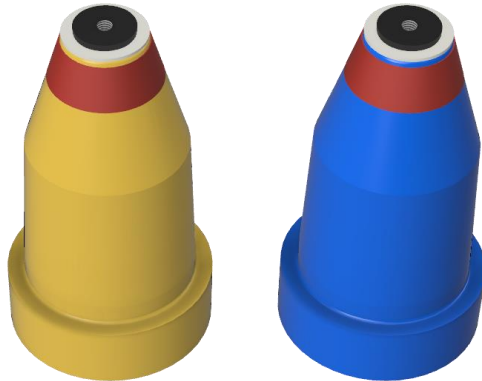


OPERATING AND MAINTENANCE MANUAL

Product: ***Wireless Phase Comparator***

Type: ***WPC***



MANUFACTURED BY:

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1 SAFETY RULES



- 1.1 Only personnel who are fully trained in the use of High Voltage Wireless Phase Comparators should use this equipment. The systems that it will be used on are powered from high voltages which can be lethal.
- 1.2 Before use ensure that the comparators and the accessories that are required for use are clean, free from cracks or deep scores, and are properly secured together.
- 1.3 Make certain that the comparators are properly rated for the voltage of the system under test.
- 1.4 Test the operation of the assembled comparators complete with accessories before and after each test (refer to Section 3).
- 1.5 Do not allow a live high voltage conductor to come in contact with the comparator at a point below the limit mark.
- 1.6 The comparators must never be used without a handle or without insulating rods incorporating a handle.

- 1.7 Safe working distances must always be observed.

- 1.8 The comparators viewing face must always be considered to be at the same voltage as the conductor under test. The safe working distance must always be from that viewing face.

- 1.9 Never attempt to touch the viewing face or press the test button should the LED's go out when the contact electrode is touching, or is in the vicinity of, the conductor under test.

REMEMBER

SAFETY IS NO ACCIDENT!

THIS TESTER SHOULD ONLY BE USED BY A COMPETENT,
SUITABLY TRAINED PERSON.

2 DESCRIPTIONS

2.1 GENERAL

The HVIL range of capacitive high voltage wireless comparators have been designed to meet the requirements of IEC standard 61481. They may be used indoors and outdoors in all weathers.

The comparators are intended for use on high voltage systems but not in switchgear.

Models are available to cover system voltages of 1kV up to 36kV. The function of the comparator is to determine whether a conductor is energised or de-energised and to detect and indicate the correct phase relationship between two energised lines at the same nominal voltage and frequency, using a Transmitter and Receiver

2.2 PRINCIPLE OF OPERATION

Cone shaped plastic mouldings house the Transmitter and Receiver comparators. The inner wall of the cone has a metallic screen coating to which the earthy parts of the circuit are connected. This screen coating is capacitively coupled to the earth of the electric field and acts as a voltage divider with an internal sensing capacitor. In this manner, high voltage appearing at the electrode is divided down and the voltage across the sensing capacitor is proportional to the voltage at the electrode with respect to earth.

This proportional signal voltage is fed to the electronic circuitry whose output drives an audible warning device and a system of indicating lamps.

The Receiver compares the Phase Relationship of the Line it is connected to, with the Line to which the Transmitter is connected
Indicating if the Lines are IN Phase or Out of Phase

Each unit must be used in conjunction with an insulating stick of the minimal insulating length, as required for the system voltage being used on.

Adaptors are supplied to connect to the Transmitter and Receiver units to various types of insulating sticks

2.3 *SELF ARMING MODE*

In this mode of operation, the Comparator automatically switches, on when an A.C. voltage greater than the set threshold voltage is applied to the contact electrode.

2.4 *INDICATING LAMPS and Audible Alarm*

Transmitter

Two RED LEDs are available

Receiver

One RED and one GREEN LED are available, and the unit is equipped with a Buzzer




2.5 *LIMIT MARK*

At the narrow top end of the comparator housing there is a red band which indicates the limit mark. By definition the limit mark

indicates the physical limit to which the comparator may be inserted between live components or may touch them. However, when the comparator is used with a contact electrode extension the shroud of the extension covers the limit mark. In some models the shroud is clear, and the limit mark is still visible but in others it is coloured red and the shroud itself constitutes the limit mark.

2.6 LABELLING

The information shown is as follows:

	<p>Read and understand the instruction manual before using the Comparators.</p>
	<p>Suitable for Live Working Designed and manufactured to meet the requirements of IEC 61481 phase comparators for voltages of 1kV to 36Kv A.C</p>
	<p>Meets EMC standards BS EN 50081-1 and BS EN 50082-2.</p>
<p>WPC TYPE XXXX</p>	<p>A unique identification for each model</p>
<p>VOLTAGE XX/XXkV</p>	<p>Indicates the system voltage or range been that the comparators can be used on</p>
<p>FREQUENCY 50/60Hz</p>	<p>The comparator will operate over the frequency range 50Hz/60Hz</p>

<p>SERIAL No. XXXXXXX</p>	<p>The year/month of production and a number are shown which gives traceability of features and threshold voltage</p>
<p>CLIMATIC CLASS</p>	<p>Normal</p> <p>The comparators will perform correctly over the temperature range -25°C to +55°C and in 20% to 96% humidity.</p> <p>Outdoor</p> <p>The comparators are suitable for use either indoor or outdoor and in wet conditions.</p>
<div style="border: 2px solid black; border-radius: 15px; padding: 10px; text-align: center;"> <p>BATTERY PP3-C IEC 6LF22 MANAGNESE ALAKLINE</p> </div>	<p>Identifies the type of battery that is recommended for use with the comparators.</p>

3 INSTRUCTIONS FOR USE

3.1 ACCESSORIES

NAME	DESCRIPTION	PART No	USED ON SYSTEM VOLTAGES
CONTACT ELECTRODE EXTENSION	100mm RED SHROUD	DFH 5053	ALL
CONTACT ELECTRODE EXTENSION	250mm RED SHROUD	DFH 5039	ALL
CONTACT ELECTRODE EXTENSION	650mm RED SHROUD	DFH 5054	UP TO 33kV
CONTACT ELECTRODE EXTENSION	1000mm RED SHROUD	DFH 5034	UP TO 33kV
STRAIGHT CONTACT ELECTRODE		CMH 0110	ALL
"Y" CONTACT ELECTRODE		CMH 0111	ALL
HOOK CONTACT ELECTRODE	40mm	DDM 5009	ALL
HOOK CONTACT ELECTRODE	60mm	DDM 5008	ALL

HVOM0002-G2

HOOK CONTACT ELECTRODE	100mm	DDM 5010	ALL
PROVING UNIT		HVP 03	
POLE ADAPTOR	BOWTHORPE	DDC 5025	ALL
POLE ADAPTOR	UNIVERSAL STAR WHEEL	DDC 5054	ALL
POLE ADAPTOR	KARL PFISTERER	DDC 5039	ALL
POLE ADAPTOR	CHANCE	DDC 5055	ALL
*ADAPTORS FOR OTHER POLE SYSTEMS AVAILABLE TO ORDER			
EXTENSION POLES			
TOP BOWTHORPE	1200mm	CMH 5045	USED IN COMBINATIONS
INTERMEDIATE BOWTHORPE	1200mm	CMH 5046	WORKING DISTANCES BEING OBSERVED
BOTTOM BOWTHORPE	1200mm	CMH 5047	
(FOAM FILLED) BOWTHORPE	1200mm	CMH 5051	FOR ALL VOLTAGES,
HANDLE - FIXED - (FOAM FILLED)	1200mm (860mm)	DDM5013	UP TO 33kV (1)

HANDLE - FIXED	1200mm (860mm)	DDM5018	UP TO 33kV (2)
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3.2 ASSEMBLING THE EQUIPMENT

3.2.1 For use on overhead lines and bus-bars up to 33kV.

Select a contact electrode to suit the application (40mm hooks are supplied as standard) and screw it to the comparator. If the straight or "Y" electrode is selected it may be necessary to use a 100mm or 250mm contact electrode extension so that the contact electrode can be seen more easily from ground level. This short extension is screwed to the comparator and the contact electrode screwed to it. Attach the required number of extension poles to the comparator using an adaptor or handle. If tests are to be carried out on system voltages in areas where interference fields could affect the indications, then a contact electrode extension should be used.

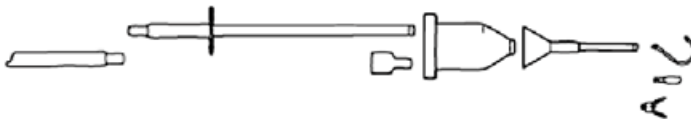


Figure 1a



Figure 1b

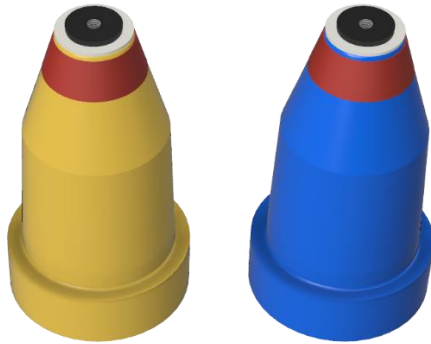


Figure 2 The Comparator Transmitter (TX—Yellow Cone) and the Comparator Receiver (RX—Blue Cone)

The **Comparator Transmitter (TX—Yellow Cone)** and the **Comparator Receiver (RX—Blue Cone)** are supplied with two types of Pole adaptors and a 40mm Hook as standard, other accessories can be supplied on request.

3.3 USING THE EQUIPMENT

3.3.1 *Assemble the equipment as required: refer to Section 3.2.*

3.3.2 *Proving*

Transmitter

(Yellow Cone and 2x RED LED's)

Press the Proving button to check the function of the internal circuitry and the condition of the battery.

The 2x RED LED'S will flash for approximately 5 seconds, after which time both RED LED'S will remain on continuously, the Transmitter is now sending a signal to the Receiver.

Receiver

(Blue Cone, 1x RED LED, 1x GREEN LED, and a BUZZER)

Press the Proving button to check the function of the internal circuitry and the condition of the battery.

The RED LED will flash for approximately 5 seconds and remain on continuously, after which time the GREEN LED will come on for approximately 5 seconds then go off for 5 seconds (repeated as long as the Prover button is pressed). When the Receiver receives a signal from the Transmitter, the Buzzer will sound each time the Green LED comes on

This proves both units are communicating with each other

Should the proving not work as described above, please change the batteries (refer to Care and Maintenance Section). If the comparators still don't prove correctly, then there is a fault, and they should be returned to the manufacturer for repair.

This Proving Test will confirm the proper operation, it will also check the battery voltage and the internal circuitry of each unit.

It will not check the input circuits; this will be done when the unit is presented to a known live source the RED LEDs should come on as described above.

3.3.3 *Self Arming*

Transmitter

When the Transmitter is presented to a Live Line, if the voltage on the Line is greater than the set Threshold voltage both RED LEDs

on the Transmitter will Flash for approx. 5 seconds then come on continuously

At this time the Transmitter sends a radio signal to the Receiver regarding the condition of the line

Receiver

When the Receiver is presented to a Live Line, if the voltage on the Line is greater than the set Threshold voltage the RED LED will flash for approx. 5 seconds, then light continuously.

When the signal is received from the transmitter, it is compared with that of the receiver

3.3.4 Receiver Phase Indication

IN Phase

Receiver

If the signal received from the Transmitter is $\leq \pm 10^\circ$ of the signal on the Receiver, the GREEN LED will Light continuously, and the Buzzer will sound continuously

OUT of Phase

Receiver

If the signal received from the Transmitter is $> \pm 20^\circ$ of the signal on the Receiver, the RED LED will Light continuously the GREEN LED will not come on and the Buzzer will not sound

4 SPECIFICATIONS

4.1 ELECTRICAL

Threshold Voltage	For the 11kV / 33kV voltage comparator the threshold voltage has been set in the range 1.3kV. The threshold may be set to a value agreed with the customer. Accuracy of threshold voltage: $\pm 10\%$ of nominal set level.
Operating Time	Transmitter and Receiver will only operate if the Proving Button is pressed or a voltage above the Threshold is encountered.
Response Time	Less than 1 second.
Spark Protection	The comparators will not be damaged as a result of spark discharge while making contact with the conductor under test.
Bridging Protection	The comparators and their accessories will not cause flashover or breakdown between live parts of the installation or between live parts of the installation and earth.
Range	30m in air (To Be Determined) Along a Network to Be Determined
Operating Frequency	433.9MHz
Phasing Indication	Positive indication for correct phase relationship

IN Phase	When the phase shift angle is (less than or equal to) $\leq \pm 10^\circ$
Out of Phase	when the phase shift angle is (greater than) $> \pm 20^\circ$
Current Consumption	45mA maximum
Battery Low	7.2V nominal (Arming via the testing/arming button is inhibited at this voltage but self-arming from signals is maintained down to 6.8V.)
Battery	9 V manganese alkaline PP3-C IEC 6LF22
Visual Indication	<p>Transmitter—</p> <p>Voltage Present: 2x Red LED's</p> <p>No Voltage Present: No LED's</p> <p>Receiver—</p> <p>Voltage Present: 1x RED LED</p> <p>No Voltage Present—No LED</p> <p>IN Phase Green LED continuous</p> <p>Out of Phase No Green LED</p>
Audible Indication	Buzzer present when IN-Phase is indicated >65dB at 5 metres
EMC	Meets BS EN 50081-1 BS EN 50082-2

4.2 **MECHANICAL:**

4.2.1 Comparators:

Transmitter / Receiver	Length:	180mm
	Diameter:	100mm
	Material:	ABS

4.2.2 Electrodes:

Straight	Length: 40mm Material: Stainless Steel
“Y”	Length: 35mm Width: 40mm Material: Stainless Steel
Hook	Diameter: 40, 60 or 100mm Material: Stainless Steel / Aluminium

4.2.3 Contact Electrode Extensions

Contact Electrode Extensions	Length:	100, 250, 650, 1000mm
	Material:	PVC / Stainless Steel

4.2.4 Pole Adaptors

Bowthorpe	Length:	125mm
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(DDC5025)	Diameter: 46mm Material: Acetal / Steel
Universal Star Wheel (DDC5054)	Length: 95mm Diameter: 27mm Material: Acetal / Steel
Karl Pfisterer: (DDC5039)	Length: 85mm Diameter: 25mm Material: Acetal / Steel

4.2.5 *Handles*

DDM5018	Length: 1200mm total (Bowthorpe Top) (Fixed 860mm insulating element length from hand guard) Material: Fibreglass/PVC
DDM5022	Length: 1200mm total (Bowthorpe Bot) (Fixed 860mm insulating element length from hand guard) Material: Fibreglass/PVC
CMH5054	Length: 2000mm total telescopic 450mm or 1050mm insulating element length Material: Fibreglass
Extension Poles	Length: 1200mm total Material: Fibreglass

4.2.7 Other

Vibration Resistance	In accordance with (IEC 68-2-6 Test Fc). The indicator and contact electrode are subjected to sinusoidal vibrations in two perpendicular directions. The frequency ranges from 10Hz to 500Hz and the duration of the sweep is set at 2hours for each direction. The test is considered passed if the comparator shows no apparent mechanical deterioration.
Drop Resistance	In accordance with (IEC 68-2-32 Test Ed). The voltage comparator is dropped from horizontal. and vertical positions from a height of 1m onto a test surface of concrete.
Shock Resistance	In accordance with IEC 1243-1 Test 6.4.5. Five mechanical shocks are performed on the most fragile parts of the indicator. The test is passed if the comparator shows no incipient fracture.
Cleaning Kit	Cloth and bottles of polymer liquid.

4.3 ENVIRONMENTAL

Operating Temperature	-25°C to +55°C
Operating Humidity	20% to 96%
Cold	IEC 68-2-1 Test 2Ab
Dry Heat	IEC 68-2-2 Test 2Bd
Damp Heat	IEC 68-2-3 Test 2Ca

Change of Temperature	IEC 68-2-32 Test N
Precipitation	IEC 1243-1 Test 6.3.3

5 CARE AND MAINTENANCE

5.1 STORAGE

The comparators and their accessories should be stored in the proprietary carrying case/bag when not in use. If the equipment is not going to be used for an appreciable length of time (one month or more) then it is a wise precaution to remove the battery. Remember to replace the battery when the equipment is used again.

5.2 TRANSPORTING

When the equipment is in transit it should be stored in its carrying case/bag. Whilst the equipment has been designed for field use it should not be subjected to excessive bumps and shocks.

5.3 CLEANLINESS

Dirt can cause surface tracking and it is therefore necessary to keep the comparators and their accessories clean by using a detergent solution. The comparators and other plastic accessories should then be polished with the liquid polymer polish provided.

5.4 MECHANICAL DAMAGE

If surface scratches or dents can be easily seen by the naked eye, then the equipment should be returned to the manufacturer for repair since these blemishes act as traps for dirt and moisture. Mechanical damage to stud or bush screw threads would also necessitate the return of the equipment to the manufacturer.

5.5 PERIODIC MAINTENANCE

5.5.1 *Battery Replacement:*

It is expected that the battery life will be many months of normal use. It is recommended therefore that the battery be replaced every six months whether or not it is found to be satisfactory when testing/arming the comparator. The battery is located on the viewing face of the comparator. Its position is clearly indicated by a distinctive label. Undo the two captive fixing screws and remove the battery compartment cover. Slide out the battery and unclip the connector. Fit a new battery type IEC 6LF22 ensure that the fixing screws are properly tightened to provide a good water seal. There are no other replaceable spares.

5.5.2 *Recalibration and Proof Testing:*

Every twelve months the comparators and accessories should be rechecked. This should include checking the threshold voltage and the

IN-Phase and Out of Phase Calibration points.

Voltage proof testing of all the accessories is also recommended, this checking should be carried out by the manufacturer.

6

6.1 **INTERFERENCE VOLTAGES**

In certain situations, due to the dimensions or configuration of the installation, electrical fields capable of affecting the indication of the comparator may occur. Erroneous indication will only occur if the body of the comparator is situated within such a field. Correct indication can be achieved by applying the comparator to horizontal conductors away from bends or connections. Unambiguous indication of the comparator depends upon the capacitance of the comparator to earth being unaffected by other fields. Some examples of interference situations are shown in sections 3.4.1 and 3.4.2. A long contact electrode extension must be used to overcome the problems created by interference voltages. See 3.2.1 Fig 1b.

6.1.1. *In-Phase Interference*

This occurs when the conductor under test is adjacent to another conductor whose voltage is in-phase. The field which is then generated can act as a screen between the comparator and earth, thereby reducing the effective capacitance of the comparator to earth. This results in an increased threshold voltage which could mean that the comparator will not indicate that a conductor is live.

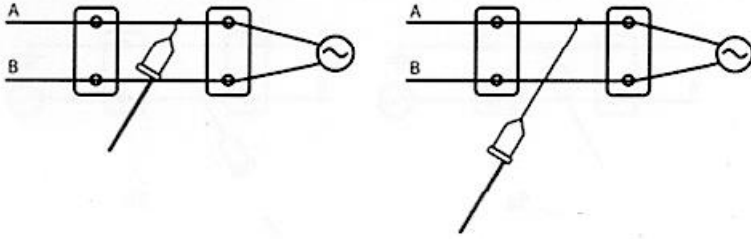


Figure 3a (left) and Figure 3b (right)

In Fig. 3a the comparator is applied to conductor A which is above conductor B. Both conductors are energised from the same phase and the field created by conductor B screens the detector from earth. This increases the threshold voltage of the comparator which may, therefore, not indicate. This is of course a dangerous situation.

On system voltages up to 33kV the introduction of the appropriate contact electrode extension in Fig. 3b removes the comparator from the interference field so that it will indicate correctly.

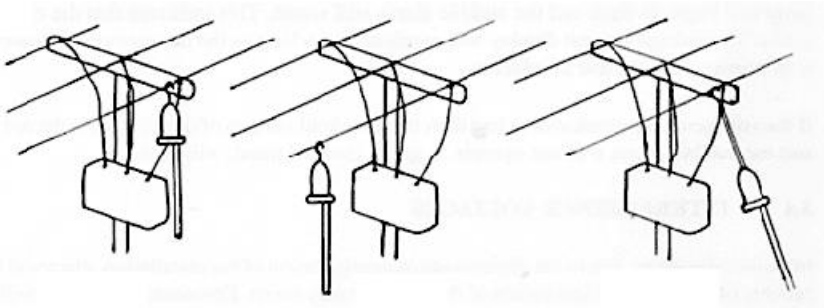


Figure 4: 4a (left), 4b (middle) and 4c (right)

Fig. 4 shows an installation where there is a pole mounted transformer and the conductor coming down from the cross arm to the transformer forms an approximate 90° bend. In Fig. 4a the comparator is applied such that the field created by the down bend

will interfere with the comparator's return path to earth and it will not indicate. Moving the comparator along from the bend as in Fig. 4b removes the comparator from the interference field and it will indicate correctly. Another solution is to use the contact electrode extension which again moves the comparator out of the interference field as in Fig. 4c.

6.1.2 *Phase-Opposition Interference*

If a conductor under test has adjacent conductors which are in phase opposition, then erroneous indication can occur. For instance, if the conductor under test is earthed and the comparator came close to a live conductor then it is possible that the comparator will indicate that the conductor under test is live. This, however, is a failsafe condition, although it is incorrect.

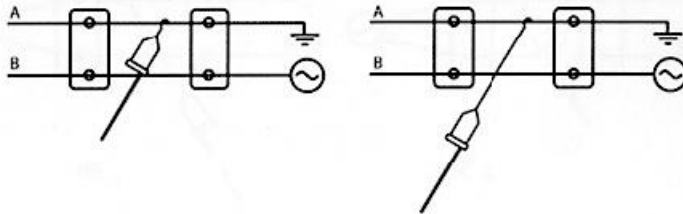


Figure 5a and Figure 5b

Fig. 5a shows two conductors A and B with A earthed and B energised. The comparator is applied to conductor A and the field created by conductor B will cause the comparator to indicate that conductor A is live. On system voltages up to 33kV the introduction of the appropriate contact electrode extension as in Fig. 5b, removes the comparator from the interference field and the comparator will indicate correctly

7 LIMITED WARRANTY

High Voltage Instruments Ltd warrant instruments and test equipment manufactured by them to be free from defective material or factory workmanship and agree to repair or replace such products which, under normal use and service, disclose the defect to be the fault of our manufacturing, with no charge for parts and service. If we are unable to repair or replace the product, we will make a refund of the purchase price. Consult the Instruction Manual for instructions regarding the proper use and servicing of instruments and test equipment. Our obligation under this warranty is limited to repairing, replacing or making refund of any instrument or test equipment which proves to be defective within twelve months from the date of original purchase.

This warranty does not apply to any of our products which have been repaired or altered by unauthorised persons in any way so as, in our sole judgement, to injure their stability or reliability, or which have been subject to misuse, abuse, misapplication, negligence or accident or which have had the serial numbers altered, defaced or removed. Accessories, not of our manufacture used with this product, are not covered by this warranty. To register a claim under the provisions of this warranty, return the instrument or test equipment to

**High Voltage Instruments Ltd,
15-16 Woodbridge Meadows
Guildford, GU1 1BJ, U.K.**

Upon our receipt and inspection of the product we will advise you as to the disposition of your claim.

ALL WARRANTIES IMPLIED BY LAW ARE HEREBY LIMITED TO A PERIOD OF TWELVE MONTHS, AND THE PROVISIONS OF THE WARRANTY ARE EXPRESSLY IN LIEU OF ANY OTHER WARRANTIES EXPRESSED OR IMPLIED.

The purchaser agrees to assume all liability for any damages and bodily injury which may result from the use or misuse of the product by the purchaser, his employees, or others, and the remedies provided for in this warranty are expressly in lieu of any other liability High Voltage Instruments Ltd may have including incidental or consequential damages.

High Voltage Instruments Ltd reserve the right to discontinue models at any time, or change specification, price or design, without notice and without incurring any obligation.

8. REVISION

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File: HVOM0002-G2.docx

Author: Mathew Clancy

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