DIGITAL SYNCHRONIZING UNIT

KS3.2

SERVICE MANUAL

CE

CONTENTS

1. APPLICATION

The KS3-2 digital synchronizing unit is destined to synchronize generators during their coupling in parallel to the network or other generators working at the rated 50 or 60 Hz frequency. The full synchronization is obtained at the moment when follows the equalization of the voltage, frequency and phase angle. The phase angle difference of signals from the generator and the network is indicated by the synchroscope which has the shape of a circle of diodes.The voltage difference between the generator and the network in the -20%...0...+20% interval is indicated by the upper horizontal line ΔV, which the zero in the middle. The lower horizontal diode line with the zero in the middle, designated Δf, indicates the frequency difference of signals from generator and the network in the -10%...0...+10% (45...55 Hz) interval. The green diodes on horizontal bargraphs and diodes inside the circle are lighting on the unit frontal plate at the moment when the synchronization is reached.

The unit includes two relay outputs. One of the relay signal indicates the moment when we reach the synchronization. The second relay signals the measuring range exceeding of the chosen quantity.

2. DELIVERY SPECIFICATION

The KS3-2 synchronizing unit set includes:

- KS3-2 synchronizing unit.....1pc
- screw holders fixing the unit on a panel 4pcs
- service manual 1pc
- guarantee card 1pc

3. BASIC REQUIREMENTS AND USER'S SAFETY

KS3-2 synchronizing units are intended to be installed in panels, switchboards and cubicles They are in conformity with IEC 1010-1+A1 (1996) safety requirements.

Remarks concerning safety:

The unit installation should be carried out by a qualified staff.
One must consider all accessible aspects of the protection.
The instrument lefs the factory in perfect condition regarding technical safety. In order to maintain this condition and to ensure safe operation, the user must comply with indications and markings contained in the following instructions:

- Before mounting, ensure that the operating voltage and mains voltage set are the same, and then proceed with installation.
- The power supply must be connected as shown in the relevant diagram.
- Before the switching on, check the correctness of meter connections
- Before any maintenance and/or repairs, whenever the instrument must be opened, it must be disconnected from all power sources.
- Maintenance and/or repairs must be carried out only by qualified authorized personnel.
- If there is ever the suspicion that safe use is no longer possible, the instrument must be taken out of service and precautions taken against accidental use.
- Operation is no longer safe when:
  - there is clearly visible damage,
  - the instrument no longer functions,
  - after lengthy storage in unfavorable conditions,
  - after serious damage incurred during transport.

Operator safety

The instrument described in this service manual is intended for use by properly trained staff only.

Maintenance and/or repairs must be carried out only by authorized personnel.

For proper, safe use of the instrument and for maintenance and/or repairs, it is essential that the persons instructed to carry out these procedures follow normal safety precautions.

Precautions in case of breakdowns

If it is suspected that the instrument is no longer safe, for example due to damage incurred during transport or use, it must be taken out of service and precautions taken to prevent accidental use.

Contact authorized technicians for checks and any repairs.

4. INSTALLATION

4.1. Fixing way

One should cut-out a hole of $138^{+0.5}$ x $138^{+0.5}$ mm dimensions in the panel and fix the synchronizing unit by means of four screw holders. The unit housing, which overall dimensions are 144 x 144 x 77 mm, is made of self-extinguishing plastics. The screw terminal strips enable the connection of external conductors which maximal cross-section is 2.5 mm^2.

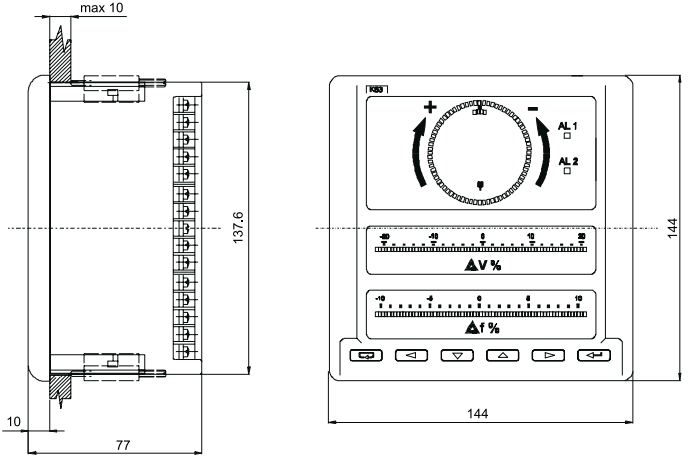
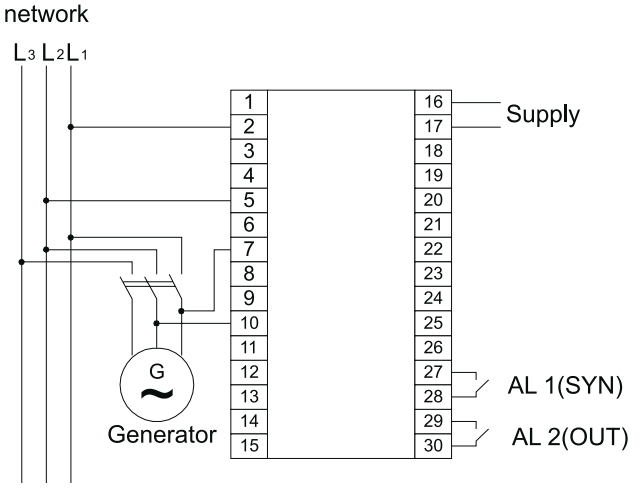


Fig. 1. Overall dimensions and fixing way of the KS3-2 unit

4.2. Scheme of external connections



CAUTION: before connection check the phase sequence

Fig. 2. Connection scheme

5. SERVICE OF THE KS3-2 UNIT

5.1. Frontal plate

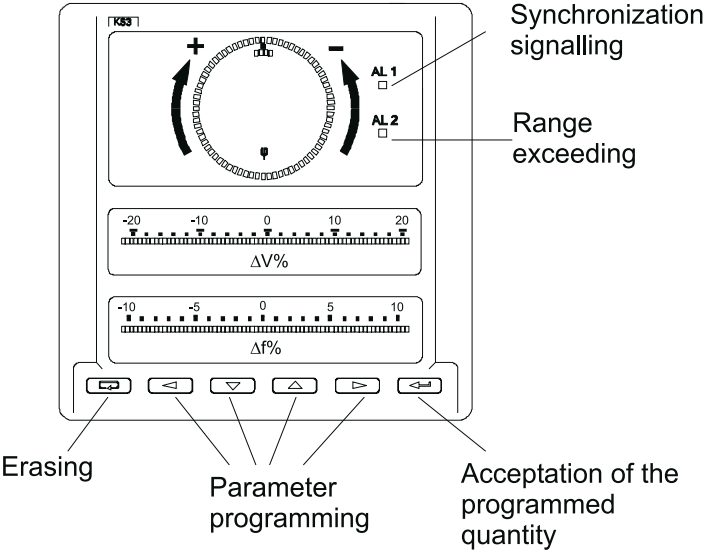


Fig. 3. View of the KS3-2 unit frontal plate

5.2. Working modes of the KS3-2 synchronizing unit.

Table 1

Working mode calling Designation	Entry	Exit
1. Measuring mode		Through the entry into another mode
2. Parameter configuration mode	In the configuration procedure	or after the last parameter
3. Interface configuration mode	In the configuration procedure	or after the last parameter

After its switching on, the unit makes an autotest and lights all diodes. This sequence occurs after each start of the unit. The measuring mode begins after carrying out tests.

5.2.1. Measurement functions of KS3-2.

The KS3-2 synchronizing unit ensures the measurement of: difference of RMS voltage and frequency in measuring circuits of the network ($U_{network1}$, $f_{network1}$) and the generator (U_{gen}, f_{gen}).

$$\Delta U = \frac{U_{gen} - U_{net}}{U_{net}} \cdot 100 \qquad \Delta f = \frac{f_{gen} - f_{net}}{f_{net}} \cdot 100$$ and the phase angle (φ).

A lighting point on each bargraphs informs about the value of the given parameter. The synchroscope enables the identification of the phase rotation direction, at $\Delta f < 5\%$ of the network frequency. The lighting point of the synchroscope rotates in the clockwise direction when the

frequency of the switched on generator is higher than the network frequency. At the generator frequency smaller than the network frequency, the lighting point rotates in the anti-clockwise direction. When one of the two quantities (Δ f, Δ V) exceeds the measuring range, the Alarm[2] (OUT) is being activated.

The signalling of each alarm can be confirmed by switching on the attributed relay. Functions of Δ f and Δ V value interval atributions for the synchronization alarm switching on and the activation of relay outputs are settled in the configuration alarm mode.

In the execution with an interface, the unit additionally ensures the measurement of the voltage RMS value and the frequency in the network ($U_{network}$, $f_{network}$) and generator (U_{gen}, f_{gen}) measuring circuits. The KS3-2 synchronizing unit also enables the measurement of minimal and maximal voltages and frequencies.

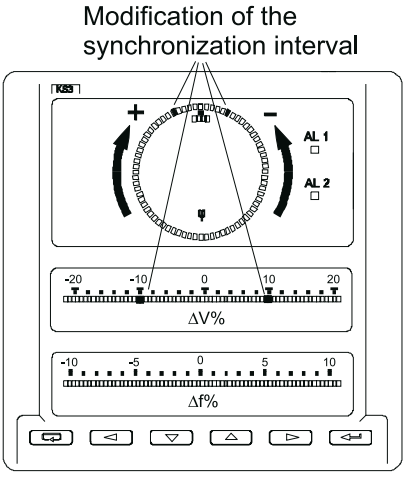
Voltages are multiplied by the set voltage ratio of measuring transformers.

5.3. Configuration

To enter into the configuration mode one should press two keys: ◄ and ► during ca 3 seconds, till the switching of the sound signal off.

One choose the parameter by means of ▼ ▲ keys. The active parameter is signalled by flashing.

Modifications are introduced by the ► key while increasing the interval and the ◄ key while decreasing the interval.



The displayed interval is defined by two pairs of symmetrical diodes regarding the middle of the line. Manufacturer's values are: for ΔU=1% $U_{network}$ and for $\varphi = \pm 2°$ (el.)

5.3.1. Alarm configuration

Interval ΔV parameter Table 2

Position	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Displayed value	<-2,2>	<-4,4>	<-6,6>	<-8,8>	<-10,10>	<-12,12>	<-14,14>
Interval for the synchro-nization	±0.2	±0.4	±0.6	±0.8	±1.0	±2.0	±3.0

Interval φ parameter

The range changes through the displacement of two lighted diodes on the synchroscope circle symmetrically regarding the 0° point. While moving from this point away, one causes the transition to the succeeding range.

Table 3

Range	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Interval for the synchro-nization	359...1	358...2	357...3	356...4	355...5	354...6	353...7	352...8	351...9	350...10

The configuration for the alarm output is carried out by [▼] [▲] keys, by choosing the screen of the appropriate alarm. The relay operation is activated by the [◄] key and released by the [◄] key. The lighting of diodes in the alarm screen corresponds suitably to this. When the relay is not assigned, the alarm is only signalled by lighting. This concerns both the alarm synchronization and the measuring range exceeding. Marking the green diodes on the synchroscope circle, we set on the bargraph the automatic synchronization switching on after a supply voltage decay. The parameter switching off causes a lack of reaction to the synchronization moment. In order to activate the process one must enter into the configuration procedure and next, without changing the setting, come back into the measuring mode.

Table 4

Parameter name	**Range**	**Remarks / Description**	**Manufacturer's value**
Synchronization alarm, modification range of voltage difference	0.2...1 [%] m.v. (step 0.2 [%] m.v.) 1...3 [%] m.v. (step 1 [%] m.v.)	1...10 (for the interface) 11...13 (for the interface)	1
Synchronization alarm, angle modification range	1...10 [°]		2

m.v. = measured value

5.3.2. Interface configuration

After pressing [↵] in the alarm mode we are configuring the RS-485 interface. The interface has got a constant 9600 kBit/s baud rate. The device's address (1...10) is modified on the ΔV bargraph. To differentiate in the interface mode, the green diodes are constantly lighted on the bargraphs and we read out the value from the graduation.

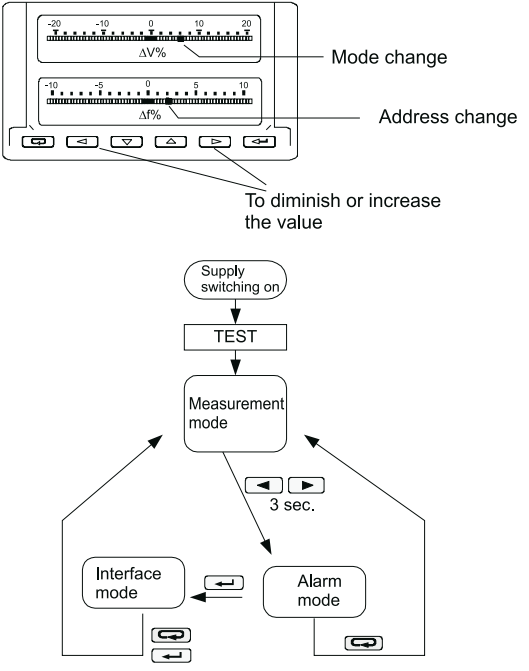


Fig. 5. Working modes of the KS3-2 unit.

6. RS-485 INTERFACE

6.1. Description

32 devices can work on one bus in the RS-485 standard. Interface sockets (2 x DB9) are situated at rear of the housing. One must use a screened strand to make the connection. The screening is necessary and the length of the installation can not exceed 1200 m. The hardware configuration defines the device number, the baud rate and parameters of the communication port.

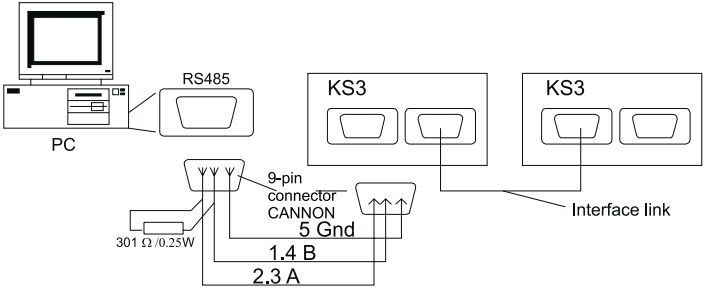


Fig. 6. Connection way of the KS3-2 interface.

Device number:	1....10
Baud rate:	9600 kBit/sec
Working mode:	1...6 (8N1, 7E1, 7O1, 8N2, 8E1, 8O1)
where:	N - no parity
	E - even parity
	O - odd parity

An asynchronous character communication protocol MODBUS is used in the device. This protocol is a standard taken by producers of industrial controllers for the asynchronous, character exchange of information between devices of measuring and control systems.

It possesses such features as:
- simple access rule to the bus, based on the master-slave principle,
- safeguard of transmitted messages against errors,
- confirmation of remote command execution and signalling of errors,
- efficient mechanisms to secure against the system suspension,
- to take advantage of asynchronous character transmission.

The information unit is the frame in ASCII or RTU code.

6.2. Register map

Data are located in 16-bit or 32-bit registers in the KS3 - synchronizing unit.
Process variables and meter parameters are located in the register address space in the way depended on the variable value type. Bits in the 16-bit register are numbered from the youngest to the oldest (b0 - b15). 32-bit registers include numbers of float type in the IEEE-745 standard.
The register map has been divided into following areas:

Address range	Value type	Description
4000 - 4006	Integer (16 bits)	The value is located in one 16-bit register. The table 5 includes the register description. Registers can be read out and written.
7500 - 7518	Float (32 bits)	The value is located in one 32-bit register. The table 6 includes the register description. Registers can only be read out.

Contents of 16-bit registers with addressses from 4000 to 4007.

Table 5

Register address	Unit, address	Description address
4000	1...4000	Voltage transformer ratio
4001	0...9999	Access code
4002	0.1	Synchronization relay switching on **0 - OFF, 1 - ON**
4003	0.1	Range exceeding relay switching on **0 - OFF, 1 - ON**
4004	0...13	Settlement of the ΔV interval acc. table 4
4005	0...10	Settlement of the φ interval acc. table 4
4006	0...10	Delay of synchronization alarm switching on
4007	0.1	Automatic activation A1_0

Table 6

Register address	Symbol	Unit	Description address
7500	U_1	V	Network voltage
7501	U_2	V	Generator voltage
7502	f_1	Hz	Network working frequency
7503	f_2	Hz	Generator working frequency
7504	ΔU	%	Voltage difference
7505	Δf	%	Frequency difference
7506	$\Delta\varphi$	° (el)	Phase angle
7507, 7508	$minU_1$, $maxU_1$	V	Min. and max. value of the network voltage
7509, 7510	$minU_2$, $maxU_2$	V	Min. and max. value of the generator voltage
7511, 7512	$minf_1$, max f_2	Hz	Min. and max. value of the network frequency
7513, 7514	$minf_2$, $maxf_2$	Hz	Min. and max. value of the generator frequency
7515, 7516	minΔU, maxΔU	%	Min. and max. value of the voltage difference
7517, 7518	minΔf, maxΔf	%	Min. and max. value of the frequency difference

7. TECHNICAL DATA

- **Measuring ranges and admissible basic errors**

Table 7

Measured quantity	Range	Basic error	Notes	Resolution
Voltage U_i*	100.0 V (Ku = 1) 110.0 V (Ku = 1) 230.0 V (Ku = 1) 400.0 V (Ku = 1)	±(0.2% m.v. +0.1% of range	Ku=1...4000 (max 400 kV)	-
Frequency f*	15.0...500.0 Hz	± 0.5% m.v. +2d		-
Voltage difference	-20...0...20%	± 0.5% of range +1 diode		0.6% $U_{network}$
Frequency difference	-10...0...10%	± 0.2% of range +1 diode		0.3% $f_{network}$
Phase angle	0...360°	± 1°		5°, 2°, $\varphi < 3°$

* quantities accessible through the interface
where: Ku = voltage transformer ratio, m.v. = measured values, d = digit

- **Additional errors**
  in % of the basic error:
  - from the fraquency of input signal — < 50%
  - from ambient temperature changes — < 50%/10 °C

- **Measuring inputs**
  - phase-to-phase input voltage — Un = 100, 110, 230, 400 V
frequency = 15...45...65...500 Hz
sinusoidal signal (TDH ≤8%)
  - momentary overload capacity (5 sec) — 2Un (max. 1000 V)
  - admissible voltage peak factor — 2

- **Interface RS-485**
  - baud rate — 9600
  - protocol — MODBUS, ASCII, 8N1, ASCII 7E1 ASCII 701, RTU 8N2, RTU 8E1, RTU 801

- **Relay outputs**
  - relays — voltage less make contacts
  - load capacity — 250 V~ / 0.5 A~
  - life time depending on $\cos\varphi$ — in the AC1 category: 1.5×10^5, $\cos\varphi = 1$ 10^5, $\cos\varphi = 0.4$, 250 V a.c.

- **Regarding field**
  - synchroscope — circle with 72 diodes
  - differential voltmeter — bargraphs with 68 diodes and the zero in the middle
  - differential frequency meter — bargraphs with 68 diodes and the zero in the middle

- **Supply**
  - supply voltage — 18...30 V d.c. a.c., 40...400 Hz 85...250V d.c. a.c., 40...400 Hz

- **Power consumption**
  - supply voltage — $\leq$ 12 VA
  - voltage circuit — $\leq$ 0.5 VA

- **Reaction to decays and supply recoveries** — Data and state preservation of the synchronization unit in case of any decay (battery support). Continuation of unit operation after the supply recovery.

- **Safety requirements** acc. IEC 1010-1+A1 (1996)
  - insulation ensured by the housing — double
  - insulation between circuits — basic

- installation category — III
- pollution degree — 2
- max. working voltage in relation to the earth — 600 V a.c.

- **Housing protection degree**
  - from the frontal side — IP40
  - from the rear side — IP10
- **Electromagnetic compatibility:**
  - immunity — EN - 5082-2 (1996)
  - emission — EN - 50081-2 (1996)

- **Rated operational conditions**
  - input signal — 0...0.01...1.2Un, for voltage frequency 15...45...65...500 Hz sinusoidal (THD ≤ 8%)
  - ambient temperature — 0...23...55°
  - air relative humidity — 25...95% (condensation inadmissible)
  - external magnetic field — 0...40...400 A/m

Housing

- frontal dimensions — 144 x 144 mm
- panel cut-out — $138^{+0.5}$ x $138^{+0.5}$ mm
- depth — 77 mm
- weight — 800 g (with packing)
- working position — arbitrary

8. EXECUTION CODES AND ORDERING PROCEDURE

Table 8

Synchronizing unit - KS3	X	XX	X	X	XX	X
Kind of display:						
- digital displays	1					
- bargraphs (diode lines)	2					
Input voltage:						
- 100 V		01				
- 110 V		02				
- 240 V		03				
- 400 V		04				
- on request, acc. order*		XX				
Digital output:						
- without interface			0			
- with an RS-485 interface			1			
Supply voltage:						
- 85...250 V d.c. a.c.				0		
- 24 V d.c. a.c.				1		
- on request, according order*				X		
Execution:						
- standard execution					00	
- custom-made execution*					XX	
Acceptance tests:						
- without additional requirements						0
- with a quality inspection certificate						1
- other requirements*						X

* The execution code will be settled by the manufacturer

ORDERING EXAMPLE

Code: KS3-2-04-1-0-00-1 means: a KS3 synchronizing unit, with bargraphs, input voltage: 400V, with an RS-485 interface, supply voltage 85...250 V d.c. a.c., standard execution, with a quality inspection certificate.

9. MAINTENANCE AND WARRANTY

KS3-2 synchronizing unit does not required any periodical maintenance. In case of some incorrect unit operation:

1. **After the dispatch date and within the period stated in the warranty certificate**
   One should return the instrument to the Manufacturer's Quality Inspection Dept. If the module has been used in compliance with the instructions, the Manufacturer warrants to repair it free of charge.
   The disassembling of the housing causes the cancellation of the granted warranty.
2. **After the warranty period:**
   One should send the instrument to repair it in an authorized service workshop. Spare parts are available for the period of five years from the date of purchase.

Our policy is one of continuous improvement and we reserve the right to make changes in design and specifications of any products as engineering advances or necessity requires and revise the above specifications without notice.

NOTE