Nixie Calculator Manual (RPN)

Contents

General information

Apart from the power supply, the nixie calculator works completely independently and requires neither an internet connection nor any peripheral devices.
This manual does not describe how to use an RPN calculator. There are numerous tutorials available online. Just this: to calculate 1 + 2 type [1] [ENT] [2] [+]

Power supply

The calculator needs a DC 12V/2A **regulated** power supply (center positive).

Power on / Power off

Use the power switch to the left of the keyboard to power on and off the calculator. During start-up, the calculator briefly shows the controller firmware version on the left and the keyboard firmware version on the right. By default, the calculator starts in calculator mode.

The [F] key

The [F] key has several functions:

- Press and release the [F] key to switch between the calculator and the clock mode and to leave the menu mode.
- Hold the [F] key for 3 seconds to enter the menu mode.
- Press the [F] key + an operator key to access the lower functions (blue) in calculator mode, for example x^2
- Press the [F] key + some defined keys to get a shortcut for some settings, for example LED lighting (see Table of shortcuts).

The [↑] key

Use the [↑] key + an operator key to access the upper functions (yellow) in calculator mode, for example n!

Calculator mode

In this mode the device works like an RPN calculator (see List of operations). However, be aware that the arbitrary-precision arithmetic used by the calculator is experimental.
The precision of the calculations and the internal registers has been set to 32 as a compromise between accuracy and performance. Some calculations with very big numbers can be slow. Exponents can be entered and displayed between -9999 and 9999.
If an error occurs (e.g. overflow, domain, divide by zero), an error code is shown in the center of the display (see List of error codes).

Clock mode

Entering date and time

In clock modes (0-7) press the [CLS] key. A blinking zero indicates that you can enter the date and the time in the YYYYMMDDhhmmss format. The [←] key deletes the last entered digit. Press [ENT] to confirm or [CLS] to abort.

Clock modes

There are several clock modes. They can be reached directly with the numeric keys:

Clock modes

0 - time only
1 - time with no seconds
2 - moving time
3 - time or date
4 - time and date
5 - time and temperature
6 - time and date and temperature
7 - raw date and time

Special clock modes

8 - timer
9 - stopwatch

Timer

In timer mode press the [CLS] key. A blinking zero indicates that you can enter the number of days, hours, minutes, and seconds in the format DDhhmmss. The [←] key deletes the last entered digit. Press [ENT] to confirm or [CLS] to abort. Press [ENT] to start and stop the timer. Press [←] to reset the timer. Blinking LEDs indicate the end of the countdown, there is no sound. The flashing can be stopped by pressing the [CLS] key. The accuracy depends on the internal MCU oscillator.

Stopwatch

In stopwatch mode press the [ENT] key to start the stopwatch. Press [ENT] to pause the display while the stopwatch keeps running. Press [←] to reset the stopwatch. The accuracy depends on the internal MCU oscillator.

Menu mode

Hold the [F] key for 3 seconds to enter the menu mode. The menu ID (see Menu table) is displayed on the left, the menu value(s) on the right. Key autorepeat is enabled in menu mode and starts after 1 second. The autorepeat speed increases after some time. Press the [F] key to leave the menu mode and store the values.

Navigation

Keys	Description
[STO]	Next menu
[RCL]	Previous menu
[+]	Next value
[-]	Previous value
[ENT]	Commit value and move to the next column if any
[←]	Restore to previously stored value
[CLS]	Reset to default value
[F] + [CLR]	Reset all settings to default
[F] + [CLS]	Exit menu mode and discard changes
[F]	Exit menu mode and store changes

Menu table

ID	Name	Description	Values
1	startupmode	Start in calculator or in clock mode	0 = calculator (default) 1 = clock
2	showversion	Show version at startup	0 = off 1 = on (default)
3	autooffmode	Auto off action after a period of no keyboard activity	0 = auto off disabled 1 = shutdown high voltage 2 = switch to clock mode (default)
4	autooffdelay	Delay in minutes for auto off mode	1 - 720 (default 5)
5	clockmode	Initial clock mode	0 = time (default) 1 = time, no seconds 2 = moving time 3 = time or date 4 = time and date 5 = time and temperature 6 = time and date and temperature 7 = raw date and time 8 = timer 9 = stopwatch
6	hourmode	12 or 24 hours mode	0 = 12 hours 1 = 24 hours (default)
7	leadingzero	Show hours leading zero	0 = off 1 = on (default)
8	dateformat	Date format	0 = ddmmyy (default) 1 = yymmdd 2 = mmddyy
9	pirmode	Use PIR to reduce the operating time of the nixie tubes	0 = off (default) 1 = on
10	pirdelay	PIR delay time in minutes before shutting down the high voltage	1 - 720 (default 5)
11	gpsmode	Sync with GPS time	0 = off (default) 1 = on
12	gpsspeed	GPS communication baud rate	0 = 2400 1 = 4800 2 = 9600 3 = 19200 4 = 38400 (default) 5 = 57600 6 = 115200
13	gpssyncinterval	GPS time sync interval in minutes	1 - 720 (default 10)
14	temperaturemode	Use temperature sensor	0 = off (default) 1 = on
15	temperaturecf	Temperature in C or F	0 = Celsius (default) 1 = Fahrenheit
16	ledmode	LEDs on by time or always **	0 = time 1 = always (default)
17	calcrgbmode	RGB mode in calculator mode **	0 = off (default) 1 = digit [pos, neg, exp & error colors] 2 = all [pos, neg & error colors] 3 = digit random 4 = digit full random 5 = all fixed [fixed color] 6 = all random 7 = all full random
18	clockrgbmode	RGB mode in clock mode **	0 = off (default) 1 = split [time, date and temp colors] 2 = split random 3 = split full random 4 = all fixed [fixed color] 5 = all random 6 = all full random

19	ledstarttime	Start time of LED lighting **	00:00 - 23:59 (default 00:00)
20	ledduration	Duration in minutes of LED lighting **	0 - 720 (default 0)
21	ledstarttime2	Start time of LED lighting **	00:00 - 23:59 (default 00:00)
22	ledduration2	Duration in minutes of LED lighting **	0 - 720 (default 0)
23	acpstarttime	Start time of cathode poisoning prevention	00:00 - 23:59 (default 00:00)
24	acpduration	Duration in minutes of cathode poisoning prevention	0 - 720 (default 0)
25	acpforceon	Force turning nixies on during cathode poisoning prevention	0 = off 1 = on (default)
26	negativecolor	RGB LED color for negative numbers in calculator mode **	0-255,0-255,0-255 (default 0,0,0)
27	positivecolor	RGB LED color for positive numbers in calculator mode **	0-255,0-255,0-255 (default 0,0,0)
28	errorcolor	RGB LED color for error in calculator mode **	0-255,0-255,0-255 (default 0,0,0)
29	negexpcolor	RGB LED color for negative exponents in calculator mode **	0-255,0-255,0-255 (default 0,0,0)
30	posexpcolor	RGB LED color for positive exponents in calculator mode **	0-255,0-255,0-255 (default 0,0,0)
31	fixedcalccolor	RGB LED fixed color in calculator mode **	0-255,0-255,0-255 (default 0,0,0)
32	timecolor	RGB LED color for time in clock mode **	0-255,0-255,0-255 (default 0,0,0)
33	datecolor	RGB LED color for date in clock mode **	0-255,0-255,0-255 (default 0,0,0)
34	tempcolor	RGB LED color for temperature in clock mode **	0-255,0-255,0-255 (default 0,0,0)
35	fixedcolor	RGB LED fixed color in clock mode **	0-255,0-255,0-255 (default 0,0,0)
36	dstweek	Daylight saving time change, week of month	0 = last (default) 1 = first 2 = second 3 = third 4 = fourth
37	dstdow	Daylight saving time change, day of week	1 = sunday (default) - 7 = saturday
38	dstmonth	Daylight saving time change, month	1 - 12 (default 3)
39	dsthour	Daylight saving time change, hour	0 - 23 (default 2)
40	dstoffset	Daylight saving time change, offset to UTC in minutes	-720 - 840 (default 120)
41	stdweek	Standard time change, week of month	0 = last (default) 1 = first 2 = second 3 = third 4 = fourth
42	stddow	Standard time change, day of week	1 = sunday (default) - 7 = saturday
43	stdmonth	Standard time change, month	1 - 12 (default 10)
44	stdhour	Standard time change, hour	0 - 23 (default 3)
45	stdoffset	Standard time change, offset to UTC in minutes	-720 - 840 (default 60)
46	gpsnotifysync	Notify GPS time sync with a short LED flash **	0 = off (default) 1 = on
47	gpssynccolor	RGB LED color for notifying GPS time sync **	0-255,0-255,0-255 (default 255,0,0)
48	notifytimer	Notify end of timer with flashing LEDs **	0 = off 1 = on (default)
49	timercolor	RGB LED color for notifying end of timer **	0-255,0-255,0-255 (default 255,255,255)
50	fixeddecimals	Number of fixed decimals	0 = floating (default) 1 - 8 = number of fixed decimals
51	anglemode	Startup angle mode	0 = degrees (default) 1 = radians
52	showbusycalc	Show animation during long calculations	0 = off 1 = moving decimal point (default) 2 = digit flickering
53	maxexplength	Max length of the exponent	2 - 4 (default 4)
54	scrolldelay	Interval while scrolling result in 1/10 seconds	1 - 20 (default 5)
55	precision	Calculator precision (restart needed)	20 - 32 (default 32)
56	brightness	Display brightness *	1 - 15 (default 8)

(*) only available for 7-segment LED version, (**) not available for 7-segment LED version

WebSocket server

If enabled in the firmware, press [F] + [ENT] in calculator mode to start an ESP32 access point (AP) and a WebSocket server. After starting, the IP address of the server is displayed for 2 seconds. By default, the IP address is 192.168.4.1. You can now connect with a smartphone or a PC to this AP and open the site (http://192.168.4.1) with a browser. You will get all the stack and memory registers with all the digits. The X register holds the current result. After a calculation, the calculator sends the result to the client; no polling and no browser refresh is needed. Because of the server running in the background, the calculations are slightly slower. Be aware that the browser connection is not encrypted and the clear text password and the SSID of the AP are stored in the flash memory and are also visible in the source code. While connected to this AP, you may have no Internet connection. Press [F] + [ENT] again to stop the server and the AP.

Table of shortcuts

Keys	Description	Mode
[F] + [←]	Switch LED lighting mode, overrides the time constraints (*)	Calculator, Clock
[F] + [CLS]	Restore the lighting time constraints	Calculator, Clock
[F] + [0] – [8]	Change the number of fixed decimals, 0 = floating (*)	Calculator
[F] + [STO]	Store the number of fixed decimals in settings	Calculator
[F] + [RCL]	Display free heap memory and minimum free heap memory	Calculator
[F] + [EXP]	Force exponent mode on or off (*)	Calculator
[F] + [.]	Start/stop scrolling additional result digits	Calculator
[F] + [ENT]	Start/stop WebSocket server	Calculator
[F] + [+]	Increase brightness (*) (**)	Calculator
[F] + [-]	Decrease brightness (*) (**)	Calculator
[F] + [00]	Display firmware versions	Calculator
[0] – [9]	Switch the clock mode (*)	Clock
[F] + [STO]	Store current clock mode in settings	Clock
[F] + [+]	Adjust the time by plus one second	Clock
[F] + [-]	Adjust the time by minus one second	Clock
[F] + [CLR]	Reset all settings to default	Menu
[F] + [CLS]	Exit menu mode and discard changes	Menu

(*) temporarily, changed settings are not stored, (**) 7-seg LED display only

List of error codes

Error Code	Description
1	Overflow
2	Divide by zero
3	Domain error / Invalid input
4	Out of memory
5	Indefinite result
6	Invalid range
7	No result
8	Unknown operation
9	Unknown error

List of operations

Operation	Description
EXP	Enter exponent
clx	Clear X register
←	Clear last entered digit / clear X register if not in input mode
CLS	Clear stack
↑	Shift key
F	Function key
x^y	Power
x^2	Square
$\sqrt[y]{x}$	Root
x^3	Cube
1/x	Reciprocal
n!	Factorial
e^x	Exponential
ln	Natural logarithm
e	e
mod	Modulo
$\log_y$	Logarithm base y
py,x	Permutations
int	Integer portion
sin	Sine
$\sin^{-1}$	Arcsine
$\sin_h$	Hyperbolic sine
cos	Cosine
$\cos^{-1}$	arccosine
$\cos_h$	Hyperbolic cosine
tan	Tangent
$\tan^{-1}$	arctangent
$\tan_h$	Hyperbolic tangent
log	Logarithm base 10
π	Pi
rnd	Random number
d↔r	Switch between degrees and radians
cy,x	Combinations
Δ%	Percent difference
±	Change sign
√	Square root
%	Percent
÷	Division
x	Multiplication
-	Subtraction
+	Addition
X↔Y	Swap X and Y registers
lstx	Load lastX into the X register
R↓	Roll down stack
R↑	Roll up stack
CLR	Clear all memory registers
STO	Store into memory register
RCL	Recall from memory register

Peripherals module

If you have assembled the peripherals module you can connect it to the calculator with a **straight** ethernet patch cable. **Turn off the calculator while connecting or disconnecting the ethernet cable.**
The default communication speed for the BE-220 GPS module is 38400 and 9600 for the older BN-220 module.

Troubleshooting

If the calculator loses the time, please change the CR2032 battery.