# CO2/523 NATLOCK-TO-PAL CONVERTER

## Introduction

The CO2/523 accepts a Natlock-frequency sinewave and derives from it a sinewave at PAL Subcarrier frequency. Circuitry within the Converter ensures that the correct frequency relationship between the input and output signals is maintained.

The stability of the output frequency is the same as that of the input.

The PAL Subcarrier output signal is inhibited if either the input signal fails or a fault develops in the Converter circuitry.

The Converter consists of the following A size units:

CO2/524 Natlock Frequency Converter
CO2/527 PAL Subcarrier Converter
OS2/513 PAL Subcarrier Oscillator

mounted on a PN3/23 Interconnection Panel.

Power for the Converter is provided by a PS2/22B Regulated Power Supply mounted on the same chassis as the OS2/513.

## General Description

The PAL Subcarrier output of the Converter is generated by a crystal oscillator which is locked to the input Natlock frequency signal. A simplified block diagram of the Converter is shown in Fig. 1.

The PAL oscillator output frequency ($f_{PAL}$) and the Natlock input frequency ($f_{NAT}$) are applied to a modulator the output of which is filtered to provide the difference frequency ($f_{PAL} - f_{NAT}$) of about 4 kHz. This signal triggers a sawtooth generator which provides one input to a phase comparator as shown in Fig. 1.

A system of digital dividers and modulators divides the input Natlock frequency to produce sample pulses which, if the PAL oscillator frequency is correct, occur at exactly half the frequency of the sawteeth. These pulses sample the sawteeth in the phase comparator, the d.c. level sampled being a direct indication of the phase difference between the sawteeth and the pulses. The samples are integrated to provide a steady d.c. voltage which is applied to a varicap diode in the PAL oscillator to maintain phase-lock between the pulses and the sawteeth and hence between the Natlock input frequency and PAL output frequency.

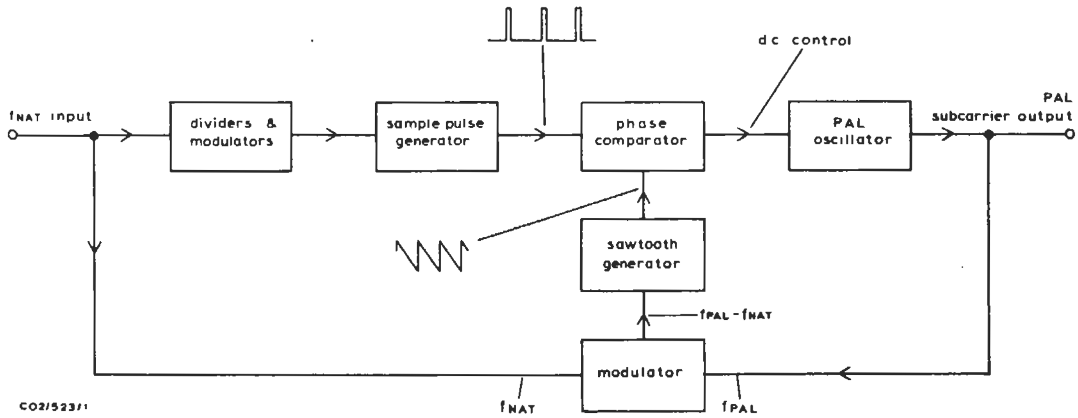



*Fig. 1. Simplified Block Diagram of the CO2/523*

## General Specification

| | |
|---|---|
| *Signal Input* | Natlock-frequency sinewave (4·4296875 MHz) |
| *Signal Input Level* | 1 volt p–p |
| *Input Impedance* | 75 ohms |
| *Signal Output* | PAL Subcarrier Sinewave (4·43361875 MHz) |
| *Signal Output Level* | 1 volt p–p |
| *Output Impedance* | 75 ohms |
| *Power Input* | 200 to 250 volts, 50 mA a.c. |
| *Fuse (on OS2/513)* | 150 mA |
| *Weight* | 2·9 kg (6 lb. 4 oz.) |

*Continued overleaf*

A complete block diagram of the Converter is shown in Fig. 2. The system of divider-modulators[1] which provides an overall fractional division ratio forms a CO2/524 Natlock Frequency Converter which is described in a separate instruction.

The remaining dividers, the phase comparator and the modulator and sawtooth generator form a CO2/527 PAL Subcarrier Converter which is also described separately. This unit produces a d.c. bias, the presence of which allows the OS2/513 PAL Subcarrier Oscillator to operate. If the Natlock-frequency input to the Converter fails, or a fault develops in one of the divider chains the d.c. bias drops to zero and the PAL Subcarrier Oscillator is suppressed.

More detailed descriptions are given in the Instructions on the Sub-units. See under *References.*

Fig. 3 shows the back-panel wiring of the CO2/523.

**Design Philosophy**

The chief design difficulty lies in the production of the sample pulses. In theory the sample-pulse frequency could be any multiple or sub-multiple of $(f_{PAL} - f_{NAT})$; in practice $\frac{1}{2}(f_{PAL} - f_{NAT})$ is the the easiest to produce. Even this, however, poses a considerable problem because Natlock frequency is not an integral multiple of $\frac{1}{2}(f_{PAL} - f_{NAT})$ and so $\frac{1}{2}(f_{PAL} - f_{NAT})$ cannot produced by straightforward division of Natlock frequency.

The simplest method of obtaining a fractional division ratio is by the use of a divider-modulator system.

The input frequency to the Natlock to PAL Converter is $f_{NAT}$, given by

$$f_{NAT} = \frac{567}{2} f_L \quad \text{where } f_L = \text{line frequency.}$$

$$f_{PAL} = \left(\frac{567}{2} + \frac{1}{4}\right) f_L + \frac{f_L}{625}$$

*Continued on page 5*

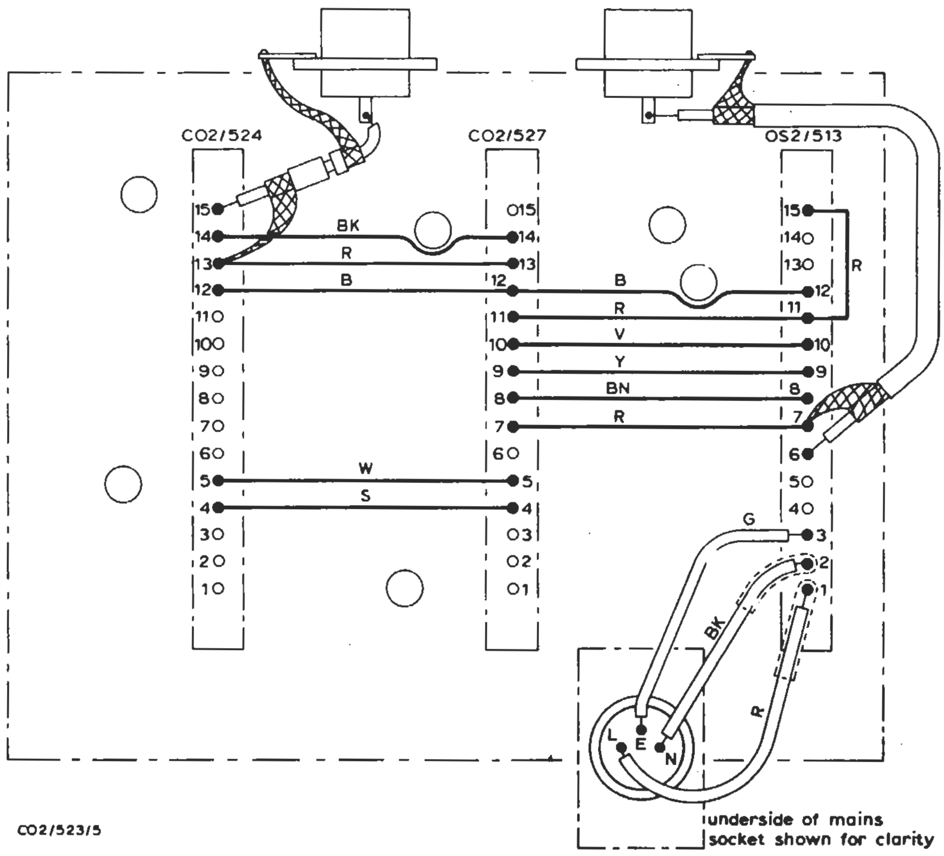
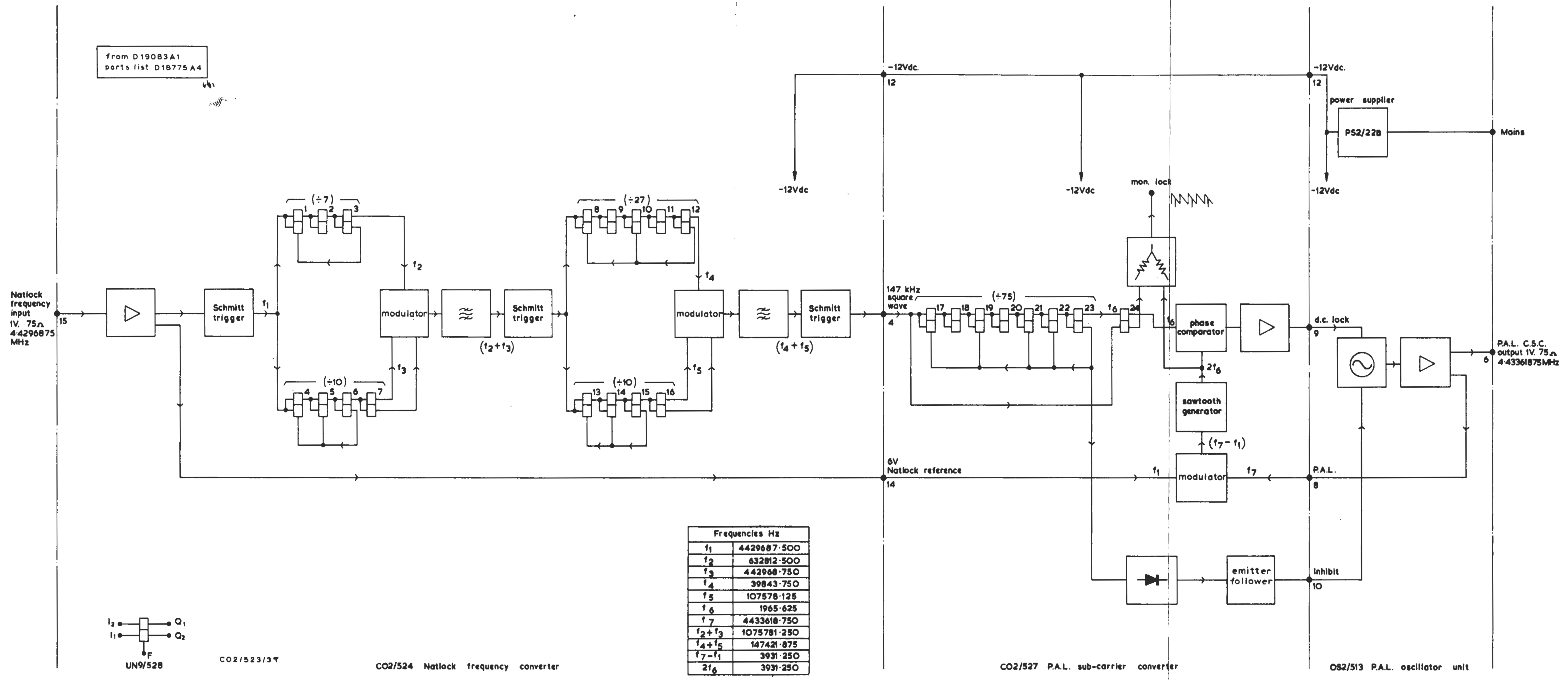



*Fig. 3. Back-panel Wiring of the CO2/523*




| Frequencies Hz | |
|---|---|
| $f_1$ | 4429687·500 |
| $f_2$ | 632812·500 |
| $f_3$ | 442968·750 |
| $f_4$ | 39843·750 |
| $f_5$ | 107578·125 |
| $f_6$ | 1965·625 |
| $f_7$ | 4433618·750 |
| $f_2+f_3$ | 1075781·250 |
| $f_4+f_5$ | 147421·875 |
| $f_7-f_1$ | 3931·250 |
| $2f_6$ | 3931·250 |

*Fig. 2. Block Diagram of CO2/523*

The desired divider-modulator output frequency

$$= \tfrac{1}{2}(f_{PAL} - f_{NAT})$$

$$= \tfrac{1}{2}\left[\left(\frac{567}{2} + \frac{1}{4}\right)f_L + \frac{f_L}{625} - \frac{567}{2}f_L\right]$$

$$= \tfrac{1}{2}\left(\frac{1}{4}f_L + \frac{f_L}{625}\right)$$

$$= \frac{629}{5000}f_L$$

The divider input is Natlock Frequency, i.e. $\frac{567}{2}f_L$ and therefore the required division ratio is 567/2 to 629/5000 i.e.

$$\frac{567 \times 2500}{629}$$

This must be expressed in the form xy/(x + y) to determine the arrangement of divider-modulators required. This can be done as follows:

$$\frac{567 \times 2500}{629} = \frac{10 \times 7}{10 + 7} \times \frac{10 \times 27}{10 + 27} \times 75$$

and the arrangement of divider-modulators required is as shown in Fig. 4.

*Procedure:*

**(a) OS2/513 PAL Subcarrier Oscillator**

1. Wire a mains cable to the Painton Socket: line to pin 1, neutral to pin 2, earth to pin 3.
2. Connect the Avo Meter (25V d.c. range) positive to pin 11, negative to pin 12 on the Painton socket. Adjust RV1 on the PS2/22B board for 12 volts.
3. Link pin 4 to pin 5 and pin 13 to pin 14 on the Painton socket.
   Connect a 75-ohm resistor between pins 6 and 7 on the socket.
5. Use the Oscilloscope, with its earth on pin 7, to monitor the waveform on pin 6.
6. Adjust the core of L2 for maximum subcarrier output, starting with the core well out and setting it for the first peak.
7. Adjust pre-set resistor R12 to give 1 volt peak-to-peak subcarrier output at pin 6 of the socket. If R12 has insufficient range to provide the the correct output level or is very close to the end of its track change the value of C13. A 20% increase in the value of C13 increases the output level by 15%. If such a change is made L2 must be re-tuned as in 6 above.
8. Remove the links between pin 4 and pin 5 and between pin 13 and pin 14.

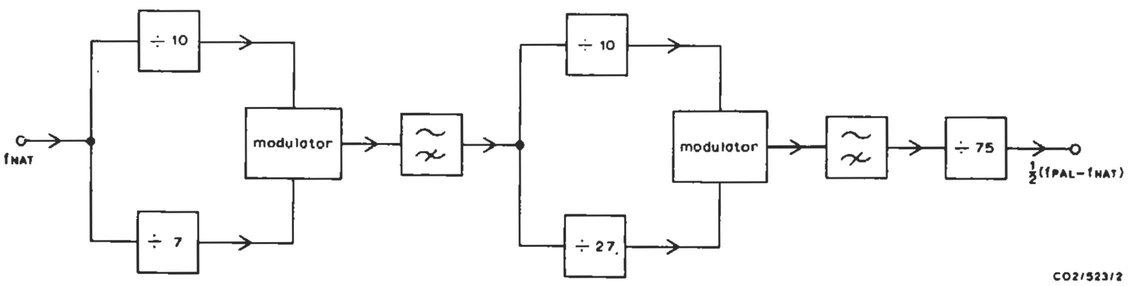



*Fig. 4. Divider-modulator system in the CO2/523*

**Alignment**

Each unit should be tested in conjunction with other units from the same Converter. Units from different Converters should not be mixed after alignment.

*Apparatus Required:*

Oscilloscope with probe
Avo Meter
Frequency Counter to read up to 5 MHz
Chassis Extender
Trimmer tool for coils
Painton 15-way socket type 316128
Source of Natlock Frequency (1 volt p–p)

**(b) CO2/524 Natlock Frequency Converter**

1. Remove the back cover from the CO2/523 Natlock-to-PAL Converter.
2. Plug the OS2/513 into the CO2/523.
3. Mount the CO2/524 on a Chassis Extender and plug the Chassis Extender into the CO2/523.
4. Connect mains and a 1-volt p–p feed of Natlock Frequency to the appropriate sockets at the rear of the CO2/523.
5. Use the Oscilloscope to monitor the amplified Natlock-frequency output on pin 14 of the CO2/524 15-way socket. Check that the level is 5·5 ±0·5 volts p–p.
6. Connect the oscilloscope probe to the collector

of TR5 in the CO2/524. Trim the core of T1 for maximum amplitude sinewave which should be 1·3 ±0·2 volts p—p.

7. Connect the oscilloscope probe to the collector of TR8. Trim T2 for maximum amplitude which should be 2·6 ±0·2 volts p—p.
8. Connect the oscilloscope probe to the collector of TR12. Trim T3 for maximum amplitude which should be greater than 8 volts p—p.
9. Connect the oscilloscope probe to the collector of TR15. Trim T4 for maximum amplitude which should be greater than 1·8 volts p—p.
10. Connect the Frequency Counter to pin 4 of the 15-way socket and check that the frequency is 147·4219 kHz.

**(c) CO2/527 PAL Subcarrier Converter**

1. Plug the tested OS2/513 and CO2/524 and the into the Natlock-to-PAL Converter back panel.
2. Connect mains and 1-volt p-p Natlock Frequency to the Converter. The Natlock-frequency input is terminated inside the Converter.
3. Monitor the waveform at pin 6 of the 15-way connector of the CO2/527. Check for a saw-tooth of amplitude 1·5 ±0·2 volts and frequency approximately 4 kHz.
4. Set the Oscilloscope controls as below:

| | |
|---|---|
| *Timebase:* | 2 ms/cm |
| *Input Attenuator:* | 100 mV/cm |
| *Triggering:* | Auto, Negative slope, Internal. |

Now check the waveform at the *Monitor Lock* socket on the CO2/527 using a direct connection to the oscilloscope (no probe). Adjust the core of L1 in the OS2/513 so that the top edge of the pulse occurs at mid-amplitude of the saw-tooth as shown in Fig. 5.

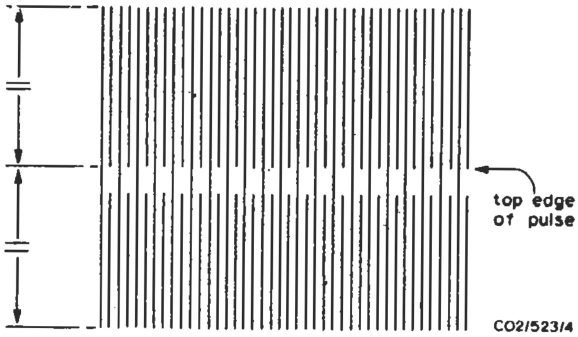



*Fig. 5. Waveform at the Monitor Lock point*

6. Check that the PAL Subcarrier-frequency output of the Converter is 1 volt p-p when terminated in 75 ohms. There may be slight modulation of the output level (at 50 Hz and 4 kHz) but this should be less than 1 mV p-p.

**References**

1. Instruction P.1, Appendix A, page 1.
CO2/524 Natlock Frequency Converter
CO2/527 PAL Subcarrier Converter
OS2/513 PAL Subcarrier Oscillator.

JRWC 12/71