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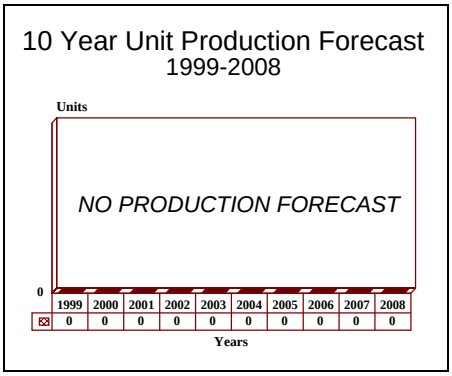
S 1800 Series - Archived 5/2000

Outlook

- Last known order delivered in 1993
- **Barring an increase in activity, this report will be archived in 2000**



Orientation

Description. Lightweight naval radars designed to act as dedicated weapons system trackers (ST1802, 1802SW) and lightweight surveillance radars (S1810, S1820, S1821, S1822).

Sponsor

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Production of S1820 is by Marconi Radar & Defense Systems Ltd and Canadian Marconi Co. Production of twisted cassegrain antenna for ST1802 and 1802SW radars is by Ericsson Radar Electronics AB.

Licensee

Samsung Electronics
Seoul
South Korea

Status. The ST1802, S1810, S1820 are in service, but believed to be out of production.

Total Produced. An estimated 28 units had been procured through 1998.

Application. Generally suitable for small to medium warship application, the 1800 series is considered to be the next generation of the 800 series.

Price Range. Analysis indicates a unit price of US$1.4 million for the surveillance radars. Due to the range of options and additional facilities available, no unit price is available for the weapons control variants.

Technical Data

	Metric	US
Characteristics		
S1802		
Operating frequency:	I-band	X-band
Peak power:	50 kW	
Range:	40 km	25 mi
Weight:	1750 kg	3850 lb
S1810		
Operating frequency:	I-band	X-band
Peak power:	50 kW	
Range:	72 km	45 mi
Weight:	600 kg	1320 lb
S1820 (SPS-503)		
Operating frequency:	E/F-band	S-band
Peak power:	20 kW	
Range:	105-145 km	65-90 mi
Weight:	1500 kg	3300 lb

Design Features.

ST1802: Developed from the earlier 800 series equipment (ST802) and broadly similar with the exception that the new radar features frequency agility. ST1802 uses a modular format enabling the radar to be readily configured to meet the requirements of the chosen weapon system. The ST1802 is designed for independent operation and control functioning as an autonomous weapon systems central computer complex. It can, however, interface with and be controlled by the ship's central computer complex.

Features of the equipment include radar and electro-optical tracking, fast reaction time (fully automatic from target indication data), lightweight director with small swept radius and low-level surveillance for sea-skimming missiles. Other features include high-accuracy tracking, MTI with frequency agility, extensive electronics counter-countermeasures (ECCM) including passive tracking (using target electronic countermeasures), shift target facility for missile attack, shell-splash spotting ability and Continuous False Alarm Rate (CFAR) to reduce the effects of countermeasures. The ST1802 is a monopulse tracking radar operating in the I-band with a switchable moving target indication (MTI) facility. The radar is autonomous (after target designation and range and bearing data have been received from the ship's surveillance radar) and subsequently requires only a ship's reference data such as roll, pitch and speed. It includes a fully coherent traveling wave tube (TWT) transmitter and produces true random frequency agility across a wide bandwidth. The MTI facility is retained in a pulse burst agile mode. The two-axis director is mounted above decks and carries the radar antenna and electro-optical package.

The radar antenna is of the twist cassegrain type with a 1 meter aperture and a beam width of 2.4 degrees rotating at a rate of 20 rpm. It is designed for continuous rotation in azimuth while operating down to minus 30 degrees and up to plus 85 degrees in elevation. The mount is controlled by electronic servos in both azimuth and elevation with stabilization of the flight line during tracking using rate gyros. A four-horn monopulse feed and comparator provide three separate radio frequencies (sum, elevation difference and azimuth difference signals) for processing in the IF receivers. Maximum tracking range of the equipment is 40 kilometers in non-MTI mode and 25 kilometers in MTI mode. The maximum director slew rate is 120 degrees per second for training and 50 degrees per second in elevation.

Below decks the equipment is contained in one cabinet. A double bay cabinet houses the transmitter, which is a driven TWT type with pulse to pulse or burst agility at a maximum power of 50 kW. Also housed in the double bay cabinet are an amplitude comparison monopulse receiver, a fully adaptive digital signal processor, the servo drive equipment and the autonomous radar control unit which controls the radar during its search and acquisition phases and provides the space-stabilized search patterns. The radar control console incorporates a color raster graphics display controlled by soft keys and providing a user friendly interface. The radar state,

mode and operating conditions are displayed together with the status of the ship's associated weapons system. ST1802 can be used as the tracking element with missile systems. When used in conjunction with a predictor, the system is capable of controlling guns of calibers in excess of 20 millimeters against aircraft, ships, and missiles or in the naval gunfire support mode. The weight of the equipment is 535 kilograms above decks and 820 kilograms below decks (depending on the electro-optical equipment selected).

S1802SW: Derived from the 1802 radar and configured for operation with the Seawolf missile system. The capability to control naval gunfire has been retained. The 1802SW radar features radar fixed frequency with or without MTI, radar pulse-to-pulse frequency agility without MTI and pulse burst frequency agility with MTI. The provision of frequency agility offers significant advantages in jamming environments and smoother tracking, while the MTI facility allows the early detection and acquisition of small, low-level targets in conditions of high clutter. This system has been specified for the Malaysian corvettes to be built by Yarrow.

S1810: This is another I-band frequency agile radar using state-of-the-art techniques for advanced detection ranges and precise target indication. It is highly resistant to the most severe electronic warfare environments. The antenna is of lightweight rugged design and can be fitted with an array of D-band dipoles for integrated identification friend or foe (IFF). The shipborne version provides target detection up to ranges of 55 kilometers on a small aircraft with surface detection up to the radar horizon. Sea-skimming missiles will be detected well beyond the engagement range of the weapon system.

S1810 operates between 8.6 and 9.5 GHz and offers pulse-to-pulse broad band frequency agility. Digital MTI provides improved detection and tracking of low-level air targets in clutter and operates with pulse burst frequency agility or fixed frequency. The antenna is mounted on a stabilized platform comprising three mutually perpendicular waveguide rotating joints and the azimuth drive. Two models are available. The S1810(A)-type antenna is the standard fit and incorporates a 2.44 meter reflector and radome rotating at 24 rpm. The S1810(C) is a smaller model intended for applications where a lightweight compact fitting is necessary and comprises a 1.2 meter reflector (rotating at 24 rpm) and radome. Shipborne features include a fully stabilized antenna to allow operation in small vessels in rough seas, a lightweight antenna to reduce ship top weight and automatic velocity compensation to remove own ship velocity effects.

Many features are common to both the shipborne (S1810) and coastal (S1810/CD) variants. These include operation in the 3 centimeter (9 GHz) range, providing good low-level coverage and angular discrimination and pulse-to-pulse or short burst frequency agility using a coherent TWT transmitter to optimize detection range and ECCM. Other joint features include the ability to select one of three transmission modes, including pulse compression mode to provide high effective peak power with good range discrimination and improved performance in clutter. Both systems provide the ability to select a particular transmission mode within operator-defined bearings with a different mode outside those bearings (to achieve, for example, splash spotting within the narrow required sector with normal detection over the rest of the area). They also feature high-accuracy resolution and data rate for target indication, CFAR to reduce sea clutter, high system availability with modern components and MTI to reduce sea clutter and chaff.

Comprehensive ECCM characteristics are provided to withstand, counter, or avoid pulse swept frequency, wide band barrage and repeater jammers. This is achieved by the use of low azimuth sidelobes, frequency agility, Pulse Repetition Frequency Discrimination (PRFD), variable pulse length and PRF, PRF stagger and jitter, wide dynamic range receiver with image rejection mixer, rapid start/stop transmission and forward or reverse swept gain.

S1810(CD): A variation on the S1810 radar described above incorporating some special features which adapt it to the coastal tracking and surveillance role. These include a selectable high rotation rate of 60 rpm to allow shell-splash spotting and a short pulse mode for surface engagements.

S1812: Originally derived from a proposed 3-D version of Sea Giraffe to be developed jointly with Ericsson, this is now completely a GEC-Marconi venture. The S1812 has a new phased-array antenna with five beams covering 25 degrees in elevation. A maximum-cover mode uses eight beams with a total of 57 degrees elevation. The weight of the phased-array antenna is 250 kilograms with the below-decks elements weighing 670 kilograms. The antenna consists of a stack of six elements, each consisting of three boards. These replace the slotted waveguides used on earlier planar arrays. The spine of the antenna consists of a stack of phased shifters and a power divider.

S1820: This is a lightweight naval surveillance radar developed in conjunction with the Canadian Marconi Co. It has low ship-fitting requirements and operates in the E/F-band (10 centimeters) using a fully stabilized antenna giving cosec-squared vertical cover to 30

degrees. Antenna rotation rate is 24 rpm. S1820 uses a coherent TWT transmitter with frequency agility and pulse compression. It has a digital MTI processor, automatic adaptive velocity compensation, pulse burst and fixed frequency modes with MTI, pulse-to-pulse frequency agility mode without MTI and hard limiting non-MTI processor (Dicke-fix). The minimum range of the equipment is 200 meters, and CFAR and PRFD are built into both MTI and non-MTI channels.

Radar Type S1820 is a medium-power system featuring built-in test equipment (BITE) and is designed to MIL-E-16400G specifications. Sidelobe cancellation receiver, jamming strobe indication, integrated IFF antenna and plot extractor are all optional features of the system. In its standard configuration, comprehensive ECCM characteristics are incorporated. The antenna constitutes Marconi Radar Ltd's contribution to the program and employs a horn-fed double curvature reflector of glass reinforced plastic (GRP) construction sprayed with a metalicized coating. It is mounted on a two-gimbal stabilized platform giving pitch and roll stabilization. It is enclosed within a GRP radome which is an important weight-reducing factor critical for small ship mounting. The antenna is designed to provide a high gain and to maintain a low sidelobe level (essential to avoid jamming via the sidelobes).

Integrated IFF is optional and provision is made to incorporate the IFF antenna with the main array. The transmitter employs a TWT amplifier output stage, driven by a solid-state frequency synthesizer which generates the frequency modulated long pulse. The overall stability of the transmitter synthesizer ensures excellent performance of the MTI signal processing. The receiver employs a low-noise GaAs FET RF amplifier. The received pulse is compressed by a SAW line and the receiver provides both in-phase and quadrature outputs to the MTI system. The plot extractor uses a dual-threshold Marcoz and Galati staircase integrator. A plot former correlates the partial plots in range and bearing and assesses the plot center. Separate plot formers are provided for the MTI and non-MTI channels.

The signal processor provides digitally processed MTI and non-MTI video. The MTI system processes both in-phase and quadrature outputs from the receiver demodulators by means of a double canceler filter. The MTI processing includes an automatic velocity compensation system which operates on an area basis with no external output. The system centers the MTI clutter notch on the mean clutter velocity, thus maximizing clutter cancellation independently on areas. Both the MTI and the non-MTI channels provide CFAR processing and incorporate PRFD systems to minimize non-synchronous interference. Analog and digital video outputs are provided by the signal processor and may be fed directly to a plan position indicator (PPI) display or the optional plot extractor.

S1821 and S1822: Variants of the S1820 using 4.7-m unstabilized and stabilized antennas respectively.

S1830: A new, coherent E/F-band (2.8 to 3.1 GHz, frequency-agile over 300 MHz) radar derived from the S1810. It features a fully digital MTI. the 18 microsecond output pulse is compressed to 0.4 microseconds on reception. Instrumented range is 200 km, low flying aircraft and sea-skimming missiles can be detected out to 20 km. The transmitter unit uses 38 solid-state modulators in parallel. The S1830 can either use a 4.7 m high-gain antenna scanning at 10 or 20 rpm (**S1831**), or a 2.4 m antenna scanning at 20 or 60 rpm (**S1832**).

S1834: A version of the S1830 that uses an enlarged, 12-beam version of the new planar array antenna developed for the S1812. The antenna consists of 44 stacked boards as opposed to 24 on the S1812 and scans at 10 or 20 rpm. Maximum range is 187 km using a five-beam transmit pattern or 120 km using 12 beams.

Variants/Upgrades

SPS-503: SPS-503 is the Canadian Marconi designation for S1820. This equipment is listed as being fitted to corvettes and larger vessels of the Canadian armed services. The only known installations are to six frigates refitted under the Delex program. The SPS-503 may have been fitted to icebreakers of the Canadian Coast Guard. The S1820 is fitted to the Egyptian Ramadan class FAC.

Program Review

Background. Marconi Radar Systems introduced the S1800 series of lightweight naval fire-control and surveillance radars during the early 1970s. Implicit in the design was provision for upgrading to more advanced specifications as circumstances dictated. By the early 1980s this program of pre-planned product improvement had led to the introduction of a new family of radars, the S 1800 group.

The S1820 is a joint venture by Marconi Radar Ltd and the Canadian Marconi Co. Only the antenna dish-head is supplied by Marconi Radar Ltd, with the remainder of the equipment being developed and manufactured in Canada. In view of the major role they have played in the S1820 (SPS-503) program, they are in many respects a Canadian Marconi Company venture with Marconi (UK) acting as subsystem supplier.

The South Korean order, worth some US$50 million, covered the supply of 24 S 1800 radar systems and certain items of computer Action Information Organization (AIO) equipment produced by Ferranti. In line with many recent high-technology defense contracts to emergent states, a technology transfer has been arranged. Marconi produced the initial few systems, while South Korea assembled the remainder. A further order for eight Series 1800 radars was received in September 1987.

The S 1800 family radars will be key parts of the sensor suite specified for the two Yarrow-built corvettes acquired by the Malaysian navy. This suite includes the S1822 stabilized search radar and the S1802SW Seawolf-capable fire-control system. The latter radar was originally an unsuccessful candidate for the Royal Navy lightweight Seawolf requirement. Following a heated debate within Malaysian navy circles, it was decided to replace the originally specified Sadral missile system with VL-Seawolf on the basis that the original system could not provide a serious air defense capability. The S1802SW radar was thus revived to provide a tracking facility for the Seawolf system.

As a direct result of the Malaysian order, procurement of the Type 911 radar, based on the older S805 system, has been curtailed and the system will be replaced on the future Seawolf-armed Royal Navy frigates by a new tracker derived from the S1802SW. In addition, GEC-Marconi received a contract in February 1996 for the mid-life upgrade of existing Type 911 fire-control radars. Although not specifically stated, it is believed this brings them up to the standard of the later equipment.

The ST1802 and S1810 radars are in production as a result of the contracts placed by the Republic of Korea. The SPS-503 has been in production for the Canadian navy, but is not currently specified for installation in future construction. An additional member of the family, the ST1803 was introduced to keep abreast of the changing threats anticipated for the 1990s. This features improved reaction times and a wide range of electro-optical and other auxiliary tracking devices.

In September 1993, GEC-Marconi Radar Systems revealed the latest version of the S 1800 family, the S1830 medium-range target acquisition and surveillance radar. This is an enhanced development of the S1810 and is often described as a navalized S711. The S1830 was designed to meet a requirement for a new air search radar to equip the four Norwegian Oslo class frigates (one Oslo class ship having been lost at sea in early 1994) and the six Type 21 frigates sold to Pakistan. An additional version of this radar, using more advanced antenna technology, is designated S1834.

Original British design studies for the Type 84 destroyer (the precursor to the Project Horizon Common New Generation frigate) featured a Seawolf secondary battery mounted amidships with four Type 911 trackers. This gave a most impressive eight-channel missile-based close-in weapon system (CIWS). Following the Malaysian order, the Type 911 was replaced by a projected development of the S-1802SW. Analysis of the performance of the Raduga P-270 Moskit anti-ship missile revealed that even the most advanced versions of Seawolf would be of only marginal effectiveness against this weapon. A new requirement for an inner-layer missile system has been formalized to fill this void; there is a strong chance that the S-1834 will be the horizon-search target acquisition radar for this system.

Funding

ST1802: This was a private company venture by Marconi Radar Ltd arising from the earlier ST802 radar in which Ericsson Radar Electronics contributed to the development of the signal processor and the antenna. Current Ericsson involvement in the program extends only to the supply of antenna equipment for ST1802 and 1802SW radars.

S1810 & 1810(CD): Developed by Marconi Radar Ltd with company funding.

S1820 (SPS-503): Developed as a joint venture by the Canadian Marconi Co and Marconi Radar Systems, with the latter providing the antenna and the former everything else.

S1830: An unknown number of these systems are in operation with NATO countries.

Recent Contracts

No contractual information has been made publicly available.

Timetable

Month	Year	Major Development
	1978	S1802/1810/1820 ordered for Ramadan class FAC
	1982	SPS-503 retrofitted to Annapolis frigates
	1983	SPS-503 retrofitted to Restigouche frigates
May	1986	First order for 1800 series from RoK
Sep	1987	Second order for 1800 series from RoK
Oct	1987	Third order for 1800 series from RoK
Aug	1991	S1802 and S1822 specified for Malaysian corvettes
Aug	1993	S1830 radar announced

Worldwide Distribution

Canada. 4 SPS-503s on Annapolis and Improved Restigouche class frigates
Malaysia. 4 ST 1802SW units on Lekiu class frigates
South Korea. 20 S1810 units on Po Hang class corvettes

Forecast Rationale

The S 1800 family of surveillance and navigation radar is a frequency agile radar that gives enhanced detection ranges and targeting data to weapons systems. It was designed to detect sea-skimming missiles beyond the engagement range of a ship's defense system. The radar is also extremely resistant to heavy ECM environments. The basic system, designated the S 800, is well over 20+ years old, with its S 1800-derived series approaching 12+ years in service.

Production of the S 1800 series started in 1986, receiving a few respectable export orders, primarily from South Korea for the Po Hang class corvettes. It appears that it never really caught on with the export market. One significant reason for this would be the failure of the UK Royal Navy to adopt this system for its ships. Many export sales rely on the *de facto* stamp of approval that occurs when a major power selects a particular system for its inventory. This approval gives a competitor a significant advantage when competing against similar systems for a contract.

The 10-year forecast has been zeroed out due to the lack of confirmed orders in recent years. This report will be archived in 2000 barring an increase in program activity

Ten-Year Outlook

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