

CRO-LCD-Key Instruction Manual:

1. General information how to use the push-buttons:

There are 4 push-buttons on the CRO-LCD-Key board. These buttons are called „**FUNC**“ (function), „<“ (left), „>“ (right) and „**ENTER**“ (Return). Depending upon the contents of the LCD display, the meaning of the buttons can be different

Basic functions:

With the push-button „**FUNC**“ one can select the next function without changing any parameters in the setup. This button can be pressed whenever you want, even if parameters have been changed on the display without setting these modifications.

Buttons „<“ and „>“ are basically used to modify existing settings, parameters and for selecting status information of the LCD display. Normally the user will be informed about the meaning of the buttons. Sometimes however these buttons are without any function depending on the current mode selected .

The push-button „**ENTER**“ is normally used to accept the settings and to terminate the current selection. Before pushing the Enter button, be aware what you are doing. In most cases it is possible to push Enter without being requested by the CRO software.

Please be aware that you will not see a response immediately after pressing a button. That means you will often not immediately see the result or that you have to press the button several times (but do not frantically "hammer" the button). The buttons are not really necessary and can be disconnected after a complete setup since the CRO-Maintenance tool is able to do the same.

2. General information about the LCD:

The LCD-Display is basically used to display Information about the status of the CRO and about parameter settings. If all settings are done, the LCD-Display is not needed anymore. Alternatively the CRO-Maintenance tool is able to replace the LCD-display.

2.1 LCD operating modes:

There are three operating modes. The first is the standard display which displays the most important information about the status of the CRO. The second mode is the display of additional information about certain conditions during normal operation. The third concerns informations about the basic setup of the CRO. In this group, there are two subgroups.

Additionally there are informations about startup of the CRO and information while the CRO is in the synchronisation phase. Also the current MC SW version can be displayed

2.2 System message:

The system message shows the current MC SW version and information about the Copyright of the system.

G	P	S	/	T	V	-	C	R	O		V	1	.	0	P
				(C)		2	0	0	1				

		D	J	8	C	Y	,	D	B	4	M	P			
		D	K	7	N	T	,	D	F	7	H	S	A		

2.3 Warm-up message:

The intention of this function was to let the OCXO warm-up after power up.

While in this state, the **FUNC** button allows to change into the setup menu.

w	a	r	m	-	u	p		s	e	q	u	e	n	c	e
				1	2	3	4	5	6	7	8	9			

Right now the function is not activated .

2.4 Availability test of reference and oscillator frequency:

There is a surveillance function available to check the error-free availability of the GPS or TV reference signal and of the signal of the oscillator to be controlled or to be measured. This function is called every time when a new synchronisation of both signals is to be performed and lasts about 5 seconds.

F	x	-	I	n		:			o	k				
1	P	P	S	-	I	n	:		f	a	i	l	e	d

Fx-In refers to the input (or the frequency) of the oscillator to be controlled. The second line displays a qualification of the 1PPS signal (GPS reference) or of the TVSYNC signal (TV reference). If the reference signal is suited for evaluation purposes, "ok" is indicated. "Failed" means that the reference signal is either not available or that the quality of the signal is not sufficient. If and only if both signals show "ok" the control loop can be activated.

2.5 Synchronization of reference and oscillator frequencies:

Provided that both signals are available a defined difference between the edges of the relevant signals must be established for phase counting. This is necessary to enable proper operation and to use the complete dynamic range of the phase counter. Since the reference signal can not be changed, only the phase of the 1 Hz signal (the output of the divided oscillator frequency) is shifted. The time needed for synchronization depends on the reference and the signal quality but should be terminated after about 10 seconds.

S	y	n	c	:		o	f	f	-	l	i	m	i	t	
O	V				2	4			2	6	4	8	3		

The first line either displays "**off-limit**" (phase shift out of range) or "**in-limit**" (phase shift within useable range). "OV" in the second line means "Overflow", i.e. the phase measured leads to an overflow of the 22 bit phase counter. Without overflow this line remains blank.

The first number from the left (24 in this example) denotes the value of the phase counter from bit 16 to bit 21. The second number represents the phase counter value (bits 0 to 15). The range of the phase counter values therefore is 0 to +32756. The phase counter can process only these values that represent the full dynamic range of the measurement system. During normal operation these data are of minor importance.

2.6 Standard Display

The standard display is the display used during normal operation. It informs about the actual value of the measurements and about the accuracy obtained.

A	A	A	A	A		B	B	B	B		C	C	C	C	C
3	2	7	7	2			-	1	3					-	1
D	L	5		0					0			1	4	3	5
D	E	E	F	F		G	G	G	G		H	H	H	H	H

A: Value of the phase counter (**absDiff**)

B: Difference between current and start value of the phase counter (**Diff**).

C: Difference between current and preceeding phase counter value (**dDIFF**).

D: Information about the "Diff" value currently displayed via RS232 with the Off/Online Analysis Tool

E: Information about the current accuracy class

F: Statistic counter of severe errors of the phase counter

G: Static counter of minor errors of the phase counter

H: Run time of the current measurement in seconds

to **A:** Phase counter value related to the last new start. Value range 0—65536, but values 0 or 65536 should never be reached (these values trigger a new synchronisation)

to **B:** Positive or negative values possible

to **C:** Positive or negative values possible

to **D:** If the „ENTER“ button is pushed in the standard display mode, the following functions are selected and indicated by appropriate letters in ascending order:

(empty): absDiff without new start correction

N : Accuracy of the first regression calculation multiplied by $1 \cdot 10^{12}$.

M : Accuracy of the 2nd regression calculation multiplied by $1 \cdot 10^{12}$.

D : Diagnostics function: Gives hints about the last new start (reason etc.)

0: after start

1: count limit reached

2: dynamic area limit reached

3: normal with prec100

4: no DAC control

5: refok != 2 1st

6: refok != 2 2nd

7: too many ld_errors

8: emergency stop

9: due to 2nd regression value

to **E:** Informations about the current accuracy class

L0: No evaluation during minimum waiting time (within **minwait**).

L1: $> 1 \cdot 10^{-9}$

L2: between $5 \cdot 10^{-10}$ and $1 \cdot 10^{-9}$.

L3: between $1 \cdot 10^{-10}$ and $5 \cdot 10^{-9}$.

L4: between $5 \cdot 10^{-11}$ and $1 \cdot 10^{-10}$.

L5: between $1 \cdot 10^{-11}$ and $5 \cdot 10^{-11}$.
L6: $< 1 \cdot 10^{-11}$

to **F**: Shows extreme deviations of the difference of the phase counter between two measurements. If 15 severe errors occur in a line a new synchronisation is initiated. This error is marked in the on-line/off-line analysis with a blue line.

to **G**: Shows minor deviations of the differences of the phase counter from sample to sample. With the setting „jitter“ the user can set the limit. An evaluation of the quality of the reference signal is possible. The quality of the reference signal is better if the number of the disturbances is reduced. This error type is indicated in the on-line/off-line analysis with a green line.

to **H**: Every reset / new start resets the run time counter to 0.

2.7 Additional status informations:

Pushing the keys „<“ or „>“ during normal operation offers additional status informations. The measurement will not be interrupted. Instead different representation of certain parameters is selected.

2.7.1 Current accuracy in exponential notation:

Pushing the key „>“ selects the representation depicted below. The first line (marked 1:) shows the accuracy of the first regression calculation since the last start. The 2nd line (2:) shows the results of the 2nd regression calculation, provided it is activated. Otherwise “not activated” is shown on the display. Instead of “2:” the characters “-” are shown during the first 3 minutes.

This is due to the fact that the 2nd regression has no sufficient accuracy after a new start within the first 3 minutes and therefore needs some settling time.

1	:			-	2	.	7	4	3	5	e	-	1	1	
2	:			-	3	.	2	2	6	3	4	-	1	1	

1	:				7	.	4	8	3	2	e	-	1	2	
-	-			-	3	.	2	2	6	3	4	-	1	1	

1	:				1	.	9	5	1	6	e	-	1	0	
		n	o	t		a	c	t	i	v	a	t	e	d	

We should mention at this point that both precision values are the product of calculated precision times the precision factor („p-factor).

2.7.2 Regression Slope Display for Test Purposes:

Pushing the key „>“ again leads to a representation suited for test purposes. The first line shows the slope of the 1st regression calculation (indicated by “slope”), the 2nd line displays the corresponding computed accuracy.

s	l	o	p	e		:	-	0	.	0	0	1	2	0	5
		-	1	.	2	0	5	2	6	3	e	-	1	1	

2.7.3 Default Setup :

The key „>“ offers the loading of predefined default values for all settings after powering up. This menu item can be reached from the one described above. First a display as shown below comes up. Hitting “ENTER” overwrites all settings with standard values.

		D	e	f	a	u	l	t		s	e	t	u	p	
			p	r	e	s	s		E	n	t	e	r		

2.7.4 Softstart :

Occasionally it could be necessary to reset the phase counter without re-synchronizing it. This function can be selected from the preceding display with the key “>”. Pushing “ENTER” leads to a soft start.

P	r	e	s	s		E	n	t	e	r		f	o	r	
			s	o	f	t	s	t	a	r	t				

2.7.5 100 seconds loop on/off :

The purpose of this function is to support the adjustment of the oscillator. In most cases the oscillator is not near enough to the required frequency and needs repetitive measurements with a measurement interval of 100 seconds. The DAC voltage is set in the middle of the tuning range (2.5 volts). “ENTER” activates this function which can be reached from the preceding display with “>”.

P	r	e	s	s		E	n	t	e	r		f	o	r	
1	0	0		s	e	c		l	o	o	p		o	n	

In the 2nd line the letter „S“ as the first character indicates a special purpose function. The loop is switched off with “ENTER”.

P	r	e	s	s		E	n	t	e	r		f	o	r	
1	0	0		s	e	c		l	o	o	p		o	f	f

The on-line analysis program draws a line similar to a sawtooth signal during the 100 seconds loop. The peaks (up and down) represent the offset of the oscillator frequency from the required frequency. The trimmer of the OCXO is then used to get the peaks as flat as possible.

2.7.6 Back to the Standard Display:

The next activation of the key „>“ leads to the normal status display. Using the key “<” selects the different displays in reverse order.

2.8 General Remarks :

For the correct operation of the CRO several settings are necessary. From the default settings as a starting point (see 2.7.3) some basic presets are to be performed and a certain kind of tuning must be exercised. Depending upon the type of oscillator used, different parameters are necessary. In order to set these parameters the normal display mode is left. Although the measurement system is operating, one can not predict how the new settings or modifications are influencing the measurements. A cold start of the CRO (or waiting for the next automatic new start) is therefore recommended.

There are two kinds of displays affecting the presets. One group concerns informations which are displayed only and which can not be changed. These informations are the result of the settings and the calculations performed based on these settings. These displays belong to the group "STATUS". Other displays concern parameters that can be changed by the user at any time. This group is called "SETUP".

Pushing the key „FUNC“ (when the standard display is active) leads to the following display:

S	t	a	t	u	s		o	r		S	e	t	u	p
		<			S	T	A	T	U	S			>	

„Status“ and „Setup“ are selected with the keys „>“ and „<“ and shown in the display subsequently. The key “ENTER” then executes the visible function. The key “FUNC” reactivates the standard display.

2.8.1 Status Display :

At this point in time there are two status displays. If TV is selected as a reference, the tuner status shows up first. Selecting GPS displays the following message:

A	c	t	.		T	u	n	e	r		s	t	a	t	e
		G	P	S		s	e	l	e	c	t	e	d		

The key „>“ then activates the second status which allows for a check of the calculated settings of the PLL-IC AV9110. This IC synchronizes the frequency of the phase counter with the oscillator frequency.

	A	V	9	1	1	0		:							
	n	:	6	0			m	:	3						

Pushing the key „>“ shows the status of the tuner again. The key “<” rotates the status display backwards. With “FUNC” the status display can be left for the standard display.

2.8.2 System Setup:

If „Setup“ has been selected (and activated by „ENTER“), several presets and their current settings can be displayed. The next activation of the “FUNC” key leads to the next setup. The keys “<” and “>” change the parameters, the key “ENTER” takes over these settings and saves them, provided that nothing else is indicated on the display. As already mentioned, every change can be reversed with the key “FUNC”.

2.8.2.1 Divider Setup for Fx:

The oscillator frequency (Fx) must be divided down to 1 Hz in order to perform a phase measurement between the reference signal and the oscillator signal. The nominal frequency is fed into the CRO (see “Divider Setup”), the CRO then computes all divider and predivider values as well as the values for the programming of the PLL-IC’s.

	D	i	v	i	d	e	r		S	e	t	u	p		
			p	r	e	s	s		E	n	t	e	r		

The key „ENTER“ leads to the display shown below. The current nominal frequency is displayed with 1 Hz resolution. The most significant digit is the 100 MHz digit. The maximum frequency accepted is 130 MHz.

				0	1	0	0	0	0	0	0	0		H	z

The nominal frequency is changed the following way: The character "|" is a pointer which marks the position to be changed. The pointer is moved with the ">" and "<" keys. After pushing "ENTER" the pointer will be the character " ". The key "<" then changes the value by -1 at this position. The key ">" increments the value by +1. With the key "FUNC" the user returns to the pointer and can select a new position. Finally if the complete line of digits represents the nominal frequency, the values are stored (indicated by "STORE" in the display) with "ENTER".

2.8.2.2 Phase-Clock Source:

In principle Fx itself can be used as phase counter clock, if Fx is greater than 100 MHz. In practice it is sufficient to use 100 MHz, all calculations are based on this frequency. Nevertheless an adjustment of the phase clock is possible:

S	e	l	e	c	t		P	h	a	s	e		c	l	k
			p	r	e	s	s		E	n	t	e	r		

With the keys ">" or "<" either 100 MHz or Fx can be selected as phase counter clock:

P	h	a	s	e		C	n	t		c	l	o	c	k	
		<			1	0	0	M	H	z			>		

"ENTER" stores the selection, "FUNC" leads to the next setup menu.

2.8.2.3 Reference Source:

Reference signal sources are either GPS or TV transmitters. The appropriate source can be selected here:

S	e	l	e	c	t		R	e	f	e	r	e	n	z	
			p	r	e	s	s		E	n	t	e	r		

The keys "<" or ">" select GPS or TV:

S	e	l	e	c	t		R	e	f	e	r	e	n	z	
		<					G	P	S				>		

S	e	l	e	c	t		R	e	f	e	r	e	n	z	
		<					T	V					>		

"ENTER" stores the selection, "FUNC" leads to the next setup menu.

2.8.2.4 Phase Counter Jitter Setup:

Due to propagation and "quantization" effects there is a certain jitter in the phase counter. This setup specifies the jitter allowed, i.e. the maximum jitter value that does not increment the error counters. Samples up to 3 times the jitter allowed increment the error counter for minor errors, larger values increment the error counter for severe errors.

	s	e	l	e	c	t		j	i	t	t	e	r		
			<				1	0				>			

The keys "<" and ">" increment or decrement the jitter value. Possible values are 0 to 255. "ENTER" stores the selection, "FUNC" leads to the next setup menu.

2.8.2.5 Recording of the Characteristic Control Curve:

For a detailed description see "Recording of the Control Curve" in CRO_STARTUP.DOC. The keys ">" and "<" activate the recording and enable a switchover between "off" and "get". "ENTER" starts the recording if "get" has been selected. Selecting "off" stops the recording. In case of larger deviations the counter for severe errors will be incremented.

	C	h	a	r	a	c	t	e	r	i	s	t	i	c	
		<				o	f	f				>			

	C	h	a	r	a	c	t	e	r	i	s	t	i	c	
		<				g	e	t				>			

"ENTER" stores the selection, "FUNC" leads to the next setup menu.

2.8.2.5.1 Display during Characteristic Curve Recording:

During the recording a 100 seconds loop(110 seconds exactly, but the first 10 seconds are not used) is executed. The first digit in the 2nd line shows "_" in the first 10 seconds, then "X" is displayed for the next 100 seconds as an optical remainder for the running computation.

A A A A A					B B B B				C C C C						
2	5	4	6	8			-	1	5	6			-	1	2
X		2	.	1	V		-	7	9	0			1	0	5
D	E E E E				F F F F				G G G						

- A:** Phase Counter Value (**absDiff**)
B: Difference between current and start value of the phase counter (**Diff**).
C: Difference between current and preceeding phase counter value (**dDIFF**).
D: Marks the first 10 seconds without computation with "_". Seconds 11 to 110 are marked by "X" and indicate that computations are performed.
E: Preset voltage of the **last** measurement
F: Phase counter value normalized to 100 seconds
G: Time counter of the measurement in progress (1 to 110 seconds)

2.8.2.6 Control Loop Open and Close:

The control loop must be closed if the CRO shall operate as a control loop instead of a measuring device. "open" on the display means that the loop is open at first. The keys ">" or "<" close or open the loop, "closed" on the display indicates that the loop will be closed. With "ENTER" the selected action is performed actually.

						L	o	o	p					
		<				c	l	o	s	e	d		>	

Pushing "FUNC" leads to the next setup menu.

2.8.2.7. Set Loop-Timer 1 :

The value for Loop Timer 1 sets the time responsible for the decision when regulation shall occur in case of worse accuracy data. This time depends on the current accuracy (see also fig. REGTIME). The following table holds true:

```

L0 : no regulation.
L1 : 0.5 * Loop-Timer 1
L2 : 1   * Loop-Timer 1
L3 : 2   * Loop-Timer 1

```

```

L4 : 3    * Loop-Timer 1
L5 : 1    * Loop-Timer 2
L6 : Regulation after 24 hours

```

	s	e	t		l	o	o	p	_	t	i	m	e	r	1
			p	r	e	s	s		E	n	t	e	r		

"ENTER" results in the following input window:

s	e	c	o	n	d	s			0	0	1	0	0		

The setting is changed the following way: The character "|" is a pointer which marks the position to be changed. This pointer is moved with the ">" and "<" keys. After pushing "ENTER" the pointer is modified to the character " ". The key "<" then changes the value by -1 at this position. The key ">" increments the value by +1. With the key "FUNC" the user returns to the pointer and can select a new position. Finally if the complete row of digits represents the nominal time, the values are stored (indicated by "STORE" in the display) with "ENTER".

Pushing "FUNC" leads to the next setup menu.

2.8.2.8. Set Loop Timer 2:

The value for Loop Timer 2 sets the time responsible for the decision when regulation shall occur in case of better accuracy data. This time depends on the current accuracy (see also Annex A). The following table holds true:

```

L0 : no regulation.
L1 : 0.5 * Loop-Timer 1
L2 : 1    * Loop-Timer 1
L3 : 2    * Loop-Timer 1
L4 : 3    * Loop-Timer 1
L5 : 1    * Loop-Timer 2
L6 : Regulation after 24 hours

```

	s	e	t		l	o	o	p	_	t	i	m	e	r	2
			p	r	e	s	s		E	n	t	e	r		

"ENTER" results in the following input window:

s	e	c	o	n	d	s			0	2	0	0	0		

Pushing "FUNC" leads to the next setup menu.

The setting is changed the following way: The character "|" is a pointer which marks the position to be changed. This pointer is moved with the ">" and "<" keys. After pushing "ENTER" the pointer is modified to the character " ". The key "<" then changes the value by -1 at this position. The key ">" increments the value by +1. With the key "FUNC" the user returns to the pointer and can select a new position. Finally if the complete line of digits represents the nominal time, the values are stored (indicated by "STORE" in the display) with "ENTER".

2.8.2.9. P-FACTOR:

This value adapts the oscillator to the CRO. Good oscillators exhibit low values, worse oscillators must operate with larger values. The range of these values is 1 to 1000 in steps of 10 (up and down). The phase counter value is divided by the P-FACTOR and then used for further computations.

	S	e	t	u	p		P	_	F	a	c	t	o	r	
			p	r	e	s	s		E	n	t	e	r		

Pushing "FUNC" leads to the next setup menu.
"ENTER" results in the following input window:

	S	e	t	u	p		P	_	F	a	c	t	o	r	
		<						1	0				>		

The key "<" decrements the factor by 10, ">" increments the factor by 10.

Pushing "FUNC" leads to the previous menu.

"ENTER" stores the new value.

2.8.2.9. Second Regression:

If needed a 2nd regression can be activated for faster regulation. This 2nd regression is formed over a much shorter time period and is restarted after a given time frame. Sudden changes that are noticeable rather late by the 1st regression are detected faster (see Annex B).

	2	n	d		r	e	g	r	e	s	s	i	o	n	
				p	r	e	s	s		E	n	t	e	r	

FUNC changes to the next setup menu

ENTER shows the following display :

	2	n	d		r	e	g	r	e	s	s	i	o	n	
	<		1	0		m	i	n	u	t	e	s		>	

Pushing **FUNC** again changes to the previous setup menu

The key "<" decrements the value by 1.

The key ">" increments the value by 1.

"ENTER" stores the new value.

Hint: The 2nd regression computes sufficiently accurate data after 3 minutes after warm up at least. Switching off is activated if the value 1 minute is reached and the key "<" is pushed.

	2	n	d			r	e	g	r	e	s	s	i	o	n	
	<						o	f	f							>

2.8.2.10. Regression Difference:

The regression difference determines the threshold where regulation begins. The 2nd regression must be active.

	R	e	g	.		d	i	f	f	e	r	e	n	c	e	
			p	r	e	s	s		E	n	t	e	r			

FUNC changes to the next setup menue
ENTER shows the following display:

	R	e	g	.		d	i	f	f	e	r	e	n	c	e	
	<					2	0									>

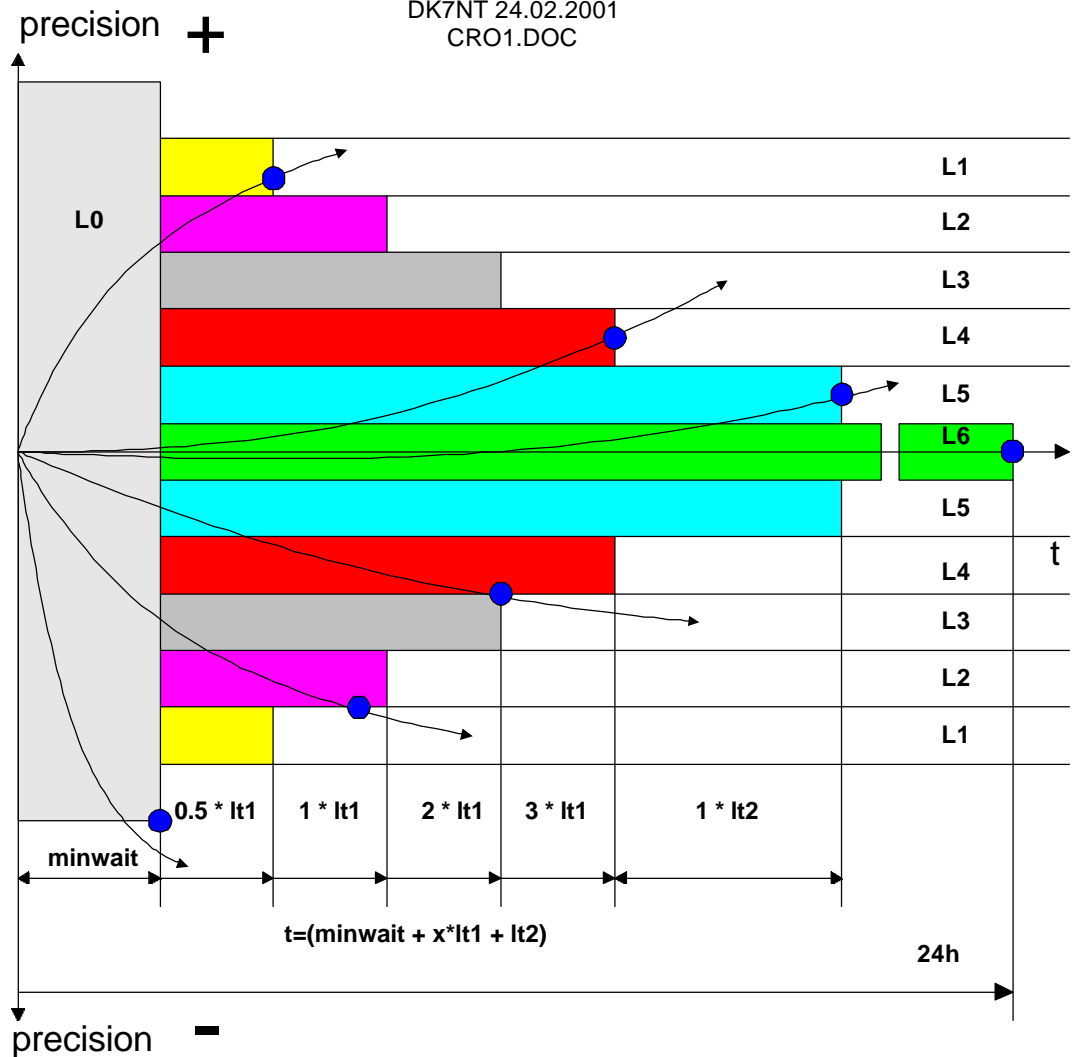
Pushing "**FUNC**" again changes to the previous setup menue.
The key "<" decrements the value by 1.
The key ">" increments the value by 1.
"ENTER" stores the new value.

The regression difference represents a normalized number adjusted to a 100 sec period and fitted to the oscillator characteristics.

Annex A:

Schematic of GPS/TV-CRO VCO control mechanism. Single Regression

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CRO1.DOC



● Point of OCXO control.

lt1 : loop_timer 1 , user selectable,
default is 800 seconds .

lt2 : loop_timer2 , user selectable,
default is 10800 seconds

minwait : time without any control, user
selectable, default is 200 seconds

..

L0 : Any precision

L1 : Precision > $1 \cdot 10^{\text{exp}-9}$

L2 : Precision between $5 \cdot 10^{\text{exp}-10}$ and $1 \cdot 10^{\text{exp}-9}$

L3 : Precision between $1 \cdot 10^{\text{exp}-10}$ and $5 \cdot 10^{\text{exp}-9}$

L4 : Precision between $5 \cdot 10^{\text{exp}-11}$ and $1 \cdot 10^{\text{exp}-10}$

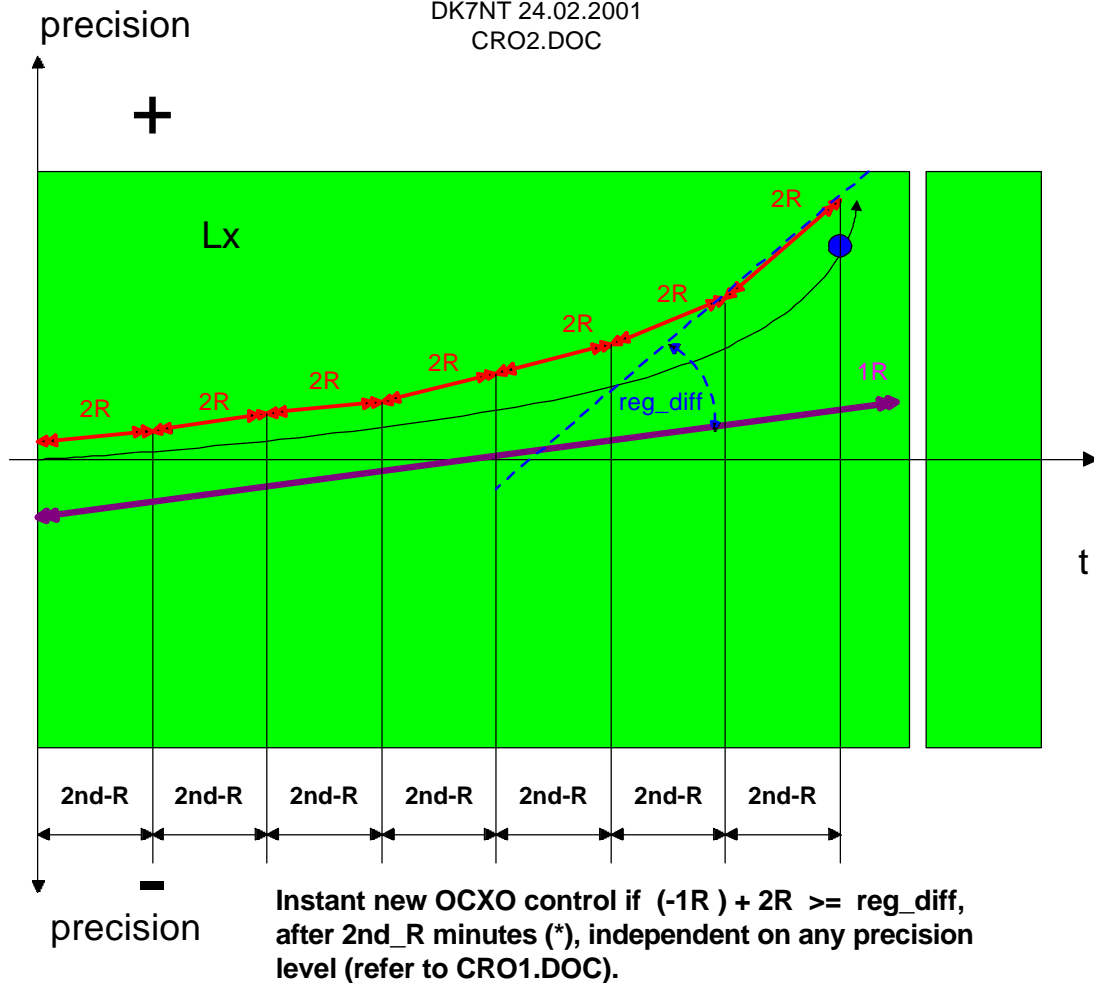
L5 : Precision between $1 \cdot 10^{\text{exp}-11}$ and $5 \cdot 10^{\text{exp}-11}$

L6 : Precision between $< 1 \cdot 10^{\text{exp}-11}$

Annex B:

Schematic of GPS/TV-CRO VCO control mechanism, with additional second regression calculation.

DK7NT 24.02.2001
CRO2.DOC



1R Result of 1st regression calculation, however formatted

2R Result of 2nd regression calculation, however formatted

reg_diff Difference between 1st regression and 2nd regression. 1..255 , default 10.

Lx any level (L1...L6)

● Point of OCXO control.

2nd-R Time for 2nd regression calculation. 0.. 255 minutes.
user selectable, default 0 (2nd regression off)

(*) blocked if 2nd_R < 3 minutes.