TELEVISION REBROADCAST RECEIVER RC5M/502

Introduction

The RC5M/502 is a high-quality rebroadcast receiver operating in Bands IV and V. It uses synchronous detection and the working channel is selected by inserting pre-tuned units.

The receiver consists of 9 sub-units, listed below, mounted in a CS2/12A carrying case with input and output connections at the rear. Sub-unit interconnections are made via links at the front. The connectors used are as follows:

R.F. input socket	50 ohm type C
R.F. interconnections	50 ohm type BNC
I.F. interconnections	75 ohms type BNC
Video inputs	Musa type P.O. No.1
Sound input	Cannon XLR-3-32
Mains Power input	Cannon XLR-LNE-32

Receiver Sub-units

U.H.F. Band-pass Filter	
Band IV	FL2/533
Band V	FL2/534
Oscillator and Multiplier	OS2/523
U.H.F. Converter	CO2M/516 or CO2/542
Shaping Filter	FL1/513
Vision I.F. Amplifier	AM1/543
I.F. Sampling Unit	UN1/616
Vision Demodulator	DM2/506
Video Amplifier	AM5/519
Vision A.G.C. Unit	UN1/564A
Control Unit	UN3/538
Sound Demodulator	DM3/501
Sound I.F. Amplifier	AM1/566
Power Supplier	PS2/117
Power Supplier	PS2/121S
Power Supplier	PS2/122

The choice between the CO2M/516 and the CO2/542 depends on circumstances. The CO2/542 has higher gain and a lower noise figure but the maximum input signal that can be accepted is lower.

General Specification

Frequency Coverage	Preset to any one channel in Band IV or Band V
Input V.S.W.R. over 8 MHz channel	not greater than 1·3
Vision Carrier if	37·5 MHz
Sound Carrier	
First if	31·5 MHz
Second if	6 MHz
Local Oscillator Frequency	37·5 MHz above vision carrier
Ambient Temperature Range	0°C – 45°C
Power Requirements	55 W at 240 V 50 Hz
Sensing Relay Contact Current	0·25 A max

Vision Data

U.H.F. Signal Input Level (max)	
When using CO2M/516	10 mV r.m.s.
When using CO2/542	5 mV r.m.s.
Video Outputs (two) across 75 ohms	1 volt p-p
Output Impedance	75 ohms nominal
A.G.C. Control (change of output level with r.f. input from 100µV to 10 mV r.m.s.)	not greater than 0·5 dB
Locking Pull-in Range	not less than ±5·5 kHz
Locking Hold-in Range	not less than ±50 kHz
Waveform Performance	
50-Hz square wave	k not greater than 1%
25-µs bar	k not greater than 1%
2T pulse	k not greater than 2%
2T pulse-to-bar ratio	k not greater than 1%
Line Time Non-linearity	not greater than 2%
Differential Gain Distortion at 4·43 MHz	1%
Differential Phase Distortion at 4·43 MHz	1°
Chrominance/Luminance	
Gain In equality	± 5%
Delay Inequality	not greater than 20 ns
Crosstalk	not greater than 1%
Hum Level	−40 dB min. below 0·7 V p-p

Noise Figure	
Using CO2M/516	16 dB
Using CO2/542	8·5 dB
Signal/Noise ratio (0·7 V sig./rms noise with CO2M/516, 3 mV rms uhf input)	weighted – 45 dB unweighted–51 dB

Sound Data

Output into 600 ohms with 50 kHz deviation at 400 Hz	+14 dB max w.r.t. 1 mW
D.C. on output when correctly terminated	not greater than 50 mV line/line or line/earth
Output Impedance Line to line balanced	600 ohms ±2%
Output Impedance Line to Earth	300 ohms ±2%
Sound A.G.C. (U.H.F. sound carrier varied from 50µV to 5 mV)	Output Constant to within ±0·2 dB
Frequency Response 30 Hz to 15 kHz	flat to within 0·2 dB
Signal/Noise Ratio for inputs above 50 µV	50 dB relative to 1 mW
Harmonic Distortion at 50 kHz deviation at 1 kHz, outputs up to +14 dB	–50 dB
Hum Level relative to zero level	–50 dB

Description

A block diagram of the receiver is given in Fig. 1. The receiver operates in preset channels and channel changes are effected by inserting appropriately pretuned uhf Filter, Oscillator and Converter units. The receiver has a very stable and accurately defined vestigial characteristic which is mainly determined by the FL1/513 Shaping Filter. The uhf and if circuits have relatively wide pass bands. The video characteristic is flat to 5 MHz.

Synchronous vision demodulation is used with a reference signal obtained from a crystal oscillator in the DM2/506 Vision Demodulator. The if signal is sampled during the line-sync period and any change of frequency results in a correction signal being fed to the OS2/523 voltage-controlled local oscillator. When the receiver is locked, the vision signal intermediate frequency and the reference frequency are the same but with a slight phase difference. The resulting error signal is just sufficient to retain control.

The sound discriminator is of the pulse counting type and is fed with a 6-MHz signal produced either by the intercarrier method or by normal frequency changing. Alternative sound converters are available, the choice depending on which facility is required.

The RC5M/502 is primarily intended as a rebroadcast receiver for satellite stations but it also provides carrier-sensing facilities which may be used to initiate executive action in the event of failure of the incoming carrier.

The EP1/517 Low-Noise Head Amplifier can be used with the receiver. This is housed in a weatherproof box and is intended to be mounted as close to the aerial array as possible. It is powered via the aerial feeder.

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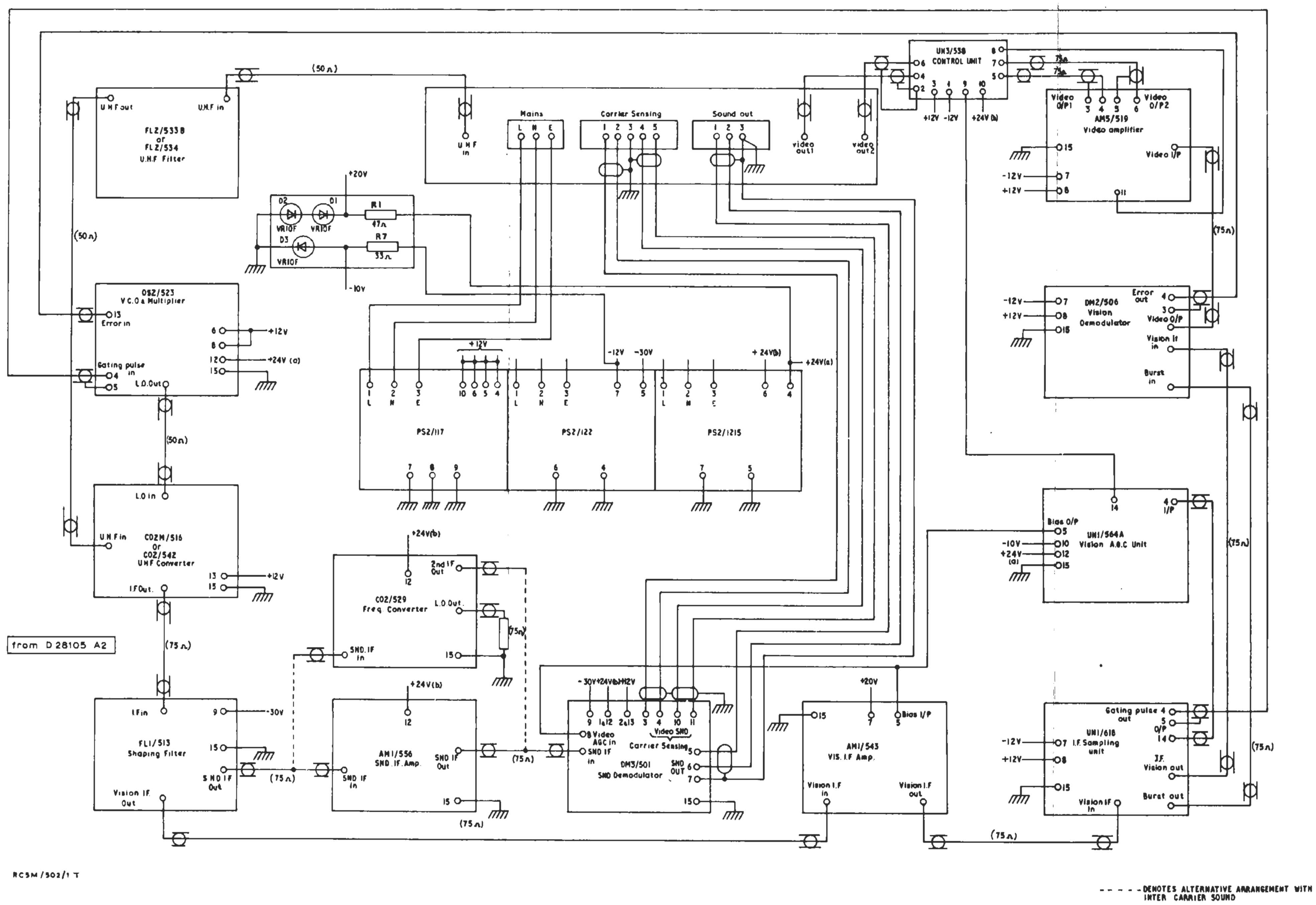

Fig. 1 RC5M/502: Block Diagram

Maintenance

Routine maintenance is not required but the following points may be checked if the performance of the receiver becomes suspect. It is assumed that all sub-units have received correct initial alignment. No adjustments should be made to the u.h.f filter or to the shaping filter.

For complete line-up instructions refer to the Designs Department Specification[1].

The frequency response of the receiver may be checked using a Polyskop SWOB type 2 or by using a sweep generator with a marker pip generator and with a suitable double-beam oscilloscope as indicator. The results at u.h.f. and i.f. should be as shown in Fig. 2a and Fig. 2b.

For the i.f. tests, the procedure is as follows:

1. Connect the input signal, sweeping between approximately 30 MHz and 40 MHz, to the input of the shaping filter FL1/513.
2. Set the a.g.c./manual control to *Manual*
3. Set the receiver gain control to give approximately 1 V p-p at the receiver output.
4. The response at 37·5 MHz, the vison carrier frequency (i.f.), relative to 35·5 MHz should be −6 dB ±0·2 dB and the response at 32·5 MHz relative to 35·5 MHz should be 0 dB ±0·5 dB. These measurements can conveniently be made by using the second oscilloscope trace as a marker for the 37·5-MHz and 32·5-MHz levels.

The same procedure is used at u.h.f. except that the input is fed to the receiver input terminals. The response at the u.h.f. carrier frequency with respect to the vision carrier frequency plus 2 MHz, should be −6 dB ±0·2 dB. The response at vision carrier plus 4·75 MHz with respect to vision carrier plus 2 MHz should be 0 dB ±0·5 dB.

The gain of the front end of the receiver may be checked as follows:

1. Feed in a known level of u.h.f. signal at mid band to the u.h.f. filter.
2. With an oscilloscope, e.g. Tektronix 585A, measure the i.f. output from the u.h.f. converter terminated in 75 ohms.
3. With 10 mV input the i.f. output should be between 40 mV and 70 mV.

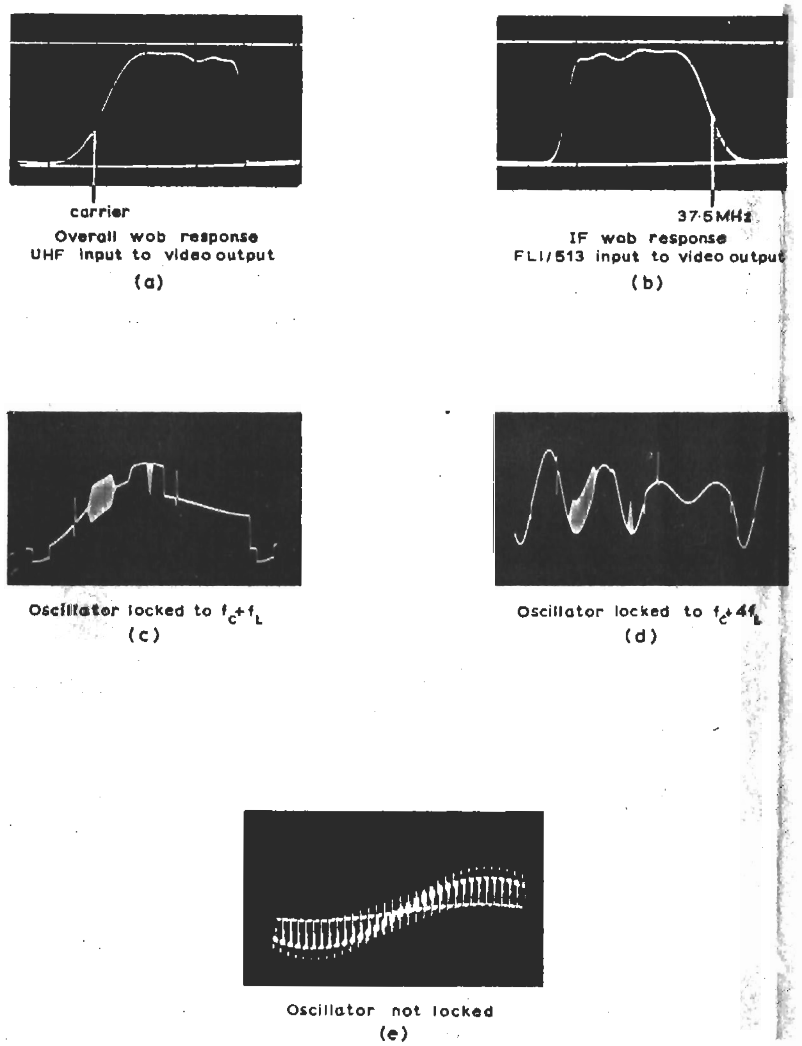

Fig.2 RC5M/502: Performance Curves
(a) Overall response
(b) IF response
(c) Oscillator locked at ($f_c + f_L$)
(d) Oscillator locked at ($f_c + 4f_L$)
(e) Oscillator unlocked.

If any of the sub-units of the receiver are changed it may be necessary to readjust the sound and vision carrier sensing circuits in the DM3/501 sound demodulator unit. The procedure is as follows, the receiver having been powered for at least one hour prior to the start of the work. The escutcheon plate of the DM3/501 must be removed.

Sound carrier sensing. Remove the input signal from the receiver and adjust the multi-turn potentiometer R33 (adjacent to the green lamp) in an anti-clockwise direction until the green lamp lights. Now turn the control slowly in the clockwise direction until the lamp ceases to glow, then add one half turn more in the same direction. Connection and disconnection of the input signal should now cause the lamp to light up and go out. Note that there will be a delay of up to 10 seconds between connection of the signal and the lamp lighting.

Vision carrier sensing. Disconnect the u.h.f. signal input and with a model 8 Avometer measure the d.c. voltage at the test point on the UN1/564A vision A.G.C. unit. Re-connect the u.h.f. input through a variable u.h.f. attenuator. Attenuate the signal until the same voltage is obtained, then reduce the attenuation until the meter just starts to move. Increase the signal input by 6 dB and adjust R66 (adjacent to the amber lamp) so that the lamp just glows. Reduce the signal 3 dB and the lamp should go out.

Receiver Locking

It is essential to ensure that the controlled oscillator in the OS2/523 locks on the correct component of the reference signal. The reference burst signal can be considered as an i.f. carrier modulated by a line-frequency rectangular wave. There will thus be side bands present on to which the receiver can lock. For example, if the controlled oscillator, when running free before the signal is applied to the receiver, is more than half line-frequency away from the correct frequency, it may lock to one of the side bands when the control is applied. The video output will then be grossly distorted and the receiver is said to be side locked, see Fig. 2c and Fig. 2d. If a fault occurs and the receiver does not lock at all, the output will be distorted as illustrated in Fig. 2e.

The voltage controlled oscillator in the OS2/523 is initially aligned to be within 72 Hz of the nominal value. This very close tolerance may not be maintained in use and, after a period, the frequency may be 200 to 300 Hz away from the nominal value. This widened tolerance will not affect locking.

If the receiver is unlocked or side locked, as occurs during the initial warm-up period, it is disconnected from the output lines by the UN3/538 control unit. In the unlocked or side locked conditions, the output from the receiver will be considerably above the normal level as indicated in Figs. 2c, 2d and 2e. It is this excess signal which operates the UN3/538. With the receiver isolated, the UN3/538 periodically applies a pulse to the a.g.c. bias line via the UN1/564A A.G.C. unit. This biases the receiver to minimum gain for about 300 ms and removes any control to the voltage controlled oscillator, thus allowing it to come nearer to the pull-in range. This pulsing procedure continues until the receiver locks correctly. The time constant of the control in the UN3/538 is long and some seconds will elapse after normal locking, before the receiver is switched back into service.

Pull-in Range

When the frequency of the input signal and of the controlled oscillator are similar, the receiver will lock immediately the input signal is applied. To check the pull-in range the input frequency is changed in discrete steps and at each step the input is removed for a few seconds to allow the receiver oscillator to return to its nominal frequency. If the input is then restored, the oscillator should pull in. This procedure is continued until a point is reached when the oscillator locks to one of the side bands. The range over which the oscillator locks to the correct frequency is the pull-in range and this should not be less than ±5·5 kHz with respect to the correct frequency.

Hold-in Range

When the receiver has locked correctly, it will stay in lock even if the input frequency is varied. The range over which it will stay in lock is the hold-in range and this should not be less than ±50 kHz. Towards the edges of the hold-in range the video signal will begin to develop overshoots due to phasing errors.

Reference

1. Designs Department Specification No.6. 169(70)