

## **THE KELVIN HUGHES MS48 SOUNDER AND DIGITISER EVALUATION BY THE U. K. HYDROGRAPHIC DEPARTMENT**

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### **SYNOPSIS**

A sea evaluation of the Kelvin Hughes MS48 hydrographic echo sounder together with its digitiser was undertaken in July 1975 with a view to its possible future introduction into the RN Hydrographic Surveying Fleet. Particular attention was paid to all operational and physical characteristics, robustness and durability. Signal generators were used to examine those design specifications incapable of being tested by practical surveying operations.

### **INTRODUCTION**

The MS48 hydrographic echo sounder has been designed to meet current requirements for high precision surveying in shallow and medium depths (0-900 metres). A new automatic digital processor (ADO 2) has also been developed for the conversion of echo signals into digital form for data logging systems. An evaluation of this equipment was undertaken in H.M. Surveying Ship *Hecate* between 2 and 7 July 1975 whilst on passage from the United Kingdom to Gibraltar; this passage included many traverses on and off the Continental Shelf and provided ideal circumstances to evaluate such an echo sounder. The deeper section in Biscay allowed ample time for all physical parameters and characteristics of the analogue recorder to be thoroughly assessed, while the Continental slopes provided an excellent test area to assess the capabilities of the digitiser. The weather remained light to moderate for the duration of the passage; the sea state never exceeded 3-4 and was more often 2-3. At no stage was quenching experienced. Sea conditions were thus approaching the ideal for most of the trial period.

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## TECHNICAL SPECIFICATIONS

### 1.1 Analogue recorder

The recorder has a rectilinear stylus movement across dry electro-sensitive paper, providing a resolution of 10 mm per metre of depth on its shallowest (largest) scale. The recorder operates in a single mode with scales and ranges as follows :

Scale 20 : 0-80 metres in seven phases.

Scale 40 : 0-160 metres in seven phases.

Scale 80 : 0-320 metres in seven phases.

Scale 200 : 0-800 metres in seven phases.

The scales are selected by the left hand control (fig. 1) and the phases by the second from left ( $\emptyset$ ).

For extending the recording range beyond the limit of maximum phasing, a gating device enables alternate transmissions to be suppressed.

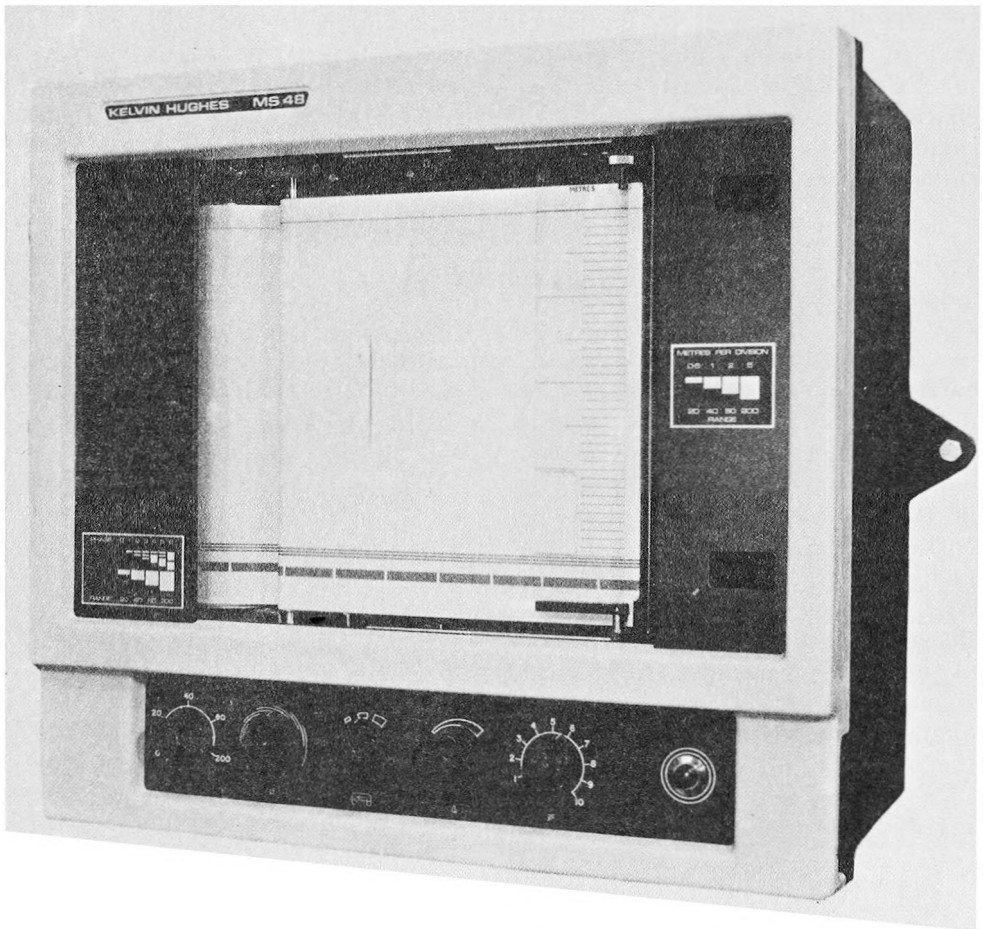


FIG. 1

The maximum depth obtained during the evaluation was in excess of 1 800 metres. The great flexibility of the recorder is most advantageous; there is for instance a facility to expand the range scale for greater discrimination in any of the deeper scales, by "round the clock" operation on a shallower range; this would be of great value in survey areas of specific importance between about 300-700 metres depth when examining particular obstructions or areas of special interest. A unique feature is the immediate indication of the scale and phase in use by coding marks on the echo trace; there is also visual indication of the minimum and maximum depths which can be recorded with the range and phase in use. A highly stable variable-speed motor drive system has been developed to enable the surveyor to set the stylus speed to correspond to the prevailing velocity of sound; this velocity is in turn clearly displayed on a digital readout, which is updated every second.

Changes in depth range are effected by changing the frequency of the motor supply, thus avoiding the use of a change-speed gearbox. The paper is driven by a separate motor, unaffected by adjustments of the stylus speed. Fix marks may be produced on the record by means of a push button or a foot-operated switch, and the fix signals may also be interfaced to other recording equipment if desired. The accuracy of the phase changes was examined by means of inject signals from a signal generator. There was negligible error throughout the seven phases, something that is not achieved by any other echo sounder.

### 1.2 Dimensions and weights

<i>Unit</i>	<i>Height</i>	<i>Width</i>	<i>Depth</i>	<i>Weight</i>
Recorder	525 mm	508 mm	265 mm	43.5 kg
Digitiser	250 mm	508 mm	205 mm	12 kg
Remote Display	140 mm	175 mm	67 mm	1 kg

### 1.3 Operating frequency

30 kHz transducers are employed and these can be fitted into the existing MS26 tanks, if required. The quality of the recording during the trial amply proved that the efficient use of a single 30 kHz frequency transducer is totally satisfactory for conventional hydrographic surveying.

### 1.4 Paper width

The total paper width is 254 mm, of which 200 mm is employed for depth data recording. The extra paper width allows space for more easily recognised range/scale and time interval marks, which are essential for ease of interpretation. The paper provided is not over-printed with scale markings, which facilitates the tidal reduction exercise.

### 1.5 Paper speed

The MS48 has three paper speeds producing a near contiguous trace on each range scale. The paper speeds are :

<i>Paper speed switch</i>	<i>Range 0-20 m</i>	<i>Range 0-40 m</i>	<i>Range 0-80 m</i>	<i>Range 0-200 m</i>
1	280 mm/min	140 mm/min	70 mm/min	28 mm/min
2	140 mm/min	70 mm/min	35 mm/min	14 mm/min
3	70 mm/min	35 mm/min	17.5 mm/min	7 mm/min

### 1.6 Sound velocity

The stylus speed is infinitely variable over a sound velocity range from 1320 to 1650 metres per second. It is controlled by a knurled thumb-wheel situated inside the front cover of the recorder. Changes in velocity of 1 metre per second are indicated by a crystal-controlled digital readout with 1 second update. When changing range scales the apparent velocity changes by up to 200 metres per second for a period of 5 seconds at worst but not usually greater than 3 seconds; this causes a momentary error in digitised depth but in no way degrades the overall performance of the equipment.

### 1.7 Gain control

One single gain control is provided externally for the operator, the adjustment of which in no way affects the performance of the digitiser. This one control has the facility of reducing the recorded analogue trace to a wisp or increasing it to excessive severity. There are also density, suppression and decay facilities situated on a subsidiary control panel within the front cover. These latter three need never be tampered with once the recorder has been properly set up. There is therefore one control only for the operator to "play with" and from which he can get the full range of sensitivity.

### 1.8 Minimum depth

Depths of less than one metre were recorded during boat trials carried out in Plymouth Sound. A bar check was carried out during the trial and this gave a good return when set at 2 metres (viz 1.4 metres below the transducers). Depths were digitised down to 1 metre during these boat trials. Whilst bar checking for transmission in the ship, a weak return was achieved when set 1 metre below the transducers; an excellent echo however was recorded with the bar set at 6 metres below the transducers. Digitisation was also good at 6 metres, but erratic at 1 metre.

### 1.9 Draft adjustment

The MS48 recorder can be adjusted for draft between 0.2 and 9.4 metres in 0.1 metre steps. The digitiser can be adjusted from 0.1 to 9.9 metres in 0.1 metre steps by the operation of a well-safeguarded thumb-wheel mounted within the digitiser outer cover. This thumbwheel also indicates the set draft/transmission for subsequent checking purposes.

### 1.10 Stylus speed accuracy

The long term accuracy of the MS48 stylus speed is better than 0.5 % consistent with variations in sound velocity. In the short term, ping to ping repeatability is not worse than 0.2 %. This compares favourably with all other echo sounding equipment tested.

### 1.11 Markings

There is adequate provision for an event marker; in addition there is very positive and instantaneous identification of the range and phase in use as soon as that particular range or phase is selected. The operation of the time interval mark is totally independent. This has great advantage in areas of rugged topography, where the echo sounder would have to be phased several times within the space of one minute. The facility eliminates the requirement for the operator to write anything but the fix number (if he desires) on the analogue trace.

### 1.12 Paper drive

The paper drive speed was checked by measuring the distance between consecutive time interval marks using different sound velocity settings. The result proved that the paper drive is totally independent of stylus speed, which is a most satisfactory arrangement.

### 1.13 General recorder specifications

Transmitter output .....	Nominal 1 kW at 30 kHz
Transmission pulse length .....	Nominal 0.33 ms
Receiver sensitivity .....	10 $\mu$ V in series with transducer to "just mark" the trace
Power supplies .....	230 V or 115 V AC, 50-60 Hz
Power consumption .....	140 VA nominal

## DIGITISER

### 2.1 Performance

The digitiser (ADO 2) (fig. 2) performed well during the evaluation and digitised round the clock to depths in excess of 1200 metres (dependent on echo quality) though at this depth it was not totally reliable. It has a reading accuracy of 0.1 metre with a maximum update rate of 10 per second. The analogue/digital feedback provides the facility to quickly check the data logged during the day with the analogue trace. It was extremely clear, well presented and infinitely superior to any other digital echo sounder evaluated.

A lot of time was spent traversing on and off the Continental slopes at various speeds in the Bay of Biscay in order to provide evidence of reliable digitisation down and up steep gradients. Although the general sea state during the trial was relatively calm, the digitising capabilities were generally excellent.

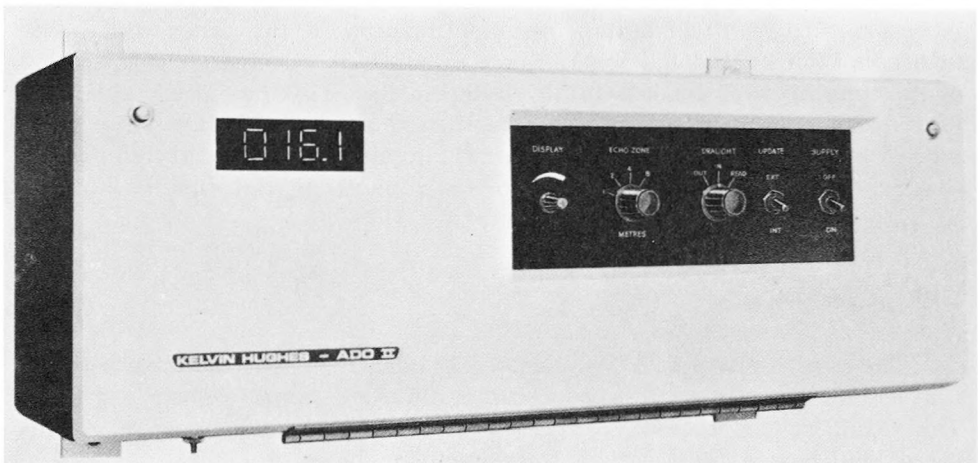


FIG. 2

### 2.2 General Specifications

Signal frequency .....	30 kHz nominal
Band width .....	3.3 kHz
AGC range .....	80 dB
Echo selection check .....	Marker on echo sounder recorder (digital feedback)
Readout units .....	metres (0.1 increments)
Measuring accuracy .....	$\pm 0.5\% \pm$ scale increment
Draft correction .....	up to 9.9 metres
Power supplies .....	230 V or 115 V AC, 50-60 Hz
Power consumption .....	70 VA nominal

Display .....	5 characters, each of LED construction
Character height .....	15.24 mm
Maximum update rate .....	10 per second

### 2.3 Remote display

A remote digital display (fig. 3) is provided for use with the digitiser in other compartments of the ship or boat as considered necessary. This has proved to be a reliable and worthwhile peripheral to the basic equipment. There is a dimmer control for night operations.

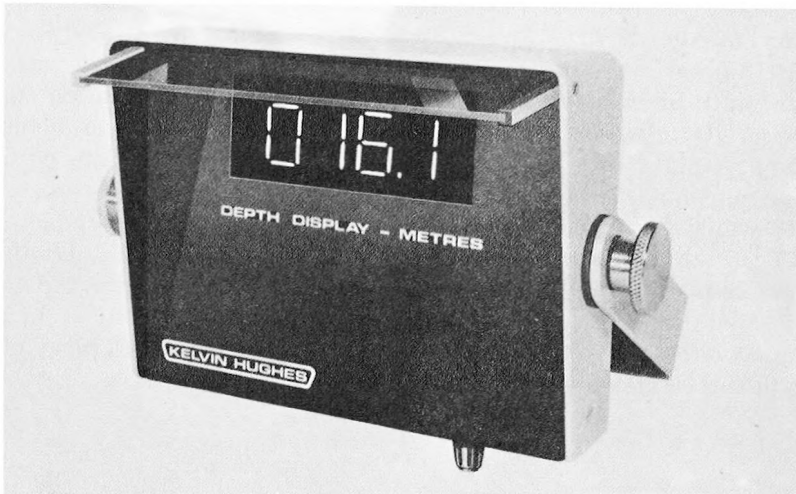


FIG. 3

## ENVIRONMENTAL TESTS

The equipment complies with Admiralty specification DEF 133 table N. 1 in respect of temperature, damp heat, vibration and water drip tests. All these tests were witnessed. For radio interference the equipment complies with British Standard 1597.

## DOCUMENTATION

Two commercially orientated and well written handbooks have been published, one for the MS48 recorder and the other for the ADO digitiser. Both volumes contain full information on diagnostic fault finding, maintenance and subsequent dismantling for repair. All information is well presented, with detailed diagrams.

### SUMMARY AND CONCLUSION

The sea evaluation of the MS48 echo sounder was the culmination of a series of trials and tests carried out on the factory work-bench and in harbour trials on the east coast of England. This included the whole series of environmental tests, which were undertaken to prove the equipment under all conditions likely to be encountered. The final sea trial in the Bay of Biscay demonstrated the full capabilities and flexibility of this new echo sounder. The whole system has been ergonomically designed, and it was noteworthy that there were barely any unfavourable comments from any of the Hydrographic Surveyors serving in the ship at the time. All the exterior controls in the MS48 are well recessed, positive in operation and unambiguously labelled; the trace illumination together with the digital readout lighting has been well designed to blend with either day or night operations. The inherent accuracy in the equipment — and in particular when phasing — leaves nothing to be desired. The ease with which the paper rolls can be changed is also commended. Whilst the 230 V or 115 V power requirement may be considered disadvantageous, it is understood that Kelvin Hughes provide a suitable inverter (inbuilt) for 24 V operation. The robustness of the system lends itself to service in the most alien environments, whether it be Arctic or tropical climates or open to the elements in a 6-metre survey motorboat.

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In January 1976 the MS48 echo sounder was accepted by the Royal Navy as the new generation sounder for the Hydrographic Surveying Fleet. A total of twelve ship hulls will be fitted with two systems each, and a further thirty-two 9-metre boats will also receive one system each. The ship fitting will take place in line with the normal refit cycle of surveying ships during 1977 and 1978. Currently one ship and five boats are using the equipment at sea.