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(71) Applicant (for all designated States except US): THE COMMONWEALTH OF AUSTRALIA [AU/AU]; c/o The Secretary, Department of Defence, Anzac Park West Building, Constitution Avenue, Canberra, ACT 2600 (AU).

(72) Inventors; and

(75) Inventors/Applicants (for US only): EARL, George, Frederick [AU/AU]; 3 Shannon Rise, Banksia Park, S.A. 5091 (AU). WARD, Bruce Donald [AU/AU]; 2 Springwood Avenue, Redwood Park, S.A. 5097 (AU).

(74) Agent: COLLISON & CO; 117 King William Street, Adelaide, S.A. 5000 (AU).

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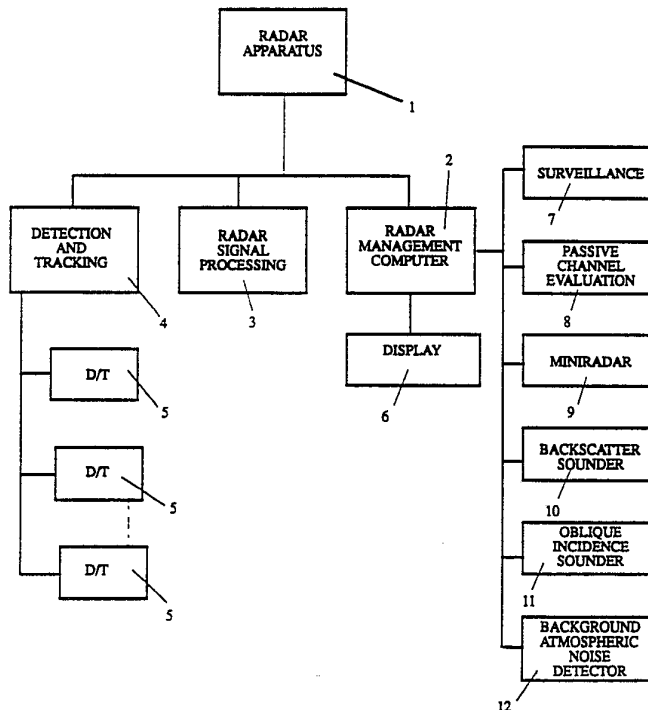
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With international search report.

(54) Title: MODULAR FREQUENCY MANAGEMENT SYSTEM

(57) Abstract

A modular transmission characteristic management system comprising a management system computer (2) to process a task and to provide a transmission and/or reception unit (1) with the necessary task parameters for that task, the management system computer being adapted to poll a plurality of sub-systems (7 to 12) to obtain setting parameters to determine the task parameters, each of the sub-systems (7 to 12) being adapted to obtain and process a set of particular setting parameters and to maintain a register of the particular setting parameters such that the management system computer (2) may poll them as necessary.



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MODULAR FREQUENCY MANAGEMENT SYSTEM

This invention relates to a transmission characteristic management system for systems which rely on high frequency radiowave propagation through the ionosphere including over-the-horizon radar, high frequency communications
5 and high frequency direction finding. The invention also relates to a method of operation of a frequency management system.

Real time transmission and reception characteristic or parameter management is a vital element in the effective operation of systems which rely on high frequency radiowave propagation through the ionosphere such
10 as an over-the-horizon backscatter radar system. To enable the selection of the best frequency for a given application at a given time at a particular range and direction it is necessary to have an adequate knowledge of propagation conditions in the directions of interest. It is also necessary to have a detailed knowledge of the environment against which the signals must be detected. A
15 transmission characteristic management system may include one or more sub-systems for determining ionosphere backscatter, vertical and oblique incidence sounding, high frequency spectral surveillance, background noise, passive channel evaluation, measurement of vertical angle of arrival and a low powered backscatter radar. By the use of these various parameters the
20 transmission characteristic management system may set up the transmitters and receivers for the type of equipment discussed above such as over-the-horizon radar to give the best results.

The problem is, however, that some of these parameters may need to be updated more often than others depending upon the nature of the task. Also
25 the time taken for some of these may mean that in a time slot allowed for transmission characteristic determination some features may be occluded. Hence a central processing unit to control these various functions can become overloaded or waste time while waiting for particular parameters to be received as raw data and processed or some signals can become lost and
30 vital information would not be updated.

This present invention provides an arrangement by which a central processing unit can more effectively determine the necessary parameters for a particular task or at least provides the public with a useful alternative.

In one form therefore the invention is said to reside in a modular transmission and reception parameter management system comprising a management system computer to process a task and to provide a transmission and/or reception unit with the necessary task parameters for that task, the management system computer being adapted to poll a plurality of sub-systems to obtain setting parameters to determine the task parameters, each of the sub-systems being adapted to obtain and process a set of particular setting parameters and to maintain a register of the particular setting parameters such that the management system computer may poll them as necessary.

Preferably each of the sub-systems may have the necessary equipment to do an entire one of the tasks. For instance each sub-system may have radio frequency equipment to carry out the obtaining of the necessary data, analogue to digital convertors, array processors and host processors to process the raw data which has been obtained with the RF equipment and to maintain a register for the data such that this data can be obtained by the management system computer as necessary.

In a preferred embodiment each of the sub-systems may be connected to the management system computer by means of a local area network.

By this means the work load on the management system computer is considerably reduced because it does not need to do all the calculations for the various sub-systems but need only obtain the data necessary for carrying out the task calculations and do those calculations.

Each of the sub-systems need only have the particular componentry necessary to process its particular task and to provide a storage for the information obtained and the individual sub-systems may have all the time necessary to do their job without interference from other parts of the system. This is particularly useful where the different tasks have different execution time. At all times however each of the subsystems will have its most recently obtained data available for polling by the management system computer.

In a further form the invention may be said to reside in an over-the-horizon radar including a modular transmission and reception parameter

management system comprising a management system computer to process an over-the-horizon radar task and to provide a transmission and/or reception unit with the necessary task parameters for that task, the management system computer being adapted to poll a plurality of sub-systems to obtain setting
5 parameters to determine the task parameters, each of the sub-systems being adapted to obtain and process a set of particular setting parameters and to maintain a register of the particular setting parameters such that the management system computer may poll them as necessary.

10 In an alternative form the invention is said to reside in a method of operating a frequency management system in an over-the-horizon radar comprising determining a set of task parameters for a particular task including determining the value of each of the task parameters in a separate sub-system adapted particularly for determining the value of that task parameter, holding the value of each of the parameters in its respective sub-system, and
15 polling each of the sub-systems by a management system as and when the value of that parameter is required.

By this method it will be seen that the management system can proceed with the task of frequency management while each of the sub-systems determines the value of its respective parameter and has this available for use by the
20 management system.

The actual function of each of the sub-systems and the number of sub-systems will be dependant on the functions carried out by the management system computer and for instance in an over-the-horizon radar system there may be six sub-systems as follows.

25 A first sub-system may be a backscatter sounder. The backscatter sounder is used to gain an appraisal of propagation conditions in a general direction of interest over the complete span of the HF band. In the preferred embodiment of as over-the-horizon radar system it may employ a high power frequency modulating continuous array of signals radiated from the transmitter site.
30 After propagation via the ionosphere, scattering from the earth's surface and return via a second ionospheric reflection the signals are received at the receiver site and de-ramped appropriately. Further processing produces a display of propagation delay or group range against transmitted frequency.

The digitised data contains information on the return power for the continuum of scatterers in range. This data is then stored as discussed above so that the management system can poll this information as required.

5 A second sub-system may be an oblique incidence sounder. The oblique incidence sounder employs a low to medium power frequency modulated continuous wave signal radiated from a remote site. After propagation via the ionosphere the signals received on the appropriate beam of the directional array at the receiver site. Following de-ramping and processing the power spectra relating to each integration period are associated with and plotted
10 against a single transmitted frequency. The resulting display of group range power with changing frequency will show traces corresponding to the various modes of propagation possible over the circuit. Any number of oblique sounders may be used and for instance up to three oblique sounders may be incorporated into each over-the-horizon radar system. The oblique incidence
15 sounder data may be used for mode recognition, estimation of reflection height and co-ordinate registration of targets. Once again the data is stored in the sub-system and available for polling from the management system computer.

A third sub-system may be a channel occupancy surveillance sub-system.
20 The high frequency channel occupancy surveillance system is required to monitor activity across the high frequency spectrum to identify unoccupied frequency channels and then to have this information available for polling.

A fourth sub-system may be a background atmospheric noise detector which is used to measure the background atmospheric noise levels in selected
25 unoccupied channels and then to have this information available for polling.

A fifth sub-system may be a mini-radar sub system. The mini-radar as the name implies is a reduced version of the main over-the-horizon radar system with limits on array size and power transmission. It radiates over a beam with equivalent to the complete radar coverage and receives on a beam similar to
30 a radar transmit beam. By including a repetitive wave form the mini-radar can provide information on the doppler profile of their returned energy. This is achieved by sampling data synchronously with the swept wave form and forming a two dimensional spectral analysis. The result is a display of clutter

power as a function of range and doppler. The level of transmitter power and the receive system sensitivity result in a system below the threshold of capability to detect targets. However, it can provide useful information regarding ionospheric behaviour and surface scattering conditions in doppler processed space. Once again this information is available for polling from the radar management system computer.

A sixth sub-system may be a passive channel evaluation sub-system. The passive channel evaluation system operates as a mini-radar without a transmitter. The results obtained from a passive channel evaluation system provide a view of range doppler space showing background levels without any reference signal. The system is required to measure the radio frequency interference and noise environment of clear channels and subject them to the same resolution and processing as for the radar in order to identify the most suitable channel for radar operation. The information obtained by the passive channel evaluation sub-system is also available for polling from the radar management system computer.

It will be seen that there is a range of different sub-systems each of which will have different sampling rates and repetition rates. To have a single computer processing all of these will mean that there may be interaction causing occlusion of some information, time wasting and at times high overheads and delays. By separating the various functions into self contained sub-systems the radar management system computer can proceed with its main task of task parameter determination in real time. For a particular application a selection of the various sub-systems may be used as necessary and the management system computer can be set up to use the information provided to determine propagation characteristics.

Generally therefore this invention provides a modular transmission characteristic management system for systems which use high frequency propagation to the ionosphere such as an over-the-horizon radar which enables sounding data such as backscatter, oblique and vertical incidence and the like to be collected by various sub-systems and the results of the processing of each of these signals being available to a task processor which determines the various characteristics at which a transmitter and receiver must be set for best efficiency. By the use of the modular system proposed by

this invention the most recent data from each of the sub-systems may be used to calculate settings which may in some cases change by a timescale of minutes so that real time processing is possible.

5 It will be realised that the configuration the subject of this invention lends itself to use with expert systems.

To assist with understanding of the invention reference will now be made to the accompanying drawing which shows one embodiment of the invention in relation to over-the-horizon radar.

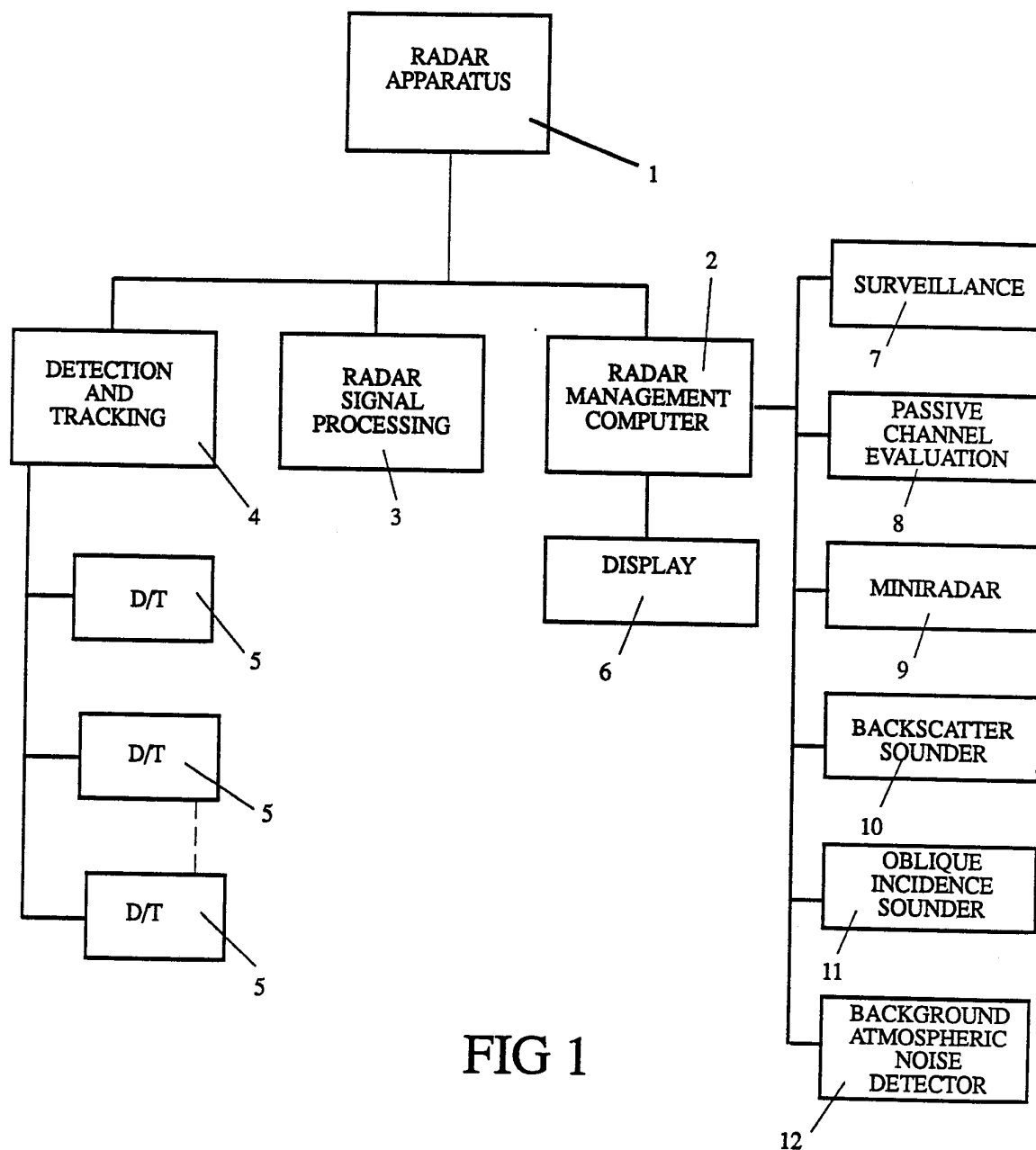
10 The drawing, Figure 1, shows a block diagram of an over-the-horizon radar system which includes the parameter determination system of the present invention. The radar apparatus 1 is managed by a radar management computer 2. Signals from the radar apparatus are processed in the radar signal processing block 3 and the particularly required signals are transferred to the detection and tracking block 4 for detection and tracking of required
15 targets. Each of the detection/tracking sub-systems (D/T) 5 can be set to follow a particular target or to carry out a particular task.

The radar management computer 2 requires the values of particular parameters such as optimum transmission frequency for the performance of a particular task. For this purpose the radar management computer 2 can poll
20 each of the management sub-systems 7, 8, 9, 10, 11, and 12 for the particular value or values determined by that sub-system. Each sub-system then holds the value or values for polling by the radar management computer. A display 6 is provided on the radar management computer 2 to show the task and parameters of that task presently being processed.

- 1 A modular transmission and reception parameter management system comprising a management system computer to process a task and to provide a transmission and/or reception unit with the necessary task parameters for that task, the management system computer being adapted to
- 5 poll a plurality of sub-systems to obtain setting parameters to determine the task parameters, each of the sub-systems being adapted to obtain and process a set of particular setting parameters and to maintain a register of the particular setting parameters such that the management system computer may poll them as necessary.
- 10 2 A modular transmission and reception parameter management system as in Claim 1 wherein each of the sub-systems has the necessary equipment to do an entire one of the tasks.
- 3 A modular transmission and reception parameter management system as in Claim 1 wherein each of the sub-systems is connected to the
- 15 management system computer by means of a local area network.
- 4 An over-the-horizon radar including a modular transmission and reception parameter management system comprising a management system computer to process an over-the-horizon radar task and to provide a
- 20 transmission and/or reception unit with the necessary task parameters for that task, the management system computer being adapted to poll a plurality of sub-systems to obtain setting parameters to determine the task parameters, each of the sub-systems being adapted to obtain and process a set of particular setting parameters and to maintain a register of the particular setting parameters such that the management system computer may poll
- 25 them as necessary.
- 5 An over-the-horizon radar as in Claim 4 wherein each of the sub-systems has the necessary equipment to do an entire one of the tasks.

- 6 A method of operating a frequency management system in an over-the-horizon radar comprising determining a set of task parameters for a particular task including determining the value of each of the task parameters in a separate sub-system adapted particularly for determining the value of
- 5 that task parameter, holding the value of each of the parameters in its respective sub-system, and polling each of the sub-systems by a management system as and when the value of that parameter is required.

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INTERNATIONAL SEARCH REPORT

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)⁶

According to International Patent classification (IPC) or to both National Classification and IPC
Int. Cl.⁵ G05B 19/05, 19/04, G01S 13/52, 13/536

II. FIELDS SEARCHEDMinimum Documentation Searched⁷

Classification System

Classification Symbols

IPC

G05B 19/05, 19/04, G01S 13/52, 13/536

Documentation Searched other than Minimum Documentation
to the extent that such Documents are included in the Fields Searched⁸

AU : IPC as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹

Category [*]	Citation of Document, ¹¹ with indication, where appropriate of the relevant passages ¹²	Relevant to Claim No ¹³
A	EP,A, 419721 (SIEMENS) 3 April 1991 (03.04.91) See Figure 4	
A	US,A, 4947314 (SUMIDA) 7 August 1990 (07.08.90) See Figure 2	
A	DE,A, 3938308 (MYCOM K.K.) 23 May 1990 (23.05.90) See abstract	
A	Patents Abstracts of Japan, P 1030, Page 89, JP,A, 2-21306 (MITSUBISHI ELECTRIC CORP) 24 January 1990 (24.01.90)	
	(continued)	

* Special categories of cited documents : ¹⁰

"A" Document defining the general state of the art which is not considered to be of particular relevance
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 "O" document referring to an oral disclosure, use, exhibition or other means
 "P" document published prior to the international filing date but later than the priority date claimed

"T"

Later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
 "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step
 "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
 "&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search
25 June 1992 (25.06.92)

Date of Mailing of this International Search Report

6 July 1992 (06.07.92)

International Searching Authority

AUSTRALIAN PATENT OFFICE

Signature of Authorized Officer

A.W. DUKE

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

- | | |
|---|---|
| A | EP,A, 331551 (APRIL S.A.) 6 September 1989 (06.09.89)
See Figure 1 |
| A | WO,A, 89/06010 (SQUARE D COMPANY) 29 June 1989 (29.06.89)
See Page 8 lines 30-33; Figure 2 |

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE ¹

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claim numbers ..., because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim numbers ..., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claim numbers ..., because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4a

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING ²

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.
2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

- ☐ The additional search fees were accompanied by applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

**ANNEX TO THE INTERNATIONAL SEARCH REPORT ON
INTERNATIONAL APPLICATION NO. PCT/AU 92/00174**

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member			
EP	419721				
US	4947314	EP	29285	JP	63289608
				KR	9109462
DE	3938308	FR	2639448	JP	2140804
EP	331551	FR	2627873		
WO	8906010	AU	618066	DK	4035/89
		US	5038318	EP	346441

END OF ANNEX