unless the -f command line option was chosen when running the program. Additionally, pressing the ENTER key or depressing the button on the reader head will accept to current OD reading for the current detector. The current detector is indicated by an inverse video '>' on the left side of the screen. You may change the current detector by using the UP ARROW and DOWN ARROW cursor keys to move to the desired detector. After an OD reading is accepted the next detector will become the current detector. If there is no next detector then one will be created and assigned the next sequential ID. ID's are incremented 'odometer' style, with 'z', 'Z' and '9' advancing to 'a', 'A' and '0', respectively. Thus 'AZ-9.z' would advance to 'BA-0.a'.

ROUTINE DOSE MEASUREMENTS

For routine dose measurements the following are the typical steps which may be taken.

1. Make sure the reader head is connected to the computer and that the computer is turned on. Switch to the directory from which you want to run the program and type FWT100 at the DOS prompt. Include any appropriate command line switches and press ENTER. The program should load and then take a few seconds to initialize. The current optical density is displayed in large digits in the lower left corner of the screen. The data is displayed in the middle window.

2. Load an existing data file, if desired, by choosing the File Load option. A file selection window will open. Use the cursor keys to highlight the desired file, then press ENTER.

3. If the wavelength is incorrect, change it by choosing the Setup Wavelength option. The current wavelength is displayed on the screen to the right of the large OD display.

4. Make sure the reader is zeroed. The large OD display may fluctuate between + or - .001; this is normal.

5. Insert a dosimeter in the slot in the film holder. Unless the -f command line option was chosen, the read head will beep after about 2-3 seconds, indicating that the OD reading has been accepted for that dosimeter. You may also press the ENTER key or the button on the read head to accept a reading (this is required if the -f command line option was chosen). Repeat this step for each dosimeter, periodically checking the zero. You should periodically save the data (using the File Save option) to protect against loss of readings.

6. When all dosimeters have been read the data may be saved on disk or printed out. These are the File Save and the File Print options, respectively.

7. To terminate the reading session, exit the program using the File Quit option or using the ALT-X hotkey.