

CODAN - Outback radio to global communications - Part 1

by Malcolm R Haskard (VK5BA)

1. Introduction

The establishment of a radio communication system by Alf Traeger and later his company Traeger Transceivers Pty Ltd, all part of the Rev. John Flynn's "mantle of safety", brought relief to the Australian outback. Following WW2, advances in technology allowed significant upgrades, including a move from AM to SSB, and these needed upgrades allowed three recent graduates, through their a newly formed company Eilco, later Codan, to meet this challenge and run with it. Over the past forty years this company has grown from a backyard operation to Australia's largest supplier of commercial HF communication equipment, as well as a major manufacturer of microwave systems, exporting some 85% of production to over 150 countries. Truly a global service.

This article is divided into two parts, the first providing an overview of the history of Codan and a discussion on their design philosophy and manufacturing methods, while the second gives a summary of the HF products marketed.

2. The history of Codan

In the 1950s three young men attended the University of Adelaide, Ian Baker Wall, Alistair Edward Rose Wood and Irvine James (Jim) Bettison, and while they were enrolled in different courses they had common interests. Ian and Alistair had met previously at St. Peters College, Adelaide, but it was during their first year at University that their interest in engineering and particularly electronics drew them together and they became friends. Alistair was the first to graduate, his Degree of Bachelor of Engineering in Mechanical Engineering being awarded in 1954. Ian undertook a Bachelors Degree in Electrical Engineering and even in 1954, his final year, there was the desire to design and commercialise his knowledge and skills, so during that year he designed a power supply for commercialisation. Ian and Alistair also obtained amateur radio certificates of proficiency being allocated the call signs VK5IW and VK5ZAE respectively. Together they built UHF mobile amateur radio equipment, perhaps their first joint venture into communications.

On graduation Alistair undertook part time lecturing in Mechanical Engineering while Ian was employed by Philips at their factory Radio and TV Design Laboratories at Hendon, Adelaide. Even during the early years of University and afterwards the two formed a working association that designed and built electronic equipment. Known everywhere as Wood and Wall, they initially operated out of Ian's home at Hampstead Gardens. Alistair's father, a marine engineer, had previously had the stables at his Gilberton home converted into a workshop so when needed there was access to this facility. The two designed and built equipment for the University, repaired taxi receivers and gradually the home business grew until with normal day work it was like having two jobs. A decision needed to be made whether or not to go full time into their own engineering business.

Jim Bettison's interests were a little different to his University engineering friends. There were common bonds such as a love of good cars (Ian having at the time an MG TC, Alistair a Triumph TR3A and Jim a Triumph TR2, both with electric overdrive), and a desire to operate a business. Jim's university fields of study were very different, yet complemented the two engineers, and included history, law and commerce. In 1961 he graduated with an Honours Degree of Bachelor of Arts in History. Having a love of theatre and the arts he secured for himself the agency for Strand Electric, UK, theatre lighting equipment manufacturers. When needed Wood and Wall were engaged to assist him designing variable reactors and such to control the lighting. With all three friends having a desire to have their own business, it was but a small leap to form a joint company,

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Ian and Alistair providing the engineering side and Jim the needed skills in commerce and law. The new company, The Electronic, Instrument and Lighting Company Limited was formed on the 1st July 1959. With the financial help of parents, adjacent house properties at 7 - 9 Osmond Terrace, Norwood were acquired, and early 1960 the company moved to this address.

In forming Eilco they saw as their main areas of operation those that were spelt out in their company's name - electronics, instruments and lighting. The long name was often truncated to Eilco, but there was opposition to this by EIL Services and it was many years before Eilco would become a registered name. The strong motivating forces for forming the company was not simply to apply their knowledge and skills, but also to bring professionalism to bear on the electronics industry. The years servicing faulty instrumentation, control and mining equipment as well as transceiver repairs had revealed that many items of equipment would not perform to the specifications the manufacturers claimed. The lessons learned from those early days would stand them in good stead both now and in the years ahead.

In the beginning the company took on a wide range of electronics work for it was a matter of survival. They applied their skills to redesign and manufacture medical instrumentation amplifiers for the company Both Equipment, the servicing of electronic instruments for government departments and other organisations, as well as the development of their own products such as theatre sound and lighting systems. Ian remained at Philips until the end of 1959 and even in later years used his TV knowledge and skills to do part time lecturing in TV at the SA Institute of Technology, School of Electronic Engineering. The Anglican Bush Church Aid Society operated a School of the Air from a base station located at Ceduna, South Australia and approached Eilco to assemble some HF radio transceivers that had been designed by the late George Cameron. By 1961 there were two major new product initiatives, firstly the move into HF communications and secondly into ultrasonics and while both produced rewards, it was particularly the first of the two. The portable "lunch box" transceiver, type 6104 that eventuated was a blessing to the people of the outback, its success enhancing the Eilco reputation. The transceiver was compact, rugged, reliable, weighing 10 lbs, having its own in-built antenna tuner so that it could work with the simplest of antennas, matching indicated by simply peaking the brightness of a lamp, and requiring only 3 amps current from a 12 volt battery or mains supply. This set became the standard for everyone, mining companies, surveyors, church organisations, and government departments, all who were using HF radio in the outback. Figure 1 shows the publicity leaflet for this set. At this stage it is interesting to note the Eilco custom of issuing a product with a four digit type number, the first two digits indicated the year the idea for that product originated (not the year released to market), while the second two digits represented the product sequential number for that year. This numbering system was retained up until the nineteen nineties, however with time the second two digits were frequently selected to have a type number which simply had a good "ring" about it.

Eilco was now starting to grow. This growth is reflected in the entries in the original products book, a hand written book where product orders and ideas were written and given a type number. In the early years the products listed are below ten per year, rising to the twenties per year by the mid 60s and peaking almost to forty by 1968. The company had diversified in many ways, including relationships with other organisations as well as forming subsidiaries. George Ramsay ran a sheet metal and machine shop, Ramsay Brothers Pty Ltd, Eliza Street, Adelaide, and being an amateur radio operator (VK5GD) had assisted in building the studios of several of the local broadcast stations. Eilco often employed him to do sheet metal and other construction work for them. This relationship proved useful in the longer term for when the Ramsay business closed in the mid 70s, Eilco purchased much of his plant for their own metal workshop.

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Printed circuit cards for Eilco were made by IMP Engineering and Associates, founded in 1965 by Roy Pettet, Bob Hodgson and Fred Fischer and located at Wingfield an outer Adelaide suburb and once again when the opportunity was right, namely when Roy and Fred in 1979 wished to retire, Eilco purchased the company, initially establishing it at Newton as IMP Engineering Pty Ltd and currently as IMP Printed Circuits Pty Ltd, at Cavan SA. Frank Choate had established a transformer making business called E F Transformers and in 1965 this became part of the Eilco organisation, housed in a weatherboard building at the back of Osmond Terrace, Norwood premises.

In the late 1960s there was an international move to change HF communication methods from AM to SSB and although a more complex system, it was more efficient in its use of the HF spectrum. Eilco initially set about designing a hybrid set utilising quick heat valve technology for the final stage of the transmitter and elsewhere transistors. Fortunately, towards the end of the design phase RF power transistors were just starting to appear on the market so the final version was delayed and redesigned, so when released, as the type 6924, it was a fully solid state transceiver. Although the delay caused some difficulties, as will be seen later, it laid the foundation for the years ahead. The change to SSB meant that all of the Royal Flying Doctor Service bases needed to be upgraded and so the Government called an initial tender in 1968. Eilco applied. At the time there was a feeling in some quarters that a newly formed, small company like Eilco could never handle a half million-dollar project. Interestingly Eilco must have sensed this for they had previously approached Alf Traeger to see if he was interested in a joint operation, he having the name and contacts while Eilco the new technology. Their invitation was declined. As frequently happens with tenders for new systems various additional considerations arose and so tenders were recalled. In June 1970 Eilco received the purchase order to re-equip twelve RFDS base stations. In addition to these base stations there was now the need for portable, mobile and home stations capable of receiving SSB, a significant new market. Kingsley Hannaford from the Department of Supply and also representing the RFDS, together with Jim Forsyth of Eilco visited each of the then twelve base stations (Alice Springs, Broken Hill, Cairns, Carnarvon, Charleville, Derby, Kalgoorlie, Meekatharra, Mt. Isa, Pt. Augusta, Pt Hedland and Wyndham) during August to October 1971 and systematically documented what was there and what needed to be changed. This was done because the contract required everything to be manufactured in Adelaide, transported to the sites and installed. The project was completed in 1973, on time and within budget. Eilco continued to prosper.

Over these years the premises at Norwood had, with Sid Wall's assistance, been remodelled, for Ian's father was now into building and property development. An extension to the original freestone house at number 9, was added to the northern side for a laboratory and production assembly, area while in 1965 the self standing weatherboard sleep out at the rear was upgraded to accommodate E F Transformers, a company L Frank Choate had founded and brought with him when he joined Eilco in that year. The second house at number 7, originally used for storage was demolished and by mid 1967 a new building constructed into which G H Systems moved allowing Eilco Sales to move into the front building. The increase in work meant that staff numbers had risen, so by the early 1970s larger premises were needed. In October 1973 the company, now employing some 80 people, moved from Norwood to a new purpose built factory on two hectares of land at 81 Graves Street, Newton, an area zoned as light industrial. Over the years two further factory buildings were added the first of these in February 1981 and the second 1990.

During the early years agents had been set up to market the Eilco products, one in Western Australia being Associated Electronic Services (AES). Because of the delay in releasing the type 6924 set, Eilco could not provide SSB transceivers for AES to market. AES was therefore told to market sets it was able to get. At the time the US company Granger Associates were assembling

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SSB transceivers in Sydney, but now wanted to dispose of this facility. Consequently AES purchased it allowing them to source their own transceivers from there, raising the potential of becoming direct competitors with Eilco. The possibility of a joint AES/Eilco venture was explored and an association was formed whereby each had a half share, AES contributing its manufacturing facility as well as its marketing network while Eilco brought with it the RFDS contract. Basil Reynolds the Director of AES suggested that the new association be called Codan, an industry acronym for Carrier Operated Device (Delay*) Anti Noise, a squelch or muting system. Being a simple name, a word already known in the industry it was accepted and proved to be a good decision. Codan Ltd business grew. About 1981 it was resolved that Codan and Eilco should amalgamate, AES remaining a separate entity, to concentrate on ticket machines and related products. This decision was quickly followed by a second move in 1983 when Eilco acquired all of the shares owned by the AES Director, Basil Reynolds, thus giving total control of Codan, including the name, to Eilco. With the growing market for SSB equipment the Codan name had now become better known than the parent name Eilco so in 1983 a decision was taken to rationalise the whole activities of the company under the name of Codan Pty Ltd. Eilco became a brand name only.

Initially Eilco set up a number of subsidiaries to handle different aspects of their business. In the early 70s and again when the major rationalisation took place in the early 80s many of them were sold off. The company Sound and Television Engineers Pty Ltd, owned by W (Bill) Harrison, manufactured recording and Hi-Fi playback equipment and had their own recording studio at 233 Rundle Street, Adelaide. Eilco purchased their assets and name in the early 60s, becoming Eilco Sales Pty Ltd where fully solid-state Hi-Fi amplifiers (product type number 6311 and based on OC26 power transistors), were designed, manufactured, housed in wooden cabinets and sold. Eilco Sales was also involved in lighting operations. After the new building was constructed at Norwood in 1967, Eilco Sales moved into the front building. As stated earlier another avenue of product development for Eilco was ultrasonic cleaning equipment. In 1966 a joint venture to make ultrasonic cleaning equipment was formed with Gerald Hochmann, who in 1952 had established a company G H Systems Ltd. One significant project was a very large industrial cleaning unit for GMH to clean plated metal Holden parts. In 1970 G H Systems changed its name to Osmond Electronics Pty Ltd, sold its ultrasonic cleaning business to K G Luke Group Ltd, a Victorian company, and took over aspects of Eilco Sales so that it could pursue entertainment lighting and stage mechanics. Still another Eilco subsidiary associated with theatre work was Stagesound Pty Ltd and managed by Eric Penrose. Over the years Eilco made a significant contributions to the setting up lighting and sound in theatres across South Australia, examples being Union Hall, Scott Theatre, Elizabeth Theatres, Adelaide Town Hall, Arts Theatre, and the sound reinforcement and intercommunications system for the second stage of the Adelaide Festival Theatre complex. A further subsidiary was General Equipment Pty Ltd an importing company, established with Reg Elvish and Alan Rawlinson, with Dave Richards appointed manager.

Under the Codan name the company became more focused and looked at ways of expanding its communication products. There was three obvious ways. The first was to extend their HF range of equipment, following up recent technology advances. Secondly to move up in frequency of operation, even to satellite and earth station equipment and finally placing even greater emphasis on the international market.

As part of the new Codan image, new styling for sets and a Codan logo were produced under contract by Chris Myers (product designer) and Lyndon Whaite (graphic designer) respectively, both lecturers in the School of Design, Adelaide School of Art at the Underdale Campus of the SA College of Advanced Education. Chris had already assisted in the styling of the type HF 2000 and

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4000 series transceivers. The first of the new style sets released was the type 8525, having a black front panel with white lettering, touch switches, and digital readout. In terms of technology it was a frequency synthesized transceiver allowing up to 99 channels. This set won the Electronics Association of South Australia's 1986 bi-annual Gold Cup, awarded for excellence in engineering and commercialisation. More will be said about such developments in Part 2 of this article.

Codan had an interest in the satellite communication field as far back as 1972 when the Australian Post Office published a study advocating Australia should enter it. In 1979 when the Hon A. A. Staley announced that a domestic system was envisaged for Australia, Codan responded. An area of unique need was identified, namely small earth terminals for two way communication and from 1980 Codan engineers, supported by the largest Industrial Research and Development Grant awarded hitherto by the Commonwealth (in excess of \$1M), became involved in developing such a terminal for Ku-band using Australia's own Aussat satellites. It is Codan policy to devote 6% of its annual turnover to research and development and by 1983 received its first satellite equipment related order for five receive only earth terminals. Codan again diversified and moved into C-band equipment giving wider market opportunities. In 1984 a joint venture was commenced with M/A-Com Inc. of USA, called Microwave Associates Australia Pty Ltd and based in Sydney, to address the growing market for microwave communication systems, both for terrestrial and satellite communications. The expectations for the area was so great that in 1988 Codan reorganised itself and separated HF Communications and Satellite Communications into two separate divisions. Early 1989 in conjunction with Sattel Technologies of California, they were awarded an OTC contract to establish and operate a satellite based telephone service in the South Pacific Region. In the same year Codan was awarded exclusive rights to manufacture and market Orbtrack, an antenna-tracking controller, developed jointly by Newcastle University, CSIRO and OTC. During 1991 there was difficulties in the industry and a widening customer base became imperative. The result of this down turn meant the bringing together once more the HF and satellite communications divisions. At the same time Codan joined a new mobile satellite communications consortium, which included Auspace Pty Ltd, CSIRO, Mitec Pty Ltd, Mosaic Electronics, Net-Comm and the Digital Communications Group at the University of South Australia. In 1998 Codan acquired Mitec, the Brisbane based company specialising in microwave RF design. All this allowed Codan to aggressively expand its existing range of satellite communications transceivers, to diversify into terrestrial microwave links, and to acquire specialist defence projects. While the initial growth in the satellite area had been slow it has currently reached the level where it is providing income at a level similar to the HF products. It is also interesting to note that Codan had concerns that they had nothing to market in the VHF and UHF range of frequencies so in 1985 an agreement was signed with Midland International to market their range of VHF and UHF land mobile radio equipment in Australia**.

Codan directors were well aware that for survival they needed to look beyond the Australian market. Once the reliability of their products were established in Australia this gave opportunity to look elsewhere, using Australian case histories to further the cause. African and South American countries all needed HF communications and frequently aid money was available to purchase such equipment. By 1975 they were selling HF equipment into African countries. About this time a license to manufacture selected Codan products was granted to a New Zealand company owned by W (Bill) E. Barlow, Electronic Products Ltd. In 1978 Codan acquired the major interest and renamed the company in 1979 Codan (NZ) Pty Ltd. All this was to get behind NZ import licenses and when such licenses between Australia and NZ were abolished Codan (NZ) was closed in 1989 and their operations transferred to Adelaide. In a similar way to get behind trade barriers and into Europe Codan established in 1980 a marketing office and some manufacturing facilities at Fleet, Hampshire, England. Again once barriers were abolished the manufacturing facilities closed, but a

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marketing office retained to cover Europe, Africa and the Middle East regions. An office, previously in Vancouver, Canada, but now in Manassas, USA covers Canada, USA and South American countries. At present Codan exports to over 150 countries, accounting for some 85% of their production. Truly a global service.

3. Design and manufacturing philosophies

An original aim of the company was to bring professionalism to the electronics industry and this was interpreted by the founders in several ways all evident in their HF products. Four ways that reflected their professionalism in technical and business matters will now be considered. Combined, these factors led to the development and marketing of reliable cost efficient products.

i) Utilising the latest advances in technology in products.

The original transceivers such as types 6104 and 6332 utilised semiconductors wherever possible. Initially this was germanium transistors in the receivers, modulators and DC to DC converters required to generate any voltage higher than the battery voltage. Vacuum tubes could only be used for the transmitter. However, as soon as RF power transistors became available they were utilised and resulted in new type 6801 and 6924 transceivers. Similarly to ensure good receiver selectivity narrow band IF filters were incorporated, right from the outset. Initially for AM work ceramic resonator filters were used in the first few sets, but from then on magnetostrictive resonator mechanical filters were employed. The advent of SSB operation immediately brought a change over to high quality narrow band crystal filters, raising the IF frequency from 455kHz to 1650kHz to give a marked improvement in image suppression at the higher frequencies of operation.

Sets were always crystal controlled, a procedure necessary to achieve good frequency stability no matter whether the sets were used in the outback, in vehicles or ships, locations where extremes in temperature frequently occur. Printed circuit cards, a means of reproducing stray reactances (important in RF circuits), and therefore overall set consistency in performance, were introduced in 1964 when a new single board receiver was made and designated the type 6415.

In about 1978 a decision was made to introduce thick film daughter board modules, each coated with a non-transparent epoxy material. This not only simplified construction, but added a measure of security to their products, in that what was in the modules remained confidential. The type 8525 set saw the introduction of microprocessor control and frequency synthesis and from then onwards there were moves to employ software to provide improved performance and flexibility.

ii) Ensuring that products were appropriate for their application, both in terms of electronic, mechanical and ergonomic performance, including appearance, robustness, reliability and maintenance procedures.

While excellent electronic design was essential so too was the mechanical construction and appearance aspects. Cadmium plated sheet steel of 16 and 18 gauges were normally used for construction, providing strength, lightness and resistance to corrosive materials. Aluminium of 18 gauge was employed for the front panel escutcheon. Controls and operating procedures were kept to a minimum so that people of all ages had little difficulty in using them. Initial sets utilised armed service styled knobs and colours (blue grey) giving the impression that these sets were equally rugged. The change to the standard grey and green colours with tear drop shaped knobs in 1968 conveyed the elegance seen on some American equipment of that era. A still later change in 1984 to the black panels with black collet knobs not only kept the sets aesthetically pleasing, made touch up/restoration easier, but allowed older reliable sets to be "disguised" as if they were truly a new generation of products. Figure 2 shows four stages in the development of the portable 6924 set. Further, the company maintained a comprehensive in house manufacturing facility under Terry

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McDonough, for this enabled it to maintain good quality control and quality assurance procedures on all products.

No matter how well a set is designed, failures and/or upgrades will occur, so sets had to be repaired or modified. The manuals made available with each product were of a standard that allowed people with the necessary skills to do this. Placement of components on PCB drawings, step-by-step descriptions of operation, upgrades, tuning, etc. were all included. True some sets had components that were difficult to replace (such as those on the RF board of the original 6924), but by and large there was easy access to boards and components with boards either having cable connectors between them or plug in card connectors used.

iii) Incorporating flexibility in products, that is, sufficient options given so all sectors of the market could be satisfied.

Even the original type 6104 set was offered in four variations. The standard was a 5 channel set, but there was also a single channel one, a 12 channel set in a larger case, plus a 5 channel version for light aircraft. Later sets had an even greater range of options, examples being, number of channels, single and two frequency simplex; modes offered AM (H3E), CW, LSB, USB or combinations; clarifier - narrow or wide range, two tone call encoder, noise blanker, mute facility; battery pack; vehicle installation kit; whip antenna. Marine versions were available and these had an added option of output power level.

iv) Using the process of incremental product design to gradually improve the overall performance of products.

The original 6104 set was constructed using valve techniques. Transistors were held in rubber grommets in the chassis with other circuit components mounted on tag strips. Both valves and transistor circuits could now be assembled in the same way. Once the 6415, a single PCB receiver was developed, it became the receiver section of the 6104 set, which was now called the 6104 Mark 2. This same combination was then used in the type 6332 transceiver, a self contained set having a screw on portable battery pack, whip antenna and carry bag. This idea of utilising modules developed in a range of products became even more common when SSB sets were made. The company developed a modular system of generation and reception of SSB signals, shown in Figure 3, and it became their standard. Improved blocks or modules developed for next generation sets could then be utilised in older type sets, resulting in an upgraded type number. A good example is the type 6924 set. After thick film modules were developed and improved RF power transistors became available a new version the type 6924 Mark 2 was released. Next there was a cosmetic change from the green/grey/teardrop knobs styling to the black/silver grey/black knobs version, which was renumbered 6924B. The 6924C version is a ruggedised, waterproof version of the 6924 Mk 2 (Refer to Figure 2). Similar circuits, concepts and flow can be seen in the sister sets type 6801 and 6801 Mk 2, that is, these sets match the 6924 to 6924 Mk 2 upgrade, but have a higher power RF amplifier with 50 ohm output impedance. Some sets were so similar that the one manual covered a series of transceivers. Naturally this process makes good engineering sense for it allows a steady progress in updating products, shares and minimises design and production costs as well as making life easier for those undertaking set maintenance.

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TYPE 6104 TRANSCEIVER

**For Flying Doctor Services
Firefighting
Small Ships**



Small size, light weight and low battery drain are outstanding features of this transceiver.

Size is 11" x 4 $\frac{1}{4}$ " x 8".

Weight is 10 lbs.

The entire unit is housed in a steel case with clip-on lid and carrying handle. All metalwork is heavily plated and passivated, and exposed surfaces are baked enamelled.

Battery drain is low (1/10 amp. on receive, 1 amp. on standby, 3 amps on transmit). Input power to final stage is 18 watts.

Circuit is almost completely transistorised; only two valves are used. Instant reception on switching on.

Up to 5 crystal locked channels, selected by switching—no coil boxes.

Simple aerial tuning—indication by globe on front panel—will tune any whip or wire aerial.

Circuit protected against incorrect battery connection.

AVAILABLE FROM

THE ELECTRONICS, INSTRUMENT AND LIGHTING COMPANY LIMITED, 9 OSMOND TCE., NORWOOD, S.A., TEL. 36345

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SPECIFICATION : "EILCO" H.F. TRANSCEIVER TYPE 6104

GENERAL.

This transceiver has been designed as an extremely compact portable station. It is of single unit construction without plug-in assemblies, eliminating coil-box storage difficulties. Up to 5 crystal controlled transmitter and receiver frequencies are provided on the standard version.

The equipment, with the exception of the transmitter which uses two valves, is completely transistorised. Power consumption is much reduced during "receive" and "standby" enabling the set to be used for long periods without exhausting the battery.

Battery cables and microphone are provided with stowage when the set is not in use. A removable steel cover completely protects the set from accidental damage in transit.

The transmitter has been designed to operate on a wide range of aeriels. Tuning adjustments are simple, adjustment of a coarse and fine control being all that is necessary. It is not possible to tune the antenna circuit to a harmonic of the operating frequency.

The modulation capability of the transmitter is 100% but the use of a simple filter and the design of the modulator ensures that overmodulation with consequent "splatter" does not occur.

Protection is also provided against damage to the equipment due to reversal of the battery polarity, and either battery lead may be grounded to the case without short circuits occurring.

TRANSMITTER.

<i>Frequency Coverage:</i>	Up to 5 crystal controlled frequencies in the range 1.5 to 10 mc/s.
<i>Frequency Stability:</i>	Better than 0.01% in the range 10° C. to 50° C. Negligible frequency shift occurs due to operation of transmitter tuning controls.
<i>RF Output Impedance:</i>	15-2000 ohms.
<i>RF Output:</i>	Up to 8 watts, depending on aerial impedance and frequency.
<i>Type of Emission:</i>	A3 (telephony).
<i>Modulation Capability:</i>	100%. Splatter prevented by clipper and filter. Frequency response 300-3000 c/s.

<i>Spurious Radiations:</i>	At least 40 db below carrier level.
<i>Capacity across final RF tank circuit:</i>	Selected to give working tank "Q" of 15 to 20 at the working frequency.
<i>Power Input to Anode of Final RF Stage:</i>	18 watts fully loaded.

RECEIVER.

<i>Frequency coverage:</i>	Up to 5 crystal controlled frequencies in the range 1.5 to 10 mc/s.
<i>Signal/Noise Ratio:</i>	More than 50 mW audio output with a 10 db signal/noise ratio for 3 microvolts RF input modulated 30% at 1000 c/s from a source impedance of 75 ohms.
<i>Image Ratio:</i>	At least 35 db.
<i>Intermediate Frequency:</i>	455 kc/s.
<i>Selectivity:</i>	Response is more than 30 db down 20 kc/s off tune.
<i>AGC Characteristics:</i>	Audio Output within 6 db for inputs from 10 uV to 10 mV.
<i>Audio Output Power:</i>	200 milliwatts.
<i>Dimensions:</i>	11" wide x 4½" high x 8" deep.
<i>Weight:</i>	Approximately 10 lb.
<i>Power Requirements:</i>	12V DC: 0.1A receive, under 1A standby, 3A transmit.
Type 6104A—Same specification as above, but up to 12 crystal locked channels in a larger case.	
Type 6104B—Special version for light aircraft. See separate specification.	
Type 6104C—Single channel version with same specification as above.	

A completely transistorised transceiver is also available for HF operation, running from self-contained batteries. See separate specification.

Prices. Type 6104:	} Plus for each channel fitted at time of ordering.
Type 6104A:	
Type 6104C:	

GP/472/1/2

Figure 1 Publicity leaflet for the type 6104 transceiver, Elico's first set

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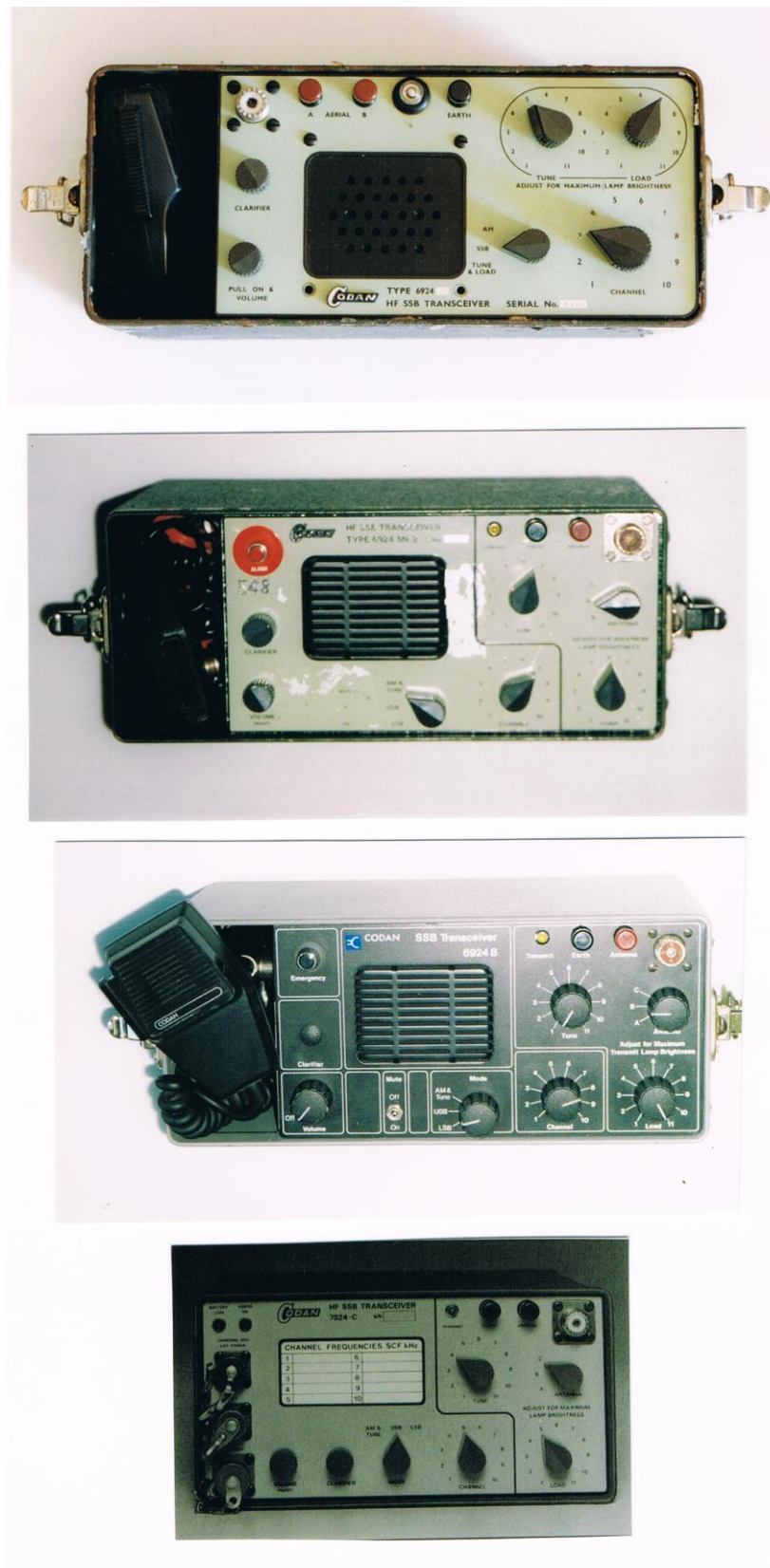


Figure 2 - Four versions of the portable type 6924 set.

- a) Original version,
- b) Mark two version having improved performance and used thick film modules,
- c) The new styling, having the same circuit as the Mark 2 and called the 6924B,
- d) Ruggedised water proof version called the type 6924C

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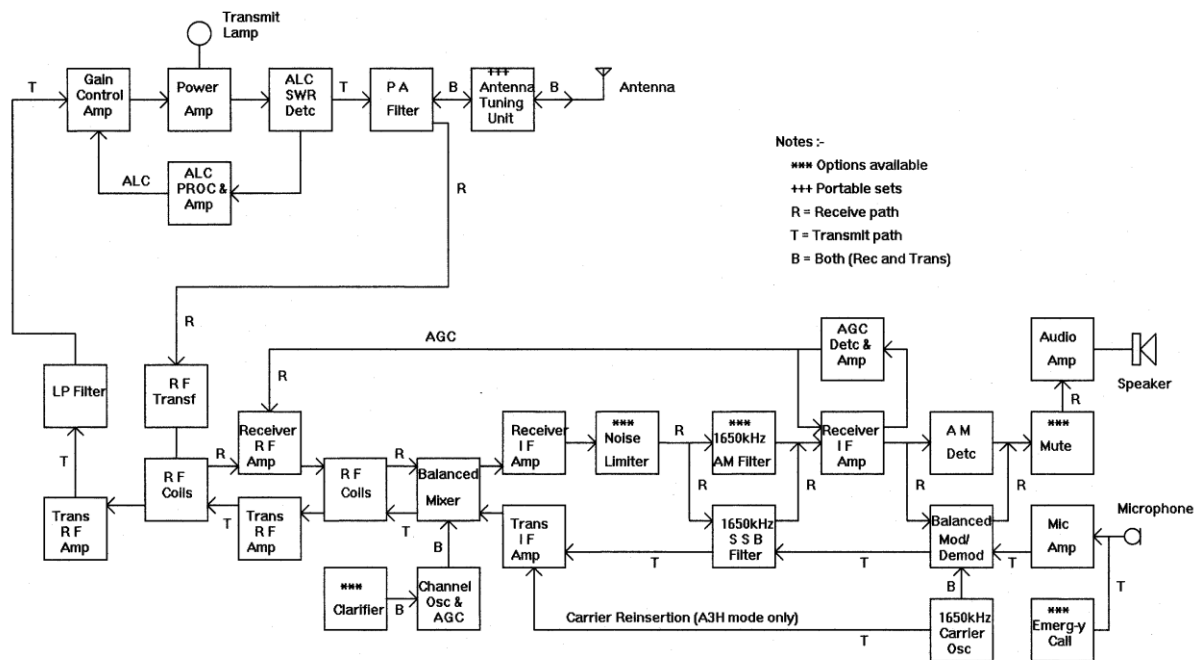


Figure 3 Block diagram of a typical Codan transceiver

4. Concluding remarks to Part 1

The growth of Codan from the original three who founded the organisation to a staff of over 350 in a period of forty years is a remarkable achievement. Annual turnover exceeds one hundred million dollars. The name Codan has become a household name, as much as Traeger. In a small way their contribution to the Australian outback and the electronics industry in general has been recognised by the winning of the Electronic Industries Association Gold Cup and in 1990 Austrade's International Business Achievers Award. In part two of the article we will examine and summarise many of the HF products produced over the past forty years.

* The CODAN acronym - According to F E Terman in "Radio Engineers' Handbook", McGraw-Hill, NY, 1943, page 653 the D stood for Device, yet Rob Gurr (VK5RG) maintains that in the local Australian industry it stood for Delay.

** In 1968, at the time the EFS and other emergency services were changing from HF to VHF radio communication, a VHF receiver (type 6802) with matching transmitter (type 6803) were designed and tested, but apparently never went into production for the two type numbers were eventually assigned to HF transceivers.

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by Malcolm R Haskard (VK5BA)

1. Introduction to HF products marketed

The products marketed by Codan covered all aspects of HF communications. At one end they designed and constructed the plant necessary for broadcasting, including studio equipment, high power transmitters, antennas, remote control facilities, while at the other end simple transceiver equipment for small outpost stations. In this article only the RF products have been categorised. Studio and remote control equipment operating over wires and telephone lines have been omitted. The categories considered are transceivers, receivers, transmitters, antennas, antenna tuners, and mains power supplies. For each category brief comments will be made followed by a table of products.

2. Transceivers

A surprising range of transceivers were produced, emphasis always being placed on compactness and performance. Certainly in todays changing world many electronic products are considered out of date after two years. Consequently in recent years new transceivers models needed to be produced more frequently. With some equipment the specifications evolved during the design process. For example, the type 6801 set (Figure 1) when first envisaged was a three channel 15 watt PEP SSB transceiver, yet the final product was five channel and 100 watts. Popular types came out as series, later improved versions either a Mark 2 or with a letter added after the four digit type number to signify a change. Significant upgrades included the use of thick film daughter boards, separate control heads, eventually all essential controls truncated to fit on the back of the microphone, frequency synthesis, microprocessor/software control, double conversion receivers, and remote interrogation from another location to ascertain the condition of a set. At least two attempts were made to produce "homestead" style sets (types 7303 and X-2), that is, sets whose appearance fitted in with modern home styling, while the new generation transceivers (NGT) begin to appear a little like a "mobile" phone in styling. In the last decade the transceivers allow attachments, so that facsimile, data transmission, email and such can be sent over the HF link. Table 1 provides a listing of transceiver sets.

Figures 2 and 3 show the original portable 6104 set and circuit diagram while Figure 4 gives examples of three different set styling.

Type No.	Use"	Style**	Comments
6104	P	A	First set. Valve type construction. SS receiver, 455kHz IF, 5 channels, ceramic filters. Two valve transmitter, 8 watts RF. AM only.
6104A	L		As above but 12 channels and in a larger case
6104B	A		Special light weight version of above for light aircraft
6104C	P		Single channel version of above
6104 Mk2	P	A	As 6104 except PCB receiver type 6415 used, 455kHz IF mechanical filter
6201	S		200kHz -18MHz receiver, transmitter 2-9MHz, marine AM set, 455kHz IF, 50 watts RF , Receiver DF loop
6319	M		1.6 - 10 MHz, 1 channel, AM set, 455 kHz IF, 25 watts RF.
6319A	M		As 6319. Minor modifications to the transmitter valve output stage.
6332	P	A	Battery pack. Whip aerial. Type 6415 single PCB SS receiver, 455kHz IF, mechanical filter. Two valve transmitter, 8 watts RF. AM only, 5 channels.

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6332A	P	A	As 6332 but 10 channels
6605*	B		Base station for EFS (CFS).
6619	P	A	1.6-10 MHz, AM set, 10 channel, 455kHz IF, mechanical filter, Valve output stage, 25 watts RF. B/C receiver built in.
6717	H		1.6 - 10 MHz, Single channel, AM, hand held, 455 kHz IF, mechanical filter, 1 watt RF, internal battery
6801	L	G	Fully solid state. 1650 kHz IF, Output impedance 50 ohm. SSB (normally USB) and AM (H3E). watts RF.
6801-P	B	G	As 6801 but made especially for PNG P & T
6801 Mk2	L, S	G	2-16 MHz. 10 channel. Fully solid state. Thick film modules used. 1650kHz IF. Output impedance 50 ohm. SSB (normally USB)and AM (H3E), 100 watts RF.
6801-S Mk2C	S	B	Marine version 6801 Mk2
6802	B	B	As above, 6801 Mk 2 receiver and exciter, modified transmitter output, 100watts PEP. RTTY and Fax operation
6803	B	B	As 6802 above, but with remote control facilities
6924	P	G	2-10MHz, 10 channel. Fully solid state. 1650kHz IF, 25 watts PEP, SSB (normally USB) and AM (H3E)
6924 Mk2	P	G	2-13MHz, 10 channel. Fully solid state. 1650 kHz IF, 30 watts PEP, SSB (normally USB) and AM (H3E), output impedance 50 ohms (as well as in built antenna tuner)
6924B	P	B	Same as 6924 Mk2 but new styling
6924C	P	G	2-13 MHz, 25 watts PEP, 10 channel, ruggedised waterproof transceiver
7005	B	G	10 channel, AM and SSB, similar to 6801 Mk 2
7007	B	G	3 channel, AM only transceiver, styling similar 6801
7303	B	G	2-11 MHz, 5 channel, Fully solid state, 1650 kHz IF, 50 watts PEP, SSB (normally USB, and AM (H3E), output impedance 50 ohms, push button operation
7307	B	P	Same as 7515, but in a special plastic case for "Homestead" use - School of the Air and RFDS. Emergency call fitted as standard.
7515	L	G	2-11 MHz, 6 channel initially then increased to 10, fully solid state, 1650kHz IF, 50watts PEP, SSB (normally USB and AM (H3E), output impedance 50 ohms
7727	L	G	Same as 7515 but increased RF power - 100 watts PEP
7727-C	L	G	As 7727 above but cosmetically upgraded. Also available with remote control box and speaker
7727-T	L	G	As 7727 but with remote control
7727-TB	L	B	As above, but cosmetically different again having a digital channel display. Remote control box and separate speaker.
7924-B	P	G	2-13 MHz, 10 channels, solid state, 1650 kHz IF, 25 watts PEP output, SSB (Normally USB) and AM (H3E), ruggedised, water proofed, carry bag, sealed internal battery.
7924-C	L	G	As 7924-B above. Option of a hand crank generator.
8121	S		2-13.2 MHz, 10 channels, 60W PEP, AM compatible only on 2182 kHz
8332	H	Y	1.6 - 6 MHz, 2 channel, 1watt PEP. Hand held set.
8525	L	B	2-18 MHz, 99 channels, 20 standard, dual conversion receiver (IFs 45MHz and 1650kHz), frequency synthesis, digital display,

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			SSB, 100 watts PEP
8525-B	L	S	2-24 MHz transmit, receive 250 kHz to 30 MHz, scanning up to 15 channels, SSB, 125 watts PEP, up to 99 channels with 20 standard, 50 ohm impedance, touch membrane controls, available with separate control head type 8530
8525-S	S	S	A marine version above, 2-18 MHz transmit, receive 1.6 -18 MHz, SSB but AM (H3E) on 2182 kHz.
8528	L	S	2-24 MHz transmit, receiver 250 kHz - 30 MHz, up to 600 channels, receiver scanning up to 15 channels, SSB, transmit power variable 25 to 125 watt PEP, 50 ohm impedance, touch controls back lit liquid crystal display, available also with separate control head type 8531
8528-S	S	S	As above but marine version. Can have separate control head type 8531S, PEP of 125, 200 or 400 watts
8528-I	L	S	International version of the 8528, having improvements in performance through new software. Identification plate carries a "K" prefix on the serial number.
8727	L	S	2-16 MHz, 10 channels, SSB, 125 watts PEP. Also available separate control head type 8730.
X-2 (Also 9105)	L	K	2-18 MHz, 10 programmable channels, LSB and USB, speech processing, audio tones indicate important operating conditions/faults, output variable 25 to 125 watts PEP, dual RF output to match whip of dipole antennas.
9313	L	S	Cut down version of the 8528 for the local market. Synthesised 15 channels, SSB, 100 watts PEP, 2-24MHz transmit, 0.25 - 30 MHz receive, control head type 9320, membrane switches, liquid crystal display
9323	L	B	As for type 9360 except transmitter 100watts PEP and on Australian 27 MHz CB band 10 watts PEP. Control head option is type 9330.
9360	L	S	Synthesised, 400 channels, 10Hz resolution, microprocessor control, SSB, 50 ohm impedance. Receiver 0.25 - 30 MHz, 45MHz and 455 kHz IFs. Transmitter 2-26.5 MHz, 125watts PEP, CW or single tone approx 60% PEP. Control front panel or microphone keypad. Available with control head type 9366. In-built remote diagnostic facility.
9390	S	S	Marine version of the 9360. With Type 4404 power amplifier increase PEP to 400 watts (Type 9390-H). Control head available type 9391.
9480	L	S	Cut down version of 8528 for international market. Synthesised 15 channels with voice scanning, SSB, 2-24 MHz transmit, 100 watts PEP, optional control head type 9482, comprehensive LCD display, new automatic emergency digital calling
9780	L	S	As for type 9360. Supports non voice applications.
HF1000	A	B	2-14MHz, SSB, 10 channels, 1650 kHz IF, 100W PEP, aviation transceiver, control head panel or rack mounting, digital channel readout
HF2000	A	B	2-16MHz, SSB with AM (H3E) option, 28 channels, 1650 kHz, 100W PEP, aviation transceiver, control head panel or rack mounting, digital channel readout

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HF4000	M	B	2-23MHz, 256 channels, marine transceiver, SSB with AM (H3E) on 2182 kHz, digital frequency readout, 150, 200 and 400 watt PEP
2010 (NGT xx)	L		1.6-30 MHz, 125 watts PEP, SSB and AM (H3E) up to 400 channels, operated from a remote desk console, supports non voice operations, receiver will tune down to 250 kHz. As a mobile unit needs junction box type 2030 Note; If the xx letters are - AR = Australia (100 watts), SR = System Radio, VR = Voice Radio (15 channels).
NGT	R		2-30 MHz, 500 or 1000 watts PEP, NGT SR remote control, SSB, AM, external control, up to 400 channels

Table 1 Codan transceiver set types and a brief description of them

3. Receivers

Separate receivers are often needed for remote control operations or separating the receiver from the transmitter site when the latter is in an electrically noisy environment. While specific contracts have called for such receivers only one general purpose receiver the type 7004 was sold in quantity. It is a single frequency type, and one signal mode (LSB, USB or AM) both specified when ordering. Matching aerial couplers and power supplies are also available so that banks of receivers can operate together from common aerials and supplies. Table 2 provides details on receivers while Figure 5 shows the 7004 receiver.

Type No.	Style"	Comments
601-		Single frequency crystal locked AM receiver for remote locations with audio output and power to receiver transmitted down one pair of lines. A IF 10.7 MHz using a lattice crystal filter. Rack mounted module
602-		Single frequency crystal locked AM receiver for remote locations, audio out and power to receiver transmitted down one pair of lines. A conventional 455kHz IF. Rack mounted module
6415	PCB	Single PCB AM receiver, 455 kHz IF, mechanical filter.
6604*		DSB, AM two channel
6608		Remote receiver, based on type 6415 receiver, internal line transformer, supply 12v DC - positive ground
6702*		22.2 MHz receiver for WRE (DSTO)
6707		2 channel receiver based on the PCB receiver from type 6619 transceiver
6718*		27 MHz receiver for Adelaide University
6809*		Single channel receiver board
6907*		SSB remote receiver
7004	G	2-30 MHz, SSB or SSB and AM, 1650 kHz IF. Table top or rack mounting (code 151) 7905 matching multicoupler (up to 6 receivers) 7207A matching power supply (up to 7 receivers)

Table 2 Codan receiver types and a brief description of them

4. Transmitters

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Transmitter of higher power were originally required for two areas. Firstly marine operation and the 4400 series was designed to satisfy this need, allowing either 200 or 400 watts. Secondly, base stations for the RFDS and similar operations required rack mounted transmitters of 500 and 1000 watts power (7010 series). The NGT is the most recent addition to the series allowing control of up to 400 channels. Table 2 lists these transmitters and provides brief details. Figure 6 shows a type 7010 series transmitter with exciter.

Type No.	Style"	Comments
6307*		AM transmitter, 300 watts
6915*		25watt RF power amplifier
4402	B	2 - 23 MHz, 200 watt power amplifier, 24v DC in
4404	B	2 - 23 MHz, 400 watt power amplifier, 24v DC in
7010 series	R	2 - 12 MHz, 500 or 1000 watts PEP, SSB, AM (A3H), external control up to 6 channels. Rack mounted
		7021 linear exciter, 7010 is linear amplifier
NGT	R	2-30 MHz, 500 or 1000 watts PEP, SSB, AM, external control, up to 400 channels. Rack mounted.

Table 3 Codan transmitter types and a brief description of them

5. Antennas

The first transceivers sold were portable with build in antenna units. For most other operation (base, mobile or marine) a transceiver with 50 ohms impedance was designed so that antennas having a 50 ohm impedance at the frequency of operation are needed. Codan provides a range of such antennas, ranging from tower supported dipoles to automatic tuning whip antennas. Codan has a close working relationship with Peter Leonard of Lencom Antennas Pty Ltd. Table 4 list the antennas available.

Type No.	Use**	Comments
300 series	M	2 - 16 MHz, multi frequency operation tapered helical whip, 1.8 metres long
311 series	M	2-16 MHz, automatic selection of preset frequencies, 50 ohms impedance, 120 watt rating, < 2.5 metres long, requires 12v DC
400-1	B	2 - 30 MHz, single frequency wire dipole antenna, 50 ohms impedance, rated 150 watts
402 series	B	2-10 or 2.5-16 MHz broadband wire antennas for multi frequency operation, 50 ohms impedance
403	L	2-16 MHz, long wire antenna approx 30 metres in length
406	B	2-15MHz, 9.5 metres vertical antenna, rated 150 watts. Self resonate at 7.5 MHz. Needs an antenna tuner (7208 or 7403)
407 series	B	2.2-15 or 3-20 MHz, broadband dipole, rated 1000 watts
408 series	B	As 407 but 100 watts rating
409 series	B	2-18 MHz, helical dipole for up to 3 frequencies of operation, rated to 100 watts. A restricted space antenna, of either 4.5 or 7.5 metres span.
420 series	B	Series of 3 sections telescopic guyed towers up to 22.5 metres height
8558	M	2-24 MHz, microprocessor controlled, multi channel automatic tuning whip antenna, 2.18 metres length, 50 ohms impedance, 12v DC required. Options are type 8551C antenna control unit

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9350	M	and type 8552 tuner-controller. 2-30 MHz, automatic tuning whip antenna, 125 watts rating
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Table 4 Codan antenna types and a brief description of them

6. Antenna tuners

To ensure correct operation a transceiver must be matched to the antenna at 50 ohm impedance. To achieve this at several frequencies an antenna tuner may be required. Table 5 list those units available. Figure 7 show the 7208 Mk 2 manual antenna tuner.

Type No.	Use**	Comments
4201	S	2-24 MHz, manual operation
4203	B, S	2-24 MHz, rated 400 watts, fully automatic
6309*		No information currently available
6826*		No information currently available
7101 Mk 2	B	Connects up to 6 antennas to a transceiver
7208 Mk2B	B	2-16 MHz, antenna tuner for long wire antenna, rated 120 watts
7403	L, S	2-16 MHz, fixed antenna tuner for whip or long wire, rated 120 watts
7411	L	
7411 Mk2B	S	Designed to operate with 6801 Mk2 marine transceivers
8551C/8552	M	See type 8558 antenna in Table 4. Type 8551C is an antenna control unit while 8552 a tuner controller
8560	S	2-24 MHz, rated to 400 watts, manual operation
9103	B	2-30 MHz, automatic antenna tuner for whip of end fed long wire antennas, 150 watts rating

Table 5 Codan antenna tuning units and a brief description of them

7. Mains power supplies

Codan sets are normally designed to operate from a 12 volt DC supply. The exception to this are the high power transmitters which require either 24 volts DC or mains supply. Where mains supply is available it is simpler to eliminate the need for a battery and use a mains maintenance free DC supply. Codan make a range of these to power their equipment and Table 6 lists them.

Type No.	Style"	Comments
507	B	Heavy duty for 24v operation, 27.5V, 40A rating
7113	B	Bench and rack mountings (code 154), 13V, 12.5A rating
7113-B	B	As for 7113
7202-A	B	Power supply for 7004 receivers, 12v, 250mA rating
8540	S	As 7113 above except 13.8V, 12.5A rating
9113B	S	Bench mounting, 13.8V, 6A rating
9114	S	Bench mounting, 13.8V, 16A rating

Table 6 Codan mains power supply types

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Solar panel power supplies were also produced to charge the 12 volt batteries that powered sets, examples being the types 531 (single solar panel, 2.7 amps charge) and 532 (dual solar panel, 5.4 amps charge) with the 7805 series of solar panel regulators.

8. Concluding Remarks

The history of Codan is quite remarkable. Established by three recent graduates, tackling a wide range of engineering jobs for survival was a high risk venture. All three were entrepreneurs, people not frightened of hard work, men who had their feet firmly on the ground in the real world. Naturally there were elements of good fortune, particularly the timing of the change over of HF services from AM to SSB, and collectively all were factors which led to the growth of the company, and its eventual success no matter whether it be judged in terms of sales turnover, number of staff employed, established global network of agents, distributors and service centres or becoming Australia's largest supplier of commercial (non military, non amateur) HF equipment, satisfying the majority of Australian needs as well as significant overseas market segments. Such customers include international relief agencies, multinational corporations and government agencies. Credit must be given to Ian Wall and Alastair Wood, founding Directors who looked after all the engineering aspects, to Managing Director, Jim Bettison, as well as to those who followed him, namely Kingsley Hannaford and currently Mike Heard. After over 40 years of continuous operation Codan has grown to become a significant world leader in commercial HF radio equipment and technology.

9. Acknowledgments

In preparing this paper I wish to acknowledge the assistance of Codan Limited and particularly Ian Wall and Jim Bettison, Founding Directors, and Neil Abraham (VK5ZJA), RF Design Manager. Also my grateful thanks for help from Kingsley Hannaford, former Managing Director of Codan; Frank Choate, former employee of Eilco; Peter Leonard, Managing Director of Lencom Antennas Pty. Ltd.; Alan Salisbury, General Manager of Transceiver Services; John Mitchell (VK5JM) former agent for Codan; Steve Ruedger (VK5RU), Andy Gluis (VK5AAQ), Paul Lawson (VK5SL), Ross O'Brien, Rob Gurr (VK5RG), John Mewett, Ron Worden (VK5RW), Bob Ramsay, John Duval, Bill Bilske, Clive Pay, Bob Rundle, Ian Hansen (VK5AIH) and Max Hilbig.

Notes for Tables 1 to 6 :-

* Extracted from original 1960 to 1969 products book

** Use - B = Fixed base use

H = Hand held

L = Land use both fixed and mobile

M = Mobile vehicle operation

P = Portable. Has in built antenna tuning unit

S = Marine use

" Style - A = Grey with military style knobs

B = Black painted with white lettering and black knobs

G = Green painted (light front panel and dark case) and tear drop knobs. Some of the later sets were painted a very dark blue

K = Polycarbonate case, khaki grey front panel, blue top cover

PCB = Printed circuit card

R = Rack mounted

S = Case silver-grey with black or blue panel

P = Plastic case with push button switches and tear drop knobs

Y = Yellow polycarbonate case/Black panel with white lettering

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Figures and captions for Part 2



Figure 1 Type 6801 SSB set, 5 channels, 100 watts PEP



Figure 2 Original type 6104 AM set. Note the two tin whistles to be blown to initiate an emergency call

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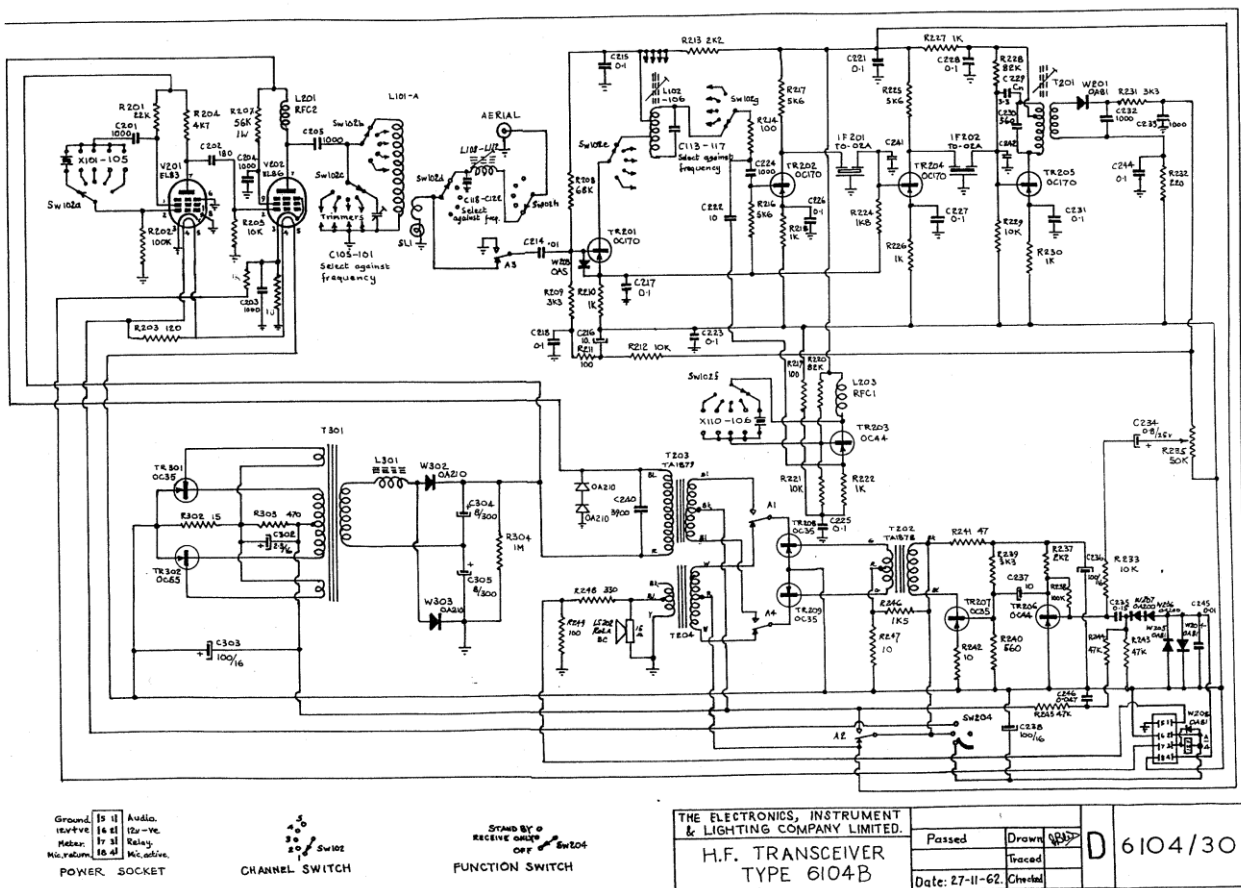


Figure 3 Circuit schematic diagram for the type 6104B



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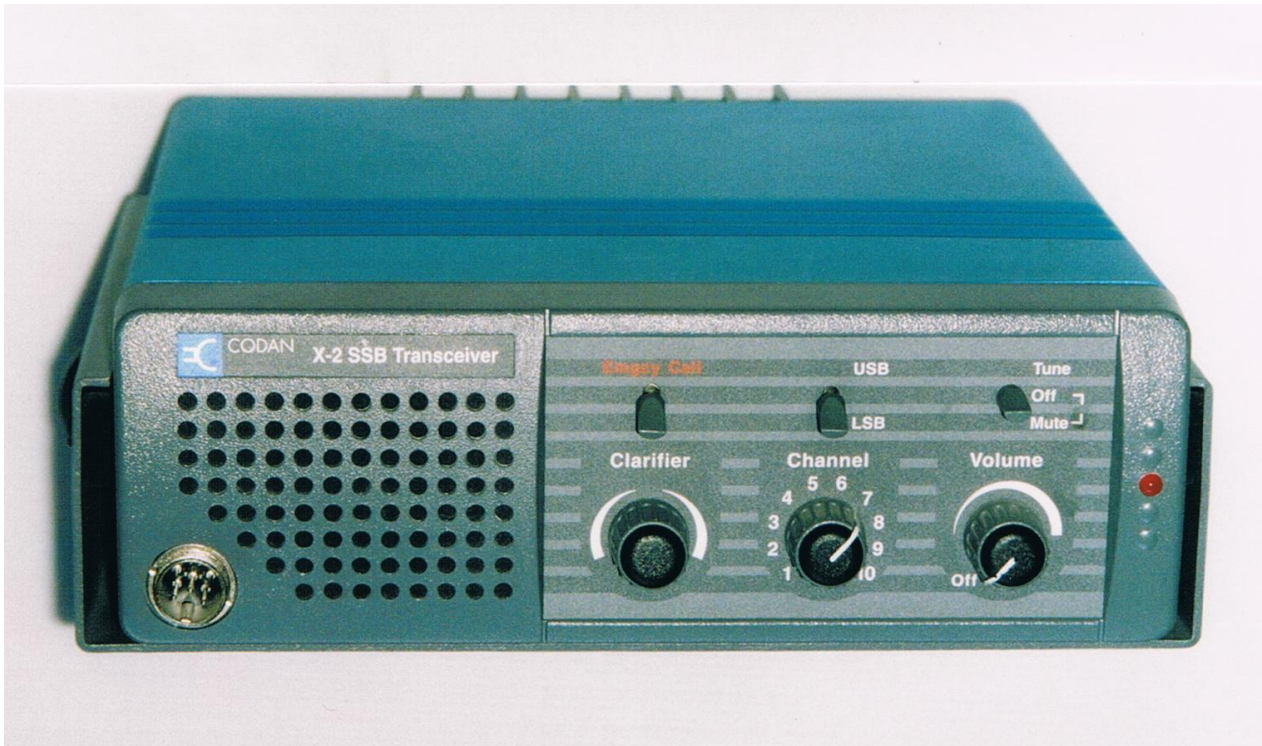


Figure 4 - Four different sets illustrating styling.

- a) Type 7727-TB (with control head),
- b) The new style synthesised set, type 8528 with control head,
- c) The X2 or 9105 plastic case set,
- d) New Generation Transceiver (mobile version) type 2010

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Figure 5 - Type 7004 receiver

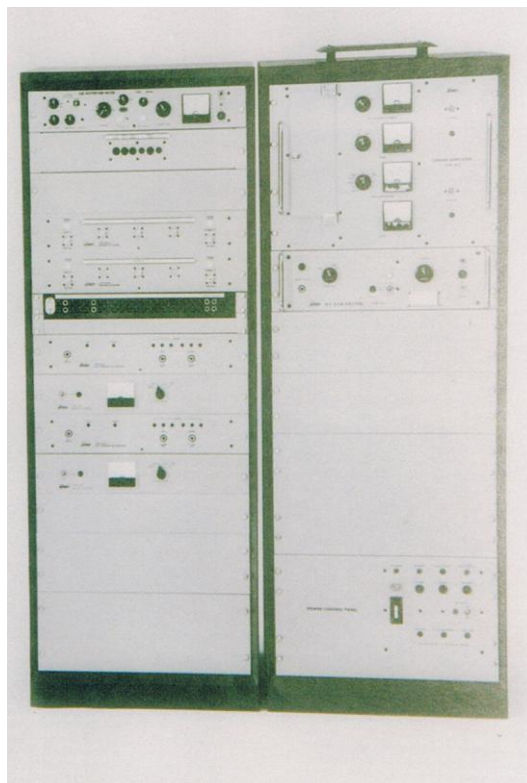


Figure 6 - High power type 7010 series transmitter (with exciter)

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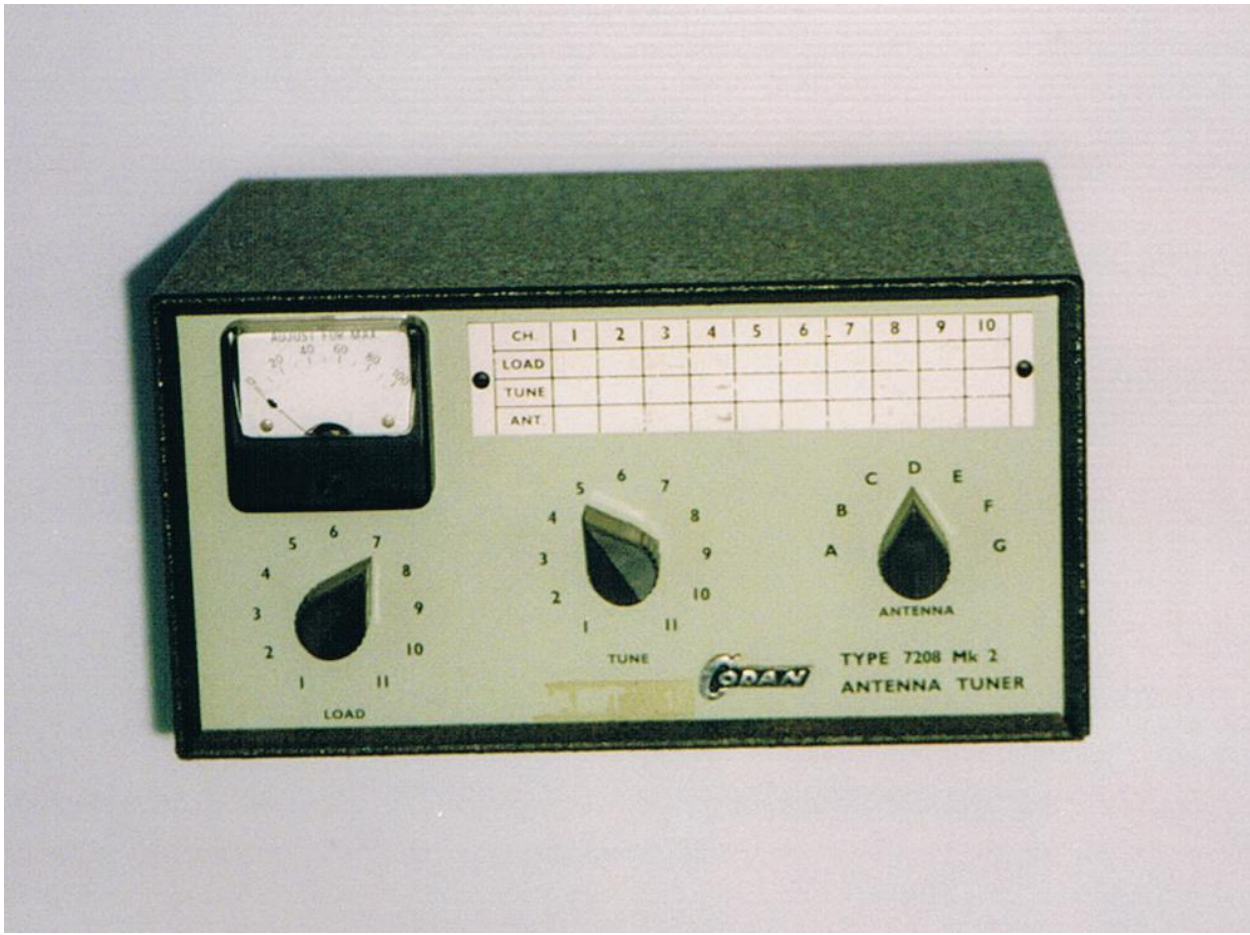


Figure 7- Manual antenna tuner, type 7208 Mk 2