The Eddystone 1995 Series of v.h.f/u.h.f communications receivers – a user's guide.

R. T. Sutton, B.Sc, C.Eng, M.I.E.E

Summary The Eddystone 1995, a new high-performance general coverage v.h.f/u.h.f communications receiver, with comprehensive signal reception and operating facilities, is described.

The operating system, based on that developed for the Eddystone 1650 l.f/h.f receiver, has been enhanced and extended for both the v.h.f/u.h.f receiver and a new version of the l.f/h.f receiver. Together, these matching equipments can monitor the complete 10kHz to 1·1GHz spectrum. Many of the operating improvements have been in tuning, scanning and sweeping, and particular attention is paid to these in this article.

Built-in test equipment (BITE) is becoming standard to aid fault finding in sophisticated equipment. A method to provide reliable BITE and the ways it can be used are described.

For remote control, compatibility with a wide range of standard data communications equipment is essential. Use of such equipment with the new receivers is detailed, as is the use of a mixture of long and short commands to maximize speed of control for the widest variety of tasks.

Introduction

The Eddystone 1995 Series of v.h.f/u.h.f communication receivers has now been introduced to complement the 1650 Series of l.f/h.f receivers. The appearance of the sealed membrane front panel (figure 1) and the method of operation of both series is similar[1]. However, improvements and additions have been made to the operating procedure and many of these are also incorporated in the new 1650/9 l.f/h.f receiver. This article will therefore describe the use of the 1995 and indicate which new or improved facilities are also available on the 1650/9.

Members of the 1995 Series

Two variants have initially been introduced. These are the 1995/1 which covers 20MHz to 470MHz and the 1995/2 which covers 20MHz to 1·1GHz. This allows users who require only the reduced range to have a simpler, more cost-effective receiver. To reduce the numbers of variants required, particularly for different remote control systems, an internal preset option selector switch is fitted on the 1995 and the new 1650/9. The 1995 also has an external frequency standard input (switchable to 1MHz or 5MHz) as a standard fitting.

Basic features

The 1995/1 is a conventional superhet. For frequencies above 470MHz, the 1995/2 has a front end downconverter using fixed oscillator injection from surface acoustic wave (SAW) oscillators stabilized in phase-locked loops (p.l.l). The rest of the 1995/2 then operates as a variable i.f in the range 100MHz to 400MHz. In all cases preselection is by block filtering.

The first i.f of the 20MHz to 470MHz range has dual 515MHz filters giving a roofing (i.e, maximum overall) bandwidth of 6MHz. After conversion to the second i.f of 10·7MHz, a low level i.f output of 6MHz bandwidth is provided for driving panoramic displays. Up to this point all circuitry is designed to have very high dynamic range so that signals within the roofing bandwidth (and outside the 10·7MHz bandwidth setting) have third order intercept points of typically +5dBm.

The bandwidth of the second i.f can be set, independently of the mode, in the range 3kHz to 60kHz (five crystal filters), to 250kHz (ceramic filter) or to 6000kHz (roofing filter). Demodulators are provided for a.m or f.m, wide or narrowband being determined by the bandwidth setting. The narrowband f.m demodulator operates at 455kHz. A product detector is provided for u.s.b/l.s.b and c.w with a b.f.o range of +9·9kHz to −9·9kHz. Indication of pulse or r.f.i levels is given by an independent quasi-peak detector with a rectified output available on the rear panel.

High-level audio, line audio and dual wideband detected outputs

R. T. Sutton

Roger Sutton obtained a First Class Honours Degree at the University of Aston in 1969 and then continued working at Eddystone Radio where he had received his industrial training for the sandwich degree course. He has been involved in the design of a wide range of radio receiving, measurement and f.s.k equipment from v.l.f to v.h.f/u.h.f, principally at Eddystone Radio in Birmingham, but including a period at the Marconi Communication Systems establishment in Chelmsford.

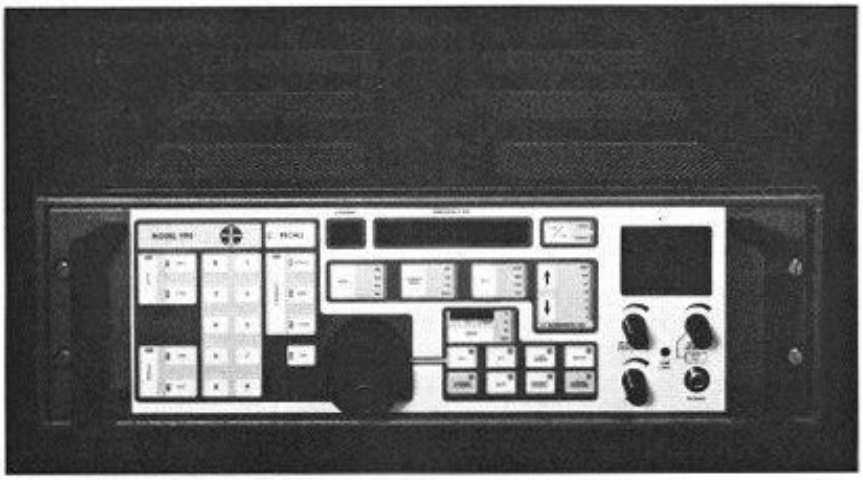


Fig. 1. View of the Eddystone 1995 receiver

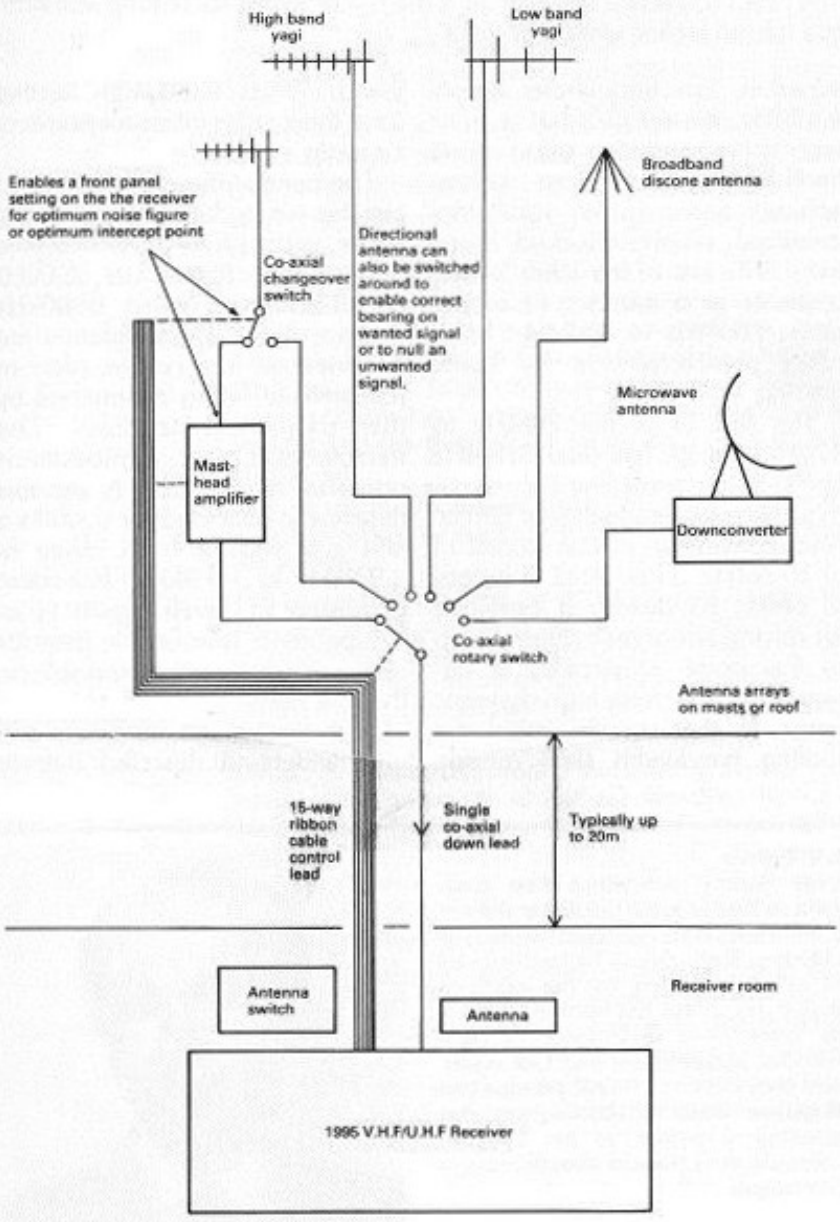


Fig. 2. Typical uses of remote antenna switch

are also available on the rear panel.

The wideband outputs can be used for wideband a.m or f.m, the frequency reponse being limited by the bandwidth setting. Typically they would be used for video signals (either polarity), stereo f.m, etc.

Front panel selection of up to ten antennas is provided. This feature is also provided on the new 1650/9 receiver (up to four antennas). Front panel switches enable the main tuning knob to select the required antenna as well as to perform other functions. The antenna can then be selected by a coaxial switch controlled by the T.T.L rear panel control lines. 12V and 5V supplies are also provided for a switch. Thus only one coaxial cable and a simple multiway d.c link is required for a group of up to ten remotely situated antennas. Note that low-noise masthead pre-amplifiers, microwave downconverters, etc, can also be selected in this way (figure 2).

Front and rear panels

As with the 1650, a sealed membrane keyboard with a colour coded l.e.d display is used (figure 3). A large control knob is provided to set frequency, BFO offset, antenna, channel or BITE test number, dependent on operating mode.

A piezo sounder indicates correct key operation and also generates a distinctive warble tone if a non-valid key operation is attempted. The sounder can be enabled or disabled by the internal preset option selection switch. The 1650/9 also has this option as an internal rather than as a front panel setting.

Apart from the phones jack, all inputs and outputs are on the rear panel (figure 4). This carries a switch to select an optional input from a 1MHz or 5MHz external frequency standard. Locking to the external standard is monitored by the BITE system.

As well as operating from all standard mains supplies, the internal switched mode power unit also operates from a 19V to 32V d.c supply (negative ground). This input is automatically selected if the mains power fails.

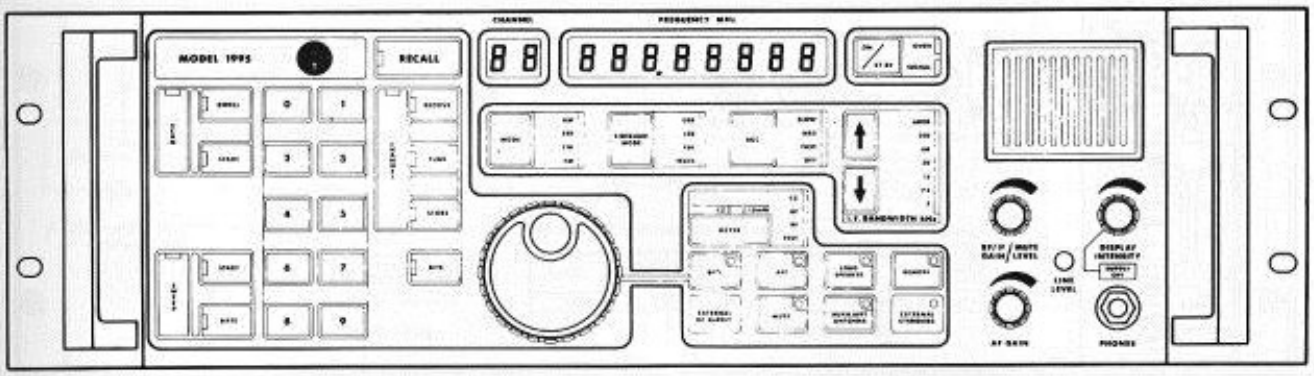


Fig. 3. Layout of the 1995 front panel

Frequency tuning

The tuned frequency can be entered directly using the numeric keypad and then can be adjusted using the tuning knob. This increases or decreases the frequency in discrete steps. Step size can be set, from the front panel, in the range 10Hz to 99·99kHz (to 10Hz resolution). Normally it is set to the standard channel spacing of the band being monitored, typically 12·5kHz. For clarification of s.s.b however, it may be reduced to about 10Hz temporarily . If a step size or 'Rate' of 00·00kHz is set, then variable rate tuning is provided where the step size depends on the rate at which the knob is turned. The 1650/9 has identical tuning facilities.

It should be noted that since any starting frequency can be entered, the actual frequencies tuned do not have to be whole multiples of the channel spacing or step size. Also, turning the tuning knob 'fills-in' any non-completed frequency setting with zeros. Thus to tune around 200MHz for example, enter '2' and just turn the tuning knob. Similarly, to tune around 163·5MHz, enter '1', '6', '3', '5' and turn the knob.

Audio muting (squelch) is provided to reduce noise between signals whilst tuning. The audio is not completely muted thus preventing signals below threshold from being missed. On f.m the muting is noise derived, the level being set internally. On all other modes it is level derived. This level is set using the front panel R.F/I.F Gain control which doubles as the Mute Level control when a.g.c is selected. This also sets the carrier operated relay (COR) threshold level, this relay operating on all modes, including f.m, and having single pole changeover contacts brought out to the rear panel.

Digital automatic frequency control (a.f.c) is provided to assist tuning to f.m signals and to enable 'tracking' of non-fading signals.

Channel storage

Ninety-nine non-volatile memories are provided for channel storage. Each memory can be loaded individually with tuned frequency, BFO offset, mode, a.g.c, selectivity and antenna settings. Being able to store the antenna setting enables automatic selection of the correct antenna, pre-amplifier, etc, when a particular channel is used. The memories can be interrogated, loaded, modified or shifted without disturbing the signal being received. A channel can be cleared by entering zero frequency.

The channels stored can be scanned or used as limits for frequency sweeping. These facilities are described in the next two sections. The 1650/9 scanning and sweeping facilities have also been updated to operate as follows.

Channel scanning

Any channel can be programmed to be scanned. Thus any number of channels from two to 99 can be in the scan sequence, for example, channels 3, 4, 27, 98 ---- 3, 4, 27, 98, ---- 3, etc. The dwell on each channel can be set in the range 100ms to 9·9s (100ms increments). If mute is selected, the scan will halt on any channel with a signal above the threshold level. The hold delay before scanning resumes after the signal ceases, can be set in the range 0 to 9s (1s increments). If the receiver is programmed to monitor (i.e, scan) the two channels of a split-frequency simplex two-way communication, a short hold delay would be used. This prevents the start of transmissions being lost when the used channel changes. Longer hold delays would be used when the transmission has occasional long gaps in the signal level (s.s.b) or when two-way simplex communications are being monitored.

Dwell and hold periods are set via the front panel controls. If a dwell of 0s is entered, the scan is totally under manual control. This enables an operator to load the channel frequencies of interest (perhaps with different modes, antenna etc.) and then just tune to these as required using the tuning knob. The scan process can also be halted or stepped-on asynchronously using a simple grounding connection to a rear-panel input line. This enables external signal identification equipment to use the receiver to search for particular signals.

Channel sweeping

Any two adjacent channel memories can be used to store the frequency limits for automatic frequency sweeping. The sweep proceeds in the steps set for manual tuning (i.e, 10Hz to 99·99kHz), the receiver remaining on each step for the dwell rate set for channel scanning (i.e, 100ms to 9·9s). The start frequency and the rest of the receiver settings (mode, bandwidth etc.) are in the lower num-

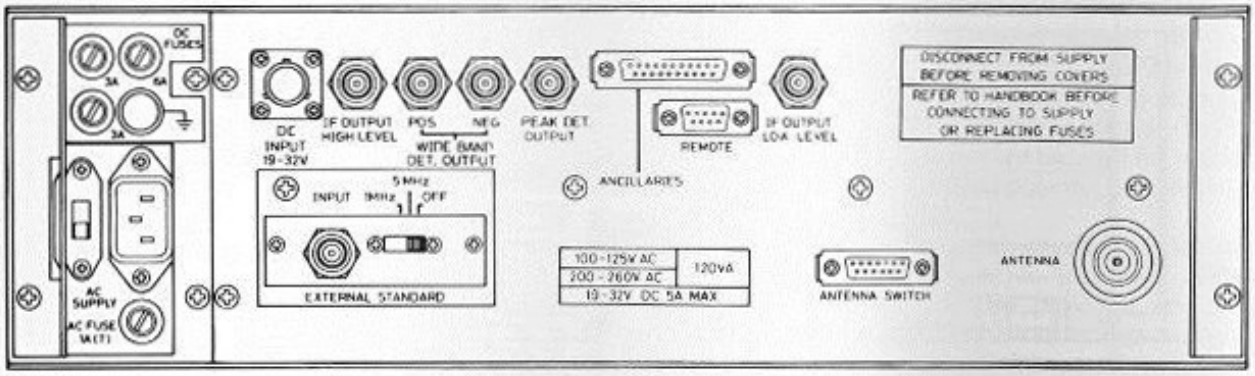


Fig. 4. Layout of the 1995 rear panel

bered channel and the end frequency is in the next highest numbered channel (for example channels 56 and 57 respectively). The sweep can be in ascending or descending frequency and cover any of the receiver's range which is greater than the step size selected. If a step size of 5kHz or more is used, the 'halt on occupied step', 'resume after hang period' and 'external control of sweep operations', as described for channel scanning, are also available. This enables a form of channel scanning over a frequency band rather than using separately stored channel frequencies. Obviously in this case many more than 99 channels can be scanned.

The sweeping facilites available are especially useful in that they enable up to 49 bands of the spectrum to be defined using the channel memories. These bands, as opposed to individual channel frequencies, can then be selected by entering the number of the lower channel of the required pair and then selecting sweep mode. The bands can then be swept automatically or, if a dwell of 0·0 seconds is used, can be manually tuned through using the tuning knob. Thus the receiver can be made to operate specifically on the frequency ranges and modes required.

Frequency data output

An internally selectable option is a rear panel output of the receiver tuned frequency. This asynchronous data output is at 2400 baud and TTL level and provides a reading to 1kHz resolution (100Hz on the 1650/9) every 50ms or every 500ms if the tuning knob is in continuous use. The data stream can be read by intelligent ancillaries, each byte consisting of a single digit, its resolution (i.e, 1kHz, 10kHz, 100kHz etc), and a parity bit. Typically the data would be used to control pre-selectors and to provide information to a panoramic display unit to enable it to indicate the true frequency of any line on the display.

Built-in-test-equipment (BITE)

Full BITE facilities are provided to aid fault finding to module level and to assist alignment and maintenance. BITE has two levels or modes of operation. The 'passive' BITE mode operates during all normal operating times monitoring d.c and r.f voltage levels and synthesizer locking. This is accomplished by 'wire-ORing' all the appropriate error sense lines using data selectors. A fault anywhere is then shown by a flashing BITE indicator. At a suitable moment the second level active BITE mode can then be entered to enable identification of the fault. In this mode, up to 99 separate internal tests can be selected by direct entry of the test number or by scanning through the tests using the tuning knob. These tests control the data selectors via an internal 'BITE BUS' to pinpoint the actual lines indicating errors. Additional tests using built-in noise and sinewave generators are also provided to check gains, etc, of individual circuit blocks.

It is important to note that there is always a finite possibility of an indicated fault being due to a failure in the BITE circuitry rather than the signal circuitry. In the 1995 the probability is reduced to a minimum by ensuring that the BITE circuitry is simple and forms only a small proportion of the total of a particular module. Furthermore, since the BITE system indicates faulty modules, failed BITE circuitry where possible must also point to the module on which it is located. Thus noise and sinewave generators are located on the actual module which they are effectively used to check.

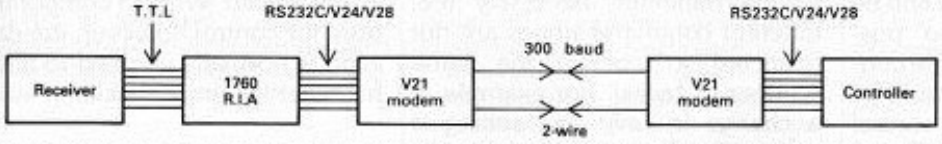
Certain BITE tests can also be used to aid receiver alignment by setting specific tuned points etc. Various internal adjustments can then be set, for example, the end points of the ranges of internal voltage-controlled oscillators.

All the tests can be performed and monitored remotely or automatically. Each provides a pass or fail when selected, a particular fault providing one or more fails. Generally, fault location is easy to determine. However it is possible for an 'expert progam' to be written for a computer which will automatically perform and monitor all the tests, build a 'fault pattern', analyse this and describe the probable fault or faults in plain English. Such a technique allows an easy-to-understand, hard-copy analysis of a faulty equipment to be obtained simply.

BITE of a similar nature is also provided in the 1650/9.

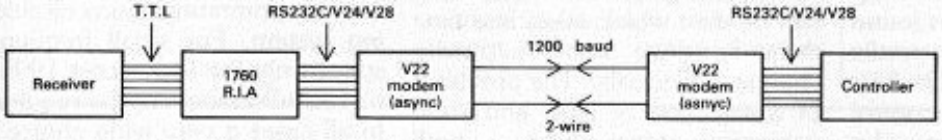
Remote and automatic control

Complete remote control and



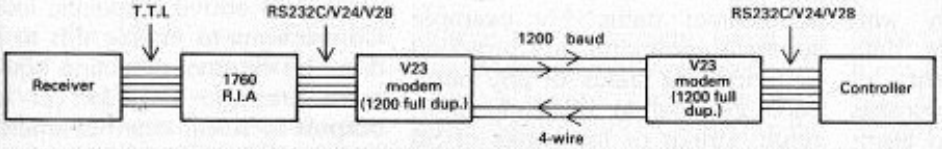
a) *V21.* Enables very low cost modems to be used over only two wires. Penalty: reduced speed of operation of the 300 baud data rate required.

Low cost and 2-wire but relatively slow.



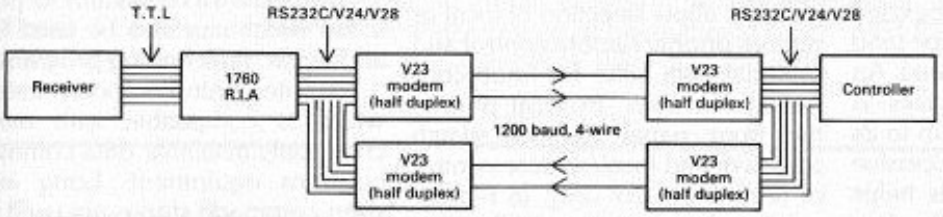
b) *V22 (asynchronous).* Enables fast control over a basic 2-wire link. Penalty: relatively high cost of the V22 (asynchronous) modems.

High speed over two wires but relatively costly.



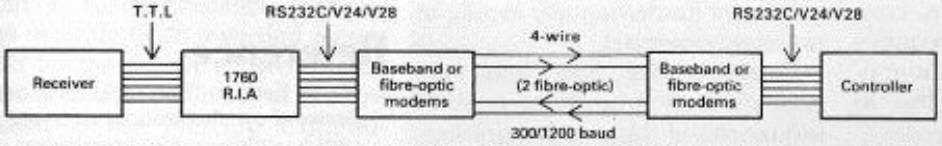
c) *V23 (full 1200 baud duplex modem).* Enables fast control using relatively low-cost modems. Penalty: requires 4-wire link.

High speed at relatively low cost but requires 4-wire link.



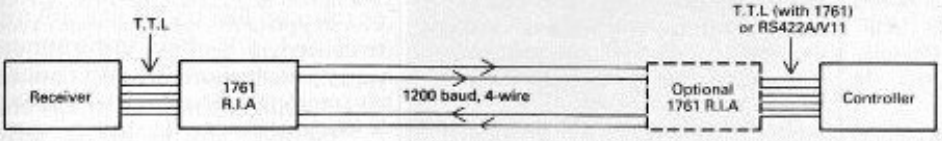
d) *V23 (1200 baud, half duplex modems).* Enables fast control using the easy-to-obtain V23 half duplex modem. Penalty: requires more modems and 4-wire link.

High speed using a low-cost, easy-to-obtain modem but requiring twice as many modems and a 4-wire link.



e) *RS232C/V24/V28 baseband modems, fibre optics and multiplexers.* Enables a wide variety of commercial RS232C/V24/V28-compatible data comms equipment to be used for control over up to several tens of km. Fibre optic links can be used in hostile r.f environments. Multiplexers can be used to concentrate control over one link for several receiver-controller pairs. In this case the aggregate data density over the link should not exceed the link's capability if control is not to be lost. Choice of 300 baud equipment data rate can help in this case at a penalty of a slower control speed.

A wide variety of options using simple data comms equipment and complex multi-plexers for control over moderate distances.



b) *RS422A/V11.* Enables fast control over a 4-wire link without any additional data comms equipment. Penalty: 1 to 1·5km maximum length of the 4-wire link.

High speed without additional data comms equipment, but limited to a maximum link distance of 1–1·5km.

Fig. 5. Control systems using standard data communication equipment

status interrogation can be provided over serial digital data links. Error detection is provided by checksum, syntax checking and by generation of a data 'echo' positive acknowledgement to the controller to allow final verification by comparison. The remote control facilities provided in the 1995 and the 1650/9 have been extended and improved in the light of experience obtained with the original 1650. Frequently it was found that users already had a specific type of modem etc, which they required to be used for the control link. It was also found that a wider range of control commands was necessary to perform specific tasks quickly and efficiently.

To ensure compatibility with most commonly available data communications equipment, all control and status data consists only of strings of standard asynchronous data bytes at a rate internally selectable as 1200 baud or 300 baud. This allows a variety of two or four wire links to be used with a choice of modem type (and thus cost) and operating speed. An outline of the main choices is given in figure 5. Gaps of up to 2s are allowed between successive bytes of a command. This helps provide compatibility with data multiplexers which may split up single command. Handshaking is provided directly between controller and receiver and requires only the intervening data communications equipment RTS line to be set true.

To maximize speed of operation of the wide variety of control and interrogation tasks required, each task has its own specific command string, the string length being kept to the minimum necessary (i.e, different command strings are not restricted to contain the same number of bytes). For example, if a change in only one setting is required, only three bytes are sent. However, if several settings require changing, a longer but more efficient composite command string can be sent which takes less time than sending each separate change individually. The provision of a selection of long and short command strings enables both simple and complex changes to be performed efficiently. Similar techniques are used for the return of receiver status. For example separate commands are provided to return the status of any particular channel (a relatively short return string) or for banks of 50 channels (a return string of several hundred bytes).

As well as baud rate, internal switches allow selection of local or remote priority remote control and optional data echo for knob-controlled functions. In local priority the front panel Remote switch selects mixed local/remote control or remote control only. In remote priority, the remote controller performs the same function. This enables systems to be configured which are fundamentally locally or remotely operated.

Disabling the data echo on knob-controlled functions enables sequences of them to be quicker. Thus manual tuning of frequency, for example, has the correct feel to the operator. This is normally done when the mimic remote control panel (Types 1775 or 1776) is used. When a computer is used for control however, the data echo is normally enabled to allow full revertive error checking.

Conclusions

The 1995/2 and 1650/9 form the basis of a complete 10kHz to 1·1GHz communications monitoring system. For small frequency spans only the lower cost 1995/1 or 1650/9 alone may be required. In all cases a very wide choice of manual and automatic tuning and searching facilities are provided including detection of and halting on signals above a specific level. Connections to enable this to be done by external detection equipment are also provided as are outputs to select external antenna options and to drive external preselectors and panoramic display units.

A versatile BITE system is provided which can also be used for an 'expert' fault finding program.

Remote control is incorporated which is compatible with most commonly available data communications equipment. Long and short command strings are used to enable both simple and complex changes to be made efficiently.

Reference

1. R. T. Sutton: 'The Eddystone 1650 Series of communications receivers – a user's guide', *'Communication & Broadcasting'*, Vol.9, No.3 (February 1985), pp.23–28.

RESUMEN

Se describe el Eddystone 1995, un nuevo receptor de comunicaciones de VHF/UHF de cobertura general y elevadas características, con amplia recepción de señales y medios de maniobra.

El sistema funcional se basa en el desarrollado para el receptor Eddystone 1650 de baja/alta frecuencia. Se han acrecentado y extendido los sistemas, tanto para el receptor de VHF/UHF como para una nueva variante del receptor de baja/alta frecuencia. Estos equipos de adaptación pueden, juntos, comprobar el espectro de 10kHz a 1,1GHz. Muchas de las mejoras han sido en la sintonización, la exploración y el barrido; y en este artículo se da atención especial a estas mejoras.

Para telecontrol, es esencial la compatibilidad con una amplia variedad de

ZUSAMMENFASSUNG

Das Gerät Eddystone 1995, ein neuer Hochleistungs-Kommunikationsempfänger für VHF/UHF-Betrieb mit vollständigen Signalempfangs- und Betriebseinrichtungen, wird beschrieben.

Das System basiert auf dem für den NF/HF-Empfänger Eddystone 1650 entwickelten. Das System wurde erweitert sowohl für den VHF/UHF-Empfänger wie auch für eine neue Ausführung des NF/HF-Empfängers. Zusammen können diese beiden aufeinander angepaßten Geräte das vollständige Wellenspektrum zwischen 10kHz und 1,1GHz überwachen. Viele der Verbesserungen sind in der Bedienung, beim Abtasten und Durchlaufen, und dieser Aufsatz widmet diesen Merkmalen besondere Aufmerksamkeit.

Eingebaute Testgeräte (Built-In Test

RÉSUMÉ

Description de l'Eddystone 1995, un nouveau récepteur de communications à zone de couverture générale VHF/UHF et à hautes performances, avec des dispositifs très complets de réception des signaux et de fonctionnement.

Le système est basé sur celui mis au point pour le récepteur Eddystone 1650 BF/HF. Ce système a été amélioré et développé à la fois pour le récepteur VHF/UHF et pour une nouvelle version du récepteur BF/HF. Ensemble, ces équipements complémentaires peuvent assurer le contrôle de toute la bande de 10kHz à 1,1GHz. Bon nombre des améliorations portent sur le réglage d'accord, le balayage et la vobulation, et une attention toute particulière a été accordée à ceux-ci dans cet article.

(continued)

equipos de comunicaciones de transmisión de datos standard. Se detalla el empleo de estos equipos con los nuevos receptores; lo mismo que el empleo de una mezcla de señales a larga y corta distancia para llevar al máximo el control de velocidad de la más amplia variedad de misiones.

Equipment – BITE) werden mehr und mehr zur Normalausführung, um Störungssuche in hochgezüchteten Geräten zu erleichtern. Eine Methode zuverlässiges BITE vorzusehen sowie Arten der Anwendung werden beschrieben.

Verträglichkeit mit einem großen Bereich genormter Datenkommunikationsausrüstungen ist unerläßlich, um Fernbedienung zu erreichen. Die Anwendung solcher Geräte mit den neuen Empfängern wird im einzelnen beschrieben, wie auch die Anwendung eines Gemisches langer oder kurzer Befehle, um maximale Geschwindigkeiten bei der Bedienung für einen großen Aufgabenbereich zu ermöglichen.

Les équipements d'essais intégrés (BITE) sont de plus en plus fournis en version standard afin de faciliter le dépannage des équipements très sophistiqués. L'article décrit une méthode de fournir des essais intégrés fiables et la manière de les utiliser.

En ce qui concerne la commande à distance, la compatibilité avec une vaste gamme d'équipements de communications de données est essentielle. L'utilisation de tels équipements avec les nouveaux récepteurs est indiquée en détail, tout comme l'utilisation d'un mélange de commandes longues et courtes pour maximaliser la vitesse de contrôle de diverses tâches.