

## SELECTIVE SIGNALLING DEVICES '07 SERIES

### GENERAL DESCRIPTION

The FX-107, FX-207 and FX-307 are a powerful and flexible family of high performance monolithic signalling devices, based on 3-tone Sequential Code signalling techniques. Constructed using MOS/LSI technology, the devices perform all frequency discrimination, tone generation and code timing functions on-chip, using simple external CR networks.

The family members are FX-107, a single code transceiver with transponder capability; FX-207, a multi-code transmitter with logic controlled selection of any one-from-eight codes; and FX-307, a multi-code Receiver which decodes 8 different input codes and provides an appropriate binary coded output.

Transmitter devices generate the programmed Group Code on receipt of a logic instruction; Receivers decode Group Codes applied to their signal input and operate integral output switches when the programmed code/s are received.

Used separately, or in any required combination, these exciting new devices combine high performance with economy and simplicity of use; they offer a new state of the art approach to applications involving selective signalling between two or more points, using a common transmission line or radio link.

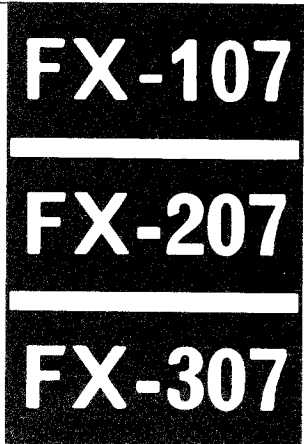
Virtually any number of outstations can be hooked into the common line and a variety of instructions signalled to each one selectively. Automatic answer-back, automatic station scanning and station status check functions are very easily implemented, and cost barriers previously associated with complex functions of this type are dramatically reduced.

Extensive applications exist for the '07 series in Telecommunications, Control Signalling, Instrumentation, Automation, Process Control and similar fields. Typical examples include selective control switching, remote alarm signalling, data transmission, selective telemetry, status transponding, selective paging, intercom systems, vehicle paging and identification, security systems and numerous similar areas.

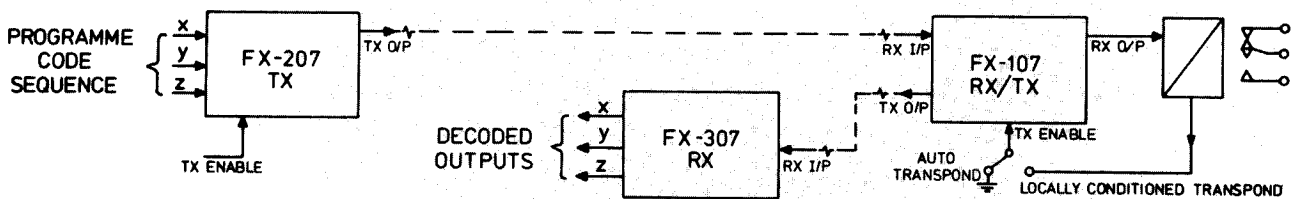
Designed for maximum compatibility, the devices employ identical frequency discrimination and code timing circuits and operate on a standard 3-Tone Sequential Code principle. Each code consists of three tones, each of different consecutive frequency and sent in a pre-determined sequence (Group Code).

The operating frequencies and channel bandwidth capabilities of the '07 family are such that upwards of hundreds of thousands of unique Group Codes are available to the user. Another particularly important feature is the extreme simplicity of setting-up and calibrating the code frequencies.

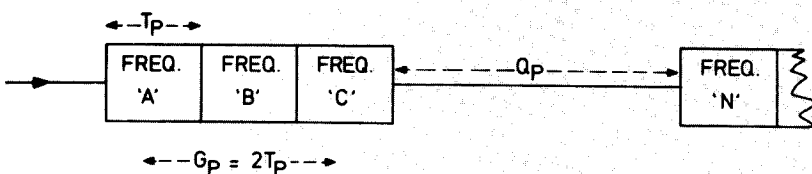
All devices are housed in 16 lead ceramic dual-in-line packages and operate from a single wide tolerance D.C. Supply.



### THE '07 SERIES OF SELECTIVE SIGNALLING DEVICES



### THE 3-TONE CODE PRINCIPLE



$T_p$  = TONE PERIOD

$G_p$  = GATE PERIOD

$Q_p$  = QUIESCENT PERIOD

FIG.1

## THE 3-TONE GROUP CODE

A Group Code consists of a series of three tones, the frequencies used and their order of transmission determines the code value.

The Group Code system employed for the '07 family operates according to the following rules;

1. All three tones in a Group Code are of equal nominal duration ( $T_p$ ), which must be sufficient to allow recognition by a receiver.
2. Consecutive tones in each Group Code *must* be of different frequency; alternate tones may, however, be repeated.

Example: Frequencies A,B,C and A,B,A are legal codes; A,A,B and A,B,B, are illegal codes.

3. A receiver will recognise a correctly addressed code *only* if consecutive tones in the group are received within a specified gate period (receiver Gate Period  $G_p$ ).
4. A minimum time interval (Quiescent Period  $Q_p$ ) must elapse between transmission of consecutive Group Codes, in order to avoid "alias codes", e.g. false codes based on the 'run-on' tone sequences present in two consecutive Group Codes.

NOTE: *Simultaneous* transmission of different Codes over a common transmission line will *inhibit* decoding at the receivers being addressed. (See Special Note on Receivers.)

The number of unique Group Codes obtainable in a system depends on the number of tone frequencies used. For codes based on non-repeat tones (all three tones are different frequencies) the number of codes possible is  $(N \times N-1 \times N-2)$ , where N is the total number of tones available. By including legal repeat tones the number of codes rises to  $(N \times N-1 \times N-1)$ .

By way of example, if 10 tones are available in a system, the number of different Group Codes are  $10 \times 9 \times 8 = 720$ ; using legal repeat tones this rises to  $(10 \times 9 \times 9) = 810$  codes. The channel selectivity of the '07 devices is such that over 40 tone channels are easily obtainable in the 200HZ to 3KHZ audio transmission range, yielding upwards of 60,000 codes.

## GROUP CODE TIMING

### TX TONE PERIOD ( $T_p$ )

To ensure correct recognition by a receiver, transmitter devices (107/207) *must* send a minimum of ten cycles of each tone in the Group Code. This is an absolute design limit and assumes accurate period timing; to allow for component and other tolerances, the recommended minimum is twelve cycles of each tone. In a multi-station system it is usually convenient if all stations have common values for timing components; in this case, the *lowest* tone frequency used in the system should be adopted as the basis for all timing calculations. Apart from this any preferred tone length may be used. A transmitter tone period is controlled by a single CR network ( $R_t$  &  $C_t$  of Figs 6 & 7); this determines the period of an internal timing stage. Note that  $T_p$  is the transmission period for *one tone*; the overall time for transmission of a Group Code is therefore  $3T_p$ , there being no interval between successive tone steps.

FORMULA.  $T_p = 0.63 R_t C_t$  &  $R_t C_t = \frac{T_p}{0.63}$

Where 0.63 is a design constant and subject to production tolerances of 0.6 to 0.7; R = Meg-Ohms, C = MFD,  $T_p$  = seconds. Recommended minimum component values: R = 100k $\Omega$  C = 0.001 MFD.

### RX GATE PERIOD ( $G_p$ )

The tone sequence decoding circuits of the 107/307 receivers include a timing gate. This gate period is triggered (or re-triggered) as each programmed tone is received and sets the *maximum* time allowed for receipt of the *next consecutive* tone in the Group Code. If one (or two) tones in the group have been detected, but the second (or third) tone is not received within this gate period, the decode system clears down and reverts to first tone search again (FX-107) or adopts an "idling" position (FX-307).

This gate period is controlled by a single CR network ( $R_s$  &  $C_s$  of Figs 6 & 10) which determines the period of an internal retriggerable monostable stage.  $G_p$  should always be slightly longer than  $T_p$ , and to allow for component tolerances throughout the system should be calculated to equal  $2T_p$ , but longer periods may be used if preferred.

FORMULA:  $G_p = 0.63 R_s C_s$  &  $R_s C_s = \frac{G_p}{0.63}$

Where 0.63 is a design constant and subject to production tolerances of 0.6 to 0.7; R = Meg-ohms, C = MFD,  $G_p$  = seconds. Recommended minimum component values: R = 100k $\Omega$  C = 0.001 MFD.

### QUIESCENT PERIOD ( $Q_p$ )

The interval between the last tone of one Group Code and the first tone of the next should not be less than period  $Q_p$ ; this ensures that all receiver tone gates have cleared down when the new code transmission commences and avoids alias code switching.

To allow for  $G_p$  (Gate Period) component tolerances, particularly with multistation systems, the general basis  $Q_p \geq 1.5G_p$  is recommended.

The rules for  $Q_p$  may be modified for special applications, e.g. "all stations call" and "station sieze" arrangements, or where consecutive Group Codes employ completely different frequencies. Where the FX-207 (multi-code transmitter) is employed in an automatic scanning system, using the cyclic mode of operation, the  $Q_p$  or  $T_d$  period is determined by a single CR network ( $R_d$  &  $C_d$  of Fig 7). This controls the period of an internal monostable ( $T_x$  Delay); (see also notes on FX-207).

FORMULA:  $Q_p$  or  $T_d = 0.7 R_d C_d$  &  $R_d C_d = \frac{Q_p \text{ or } T_d}{0.7}$

Where 0.7 is a design constant and subject to production tolerances of 0.65 to 0.75; R = Meg-ohms, C = MFD,  $Q_p$  or  $T_d$  = seconds. Recommended minimum component values R = 100k $\Omega$ , C = 0.001 MFD.

## SPECIAL NOTE ON RECEIVERS

The tone recognition system employed by the FX-107/307 receivers is based on a period sampling technique. Input signals are amplified and shaped to provide clock signals to the bistable flip-flop, the output of which is a square wave having a period equal to the interval between successive input wave-form 'zero-crossings' (see Figs 6 & 10).

The flip-flop output triggers a dual monostable, which generates reference periods corresponding to  $\frac{1}{f'_a}$  and  $\frac{1}{f'_b}$ , where  $f'_a$  and  $f'_b$

represent the tone accept channel edges, i.e. Bandwidth. These periods are determined by  $R_A/R_B/R_C$ ,  $C_1$  &  $C_2$  and the D.C. reference levels applied to the monostables via  $R_{k1,2,3}$ . The reference periods are compared against the signal input period in a comparator, the output of which controls a special counter/storage system. This counting system discriminates against random spurious information and delivers an output only when a true inband tone signal is received. Gating circuits are incorporated which prevent false operation when harmonics of the tone frequency are applied. This tone recognition system yields extremely sharp tone channel definition, coupled with a fast response time and high immunity to false turn-on due to outband noise; regardless of the noise frequency and amplitude. The period sampling system requires, however, a 'regular' input waveform for correct operation. Input noise can, if mixed with the required inband tone, prevent the circuit from recognising that the tone is present. This effect is produced because the noise 'jitters' the interval between successive signal zero-crossings and the comparator/counter rejects the information as not being consistent with an input signal having a frequency actively within the tone channel limits.

If the noise is random in nature, e.g. spurious noise spikes, or short term interference, it will have little effect other than possibly to increase the overall tone recognition time by a few cycles. If the noise is *continuous*, e.g. parallel inband and outband tones are on the signal line simultaneously, the device will not recognise the inband tone. If the noise is semi-continuous, e.g. speech signals, increasing the inband tone duration will allow the tone to be recognised during a momentary 'noise' pause.

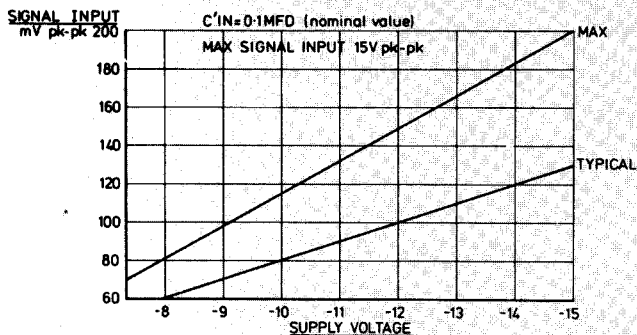
The device is therefore ideal for use when inband tones (Group Codes) are transmitted sequentially, but operation in parallel-tone signalling schemes is not recommended, unless adequate pre-filtering is used.

## SIGNAL INPUT NOTES

All the devices incorporate a signal input amplifier offering a high input impedance. The amplifier is designed using negative feedback principles and therefore the input is D.C. self-biased. Signals to the input pin should normally be A.C. coupled to avoid disturbing this bias point. High level pulse signals ( $\geq -6V$ ) may be directly coupled. The actual shape of the signal waveform is not important and may be sine, square or pulse in form.

Input impedance is typically 50k $\Omega$  at mid-range supply voltages. This value varies with supply voltage and production tolerances, and a total spread of 25k $\Omega$  to 200k $\Omega$  should be assumed. Fig. 2 shows the production spread of input sensitivity versus supply voltage.

FIG.2 SIGNAL SENSITIVITY versus SUPPLY VOLTAGE



**TX TONE & RX CHANNEL FREQUENCIES**

Fig. 3 illustrates 3 typical tone channels. Provided adjacent channels do not overlap, they may be spaced as required. A tone frequency ( $f_c$ ) falling between the channel edges ( $f'a-f'b$ ) is recognised as an 'inband' tone.

Tone/channel frequencies are determined by resistors RA/B/C and capacitors C1/C2. (See Fig. 4.)

Any *one* resistor, together with *both* capacitors, determines the frequency of the lower edge ( $f'b$ ) of a receiver channel or, in the case of FX-207, the frequency of one tone. Commutator switches select each resistor in a programmed sequence, thus forming the Group Code.

The commutators have a low 'on' resistance, typically  $300\Omega$ , and errors between frequency steps depend principally on the *ratio* tolerances between RA-RB-RC. If required, these can be minimised by including a common ballast resistor RZ; ratio errors are then reduced by a factor  $\frac{RZ}{RZ + RN}$ , where RN is the incremental resistance of the highest value path. All resistor calculations are based on *total* path resistance, including any value RZ.

Capacitors C1/C2 are switched alternately during Tx operation (parallel connected for Rx operation) and differences in value may unbalance the Tx output waveform. More important, unbalanced values may cause the FX-107 Tx-mode tones to deviate from the centre of the corresponding Rx-mode channels; this may cause difficulties in narrow channel transponder applications. Observe the recommended tolerances.

Note that two capacitors, connected to a common pin, are specified for receiver FX-307; this assists in system component standardisation (2X values are not preferred listing) and allows channel frequencies to be coded simply by standard resistor values, regardless of device type. RA/B/C and C1/C2 should all be high stability components, metal oxide resistors and polystyrene or good grade polycarbonate capacitors are suggested.

**TX TONES/RX CHANNELS** FIG.3

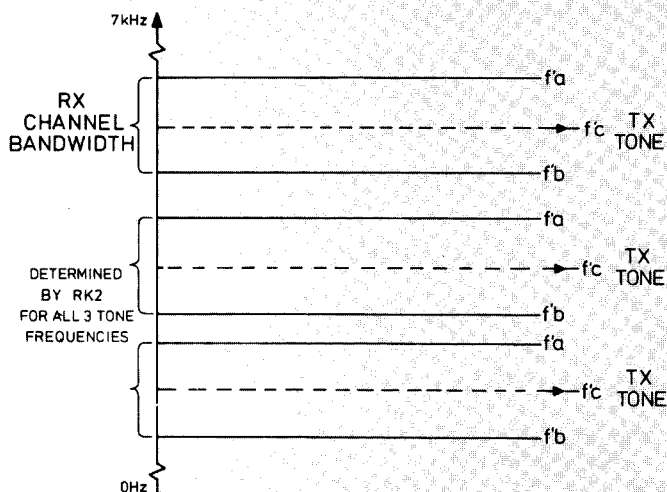
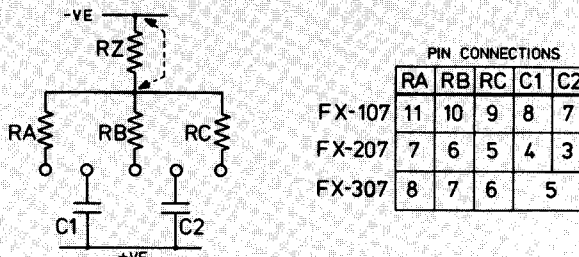


FIG.4 TONE/CHANNEL FREQUENCY COMPONENTS



PIN CONNECTIONS

	RA	RB	RC	C1	C2
FX-107	11	10	9	8	7
FX-207	7	6	5	4	3
FX-307	8	7	6	5	

FX-107/307 RECEIVER CHANNEL

$$f'b = \frac{1}{0.7 R (C1+C2)} \text{ Hz}$$

$$f'a = f'b \left[ 1 + \frac{BW}{100} \right] \text{ Hz}$$

i.e BW(%) above  $f'b$

FX-207 TX. TONE  $\rightarrow f_c = \frac{1}{0.7 R (C1+C2)} \text{ Hz}$

FX-107 TX. TONE  $\rightarrow f_c = f'b \left[ 1 + \frac{BW}{200} \right] \text{ Hz}$

i.e Mid-way between  $f'a$  &  $f'b$

**COMPONENT LIMITS (no maximum values specified)**

RA, RB, RC =  $100K\Omega$  min  
2% tolerance max

C1 & C2 =  $0.001\text{MFD}$  min  
5% tolerance max

**CHANNEL BANDWIDTH**

The bandwidth (BW) of a receiver tone channel is the difference in channel edge frequencies  $f'a$  and  $f'b$ , expressed as a percentage of  $f'b$ . BW is independent of operating frequency and is determined simply by the ratio of RK1 and RK2 in fig. 5. These resistors form a potential divider applying reference levels to the specified pins.

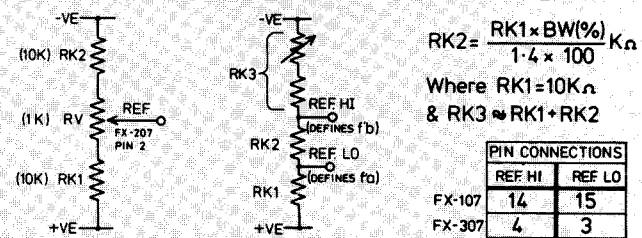
The *difference* in the two levels determines BW; the *absolute* level, as a fraction of the supply, controls a constant 'K' used in frequency calculations. When REF. H1. = 50% of supply,  $K = 0.7$  (as given in the formulae for fig. 4), subject to a production tolerance of  $\pm 5$  nominal.

RK3 may be used to adjust factor K and offset tolerances in components R, C1 & C2, thus calibrating one tone channel. Frequency accuracy of the remaining two channels is then subject basically to tolerances of the remaining channel resistors. With transmitter FX-207, no BW applies and only one reference level is used (see fig. 5), and adjustment of K is effected via RV.

Maximum adjustment limits for reference levels are 45% to 55% of supply voltage, yielding K values of 0.6 to 0.8. Resistors used for potential divider should be high stability types and the value of RV just sufficient to provide the required adjustment range. Convenient values for 107/307 would be  $RK3 = 8.2K\Omega$  fixed resistor plus  $4.7K\Omega$  RV.

Unless high channel density is mandatory, a BW value providing good margins for system tolerances should be adopted; these include temperature/supply variations, RA/B/C tolerances and to a less extent, BW component tolerances. Values of 5% to 8% are suggested for general use; these can yield high code numbers (up to 14 channels/octave) with good system operating tolerances.

**FX-207 TONE TRIM** **FX-107/307 BANDWIDTH COMPONENTS**



$$RK2 = \frac{RK1 \times BW(\%)}{1.4 \times 100} K\Omega$$

Where  $RK1 = 10K\Omega$   
&  $RK3 \approx RK1 + RK2$

PIN CONNECTIONS

	REF HI	REF LO
FX-107	14	15
FX-307	4	3

**RK2 versus BANDWIDTH (where  $RK1 = 10K, RK3 = 8.2K$  &  $RV = 4.7K$ )**

BANDWIDTH	4.5%	5.0%	6.0%	9.5%
RK2	$330\Omega$	$360\Omega$	$430\Omega$	$680\Omega$

FIG.5

## GENERAL INFORMATION FX-107

SIMPLIFIED BLOCK DIAGRAM FX-107 SHOWING EXTERNAL COMPONENTS REQUIRED FOR OPERATION

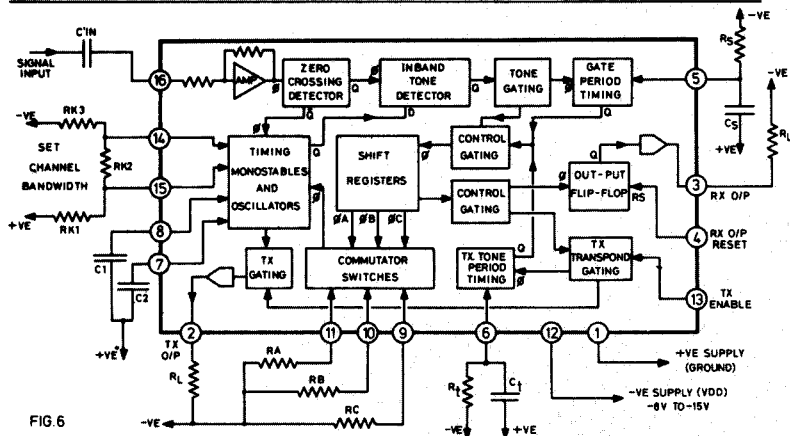


FIG. 6

The FX-107 functions as either a receiver (RX) or a transmitter (TX); simultaneous operation in both modes is not possible. The rules are:

- If the RX section has received the first tone in the Group Code, no TX action can take place until the decoding sequence is completed.
- If the TX section is in the process of transmitting a Group Code, the RX section is inhibited.

Otherwise, both functions are available on a 'first come, first seize' basis.

TX/RX code frequencies are determined by the values of resistors RA/RB/RC connected to pins 11, 10 and 9. A commutator selects these pins in the fixed sequence 11-10-9, the resistor value at pin 11 therefore determines the first frequency in the Group Code.

The RX section incorporates a signal amplifier, which permits operation from low level signals (A.C. coupled). (See signal input notes). The RX output switch has a *bistable* action and *changes state* once for each correct Group Code received. The switch may be turned ON by a

correct address; it then remains ON until turned OFF by repeating the address code. The switch may also be turned OFF by momentarily grounding the RX Reset input; a permanent ground will hold the output OFF regardless of input codes.

The TX section comprises a square wave tone generator driving a transistor switch coupled to the TX output pin, the TX code is determined by RA thro' RC in the same manner as the RX code.

TX tone frequencies lie approximately central within the corresponding RX-mode channels; this is a particular advantage in transponder application and also allows TX and RX frequency calibration to be simultaneously effected, using one common adjustment. Note that deviation from channel centre may occur if C1 & C2 are not closely tolerated (the % difference between C1 & C2 causes  $f_c$  to shift only by an equivalent % of BW total,) however some deviation may also become apparent at frequencies above 3kHz.

Transmission commences when the TX Enable input is changed from '1' to '0', one complete Group Code being sent for each 1-0 enable instruction. Transponder gating circuits in the 107 allow a choice of transpond functions. If the TX Enable input is at '1' when an address code is received no transpond occurs. If the enable input is permanently at ground a reply code is transmitted on receipt of every address code. By connecting the TX Enable input to the RX output, a reply code is transmitted only when an address code is received which turns the RX output from OFF to ON. (1-0).

With every transpond action there is a delay between receipt of an address and transmission of a reply; this delay is equal to  $G_p$  and commences from the moment of operation of the RX output switch. This delay is rather short for the recommended value  $Q_p = 1.5G_p$  and where a single common line is used for call and reply codes, it results in two successive Group Codes appearing on-line separated by a period less than  $1.5G_p$ . Dependent on the codes employed this could result in alias code switching at other stations; auto-transpond operations with FX-107 are therefore best performed using separate lines for system address and system reply codes.

If the FX-107 is used only in the Receiver mode or Transmitter mode all the associated components of the *unused mode must* be fitted.

## GENERAL INFORMATION FX-207

The FX-207 is a logic programmable multi-code transmitter which transmits any one of eight different Group Codes, all based on permuted sequences of the three programmed frequencies given by RA, RB and RC connected to pins 7, 6 and 5.

Code selection is carried out by applying logic levels to the X, Y, Z inputs, either singly or in 3-line binary coded form (see fig. 8).

Two transmission modes are provided; single shot (one Group Code per TX Enable instruction) or cyclic (repetitive transmission of the selected code/s). The required mode is obtained by appropriate inputs to the TX Enable and Enable Control pins, as shown in fig. 8.

Each Group Code transmission is preceded by a delay interval  $T_d$ , determined by an internal monostable according to the formula given in the notes on  $Q_p$ . This delay is adjustable over wide limits, ranging from microseconds to many seconds, and allows code transmissions to be time sequenced following a common instruction, e.g. transponding of data to follow and address acknowledge by an associated device as shown in fig. 13. It also provides the quiescent interval ( $Q_p$ ) between successive Group Code transmissions during cyclic mode operation, the delay period being automatically re-triggered on completion of each transmitted Group Code.

Code select data may be entered or changed at any time, but only the data levels present at the *instant the delay period expires* is transferred

SIMPLIFIED BLOCK DIAGRAM FX-207 SHOWING EXTERNAL COMPONENTS REQUIRED FOR OPERATION

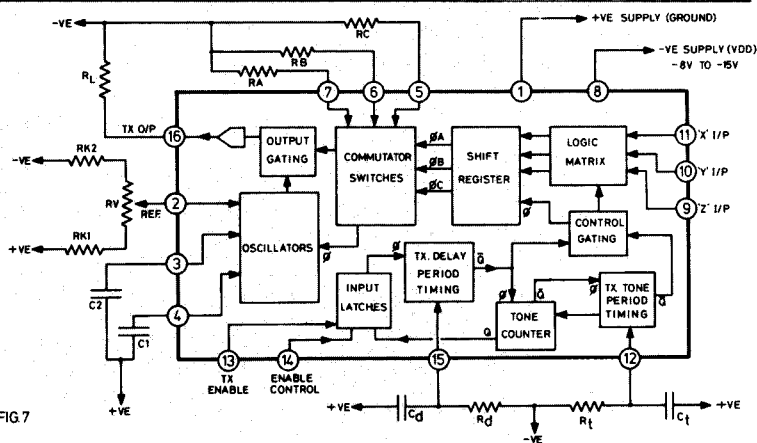


FIG. 7

to the internal store and the corresponding code transmitted. Once transmission commences it cannot be cancelled or the Group Code changed.

If no TX delay period is required note that components  $R_d$   $C_d$  must still be fitted, use of the minimum values specified will yield  $T_d = 70$  micro-seconds. Internal 300K $\Omega$  pull-up resistors are fitted to the X, Y, Z inputs giving logic '1' when the pin is open-circuit.

FIG. 8 FX-207 TRUTH TABLES

TX ENABLE	ENABLE CONTROL	TX OUTPUT
1 → 0	0	1 GROUP CODE
1	1	NO TX
1 → 0	1	CYCLIC
1	0	NO TX

ENCODING

INPUTS			OUTPUT		
X	Y	Z	CODE SEQUENCE		
0	0	0	A	B	A
0	0	1	C	B	A
0	1	0	C	A	B
0	1	1	B	C	A
1	0	0	B	C	B
1	0	1	A	C	B
1	1	0	B	A	C
1	1	1	A	B	C

FIG. 9 FX-307 TRUTH TABLES

CONTROL		MODE OF OPERATION
1	2	
1	1	UPDATE CONTINUOUSLY
0	0	RESET (X, Y, Z = 1, 1, 1)
0	1	LATCH AS DISPLAYED
1	0	LATCH TO NEXT CODE

DECODING

INPUT			OUTPUTS		
CODE SEQUENCE			X	Y	Z
A	B	A	0	0	0
C	B	A	0	0	1
C	A	B	0	1	0
B	C	A	0	1	1
B	C	B	1	0	0
A	C	B	1	0	1
B	A	C	1	1	0
A	B	C	1	1	1

GENERAL INFORMATION FX-307

The FX-307 is a multi-code Receiver programmed to decode any one from eight different input Group Codes, all based on sequential permutations of the three programmed frequencies. The three code frequencies are determined by resistors RA, RB and RC connected to pins 8, 7 & 6.

Receipt of a programmed code appears at the X, Y, Z logic outputs as a 3-line binary number, the decoding truth table is shown in fig. 9. Note that the encoding/decoding truth tables for 207 and 307 are identical.

Following receipt of a code the appropriate data is maintained at the X, Y, Z outputs until a different code is received, or until reset by a Reset logic input. No change takes place at X, Y, Z if the displayed code is repeated. For every programmed Group Code received, including repetitive codes and irrespective of the status of the Control Inputs, a pulse appears at the Code Received Output. This pulse is a '0' level maintained for approximately two cycles of the third code tone ( $t = \frac{2}{f}$ ), the trailing edge occurring

simultaneously with any updating of the X, Y, Z outputs. The pulse may be used for strobe or display clocking purposes, and as a monitor that programmed codes are being received, even where these do not cause updating of the X, Y, Z outputs.

The two Control Mode Inputs, pins 13 & 14, provide for a choice of operating modes, as shown in fig. 9. Instructions to these inputs are direct-acting, i.e. they are not conditional on the status of the internal tone decoding circuits. In "Updating Continuously" the X, Y, Z outputs reflect continually the value of the last Group Code received. "Latch to Next" causes the X, Y, Z outputs to latch when the next input code is received, even if this is a repeat of the code displayed. "Latch as Displayed" gives immediate latching of the existing X, Y, Z output state and "Reset" switches the

outputs to the state shown in fig. 9. A signal input amplifier is also incorporated in the circuit. (See signal input notes.)

The FX-307 is so designed that the Reset state should appear at the X, Y, Z outputs when power is first applied. If a guaranteed start-up reset state is required small capacitors should be fitted between the Control Mode inputs (1 & 2) and ground.

The tone decoding system used in the FX-307 (and in the FX-107 Rx/section) will also accept input codes where each tone step is separated by an interval between successive tones, provided the Gating Period (Gp) is calculated to include these intervals. This only applies where Group Codes are transmitted from sources other than the FX-207 or FX-107 TX/section.

SIMPLIFIED BLOCK DIAGRAM FX-307 SHOWING EXTERNAL COMPONENTS REQUIRED FOR OPERATION

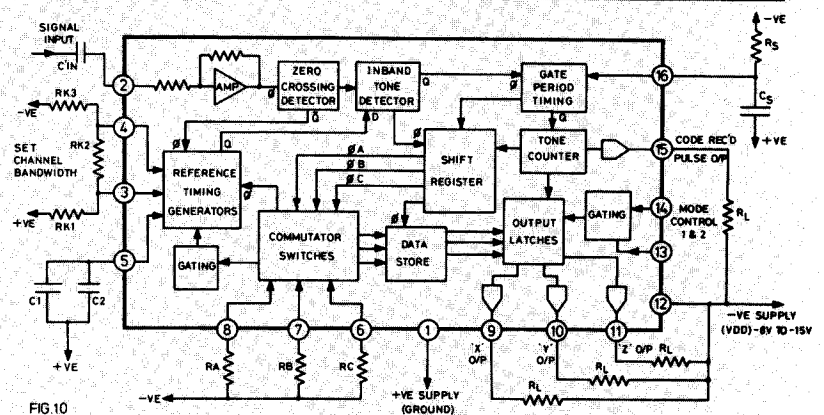


FIG. 10

SELECTIVE SUB-STATION CALLING, WITH CALL ACKNOWLEDGE

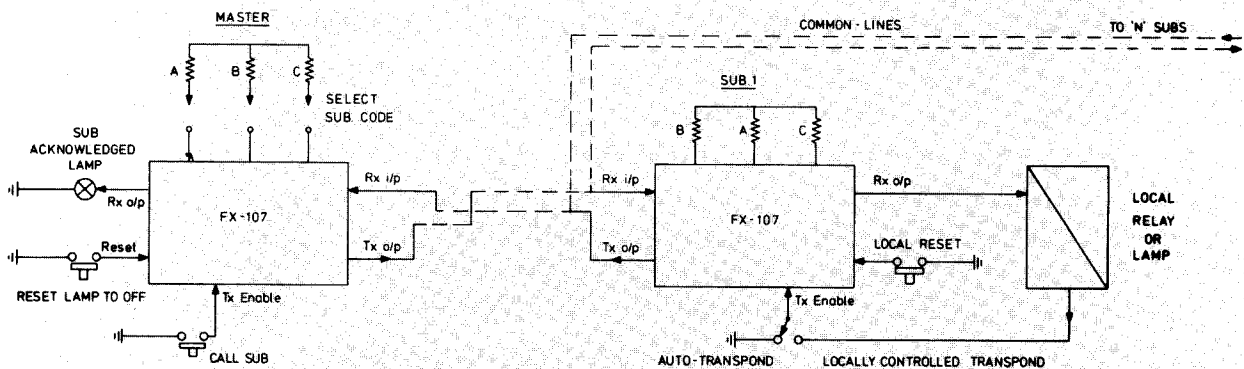


FIG. 11

Fig. 11 shows a simple master/sub-station calling system employing FX-107's. Sub-station address codes are selected by switching RA/B/C at the master; receipt of an address code operates a local sub-station switch function.

Sub-station 107's are connected for auto-transpond and re-transmit their address code each time it is received; this operates the acknowledge lamp at the master, which is ready-coded for the reply. The sub transpond action can be locally gated, if required, to verify that the local function has switched satisfactorily.

Master and sub may be reset to OFF locally or the master can

re-transmit the address, switching off the sub local circuit and (by separate action) the master acknowledge lamp.

Separate lines are used for call and reply, due to the short transpond delay of a 107 (transpond  $Q_p = G_p$ ). With a single line other sub-stations may respond to an alias code formed by an address followed by a transponded reply. If a transpond is locally delayed ( $Q_p = 1.5 G_p$ ) or the same first tone used for all stations, one common line may be used for address and reply codes.

Note: Signals are applied between the transmission lines and a common ground line.

## MULTI-CODE SIGNALLING BETWEEN TWO POINTS

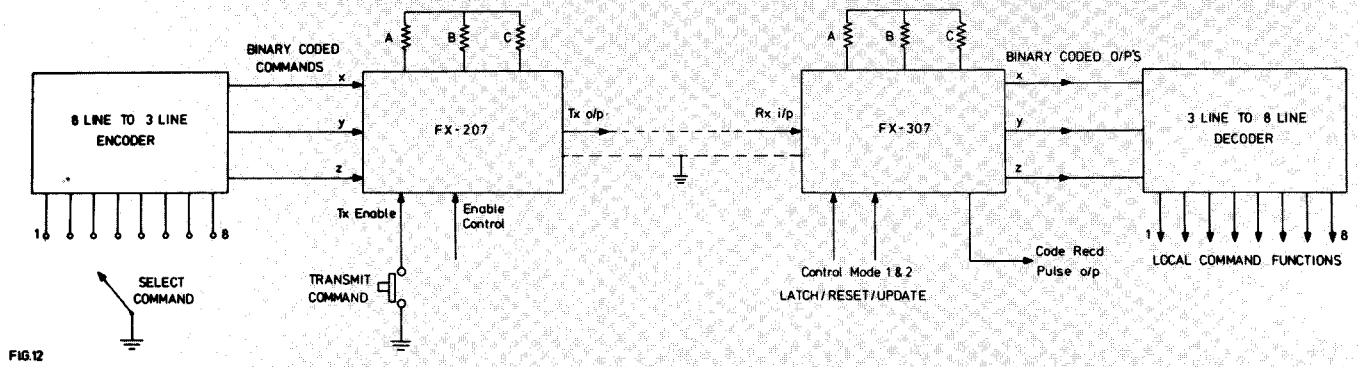


FIG.12

Fig. 12 shows how a FX-207 and a FX-307 can be used to transmit several coded instructions to a remote point, using one common line.

The required command code is entered at the X, Y, Z inputs of the 207, either directly or via the octal/binary encoder illustrated, and transmitted by grounding the TX Enable input.

If the Enable Control is at '0' level, one Group Code is sent for each TX Enable command. With TX Enable at '0' and Enable Control at '1' continuous code transmissions take place, representing the current data at the X, Y, Z inputs.

Group Codes received by the remote FX-307 appear as decoded logic levels at the X, Y, Z outputs and operate appropriate local functions through the binary/octal decoder. The Code Received Output pulse may be used for strobing purposes; latching and other functions may be selected using the Control Mode inputs. The 207 encoder can be a simple diode matrix; a suitable 307 output decoder is a SN 74145 with MOS/TTL interface buffers in the X, Y, Z lines.

## SELECTIVE CALLING WITH ACKNOWLEDGE + STATUS TRANSPONDING

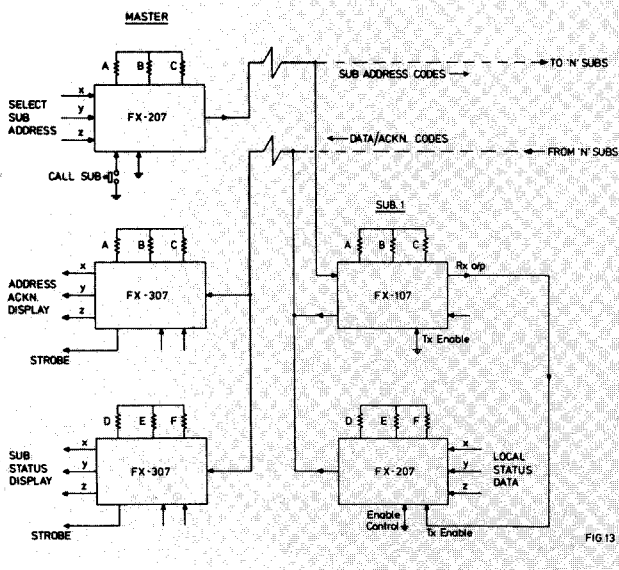


FIG.13

Sophisticated signalling functions are easily implemented using '07 series devices. Fig. 13 outlines a system where remote sub-stations are selectively addressed, receipt of an address verified and the sub-station status displayed.

Sub-station 107's act as address decoders and transmit an acknowledgement when called. The 107 simultaneously instructs the substation 207 to transmit the current status (alarm conditions, data etc), the 207 TX Delay period allowing sufficient time for the acknowledge code to be cleared before data is sent.

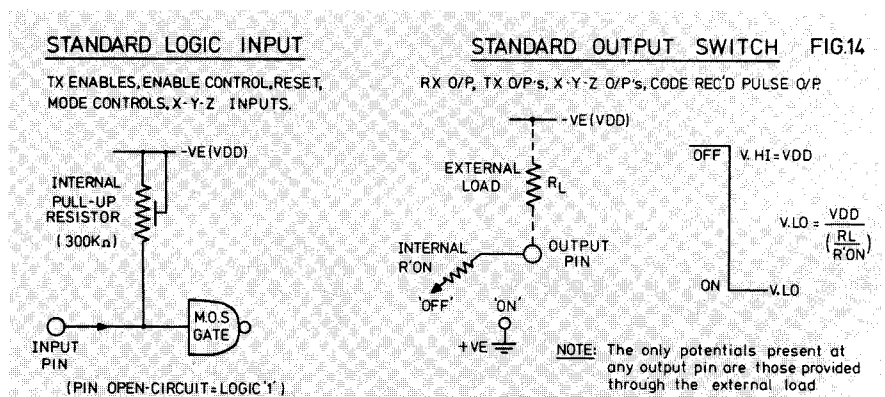
ABC channels are used for address codes and DEF channels for data, this allows up to 8 substations to be called and the status of each verified (any 1 of 8 values). The number of outstations and status data codes can be expanded as required. Automatic station scanning can also be obtained by arranging for the Address Acknowledge display to encode the 207 Address transmitter (next address forward); the 207 may then transmit repetitively (cyclic mode) or in response to a clock from the 307 Code Received strobe output.

Fig. 14 shows the equivalent circuit for an uncommitted MOS output switch employed on all the '07 series. Interfacing to TTL may be achieved by a suitable choice of RL to provide to the correct TTL input levels for the supplies used. Logic inversion may be obtained by using a buffer transistor (NPN) between the MOS output and the TTL input.

i.e. With RL only, output ON = TTL logic '0'  
With transistor buffer output ON = TTL logic '1'.

Each control input (TX Enable, Enable Control, Rx Reset, Control Mode 1 & 2, X, Y, Z data inputs) has a 300KΩ internal pull-up resistor which gives input = '1' when pin O/C.

## INTERFACE NOTES

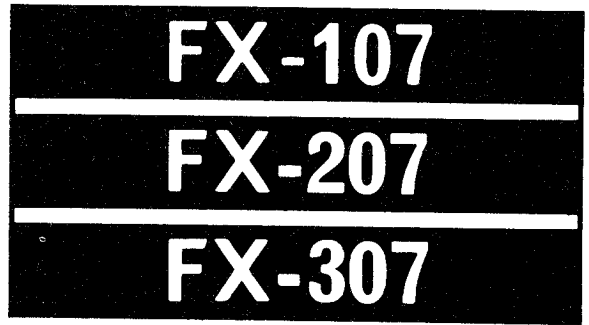


# SPECIFICATION

## MAXIMUM RATINGS'

Applicable to all devices unless stated

Max. Voltage between any pin and +ve supply pin	-20v & +0.3v
Max. Output Switch Load Current	-5mA
Max. device dissipation @ 20°C T'amb	400mw
Operating temperature range	-30°C to +85°C
Storage temperature range	-55°C to +125°C



## CHARACTERISTICS

(Supply voltage - 12v ± 2v, T'amb = 20°C, operating frequencies 200 HZ to 3KHZ unless specified)

Symb.	Parameter	Conditions & Notes	Min	Typ.	Max	Units
VDD	SUPPLY VOLTAGE	Operating limits	-8	-12	-15	V
IDD	SUPPLY CURRENT	Total, excluding output load current	FX107/307		6	mA
			FX-207		3	
	OPERATING FREQUENCIES	Recommended operating limits, Tx Tone/Rx Channel frequencies	0.1		7	KHZ
BW	CHANNEL BANDWIDTH	Recommended limits	FX-107/307		2	10 %
Δf	FREQUENCY STABILITY	Tx/Rx Frequency stability vs Supply Volts & T'amb. Ext. component co-efficient excluded.	SUPPLY	0.04		%/%
			T'AMB	0.01		%/°C
Vin	SIGNAL AMPLITUDE RANGE	Sine or pulse input signals, A.C. coupled. Input impedance typically 50 KΩ.	FX-107/307		0.1	15 V pk-pk
R'on	OUTPUT 'ON' RESISTANCE	Tx,Rx,X,Y,Z & Code Rec'd Outputs. Internal resistance between O/P pin & ground with switch 'ON' ('OFF' resistance > 10MΩ)		0.3	1	KΩ
'1'	LOGIC HIGH	Logic levels to all control inputs (Internal 300KΩ pull-up resistors give logic '1' when pin O/C)	'1'	-6	-15	V
'0'	LOGIC LOW		'0'	0	-1.5	V

## SUPPLY NOTES

Reference to ground, logic '0' and logic '1' in this data sheet are based on the use of a grounded positive supply, i.e. HT (VDD) is negative. A logic '1' level is therefore near VDD (-ve) and a logic '0' level near ground (+ve). There is however, no objection to operation with the -ve supply grounded, but reference to logic polarities remain unchanged; i.e. a logic '1' is *always* -ve with respect to a logic '0'.

**Example** a) VDD = -12V; +ve = GROUND logic '1' = -12V & logic '0' = 0V  
 b) VDD = 0V; ; +ve = +12V logic '1' = 0V & logic '0' = +12V

It is also important to ensure that no pin receives a potential which is positive with respect to the +ve supply pin. Failure to observe this rule may result in damage to the device.

**NOTE:** Where VDD is below -10V, devices may latch-up if VDD is applied at a slowly increasing rate. To avoid this condition, supplies should rise from zero to VDD in 10mS max.

**COMPONENT EXAMPLES  
& CORRESPONDING TIME PERIODS  
FOR 6 TONE FREQUENCIES**

R	C1 & C2	Hz
270K <sub>Ω</sub>	3300pf each	801
220K <sub>Ω</sub>	"	983
180K <sub>Ω</sub>	"	1202
150K <sub>Ω</sub>	"	1443
120K <sub>Ω</sub>	"	1803
100K <sub>Ω</sub>	"	2164

MINIMUM PERIODS BASED  
ON USE OF 801Hz

R <sub>t</sub>	C <sub>t</sub>	T <sub>p</sub>
270K <sub>Ω</sub>	0.1MFD	17mS

R <sub>s</sub>	C <sub>s</sub>	G <sub>p</sub>
560K <sub>Ω</sub>	0.1MFD	35mS

FX-107 PIN DATA		FX-207 PIN DATA		FX-307 PIN DATA		PACKAGE DETAIL	
1. +V SUPPLY	9. RC	1. +VE SUPPLY	9. DATA Z	1. +V SUPPLY	9. O/P X		
2. TX O/P	10. RB	2. REF.	10. DATA Y	2. SIGNAL I/P	10. O/P Y		
3. RX O/P	11. RA	3. C2	11. DATA X	3. REF LO	11. O/P Z		
4. RX O/P RESET	12. -VE SUPPLY	4. C1	12. TX TONE PERIOD	4. REF HI	12. -VE SUPPLY		
5. RX GATE PERIOD	13. TX ENABLE	5. RC	13. TX ENABLE	5. C1 & C2	13. MODE CONTROL 1		
6. TX TONE PERIOD	14. REF HI	6. RB	14. ENABLE CONTROL	6. RC	14. MODE CONTROL 2		
7. C2	15. REF LO	7. RA	15. TX DELAY	7. RB	15. CODE RECD PULSE WP		
8. C1	16. SIGNAL I/P	8. -VE SUPPLY	16. TX O/P	8. RA	16. RX GATE PERIOD		

## P.C.B's C-07, C-072, C-073

Three printed circuit cards, types C-07, C-072, C-073 are available to assist in laboratory assessment and system development work using devices from the '07 family. The cards are purposely made larger than necessary to facilitate easy assembly of various sized components, but apart from this they are also suitable for short-run production use.

Manufactured from 1/16" S.R.B.P. with tinned copper conductors, they measure 4" (103mm) x 3" (76mm) and all component positions are clearly printed on one side. Card connections are shown by printed letter code. The cards are supplied complete with a set of press-in terminal posts for mounting those components most likely to be changed during experiments, thus minimising possible damage to the metal tracks. Components are not supplied. Connection to the cards may be made by direct wiring or by edge connectors, using a 12 way 0.15" pitch P.C.B. Socket. Normally the FX device is soldered directly into position, but a 16 way D.I.L. socket may be used if required. Care must be taken to ensure that supply polarities are correct, as a reverse voltage can damage the devices. References to logic level polarities in this data sheet are based on use of a grounded positive supply, but there is no specific objection to operation with a grounded negative supply.

### CIRCUIT NOTES

Card C-07 has provision for a NPN transistor which may be used as a buffer for the Rx or Tx output as required. Connect C to M or a higher -ve supply with the external load between B and H. Cards C-07 and C-073 have provision for A.C. signal coupling via C'in. Input protection diodes D1 and D2 may be fitted where line over-voltages or transients are expected at the signal input; R'in should then be 10K $\Omega$  ohms to limit input current, for normal use R'in should be a wire link. Load resistors (RL) must be fitted to obtain voltage swings at the Tx O/P. Where several Tx O/P's are connected to a common line, only one RL is necessary as a common lead. If RZ ballast is not required, a shorting link must be fitted. The connection sequence of RA/B/C on P.C.B. C-07 may be externally switched by mounting RA/B/C in the alternative adjacent positions and using the numbered connecting holes.

### COMPONENT NOTES.

D1 and D2	: (Optional) 1N914 or similar	Tr	: To-5 silicon NPN, rating to suit load
Rv	: Plessey type WRM or equivalent	C'in	: 0.1 MFD

## CALIBRATING TONE/CHANNEL FREQUENCIES

To calibrate the FX-107, switch on supplies and allow a few seconds for the circuit to stabilise. Check that a tone burst appears at the Tx O/P when Tx Enable instructed. Temporarily connect a shorting link across Ct. Connect frequency measuring equipment to the Tx O/P and momentarily ground the Tx Enable input. Adjust RV until the correct Tx frequency (f'c) for tone A is obtained (tone is transmitted continuously). Set centrally between f'a & f'b of corresponding Rx channel. Remove shorting link and temporarily connect a large value capacitor (10MFD) across Ct. Momentarily ground Tx Enable again and the device will step through the three code frequencies at a slow step-rate, all three f'c's may be read off. No further adjustment is necessary.

A source of accurate Group Code frequencies is required to calibrate a FX-307; the simplest method is to use a FX-207 arranged to transmit a repetitive code using the correct frequencies. Connect an oscilloscope to the FX-307 Pulse received output, which must have a load resistor fitted. Control Mode inputs 1 & 2 should both be at '1' level (open circuit). Apply code signals from the 207 to the 307 signal input and adjust RV on C-073 until output pulses are displayed on oscilloscope (one pulse shown for each Group Code transmitted) set RV to mid-position of adjustment range over which pulses appear. No further adjustment is necessary.

CML does not assume any responsibility for the use of any circuitry described. No circuit patent licences are implied and CML reserves the right at any time without notice to change the said circuitry.

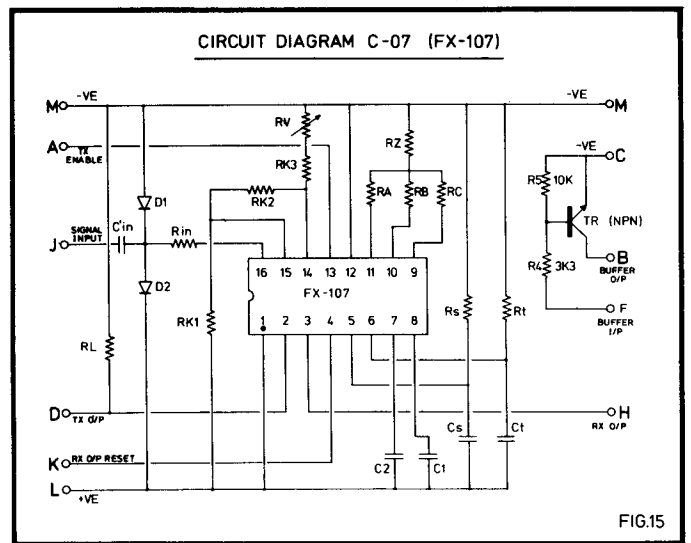


FIG.15

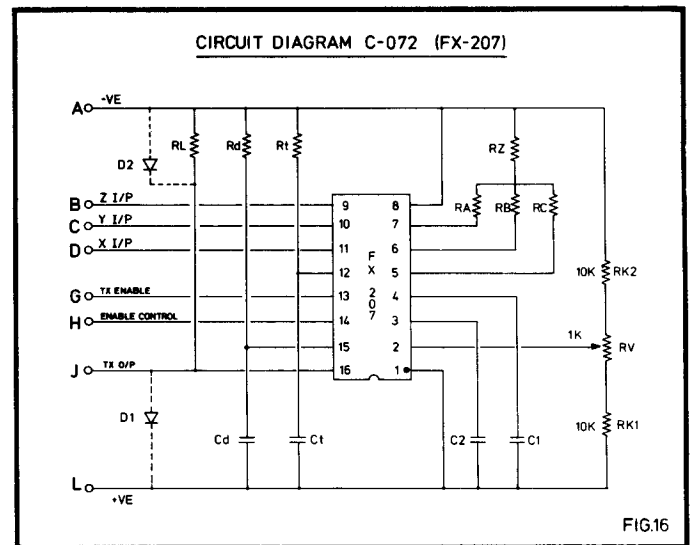


FIG.16

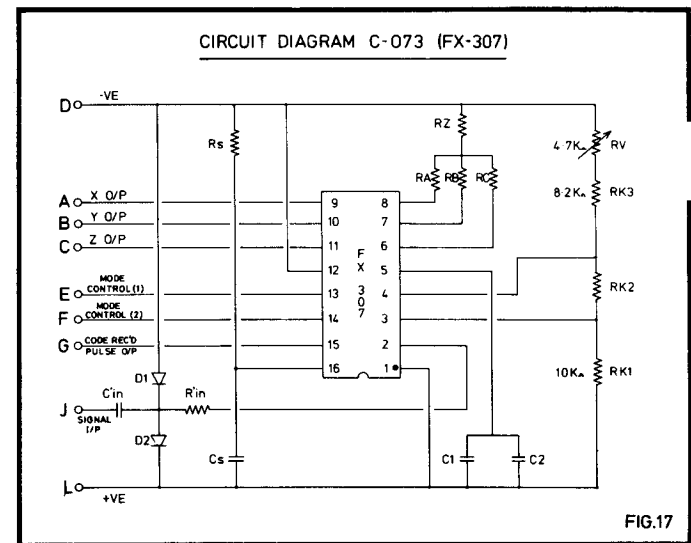


FIG.17