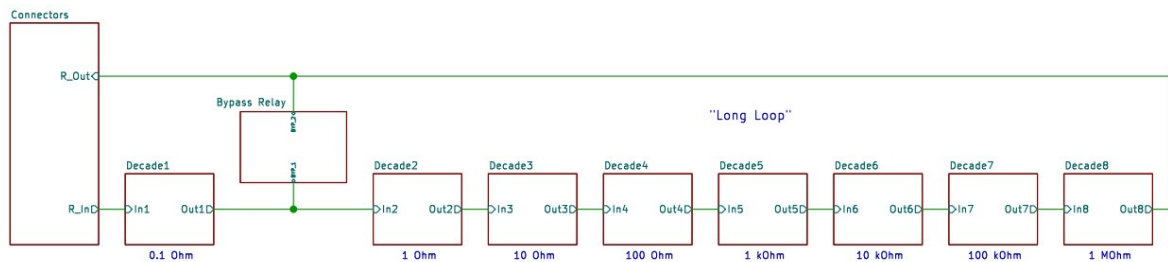


RDEC7 Manual

RDEC7 is a resistor decade box which covers 8 decades from 0.1 Ohm to 10MOhm.

Theory of Operation



Topology

Large resistance values are set using the “long loop” which includes all 8 decades. For small resistances decades 2-8 are shorted by the bypass relay, creating the “short loop”. This reduces the effects of parasitic resistances of traces and relay contacts. The firmware takes care of setting all relays correctly depending on the set resistance value.

Manual Operation



Main Screen

To set a resistance tap on the number and enter the desired value in the Resistance Editor screen.



Resistance Editor

Remote Control

RDEC7 can be remote controlled via its USB interface. To the host it presents itself as a composite device with a USBTMC and a CDC (serial) interface.

CDC (serial) communication

These are the steps to get started with serial communication:

- Find the serial port of the device. On Windows you can open Device Manager, observe the list of serial devices and see which one pops up when you plug in the device to the USB port.
- Open your favourite terminal program (e.g. Tera Term or Hercules) and open a session to this port (parameters no not care).
- Type in *IDN? and press Return
- You should now see a reply like "RDEC7-895909,1.3.1" with the device's serial number and the firmware version

USBTMC communication

- To communicate via USBTMC you need a Visa library. Install a Visa library from one of the manufacturers e.g. from [Rohde&Schwarz](#) or [NI](#) .
- If you have the R&S Visa: Open RsVisaTester (Tester64) and enter the device's Visa resource string into the Resource field. (You can find the resource string on the device's USB screen.) Alternatively use the Find Resource function on RsVisaTester to get its resource string.
- Click Connect, enter *IDN? into the command field and click Query.
- You should now see a reply like "RDEC7-895909,1.3.1" with the device's serial number and the firmware version
- If you are using the NI Visa: NI-MAX has functions similar to the ones described here.

Calibration

The device can be calibrated in two ways.

Method 1, Simple Calibration

This calibration requires only 3 values:

- The resistance of the "long loop"
- The resistance of the "short loop".
- The resistance value of a relay contact pair.

Via remote control

1. Send *ADJustment:LLOop:CLOSe* to close the "long loop".
2. Measure the resistance <R> with a multimeter
3. Send *ADJustment:LLOop:RESistance* <R> to update the calibration value.
4. Send *SOURce:RESistance 0* to close the "short loop".
5. Measure the resistance <R> with a multimeter
6. Send *ADJustment:SLOop:RESistance* <R> to update the calibration value.
7. Optionally send *ADJustment:RELAy:RESistance* <R> where <R> is the resistance of a contact pair ($\frac{1}{2}$ of a single contact resistance)

8. Send *ADJustment:SAVe* to save the new calibration values.

Using the GUI

1. Open the menu and select *Calibrate*
2. Connect an ohmmeter to the terminals and continue to the next screen
3. On screen Calibrate2 open the long loop and read the resistance on your meter
4. Enter this value as Rll
5. Continue to the next screen
6. On screen Calibrate3 set 0 Ohm and read the resistance on your meter
7. Enter this value as Rsl
8. Continue to the next screen
9. Enter the value of Rrelay ($\frac{1}{2}$ the datasheet contact resistance or measured value) as Rrelay.
10. Save adjustment

Method 2, Stage Calibration

This is a more elaborate calibration which significantly improves accuracy for small resistances. It takes a measurement for each individual relay stage up to 50 Ohm. This method requires that you can control the device remotely (see above).

Use Python skript *AdjustStageResistances* in the download package to perform this calibration. You need a multimeter with Visa remote control for this skript to work.

Limits

To prevent inadvertently setting a resistance which may damage a connected device or the device itself the firmware includes a limiting function.

```
[ :SOURce]:LIMits:ENABle[:STATe]?  
[:SOURce]:LIMits:LOWer?  
[:SOURce]:LIMits:UPPer?
```

For safety reasons these three parameters are not affected by a *RST or reset via the GUI..

Registration

The RDEC7 firmware has a time limitation. After 30 minutes hardware settings are no longer possible and you have to restart the firmware to continue. This limitation can be removed by entering a registration key. To enter the key use either command *SYSTem:REGistration:KEY* or enter it manually on the Registration screen. The key can be obtained by sending the device type (RDEC7) and its serial number to info@mcu-projects.de. See the About screen for these informations.

Firmware Update

1. Download the STM32CubeProgrammer program from ST's Website <https://www.st.com/en/development-tools/stm32cubeprog.html>
2. Connect the device to a USB port on your computer
3. Bridge the two pins labelled "Boot" using a jumper (or see Note below)
4. Switch on the device: it should now be visible on your computer as a "STMicroelectronics STM32 Bootloader" device
5. Start STM32CubeProgrammer
6. On the top right hand corner select "USB" and then click "Connect".
7. Click on "Open File" and navigate to and select the binary xxx.elf
8. Click on "Download"
9. Wait until the download completes
10. Remove the jumper and restart the device
11. On the device open the About screen and verify the new FW version

Note: If the device is already running you can start the bootloader without having to open the enclosure: Instead of bridging the two boot pins you can send command *SYSTem:BOOTloader* to the device or go to the System2 screen on the GUI and start the bootloader there. Continue with step 4.

SCPI Command Set

*CLS

*ESE?

*ESR?

*IDN?

*OPC?

*SAV

*STB?

*SRE?

*RCL

*RST

ADJustment:STAGe:CALibration:ENABle[:STATe]

ADJustment:STAGe:CALibration[:STATe]?

ADJustment:STAGe:COUNT?

ADJustment:STAGe:RESistance?

ADJustment:RELay:RESistance?

ADJustment:LLOop:RESistance?

ADJustment:SLOop:RESistance?

ADJustment:LLOop:CLOSe[:STATe]?

ADJustment:SAVe

FORMat:BORDER?

FORMat:DATA?

SOURce:LIMit:ENABle[:STATe]?

SOURce:LIMit:LOWer?

SOURce:LIMit:UPPer?

SOURce:RESistance:STAGe

SOURce:RESistance?

SOURce:RESistance:OPEN[:STATe]?

SOURce:RESistance:ACTual?

SOURce:RESistance:SWITching:MODE?

STATus:PRESet

STATus:DEVIce:CONDition?

STATus:OPERation:CONDition?

STATus:DEVIce:EVEnt?

STATus:OPERation:EVEnt?

STATus:DEVIce:ENAB?

STATus:OPERation:ENAB?

STATus:DEVIce:NTRansition?

STATus:OPERation:NTRansition?

STATus:DEVIce:PTRansition?

STATus:OPERation:PTRansition?

SYSTem:ASAVe[:STATe]?

SYSTem:BATTery:VOLTage?

SYSTem:BOOTloader

SYSTem:ERRor:COUNt?

SYSTem:ERRor:ALL?

SYSTem:ERRor[:NEXT]?

SYSTem:FPReset

SYSTem:HELP:HEADers?

SYSTem:REGistration:KEY

SYSTem:REStart

SYSTem:SLEep[:NOW]

SYSTem:SLEep:ENABle[:STATe]?

SYSTem:SLEep:TIME?

Details

Command	*CLS
Type	-
Default	-
Range	-
R/W	W
Persistent	N
Resettable	N

Description	Clear status byte
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Command	*ESE?
Type	-
Default	-
Range	-
R/W	R
Persistent	N
Resettable	N
Description	Return the value of the Standard Event Status Enable Register.

Command	*ESR?
Type	-
Default	-
Range	-
R/W	R
Persistent	N
Resettable	N
Description	Return the value of the Standard Event Status Register.

Command	*IDN?
Type	string
Default	-
Range	-
R/W	R
Persistent	N
Resettable	N
Description	Output an identifying string,

Command	*OPC?
Type	string

Default	-
Range	-
R/W	R
Persistent	N
Resettable	N
Description	Returns the ASCII character 1 when all pending operations have finished

Command	*SAV
Type	-
Default	-
Range	-
R/W	W
Persistent	N
Resettable	N
Description	Save device state.

Command	*STB?
Type	numeric
Default	-
Range	-
R/W	R
Persistent	N
Resettable	N
Description	Read the Status Byte.

Command	*SRE?
Type	numeric
Default	0
Range	0-255
R/W	RW
Persistent	N
Resettable	N

Description	Value of the Service Request Enable Register.
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Command	*RCL
Type	-
Default	-
Range	-
R/W	W
Persistent	N
Resettable	N
Description	Recall device state.

Command	*RST
Type	-
Default	-
Range	-
R/W	W
Persistent	N
Resettable	N
Description	Put device in its default state.

Command	SYSTem:BOOTloader
Type	-
Default	-
Range	-
R/W	W
Persistent	N
Resettable	N
Description	Start bootloader for FW update

Command	SYSTem:ERRor:COUNT?
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Type	numeric
Default	0
Range	-
R/W	R
Persistent	N
Resettable	N
Description	Return number of entries in the error queue

Command	SYSTem:ERRor:ALL?
Type	string
Default	-
Range	-
R/W	R
Persistent	N
Resettable	N
Description	Return all error messages from the error queue.

Command	SYSTem:ERRor[:NEXT]?
Type	string
Default	-
Range	-
R/W	R
Persistent	N
Resettable	N
Description	Return next error message from the error queue.

Command	SYSTem:HELP:HEADers?
Type	binary block with ASCII data
Default	-
Range	-
R/W	R
Persistent	N

Resettable	N
Description	Return list of commands.

Command	SYSTem:REStart
Type	-
Default	-
Range	-
R/W	W
Persistent	N
Resettable	N
Description	Restart device

Command	SYSTem:FPReset
Type	-
Default	-
Range	-
R/W	W
Persistent	N
Resettable	N
Description	Restore device to factory state.

Command	SYSTem:SLEep[:NOW]
Type	-
Default	-
Range	-
R/W	W
Persistent	N
Resettable	N
Description	Put device in sleep mode.

Command	SYSTem:SLEep:ENABle[:STATe]?
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Type	mnemonic
Default	OFF
Range	OFF 0 ON 1
R/W	RW
Persistent	Y
Resettable	N
Description	Set/get the sleep enabled state.

Command	SYSTem:SLEep:TIME?
Type	Numeric, Units: S MIN
Default	300
Range	30-3600
R/W	RW
Persistent	Y
Resettable	N
Description	Set/get timeout for sleep mode.

Command	SYSTem:ASAVe[:STATe]?
Type	Mnemonic
Default	OFF
Range	OFF 0 ON 1
R/W	RW
Persistent	Y
Resettable	N
Description	Set/get the autosave state. Note: when autosave is enabled, changes will be saved only 5s after the last change to the device's state.

Command	SYSTem:REGistration:KEY
Type	numeric
Default	-
Range	-
R/W	W
Persistent	N

Resettable	N
Description	Enter registration key to remove FW time limitation.

Command	SYSTem:BATTery:VOLTage?
Type	numeric
Default	-
Range	-
R/W	R
Persistent	N
Resettable	N
Description	Return battery voltage in V.

Command	STATus:PRESet
Type	-
Default	-
Range	-
R/W	W
Persistent	N
Resettable	N
Description	Reset status registers.

Commands	STATus:DEVIce:CONDition? STATus:OPERation:CONDition?
Type	numeric
Default	-
Range	0-65535
R/W	R
Persistent	N
Resettable	N
Description	Return condition part of the Device/Operation status register

Commands	STATus:DEVIce:EVEnt? STATus:OPERation:EVEnt?
Type	numeric
Default	-
Range	0-65535
R/W	R
Persistent	N
Resettable	N
Description	Return event part of the Device/Operation status register

Commands	STATus:DEVIce:ENAB? STATus:OPERation:ENAB?
Type	numeric
Default	-
Range	0-65535
R/W	RW
Persistent	N
Resettable	N
Description	Set/get enable part of the Device/Operation status register

Commands	STATus:DEVIce:NTRansition? STATus:OPERation:NTRansition?
Type	numeric
Default	-
Range	0-65535
R/W	R
Persistent	N
Resettable	N
Description	Set/get ntransition part of the Device/Operation status register

Commands	STATus:DEVIce:PTRansition? STATus:OPERation:PTRansition?
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Type	numeric
Default	-
Range	0-65535
R/W	R
Persistent	N
Resettable	N
Description	Set/get ptransition part of the Device/Operation status register

Command	FORMat:BORDER?
Type	mnemonic
Default	NORMal
Range	NORMal SWAPped
R/W	RW
Persistent	N
Resettable	N
Description	Set/get byte order of numeric data.

Command	FORMat:DATA?
Type	mnemonic
Default	ASCii
Range	ASCii PACKed
R/W	RW
Persistent	N
Resettable	N
Description	Set/get format of numeric data

Command	SOURce:RESistance:STAGe
Type	numeric
Default	0
Range	0-999999999
R/W	W

Persistent	N	
Resettable	N	
Argument1	Bypass Relay	
	Type	mnemonic
	Range	OFF 0 ON 1
Description	Set bypass relay and resistance stage. This command is for calibration purposes and sets the relays directly. Example: stage 451 sets decade 1 to 1, decade 2 to 5 asf.	

Command	SOURce:LIMit:ENABle[:STATe]?	
Type	mnemonic	
Default	OFF	
Range	OFF 0 ON 1	
R/W	RW	
Persistent	Y	
Resettable	N	
Description	Set/get limit enable state.	

Command	SOURce:LIMit:LOWer?	
Type	Numeric, Unit: OHM KOHM MOHM	
Default	1000	
Range	0-10e6	
R/W	RW	
Persistent	Y	
Resettable	N	
Description	Set/get lower limit	

Command	SOURce:LIMit:UPPer?	
Type	Numeric, Unit: OHM KOHM MOHM	
Default	10e6	
Range	0-10e6	
R/W	RW	
Persistent	Y	
Resettable	N	

Description	Set/get upper limit
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Command	SOURce:RESistance?
Type	Numeric, Unit: OHM KOHM MOHM
Default	1000
Range	0-10e6
R/W	RW
Persistent	Y
Resettable	Y
Description	Set/get resistance.

Command	SOURce:RESistance:OPEN[:STATe]?
Type	mnemonic
Default	OFF
Range	OFF 0 ON 1
R/W	RW
Persistent	N
Resettable	Y
Description	Open relays. Resistance = “infinite”

Command	SOURce:RESistance:ACTual?
Type	Numeric, Unit OHM
Default	-
Range	-
R/W	R
Persistent	N
Resettable	N
Description	Return computed resistance value.

Command	SOURce:RESistance:SWITching:MODE?
Type	mnemonic

Default	NORMal
Range	NORMal MAKE BREak
R/W	RW
Persistent	Y
Resettable	Y
Description	Set/get switching mode. NORMal: Fastest. Undefined transition between states MAKE: Make Before Break BREak: Break Before Make

Command	ADJustment:STAGe:CALibration:ENABLE[:STATe]
Type	mnemonic
Default	ON
Range	OFF 0 ON 1
R/W	RW
Persistent	N
Resettable	Y
Description	Set/get if stage calibration is enabled or not. Stage calibration data are used if they are available (see ADJustment:STAGe:CALibration[:STATe]?) and this switch is on. Turn this switch off when determining the optimum relay contact resistance.

Command	ADJustment:STAGe:CALibration[:STATe]?
Type	mnemonic
Default	-
Range	OFF 0 ON 1
R/W	R
Persistent	N
Resettable	N
Description	Query, if stage calibration data are available.

Command	ADJustment:STAGe:COUNt?
Type	numeric
Default	-
Range	-
R/W	R

Persistent	N
Resettable	N
Description	Return number of calibration stages.

Command	ADJustment:STAGe:RESistance?	
Type	Numeric: Unit Ohm KOHM MOHM	
Default	-	
Range	0-10MOhm	
R/W	RW	
Persistent	N	
Resettable	N	
Argument1	Bypass Relay	
	Type	mnemonic
	Range	OFF 0 ON 1
Argument2	stage	
	Type	numeric
	Range	0 - ADJustment:STAGe:COUNt -1
Description	Calibration value: Resistance of stage. See SOURce:RESistance:STAGe	

Command	ADJustment:RELay:RESistance?	
Type	Numeric, Unit: Ohm	
Default	0.34	
Range	0 - 0.1	
R/W	RW	
Persistent	N	
Resettable	N	
Description	Calibration value: Resistance of a relay contact.	

Command	ADJustment:LLOop:RESistance?	
Type	Numeric, Unit OHM	
Default	0.58	
Range	0 - 1	

R/W	RW
Persistent	N
Resettable	N
Description	Calibration value: Resistance of the “long loop”.

Command	ADJustment:SLOop:RESistance?
Type	Numeric, Unit OHM
Default	0.01
Range	0 - 1
R/W	RW
Persistent	N
Resettable	N
Description	Calibration value: Resistance of the “short loop”.

Command	ADJustment:LLOop:CLOSe[:STATe]?
Type	mnemonic
Default	OFF
Range	OFF 0 ON 1
R/W	RW
Persistent	N
Resettable	Y
Description	Close the “long loop”. (All relays = 0. Bypass relay = open)

Command	ADJustment:SAVe
Type	-
Default	-
Range	-
R/W	W
Persistent	N
Resettable	N
Description	Save calibration data. (Takes several seconds. Increase timeout value if required.)

Document Revision:

Revision	Date	FW	Remark
1	1.5.2026	1.3.2	
2	1.5.2026	1.3.5	Switching mode
3	05.05.2026	1.4.2	Calibration screens, SYST:BOOT