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DOSE-X
Reference Guide

DOSIMETRY

DOSE-X Reference Guide

Notice

This document is an integral part of the DOSE-X system and should always be kept at hand. If the document is missing, immediately contact the IBA Dosimetry GmbH for a copy.

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About this Reference Guide

The *DOSE-X Reference Guide* is a supplement to the *DOSE-X Instructions for Use*.

It contains information on the algorithms used for measurements, device troubleshooting, and country specific RF symbols. For general information, including the health and safety precautions, and detailed functionality descriptions, please refer to *DOSE-X Instructions for Use*.

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1. Algorithms

1.1. Temperature and Pressure Correction

The sensitivity of an ionization chamber is determined by the number of atoms in the active volume which are available for ionization. In the case of sealed chambers, this number is (at least in medium - term) constant, in the case of vented chambers it depends on air pressure and temperature. Therefore, the measured absolute dose value delivered by vented chambers must be corrected to compensate deviations due to the current air pressure and temperature conditions. Since there are worldwide two different reference temperatures in use, the applicable reference temperature is stored together with the chamber data. The correction is carried out according to the following equation:

$$k_{\mathrm{Tp}} = \frac{p_0 T}{p T_0} = \frac{p_0(273.15\mathrm{K} + \vartheta)}{p_0(273.15\mathrm{K} + \vartheta_0)}$$

k_{Tp} = correction factor for temperature and pressure

p = actual air pressure in Pa

p_0 = reference pressure in Pa

T = actual temperature in K

T_0 = reference temperature in K

ϑ = actual air temparature in °C

ϑ_0 = reference air temperature in °C

1.2. Application of Calibration and Correction Factors

Correction factors are usually the result of a multiplication of several single factors, each of which is used to correct the measured dose value for a specific detail. The user factor can be entered directly into the DOSE-X.

The factors are applied according to the following equation:

$$D = Q\, N_{\mathrm{D,W}}\, k_{\mathrm{Q}}\, k_{\mathrm{Tp}}\, k_{\mathrm{S}}\, k_{\mathrm{pol}}\, k_{\mathrm{user}}\,,\ \dot{D} = I\, N_{\mathrm{D,W}}\, k_{\mathrm{Q}}\, k_{\mathrm{Tp}}\, k_{\mathrm{S}}\, k_{\mathrm{pol}}\, k_{\mathrm{user}}$$

D = Dose reading

$\dot{D}$ = Dose rate reading

Q = Charge reading

I = Dose rate reading

$N_{\mathrm{D,W}}$ = calibration factor

k_{Q} = energy

k_{Tp} = temperature and pressure

k_{S} = ionization

k_{pol} = polarity

k_{user} = user correction

Dose and Dose Rate

Dose and dose rate are determined through measured charge and current according to the following equations:

$$D_{\text{act}} = Q_{\text{act}} * CF_{corr}$$

$$D'_{\text{act}} = I_{\text{act}} * CF_{corr}$$

CF_{corr} = conversion / correction factor

D_{act} = actual dose

D'_{act} = actual dose rate

I_{act} = actual current

Q_{act} = actual charge

1.3. Background Compensation

The background definition procedure measures all present leakage currents and stores the measured value. This is then subtracted from all subsequent dose measurements. The duration of the background measurement is set to 60 second by default for all three input sensitivity ranges and it is adjustable.

It is possible to disable the background compensation. The measured background value remains in the memory, and the subtraction can later be activated again. The background value is shown in the Background pop up menu (Tap and hold the **BACKGROUND** button)

Note: With the exception of special measurement tasks, always ensure that radiation is switched off before starting the background measurement.

$$I_{\text{bkg}} = \frac{Q_{\text{bkg}}}{t_{\text{bkg}}}$$

I_{bkg} = background current, as displayed in the background pop-up menu

Q_{bkg} = leakage charge collected during background measurement

t_{bkg} = duration of background measurement

1.4. Current Measurement

The measuring channel is constantly collecting electrical current samples [I_{meas}] , with a sampling rate of 1kHz. This value will be further compensated with background current values if the background subtraction is enabled. The value showing on the main screen during the measurement is a sliding average of current and, after the measurement, the average over the complete measurement. The measurement value during the measurement will be refreshed every 0.5 second. The current value displayed once the measurement is finished is the average current over the complete measurement duration.

1.5. Charge Measurement

While a measurement is ongoing, the background subtracted current is integrated over the measurement duration. The result of this integration is the measured charge *Q*. The display of the measured charge is updated every 0.5 seconds.

$$Q = Q_0 + \int_{t_0}^{t_0 + t_{meas}} I_{meas} - I_{bkg} t$$

$$I = \frac{Q}{t_0 + t_{meas}}$$

Q_0: charge at the beginning of a measurement, Q_0 = 0 when automatic reset is enabled (default), or the value of the previous measurement when automatic reset is disabled.

t_{meas}: the measurement time for one measurement

t_0: initial measurement time, t_0 = 0 when automatic zeroing is enabled (default) the accumulated measurement time of the previous measurement when automatic reset is disabled

I_{meas}: raw measured input current on the measurement channel

I_{bkg}: calculated background current

Initial Dose (Radioactive Check Source)

An initial dose measurement is performed when measuring a reference dose value with a detector for the first time, using a radioactive check source. This reference dose is determined in the way that it is always related to January 1st, 1970, 00:00 hours (midnight). Due to this convention, a separate storage of date and time together with the reference dose measurement becomes unnecessary.

$$D_0 = D_{meas} * e^{0.69315 * \frac{t_{meas} - t_0}{T_{1/2}}}$$

D_0 = dose at reference time t_0

D_{meas} = measured dose

t_{meas} = time (moment) of the measurement

t_0 = reference time: January 1st, 1970, 00:00 hours (midnight)

$T_{1/2}$ = half life of the isotope used in the radioactive check source.

1.6. Average Dose Rate

The average dose rate, *i.e.*, the average of multiple measuements taken over a certain period of time, is calculated according to the following equation:

$$D'_{avg} = \frac{D_{meas}}{t_{meas}}$$

D'_{avg} = average dose rate

D_{meas} = measured dose

t_{meas} = measuring time

2. DOSE-X API Documentation

2.1. Availability

To access the device remotely the item `Remote Access` has to be initially enabled on the touchscreen UI using **System Settings** > **Network** and turning on **Allow remote control**.

- The device exposes a WebUI on the default http[s] ports 80 and 443.
- The WebUI uses the API exposed as websocket on port 8081 (ws) and 8083 (wss).
- The device is discoverable using zeroconf providing the services `_ibadose-x._tcp` and `_ibadose-x-tls._tcp`. For that a mdns service is running on port 5353/udp.

2.2. General Message Structure

1. The server exposes a websocket API.
2. The message format follows a simple format which is *json* based.
3. Every message has a mandatory field `cmd` to identify its purpose often followd by a `values` field.

2.3. Authentication

There are two access levels available to the user:

- User (no authentication needed)
- Admin

2.3.1. Sessions

The User session ends when the websocket connection is closed.

2.3.2. Control Token

The User session ends when the websocket connection is closed.

```
# Req
{"cmd": "control", "value": "request"}

# Resp
{"cmd":"remote_status","values":{"blocked":false,"control":true}}
```

2.3.3. Admin authentication

The Admin password is set by the user on initial setup at the customer. It is required to access certain functionality like editing libraries or changing network configurations.

```
# Req
{ "cmd": "login", "password": "fooobar" }

# Resp success
{ "cmd": "login", "result": true }

# Resp error
{ "cmd": "login", "result": false }
```

2.3.4. Resetting the Admin password

The Admin Password can be reset by sending the `recovery_token` instead of the password.

The token is generated using the following algorithm and requires the knowledge of the seed.

```
base64.b64encode(hashlib.sha512(seed+b'recovery').digest())[0:10].

# Req
{ "cmd": "login", "password": "recovery_token" }

# Resp
{ "cmd": "value_update", "values": { "adminPasswordIsSet": false } }
```

2.4. Configuration Items

The central concept of the API are Configuration Items. Most Settings and States are represented using these commands.

Reading Configuration Items:

```
# Resp
{ "cmd": "get_values",
"values": [ "key1", "key2", ...]
}

# Resp
{ "cmd":"value_init",
"values": {"key1": "value",
"key2": {"value": 1, "unit": "s"},
...}
}
```

Setting Configuration Items:

```
# Req
{ "cmd": "change_values",
"values": [ "key1": "value",
"key2": "value",
...}
}
```

```
# Req
{ "cmd": "value_update",
"values": [ "key1": "value",
"key2": "value",
...}
}
```

- The calling client always gets a `value_update` with the updated values.
- Unknown keys or illegal values are silently ignored.
- `value_updates` might be broadcasted by the system when values change.

2.5. Functional Blocks

Functional Blocks are commands that are connected.

2.5.1. Properties of the Firmware

All fields are read-only.

ID	Datatype	Description
firmwareVersion	String	Version of the installed FW
deviceInfo	String	Content for DeviceInfo Page

2.5.2. Device FRAM

ID	Datatype	Read	Description
deviceType	string	User	Type of the Device, should currently always be `DoseX`
serialNumber	string	User	serial number as defined by production
hardwareVersion	string	User	Version of the HW, usually `1.0`
productionDate	int (seconds)	User	The Date of Production as timestamp in seconds

2.5.3. Measurement

The DOSE-X has a constantly measuring electrometer. Therefore, the device is permanently calculating the average current. Measurements are using the integrator to integrate a number of currents.

2.5.3.1 Peak Value

The API is sending the measured Peak Current every 200ms.

```
{"cmd":"measurement_data", "values":{"peakValue": 3.051757735406113e-10}}
```

2.5.3.2 Measurement

Measurement Related Properties

Properties changeable when token was acquired.

ID	Datatype	Allowed Values	Description
measurementMode	string	`dose`, `charge`	Mode that Integrator uses
measurementStartType	string	`manual`, `timer`, `trigger`	How the integrator is started/stopped
measurementTimer	int (milliseconds)	--	Duration of measurement in mode `timer`
autoReset	bool	--	Reset integrator on start of measurement
backgroundSubtractionEnabled	bool	--	Subtracts Background if available
backgroundMeasurementTime	int (milliseconds)	--	Runtime of a background measurement
measurementComment	string	--	Comment to be stored with the Result
sensitivity	string	`low`, `mid`, `high`, `auto`	The sensitivity range to be used. When `auto` is set the range selection is performed.
highVoltageEnabled	bool	--	Enable/Disable the HV Module
biasVoltage	ValueUnit	`{ "value": <+/- [50..550]>, "unit": "V" }`	HV to be generated by the device.
electrometerInput	string	`floated`, `grounded`	Mode of the HV Module
beamOnTime	ValueUnit	`{ "value": >0, "unit": "s" }`	Time the threshold needs to be exceeded to consider the Beam On

ID	Datatype	Allowed Values	Description
beamOffTime	ValueUnit	`{ "value": >0, "unit": "s" }`	Time the threshold needs to be exceeded to consider the Beam Off
preTriggerTime	ValueUnit	`{ "value": >0, "unit": "s" }`	Duration while values are integrated before the beam was considered On
postTriggerTime	ValueUnit	`{ "value": >0, "unit": "s" }`	Duration while values are integrated after the beam was considered Off

Read-only properties:

ID	Data type	Description
measurementRunning	bool	--
backgroundCorrectionTimeStamp	string	Formatted timestamp when the Background was measured
beamOn Threshold	string	Threshold used in trigger mode formatted as 'A'

Start a Measurement

Start a Measurement. If `autoReset` is set to false the integrator will start with the result of the previous measurement.

```
-> {"cmd": "measurement", "value": "start"}
```

Measurement Data

When a Measurement is running an update is sent every 500ms. The data may contain additional fields for UI purposes which can be ignored.

Measurement Data in Charge Mode:

```
{"cmd":"measurement_data",
"values":
{ "charge":-2.3780011453311807e-09,
"current":-2.698900403281331e-10,
"measurementRunning":true,
"measuringTime":8811
}
}
```

Stop a Measurement

This always stops the current Measurement. In Manual-Mode this is the only way to stop it.

```
-> {"cmd": "measurement", "value": "stop"}
```

Reset Integrator

Reset the Data of the last Measurement. If `autoReset` is set to false this command has to be used to Zero the integrator.

```
-> {"cmd": "measurement", "value": "reset"}
```

Background Measurement

Trigger a Background Measurement. The Measurement is running for the configured 'backgroundmeasurementTime'.

This behaves just like a normal measurement with two differences:

1. No Background is subtracted
2. The resulting Average Current is used as Background for the selected Range

```
-> {"cmd": "measurement", "value": "start_background"}
```

Libraries

The History and the Libraries behave similar. Most Noticable difference is that the user can't add or edit entries in the Measurement History.

History and Libraries can be read by requesting the according Configuration Item:

1. No Background is subtracted
2. The resulting Average Current is used as Background for the selected Range

- `` `measurementHistory` ``
- `` `detector` ``
- `` `machine` ``

Detector Library

Removing a measurement requires an array of ids send.

```
```json
# Req
{"cmd":"delete_measurement","values":[419]}

# Resp
{"cmd":"value_update","values":{"measurementHistory":[...]}
}
```
```

Machine Library

To edit a Library item the `` `library_update` `` command is used.

The Client can either request a template entry by using `` `get_new_detector`/`get_new_machine` `` or by editing an existing entry. It is highly recommended to use the json received from the api instead of manually composing an entry.

To remove an entry the `` `library_remove` `` is used.

2.6. List of Configuration Items

Name	Read	Write	Control	Persist
adminPasswordIsSet	User	--	false	false
allowRemoteControl	User	Admin	false	true
audioAlertMuted	User	--	false	false
audioMeasurementMuted	User	User	false	true
audioMeasurementVolume	User	User	false	true
audioTouchMuted	User	User	false	true
audioTouchVolume	User	User	false	true
autoLogOutTimeSpan	User	Admin	false	false
autoReset	User	User	true	false
averageValue	User	--	false	false
background	User	--	false	false
backgroundCorrectionTimeStamp	User	--	true	false
backgroundMeasurementTime	User	User	true	false
backgroundSubtractionEnabled	User	User	false	false
beamOffTime	User	Admin	false	false
beamOnThreshold	User	--	false	false
beamOnTime	User	Admin	false	false
biasTest	User	--	true	false
biasVoltage	User	User	false	false
brightness	User	User	false	true
currentDate	User	--	false	false
currentTime	User	--	false	false
currentTimestamp	User	Admin	false	false
dateFormats	User	Admin	false	false
detector	User	User	false	false
deviceInfo	User	--	false	false
deviceReady	User	--	false	false
doseLanguage	User	Admin	false	true
doseTheme	User	User	false	true
electrometerInput	User	User	false	false
ethernet	User	--	false	false
firmwareVersion	User	--	false	false
friendlyName	User	Admin	false	true
highSensitivity	User	--	false	false

Name	Read	Write	Control	Persist
highVoltageEnabled	User	User	true	false
hostName	User	Admin	false	false
isDefaultCertificate	User	--	false	true
ktp	User	--	false	false
ktpEnabled	User	User	false	false
leakageTest	User	--	false	false
licenses	User	--	false	false
lowSensitivity	User	--	false	false
machine	User	User	false	false
mainValue	User	--	false	false
measurementComment	User	User	true	false
measurementHistory	User	--	false	false
measurementMode	User	User	true	false
measurementRunning	User	--	false	false
measurementTimer	User	User	true	false
measurementTimerMode	User	User	true	false
mediumSensitivity	User	--	false	false
networkInfos	User	--	false	false
postTriggerTime	User	Admin	false	false
pressure	User	User	false	false
pressureUnit	User	Admin	false	true
preTriggerTime	User	Admin	false	false
randomizer.automatic	User	User	false	false
randomizer.params	User	User	false	false
releaseActiveControlTimeSpan	User	Admin	false	false
screenSaverTimeout	User	User	false	true
selectedEnergyKqId	User	User	false	false
selectedIonizationId	User	User	false	false
selectedPolarityCorrectionId	User	User	false	false
selectedUserCorrectionId	User	User	false	false
sensitivity	User	User	false	false
temperature	User	User	false	false
temperatureUnit	User	Admin	false	true
testRunning	User	--	false	false
timeFormats	User	Admin	false	true
timeZones	User	Admin	false	true

Name	Read	Write	Control	Persist
tlsLicenseInfo	User	--	false	false
userCalibrationApplyFactors	User	Admin	true	true
userCalibrationHighSensitivityFactor	User	Admin	true	true
userCalibrationLowSensitivityFactor	User	Admin	true	true
userCalibrationMediumSensitivityFactor	User	Admin	true	true
useTimeFromNetwork	User	Admin	false	true
wlanEnabled	User	Admin	false	true
wlanNetworks	User	--	false	false

2.7. List of Known Commands

Name	Permission
automatic_range_detection	User
change_pass	User
change_values	User
control	User
delete_measurement	Admin
diagnostic	User
export	User
firehose	User
get_alarms	User
get_firmware_file_info	Admin
get_new_detector	User
get_new_doserate	User
get_new_kq_correction	User
get_new_machine	User
get_usb_content	Admin
get_values	User
get_values_detailed	User
identify	User
library_remove	Admin
library_update	Admin
login	User
logout	User
measurement	User
notification_remove	User
reset_factory	Admin
reset_units	User
start_update_or_import	Admin

3. Troubleshooting

Questionable Readings

If readings are off, determine if there is any leakage from the DOSE-X or ionization chamber it is advised to check the system and perform the self-test function (see *Section 3.2.1 Diagnostic Functions* in the *DOSE-X Instructions for Use*).

No Response

If the DOSE-X does not respond to any commands from the touch screen for more than 10 seconds, press and hold the **Power** button on the front of the device for at least 6 seconds. Press the **Power** button again to restart the device.

If the issue is not resolved, use the **Power** switch on the back to power cycle the device.

Electromagnetic or Other Interference

If the DOSE-X causes or is affected by interference with other equipment, try to correct the interference by performing the following:

- Increase separation between equipment.
- Connect the power supply power cord into a different grounded AC outlet or into a circuit controlled by a different circuit breaker.
- Consult IBA Dosimetry.

Cannot detect USB flash drive

The following error may occur when searching for the USB flash drive:

Some flash drives may take up to 15 seconds to register with the DOSE-X FW. Ensure the flash drive is connected properly and wait a brief moment before attempting to perform the update again.

Try to unplug and re-plug the flash drive from the DOSE-X. If the flash drive is plugged into the DOSE-X before the device is turned on, it may not be recognized by the FW.

4. Country Specific RF Symbols

Country	Symbol
Argentina	<table><tr><td></td><td>CNC marking</td></tr><tr><td>Intel</td><td>C-20821</td></tr></table> CNC COMISIÓN NACIONAL DE COMUNICACIONES
Australia	
Botswana	BOCRA REGISTERED No : BOCRA/TA/2020/3604
Brazil	Module Marking: Anatel: 05831-17-04423 Host Labeling:  **05831-17-04423**
Canada	**IC: 1000M-9260NG** **CAN ICES-001 [A] / NUM-001 [A]**
China	**9260NGW => CMIIT ID: 2017AJ4605 [M]**
Comoros	**ANRTIC 17/016/AGR/GF/DG**
Djibouti	AGREE PAR LE MCPT (REPUBLIQUE DE DJIBOUTI) Numéro d'agrément: 612/dpt/2017 Date d'agrément: 13/08/2017
Ghana	**NCA APPROVED: 1R3-1M-7E1-0D1**
India	**9260NGW => NR-ETA/6865 and NR-ETA/6864**

Country	Symbol
Indonesia	 **70981/SDPPI/2020** **7965**
Japan	
Jordan	**TRC/16/7286/2020**
Mauritania	*Agrée par l'ARE Mauritanie* *Numéro d'agrément : 0427/ARE/2017* *Date d'agrément : 27/07/2017*
Mexico	**RCPIN9517-1585**
Moldova	
Morocco	AGREE PAR L'ANRT MAROC Numéro d'agrément : MR 14428 ANRT 2017 Date d'agrément : 27/07/2017
Nigeria	**Connection and use of this communications equipment is permitted by the Nigerian Communications Commission**
Oman	Applicant n°D080001 Approval n° : TRA/TA-R/4583/17

Country	Symbol
Pakistan	Approved by PTA: 9.62/2020
Paraguay	NR 2017-09-I-0000330
Serbia	И011 17
Singapore	Complies with IMDA Standards (DA108442) *This system contanis the following wireless module: Intel 9260NGW*
South Africa	**TA-2017/1348** APPROVED

Country	Symbol
South Korea	MSIP-CRM-INT-9260NGW 1.상 호 명: INTEL CORPORATION 2.기자재의 명칭 (모델명): 특정소출력 무선기기(무선랜을 포함한 무선접속시스템용 무선기기) 9260NGW 3.제 조 시 기 : 2017/07 4.제 조 자 /제 조 국 : INTEL CORPORATION / China
Taiwan	**9260NGW** CCAH17LP2590T7
United Arab Emirates (UAE)	TDRA هيئة تنظيم الاتصالات والحكومة الرقمية TELECOMMUNICATIONS AND DIGITAL GOVERNMENT REGULATORY AUTHORITY **TDRA - UNITED ARAB Emirates** **Mode Dealer ID Name:** 0018841/09 **TARTTE:** ER57060/17 **Model Name:** 9260NGW **Product Type:** Wireless LANs (WLANs) or Wi-Fi
United Kingdom (UK)	UK CA
Unites States of America (USA)	**FCC ID: PD99260NG**
Ukraine	UA.TR.028
Zambia	ZICTA ZMB / ZICTA / TA / 2017 / 8 / 4

5. Technical Support

5.1. Contacts for Technical Support

If you need technical support, please contact the local IBA Dosimetry GmbH representative first. If you need any further assistance, please contact:

USA, Canada, Latin America	Europe, Middle East, Africa	Asia Pacific
Phone: +1 786 288 0369	Phone: +49 9128 607 38	Phone: +65 3129 2472
service-usa@iba-group.com	service-emea@iba-group.com	service-apac@iba-group.com

5.2. Reporting Complaints and Incidents

Reporting Complaints

The Quality Management System of IBA Dosimetry GmbH includes a routine to handle any reported complaints.

All complaints about the product should be reported to any representative of IBA Dosimetry GmbH or directly to the technical support, see the contact information in the above section.

Reporting Serious Incidents

Any serious incident that has occurred in relation to the device should be reported to the manufacturer and the competent authority of the Member State in which the user and / or patient is established.

5.3. Returning Device for Repair

Procedure for shipping the device to the factory for repair:

- Contact your local IBA Dosimetry GmbH representative first to get support for the shipment.
- The Service personnel will generate an RMA (Return Material Authorization) number. You will receive an *RMA Form* with the RMA number and provided information by e-mail.
- Place the *RMA Form* into the package and ship the device to the address below:

  Service Department, IBA Dosimetry GmbH

  Bahnhofstrasse 5

  DE-90592 Schwarzenbruck

  Germany