Remote control I.C.'s

RS data

A range of remote control I.C.'s consisting of one transmitter (308-073), an infra-red pre-amplifier (309-975) and five receivers, (303-826, 308-089, 309-981, 309-997 & 305-248) with individual characteristics to suit many control requirements.

The system is based on the transmission of coded P.P.M. (Pulse Position Modulation) signals over a wide variety of transmission media e.g. sound, ultrasonics, infra-red, fibre optics, cable links. Provision is made for carrier frequency generation where required to suit the medium employed. Processing of the received P.P.M. signal is performed by a discrete amplifier or for infra-red a single I.C. is available. The restored signal is passed to one, or a combination, of the five receiver I.C.'s where an error checking system inspects the P.P.M. data before activating the appropriate output. The output functions available include parallel 4-bit binary, in either latched or momentary forms, analogue output controls and discrete outputs.

The ability of one transmitter to control a combination of different receivers enables this system to satisfy the majority of remote control applications including sound systems, light displays, machine control, security devices etc.

Printed circuit boards to suit an infra-red link are available (434-807/813/829/835).

Remote control transmitter Stock number 308-073 RS 490

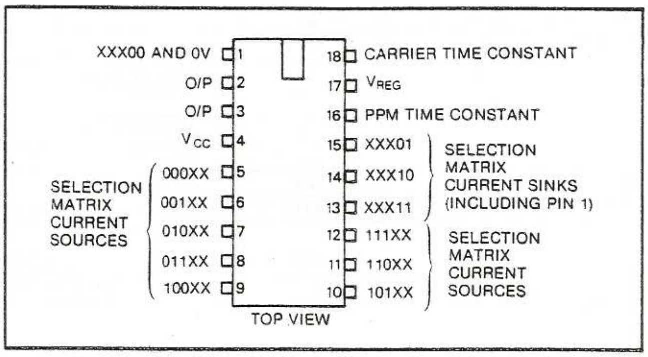
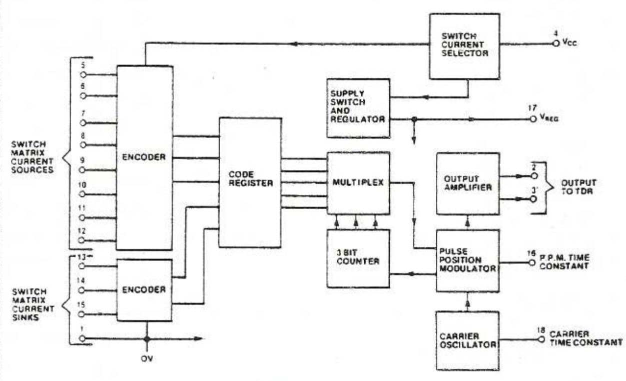


Figure 1 **RS 490 Transmitter block diagram**



Electrical characteristics

Test conditions (unless otherwise stated):

T_{amb} = 25°C f_c (carrier frequency) = 40kHz

V_{CC} = +9V t_1 (pulse interval for a '1') = 18ms

t_0 (pulse interval for a '0') = 27ms

Absolute maximum ratings

Max. supply voltage 9.5V

Operating voltage range, V_{CC} 7V to 9.5V

Maximum power dissipation 600mW

Operating temperature range −10°C to +65°C

Storage temperature range −55°C to +125°C

Characteristic	Pin	Value			Units	Conditions
		Min.	Typ.	Max.		
Supply voltage	4	7	9	9.5	V	
Operating supply current	4		8	16	mA	V_{CC} = 9.5V
Standby supply current	4			30	μA	
Stabilised voltage	17	4.3	4.6	4.9	V	
Output current available	17			1	mA	
Output voltage swing	2, 3	1		V_{CC}	V	Unloaded
Output current	2, 3			5	mA	Peak value
External switch resistance				1	kΩ	
External switch closure time		6			ms	
External carrier oscillator resistor required, R_1	18	20	40	80	kΩ	C_1 = 680p
External P.P.M. resistor R_2 required	16	15	30	100	kΩ	C_2 = 680n
Ratio t_0/t_1	2, 3	1.4	1.5	1.6		
Pulse width, t_p	2, 3	2	3	4	ms	
Inter word gap, t_g ≡ 'S'	2, 3	50	54	58	ms	

Remote control receiver
RS 922 Stock number 308-089

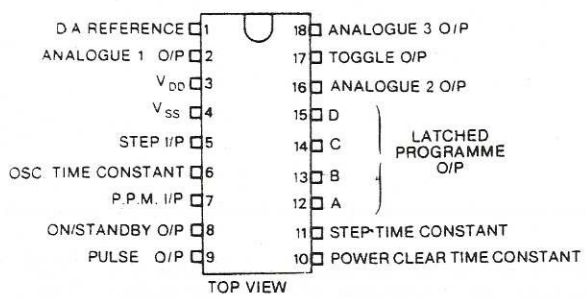
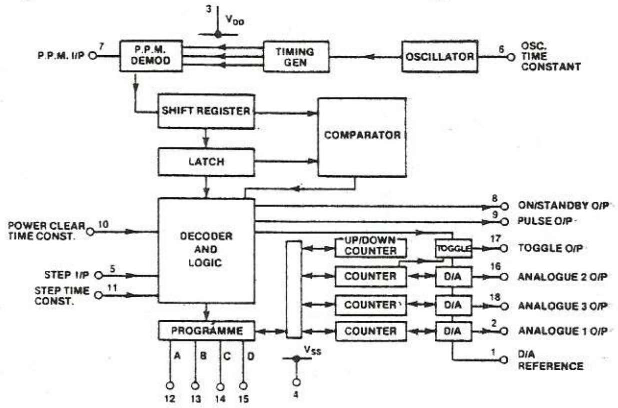


Figure 2 **RS 922 Receiver block diagram**



Absolute maximum ratings (V_{DD} = 0V)

Supply voltage V_{SS} ______ −0.3V to +25V
Voltage at any input ______ −0.3V to +25V
Maximum power dissipation ______ 600mW
Operating temperature range ______ −10°C to +65°C
Storage temperature range ______ −55°C to +125°C

Electrical characteristics

T_{amb} = 25°C V_{DD} = 0V V_{SS} = +16V

Characteristic	Pin	Value			Units	Conditions
		Min.	Typ.	Max.		
Operating voltage	4	14		18	V	
Supply current	3		8	14	mA	
Input logic level '0'	5, 7	15		16	V	
'1'		0		3.5	V	
Output logic level '0'	8, 9, 12, 15, 17	15		16	V	50k to V_{DD}
'1'		V_{DD}		0.5	V	50k to V_{DD}
Analogue outputs current range	2, 16, 18	0		$\frac{31}{8}$	I_{ref}	3k9 to V_{DD}
Analogue step size	2, 16, 18	0	1/8	1/4	I_{ref}	$V_{out}<(V_{SS}-5)$V
D/A reference, I_{ref}	1	−250	−345	−455	μA	33k to V_{DD}
Oscillator timing	6		1.6		kHz	C = 82n, R = 50k
Power clear time constant	10		400		ms	C = 4μ7 R = 100k
Step time constant	11		2		s	C = 470n R = 3M3
PPM input logic level high	7	15		16	V	
PPM input logic level low	7	0		10	V	

Infra-red pre-amplifier
RS 480 Stock number 309-975

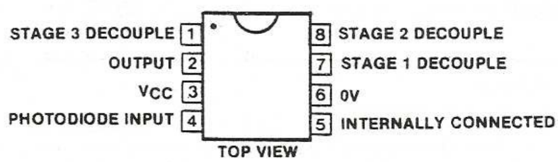
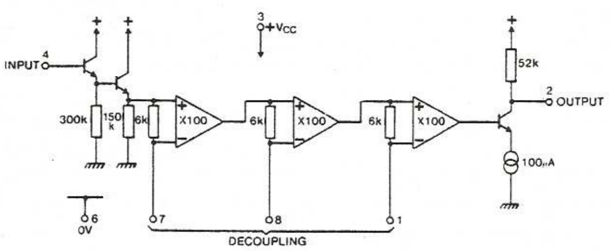


Figure 3 **RS 480 Block diagram**



Absolute maximum ratings

Supply Voltage, V_{CC} ______ 20V
Maximum power dissipation ______ 480mW
Operating temperature range ______ −10°C to +65°C
Storage temperature range ______ −55°C to +125°C

Electrical characteristics

Test conditions (unless otherwise stated):
T_{amb} = 25°C
V_{CC} = +15V

Characteristic	Pin	Value			Units
		Min.	Typ.	Max.	
Operating voltage range	3	12		18	V
Supply current	3		1.5		mA
Open loop gain	4, 2		100		dB
Input impedance	4		20		MΩ
Output current sink	2		100		μA
Internal pullup resistor	2		50		kΩ
Quiescent O/P voltage (low)	2	9	11		V
Pulse O/P (high)	2	15.5			V

Remote control receivers

RS 928 — **Stock numbers 309-997**
RS 929 — **305-248**

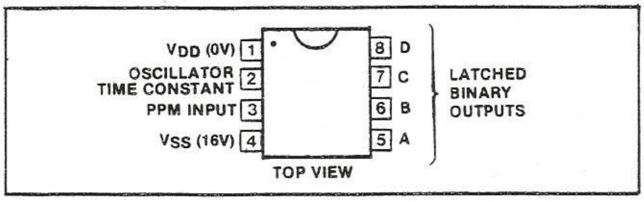
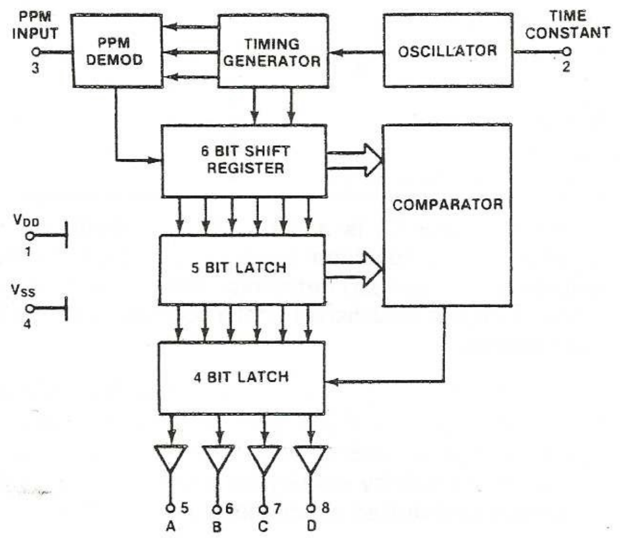


Figure 4 **RS 928 & 929 Block diagram**



Absolute maximum ratings

V_{SS} supply and inputs w.r.t. V_{DD} — −0.3V to +25V
Storage temperature — −55°C to +125°C
Operating temperature ambient — −10°C to +65°C

Electrical characteristics

Test conditions (unless otherwise stated):
V_{SS} = +16V
V_{DD} = 0V
T_{amb} = +25°C

Characteristic	Pin	Value Min.	Typ.	Max.	Units	Conditions
PPM input	3					
Logic '0' level		+15		+16	V	t_{osc} = oscillator time constant (see receiver and oscillator section)
Logic '1' level		V_{DD}		+10	V	
Input pulse width		1		22 t_{osc}	µs	
Oscillator Timing Frequency	2	15	4k	150k	Hz	Typical timing components 33nF to V_{SS} 47kΩ to V_{DD}
Variation w.r.t. V_{SS}			1		%/V	
Latched binary output	5,6,7,8					
Logic '0' output current		5			mA	3kΩ resistor to V_{DD}
Output leakage in logic '1' state				1	µA	
Current Consumption V_{SS}	4	3	4	5	mA	
Supply voltage	4	+14		+18	V	Normal conditions of use

Remote control receivers

RS 926 — **Stock numbers 309-981**
RS 927 — **303-826**

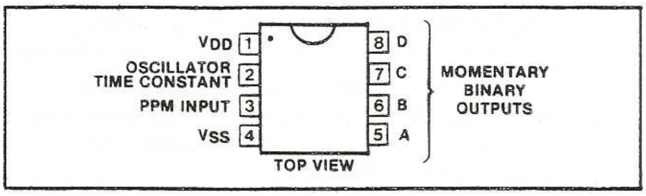
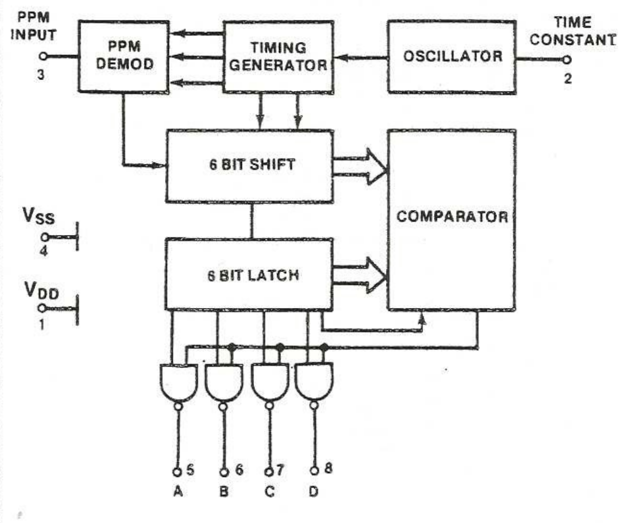


Figure 5 **RS 926 & 927 Block diagram**



Absolute maximum ratings

V_{SS} supply and inputs w.r.t. V_{DD} — −3V to +25V
Storage temperature — −55°C to +125°C
Operating temperature ambient — 0°C to +65°C

Electrical characteristics

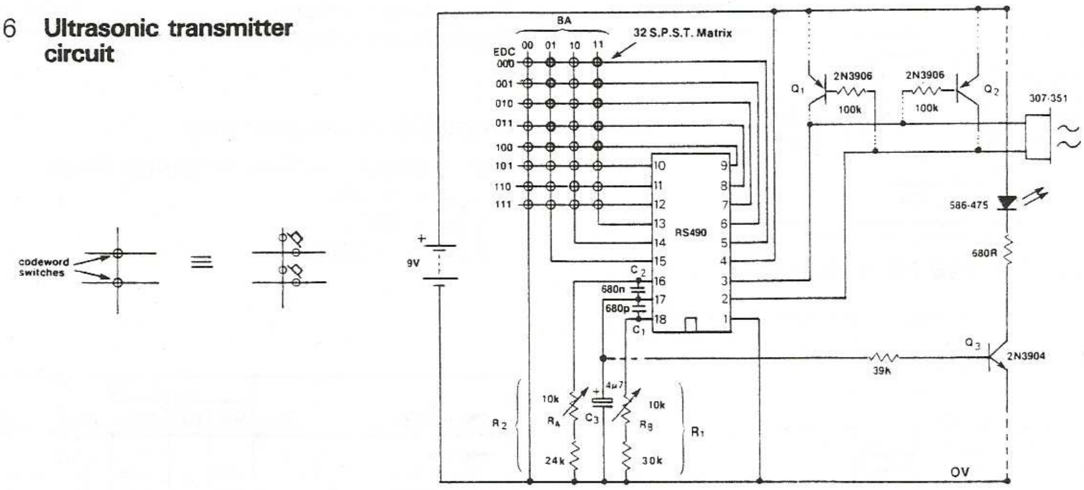
Test conditions (unless otherwise stated):
V_{SS} = +16V
T_{amb} = 25°C

Characteristic	Pin	Value Min.	Typ.	Max.	Units	Conditions
PPM input						
Input logic level high	3	+15		+16	V	t_{osc} = oscillator time constant (see receiver oscillator section)
Input logic level low	3	V_{DD}		+10	V	
Input pulse width	3	1		22 t_{osc}	µsec	
Oscillator Time constant Oscillator frequency	2	15	4k	150k	Hz	Typical timing components: 33nF to V_{SS} 22k + 50k variable to V_{DD}
Variation w.r.t. V_{SS}			1		%/V	
A, B, C, D Output current	5,6,7,8	5			mA	3kΩ resistor to V_{DD} (Output ON)
Operating voltage range	4	12	14	18	V	
Current consumption	4	2	3	4	mA	no load
A, B, C, D Output voltage high	5,6,7,8	14		V_{SS}	V	R_L 3k to V_{DD}
Output device leakage (Output OFF)	5,6,7,8			1	µA	

RS 490 Transmitter (ultrasonic)

The internal structure of the RS 490 remote control I.C. is illustrated in Fig. 1 and Fig. 6 shows the complete circuit of an Ultrasonic Transmitter.

Figure 6 **Ultrasonic transmitter circuit**



Thirty-two single pole momentary switches are used to programme the transmitter into producing a pulse position coded signal. The components R_1 and C_1 define the carrier frequency according to Eqt. 1.

$f \approx \frac{1}{C_1R_1}$ Hz . . . Eqt. 1 C_1 in F $0 \leqslant f \leqslant 200kHz$

R_1 in Ω $20k\Omega \leqslant R_1 \leqslant 80k\Omega$

The components employed in Fig. 6 allow adjustment of the carrier frequency about 40kHz which is the approximate resonant frequency of the RS Ultrasonic Transducer 307-351.

R_2 and C_2 select the modulation rate according to Eqt. 2.

$t_0 \approx 1.4C_2R_2$ sec . . . Eqt. 2

t_0 = time for a '0' interval (see later)

R_2 in Ω $15k\Omega \leqslant R_2 \leqslant 100k\Omega$

C_2 in F

1bit/sec ⩽ t_0 rate ⩽ 10kbit/sec

The capacitor C_3 is a decoupling capacitor for the internal voltage regulator used to provide a constant voltage for the two CR networks. The regulator voltage on pin 17 is not established until a codeword switch has been closed.

The RS 490 is capable of driving the RS Ultrasonic Transmitter directly from pins 2 & 3 providing an effective rage of ≈8m. An increase in range up to ≈10m is possible by employing active pull ups Q_1 and Q_2 shown with dotted connections in Fig. 6.

To indicate transmitter operation the voltage appearing on pin 17 at switch closure can be used to drive an NPN transistor feeding an L.E.D. and this modification is shown with dashed connections in Fig. 6.

Because the standby current of the RS 490 is very low (≈6µA) rising to about 8mA when transmitting, the power requirements can be satisfied by a PP3 battery. Using the L.E.D. indicator modification shown the operating current will be approximately 20mA.

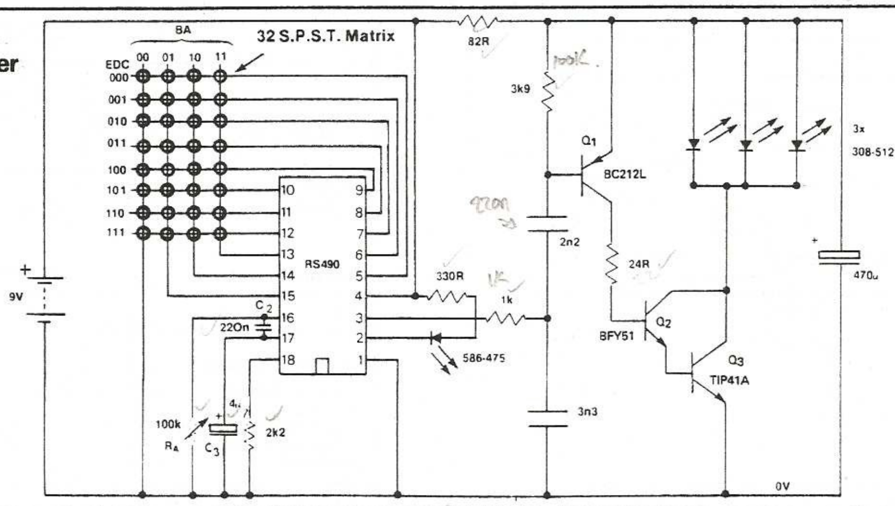
RS 490 Transmitter (infra-red)

Operating a remote control system on an infra-red link offers some advantages over the previously discussed ultrasonic mode. The important gains are less multipath interference, lower spurious radiation, a higher modulation rate capability and more robust transducers. Fig. 7 shows the complete circuit of an Infra-red Transmitter.

The modulation rate formula by Eqt. 2 is applicable to the infra-red transmitter circuit. A visual indication of transmitter operation can be provided by employing the unused output on pin 2 to drive an L.E.D. via a pull up resistor as shown in Fig. 7.

The programming of the infra-red transmitter is identical to the ultrasonic system in employing 32 S.P.S.T. switches to produce a pulse position coded signal. No carrier frequency is required by the infra-red transducers hence C_1 is omitted and a 2.2kΩ resistor substituted for R_1.

Figure 7 **Infra-red transmitter circuit**



The positive pulses appearing on pin 3 are amplified by Q_1, Q_2 and Q_3 to provide high current pulses to supply 3 RS Infra-red sources, 308-512.

All wiring to the transmitters should be short with thick conductors and the 470μF electrolytic mounted close to minimise lead inductance.

A suitable p.c.b. (434-807) is available.

RS 490 Output and coding

Fig. 8a shows the output voltage waveforms from pins 2 and 3 with respect to 0V. A carrier wave is shown as it depicts a typical output for the ultrasonic system. The carrier wave frequency is shown lower than normal for clarity. The RS 490 transmits a codeword as a group of 6 carrier or d.c. pulses (depending on the system being used) continuously for as long as a programme switch is operated. The minimum switch closing time is 6ms and the transmitter will transmit until the end of a codeword even if the switch is released during a word. On completion of the word the device reverts to standby mode. Each of the five intervals between these pulses may take up 2 possible values, a short interval corresponding to a '1' or a long interval corresponding to a '0'. Fig. 8b shows the timing relationship between the carrier pulses '1' and '0'. At the end of each word a synchronising interval 'S' is generated to define a codeword ending. The transmitter maintains a fixed relationship between the '1', '0' and 'S' intervals of 2:3:6. Also the width of the carrier pulse is approximately 1/6th of a '1' interval or 1/3:2 on the above ratio scale. From the possible combinations of the 5 bit codeword up to 2^5 or 32 different words can be generated.

A carrier burst of 3ms duration is shown in Fig. 8b as an example of the timing relationships.

Figure 8a **P.P.M. output showing ultrasonic carrier frequency**

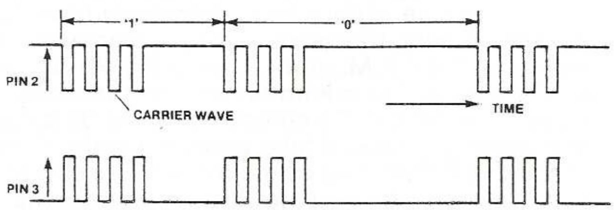
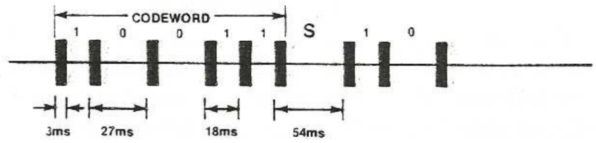


Figure 8b **Ultrasonic transmitter output (for a '1' period of 18ms)**



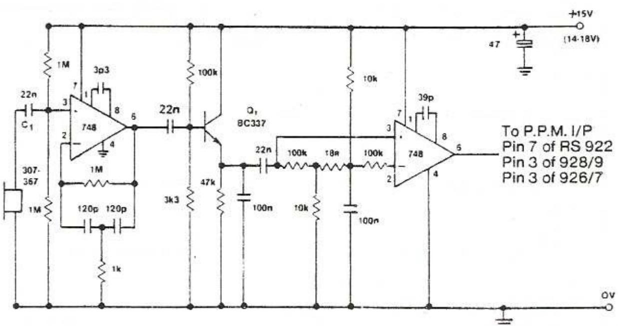
Amplifiers

Receiver amplifier (ultrasonic)

At the receiving end of the ultrasonic link a gain and bandwidth defining system will be required before the incoming signal is suitable for reception by the remote control receivers.

Fig. 9 shows a suitable two stage amplifier designed for receiving signals from the RS Ultrasonic Transducer, 307-367.

Figure 9 **Ultrasonic receiver amplifier.**

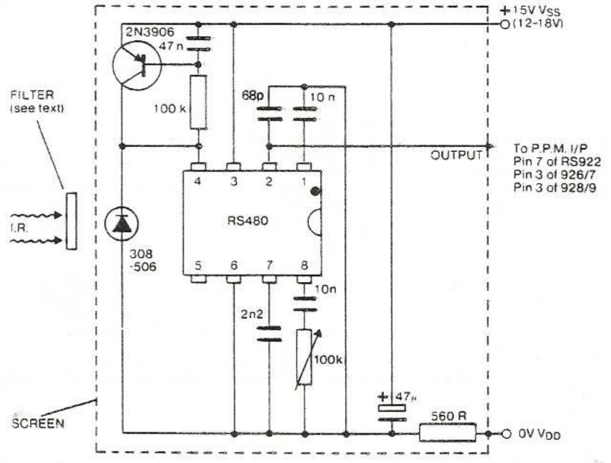


RS 480 Receiver amplifier (infra-red)

For infra-red links the RS 480 infra-red pre-amplifier i.c. is employed as an interface between the RS High Power infra-red sensor, 308-506 and any of the remote control I.C.'s. The gain of this stage is adjustable via the 100kΩ pot on pin 8, maximum gain being achieved with the pot adjusted to minimum resistance.

The high input impedance (20MΩ) and high gain (100dB max) associated with this device does make it susceptible to extraneous noise pickup. Good electrical screening, short connecting leads and good supply decoupling is recommended to avoid circuit instability.

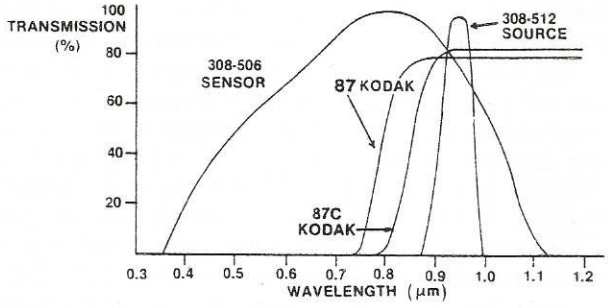
Figure 10 **Infra-red receiver amplifier**



A suitable p.c.b. (434-829) is available.

The optical responses of the source and sensor are shown in Fig. 11. The broad spectral response of the sensor makes it susceptible to interference from visible light which could produce sensor saturation from strong sunlight or high output fluorescent gas tubes. Placing an optical filter in front of the sensor can effectively reduce the system bandwidth to exclude visible light sources. The responses of the two Kodak filters type 87 and 87C are shown in Fig. 11 and are suitable for limiting the bandwidth of the RS sensor. These filter materials are available from most photographic suppliers.

Figure 11 **Optical response characteristics**



Remote control receivers: introduction

All of the five remote control receiver I.C.'s have similar signal reception and decoding circuits. The receiver differences are fundamentally confined to the number of P.P.M. codewords to which each responds and the different output functions available.

A general discussion of the circuit operation common to all receivers is given below and each receiver's capabilities are covered later.

Receiver oscillator

After processing by the receiver amplifier the processed P.P.M. signal is transferred to the P.P.M. input of the remote control receiver I.C.

An internal oscillator uses the external components R_1 R_2 & C_1 (see Figs. 13 & 15) to generate a frequency in accordance with Eqt 3.

$$f\ osc = \frac{1}{0.15\ C_1 R_T}\ Hz \ldots \text{Eqt 3}$$

C_1 in F

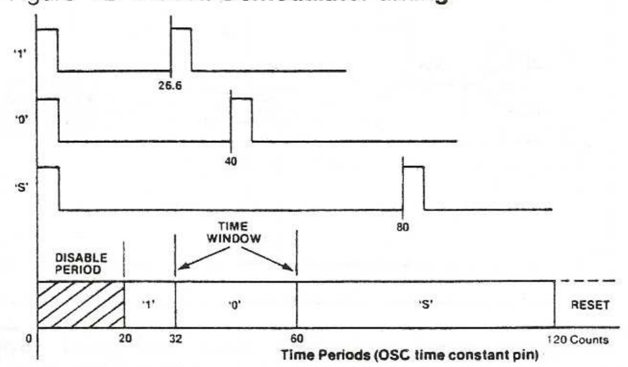
$25k\Omega \leqslant R_1 \leqslant 200k\Omega$ R_T is the total resistance of R_1 and R_2 in Ω

The set frequency of this oscillator is dependent on the received P.P.M. rate from the RS 490 transmitter. The importance of this setting is apparent when the internal operation of the receiver is considered.

Internal operation

Whenever a P.P.M. pulse is received by the receiver an internal counter is reset. This counter defines timing windows for the following pulses as shown in Fig. 12.

Figure 12 **P.P.M. Demodulator timing**



After receipt of the first P.P.M. pulse the counter is reset and disabled for 20 periods of the internal oscillator frequency. This is to reduce the possibility of pulse echoes from multipath reflections between the transmitter and receiver upsetting the correct transmission. If a pulse is received after the counter reaches 20 periods the internal logic examines the spacing or time interval between the receipt of the first pulse and the second and depending on this interval assigns the value '0' or '1' to the pulse spacing. This second pulse again resets the counter and disables it for 20 periods before repeating the above process with the next pulse. In this way the receiver reconstructs the transmitted P.P.M. code, the receipt of an 'S' interval defining the end of the codeword. On receipt of 'S' the receiver verifies that 6 pulses have been received before accepting the code.

The receiver stores this code while receiving another set of P.P.M. pulses. At the end of the second codeword a comparison is made; if the codewords are the same the data is accepted and passed on to a decoder to produce the output function defined by the code; if they are different the first codeword is rejected and the second code used as a reference for comparison with the next code received and no change in an output function occurs. This sequential codeword comparison coupled with P.P.M. and time window checking provides the system with a high degree of noise immunity against producing an incorrect output.

As can be seen from Fig 12 for correct interpretation of the transmitted code each pulse interval for a '0' or '1' must lie within the timing windows defined. This is achieved by setting the 'on chip' oscillator so that 40 periods at the oscillator time constant pin are equal to a '0' interval received at the P.P.M. input. This places a '0' interval at approximately the centre of the '0' time window hence providing some allowance for oscillator drift both in the transmitter and receiver.

P.P.M. rate selection

The minimum time taken for any receiver to respond to a transmitter command is twice the time to transmit the appropriate codeword, because of the error checking logic. This delay is depedent on the P.P.M. rate chosen at the transmitter and in the example shown in Fig. 8b the receiver will respond to the code 10011 in a minimum time of 324 milliseconds. For the discrete outputs this delay is usually of little significance, however, for each step of an analogue output two codewords have to be received. Taking the 'analogue 1+' command 10100 and using the P.P.M. rate shown in Fig. 8b one word is 171ms long. The minimum time for the receiver to respond is 342ms. To complete all the 32 steps of 'analogue 1−' would take approximately 11 secs. Hence the P.P.M. rate at the transmitter end of the ultrasonic link should be chosen to provide the desired full range analogue output sweep time.

Usng the RS Ultrasonic Transducers the P.P.M. rate is limited by the rise time of the transmitter ($tr \approx 2ms$).

The recommended P.P.M. rate is 37bit/sec corresponding to a t_0 time of 27ms as shown in Fig. 8b. This rate can be increased to approximately 74bit/sec, a t_0 time of 13ms, with some loss of range caused by the transducer rise time limitation. The spread in the characteristics of the transducers may increase or reduce this figure.

The infra-red system can be operated up to the maximum P.P.M. rate of the transmitter i.e. 10kbit/sec.

Each receiver I.C. responds to a specific set of codewords from the RS 490 transmitter. A description of each receiver type is given below.

I.C. Receivers

RS 922 Receiver

This device accepts 21 of the transmitted codewords. The command set and output functions for each pin are given in Tables 1 & 2 respectively.

The RS 922 receiver features a parallel 4-bit latched binary output with 10 output codes, 3 independent analogue outputs and 3 other digital outputs.

Table 1 Basic 21 command set for RS 922 receiver

Transmitter code	Function	Programme O/P's D C B A
EDCBA		0 0 0 0
0000X	Programme 1	0 0 0 1
00C1X	Programme 2	0 0 1 0
0010X	Programme 3	0 0 1 1
0011X	Programme 4	0 1 0 0
0100X	Programme 5	0 1 0 1
0101X	Programme 6	0 1 1 0
0110X	Programme 7	0 1 1 1
0111X	Programme 8	1 0 0 0
1000X	Programme 9	1 0 0 1
1001X	Programme 10	
10100	Analogue 1 +	
10101	Programme Step +	
10110	Analogue 2 +	x = Don't care digit
10111	Analogue 3 +	
11000	Standby	
11001	Toggle O/P (Analogue 2)	i.e. 00110 and 00111 both produce programme 4
11011	Normalise	
11100	Analogue 1 −	
11101	Programme Step −	
11110	Analogue 2 −	
11111	Analogue 3 −	

N.B. LOGIC CONVENTION
RS922
Logic "O" — output transistor ON
— pulls output to V_{SS}
Logic "1" — output transistor OFF
ie: **NEGATIVE LOGIC**

Table 2 Pin functions of RS 922

Pin No.	Name	Function
1	D/A Reference	A current drain I_{ref} set by a single external resistor which fixes the nominal step of the analogue O/P's to $I_{ref}/8$.
2, 16, 18,	Analogue O/P's 1,2,3	These 3 outputs are from three static 5 bit current mirror converters. They are referenced to the current drawn from pin 1, I_{ref} and provide 32 steps, $I_{ref}/8$ from 0 to 31/8 I_{ref}. The 'initial' and 'normalised' condition is 12/8 I_{ref}.
5	Step I/P	Connecting this pin to V_{DD} causes the programme outputs to step up by 1. The time period between steps is defined by the RC network connected to pin 11. The programme output will continue to step for as long as Step I/P is held at V_{DD}, continually cycling.
6	Osc. time Constant	An RC time constant connected to this pin defines the internal oscillator frequency. This frequency controls the timing windows for the incoming P.P.M. pulses from the RS490 transmitter.
7	P.P.M. I/P	The output of the receiver amplifier provides positive P.P.M. pulses which supplies the data input to this pin. With no signal this I/P is held low.
8	On/Standby O/P	An open drain O/P with an initial condition of logic 0. This output remains at this level until a programme codeword or programme step is received whereupon it changes to a logic 1. The 'standby' codeword 11000 returns the output to logic 0 until a programme change is commanded. No other codes affect this output.
9	Pulse O/P	This is an open drain O/P with an initial condition of logic 0. A logic 1 pulse is produced on receipt of a programme codeword or programme step command. The width of the 1 pulse is equal to the periodic time of the internal oscillator which can be monitored on pin 6. This pulse is repeated as long as the programme codeword or programme step command is activated. The repetition period is equal to the time taken to transmit the appropriate programme codeword or step command.
10	Power Clear Time Constant	A single RC network connected to this pin defines the time delay before the 'initial' conditions are established, nominally set to 2 sec. by the components indicated in Fig. 9
11	Step Time Constant	An RC network connected on this pin defines the time period between increments of the channel number when the programme step codewords are transmitted.
12, 13, 14, 15	Programme O/P's	These are latched 4 bit binary outputs which respond to the programme transmitter codes and the programme codes. When power is first applied to the receiver programme 1 is established i.e. ABCD outputs are all at logic 0 corresponding to programme 1.
17	Toggle O/P	This pin has an 'initial' condition of logic 1 and only changes to logic 0 when Analogue 2 O/P is at the zero level. Transmission of the 'toggle' command 11001 changes this output to 0 or 1 for each separate transmission of toggle, provided Analogue 2 O/P is not at the zero level.

The 'Initial' condition

This describes the state of the outputs of the RS 922 receiver every time power is applied and no P.P.M. data has been received.

Programme O/P's — ABCD 0000
Analogue O/P's — All at 12/8 I_{ref}
On/Standby O/P — Logic 0
Pulse O/P — Logic 0
Toggle O/P — Logic 1

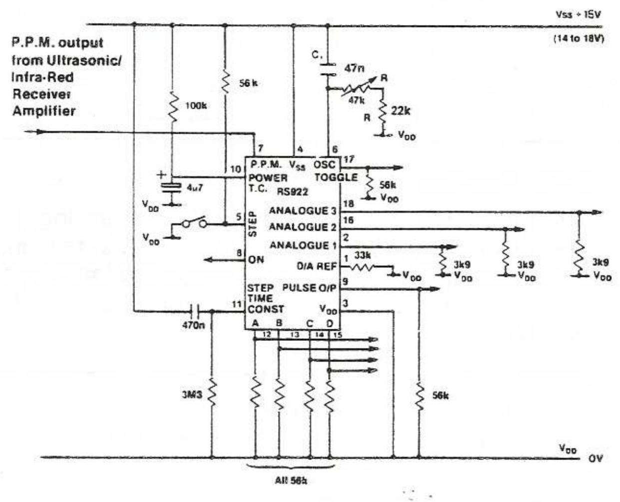
Note: Logic '0' is ≈ +14 to +15V
Logic '1' is 0 to +0.5V
measured w.r.t V_{DD} (0V)

The 'Normalised' condition

Reception of the 'Normalise' command 11011 affects the following outputs only:

Analogue O/P's — Taken to 12/8 I_{ref}
Toggle O/P — Taken to 1 or 0 (see above)

Figure 13 **RS 922 Receiver circuit**



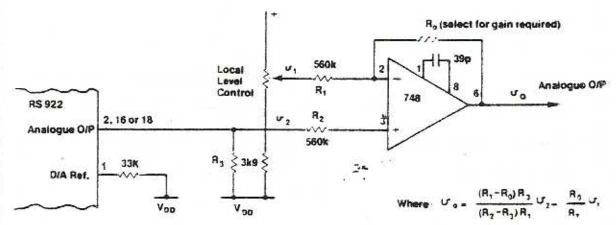
RS 922 Analogue O/P's

Analogue 1, 2, 3 '+' transmitter codes cause the respective analogue outputs to step up for as long as the transmitter code is being received until the max value of I_{ref} is reached at which point continued receipt of the analogue '+' codes have no effect. Similarly the analolgue '−' transmitter codes cause the respective output to step down until I_{ref} reaches zero where it remains even under further transmitter command.

The step for the analogue outputs is typically 1/8 I_{ref} and the analogue output current range is 0 to 31/8 I_{ref} hence 32 discrete levels (typically 0 to 1.3mA) are possible from each analogue output.

The analogue outputs are current sources and should normally feed 3.9k sink resistors connected to the V_{DD} and 0V rail. Greatest linearity is obtained if the current sink resistors do not exceed 3.9k giving a 0 to 5V D/A output control range. However a 0 to 10V range may be obtained with higher resistor values if some reduction in linearity of step size can be tolerated. The simplest form of local adjustment of analogue control levels is to make the current sink resistors variable. An analogue output interface circuit is shown below which increases the analogue O/P current and voltage capability without loss of linearity.
A suitable p.c.b. (434-813) is available.

Figure 14 **Analogue output interface**



Where $v_o = \frac{(R_1 - R_0)R_3}{(R_2 - R_3)R_1} v_2 - \frac{R_0}{R_1} v_1$

RS 928, 926, 927 & 929 Receivers

The Rs 928 & 929 have parallel 4-bit binary latched open drain outputs only and respond to 16 codewords each. They are identical in circuit operation and application and differ only in their command sets, as shown in Table 3.

The RS 926 & 927 respond to 15 codewords each as shown in Table 3. The circuit applications for the RS 928 & 929 are equally applicable to the RS 926 & 927. The outputs of the 926 & 927 differ from the 928 & 929 by being 4-bit parallel momentary outputs and not latched. The outputs are activated for as long as a valid code is being received and return to their inactive 'off' state under no signal conditions.

Table 3 Command set 928/9 & 926/7

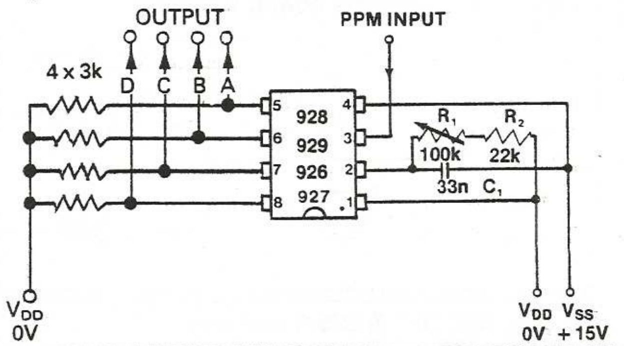
RS490 Transmitter Code EDCBA	RS926/8 DCBA	RS927/9 DCBA
00000	0000	No change
00001	0001	
00010	0010	
00011	0011	
00100	0100	
00101	0101	
00110	0110	
00111	0111	
01000	1000	
01001	1001	
01010	1010	
01011	1011	
01100	1100	
01101	1101	
01110	1110	
01111	1111	
10000	No change	0000
10001		0001
10010		0010
10011		0011
10100		0100
10101		0101
10110		0110
10111		0111
11000		1000
11001		1001
11010		1010
11011		1011
11100		1100
11101		1101
11110		1110
11111		1111

N.B. LOGIC CONVENTION
RS928 & RS929 (Latching output)
Logic "0" — output transistor ON
—pulls output to V_{SS}
Logic "1" — output transistor OFF
ie: **NEGATIVE LOGIC.**
RS926 & RS 927 (Momentary outputs)
Logic "0" — output transitor OFF
Logic "1" — output transistor ON
— pulls output to V_{SS}
ie: **POSITIVE LOGIC**

RS data

A typical basic circuit application is given in Fig. 15. The outputs are capable of driving visible L.E.D.'s, opto-coupled thyristors/triacs or alternatively the 4-bit binary outputs can be decoded using a 4028B C-MOS logic I.C. to provide up to 10 outputs or a 4514B to produce the full 16 outputs.

Figure 15 **RS 928/9 & 926/7 Circuit**



Applications

Ultrasonic control system

Setting up procedure

Transmitter

The potentiometers R_A and R_B in the transmitter circuit shown in Fig. 6 require adjustment to define the carrier frequency and P.P.M. rate required.

Activate the switch controlling transmitter code 0000X and monitor the output waveform of the transmitter I.C. appearing at pins 2 & 3. Expanding one of the pulses displayed, adjust R_B to produce a carrier period of approximately 24.5μs corresponding to a frequency of 40.8kHz. Display several pulses of the transmitter code and by adjusting R_A alter the time interval for a '0' to provide the required P.P.M. rate (see Fig. 8b).

Receiver

A)
Position the transmitter and receiver transducers 3m apart. Activate the transmitter to produce the codeword 0000X continuously and monitor the P.P.M. I/P Pin on the receiver I.C.

B)
Re-adjust R_B controlling the carrier frequency on the transmitter circuit to provide a maximum signal at the P.P.M. I/P of the receiver I.C. Finally monitor the oscillator waveform on the osc time constant pin of the receiver I.C. and adjust R_1 so that the periodic time is 1/40th of the time of a '0' interval on the received P.P.M.

Infra-red control system

Setting up procedure

Transmitter

The potentiometer R_A shown in Fig. 7 should be adjusted for the required P.P.M. rate, following the same procedure outlined for the ultrasonic system

Receiver

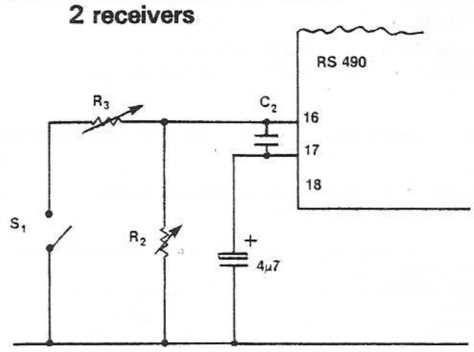
Follow part A of the setting up procedure for the ultrasonic system. Adjust the 100kΩ potentiometer shown in Fig. 10 to achieve the gain required and best signal to noise ratio. Monitor the oscillator waveform on the osc time constant pin of the receiver I.C. and adjust R_1, so that the periodic time is 1/40th of the time of a '0' interval on the received P.P.M. of the appropriate input pin.

Additional circuits

Transmitter control for 2 receivers

Fig. 16 illustrates a method of employing one RS 490 transmitter to control two independent receivers. The P.P.M. rate for one receiver is selected by the potentiometer R_2. The second receiver should be adjusted to receive the P.P.M. rate defined by the parallel combination of R_2 and R_3. The two different P.P.M. rates can be chosen such that data accepted by one receiver is outside the timing windows defined by the oscillator time constant of the other. The P.P.M. rates should be within the limitations of the transducer, only one receiver amplifier being required to directly feed the P.P.M. inputs on the two receivers.

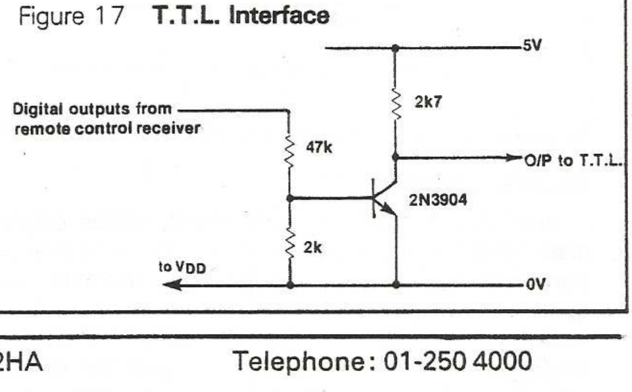
Figure 16 **Transmitter modification for controlling 2 receivers**



T.T.L. Interface

Fig. 17 shows a simple interface between logic level outputs of the remote control receiver I.C.'s, to standard T.T.L. inputs. This circuit also inverts the logic levels, a logic 1 from the receiver producing a logic 0 T.T.L. output.

Figure 17 **T.T.L. Interface**



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