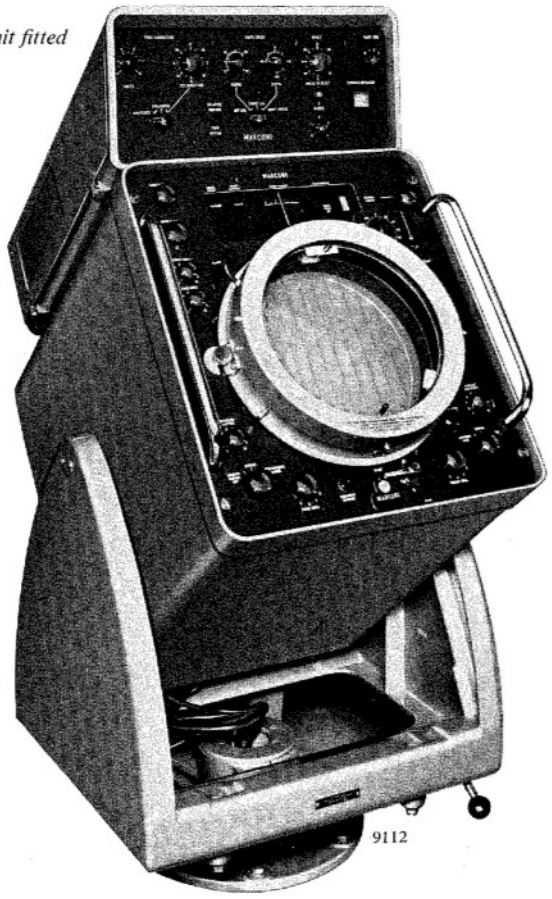
3 cm Marine Radar Equipment NR 506 Series

The conventional display unit fitted with a reflection plotter.



The NR 506 series of marine radars provide the most effective and advanced form of plan-position (PPI) presentation of radar navigational information. The latest design techniques both electronic and mechanical, where advantageous from the viewpoints of performance and reliability, have been incorporated.

Features

First true-motion radar with instant selection of compass-stabilized ship's-head-up or North-up presentation.

12 in. high definition, high brilliance cathode-ray tube.

Up to three display units, having independent control of range scale, mode of presentation, range and bearing markers, etc., may be operated up to 1000 ft (300 m) from the transmitter/receiver unit.

Exceptionally short pulse (0·07 μs) and 25 Mc/s-wide passband in receiver, maintaining crisp picture definition on shortest ranges.

Automatic seven-fold multiplication of pulse length and narrowing of receiver bandwidth ensure maximum performance on longer ranges.

Receiver incorporates automatic frequency control.

Logarithmic receiver and differentiator circuits improve performance under conditions of sea clutter or rain storms.

Built-in overall performance monitoring system.

Electronic parallax-free bearing indicator provides direct reading of relative or true bearings.

With true-motion facility, display may be off-centred in any direction to give an extended view.

Automatic resetting of true-motion tracking as own-ship approaches edge of screen. Manual resetting, by single-button operation, may be initiated at any time.

THE STABILIZED SCREEN PRINCIPLE

IF THE INFORMATION provided by a marine navigational radar is to be of full value in times of danger, it must be capable of immediate and easy interpretation. Under conditions of stress, the radar display picture can be most easily co-ordinated and best put to effective use if it is presented in the same orientation as the real situation beyond the wheelhouse windows. Also, a form of radar display incorporating compass stabilization must be employed to facilitate the evaluation of a situation of unchanging compass bearing, and to prevent any interruption of the picture on the display screen, or of the reflection plot, when 'own-ship' is obliged to alter course.

For many years it has been possible for the mariner to have either of the following alternatives only:

(a) The radar display in the natural ship's head-up alignment. Under this condition all target bearings are 'relative' and therefore have the variations of own-ship's heading superimposed upon them. The display picture may be subject to smearing due to yawing or changes of own ship's course.

(b) The benefits of compass stabilization with the display in North-up alignment. Under this condition, in the extreme case, the radar situation may be presented upside down with port and starboard reversed relative to the real-life situation.

There are obvious disadvantages in having an unstabilized ship's head-up alignment and the possible difficulty of rapid and

accurate co-relation of a North-up stabilized radar picture with the actual situation.

Now, with the introduction in the Marconi NR 506 Series Radar, using the stabilized screen principle, it is possible for the first time for the mariner to have the benefits of compass stabilization continuously at all times with either natural ship's head-up or North-up orientation. Thus, with the radar picture compass-stabilized in ship's head-up orientation, the picture is aligned with the real situation, all bearings are 'true', smearing of the picture or inaccuracies due to yawing are eliminated and the validity of earlier plots on the reflection plotter are not affected by alteration of own-ship's course.

With the addition of a true-motion indicator to the stabilized-screen display unit, the mariner can select at will any of the following forms of presentation, all incorporating compass stabilization:

Ship's head-up – relative motion – picture centred
Ship's head-up – relative motion – picture off-centred
Ship's head-up – true motion
North-up – relative motion – picture centred
North-up – relative motion – picture off-centred
North-up – true motion.

THE SERIES

Each radar of the NR 506 series consists of four groups of apparatus. These are:
(1) Display unit and true-motion indicator
(2) Transmitter/receiver unit
(3) Scanner unit
(4) Power supply.

Two 12-inch cathode-ray-tube display units are available. One incorporates the revolutionary stabilized screen principle, previously described. The other is a conventional type with provision for the addition of North-up compass stabilization and true motion.

The aerial may be either a 12 ft (3·6 m) or a 6 ft (1·8 m) slotted-waveguide array contained in a sturdy Fibreglass tube. The 12 ft aerial has a very narrow beamwidth. This gives great accuracy in bearing measurement, enhanced picture definition and increased pulse energy, which results in improved detection of small or long-range targets.

The NR 506 series complies with the British Ministry of Transport's Marine Radar Performance Standards, 1957, and also the applicable sections of Lloyds Regulations.

The stabilized-screen (SS) display unit.

9113

EQUIPMENT

Display units and true-motion indicator

The conventional and stabilized-screen (SS) display units are similar in appearance and are electrically interchangeable. Each display unit, contained in a light alloy cabinet of generally rectangular form, incorporates a timebase, video circuits, range rings, range marker, pulse brightening, servo system, electronic bearing indicator and EHT, including the requisite power supplies. The SS display also contains the system for stabilizing the screen.

Both display units may be supplied with or without the true-motion indicator. When fitted, this unit is mounted directly on the display unit so that the control panels of the display unit and the true-motion indicator unit form an integrated layout.

The display units are normally mounted on a trunnion giving adjustable tilt. Also a turntable giving azimuth adjustment can be supplied, thus enabling the display to be adjusted for any viewing angle.

The conventional display unit provides a relative-motion picture with ship's-head-up orientation, but compass-stabilized North-up orientation can be provided by the addition of an external unit. The SS display unit provides a compass-stabilized picture with either ship's head-up or North-up orientation. Thus, with the SS display, the navigator has the advantage of being able to select a radar picture directly aligned with the real-life situation and, in both conditions, all bearings are 'true'. With the true-motion indicator added to the conventional display, the PPI presentation can be switched to ship's head-up, North-stabilized or true-motion. The stabilized-screen display has the advantage that the true-motion indicator can be used either in the ship's-head-up or North-up orientation.

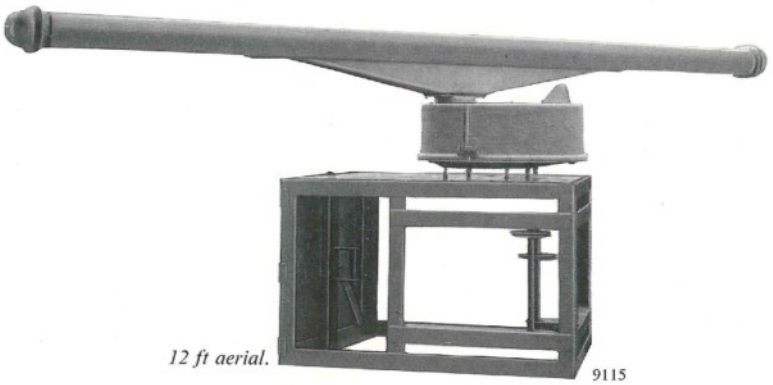
The true-motion indicator unit is self-contained, housing the ship's speed conversion circuits resolver integrators, amplifiers, reset and limit circuits, together with the requisite power supplies. It is electronic in action and almost fully transistorized. This unit is connected to the display unit by means of a pre-formed cable harness. The true-motion indicator will accept own-ship's speed information from a variety of ships' logs or shaft tachometers or, alternatively,

the ship's speed may be fed in by means of an artificial log. Provision is also made for course information to be fed in from a number of different types of gyro compass. Tidal correction facilities are also incorporated. The direction of off-centring or resetting is effected by a single control and a further control provides for the amount of off-centring in the selected direction. When own-ship approaches the edge of the screen it is automatically reset to the preselected position.

In addition, the reset circuits may be operated at any instant by depressing a single button on the front panel.

A switch located on the true-motion indicator causes the display to show either the TRUE motion or the RELATIVE motion of targets. One purpose of this switch is, during true motion working, to allow the tracking of own-ship across the screen to be temporarily halted, thus enabling the motions of all targets relative to own-ship to be observed. The 'relative motion' position of this switch also allows the true motion indicator to be used to provide an off-centred relative motion display to obtain an extended view in any direction. When so desired, the display can be instantly switched to present true motion.

The display units provide for the fitting of alternative viewing shades and/or a reflection plotter. When fitted to the stabilized-screen display unit, the reflection plotter is also compass-stabilized with the PPI picture. Inaccuracies due to yawing are thereby eliminated, the validity of earlier plots is maintained even when an alteration of own ship's course is made, and the plot is at the same time held, if so desired, in natural ship's-head-up orientation.



12 ft aerial. 9115

6 ft aerial. 9114

Transmitter/receiver unit

This is housed in a steel cabinet designed for bulkhead mounting. It contains the trigger circuits, pulse forming, modulating and transmitting stages and also the RF head, AFC, IF amplifier and detector, together with their requisite power supplies. The unit also contains a tuned echo box which is automatically swept through the transmitter frequency at a rate synchronized with the aerial rotation. It may be switched into circuit from the display unit, as desired, to provide an overall check on the performance of the transmitter, receiver and display unit circuits. Performance indication is by means of a plume on the PPI display. (A separate check on the efficiency of the transmitter, waveguide system and aerial is provided by means of a pick-up probe in the scanner unit which feeds a neon tube on the display unit).

The transmitter provides a peak power of 70 kW (nominal) and has two automatically switched pulse lengths of 0·07 μs and 0·5 μs, thus maintaining excellent definition on the shorter ranges and maximum pulse energy on the longer ranges. An over-ride switch permits the use of the long pulse on the short ranges. The pulse repetition frequency is maintained at 1250 p.p.s. on all ranges, thus permitting independent selection of range of view in an installation having two or three display units. In such installations, the pulse length is under the control of only one display unit.

The receiver incorporates a double-crystal balanced-type mixer (to achieve an extremely low noise factor) and a logarithmic IF section which, in conjunction with the display unit differentiator and video amplifier circuits, eliminates the need for frequent adjustment of receiver controls and also considerably improves the performance under conditions of sea-clutter and rain storms.

To maintain the best performance on each range, the receiver has two bandwidths switched simultaneously with transmitter pulse length, 25 Mc/s on short pulse ranges and 5 Mc/s on long pulse ranges.

An automatic frequency control unit ensures that the receiver is maintained on the transmitter magnetron frequency.

A small local control panel facilitates adjustment of the transmitter/receiver unit during installation and servicing.

Scanner unit

The scanner unit consists of a 12 ft (3·6 m) slotted-waveguide type of aerial mounted on an aerial driving unit.

The aerial is contained in a slim Fibreglass tube. The slotted waveguide aerial feed system has been so designed as to achieve optimum energy distribution across the face of the aerial, thus reducing side lobes to a very low level and consequently minimizing the presence of 'ghost' images

on the display picture. This 12 ft aerial has a very narrow horizontal beamwidth (0·75° nominal), thus effectively increasing the transmitted power and enhancing the picture definition. Improved detection of small or distant targets and greater bearing accuracy result.

The aerial driving unit incorporates, in addition to the aerial driving mechanism, (a) contact assemblies initiating the heading marker flash and echo box sweep, (b) a pick-up probe and detector which feeds a neon tube in the display unit to indicate that power leaving the aerial is normal, and (c) a servo transmitter providing self-synchronous aerial bearing information to the display unit. As an alternative, a 6 ft (1·8 m) aerial is available for use where siting difficulties may prohibit the larger aperture aerial.

Power supply

The transmitter/receiver, display unit and true-motion indicator require an input supply of 150 V, 1150 c/s. This is provided by a motor alternator set, different editions being available to suit various DC and AC mains supply. The units also require 110 V or 220 V DC or 115 V AC for fans and drying heater circuits, this being obtained from the ship's mains supply via the motor alternator set. The aerial driving unit incorporates a motor suitable for the particular DC or AC mains supply.

Data Summary

Display unit

Ranges: $\frac{3}{4}$, $1\frac{1}{2}$, 3, 6, 12, 18, 24 and 48 nautical miles.

Minimum range: Less than 30 yds.

Range discrimination: 15–20 yds on short pulse. 100 yds on long pulse.

Range accuracy: Range rings $\frac{1}{2}\%$, range marker 1%, of range in use or 30 yds (whichever is greater).

Side lobe attenuation: 6 ft; 26 dB up to 4°, 34 dB 4° to 8°, 38 dB outside 8°. 12 ft: 26 dB up to 2°, 34 dB 2° to 4°, 38 dB outside 4°.

Bearing accuracy: Better than ±1°.

Transmitter/receiver unit

Frequency: 9415–9475 Mc/s.

Transmitter peak power: 70 kW (nominal).

Pulse repetition frequency: 1250 p.p.s.

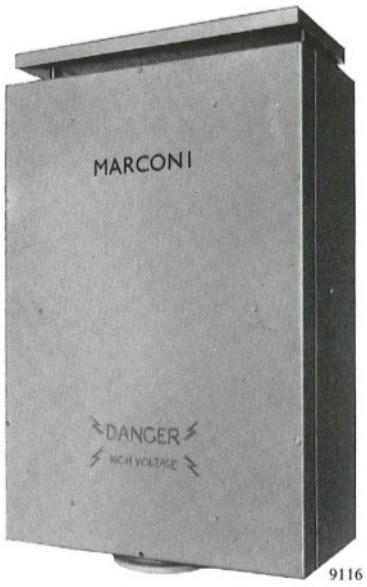
Pulse length: 0·07 μs up to 3 mile range 0·5 μs above 3 mile range. (Long pulses may be switched in for short ranges).

Receiver IF: 80 Mc/s.

Receiver IF bandwidth: 25 Mc/s on short pulses. 5 Mc/s on long pulses.

Receiver IF response: Logarithmic between −20 dB to + 60 dB with respect to noise.

Receiver noise factor: better than 11 dB.



9116

The transmitter/receiver.

Aerial

Horizontal beamwidth:
12 ft – 0·75° } at half-power
6 ft – 1·5° } points.

Vertical beamwidth: 20°.

Side lobe attenuation: Better than 26 dB within ±6° of main beam. Better than 35 dB outside ±6° of main beam.

Rotation: 25 r.p.m. nominal.

Wind velocity: Up to 80 knots.

True-motion indicator

Log information: Walker Commodore, Chernikeef and Sal.

Shaft information: Evershed & Vignoles, Smiths, Elliots, Chadburns, Siemens, Revometer and M.A.M. (with slip correction).

Artificial log: 0–30 knots.

Compass information: Brown, Sperry, Admiralty or Anschutz. (Also Plath and Microtecnica by small extra unit).

Tidal correction: Direction – 'Following', 'Contrary' or by compass scale.
Speed, 0–10 knots.

Reset direction: Selectable on compass scale.

Reset radius: Adjustable.

Power supply

Voltage: (a) 110 or 220 V DC
or
(b) 115 or 230 V 50 or 60 c/s, single-phase AC
or
(c) 380–440 V 50 or 60 c/s 3-phase AC.

Consumption: Approx. $2\frac{1}{2}$ kW for a single display installation.

Dimensions

Height	Width	Depth	Weight (approx.)
Display unit			
1 ft 10 in. (56 cm)	1 ft $7\frac{1}{2}$ in. (50 cm)	2 ft $6\frac{1}{8}$ in. (76 cm)	235 lb. (106·7 kg)
Display unit and true motion indicator			
2 ft 5 $\frac{7}{16}$ in. (74 cm)	1 ft $7\frac{1}{4}$ in. (49·5 cm)	2 ft $7\frac{3}{4}$ in. (80·6 cm)	289 lb. (131 kg)
SS display unit			
2 ft $4\frac{1}{8}$ in. (71·5 cm)	2 ft $3\frac{1}{8}$ in. (70 cm)	2 ft 9 in. (84 cm)	320 lb. (145 kg)
SS display unit and true motion indicator			
2 ft 11 $\frac{9}{16}$ in. (90 cm)	2 ft $3\frac{1}{8}$ in. (69 cm)	3 ft (92·5 cm)	374 lb. (169·8 kg)
Transmitter/receiver			
2 ft $9\frac{7}{8}$ in. (86 cm)	1 ft 10 in. (56 cm)	$11\frac{1}{2}$ in. (29 cm)	136 lb. (61·7 kg)
Scanner unit (12 ft Aerial)			
1 ft $11\frac{1}{8}$ in. (58·7 cm)	12 ft $8\frac{1}{8}$ in. (386 cm)	1 ft $10\frac{1}{2}$ in. (57 cm)	200 lb. (90·8 kg)
Scanner unit (6 ft Aerial)			
1 ft $6\frac{3}{8}$ in. (46·6 cm)	6 ft 8 in. (203 cm)	2 ft (61 cm)	129 lb. (58·6 kg)
Compass stabilisation unit (only required when TMI not fitted)			
$5\frac{7}{8}$ in. (14·6 cm)	$11\frac{3}{8}$ in. (29 cm)	$5\frac{3}{4}$ in. (13·6 cm)	5 lb. (2·3 kg)
*Motor alternator and control panel**			
1 ft $4\frac{3}{8}$ in. (41·5 cm)	1 ft 2 in. (35·6 cm)	2 ft $6\frac{7}{8}$ in. (80 cm)	550 lb. (249·7 kg)
Control panel			
3 ft 3 in. (99 cm)	1 ft $8\frac{3}{4}$ in. (52·7 cm)	1 ft 3 in. (38 cm)	150 lb. (67 kg)

Note: The trunnion slightly increases the above sizes and weights.

* The sizes given for the motor alternator are typical and will vary according to the supplies available.

Marconi

Marconi's Wireless Telegraph Company Limited
Marconi House, Chelmsford, Essex
Telephone: Chelmsford 3221 · Telex: 1953
Telegrams: Expanse Chelmsford Telex