GENERAL INSTRUMENT

AY-3-8470

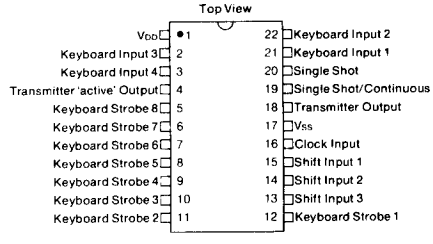
256 Command Infrared Remote Control Transmitter

FEATURES

- 256 Commands (possibly 32 commands by 3 bit address)
- Low Standby current (<20μA)
- Low duty cycle (< 8%)
- 6/9 Volt battery operation
- Simple RC defined on chip Oscillator
- 22 pin DIL package
- Single shot or continuous operation
- Transmission format ensuring error free reception

PIN CONFIGURATION

22 PIN DUAL IN LINE



DESCRIPTION

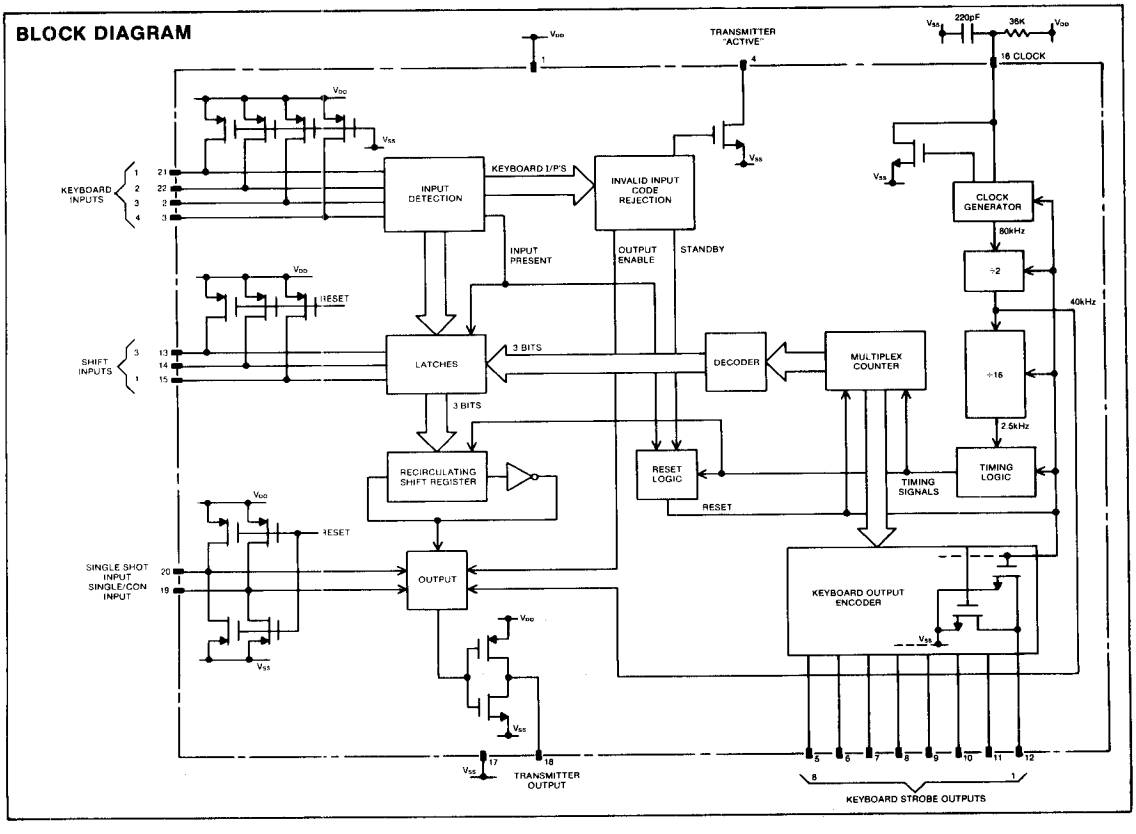
The AY-3-8470 transmitter together with AY-3-8475 receiver, an infrared link and an amplifier, forms a complete remote control system. Control of standard functions of radios and televisions is possible together with TV games, Teletext and Viewdata applications.

Complementary MOS technology for this device allows low voltage battery operation with a very low standby current.

256 output commands are possible which can be simply activated by a standard 8 x 4 keypad together with 3 shift inputs.

A non critical, simple RC oscillator is used to fix the transmitter frequency.

BLOCK DIAGRAM



ELECTRICAL CHARACTERISTICS

Maximum Ratings*

Voltage on any Pin with Respect to V_{SS} ..... −0.3 to +12V
Ambient Operating Temperature ..... 0° C to 70° C
Storage Temperature ..... −65° C to +150° C

*Exceeding these ratings could cause permanent damage to the device. This is a stress rating only and functional operation of this device at these conditions is not implied—operating ranges are specified in Standard Conditions. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

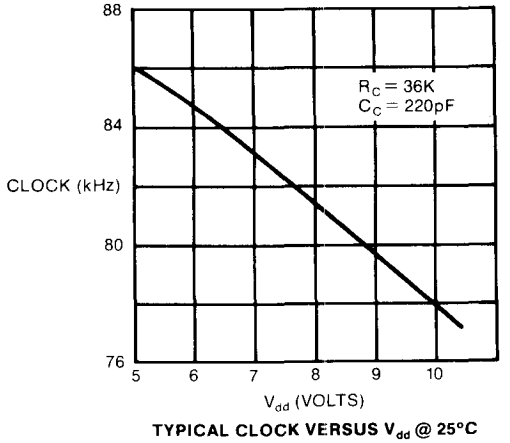
Standard Conditions (unless otherwise stated)

V_{SS} = 0 Volts
V_{DD} = +5.5 to +10 Volts
Temperature = 0° C to 70° C

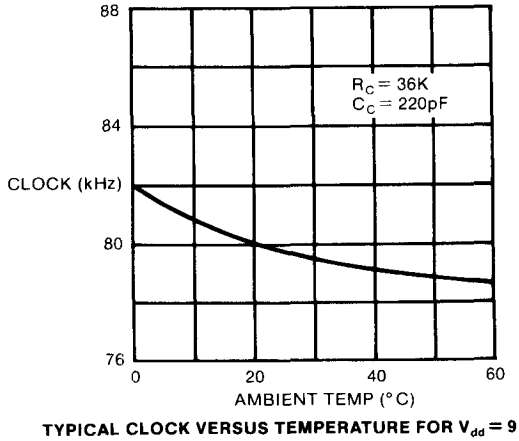
Data labeled "typical" is presented for design guidance only and is not guaranteed.

Characteristic	Sym	Min	Typ	Max	Units	Conditions
Clock Frequency (16)	F_C	60	80	100	kHz	V_{DD} = 5.5 to 10.0 V, T = 25° C C_C and R_C at typical values and C_C R_C tolerance ±5%
Resistor to V_{DD}	R_C	12	39	100	KΩ	
Capacitor to V_{SS}	C_C	—	220	—	pF	
Leakage to V_{SS}	—	—	—	2	μA	Clock "OFF" in 'standby' and V_{out} = V_{DD} = 10.0 Volts
Shift (13, 14, 15), Keyboard (2, 3, 21, 22) and Single Shot (19, 20) Input Thresholds						
Low Level	V_{IL}	V_{SS}	—	1.5	V	V_{DD} = 5.5 Volts
	V_{IL}	V_{SS}	—	2.5	V	V_{DD} = 10.0 Volts
High Level	V_{IH}	V_{DD}-1.5	—	V_{DD}	V	V_{DD} = 5.5 Volts
	V_{IH}	V_{DD}-2.5	—	V_{DD}	V	V_{DD} = 10.0 Volts
Pull Up to V_{DD}						
Low Level Source	I_{IL}	—	—	50	μA	V_{IN} = 1.5 Volts, V_{DD} = 5.5 Volts
	I_{IL}	—	—	200	μA	V_{IN} = 2.5 Volts, V_{DD} = 10.0 Volts
High Level	—	V_{DD}-1.5	—	—	V	I_{IH} = 2μA source
Transmitter Output (18)						
Low Level	V_{OL}	—	—	0.5	V	I_{OL} = 75μA sink
High Level	V_{OH}	V_{DD}-0.5	—	—	V	I_{OH} = 1.0mA source
Keyboard Strobe Outputs (5-12)						
Low Level	V_{OL}	—	—	0.5	V	I_{OL} = 150μA sink, V_{DD} = 5.5 Volts
	V_{OL}	—	—	1.5	V	I_{OL} = 600μA sink, V_{DD} = 10.00 Volts
Off Leakage to V_{SS}	—	—	—	2.0	μA	V_{OUT} = V_{DD} = 10.0 Volts
Transmitter 'Active' Output (4)						
Low Level	V_{OL}	—	—	1.5	V	I_{OL} = 1.5mA sink
Off Leakage to V_{SS}	—	—	—	2	μA	V_{OUT} = V_{DD} = 10.0 Volts
Single Shot (20), Single Shot/Continuous (19) Inputs						
Standby Pull Down to V_{SS}	V_{OL}	—	—	0.5	V	I_{OL} = 10μA sink
Supply Current V_{DD} (1)	I_{DD}	—	1	3	mA	V_{DD} = 10.0 Volts
Standby Current V_{DD} (1)	I_{DD}	—	5	20	μA	V_{DD} = 9.0 Volts, T = 25° C

NOTES: 1. Pull Ups are configured with Enhancement FET's.
2. Current from the device is defined as 'source' current, current into the device is 'sink' current.



TYPICAL CLOCK VERSUS V_{dd} @ 25°C



TYPICAL CLOCK VERSUS TEMPERATURE FOR V_{dd} = 9 VOLTS

PIN FUNCTIONS

Pin No.	Name	Function
1	V_{DD}	Positive Supply 5.5 to 10.0 Volts.
2	Keyboard Input 3	Together with Pins 21, 22, these are the 4 keyboard inputs which under normal operations may only go active low one at a time.
3	Keyboard Input 4	
4	Transmitter 'active' output	Output goes low during a cycle in which a transmission is output.
5	Keyboard O/P 8	The 8 Keyboard Outputs are active low which strobe the Keyboard every transmission cycle (i.e. every 102.4ms for 80kHz clock). (See Fig. 1.) The outputs are open drain.
6	Keyboard O/P 7	
7	Keyboard O/P 6	
8	Keyboard O/P 5	
9	Keyboard O/P 4	
10	Keyboard O/P 3	
11	Keyboard O/P 2	
12	Keyboard O/P 1	
13	Shift 3	The Shift inputs correspond directly to the 3ms Bits of the output word. These inputs are active low.
14	Shift 2	
15	Shift 1	
16	Clock Input	Connect a resistor to V_{DD} and a capacitor to V_{SS} to determine the clock frequency.
17	V_{SS}	Connect to 0 Volts.
18	Transmitter Output	This output is in the form of a high going pulse stream at half clock rate modulated by the output code. (See Fig. 1).
19	Single/Continuous Select	With this input low, Pin 19 high, and Shift 3 low, single shot is selected.
20	Single Shot I/P	Connection low puts chip into single shot mode for all commands.
21	Keyboard Input 1	
22	Keyboard Input 2	

OPERATION

Standby

Standby mode is entered when power is applied to the chip. In this mode the 'clock' is inhibited, 'pull ups' are inactive (except Keyboard inputs), and all the Keyboard outputs are low (active).

Any key depression will now be immediately recognized, the chip will come out of standby and the 'all Keyboard outputs active' condition will be removed.

Keyboard outputs now strobe the keyboard and detect which key is depressed. At the end of a complete keyboard scan the relevant output is transmitted. Keyboard scans continue and the relevant outputs transmitted, until a full keyboard scan occurs detecting no key depression, the chip then reverts to standby.

Invalid Inputs

Invalid inputs occur due to multiple key depressions, they are:

(a) More than one Keyboard input active during a single keyboard output strobe time.

(b) More than one keyboard input active during different keyboard output strobe times within a 'full' keyboard scan.

The above inputs are rejected as invalid and no output code is transmitted although the chip remains active scanning the keyboard until it:

(a) receives a valid input which can be transmitted or

(b) it detects no keys pressed and reverts to standby.

Output Code

Figure 1 shows a typical output code sequence and the relevant strobe timings.

The output code takes the form of an 8 bit word followed by its inverse so ensuring a 'secure' infrared link. The infrared receiver being able to distinguish this 'data' from spurious inputs.

An example of the data is shown below. Note the L.S. Bit is transmitted first.

e.g. 0 0 1 1 0 1 0 0 (LSB) — INVERSE

1 1 0 0 1 0 1 1 (LSB) — TRUE

Each '0' bit is comprised of 32 pulses and each '1' bit 48 pulses. The complete command consists of 16 bursts of 32 or 48 pulses. The pulses have a nominal period of 25μs (i.e. 40kHz repetition rate). A burst takes 1.6ms and 16 bursts 25.6ms. During the 76.8ms the transmitter is inactive.

Output Code Derivation —'the 8 bit word'

Figure 2 identifies the binary output codes associated with the 'basic' keyboard matrix.

Binary codes can be expanded up to 255 by means of the shift inputs. The table Figure 3 shows the states of these inputs for relevant output codes.

Single Shot Operation

In this mode the code is transmitted only once after a key 'ON' is detected. The key must now be released, the chip enters standby mode and is then ready for a further key depression. Commands can be entered up to a rate of 5 per second.

An application for this mode of operation would be for transmitting page numbers for the General Instrument Teleview System.

The following table Fig. 4 shows the Single Shot modes of operation.

Keyboard Implementations

Figure 5 shows how diodes can be employed to expand the basic 8 x 4 matrix to 128 keys. The further Shift input expands the matrix to 256 commands.

Figure 6 shows how a simple 8 way switch can be used to enable 256 commands from the basic 8 x 4 matrix.

Transmitter

The circuit of Figure 6, employs 3 transmitting diodes pulsed at approximately 300mA, giving a range of up to 20 meters. Average battery current for transmission is around 20mA with a standby current of only 20μA.

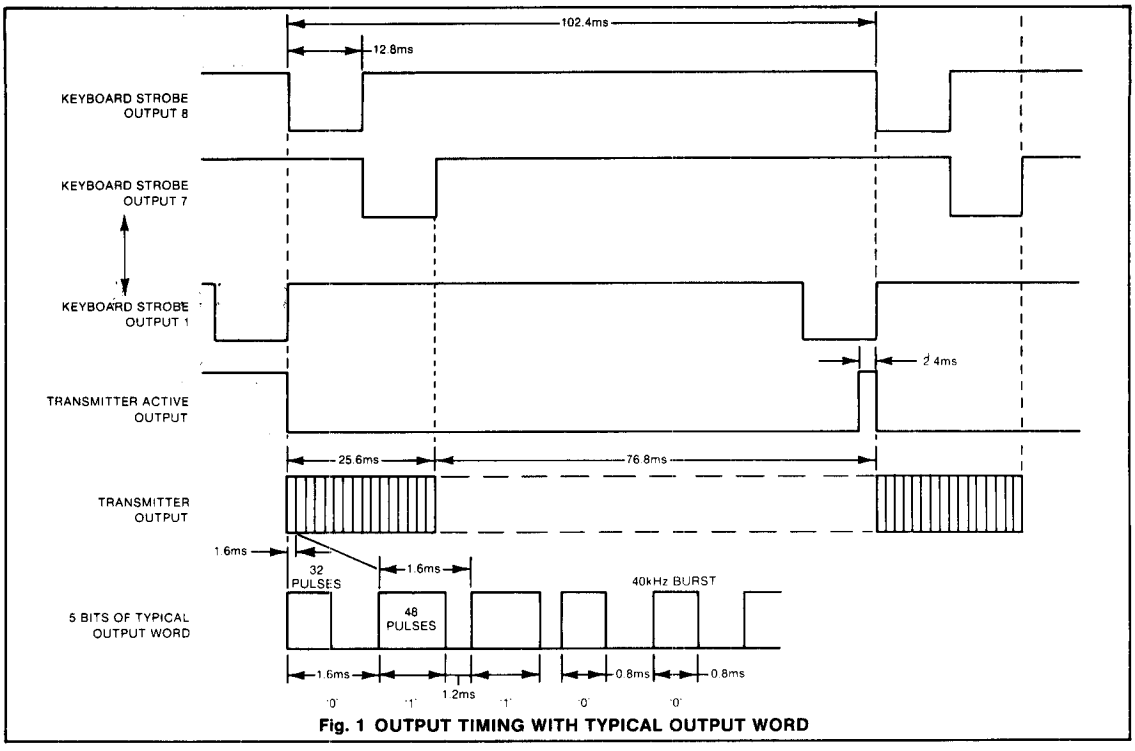
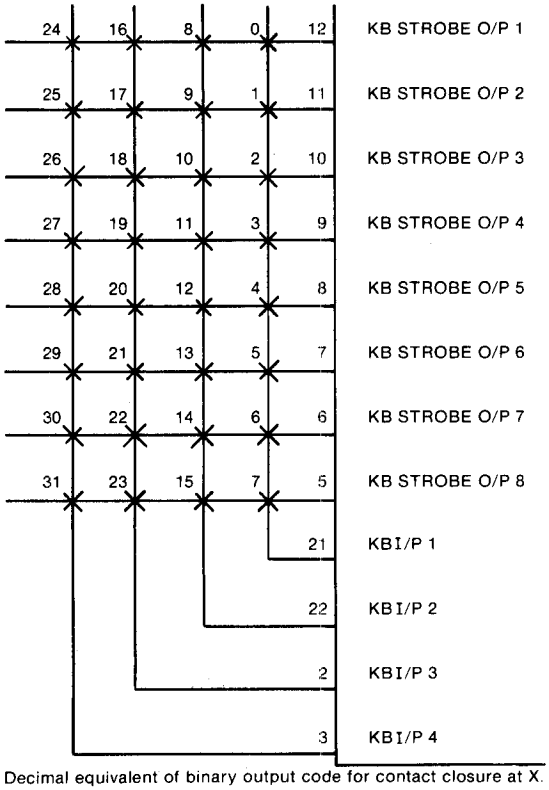


Fig. 1 OUTPUT TIMING WITH TYPICAL OUTPUT WORD



Decimal equivalent of binary output code for contact closure at X.

Fig. 2 MATRIX FORMAT

Shift Input 3 (13)	Shift Input 2 (14)	Shift Input 1 (15)	Output Codes
H	H	H	0 to 31
H	H	L	32 to 63
H	L	H	64 to 95
H	L	L	96 to 127
L	H	H	128 to 159
L	H	L	160 to 191
L	L	H	192 to 223
L	L	L	224 to 255

H signifies High Level
L signifies Low Level

Fig. 3 SIGNIFICANCE OF SHIFT INPUTS

Single Shot Input (20)	Single Shot/ Continuous (19)	Mode
H	H	Continuous on all Codes.
L	'Don't care'	Single Shot on all Codes.
H	L	Codes 0 to 127 continuous. Codes 128 to 255 Single shot.

NOTE: During Standby Single Shot Input (20) and Single Shot/ Continuous Input (19) are pulled low internally.

Fig. 4 SINGLE SHOT MODES OF OPERATION

Code Allocations

Transmitted Code*	Receiver Functions (Using the AY-3-8475)
0	Program 1
1	Program 2
2	Program 3
3	Program 4
4	Program 5
5	Program 6
6	Program 7
7	Program 8
8	Program 9
9	Program 10
10	Program 11
11	Program 12
12	Program 13
13	Program 14
14	Program 15
15	Program 16
16	Volume Increase
17	Volume Decrease
18	Color Increase
19	Color Decrease
20	Brightness Increase
21	Brightness Decrease
22	Spare Increase
23	Spare Decrease
24	Normalize
25	Mute
26	ON/OFF to OFF
27	Spare 1 On
28	Spare 1 Off
29	Spare 1 Toggle
30	Spare 2 On
31	Spare 2 Off
32-47	Program 17-32
48-255	Spare

*Decimal equivalent of 8 bit binary word listed for convenience.

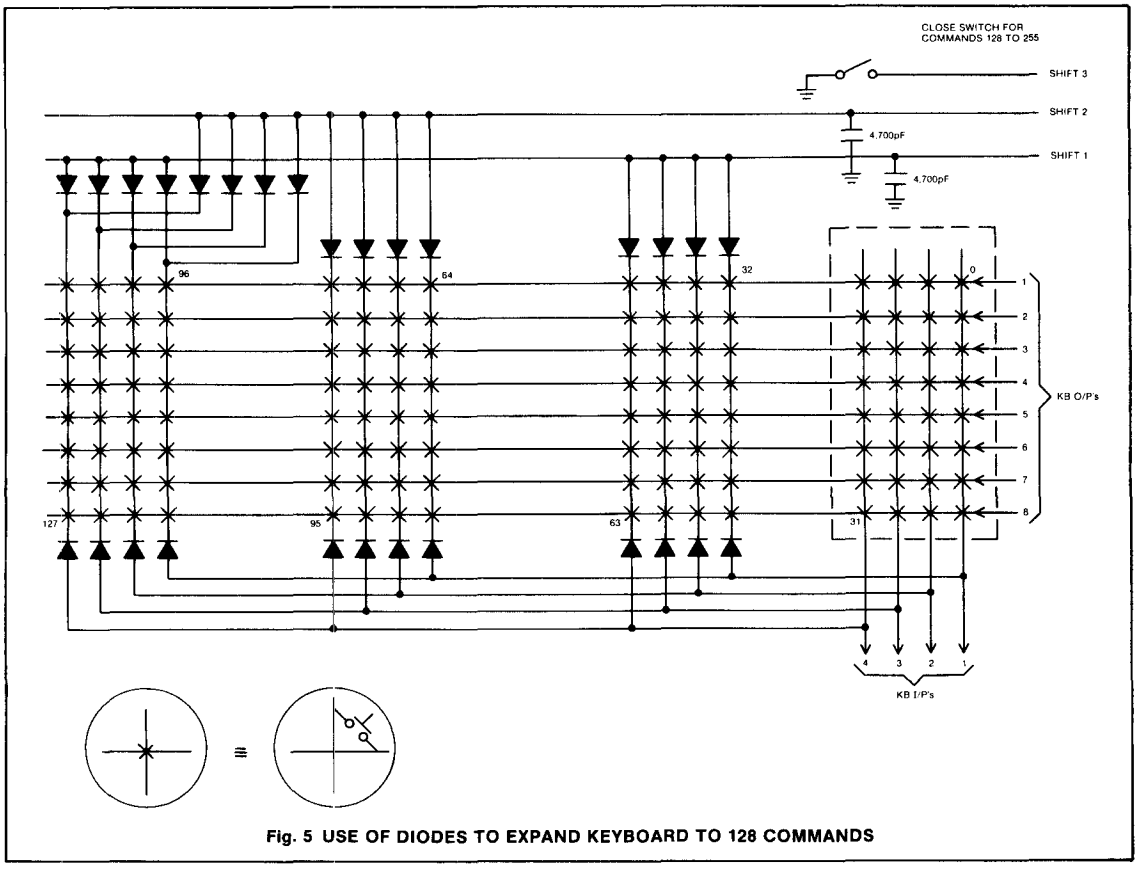


Fig. 5 USE OF DIODES TO EXPAND KEYBOARD TO 128 COMMANDS

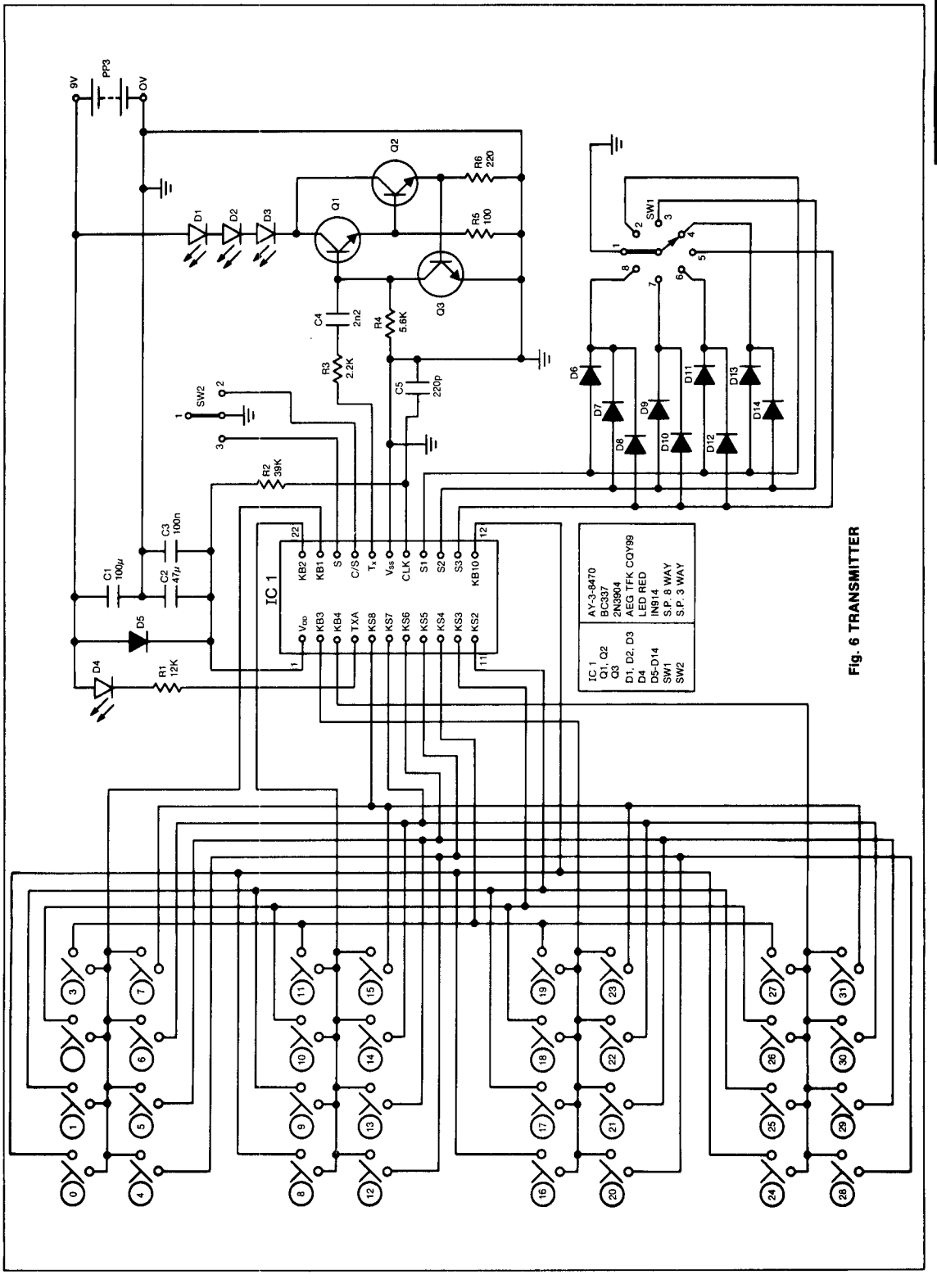


Fig. 6 TRANSMITTER