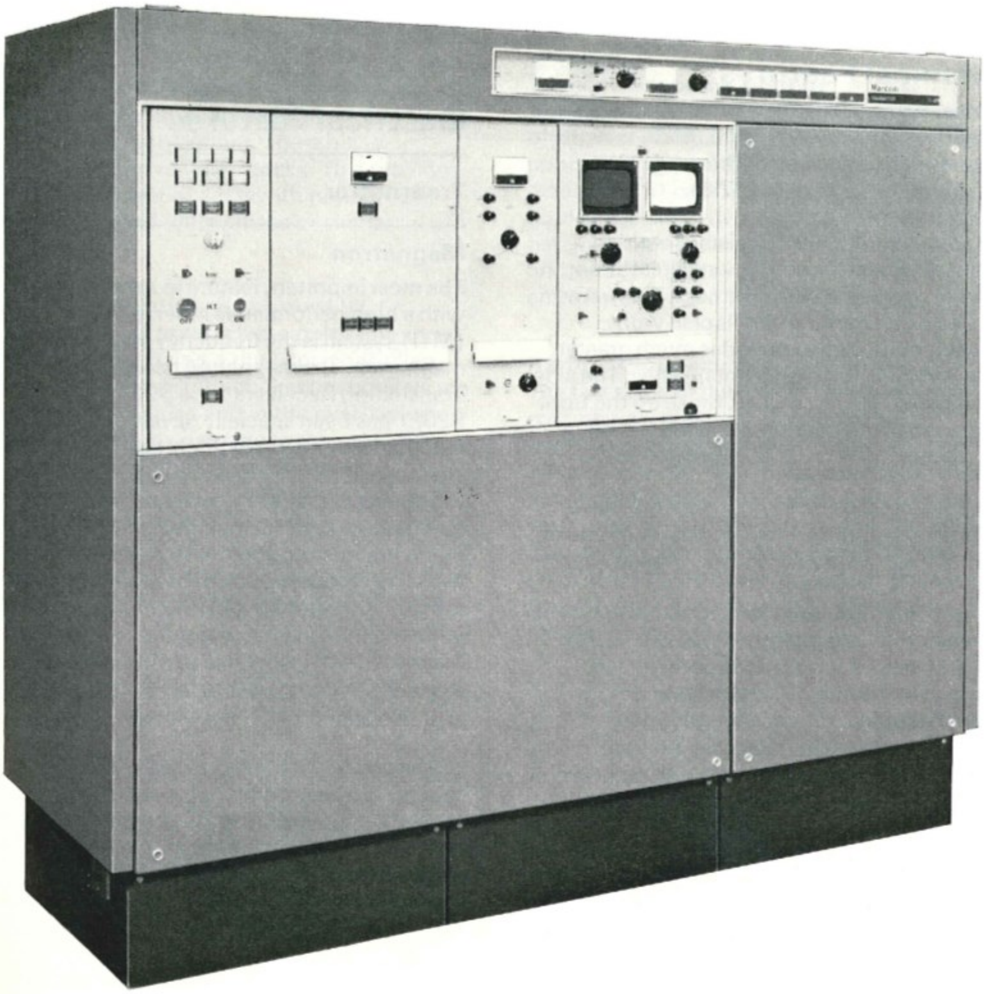
Marconi R[illegible] Data Sheet B2

[illegible]n L-Band Transmitter/Receivers Type S2011 – 2MW Type S2021 – 800kW



Frequency range : 1 250 to 1 365MHz covered by two versions each continuously tunable over 60MHz

Receiver : parametric amplifier having a noise figure of 2·8dB

The Marconi Transmitter/Receivers Type S2011 and Type S2021 are two of a range of transmitter/receivers, individually covering S, L and C bands, housed in similar cabinets and using common techniques and components.

Type S2011 and Type S2021 both operate in the 23 cm L band and differ only in power output which is determined by magnetron running conditions. Either type can be modified to obtain the power output of the other. Both types are available in two versions, covering the frequency bands 1250 to 1310MHz and 1305 to 1365MHz. In each case the magnetron is tunable over the 60MHz band. Type S2011 and Type S2021 are used with Marconi signal processing equipment which is fully described in the C series of Marconi Radar Data Sheets.

Mechanical Features

The transmitter is housed in a small attractively styled lightweight cabinet 1·68m (5ft 6in) high by 1·91m (6ft 3in) wide by 648mm (2ft 1½in) deep and weighs 1030kg (2267lb).

The cabinet framework consists of welded square tubular steel sections giving great strength and rigidity combined with lightness. This frame is enclosed by aluminium panels clad with polyvinylchloride, which provides much greater resistance to abrasion than paint finishes. The side and front panels are removable, those on the front giving access to the interior of the radio-frequency and modulator power supply compartments.

The cabinet stands on a strong, integral base frame forming a plinth which houses input power controls and a 24V internal services power supply.

The right-hand compartment contains the pulse transformer, magnetron assembly, ferrite isolator and items such as the vapour-phase cooling system for the magnetron and the directional couplers for transmitted power samples and radio-frequency (r.f.) power measurement. This compartment is completely enclosed to minimize radiation of spurious energy.

The r.f. output is taken into a compartment which spans the top of the transmitter/receiver cabinet. This top compartment houses the duplexer, the final output to the aerial being at the rear of the cabinet.

The remainder of the cabinet is divided into two further compartments, one containing the high-voltage power supply and modulator, the other containing the low-level electronic units.

The modulator compartment contains the extra-high-tension (e.h.t.) transformer, e.h.t. controller and thyristor regulator, e.h.t. rectifier unit, smoothing components, charging and charge stabilizing components, thyratron unit and pulse-forming network. Each of these items is mounted on a tray assembly and can be withdrawn and handled easily for servicing.

The electronics compartment contains four main units. The first unit is a controller for the transmitter, providing a trigger source for the modulator, the noise-tube, monitoring equipment and the interlock system with fault indicators. The third unit is the intermediate-frequency and video system of the receiver. The fourth unit, if fitted, is the performance monitor Type S2040 which is fully described in Marconi Radar Data Sheet E6. These three units are mounted on runners and can be withdrawn for servicing. The second unit is a composite assembly comprising various receiver items, including the parametric amplifier, the mixer/head amplifier, the local oscillator and the automatic frequency control system. Access to these items is obtained via the hinged front panel.

Fastenings hold all withdrawable units and assemblies in the normal operating position during transit.

Electrical Features

Transmitter

Magnetron

The most important feature in a transmitter used with a high performance moving target indication (MTI) system is the frequency stability of the magnetron. The magnetron used in the Transmitter/Receivers Type S2011 and Type S2021 has been specially developed for this requirement and its electrical and mechanical characteristics have been arranged to minimize the effects of disturbing external influences. The magnetron is vapour-cooled, which makes a water pump unnecessary, and removes vibration associated with the flow of water through the system. All vibration and noise have been dealt with and the transmitter is quiet in operation. This leads to a better electrical performance and enables the transmitter to be located near a display without causing operator fatigue.

Another advantage of using vapour cooling is that the magnetron operates at constant temperature. This means that there are no changes of frequency due to changes in ambient temperature and the valve design can be optimized, since the operating temperature is controlled very closely.

The frequency of operation is determined by a crystal-controlled oscillator, with the magnetron tuned to it by an automatic frequency control (a.f.c.) system, using an electric motor. The magnetron has a fast tuning rate of approximately 500kHz/s, used when changing the operating frequency, and a slow rate, used for final pull-in and for the normal a.f.c. mode. This system has advantages over previous systems where the stabilized local oscillator (STALO) is tuned to the magnetron, since clutter cancellation is not possible while the STALO is being tuned whereas the tuning rate of the magnetron is too slow to affect clutter cancellation.

The MTI performance is enhanced by removing the causes of magnetron frequency shift. Frequency pulling, caused by changes in the match to the aerial, rotating joint and feeder system is eliminated by incorporating a ferrite isolator between the magnetron and duplexer. Frequency pushing, caused by changes in modulator output, i.e. pulse-to-pulse changes when pulse recurrence frequency stagger (p.r.f.s.) is in use, is eliminated by using a special modulator pulse stabilizing circuit. The magnetron field is provided by a permanent magnet, the strength of which determines the power output and hence the type of transmitter.

Modulator

The modulator is a conventional line type employing a pulse-forming network, direct current resonant charging and thyratron switch. Additional special features ensure the necessary high degree of stability.

The control of extra-high-tension (e.h.t.) level is achieved by a thyristor regulator operating on the input to the e.h.t. transformer. The e.h.t. is produced by silicon rectifier stacks. This provides fast, accurate control of e.h.t. with none of the problems associated with variacs or similar devices.

Pulse-to-pulse stability is achieved by controlling the level to which the pulse forming network is charged using a thyristor-controlled charge stabilizing transformer. Silicon rectifiers are used as charging diodes and in the over-swing circuit which prevents damage to the modulator should the magnetron arc or miss a pulse.

The modulator switch, an extremely rugged ceramic tetrode hydrogen thyratron, is separately pulsed on the priming and firing grids to give very low jitter and anode delay-time variations.

Receiver

Receiver beam switch

To operate with the Type S1020 23cm L-band dual-beam aerial, the Type S2011 or Type S2021 transmitter/receiver is fitted with a fast-acting r.f. switch which operates at a preset range, to change the receiver input from the auxiliary feed to the main feed and simultaneously to apply a particular r.f. swept gain law in each case.

Beam combining unit

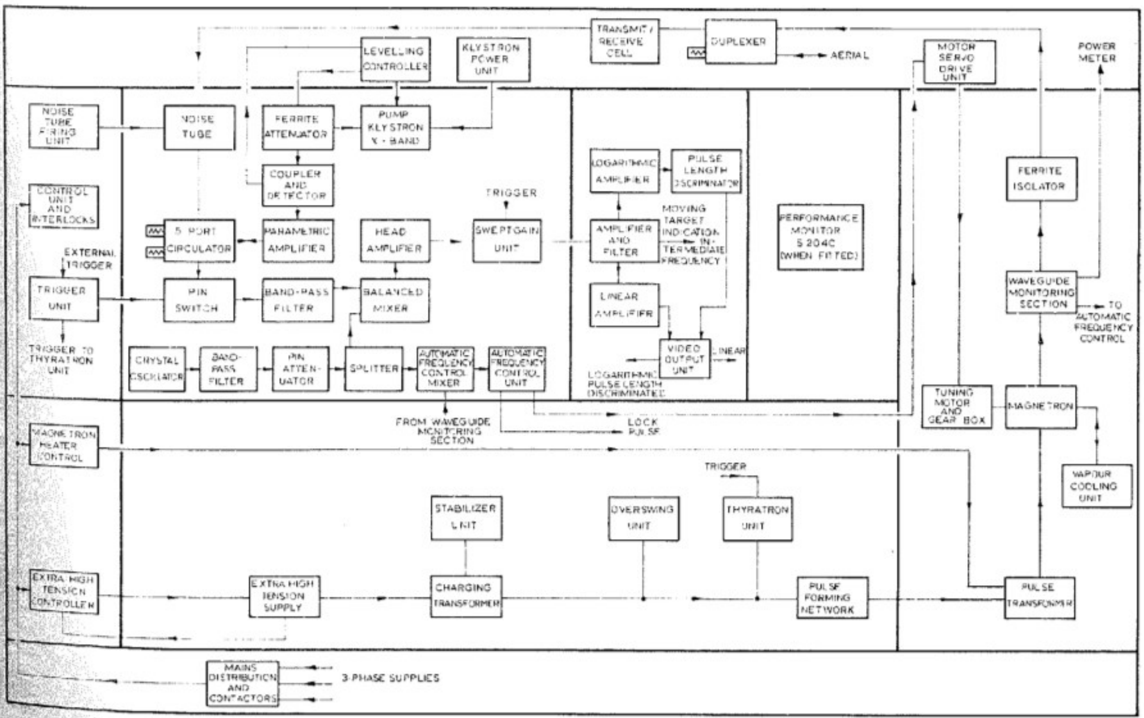
To enhance the clutter suppression properties of the Type S1020 aerial, a phase feedback system can be fitted between the auxiliary and main feeds to produce sharper bottom cut-off of the aerial cover.

Transmit-receive system

Common aerial working is provided for by means of a balanced duplexer employing Riblett 3dB couplers and two sets of gas-filled transmit/receive (T/R) cells. The receiver is protected from duplexer leakage by a T/R cell in front of the parametric amplifier and by a pulsed attenuator and varactor limiter between the parametric amplifier and the mixer.

Radio-frequency (r.f.) amplifier

The first stage of the receiver is a low-noise parametric amplifier of the single-port, non-degenerate negative-resistance type, tunable over 60MHz. The parametric amplifier is temperature stabilized and the X-band pump level is controlled in order to stabilize amplifier gain and frequency. The input circulator is of the five-port type giving maximum protection against second-stage and signal source mis-matches.



Block diagram 2·0MW 23cm L-band Radar Transmitter/Receiver Type S2011 showing approximate mechanical configuration

Intermediate-frequency (i.f.) and video
A balanced mixer is used to convert signals to i.f. and is followed by a wide-band, low-noise transistor head amplifier.

The basic receiver has a logarithmic channel followed by a pulse length discriminator and a linear channel.

The video output circuits include adjustable limiters to enable signal-to-noise ratios to be set. The receiver output thus can be fed straight to a display unit. There is also an i.f. output for an MTI system.

Local oscillator (l.o.)
To provide the necessary high degree of stability to enable MTI performance to be achieved out to the full working range of the radar, a crystal-controlled stabilized oscillator is used. The crystal frequency is about 110MHz and a series of broad-band multipliers generate the required l.o. signal.

Automatic frequency control (a.f.c.)
A normal a.f.c. system is employed in which a sample of the transmitter pulse is combined with an output from the stabilized oscillator to produce an i.f. pulse which is applied to a Foster-Seeley discriminator. The pulse output is integrated and used to control the magnetron tuning motor. To avoid unnecessary operation of the tuning system, the magnetron frequency is not corrected unless the deviation is greater than 40kHz.

Control System

The only controls necessary for the operation of the transmitter/receiver are a TRANSMITTER ON/OFF key-switch and EXTRA-HIGH-TENSION ON and OFF buttons. Six minutes after the key-switch is turned to ON, the magnetron and thyratron cathodes reach operating temperature. The STANDBY lamp then lights and the ON button is pressed, making the transmitter/receiver fully operational. When the OFF button is pressed the transmitter/receiver reverts to STANDBY. These controls and the relevant indicator lamps may be remoted.

An executive interlock system allows operation only when essential services are present. It provides safe run-down should a failure or dangerous overload occur. A non-executive interlock system indicates faults which cause degraded performance or conditions which could lead to executive interlock action. The state of all interlocks is shown by lamps. A logic system controls the application of power to the units in the transmitter/receiver and stores any interlock failure by holding the appropriate lamp extinguished. A SYSTEM NORMAL lamp provides an overall indication which may be remoted.

One of three built-in crystals may be selected by a single front-panel switch to determine the spot frequency within the operating band.

Metering

Considerable built-in metering is provided to assist in fault finding. Seven meters, mounted on the front panels, provide continuous indication of:

1) High tension volts
2) High-tension current
3) Magnetron cathode current
4) a) Overswing current; b) Stabilizer current
5) Output power
6) Receiver crystal current
7) Parametric amplifier pump level.

Meter (4) can be switched also to a wander lead which can be plugged into various units to enable the voltage and current of the built-in unit power supplies to be measured.

Meter (6) can be switched to measure other voltages and currents associated with the parametric amplifier, pump, a.f.c. system, etc.

The receiver unit has a meter to give a continuous indication of TUNING ERROR. The i.f. and video unit has a meter to indicate i.f. levels.

Monitoring

Facilities for monitoring the main performance parameters are built-in.

The transmitter power output level is shown directly on a meter and the receiver noise figure is measured by a built-in noise source. By switching this on and noting the increase in noise level in the linear channel, the noise ratio is obtained.

More comprehensive monitoring of waveforms, magnetron spectrum, noise ratio etc. is provided by an additional performance monitor (Type S2040) which fits into a ready-wired position in the transmitter.

Fault finding whether by the performance monitor or by a separate oscilloscope is greatly assisted by the use of withdrawable units and the provision of special monitor points on printed boards for input and output signals.

Data Summary

Power input:
415V±5%, 48 to 52Hz standard, or 380V±5%, or 58 to 62Hz to order.
12kVA, 3-phase, 4-wire.
Frequency Band:
1) 1250 to 1310MHz standard.
2) 1305 to 1365MHz to order.

Transmitter

Nominal power output (magnetron):
S2011 : 2·3MW peak, 3kW mean at maximum duty cycle.
S2021 : 800kW peak, 1·5kW mean at maximum duty cycle.

Pulse length:
S2011: 2·5, 3, 4, or 5μs standard. Other values from 2·5 to 5μs to order.
S2021: 2μs standard, other values from 1.5 to 5μs to order.
Pulse recurrence frequency:
S2011: 220 to 750 p.p.s. dependent on duty cycle and stagger ratio.
S2021: 220 to 850 p.p.s. dependent on duty cycle and stagger ratio.
Duty cycle (maximum):
S2011: 0·0015.
S2021: 0·0018.
Magnetic field:
permanent magnet.
Waveguide:
No. 6, pressurized at 0·21kg/cm^2 (3lb/in^2 gauge).
Trigger input:
+5V, 2μs into 75 Ω.

Receiver

Parametric amplifier:
Noise figure: 2·8dB.
Gain: 20dB (pre-set).
Bandwidth: 17 to 35MHz.

Mixer/Head amplifier:
Noise figure: 9dB.
Gain: 30dB.
Bandwidth: 20MHz.
Intermediate frequency: 45MHz.
Linear channel:
Bandwidth: to suit pulse length.
Output: +1V r.m.s. noise (adjustable); +5V signal (maximum) into 75 Ω.
Logarithmic channel:
Bandwidth: to suit pulse length.
Dynamic range: greater than 60dB.
Output (logarithmic pulse length discriminated expanded): +1V r.m.s. noise (adjustable); +5V signal (maximum) into 75 Ω.
Intermediate frequency channel:
Level (noise): 10μV minimum.
Impedance: 75Ω.
Lock pulse:
Frequency: 45 MHz.
Level: 1·0V peak-to-peak minimum.
Impedance: 75Ω.

Environment

Temperature:
Operational: 0 to +50°C.
Survival: −40 to +65°C.
Relative Humidity:
Operational: 95% at 25°C.
Survival: 95% at 40°C.
Pressure:
Operational: 750 mb.
Survival: 420 mb.

Dimensions

Height:
1·68m (5ft 6in).
Width:
1·91m (6ft 3in).
Depth:
648mm (2ft 1½in).
Weight:
1030kg (2267lb).

The information given herein is subject to confirmation at the time of ordering.

Marconi Radar Systems Limited
A GEC–Marconi Electronics Company
Crompton Works, Chelmsford, England CM1 3BN
Telephone: Chelmsford (0245) 67111. Telegrams: Marstor Chelmsford Telex.
Telex: 99108 and 99449.

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