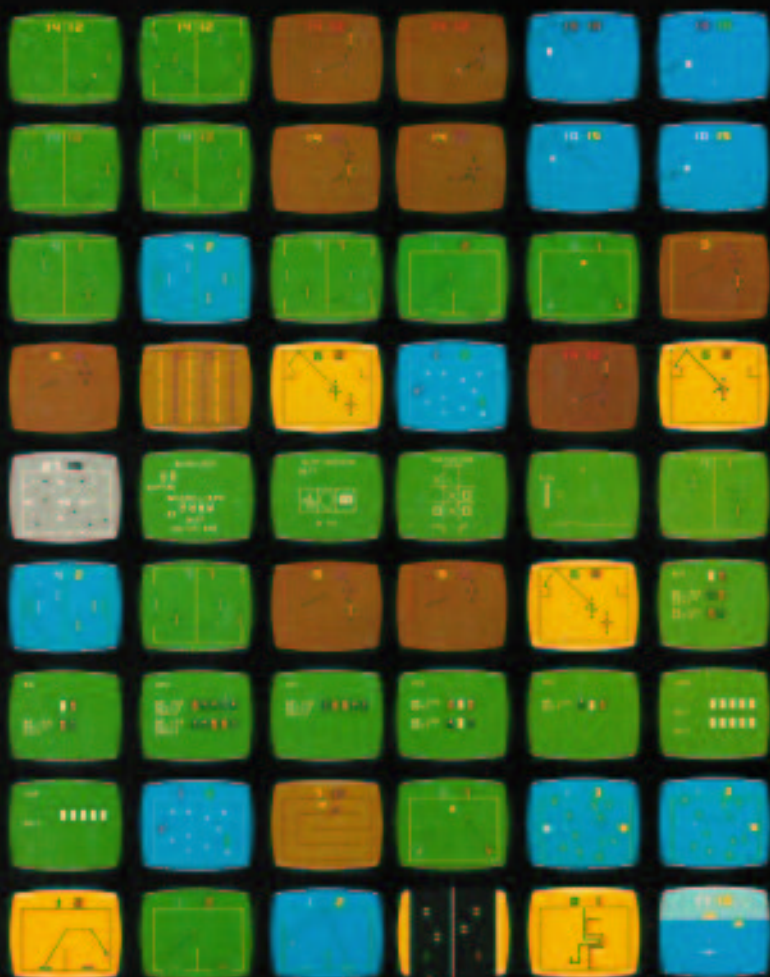


GIMINI

TV GAME CIRCUITS



MICRO
ELECTRONICS

GENERAL INSTRUMENT CORPORATION • MICROELECTRONICS

GIMINI

PART I DEDICATED TV GAMES 3

PART II PROGRAMMABLE TV GAMES 49

PART III APPLICATION NOTES 69

PART I

DEDICATED TV GAMES

FUNCTION	DESCRIPTION	PART NUMBER	PAGE NUMBER
SUPERSTAR	Ten selectable games for one or two players, with horizontal and vertical paddle motion.	AY-3-8610	26
		AY-3-8610-1	26
SUPERSTAR COLOR CONVERTER	Converts the black & white video outputs of the AY-3-8610-1 to a single color composite video signal.	AY-3-8615	37
BATTLE	A two player "tank battle" game where each player has a completely steerable tank with forward and reverse speed control and a firing button.	AY-3-8710	38
		AY-3-8710-1	38
CYCLE	A one player game where the player controls the speed of a motorcycle and rider through variations of a three track course.	AY-3-8760	42
BALL & PADDLE	Six selectable for one or two players, with vertical paddle motion.	AY-3-8500	4
		AY-3-8500-1	4
BALL & PADDLE (TWO AXIS)	Six selectable games for one or two players, with horizontal and vertical paddle motion.	AY-3-8550	16
		AY-3-8550-1	16
BALL & PADDLE COLOR CONVERTER	Converts the black & white video outputs of either the AY-3-8500-1 or AY-3-8550-1 to a single color composite video signal.	AY-3-8515	25



AY-3-8500

AY-3-8500-1

Ball & Paddle

FEATURES

- Full **COLOR** operation with AY-3-8515.
- 6 Selectable Games—Tennis, soccer, squash, practice and two rifle shooting games
- 625 Line (AY-3-8500) and 525 Line (AY-3-8500-1) versions
- Automatic Scoring
- Score display on T.V. Screen, 0 to 15
- Selectable Bat Size
- Selectable Rebound Angles
- Selectable Ball Speed
- Automatic or Manual Ball Service
- Action Sounds
- Shooting Forwards in Soccer Game
- Visually defined area for all Ball Games.

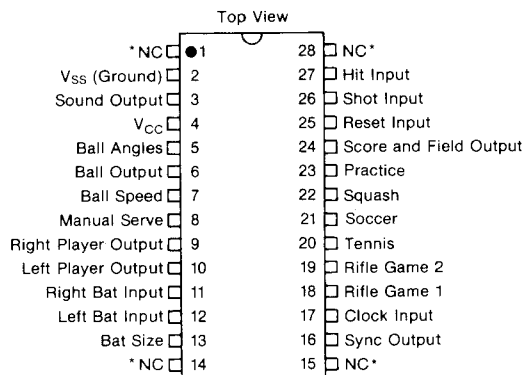
DESCRIPTION

The AY-3-8500 and AY-3-8500-1 circuits have been designed to provide a TV 'games' function which gives active entertainment using a standard domestic television receiver.

The circuit is intended to be battery powered and a minimum number of external components are required to complete the system.

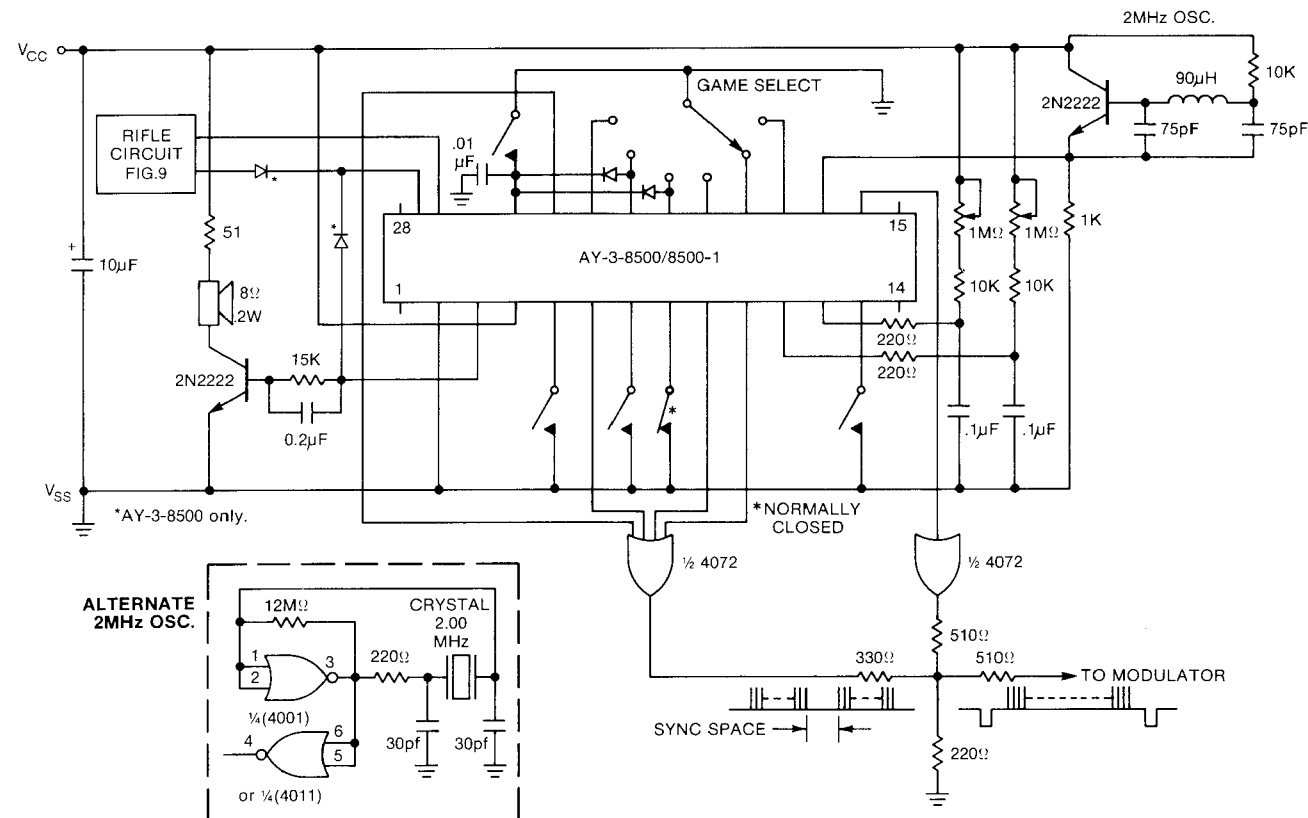
PIN CONFIGURATION

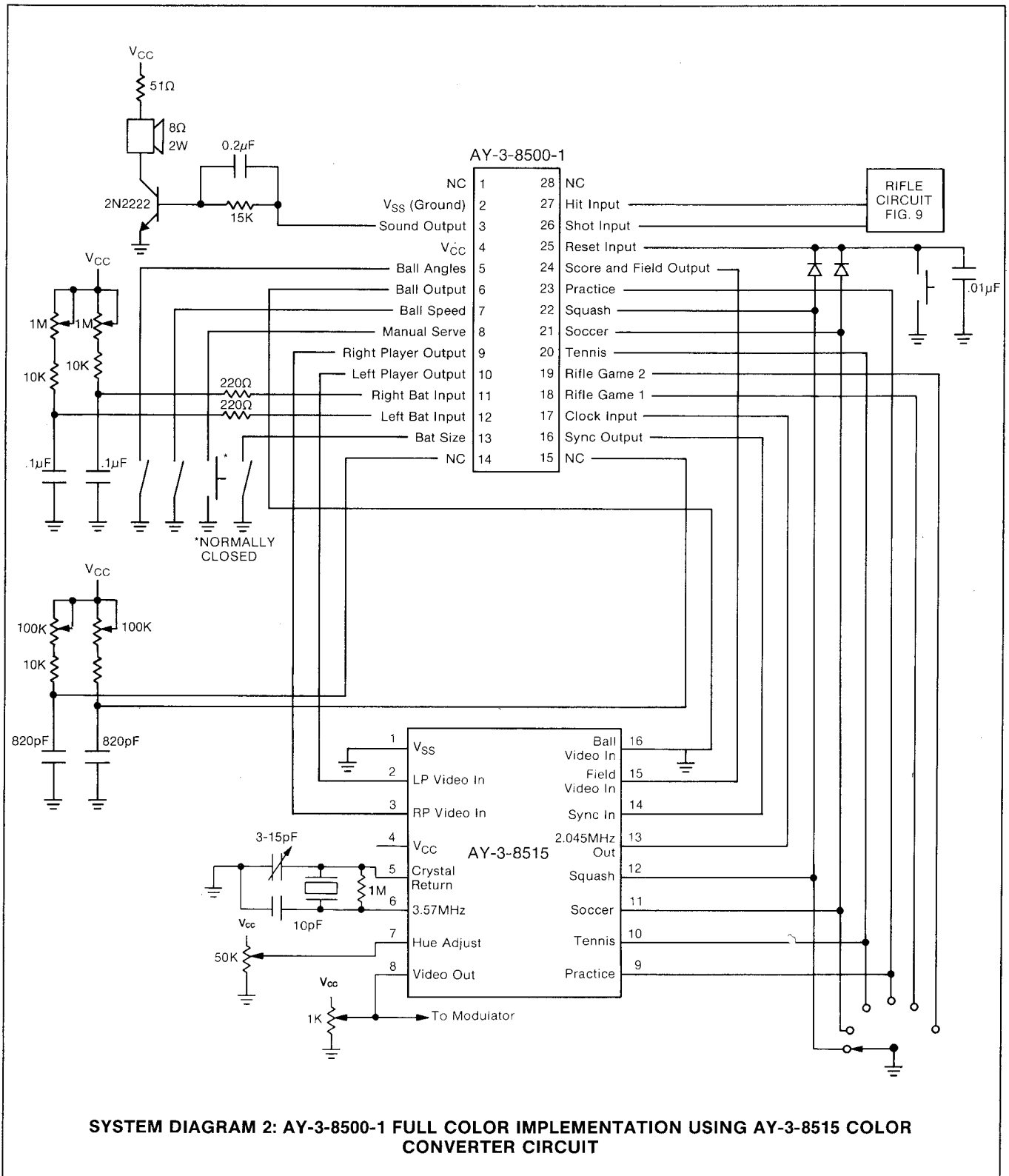
28 LEAD DUAL IN LINE



*Do not use as tie point.

SYSTEM DIAGRAM 1: BLACK AND WHITE IMPLEMENTATION





SYSTEM DIAGRAM 2: AY-3-8500-1 FULL COLOR IMPLEMENTATION USING AY-3-8515 COLOR CONVERTER CIRCUIT

**PIN FUNCTIONS (Pin numbers in parentheses)****V_{SS} (2)**

Negative supply input, nominally 0V(GND).

Sound Output (3)

The hit (32ms pulse/976Hz tone), boundary reflection (32ms pulse/488Hz tone) and score (32ms pulse/1.95KHz tone) sounds are output on this pin.

V_{CC} (4)

Positive supply input.

Ball Angles (5)

This input is left open circuit (Logic '1') to select two rebound angles and connected to V_{SS} (Logic '0') to select four rebound angles. When two angles are selected they are $\pm 20^\circ$, when four are selected they are $\pm 20^\circ$ and $\pm 40^\circ$. See Fig. 11.

Ball Output (6)

The ball video signal is output on this pin.

Ball Speed (7)

When this input is left open-circuit, low speed is selected (1.3 seconds for ball to traverse the screen). When connected to V_{SS} (Logic '0'), the high speed option is selected (0.65 seconds for ball to traverse the screen).

Manual Serve (8)

This input is connected to V_{SS} (Logic '0') for automatic serving. When left open circuit (Logic '1') the game stops after each score. The serve is indicated by momentarily connecting this input to V_{SS}.

Right Player Output/Left Player Output (9,10)

The video signals for the right and left players are output on separate pins.

Right Bat Input/Left Bat Input (11,12)

An R-C network connected to each of these inputs controls the vertical position of the bats. Use a 10K resistor in series with each pot.

Bat Size (13)

This input is left open circuit (Logic '1') to select large bats and connected to V_{SS} (Logic '0') to select small bats. For a 19" T.V. screen, large bats are 1.9" and small bats are 0.95" high.

Sync Output (16)

The T.V. vertical and horizontal sync signals are output on this pin. See Fig. 1.

Clock Input (17)

The 2MHz master timing clock is input to this pin. The exact frequency is $2.012160 \pm 1\%$.

Rifle Game 1, Rifle Game 2, Tennis, Soccer, Squash, Practice (18 thru 23)

These inputs are normally left open circuit (Logic '1') and are connected to V_{SS} (Logic '0') to select the desired game.

Score and Field Output (24)

The score and field video signal is output on this pin.

Reset (25)

This input is connected momentarily to V_{SS} (Logic '0') to reset the score counters and start a new game. Normally left open circuit.

Shot Input (26)

This input is driven by a positive pulse output of a monostable to indicate a "shot".

Hit Input (27)

This input is driven by a positive pulse output of a monostable which is triggered by the shot input if the target is on the sights of the rifle.

NOTE: The "Shot" and "Hit" inputs have on-chip pull-down resistors to V_{SS}. All other inputs (except the "Bat" inputs) have on-chip pull-up resistors to V_{CC}.

ELECTRICAL CHARACTERISTICS**Maximum Ratings***

Voltage on any pin with respect to V_{SS} pin -0.3 to +12V
Storage Temperature Range -20°C to +70°C
Ambient Operating Temperature Range 0°C to +40°C

*Exceeding these ratings could cause permanent damage. Functional operation of these devices at these conditions is not implied — operating ranges are specified below.

Standard Conditions (unless otherwise noted)

V_{CC} = +6 to +7V

V_{SS} = 0V

Operating Temperature (T_A) = 0°C to +40°C

Characteristics at 25°C and V _{CC} = +6 Volts	Min	Typ	Max	Units	Conditions
Clock Input					
Frequency	1.99	2.01	2.03	MHz	Maximum clock source impedance of 1K to V _{CC} or V _{SS} .
Logic '0'	0	—	0.5	Volts	
Logic '1'	V _{CC} -2	—	V _{CC}	Volts	V _{IN} = 0V, F = 1MHz
Pulse Width — Pos.	—	200	—	ns	
Pulse Width — Neg.	—	300	—	ns	
Capacitance	—	10	—	pF	
Leakage	—	100	—	μA	
Control Inputs					
Logic '0'	0	—	0.5	Volts	Max. contact resistance of 1K to V _{SS}
Logic '1'	V _{CC} -2	—	V _{CC}	Volts	
Input Impedance	—	1.0	—	M Ω	Pull up to V _{CC} Pull down to V _{SS}
Rifle Input	—	1.0	—	M Ω	
Outputs					
Logic '0'	—	—	1.0	Volt	I _{out} = 0.5mA
Logic '1'	V _{CC} -2	—	—	Volts	I _{out} = 0.1mA
Power Supply Current	—	40	60	mA	at V _{CC} = +7V

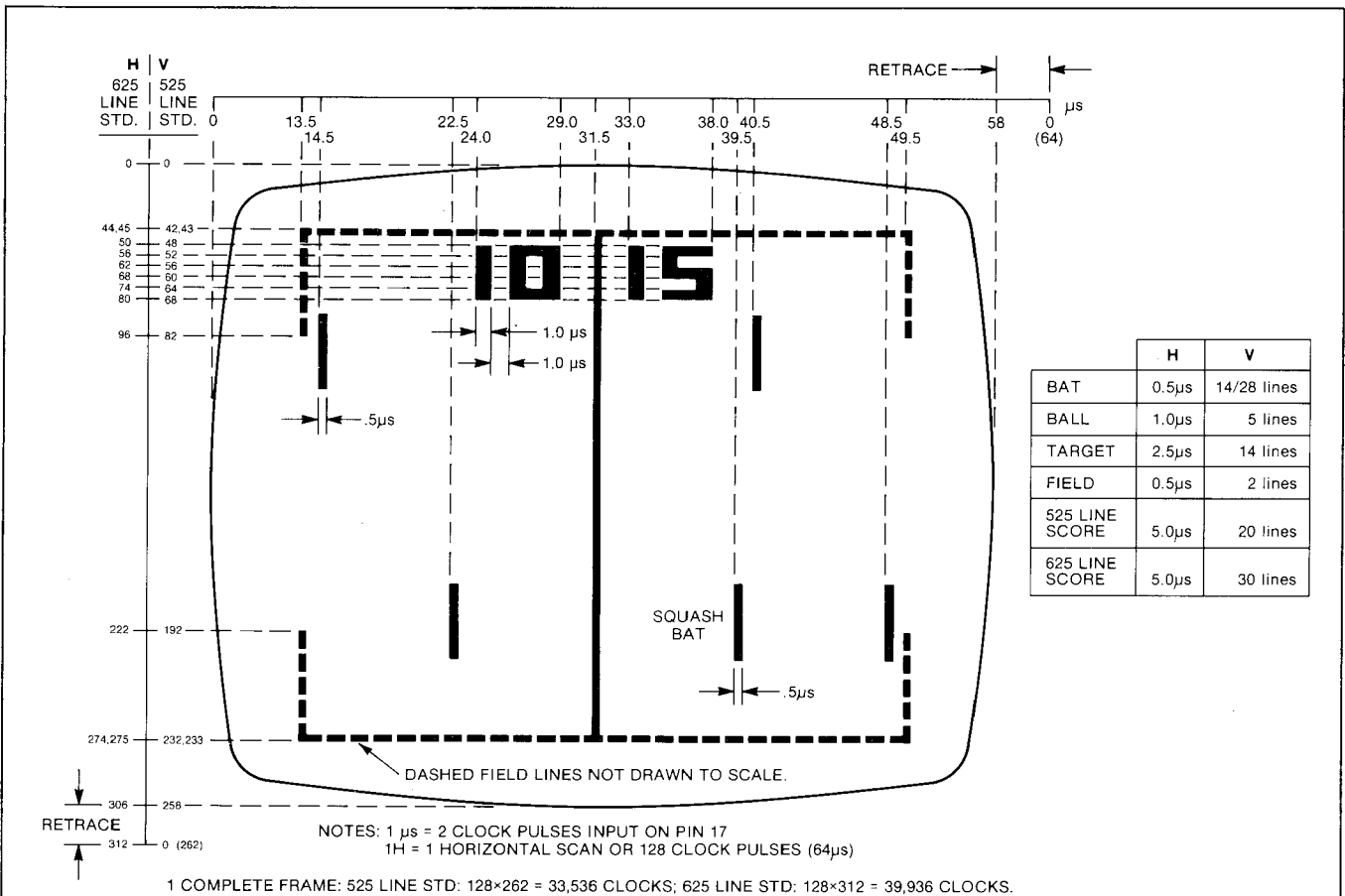


Fig.1 LOCATION OF DATA OUTPUT PULSES

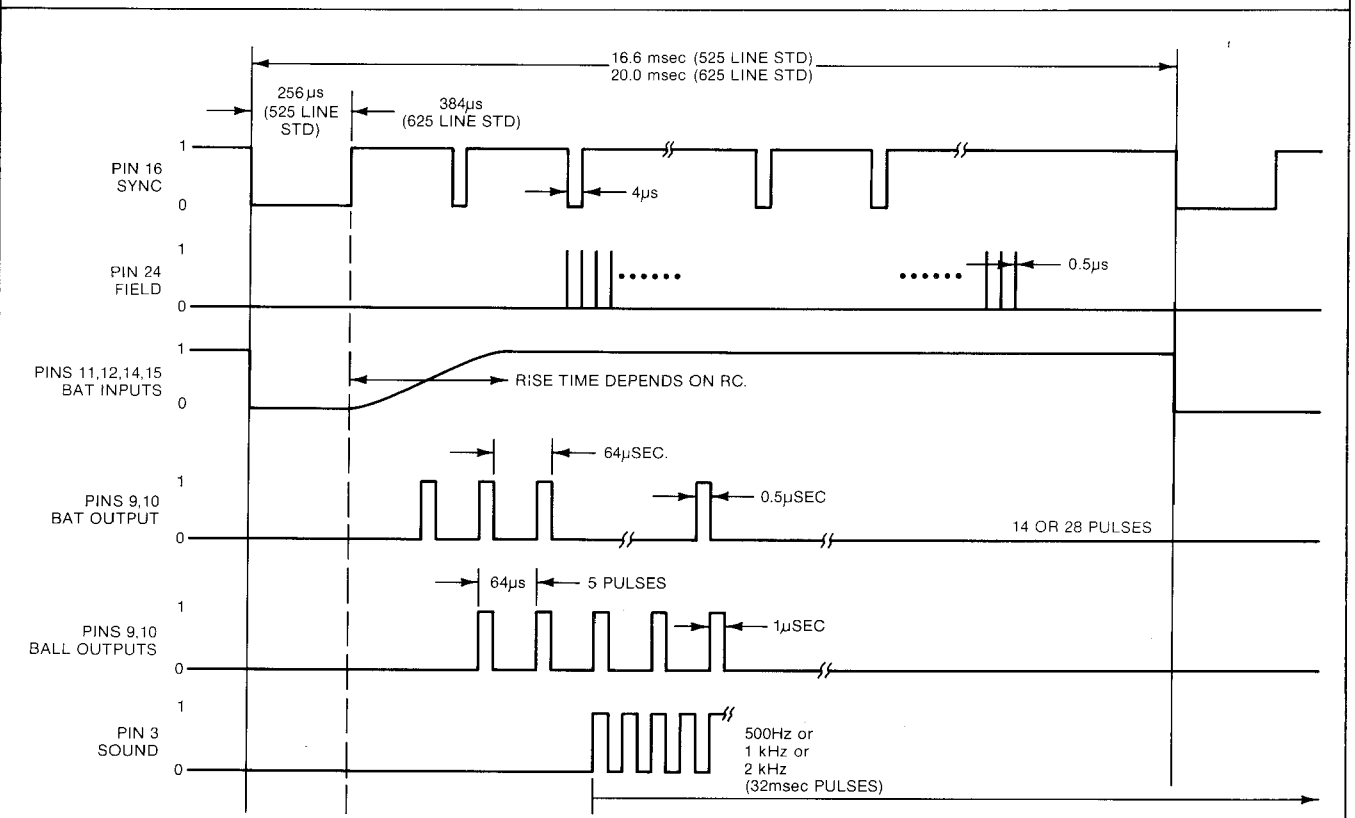


Fig.2 TIMING DIAGRAM

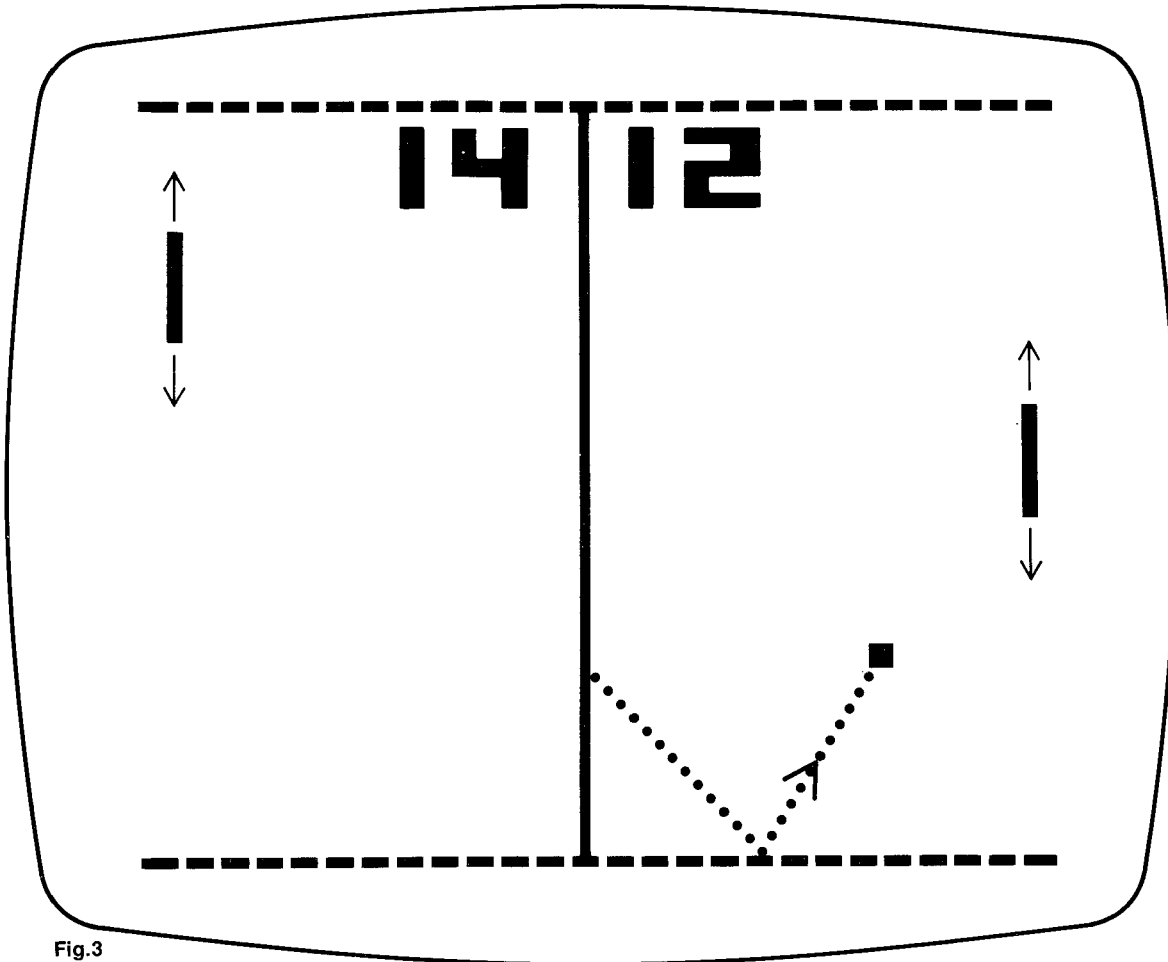


Fig.3

Tennis

With the tennis game the picture on the television screen would be similar to Figure 3 with one 'bat' per side, a top and bottom boundary and a center net. The individual scores are counted and displayed automatically in the position shown. The detail of the game will depend upon the selection of the options. Considering the situation where small bats are used and all angles, after the reset has been applied, the scores will be 0, 0 and the ball will serve arbitrarily to one side at one of the angles. If the ball hits the top or bottom boundary it will assume the angle of reflection and continue in play. The player being served must control his bat to intersect the path of the ball. When a 'hit' is detected by the logic, the section of the bat which made the hit is used to determine the new angle of the ball.

To expand on this, all 'bats' or 'players' are divided logically into four adjacent sections of equal length. When using the four angle option it is the quarter of bat which actually hits which defines the new direction for the ball.

The direction does not depend upon the previous angle of incidence. With the two angle option the top and bottom pairs of the bats are summed together and only the two shallower angles are used to program the new direction for the ball.

The ball will then traverse towards the other player, reflecting from the top or bottom as necessary until the other player makes his 'hit'. This action is repeated until one player misses the ball. The circuitry then detects a 'score' and automatically increments the correct score counter and updates the score display. The ball will then serve automatically towards the side which has just missed. This sequence is repeated until a score of 15 is reached by one side, whereupon the game is stopped. The ball will still bounce around but no further 'hits' or 'scores' can be made. While the game is in progress, three audio tones are output by the circuit to indicate top and bottom reflections, bat hits and scores.

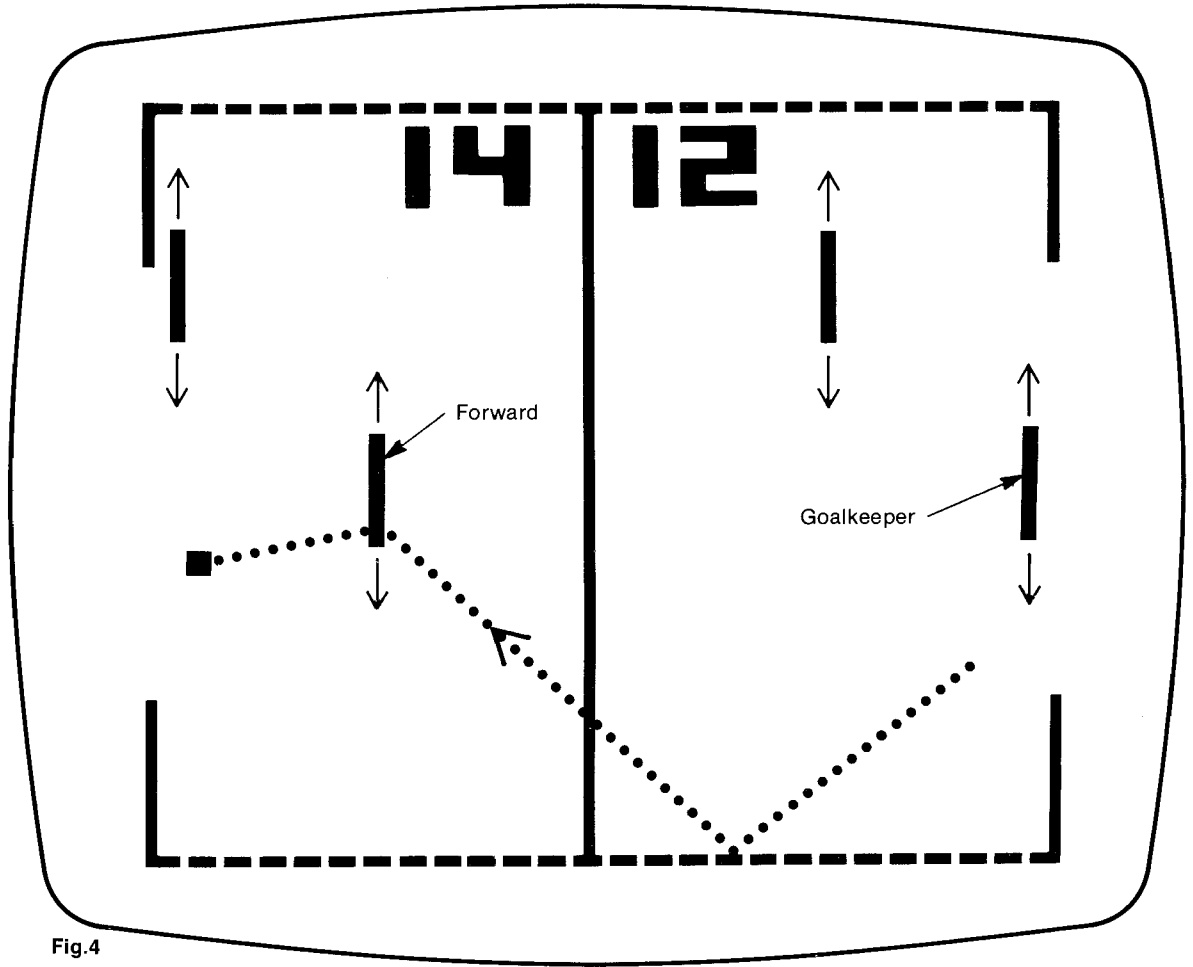


Fig.4

Soccer

The "soccer" type game is shown in Figure 4. With this game each participant has a 'goalkeeper' and a 'forward'. The layout is such that the 'goalkeeper' is in his normal position and the 'forward' is positioned in the opponent's half of the playing area.

When the game starts, the ball will appear travelling from one goal line towards the other side. If the opponent's forward can intercept the ball, (Figure 4a), he can 'shoot' it back towards the goal. If the ball is missed it will travel to the other half of the playing area and the first team's forward will have the opportunity

of intercepting the ball and redirecting it forward at a new angle according to the 'player' section which is used (Figure 4b). If the ball is 'saved' by the 'goalkeeper' or it reflects back from the end boundary, the same forward will have the opportunity to intercept the outcoming ball and divert it back towards the 'goal'.

A 'score' is made in the "soccer" game by 'shooting' the ball through the defined goal area. The scoring and game control is done automatically as for the tennis game. The same audio signals are used to add atmosphere to the game.

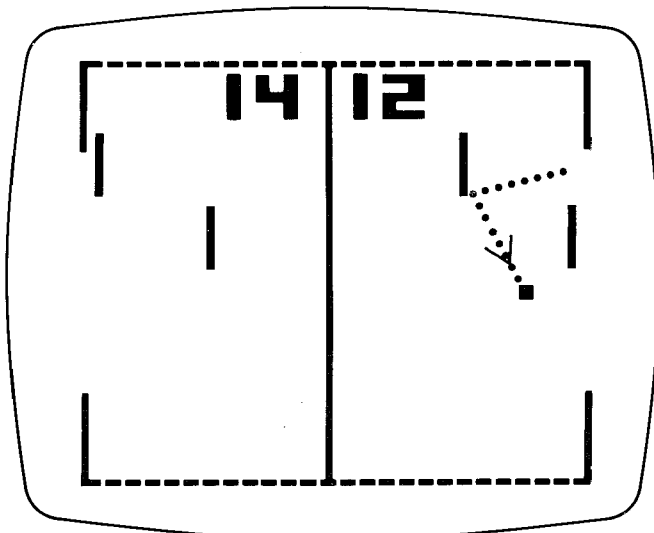


Fig.4a Return of "Goal Save"

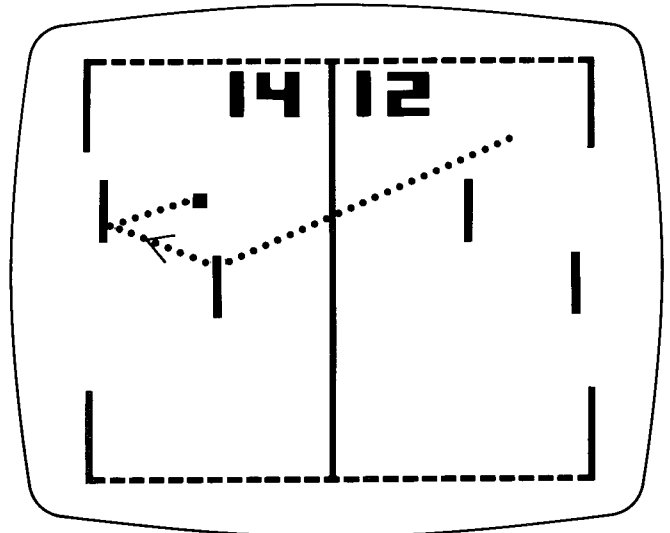


Fig.4b "Shooting" Forward

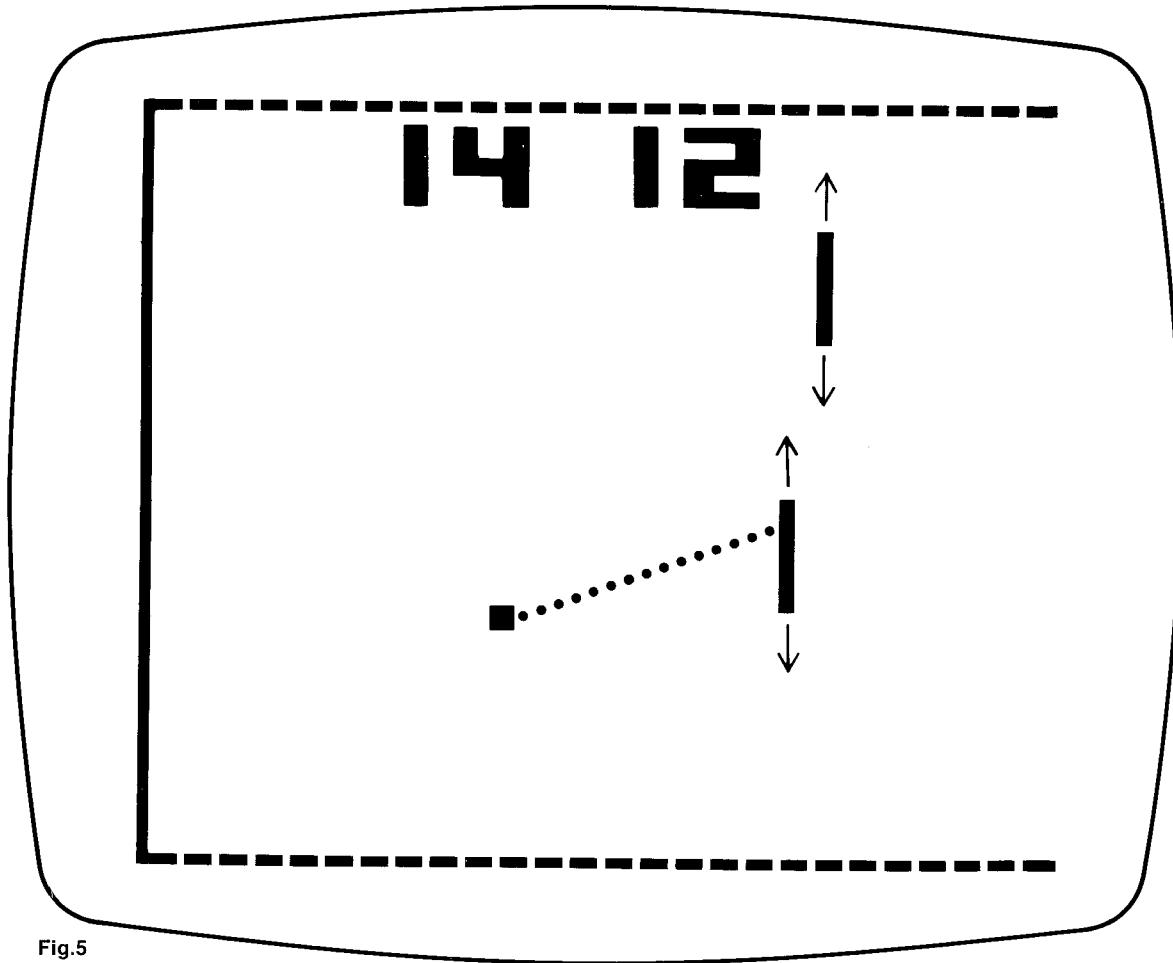


Fig.5

Squash

This game is illustrated in Fig.5. There are two players who alternately hit the ball into the court. The right hand player is the one that hits first; it is then the left hand player's turn. Each player is enabled alternately to ensure that the proper sequence of play is followed.

Practice

This game is similar to squash except that there is only one player. See Fig. 6.

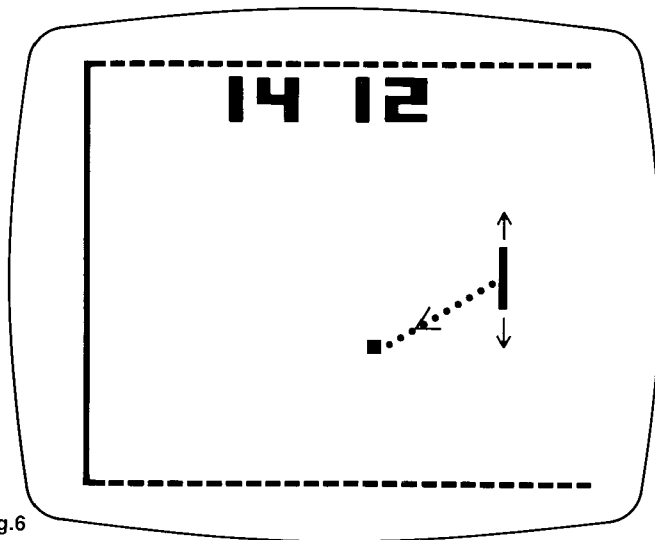


Fig.6

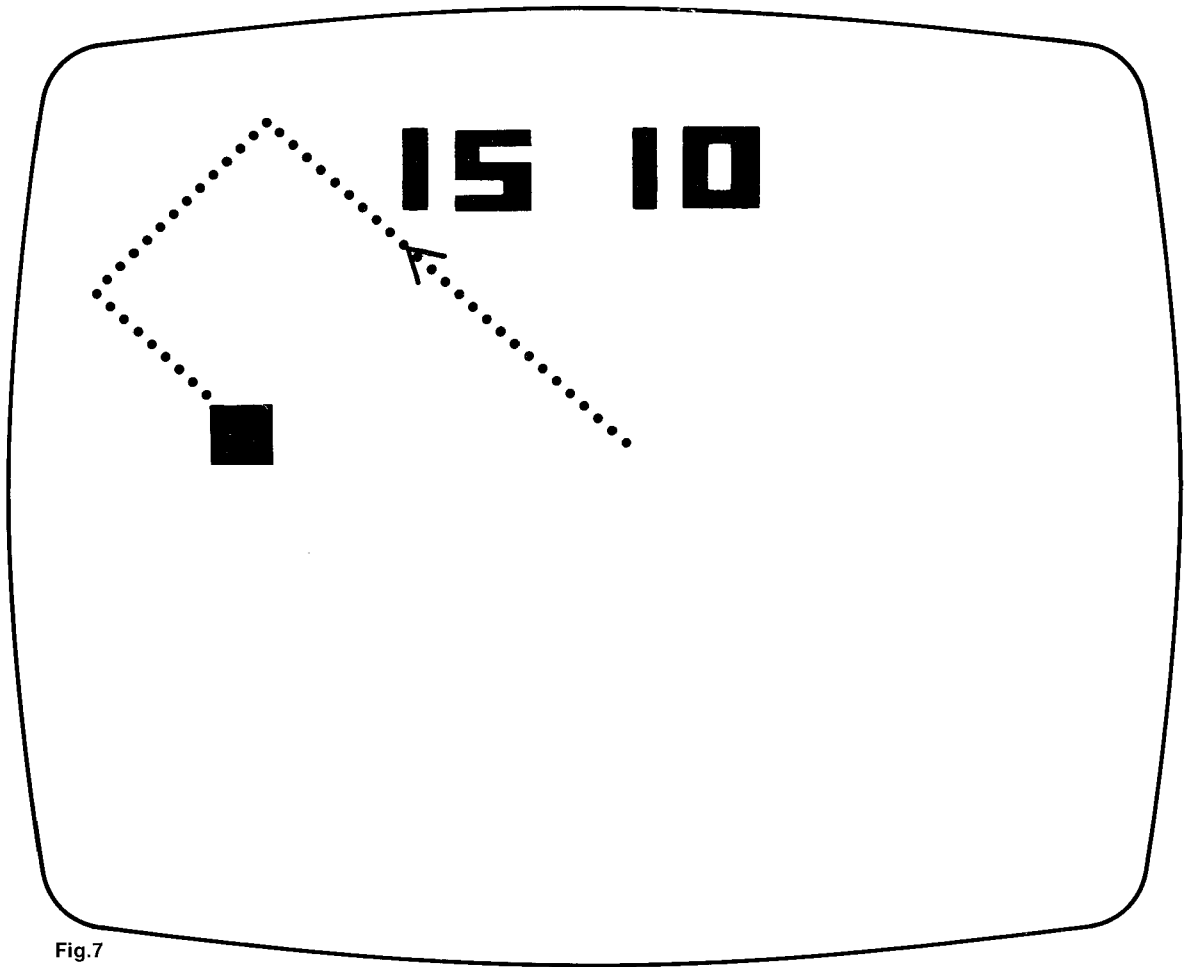


Fig.7

Rifle Game No. 1

This game is illustrated in Fig. 7. It has a large target which bounces randomly about the screen. A photocell in the rifle is aimed at the target. When the trigger is pulled, the shot counter is incremented and, if the rifle is on target, the hit counter is incremented, a hit noise is generated and the target is blanked for a short period. After 15 shots the score appears but the game can still continue without additional scoring.

Rifle Game No. 2

In this game illustrated in Fig. 8, the ball traverses the screen from left to right under control of the manual serve button. Otherwise the game is as described for Rifle Game No. 1.

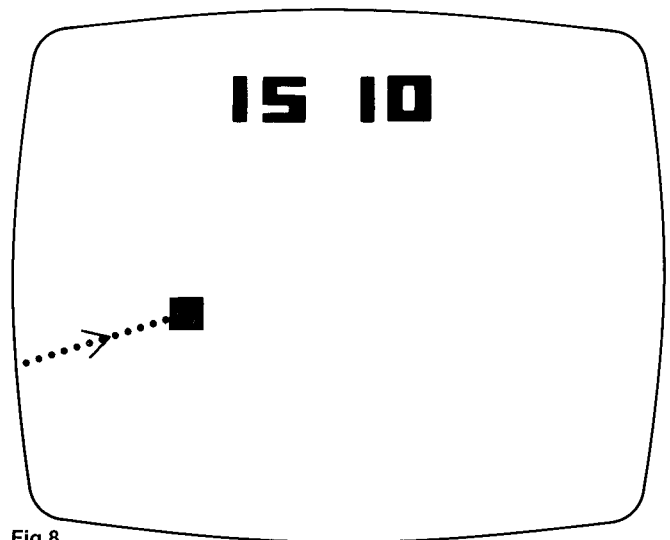


Fig.8

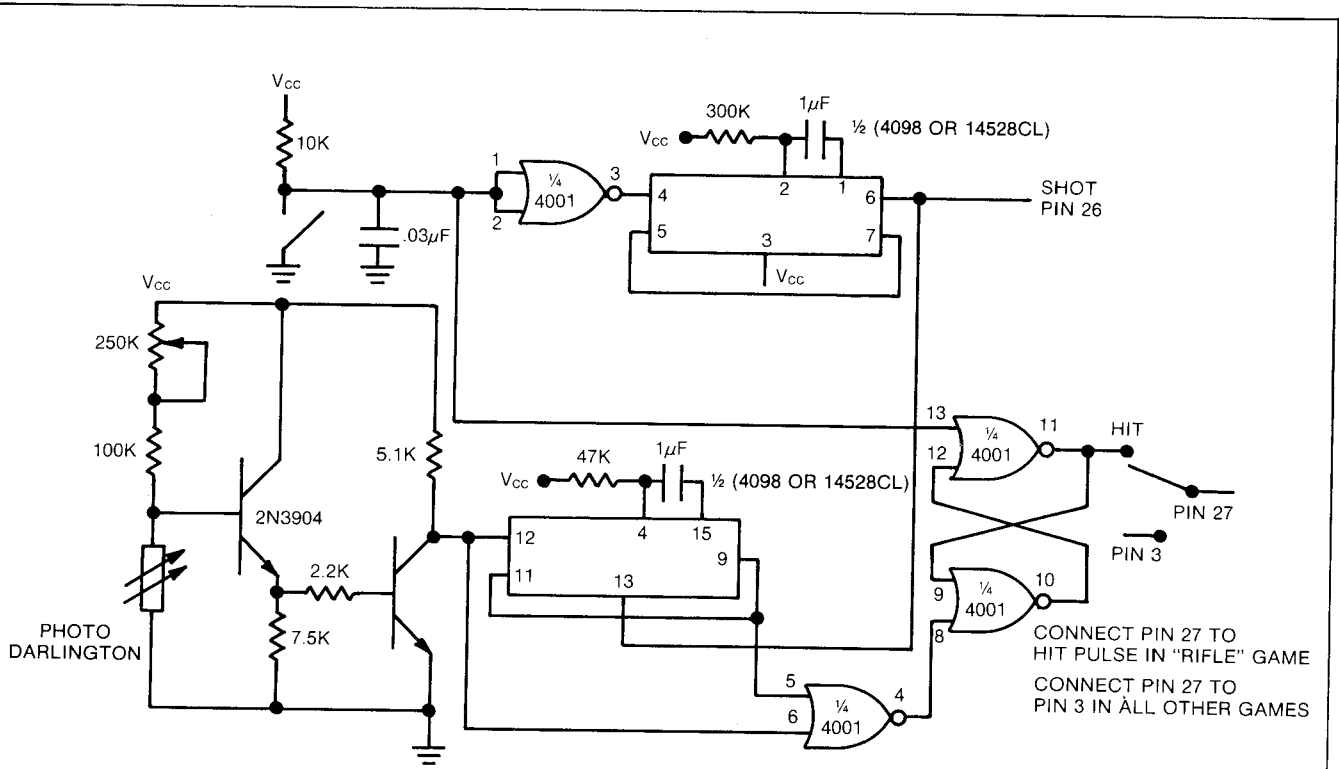


Fig.9 RIFLE INTERFACE

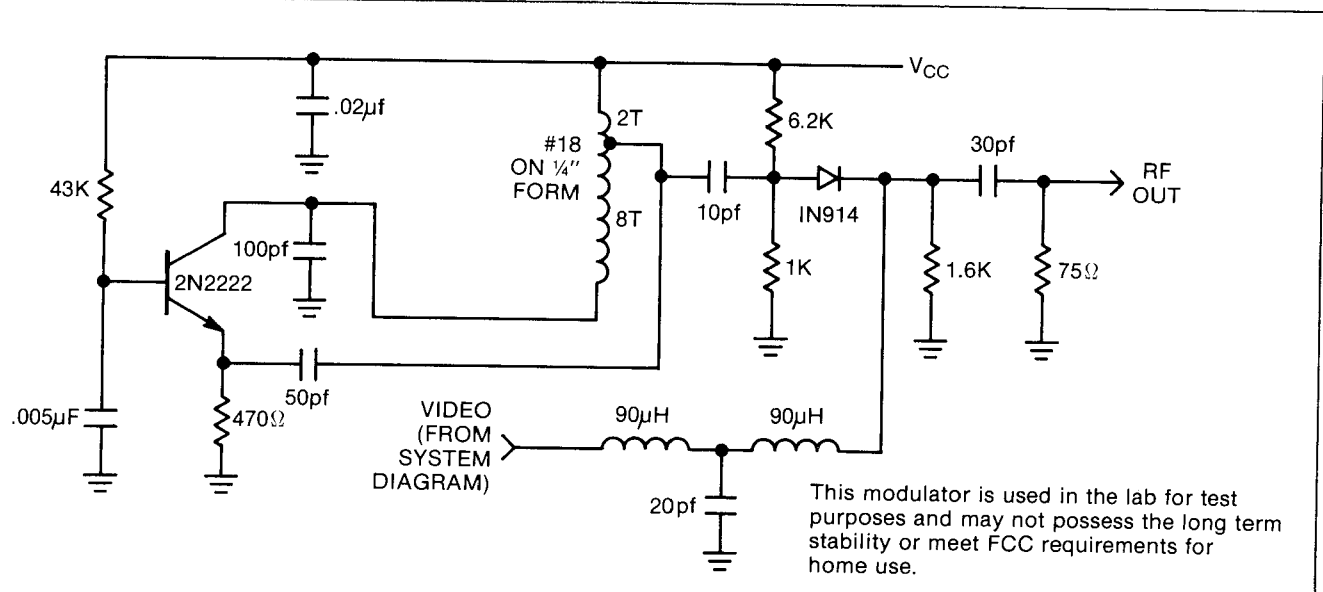


Fig.10 VHF MODULATOR

	Horizontal	Vertical
Slow	± .5µs	2 angles ± 1 line 4 angles ± 3 lines
Fast	± 1µs	2 angles ± 2 lines 4 angles ± 5 lines

Fig.11 ANGULAR MOTION



RANDOM BALL SPEED/RANDOM ANGLES

To enhance the excitement and challenge of the various games, this option provides random variations of the ball speed and random changes in the ball rebound angle as the games are being played.

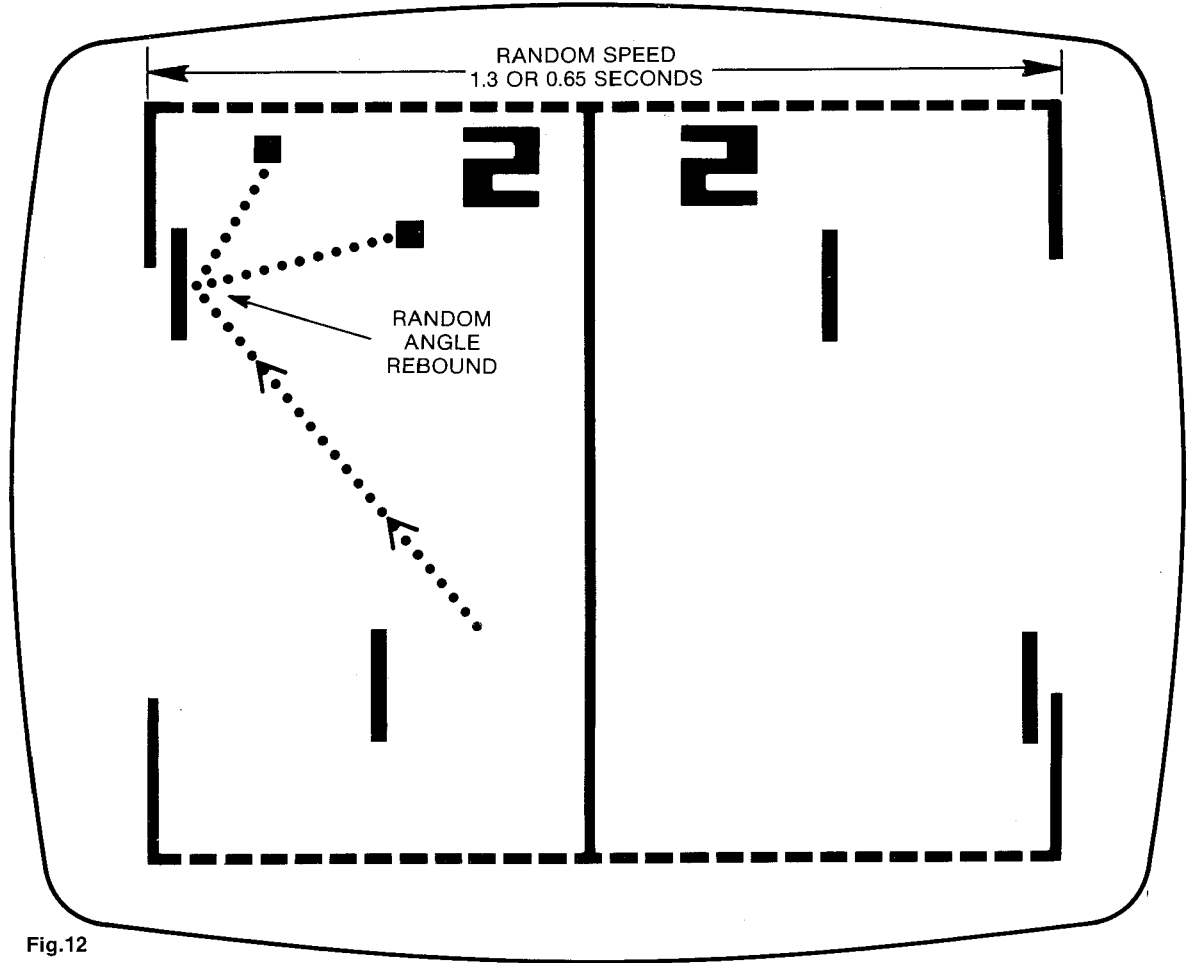


Fig.12

Soccer

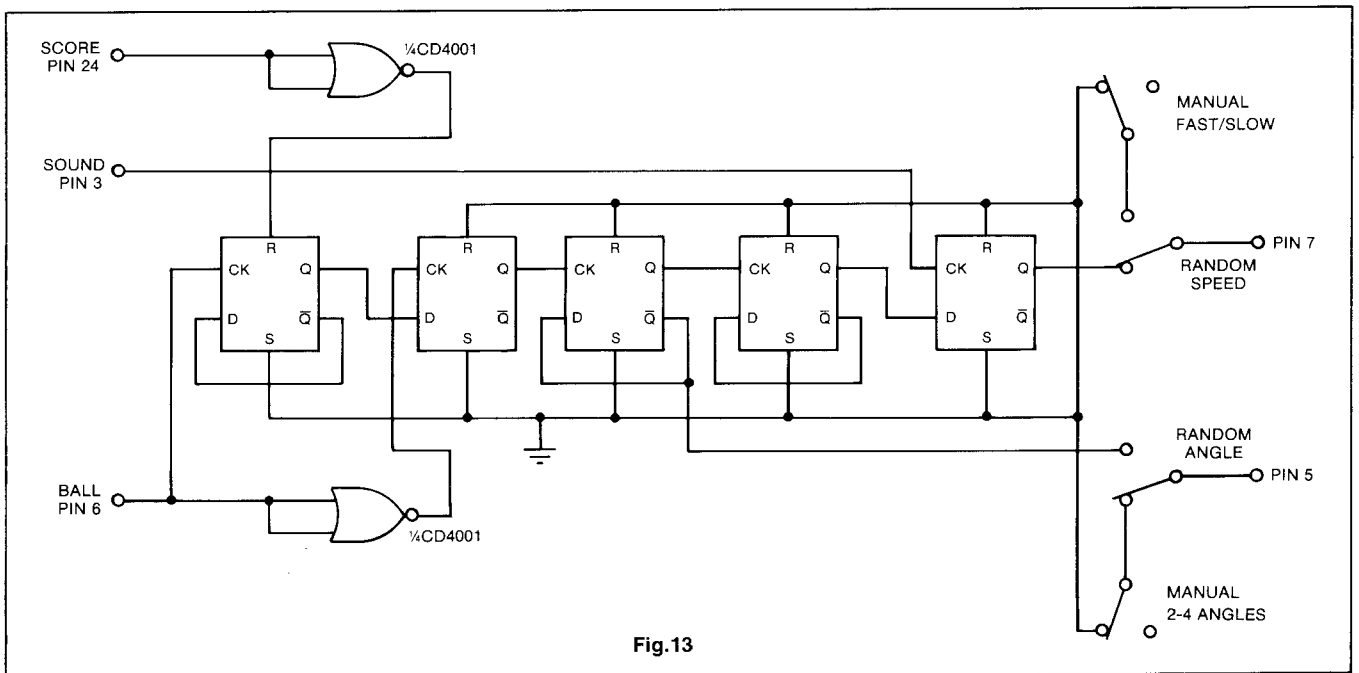


Fig.13



BLACK AND WHITE BATS/GRAY BACKGROUND

This option provides an added factor for player team recognition. The field or court is produced as a gray background with the bats in black and white. This option is particularly helpful for the squash game where the players are positioned close together.

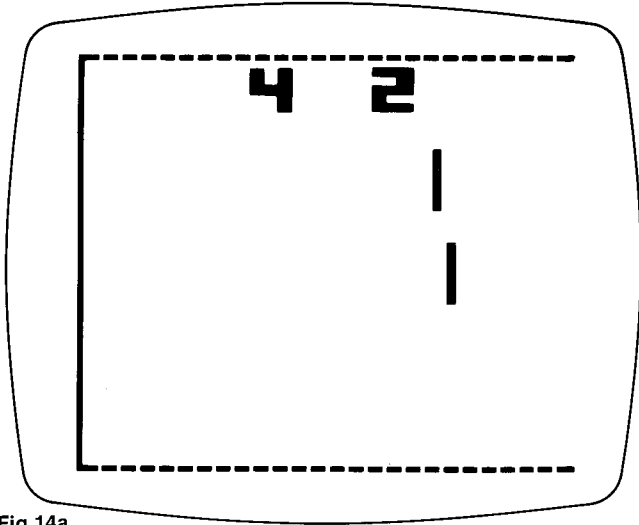


Fig. 14a

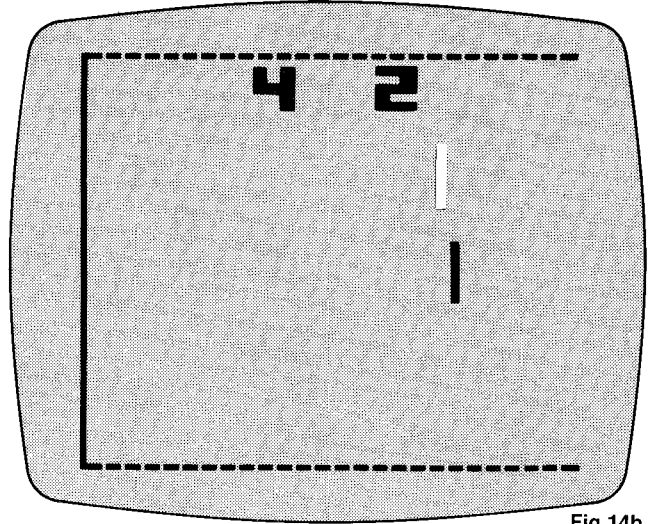


Fig. 14b

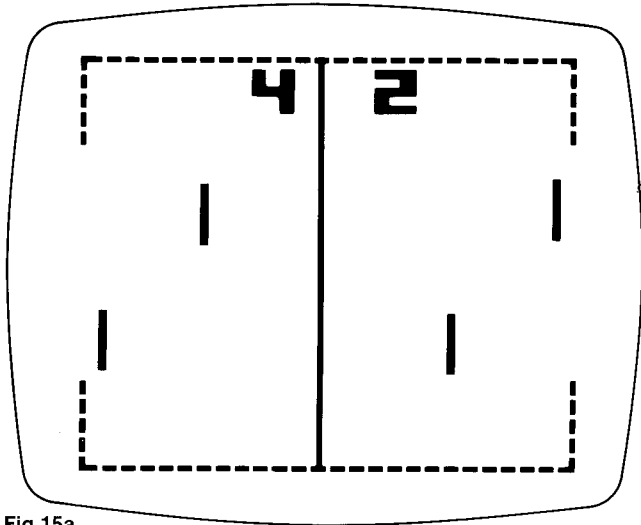


Fig. 15a

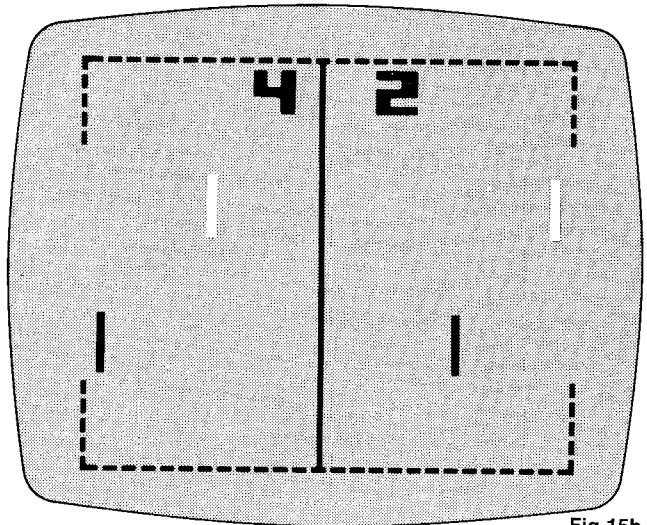
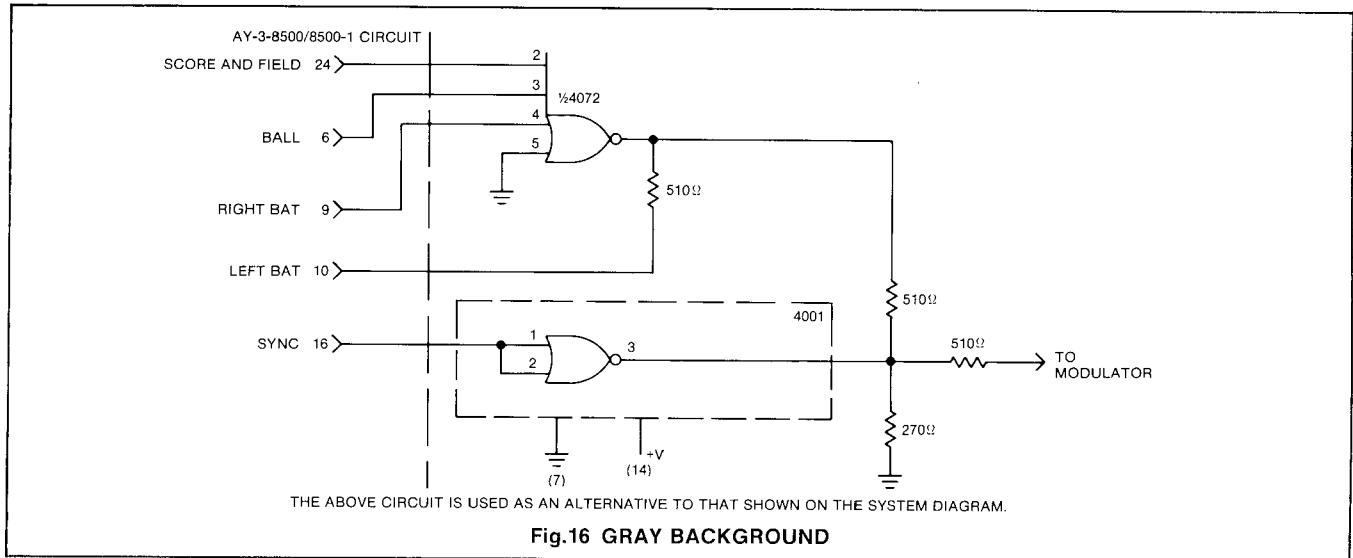


Fig. 15b





FOUR PLAYER CONFIGURATION

With this option, the basic two player tennis game can be expanded to true four player doubles. Each player is capable of playing the full width of the court.
 A variation of this option allows for a three player handicap game with two players against one.

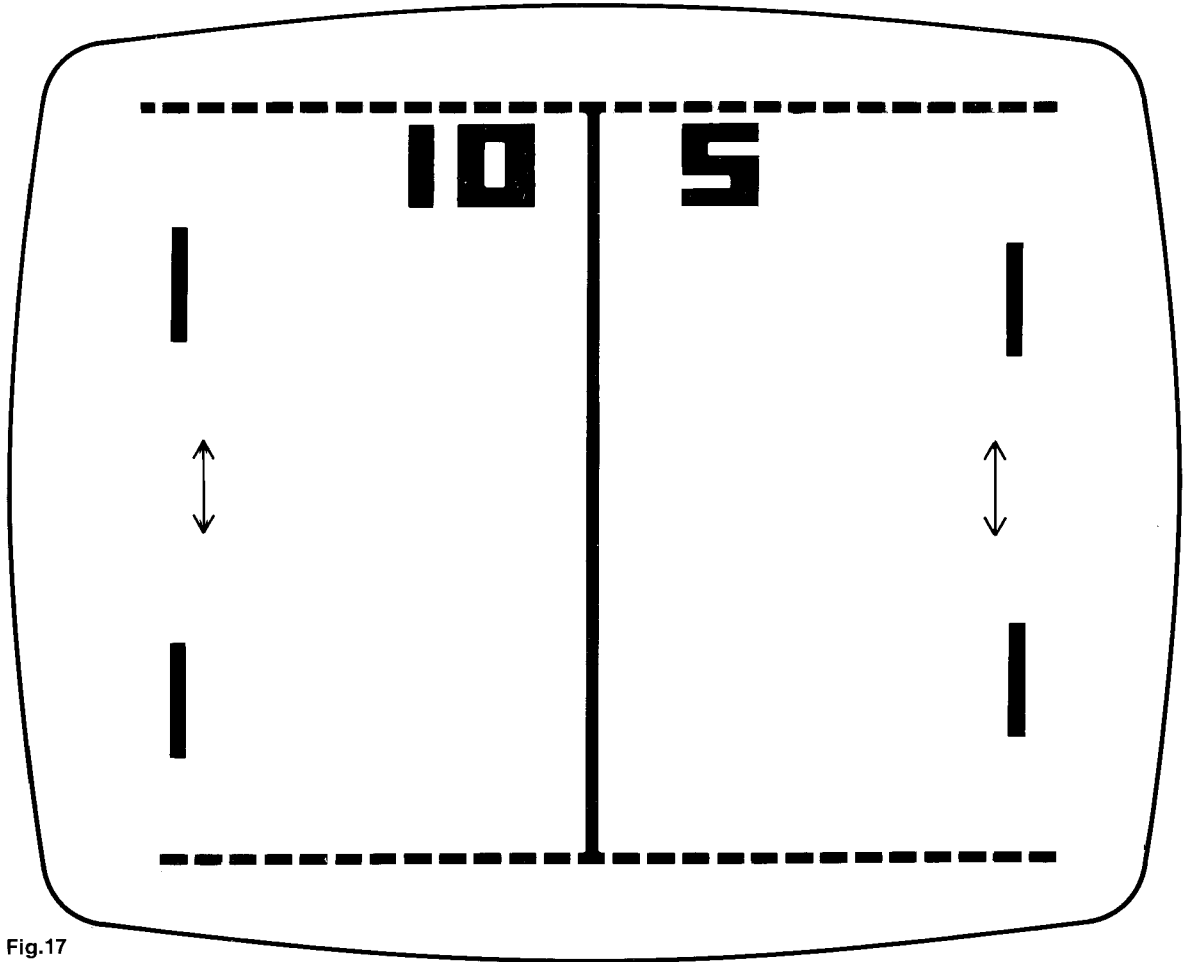


Fig.17

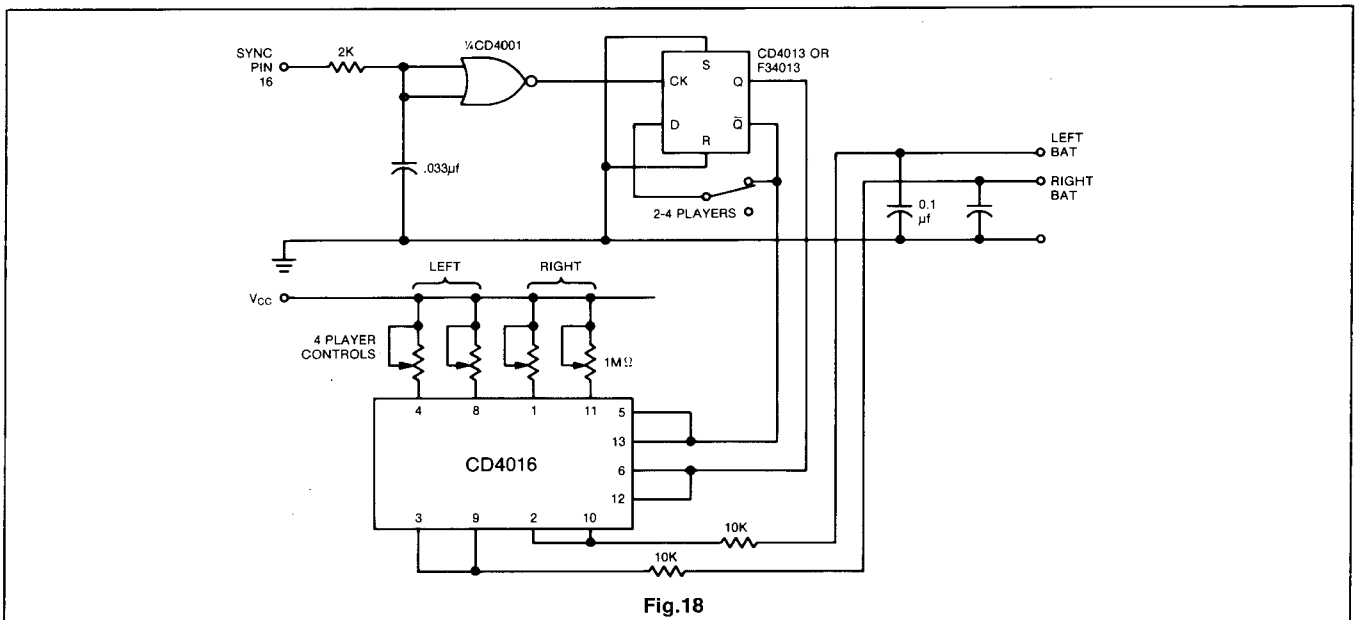


Fig.18



Ball & Paddle (Two Axis)

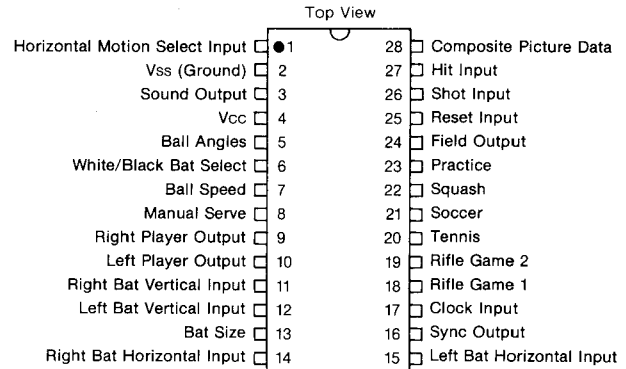
FEATURES

- Full **COLOR** Operation with AY-3-8515.
- 6 Selectable Games—Tennis, soccer, squash, practice and two rifle shooting games
- 625 Line (AY-3-8550) and 525 Line (AY-3-8550-1) versions
- Selectable horizontal motion
- Special Composite outputs for color coding, players and score, ball and boundaries
- Automatic Scoring
- Score display on T.V. Screen, 0 to 15
- Selectable Bat Size
- Selectable Rebound Angles
- Selectable Ball Speed
- Automatic or Manual Ball Service
- Action Sounds
- Shooting Forwards in Soccer Game
- Visually defined area for all Ball Games
- Score color-coded to player
- Ball output coded to player in Squash
- Practice game scores both hits and misses
- Composite picture data on one pin, and individual video signals for color
- Pin compatible with AY-3-8500/8500-1.

DESCRIPTION

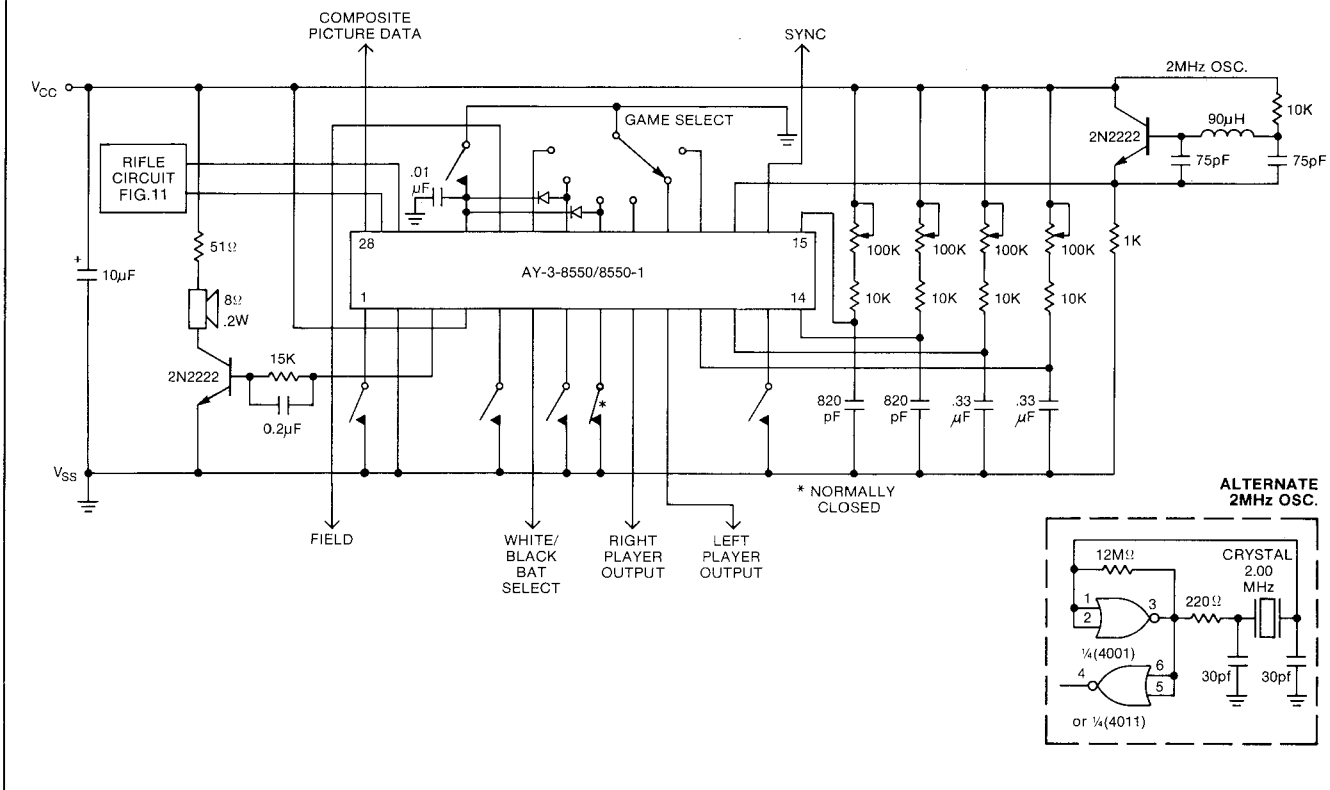
The AY-3-8550 and AY-3-8550-1 circuits have been designed to provide a TV 'games' function which gives active entertainment using a standard domestic television receiver.

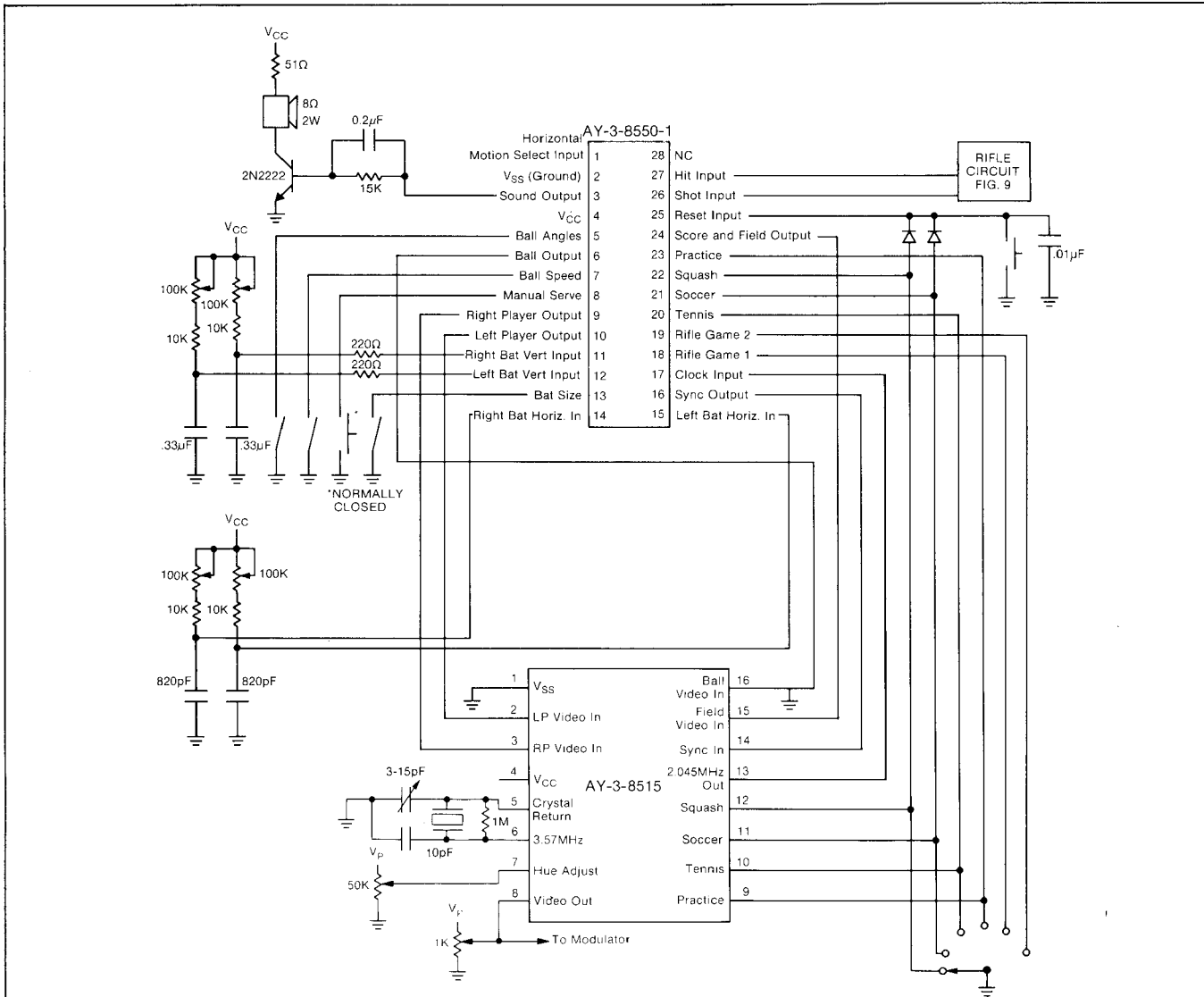
PIN CONFIGURATION 28 LEAD DUAL IN LINE



The circuit is intended to be battery powered and a minimum number of external components are required to complete the system.

SYSTEM DIAGRAM 1: BLACK AND WHITE IMPLEMENTATION





SYSTEM DIAGRAM 2: AY-3-8550-1 FULL COLOR IMPLEMENTATION USING AY-3-8515 COLOR CONVERTER CIRCUIT

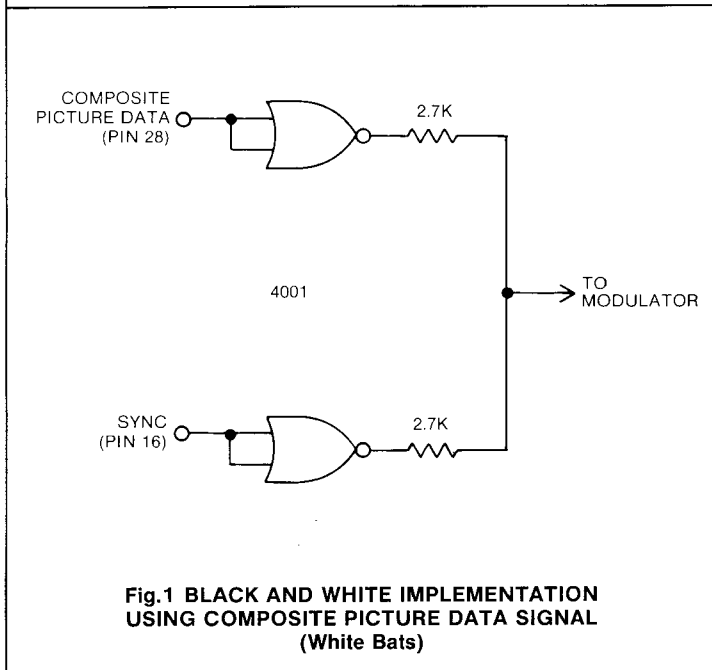


Fig.1 BLACK AND WHITE IMPLEMENTATION USING COMPOSITE PICTURE DATA SIGNAL (White Bats)

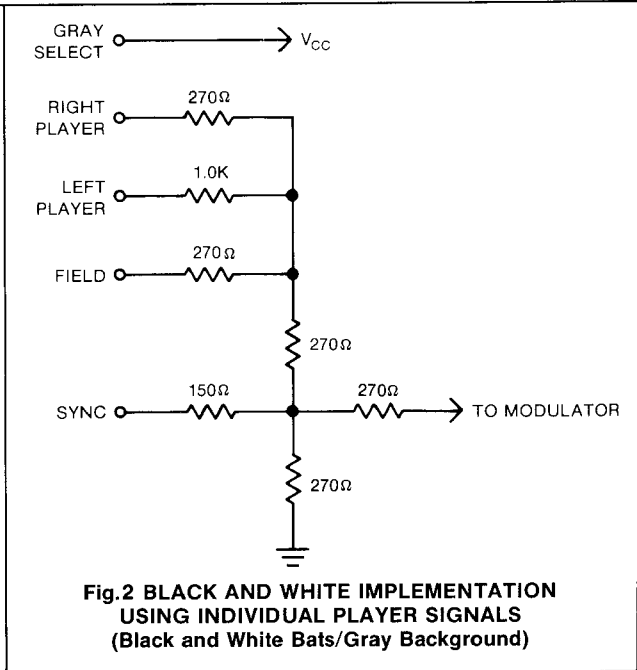


Fig.2 BLACK AND WHITE IMPLEMENTATION USING INDIVIDUAL PLAYER SIGNALS (Black and White Bats/Gray Background)

**PIN FUNCTIONS**

Horizontal Motion Select (1) When connected to V_{SS} (Logic '0'), the horizontal motion controls are enabled. Open circuit fixes paddles at baselines for vertical motion only.

Vss (2) Negative supply input, nominally 0V(GND).

Sound Output (3) The hit (32ms pulse/976Hz tone), boundary reflection (32ms pulse/488Hz tone) and score (32ms pulse/1.95KHz tone) sounds are output on this pin.

Vcc (4) Positive supply input.

Ball Angles (5) This input is left open circuit (Logic '1') to select two rebound angles and connected to V_{SS} (Logic '0') to select four rebound angles. When two angles are selected they are $\pm 20^\circ$, when four are selected they are $\pm 20^\circ$ and $\pm 40^\circ$. See Fig. 13.

White/Black Bat Select (6) Connection to V_{CC} (Logic '1') inverts the right player output for black right player. This input is pulled to V_{SS} so this circuit may be used in AY-3-8500/8500-1 sockets.

Ball Speed (7) When this input is left open-circuit, low speed is selected (1.3 seconds for ball to traverse the screen). When connected to V_{SS} (Logic '0'), the high speed option is selected (0.65 seconds for ball to traverse the screen).

Manual Serve (8) This input is connected to V_{SS} (Logic '0') for automatic serving. When left open circuit (Logic '1') the game stops after each score. The serve is indicated by momentarily connecting the input to V_{SS} .

Right Player Output/Left Player Output (9,10) Normally positive going video signals representing the right hand player (paddle, score, and when playing Squash, the ball when it is the right hand player's turn to hit) and the left hand player (paddle, score, and ball — except that in Squash the ball is output only when it is the left hand player's turn to hit). When connected to V_{CC} , the output is negative going with the "off" state at V_{CC} .

Right bat Vertical Input/Left Bat Vertical Input (11,12) An R-C network connected to each of these inputs controls the vertical position of the bats. Use a 10K resistor in series with each pot.

Bat Size (13) This input is left open circuit (Logic '1') to select large bats and connected to V_{SS} (Logic '0') to select small bats. For a 19" T.V. screen, large bats are 1.9" and small bats are 0.95" high.

Right Bat Horizontal Input/Left Bat Horizontal Input (14,15) An R-C network connected to each of these inputs controls the horizontal position of the bats. Use a 10K resistor in series with each pot.

Sync Output (16) The T.V. vertical and horizontal sync signals are output on this pin. Sync must always be one of the signals included in the composite video to the modulator. See Fig. 3.

Clock Input (17) The 2MHz master timing clock is input to this pin. The exact frequency is $2.012160 \pm 1\%$.

Rifle Game 1, Rifle Game 2, Tennis, Soccer, Squash, Practice (18 thru 23) These inputs are normally left open circuit (Logic '1') and are connected to V_{SS} (Logic '0') to select the desired game.

Field Output (24) The field video signal is output on this pin.

Reset (25) This input is connected momentarily to V_{SS} (Logic '0') to reset the score counters and start a new game. Normally left open circuit.

Shot Input (26) This input is driven by a positive pulse output by a monostable to indicate a "shot".

Hit Input (27) This input is driven by a positive pulse output of a monostable which is triggered by the shot input if the target is on the sights of the rifle.

Composite Picture Data (28) This positive going output is the sum of the picture data for the bats, ball, field and score and can be used in lieu of the data on pins 9, 10 and 24. This signal and Sync are the only signals required for black and white operation (see Fig. 1).

NOTE: The "Shot" and "Hit" inputs have on-chip pull-down resistors to V_{SS} . All other inputs (except the "Bat" inputs) have on-chip pull-up resistors to V_{CC} .

ELECTRICAL CHARACTERISTICS (PRELIMINARY INFORMATION)**Maximum Ratings***

Voltage on any pin with respect to V_{SS} pin -0.3 to +12V
Storage Temperature Range -20°C to +70°C
Ambient Operating Temperature Range 0°C to +40°C

*Exceeding these ratings could cause permanent damage. Functional operation of these devices at these conditions is not implied — operating ranges are specified below.

Standard Conditions (unless otherwise noted)

$V_{CC} = +6$ to +7V

$V_{SS} = 0V$

Operating Temperature (T_A) = 0°C to +40°C

Characteristics at 25°C and $V_{CC} = +6$ Volts	Min	Typ	Max	Units	Conditions
Clock Input					
Frequency	1.99	2.01	2.03	MHz	Maximum clock source impedance of 1K to V_{CC} or V_{SS} .
Logic '0'	0	—	0.5	Volts	
Logic '1'	$V_{CC}-2$	—	V_{CC}	Volts	$V_{IN} = 0V, F = 1MHz$
Pulse Width — Pos.	—	200	—	ns	
Pulse Width — Neg.	—	300	—	ns	
Capacitance	—	10	—	pF	
Leakage	—	100	—	μA	
Control Inputs					
Logic '0'	0	—	0.5	Volts	
Logic '1'	$V_{CC}-2$	—	V_{CC}	Volts	
Input Impedance	—	1.0	—	M Ω	
Rifle Input	—	1.0	—	M Ω	Pull up to V_{CC} Pull down to V_{SS}
Outputs					
Logic '0'	—	—	1.0	Volt	$I_{out} = 0.5mA$
Logic '1'	$V_{CC}-2$	—	—	Volts	$I_{out} = 0.1mA$
Power Supply Current	—	40	60	mA	at $V_{CC} = +7V$

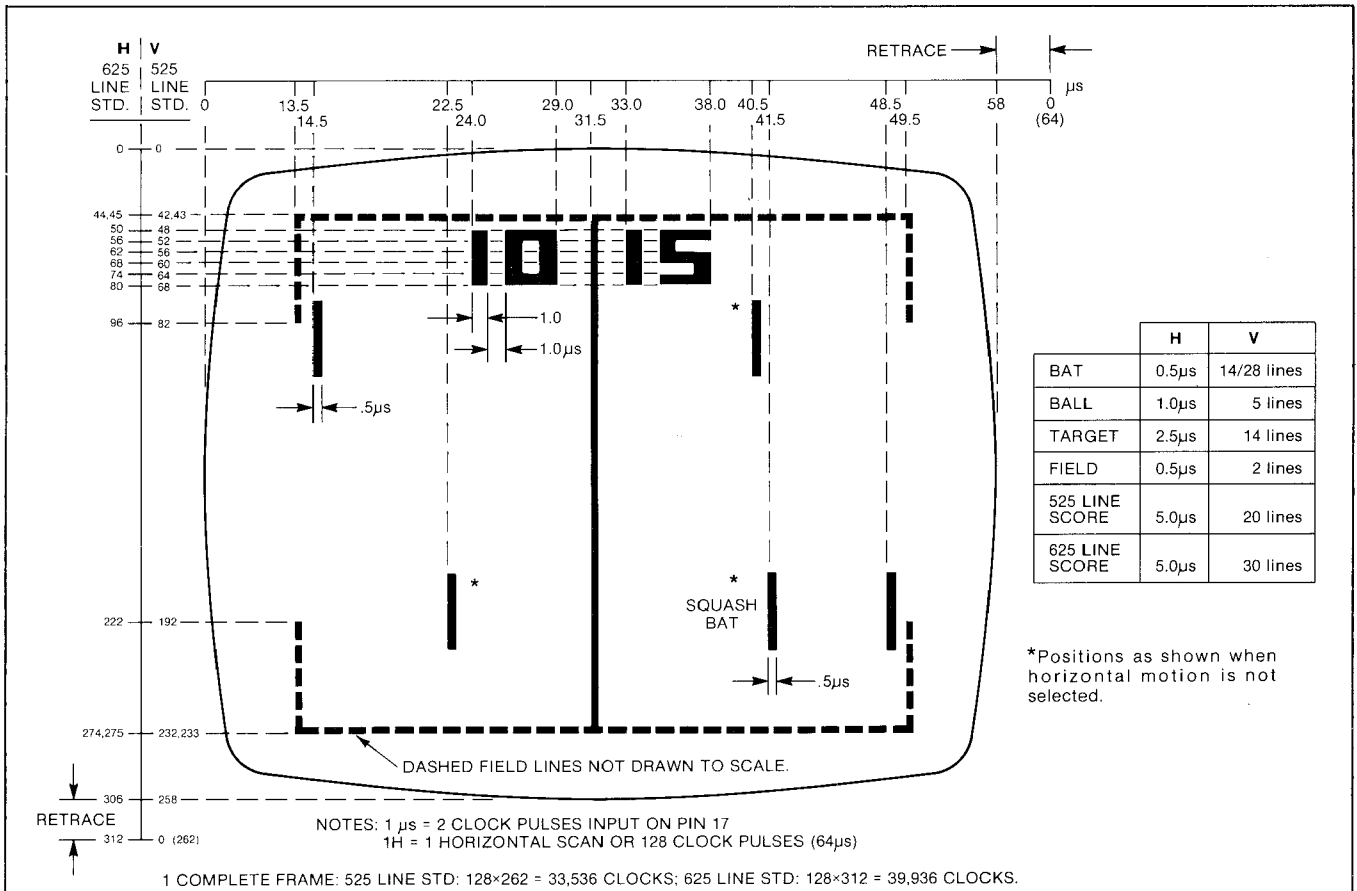


Fig.3 LOCATION OF DATA OUTPUT PULSES

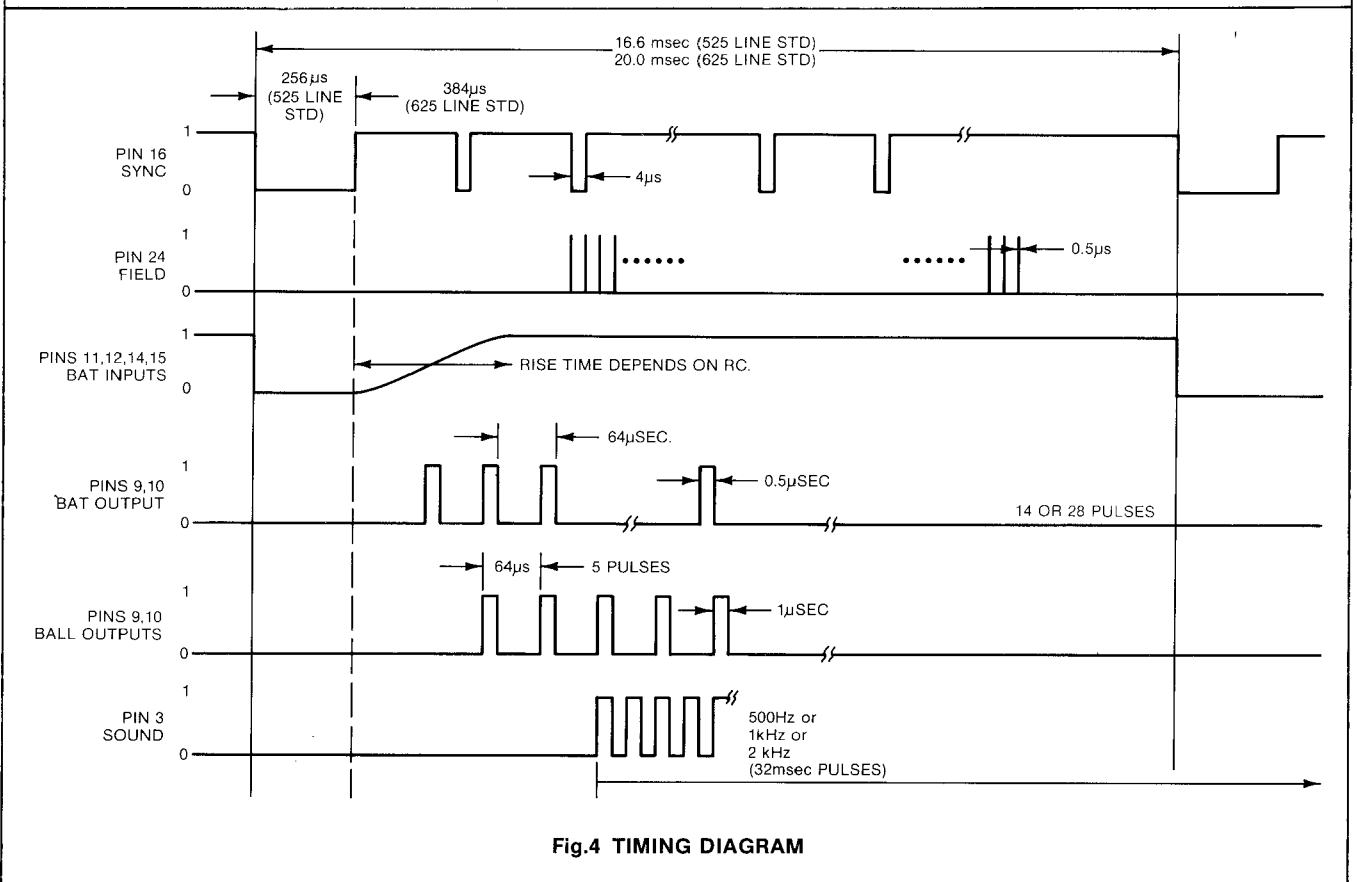


Fig.4 TIMING DIAGRAM

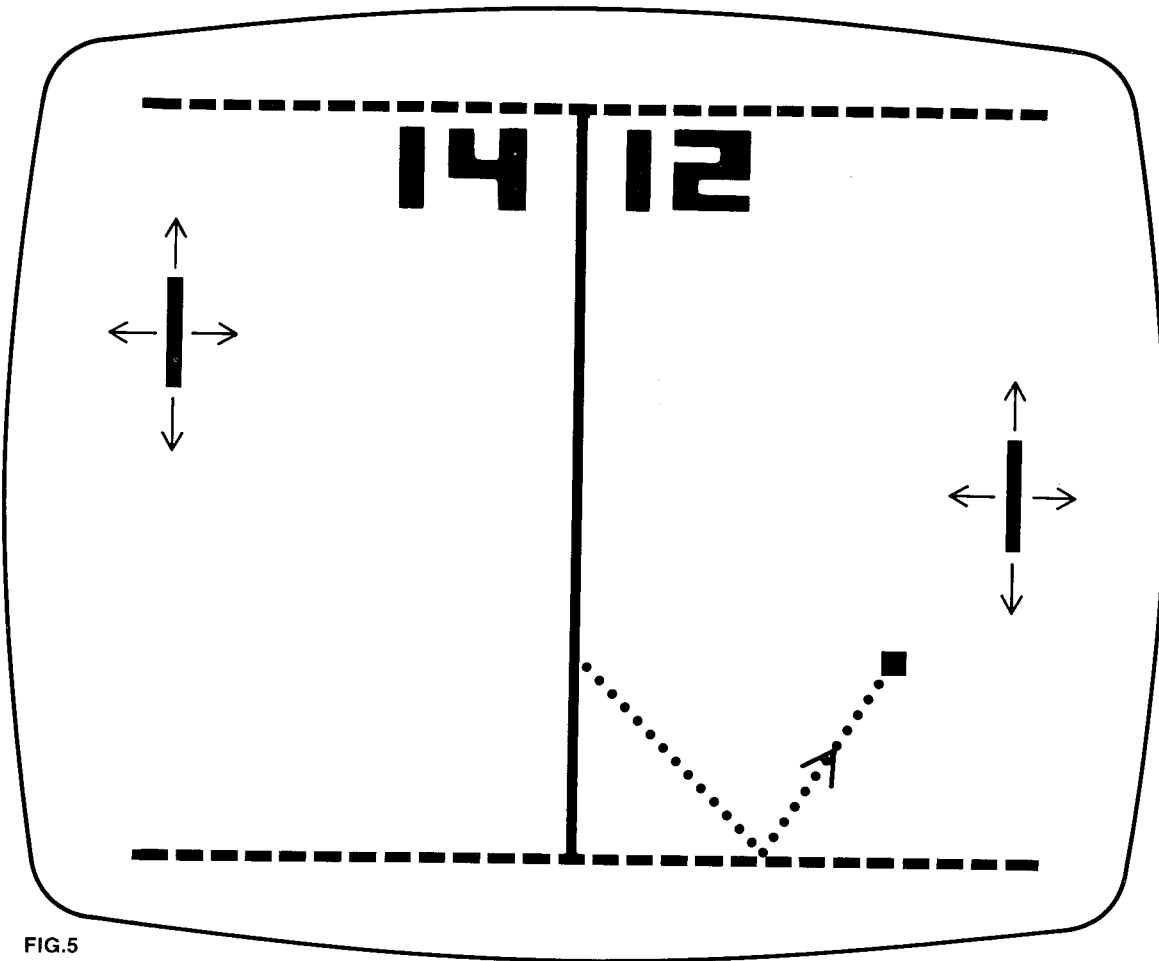


FIG.5

Tennis

With the tennis the picture on the television screen would be similar to Figure 5 with one 'bat' per side, a top and bottom boundary and a center net. The individual scores are counted and displayed automatically in the position shown. The detail of the game will depend upon the selection of the options. Considering the situation where small bats are used and all angles, after the reset has been applied, the scores will be 0, 0 and the ball will serve arbitrarily to one side at one of the angles. If the ball hits the top or bottom boundary it will assume the angle of reflection and continue in play. The player being served must control his bat to intersect the path of the ball. When a 'hit' is detected by the logic, the section of the bat which made the hit is used to determine the new angle of the ball.

To expand on this, all 'bats' or 'players' are divided logically into four adjacent sections of equal length. When using the four angle option it is the quarter of bat which actually hits which defines the new direction for the ball.

The direction does not depend upon the previous angle of incidence. With the two angle option the top and bottom pairs of the bats are summed together and only the two shallower angles are used to program the new direction for the ball.

When horizontal motion is selected, the players are restricted to the proper side of the net.

The ball will then traverse towards the other player, reflecting from the top or bottom as necessary until the other player makes his 'hit'. This action is repeated until one player misses the ball. The circuitry then detects a 'score' and automatically increments the correct score counter and updates the score display. The ball will then serve automatically towards the side which has just missed. This sequence is repeated until a score of 15 is reached by one side, whereupon the game is stopped. The ball will still bounce around but no further 'hits' or 'scores' can be made. While the game is in progress, three audio tones are output by the circuit to indicate top and bottom reflections, bat hits and scores.

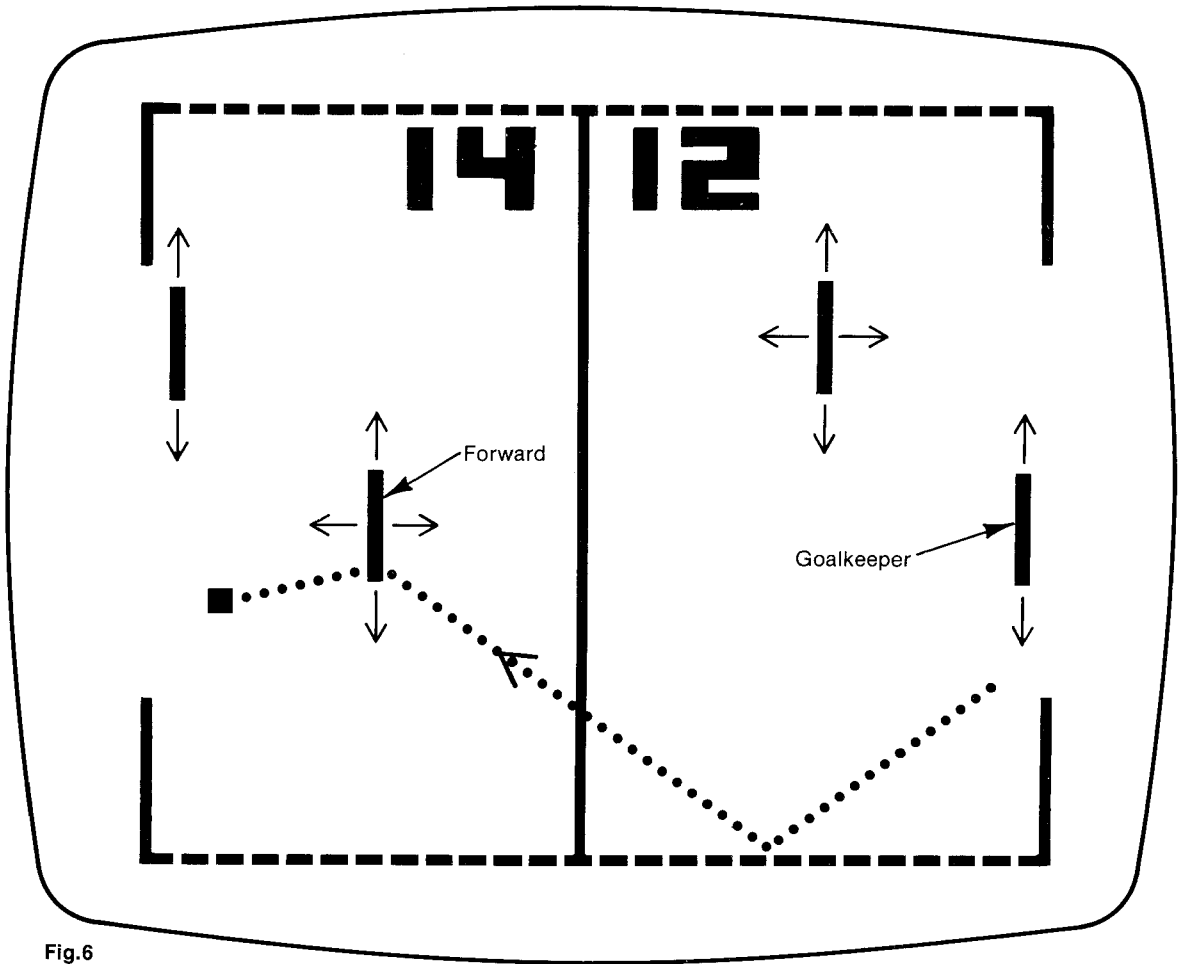


Fig.6

Soccer

The 'soccer' type game is shown in Figure 6. With this game each participant has a 'goalkeeper' and a 'forward'. The layout is such that the 'goalkeeper' is in his normal position and the 'forward' can be positioned in any part of the playing area.

When the game starts, the ball will appear travelling from one goal line towards the other side. If the opponent's forward can intercept the ball, (Figure 6a), he can 'shoot' it back towards the goal. If the ball is missed it will travel to the other half of the playing area and the first team's forward will have the opportunity

of intercepting the ball and redirecting it forward at a new angle according to the 'player' section which is used, (Figure 6b). If the ball is 'saved' by the 'goalkeeper' or it reflects back from the end boundary, the same forward will have the opportunity to intercept the outcoming ball and divert it back towards the 'goal'.

A 'score' is made in the 'soccer' game by 'shooting' the ball through the defined goal area. The scoring and game control is done automatically as for the tennis game. The same audio signals are used to add atmosphere to the game.

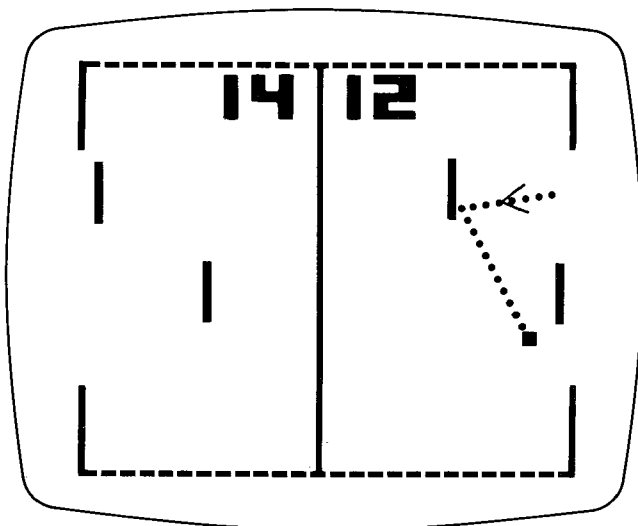


Fig.6a Return of "Goal Save"

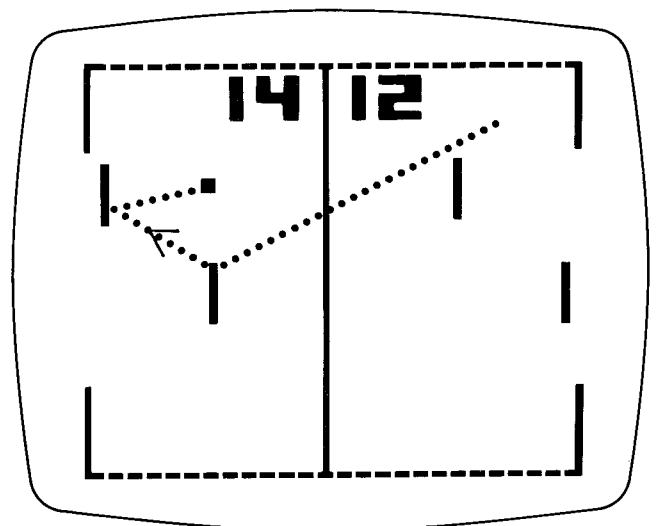


Fig.6b "Shooting" Forward

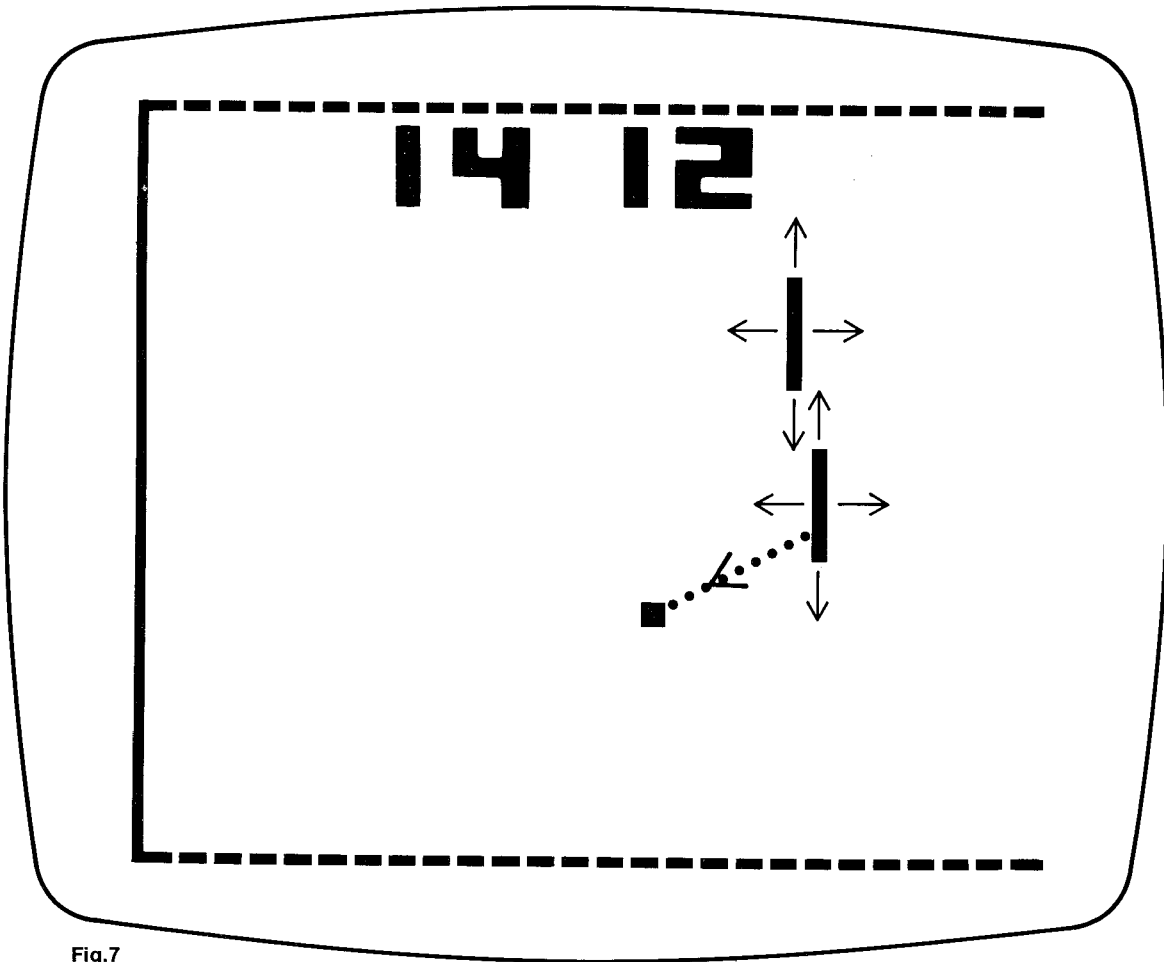


Fig.7

Squash

This game is illustrated in Fig. 7. There are two players who alternately hit the ball into the court. The right hand player is the one that hits first; it is then the left hand player's turn. Each player is enabled alternately to ensure that the proper sequence of play is followed. The ball is colored to the color of the bat of the next player who's to hit the ball.

Practice

This game is similar to squash except that there is only one player. See Fig. 8. The left score counts misses; the right score counts hits. The game ends when either 15 misses occur or when 15 consecutive hits are made without a miss. The right score is reset if it is not 15 and a miss occurs.

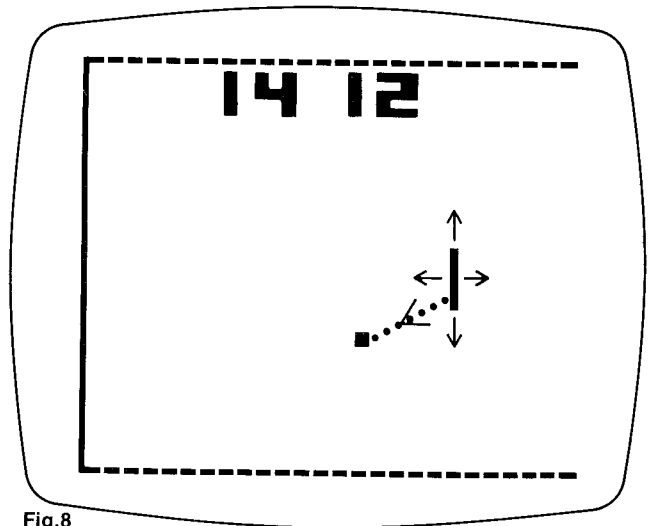


Fig.8

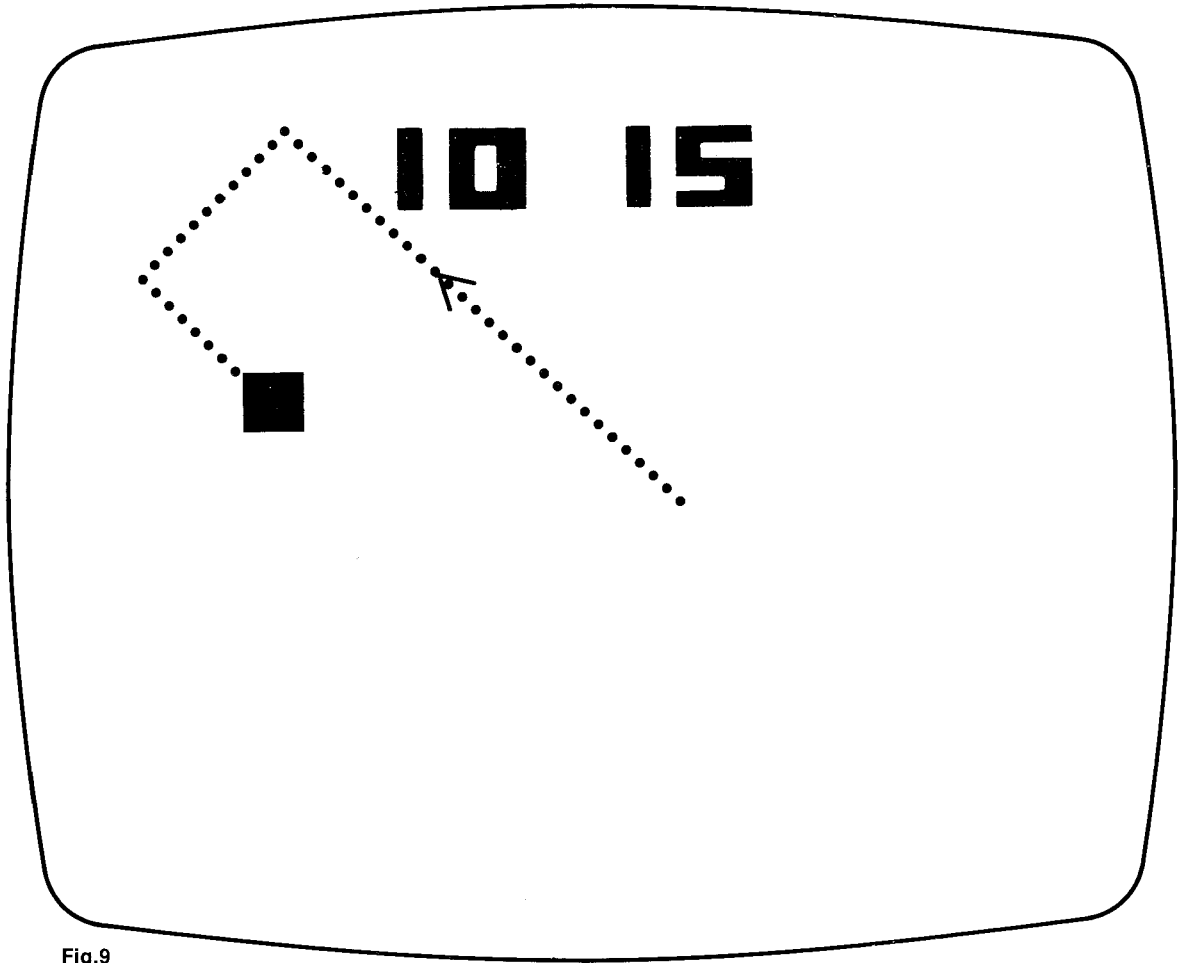


Fig.9

Rifle Game No. 1

This game is illustrated in Fig. 9. It has a large target which bounces randomly about the screen. A photocell in the rifle is aimed at the target. When the trigger is pulled, the shot counter is incremented and, if the rifle is on target, the hit counter is incremented, a hit noise is generated and the target is blanked for a short period. After 15 shots the score appears but the game can still continue without additional scoring.

Rifle Game No. 2

In this game, illustrated in Fig. 10, the ball traverses the screen from left to right under control of the manual serve button. Otherwise the game is as described for Rifle Game No. 1.

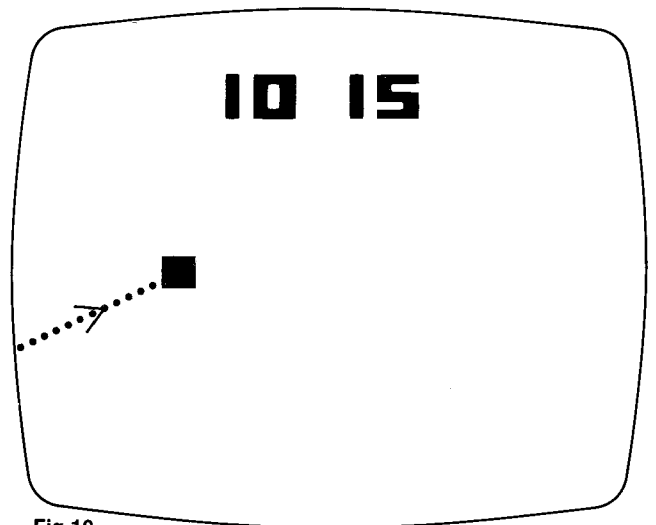


Fig.10

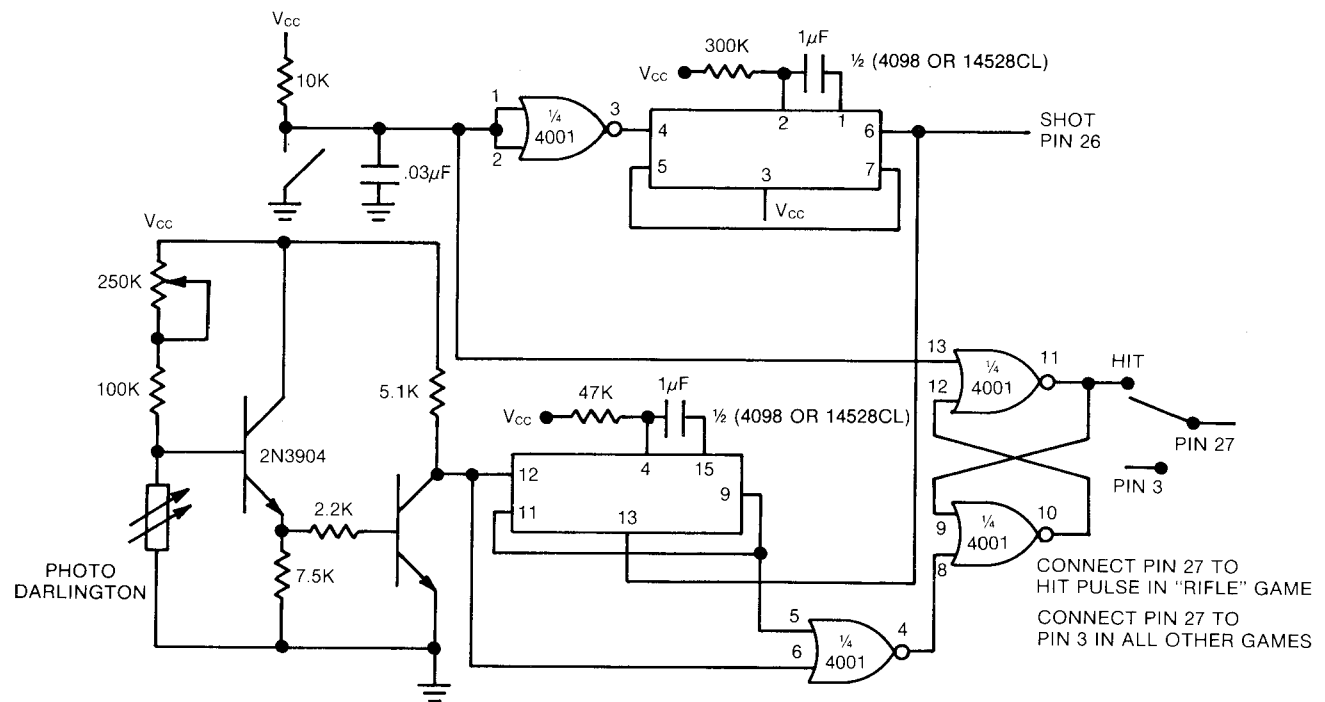


Fig.11 RIFLE INTERFACE

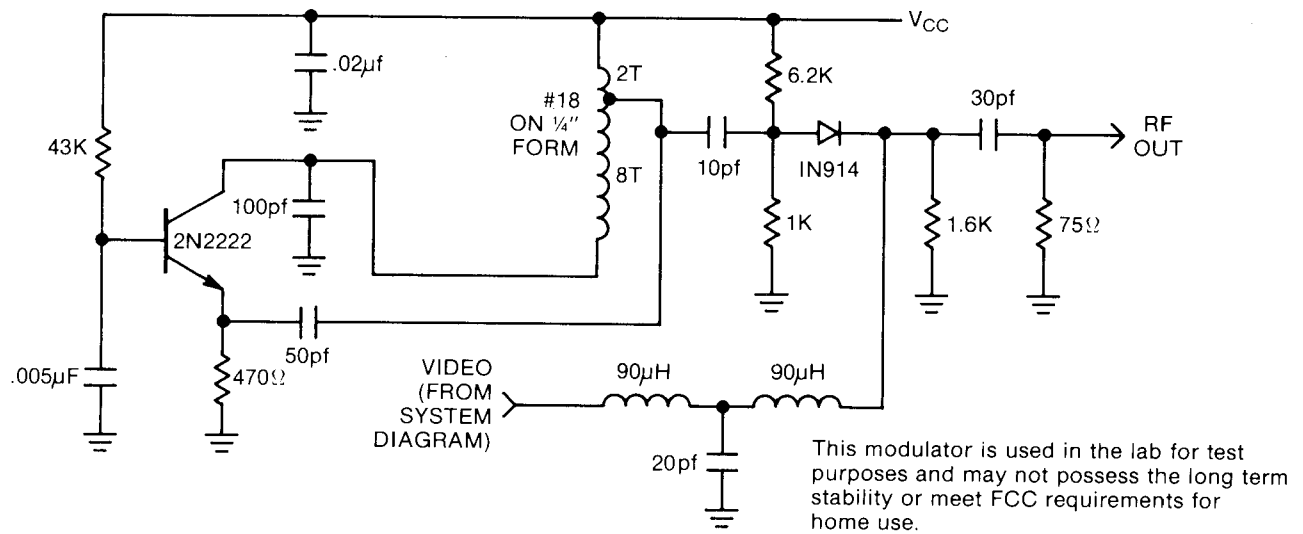


Fig.12 VHF MODULATOR

	Horizontal	Vertical
Slow	± .5µs	2 angles ± 1 line 4 angles ± 3 lines
Fast	± 1µs	2 angles ± 2 lines 4 angles ± 5 lines

Fig.13 ANGULAR MOTION



Ball & Paddle Color Converter

DESCRIPTION

The AY-3-8515 is a single N-Channel MOS circuit which accepts the video outputs of the AY-3-8500-1 and AY-3-8550-1 game circuits and converts the black and white signals to a single color composite video output. The colors of the background and paddle outputs are selectively changed directly by the game select inputs. The circuit also provides, as an output, a 2.045MHz clock for the game chip.

OPERATION

The AY-3-8515 provides a color composite video signal with color burst envelope and sync for input to the RF modulator of a TV game.

Sync: The sync input from the AY-3-8500-1 or AY-3-8550-1 is reconstructed in the color circuit and provides both front and back porches to insure correct operation in color TV circuits.

Color Burst: A color burst signal, containing ten cycles of the 3.579MHz color reference, is supplied after sync. The color phase of the burst is internally selected by the game select inputs with respect to the phases of the background, right player and left player so that different colors may be rendered for each game. This color change may be affected with no external components for ball and paddle games and only requires the addition of two diodes when target games are also selected.

The color burst is followed by an appropriate blanking interval so the TV set will not lock on to the background phase.

Video Inputs: Four video inputs are provided on the AY-3-8515. These are: field and score, left player, right player and ball. When operated with the AY-3-8550-1, the ball input should be grounded.

Video Output: After sync, color burst and blanking, the video consists of background, field and score, right player, left player and ball. The ball output is always white. In the absence of other signals, the background is output.

The color outputs are:

Grounded Select Input	Back-ground	Field	Right Player	Left Player
1 Tennis	Green	Yellow	Magenta	Blue
2 Soccer	Blue	Cyan	Dk Blue	Red
3 Squash	Magenta	Lt. Red	Blue	Yellow
4 Practice	Cyan	Green	Brown	Blue

Colors may be adjusted for system variations by the chip hue control which varies the phase delay of the color outputs.

For games incorporating rifle, select input 3 may be connected by diodes to the squash select and practice select inputs of the game circuit, and select input 4 may be connected by diodes to the two rifle inputs.

Luminescence Levels: The luminescence levels of the various signals in the composite video output have been selected to provide black and white compatibility. The field and left player signals are set to near white levels, the right to near black, and the background is set at a mid level to show gray.

Figure 1 shows the typical composite video waveform from the circuit.

PIN CONFIGURATION 16 LEAD DUAL IN LINE

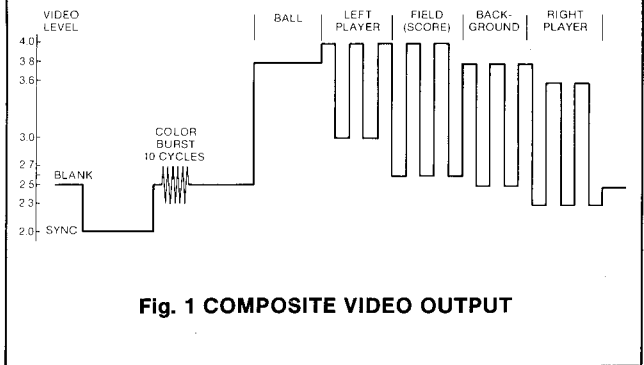
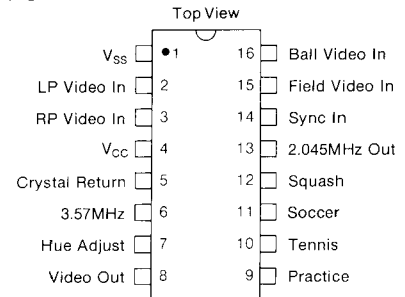


Fig. 1 COMPOSITE VIDEO OUTPUT

Characteristics at +25°C & V _{cc} = +6.0V	Min	Typ	Max	Units
Clock Input (Crystal)	—	3.579545	—	MHz
Video & Game Select Inputs				
Logic "0"	—	—	1.0	Volts
Logic "1"	V _{cc} - 2	—	—	Volts
Hue Adjust (External)	2.0	—	V _{cc}	Volts
Video Output (bias to V _{cc})	—	1K	—	Ω
Clock Output Rise & Fall Time	—	100	—	ns

In order to assure the correct video levels, a 1K variable potentiometer should be used to adjust the output to a maximum of 4 volts and a minimum of 2 volts.

CLOCK INPUT

The AY-3-8515 is operated directly from a 3.579MHz crystal input. A variable capacitor with a range of 3 to 15 pF should be used to tune the crystal.

CLOCK OUTPUT

The AY-3-8515 generates a low impedance 2.045MHz clock to directly drive the game chip without external components.



Superstar

FEATURES

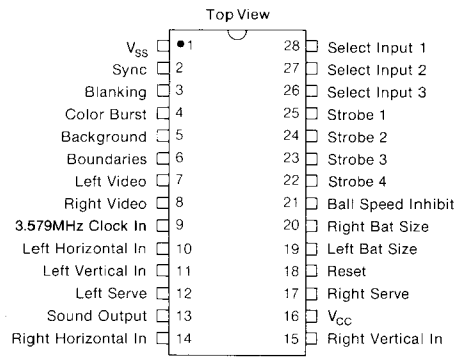
- Full **COLOR** Operation with AY-3-8615
- Ten selectable games — tennis, hockey, soccer, squash, practice, gridball, basketball, basketball practice, one and two player target
- 625 Line (AY-3-8610) and 525 Line (AY-3-8610-1) versions
- T.V. raster generator
- Two axis player motion
- Automatic on-screen scoring, 0-15
- Automatic ball speed-up after 7 hits or may be disabled by ball speed inhibit input
- Realistic ball service and scoring
- Score color keyed to player
- Independent player selectable bat size for handicapping
- Fast ball speed inhibit
- Five segment bats giving high, low, and horizontal ball angles
- Sound outputs for hit, rebound and score
- Shooting forwards in hockey and soccer

DESCRIPTION

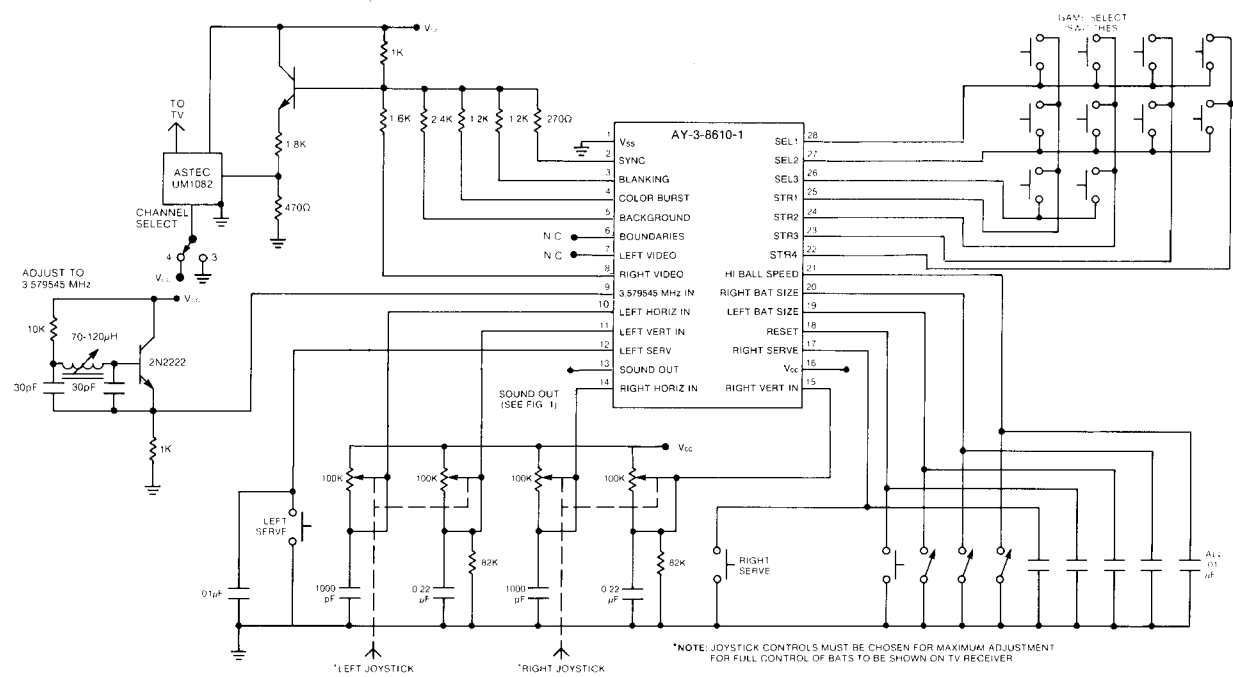
The AY-3-8610 and AY-3-8610-1 circuits have been designed to provide a TV 'game' function which gives active entertainment using a standard color or black and white domestic television receiver.

The circuit is intended to be battery powered and a minimum number of external components are required to complete the system.

PIN CONFIGURATION 28 LEAD DUAL IN LINE

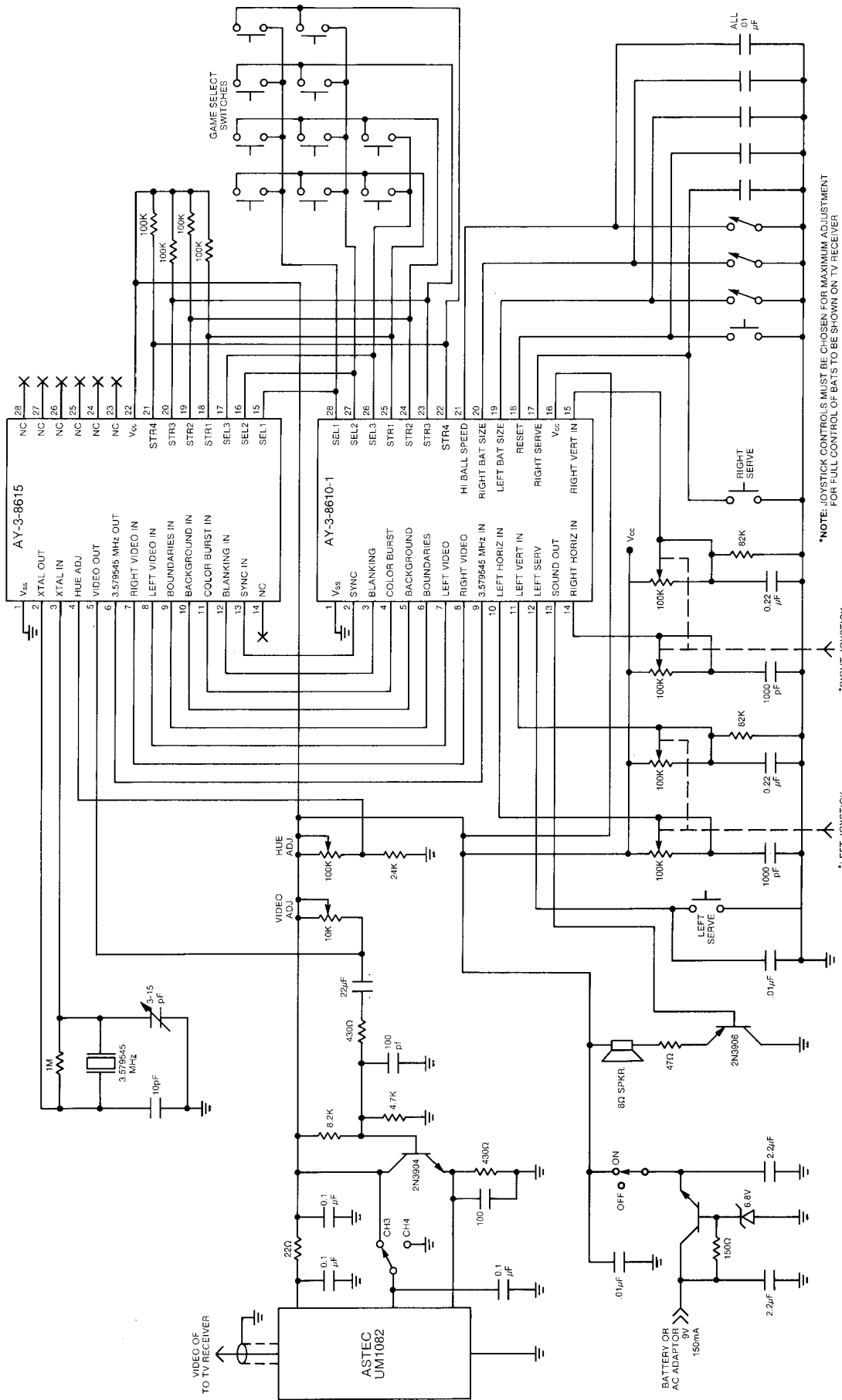


SYSTEM DIAGRAM 1: BLACK AND WHITE IMPLEMENTATION





SYSTEM DIAGRAM 2: AY-3-8610-1 FULL COLOR IMPLEMENTATION USING AY-3-8615 COLOR CONVERTER CIRCUIT



*NOTE: JOYSTICK CONTROLS MUST BE CHOSEN FOR MAXIMUM ADJUSTMENT FOR FULL CONTROL OF BATS TO BE SHOWN ON TV RECEIVER

*LEFT JOYSTICK

*RIGHT JOYSTICK



PIN FUNCTIONS

Power

V_{CC} positive supply input
 V_{SS} negative (substrate) supply input

Clock Input — 3.579MHz — color burst to N.T.S.C.

For black and white operation, a simple LC oscillator can be used for the clock, but for color, the clock must be derived from a color crystal as shown in System Diagram 2.

Color Inputs

- Right player vertical control
- Right player horizontal control
- Left player vertical control
- Left player horizontal control
- Right player serve
- Left player serve
- Right player bat size
- Left player bat size
- High speed ball inhibit
- Game reset

The game is reset with scores set to zero and ball returned to the service position by momentarily connecting the reset input to V_{SS}.

Bat size can be selected as either small or large individually for handicapping purposes. Connection of the bat size input to V_{SS} selects small bat.

Bat position is set by a variable resistor and capacitor connected as shown in the System Diagram.

Fast ball speed may be inhibited by connecting V_{SS} to the High Speed Ball Inhibit input.

Game Select Inputs/Outputs

Strobe 1	Select Input 1
Strobe 2	Select Input 2
Strobe 3	Select Input 3
Strobe 4	

Game selection is made by the interconnection of one of the output strobes, STR 1, STR 2, STR 3, or STR 4, with one of the three input selection lines SEL 1, SEL 2, or SEL 3.

The game selections are defined as:

STR 1/SEL 1	Tennis
STR 1/SEL 2	Hockey
STR 1/SEL 3	Squash
STR 2/SEL 1	Practice
STR 2/SEL 2	Soccer
STR 2/SEL 3	Basketball
STR 3/SEL 1	Basketball Practice
STR 3/SEL 2	Gridball
STR 4/SEL 1	Single Player Target
STR 4/SEL 2	Two Player Target

Video Outputs

- Right bat, score and ball
- Left bat, score and ball
- Boundaries
- Background
- Sync
- Blanking
- Color burst locator

All signals are present in the circuit to generate a composite video signal with composite blanking and sync. The combined video signal provides the input to the game RF modulator.

In addition to the above outputs, a color burst locator output is provided for use where external color generation is desired. The signal locates the position in the waveform behind the sync pulse.

In all games, the ball starts at slow speed. If the high speed mode has been selected the ball will switch to high speed after 7 consecutive hits by the players without a goal being scored.

The bats will be segmented into 5 zones, each zone defining a different rebound angle. The zones listed from top of bat to bottom are nominally high angle up, low angle up, horizontal, low angle down, high angle down. A ball passing through a forward from behind will have its angle influenced as above, but not its left/right direction.

All two player games will terminate when one player has 15 points at which time the bats have no further effect on the ball. The ball cannot be restarted until a game reset is applied.

Sound Output

Tone of approximately 500Hz, 1kHz and 2kHz will be output for a nominal period of 24msecs for ball hits wall, ball hits bat and score. The output is capable of directly driving 100 ohm speakers.

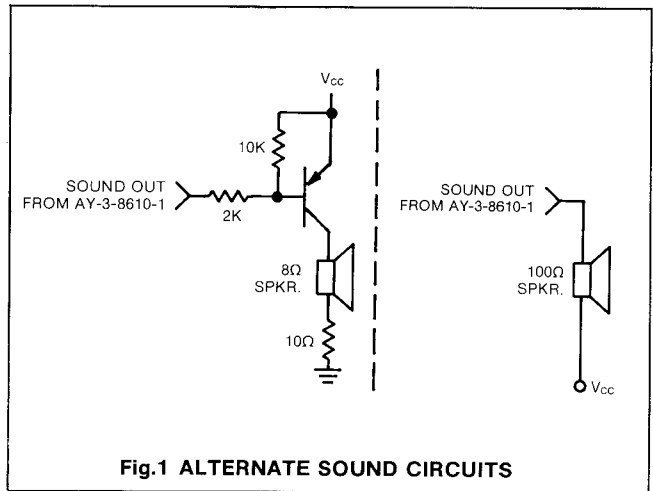


Fig.1 ALTERNATE SOUND CIRCUITS

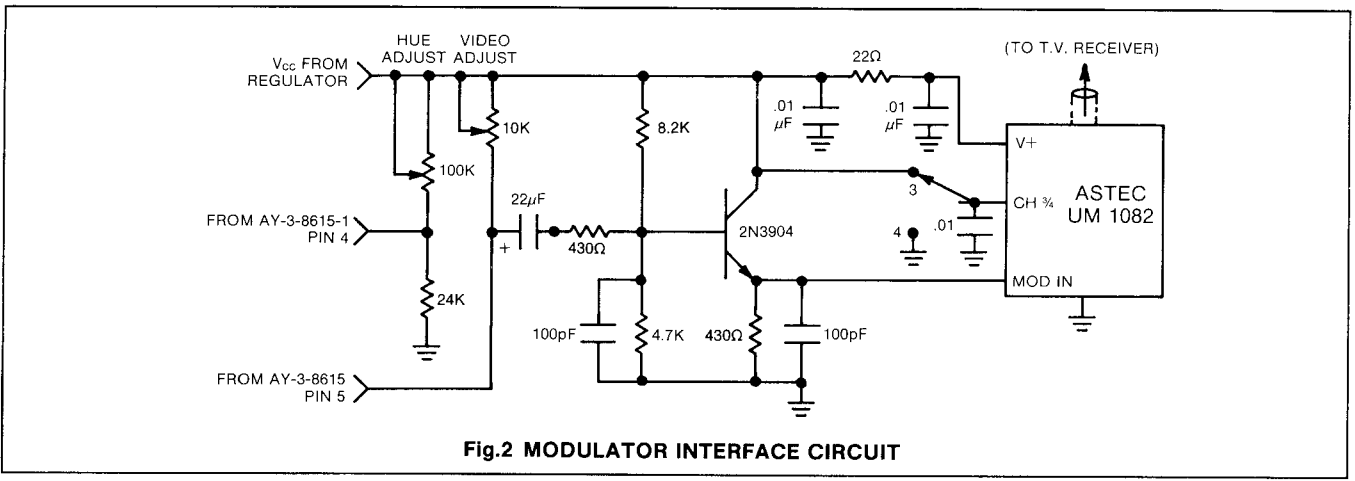


Fig.2 MODULATOR INTERFACE CIRCUIT



ELECTRICAL CHARACTERISTICS

Maximum Ratings*

Voltage on any pin with respect to V_{SS} pin -0.2 to +12V
 Storage Temperature Range -20°C to +70°C
 Ambient Operating Temperature Range 0°C to +40°C

*Exceeding these ratings could cause permanent damage. Functional operation of these devices at these conditions is not implied—operating ranges are specified below.

Standard Conditions (unless otherwise noted)

$V_{CC} = +6$ to +7V
 $V_{SS} = 0V$

Characteristics**	Min	Typ	Max	Units	Conditions
Clock Input					
Frequency	—	3.579545	—	MHz	
Logic '0'	0	—	0.5	Volts	50% duty cycle $\pm 5\%$
Logic '1'	$V_{CC} - 2$	—	V_{CC}	Volts	
Leakage	—	—	100	μA	
Control Inputs 12, 17, 18, 19, 20, 21, 26, 27, 28					Max. contact resistance of 1K to V_{SS}
Logic '0'	0	—	0.5	Volts	Pull up to V_{CC}
Logic '1'	$V_{CC} - 2$	—	V_{CC}	Volts	
Input Impedance	—	100	—	$k\Omega$	
Outputs Pins 2-8, & 13					
On	—	—	1.0	Volts	$I_{out} = 2$ mA
Off	—	—	100	μA	$V_{out} = V_{CC}$ (open drain)
Outputs Pins 22-25					
On	—	—	1.0	Volts	$I_{out} = 0.5$ mA
Off	—	—	100	μA	$V_{out} = V_{CC}$ (open drain)
Power supply current	—	—	60	mA	At $V_{CC} = +7.0V$

**At 25°C & $V_{CC} = 6V$

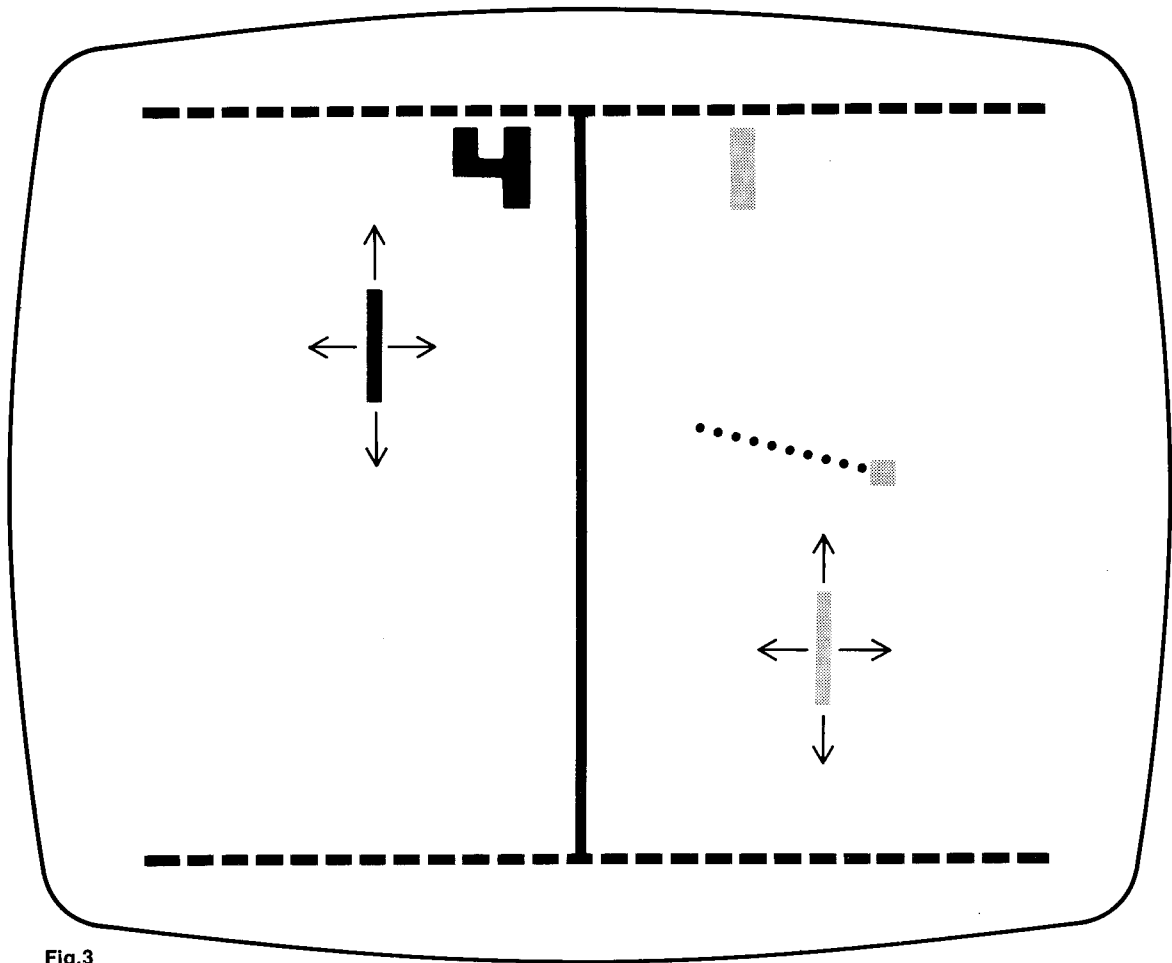


Fig.3

Tennis

This game uses a playing area as shown in Fig. 3. Each player can only move around his side of the court. The game will start when the player whose turn it is to serve, depresses his service button. The service will automatically change every five points scored. At service the ball will move away from the service point with a random angle but always toward the net.

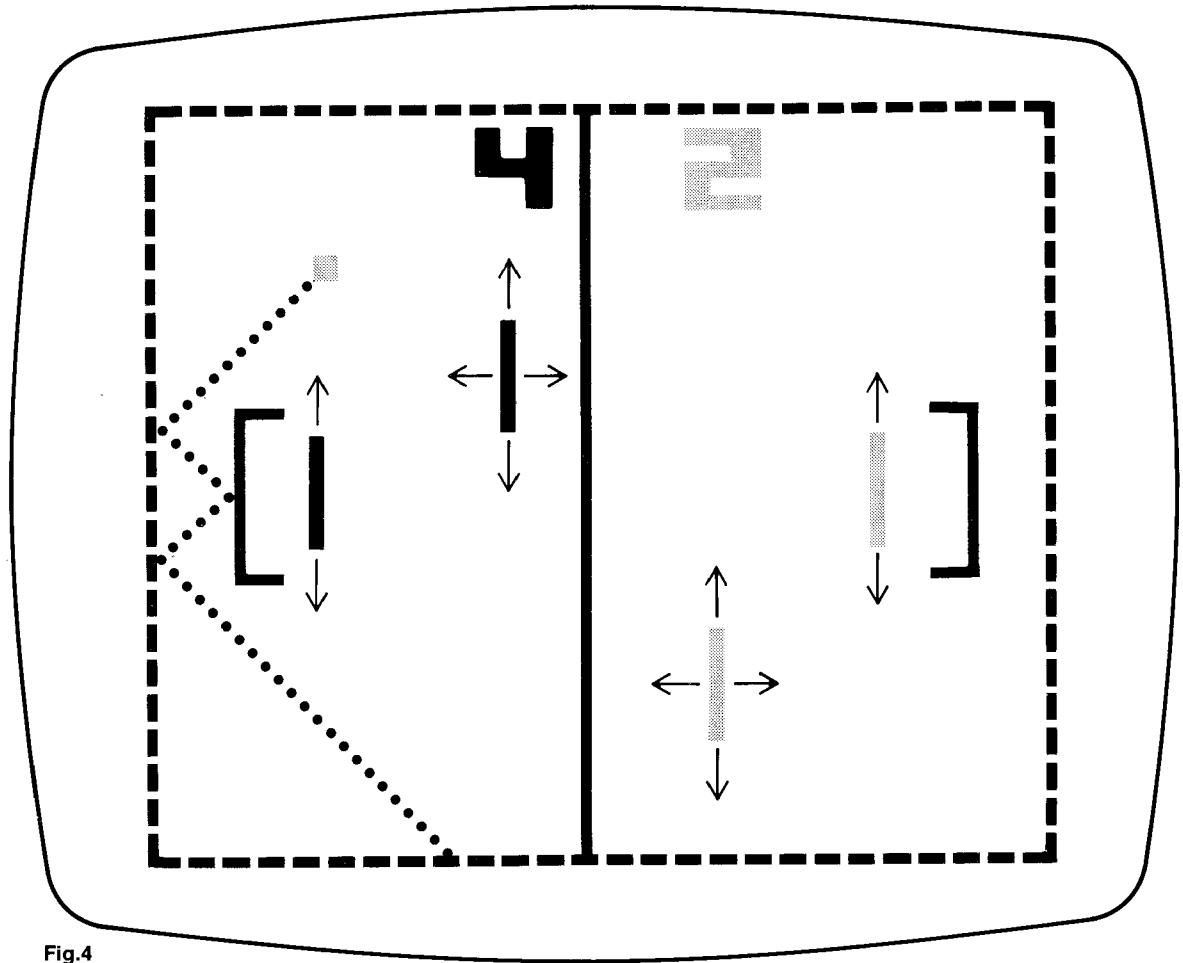


Fig.4

Hockey

This game uses a playing area as shown in Fig. 4. The forwards on both sides have freedom to move over the entire playing area. The goal keepers will be locked in the horizontal axis in front of their respective goals but will move in the vertical axis in the same manner as the forwards.

The game starts when both players have depressed their service buttons. The ball will move away from the face off point with a randomly selected angle in either direction.

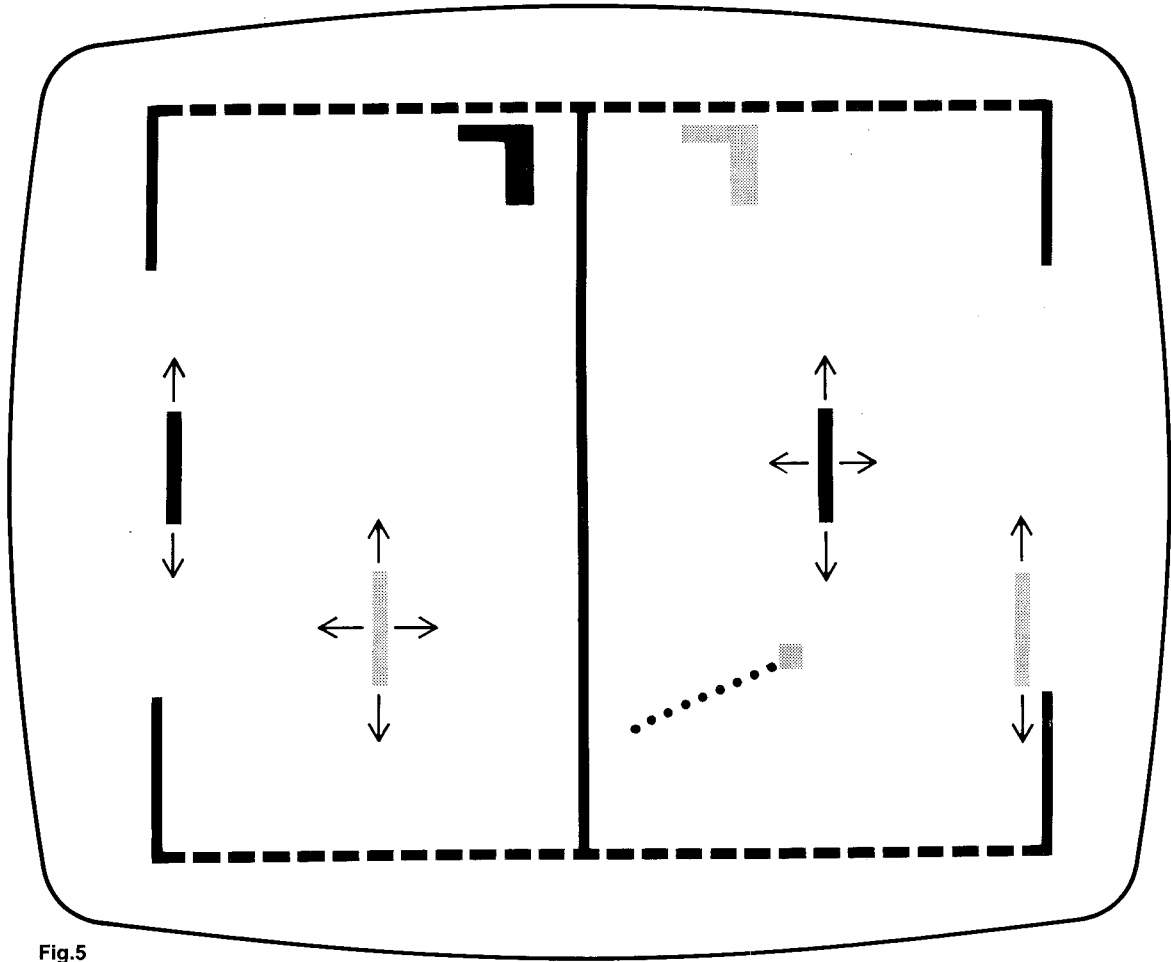


Fig.5

Soccer

This game uses a playing area as shown in Fig. 5. The motion of the players is as in the hockey game. The game will start when the loser of the previous goal depresses his service button. The ball will move away from the kickoff point with a randomly selected angle but always towards the goal of the winner of the previous goal.

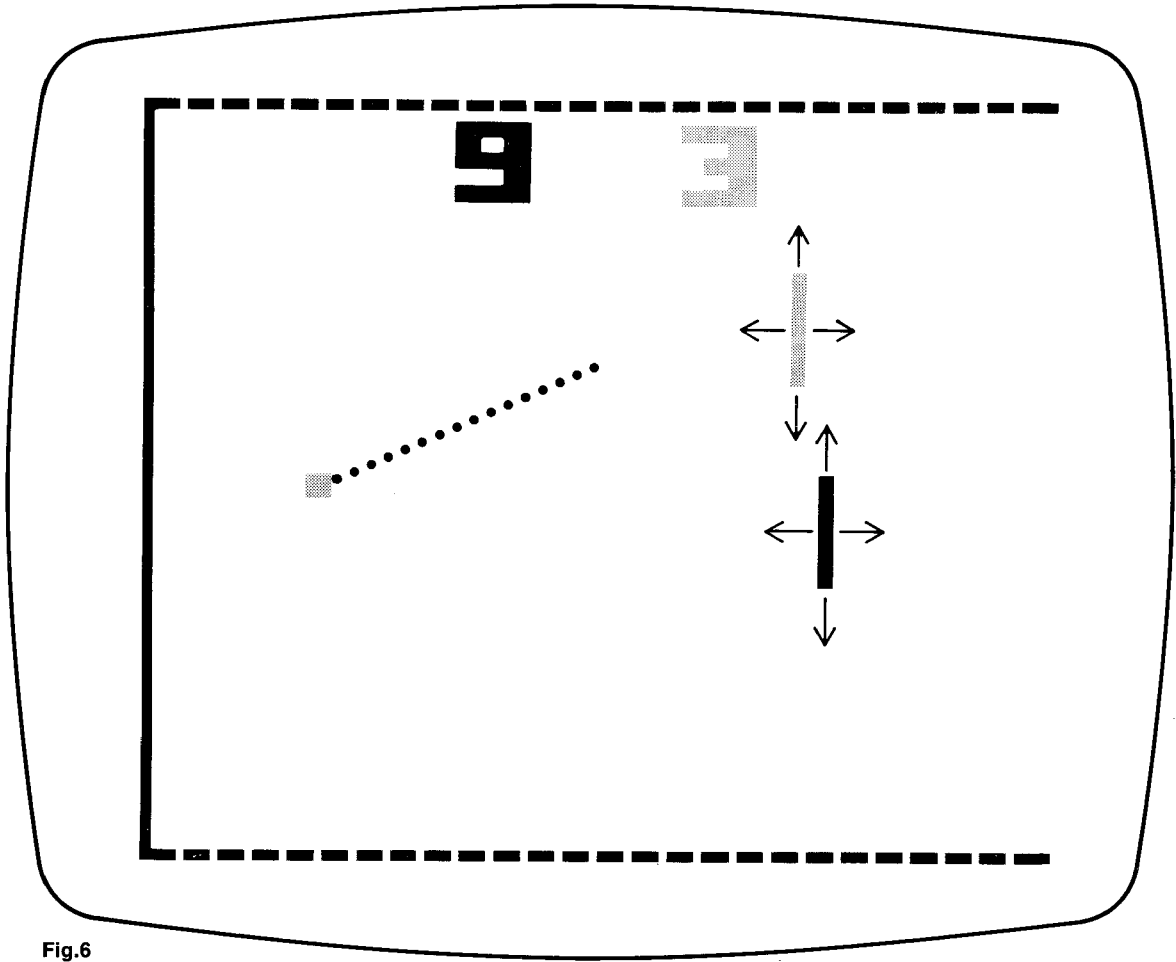


Fig.6

Squash

This game uses a playing area as shown in Fig. 6. Each player can move over the whole court. The game will start when the player whose service it is, depresses his service button. The ball moves off with a random angle toward the front wall. The color of the ball will change to the color code of the next player to hit the ball. Should the wrong player intercept or be hit by the ball it will be considered a fault. Points will only be given if won on player's own service. Points won on opponents serve will only cause a service change.

Practice

This game is a single player squash (See Fig. 7). The right score counts the number of successive hits in the current game (to a maximum of 15), the left score the number of volleys played.

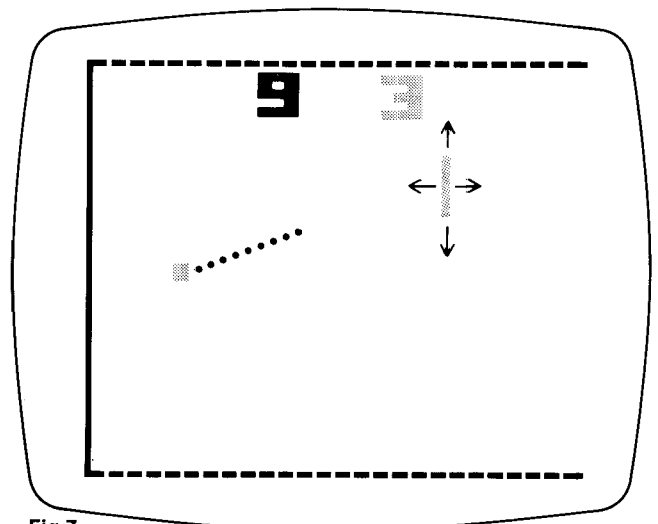


Fig.7

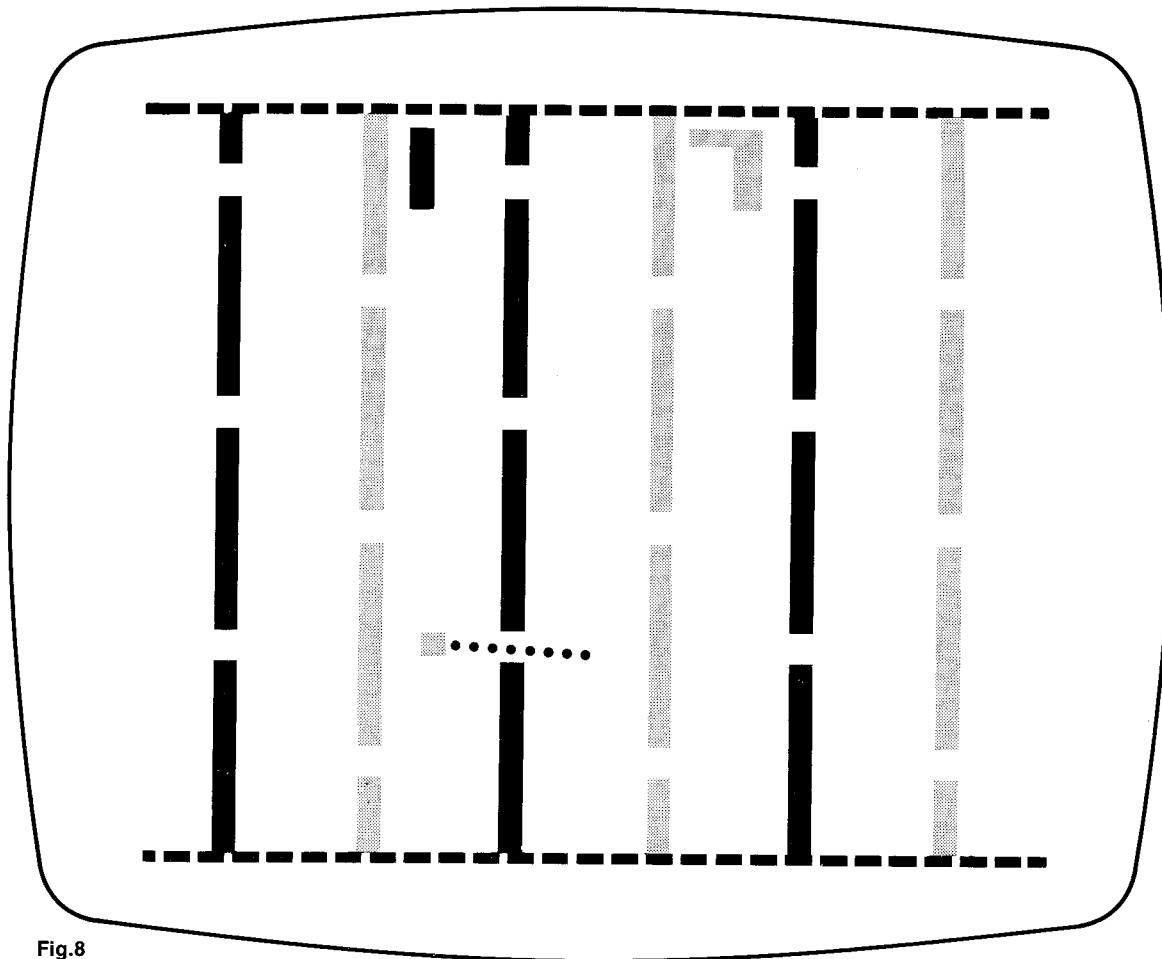


Fig.8

Gridball

This game uses a playing area as shown in Fig. 8. Each player has three sets of vertically moving barriers to block the ball from approaching his end and opening in the barriers to permit the ball to advance toward the opponent's end. The game starts when both players have depressed their service buttons. The ball moves away from the face off point with a random angle in either direction.

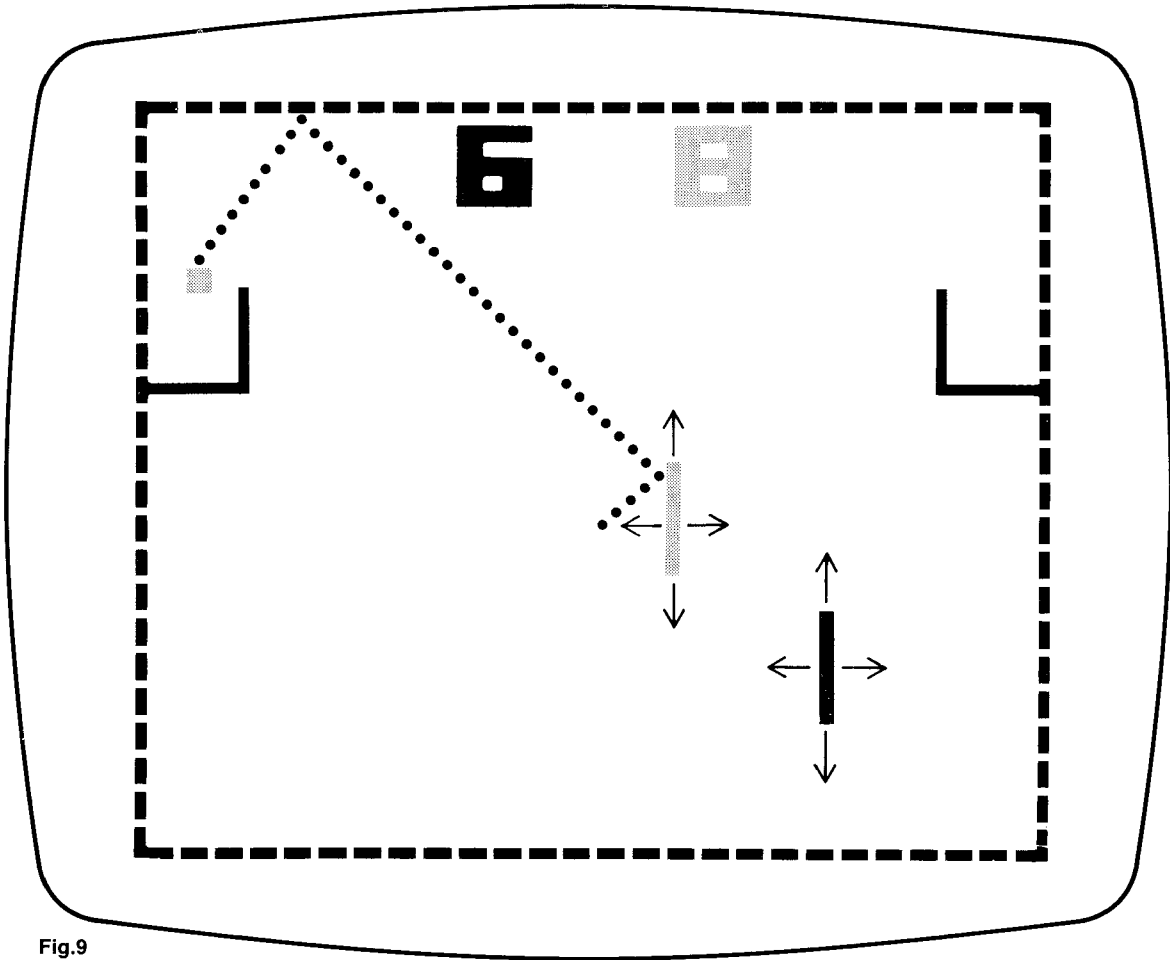


Fig.9

Basketball

The basketball games use the closed playing area as shown in Fig. 9. The players must deflect the ball and cause it to either the top of the goal to score. The game starts when both players depress the service buttons. The ball moves from the serve point with a random angle in either direction.

Basketball Practice

Basketball practice is a one player game which utilizes only the left basket as shown in Fig. 10. The right counter displays the number of hits the player makes without scoring while the left counter shows the number of baskets made. Play starts when the right serve button is depressed.

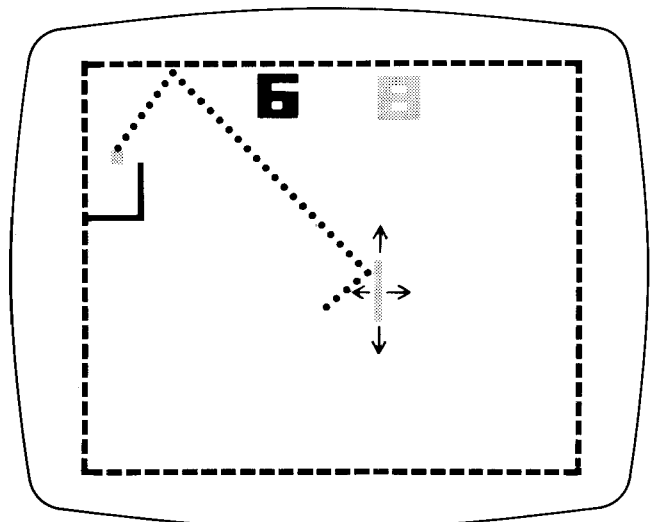


Fig.10

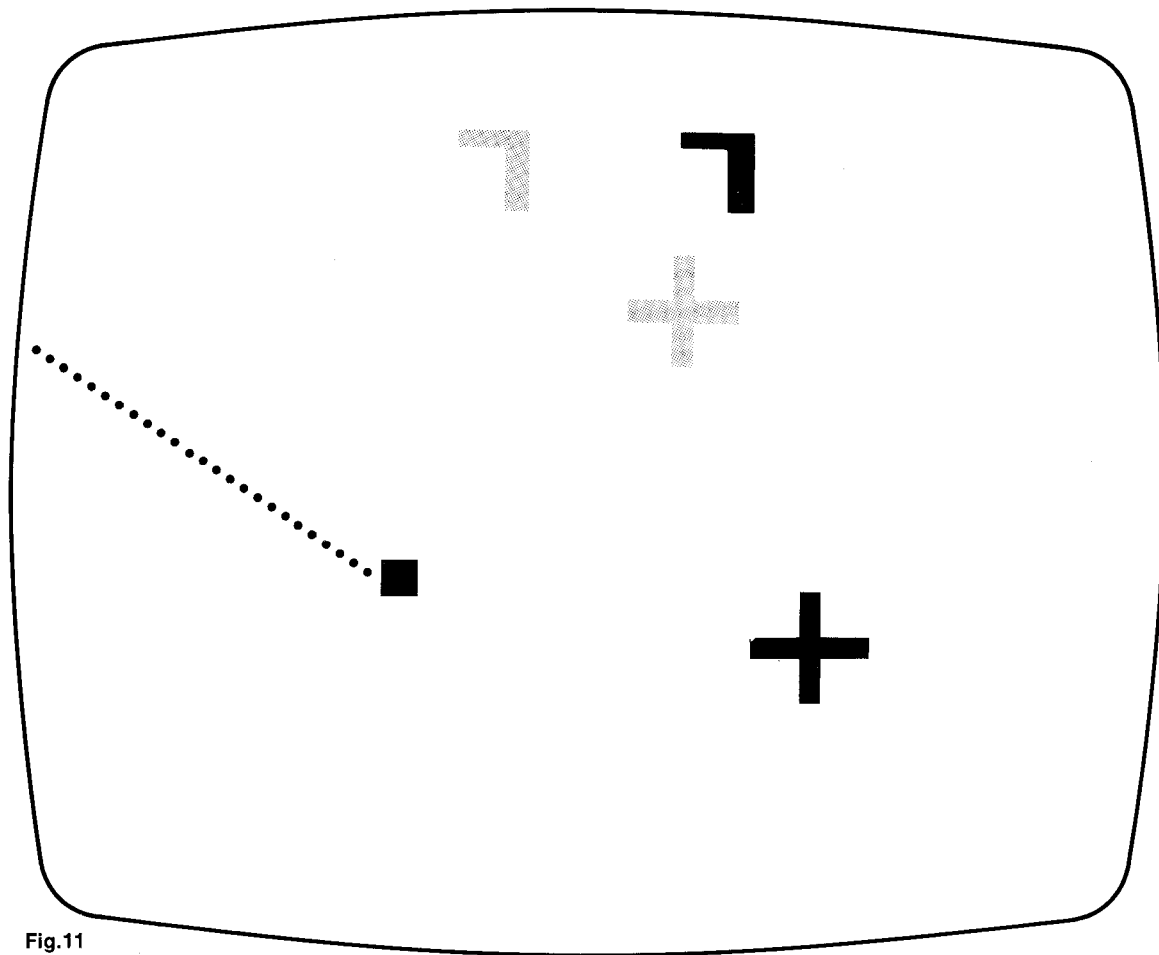


Fig.11

Two Player Target

The two player target game follows the same rules as the single player game except that both players control their own cursors and shot buttons. The left score displayed is for the left player and the right score displayed is for the right player. The target can only be shot at once on each traverse by either player but only recognizes the first hit. The first player to reach a score of 15 wins the game.

Single Player Target

The single player target game is a game in which the player moves a cursor displayed on the T.V. screen over a moving target and depresses the serve button for shots to be taken. The player has only one "shot" for each traversal of the screen by the target. Additional "shots" are ignored after the first shot on each traverse. The right score indicates the number of hits made and the left score indicates the misses. A count is made on either score on each traverse of the target across the screen. The target disappears when hit and the game ends when either of the scores displayed reaches 15.

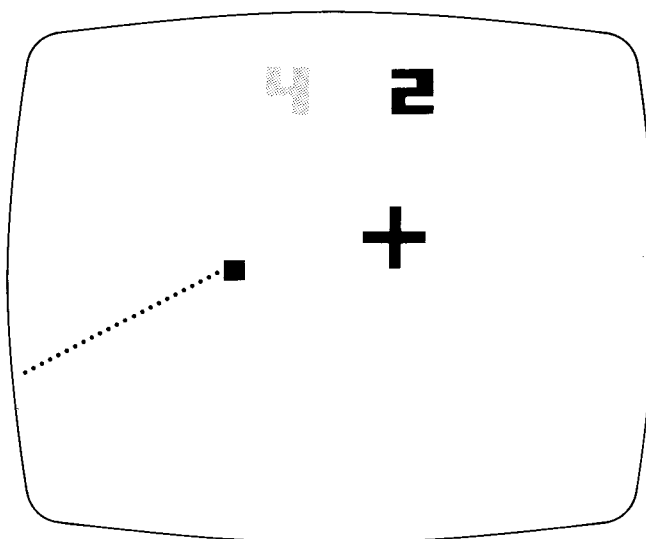


Fig.12



Superstar Color Converter

DESCRIPTION

The AY-3-8615 is a single N-Channel MOS circuit which processes video signals from any of the Gimini "8600" Game Series circuitry. It converts these video signals into a single color composite video output. The colors of the background and objects are selectively changed directly by the game select matrix. The circuit also provides, as an output, a buffered 3.579 MHz clock for the game chip.

OPERATION

The AY-3-8615 provides a color composite video signal with color burst envelope and sync for input to the RF modulator of a TV game.

Sync: The sync input from any of the "8600" games is OR'ed with the video output of the color circuit. The sync amplitude level is compensated to ensure correct operation in color TV circuits.

Color Burst: A color burst signal, containing ten cycles of the 3.579MHz color reference is supplied after sync. The color phase of the burst is internally shifted by the game matrix inputs with respect to the phases of the background, right player and left player so that different colors may be rendered for each game. This color change may be affected with no external components.

Video Inputs: Seven video inputs are provided on the AY-3-8615. These are: field, background, color burst locator, left player, right player, blanking, and sync.

Video Output Mixer: With OR'ed sync, color burst and blanking, the video consists of background, field scores, right player, left player, and objects on a single output pin.

Grounded Select Input	Back-ground	Field	Right Player	Left Player
1. Sel1/Str1, Sel2/Str2, Sel2/Str4	Green	Yellow	Magenta	Blue
2. Sel2/Str1, Sel2/Str3	Blue	Cyan Blue	Dk. Blue	Red
3. Sel3/Str1, Sel3/Str2	Magenta	Lt. Red	Blue	Yellow
4. Sel1/Str2, Sel1/Str3, Sel1/Str4	Cyan Green	Green	Brown	Blue

Colors may be adjusted for system variations by the chip hue control which varies the phase delay of the color outputs.

Luminescence Levels: The luminescence levels of the various signals in the composite video output have been selected to provide black and white compatibility. The field and left player signals are set to near white levels, the right to near black, and the background is set at a mid level to show gray.

Figure 1 shows the typical composite video waveform from the circuit.

In order to assure the correct video levels, a 1K variable potentiometer should be used to adjust the output to a maximum of 4 Volts and a minimum of 2 Volts.

PIN CONFIGURATION

28 LEAD DUAL IN LINE

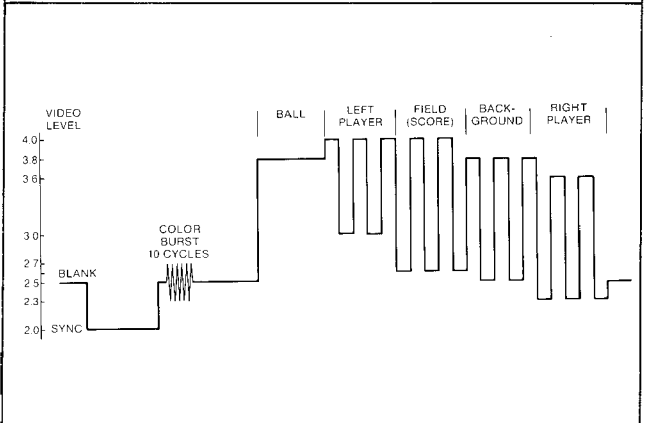
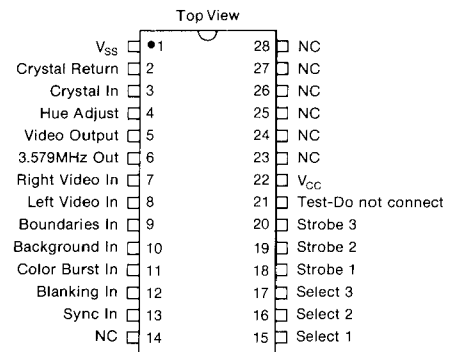


Fig. 1 COMPOSITE VIDEO OUTPUT

CLOCK INPUT

The AY-3-8615 is operated directly from a 3.579MHz crystal input. A variable capacitor with a range of 3 to 15 pF should be used to tune the crystal.

CLOCK OUTPUT

The AY-3-8615 generates a low impedance 3.579MHz clock to directly drive the "8600" series game chips without external components.

Characteristics at +25°C & V _{CC} = +6.0V	Min	Typ	Max	Units
Clock Input (Crystal)	—	3.579545	—	MHz
Video & Game Select Inputs				
Logic "0"	—	—	1.0	Volts
Logic "1"	V _{CC} - 2	—	—	Volts
Hue Adjust (External)	2.0	—	V _{CC}	Volts
Video Output (bias to V _{CC})	—	1K	—	Ω
Clock Output Rise & Fall Time	—	100	—	ns



AY-3-8710

AY-3-8710-1

Battle

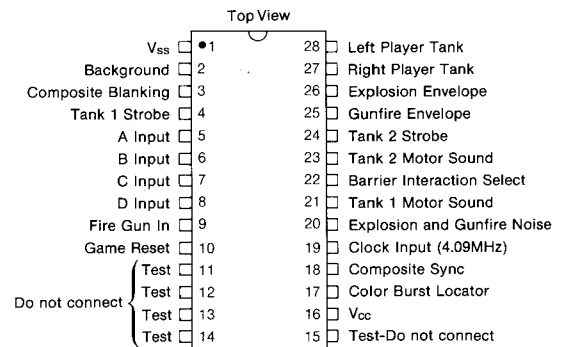
FEATURES

- Two independently controllable tanks
- Tank explosion and sounds when hit by shell or mine
- Exploding mines
- Shell firing and burst video and sound
- Three forward and reverse tank speeds
- 32 rotational angles
- Fixed terrain barriers
- Realistic tank sounds
- Automatic on-screen scoring
- Scores color keyed to player
- 625 Line (AY-3-8710) and 525 Line (AY-3-8710-1) Versions
- TV raster generator

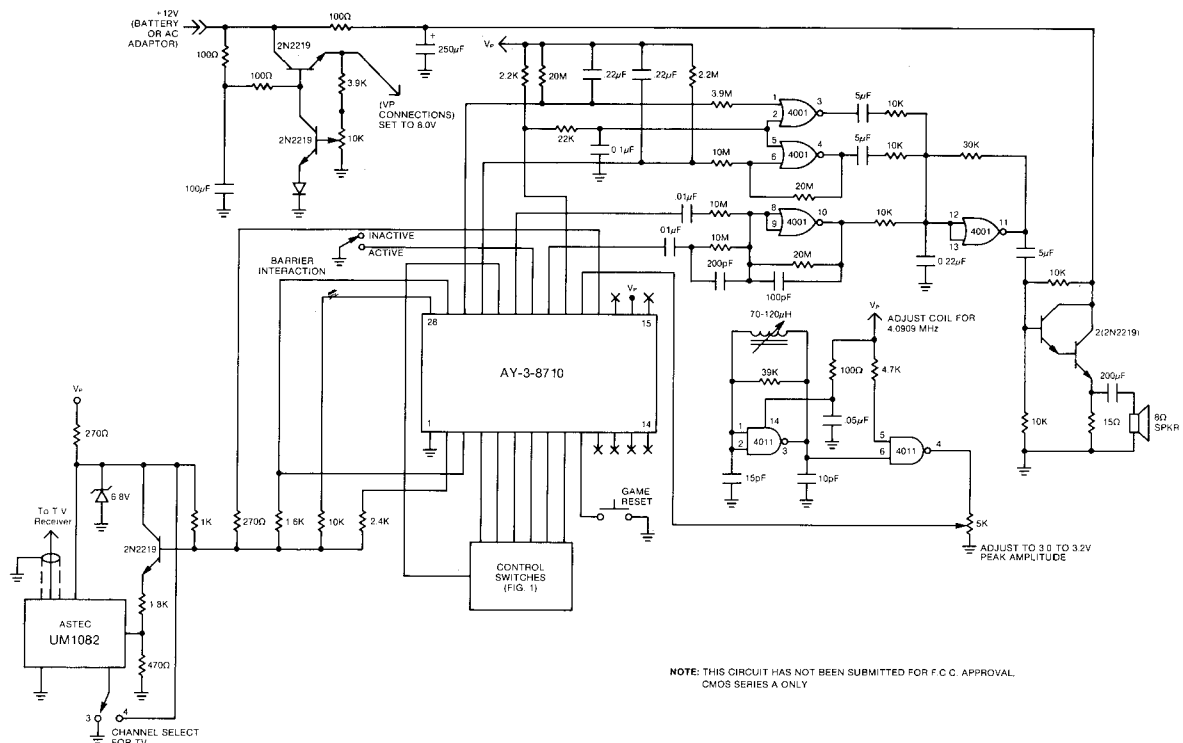
DESCRIPTION

The AY-3-8710/8710-1 circuit is a "tank battle game" and has been designed for two players where each player has a completely steerable tank with forward and reverse speed control and a firing button. Anti-tank barricades and mines are in the battlefield to retard each tank's progress while under battle conditions. The object of the game is to score as many hits on the enemy tank as possible. The first player to reach 16 hits ends game. The circuit is designed to be used with standard domestic television receivers. The AY-3-8710/8710-1 is manufactured in a 28 pin dual-in-line package and can be used in battery systems with a minimum number of components to provide a complete game.

PIN CONFIGURATION 28 LEAD DUAL IN LINE



SYSTEM DIAGRAM





PIN FUNCTIONS

Sound Outputs

- Tank 1 motor
- Tank 2 motor
- Bearing and track squeak
- Explosion envelope
- Gun fire envelope
- Explosion and gun fire noise

Power Input

- V_{CC} positive voltage
- V_{SS} substrate (negative) voltage

Control Inputs and Outputs

- A Input
- B Input
- C Input
- D Input
- F Input
- Control strobe 1
- Control strobe 2
- Game reset

Video outputs

- Right player tank, shell, shell burst, score and mines.
- Left player tank, shell, shell burst, score and fixed barriers.
- Blanking
- Background
- Sync
- Color burst locator

All signals are present in the circuit to generate a composite video signal with a sync waveform which includes composite blanking equalization pulses and color burst locator. This video signal provides the input to the game RF modulator.

The luminance levels are set by the ratios of the resistor shown in the System Diagram. This output configuration provides maximum flexibility to the user.

Five outputs are provided; sync, right player, left player, background and blanking. The right player output includes the tank symbol, right player score, shells fired by the right tank, shell burst from right tank shells and mines. The left player output includes the left tank, left player score, shells fired by the left tank, left tank shell bursts and fixed barriers.

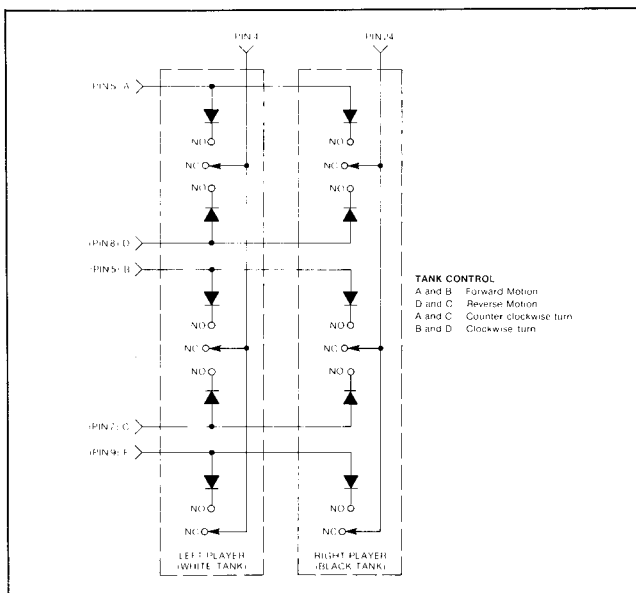
One tank is displayed in white, one in black, and the background in gray.

The blanking and black outputs are shown connected to a single resistor since the modulation level is approximately the same for both.

In addition to the preceding five outputs, a color burst locator is provided to enable users who wish to provide a color background to locate the color burst envelope at the correct waveform position after the sync output.

Clock Input

4.09MHz clock input—This is the only clock required for black and white operation. A typical 4.09MHz oscillator circuit with control input is shown in the System Diagram.



ELECTRICAL CHARACTERISTICS (PRELIMINARY INFORMATION)

Maximum Ratings

- Voltage on any pin with respect to V_{SS} 0 to 12V
- Storage temperature range -20°C to 70°C
- Ambient Operating Temperature Range 0° to +40°C

Standard Conditions (Unless stated otherwise)

- V_{CC} = +6.0 to 7.0 volts (subject to further characterization)
- V_{SS} = 0 volts

*Exceeding these ratings could cause permanent damage. Functional operation of this device at these conditions is not implied—operating ranges are specified below.

Characteristics at 25°C, V _{CC} =6 Volts	Min	Typ	Max	Units	Conditions
Clock input frequency (Duty Cycle 50% ± 5%)	—	4.0909	—	MHz	
Rise and Fall Times	—	—	40	ns	
Logic '0'	0	—	0.5	Volts	
Logic '1'	3.0	—	4.0	Volts	
Input Current	—	—	100	µA	
Outputs: Pins 2, 3, 4, 17, 18, 20, 24, 25, 26, 27, 28 (Open drain)	—	—	300	Ω	V _{OUT} = 0.5V, 4.7K to V _{CC}
Outputs: Pins 21, 23 (push pull)					
Logic '0'	0	—	0.5	Volts	
Logic '1'	V _{CC} - 2	—	V _{CC}	Volts	
Inputs: Pins 5, 6, 7, 8, 9					
Logic '1'	V _{CC} - 2	—	V _{CC}	Volts	See System Diagram for correct circuit
Maximum supply current	—	—	75	mA	

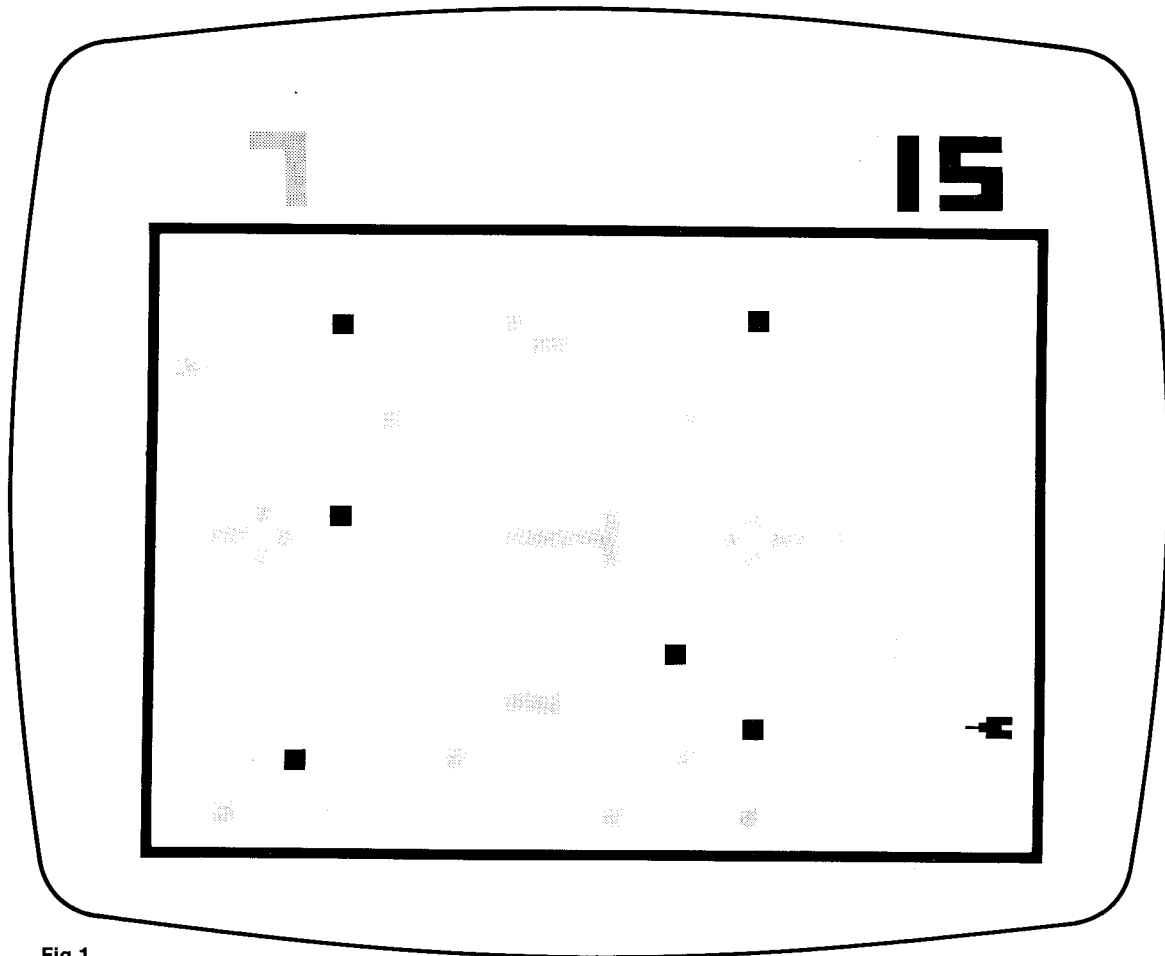


Fig.1

Battle

DISPLAY SYMBOLS AND CONTROL

TANKS

Control — The tanks are controlled by connecting the appropriate strobe outputs to the inputs A, B, C, D, or F. Forward motion is achieved when both the A and B inputs are connected to the strobe. On connection, the tank will advance in low speed. If the connection is held, the medium speed will select after one half second. After another one half second of connection, high speed is selected. Breaking the connection when any speed is achieved will cause the tank to remain at the selected speed. The controls should each be single pole double throw center off momentary switch. To stop the tank, the controls should be momentarily contacted opposite to tank direction.

The tank can be made to go through the three reverse speeds at one half second intervals by connection of the C and D inputs to the appropriate strobe output. Tank rotation in a clockwise (right turn) direction is caused by connection of the B and D inputs to the strobe while counterclockwise (left turn) direction is caused by connection of the A and C inputs to the strobe. The tanks are able to turn while either in forward or reverse speed and rotate when stationary.

Tank Details

Definition and resolution	64 bits (8x8) or 8/100 of TV screen width
Orientations	32
Direction of travel and firing angles	32
Forward speeds	3
Reverse speeds	3
White tank exhibits line displacement on top.	

SHELLS

Firing — connection of the gun fire input to a strobe output with a SPST normally open pushbutton switch causes the firing of a tank gun and release of a shell. The firing rate is approximately once every four seconds and the refire requires release of the button and redepression. Depression made during the four second interfering time will initiate fire sound but will not initiate shell.

When a shell is in flight, the rotation of the tank will cause the shell to follow a curved trajectory in the direction of tank rotation.

Range — the range of a shell is approximately 2/3 of the screen length or width dependent on firing angle.

Size — the shell is a 1x1 bit dot.

BATTLEFIELD BARRIERS

Fixed Terrain Barriers — Twenty two fixed terrain barriers are on the battlefield to provide protection from shells. Tanks cannot pass through barriers when Barrier Interaction is selected.

Mines — six mines are distributed on the battlefield. Hitting a mine with a tank causes the tank to explode and become stationary with its gun inactive for a period of 2 to 4 seconds. The mine then vanishes for the duration of battle. A mine being hit scores for the enemy tank.

Barrier Sizes — barriers and mines are 4x4 bit square minimum size.



EXPLOSIONS (VIDEO)

Shell Bursts — shell burst patterns are produced when a shell is at end of range or when the shell makes contact with a barrier.

Tank Explosions — a tank will explode and fragment momentarily when a tank hits a mine or is struck by a shell.

SCORING

Separate scores, color coded to the tank, are indicated for each player. A player's score is incremented when his tank scores a hit

on his opponent's tank or the opponent's tank hits a mine. The game ends when either player scores 16 points, at which time the score flashes at a 1 Hz rate and no further hits are recorded.

RESET

The game is reset by momentarily connecting Reset input to V_{SS} through an SPST pushbutton. On reset, the scores are cleared to zero, mines replaced and the tanks reset to the upper left and lower right corners in the stationary condition.

SOUND OUTPUT

GENERAL

The sound outputs produced by the circuit are low frequency typical of those associated with heavy equipment motors and of explosions. It is recommended that the sound be reproduced through the TV set or in a large speaker so the full richness of the sound can add the proper atmosphere to the game.

ENGINE SOUND

Outputs are provided for the engine sound associated with each tank. Four motor frequencies are provided; three for the three speed ranges and one for stationary condition. A typical sound circuit for filtering each output is shown in the System Diagram.

GUN FIRE SOUND

Gun fire sounds are produced mixing the noise output with the fire output. The fire output should be filtered and mixed with the noise output as shown in the System Diagram.

SHELL BURST AND TANK EXPLOSION SOUNDS

Shell burst sounds are produced when a shell reaches the end of its range or hits a barrier, a border, or the enemy tank. Tank explosion sounds are produced when a tank hits a mine or is struck by a shell. A typical circuit is shown in the System Diagram.



Cycle

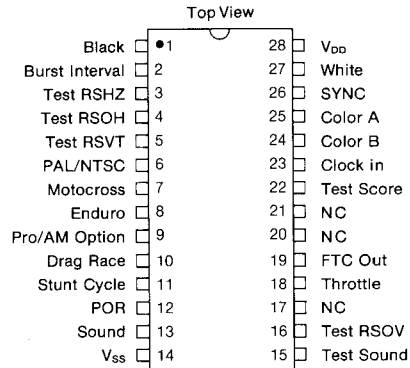
DESCRIPTION

Cycle is a game for one player who controls the speed of a motorbike and rider. At the start of each game, the motorbike and rider are stationary at the upper left-hand side of the TV screen. As the player turns the throttle controller, the motorbike and rider move across the screen on track 1. The motorbike sound starts with the bike movement and as the bike and rider accelerate, the motorbike sound reflects these speed changes. The motorbike wheels have an appearance of rotating at a speed also related to the throttle setting.

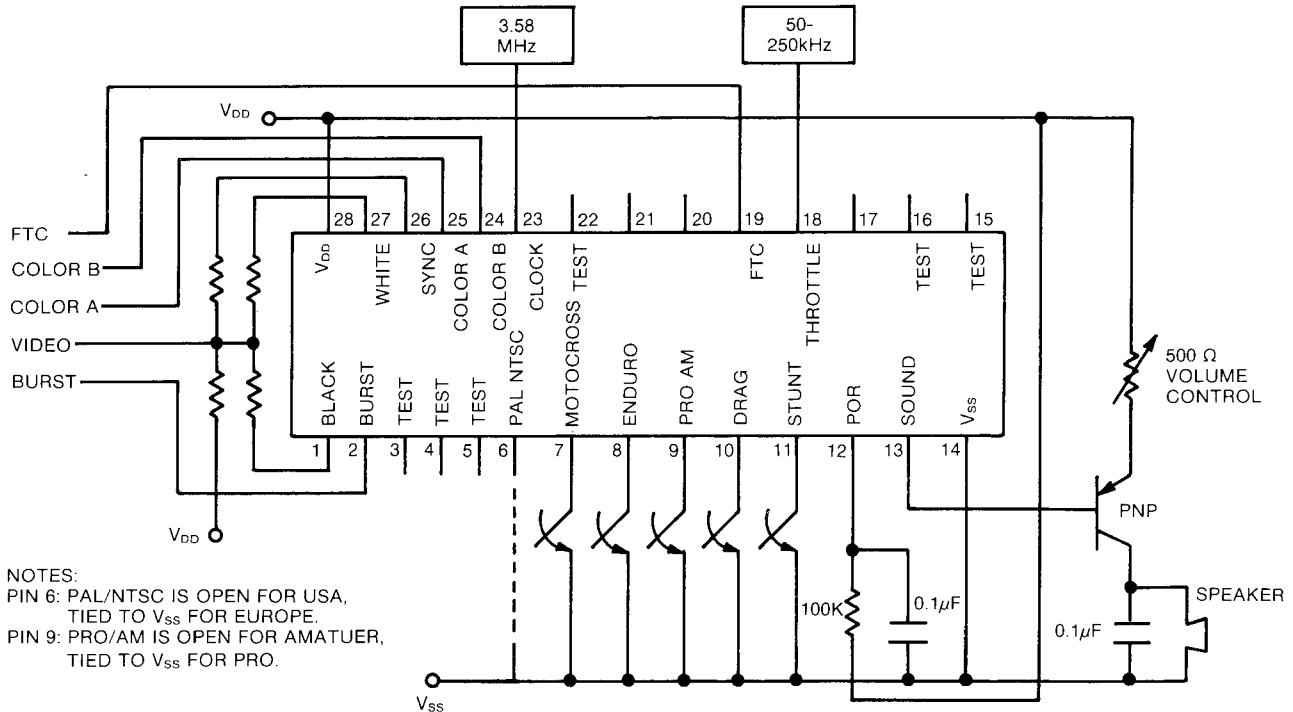
At the end of track 1, the bike and rider reappear on track 2 at the left-hand side, and likewise at the end of track 2 the bike appears on track 3 at the left-hand side of the screen. The movement of the bike and rider on track 3 to the right edge of the screen will cause a reinitialization of the bike and rider at the left of the screen on track 1. There will be no movement until the throttle is reset to a slow speed and then increased. A system diagram is shown below.

PIN CONFIGURATION

28 LEAD DUAL IN LINE



SYSTEM DIAGRAM



NOTES:
 PIN 6: PAL/NTSC IS OPEN FOR USA,
 TIED TO V_{SS} FOR EUROPE.
 PIN 9: PRO/AM IS OPEN FOR AMATUER,
 TIED TO V_{SS} FOR PRO.



PIN FUNCTIONS

Pin No.	Name	Function
1	Black	The output of this pin is the video signal of ramps, tracks and the composite blanking.
2	Burst Interval	The output of this pin is the color time slot which occurs after the SYNC signal during Horizontal Blanking.
3	Test RSHZ	Functional test input. Normally open pin NOT to be used as a tie point.
4	Test RSOH	Functional test input. Normally open pin NOT to be used as a tie point.
5	Test RSVT	Functional test input. Normally open pin NOT to be used as a tie point.
6	PAL/NTSC	This input is provided with an internal resistor pull-up to V_{DD} . If this input is tied to V_{SS} , NTSC (262 vertical lines) is selected. If this input is tied to V_{DD} or allowed to float, PAL (312 vertical lines) is selected.
7	Motocross	This pin is provided with an internal resistor pull-up to V_{DD} . If this input is momentarily connected to V_{SS} , this game will be selected. Otherwise, this pin is normally open.
8	ENDURO	This pin is provided with an internal resistor pull-up to V_{DD} . If this input is momentarily connected to V_{SS} , this game will be selected. Otherwise, this pin is normally open.
9	PRO/AM Option	This pin is provided with an internal resistor pull-up to V_{DD} . If this input is switched to V_{SS} , the PRO (hard) mode is selected. Switching this pin to V_{DD} or allowing it to float selects the AM (easy) mode.
10	Drag Race	This pin is provided with an internal resistor pull-up to V_{DD} . If this input is momentarily connected to V_{SS} , this game is selected. This pin is normally open.
11	Stunt Cycle	This pin is provided with an internal resistor pull-up to V_{DD} . If this input is momentarily connected to V_{SS} , this game is selected. This pin is normally open.
12	POR	The input to this pin is provided by an external RC network which generates a power-on reset signal. This network consists of 100K resistor from this pin to V_{DD} and a 0.1 μ F capacitor from this pin to V_{SS} .
13	Sound	The output of this pin are the sounds for the bike engine, bus hit, crash, screech, and a good jump. This output is designed to drive a PNP transistor which in-turn drives the game speaker.
14	V_{SS}	This input is the negative power supply.
15	Test SOUND	Functional test input. Normally open pin NOT to be used as a tie point.
16	Test RSOV	Functional test input. Normally open pin NOT to be used as a tie point.
17	NC	Not connected.
18	Throttle	The input to this pin is an oscillator signal for controlling the motion of the bike and rider.
19	FTC Out	The output of this pin controls the intensity of the display. When this output is V_{DD} , it indicates that the game has not been initiated, no motion exists on the screen, and the intensity is at a reduced level.
20	NC	Not connected.
21	NC	Not connected.
22	Test Score	Functional test input. Normally open pin NOT to be used as a tie point.
23	Clock In	The input to this pin is the 3.58 MHz oscillator.
24	Color B	See TABLE 1 Below
25	Color A	See TABLE 1 Below
26	SYNC	This pin provides the combined output of horizontal SYNC or vertical flyback.
27	White	The output of this pin is the video output signal for the bike, buses, score and obstacles.
28	V_{DD}	This input is the positive power supply.

Table 1

	Color Pin A	Color Pin B
Motocross (Green)	Off Fet	Clk
Enduro/Stunt Cycle (Blue)	Clk	Off Fet
Drag Race (Red)	Clk	Clk
Burst	Clk	Off Fet
Sync	Off Fet	Off Fet

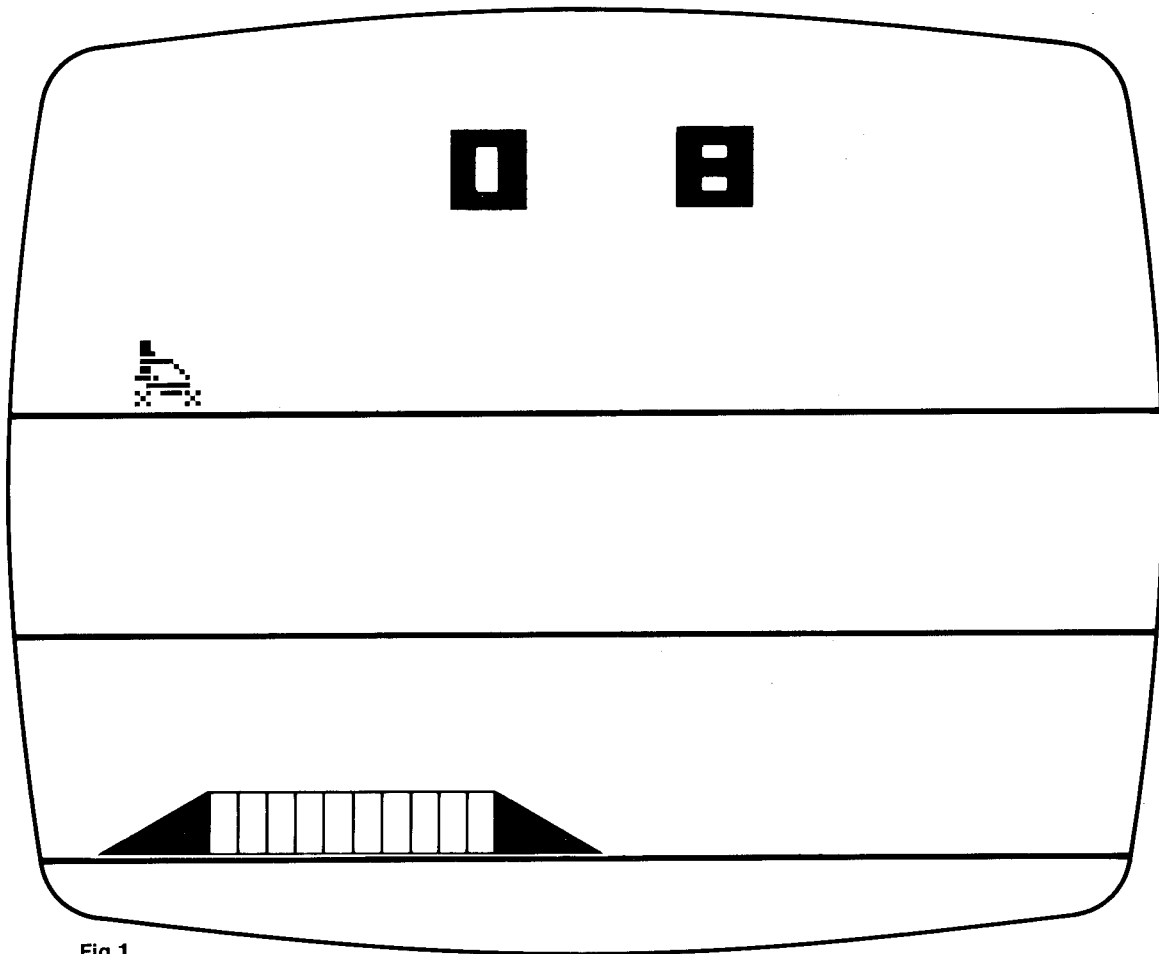


Fig.1

Stunt Cycle

The object of this game is to control the throttle speed to properly jump the ramp and buses located on track 3. The game begins with 8 buses and with each successful jump over the ramp and buses, an additional bus appears. The game is over when the maximum number of errors has been reached, which is 3 or 7 errors depending on the position of the PRO/AM switch. The game is then started by reselecting the Stunt Cycle game input. Errors are caused by accelerating too rapidly, insufficient speed to clear the buses, or landing too far past the back ramp after the jump. The bike and rider flip upside down and a screeching sound indicates an error. The score records the number of errors in the first digit and the number of displayed buses in the next two digits.

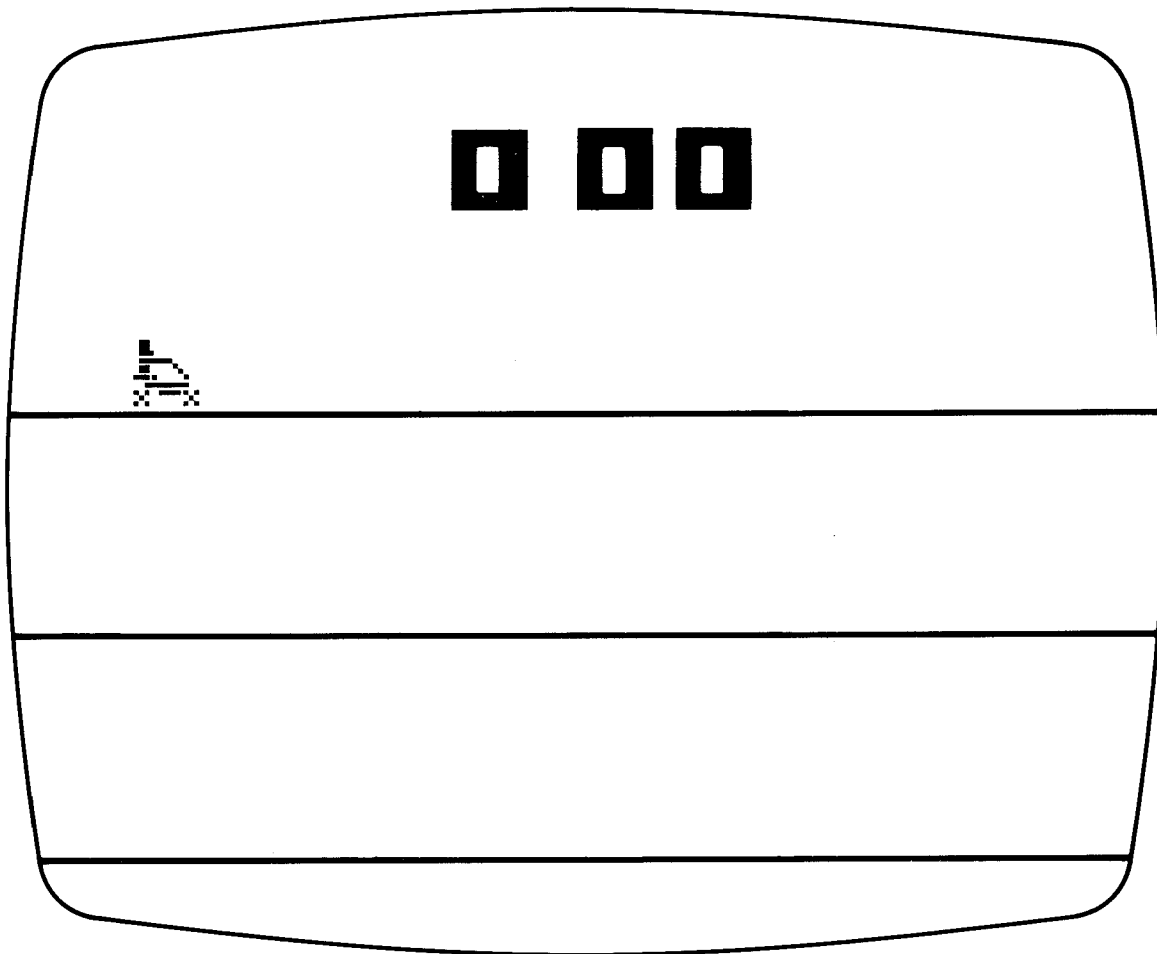


Fig.2

Drag Race

The object of this game is to reach the end of track 3 in the shortest time. The three-digit score is automatically reset as the rider first begins to move on track 1 and the score is incremented until the game is over. The score appears centered on the screen above track 1, and the score remains until the start of the next game.

Drag Race requires a speed shifting to achieve the lowest time scores. As the throttle speed is increased and the rider begins to move, the bike object is in speed one and moves at a set rate across the screen. The only way to accelerate the bike object motion is to return the throttle to a "slow" position and then turn to a "fast" position. This shifting procedure will move the bike into speed 2 and the object will go across the screen at a faster rate. Another "shift" will allow speed 3.

A PRO/AM option switch is provided to select a difficulty factor. In the hard mode, a crash occurs if the player tries to increase the throttle speed too rapidly. A crash will flip the bike and rider upside down and the sound will be a high-pitch screech. At the end of the crash, the bike and rider are reinitialized on track 1 and the score reset. In the easy mode, no crash is allowed.

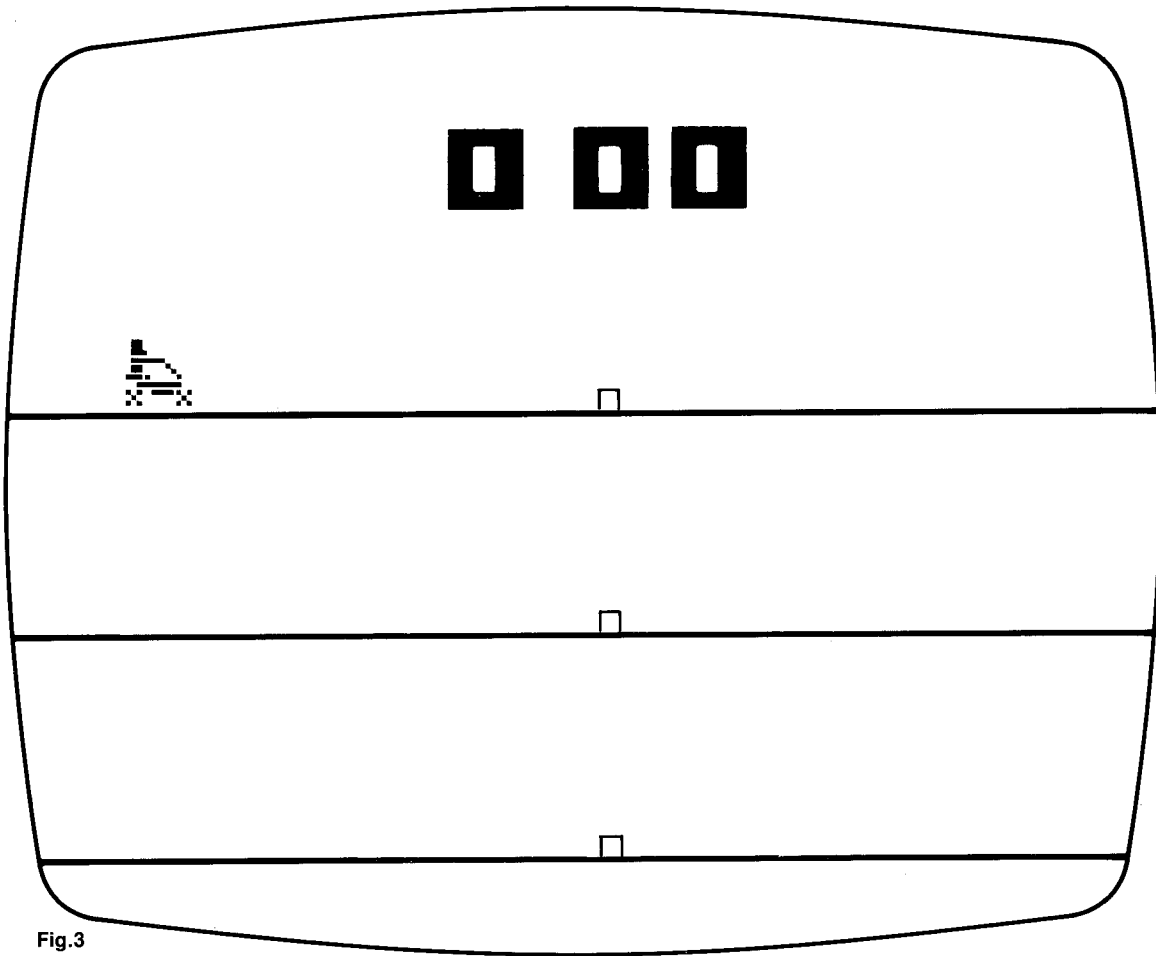


Fig.3

Motocross (Easy Mode)

As the throttle speed is increased, the bike and rider move across track 1 at a rate determined by the throttle controller setting. Motocross has no speed shifting. Located on each of the three tracks are obstacles. The easy/hard option switch selects the number of obstacles per track. The easy mode has one obstacle per track and the hard mode has two obstacles per track.

The object of this game is to traverse the three tracks in the shortest time, doing a wheelie over each obstacle. The score

counters record the run time in the same manner as the Sprint game.

In Motocross, the crash is not caused by accelerating too rapidly. The crash is caused by not doing a wheelie over an obstacle. In the wheelie position, the bike will have the front wheel lifted off the track. A crash into an obstacle will flip the bike upside down and produce the screech sound. The score is reset at the end of the crash.

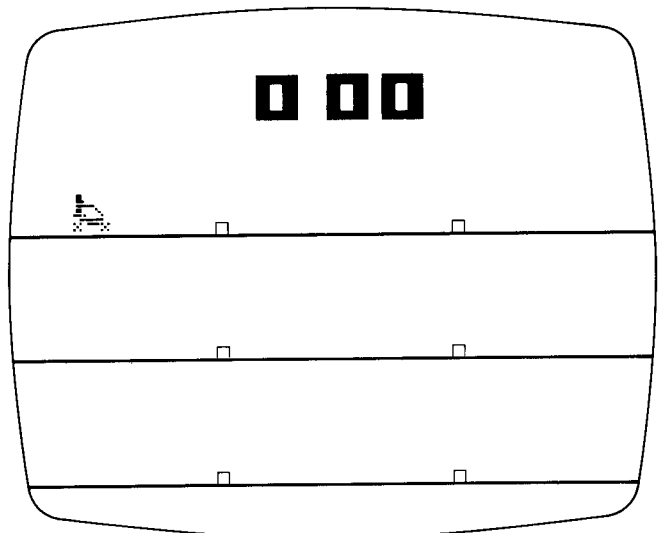


Fig. 4

Motocross (Hard Mode)

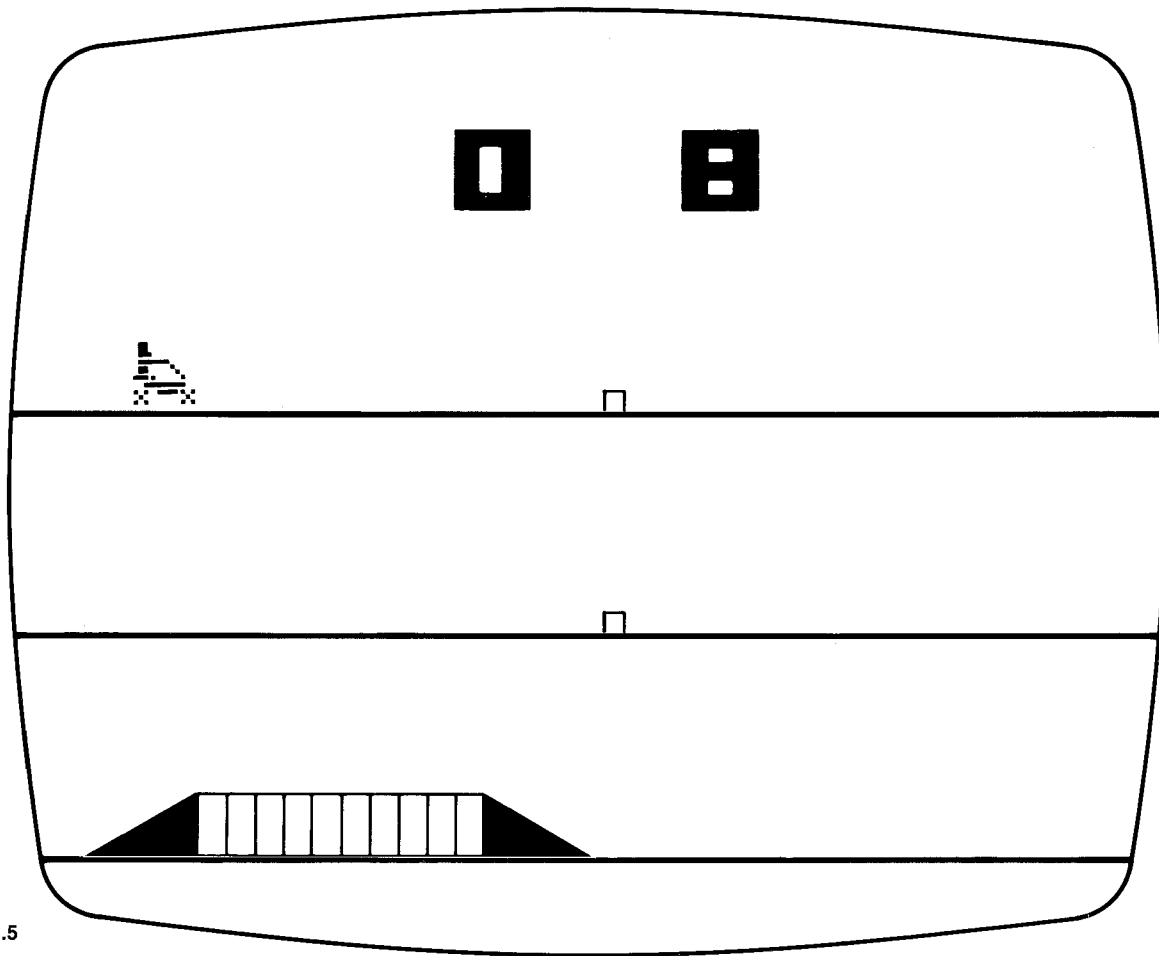


Fig.5

Enduro (Easy Mode)

This game is similar to Stunt Cycle with the addition of obstacles on track 1 and track 2. The object of Enduro is to do a wheelie over each obstacle and then adjust the throttle for the correct speed to jump the buses on track 3. The PRO/AM option switch selects 2 obstacles per track and allows 3 errors per game in the hard mode, and 1 obstacle per track and 7 errors per game in the

easy mode. Errors are caused by accelerating too rapidly, not in wheelie position over the obstacles, insufficient speed to clear the buses, or landing too far past the back ramp after the jump. The score records the number of errors and the number of buses displayed the same as in the game of Stunt Cycle.

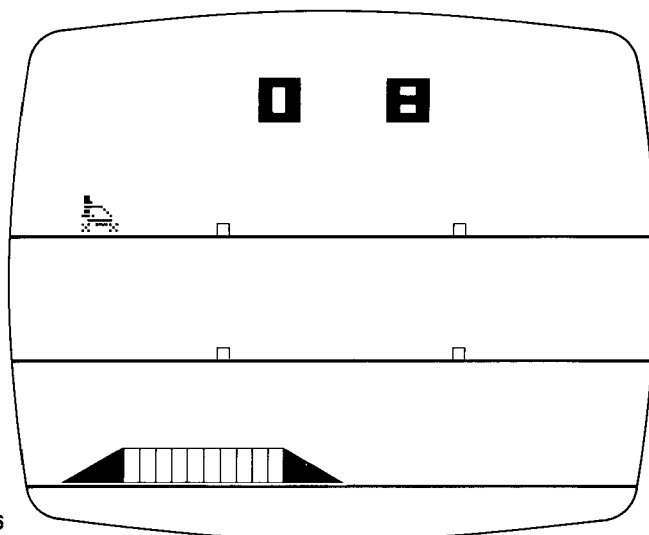


Fig. 6

Enduro (Hard Mode)

PART II

PROGRAMMABLE TV GAMES

FUNCTION	DESCRIPTION	PART NUMBER	PAGE NUMBER
GIMINI ECONOMY "8600" PROGRAMMABLE GAME SET	With a single AY-3-8615 "Resident Processor" chip in the console, the GIMINI "8600" minimizes system cost. Each game cartridge provides full color with realistic sounds and scoring.	AY-3-8615	51
		AY-3-8603-1	53
		AY-3-8505-1	54
		AY-3-8606-1	55
		AY-3-8607-1	56
		AY-3-8610-1	57
		AY-3-8750-1	58
		AY-3-8765	59
GIMINI FULL RANGE "8900" PROGRAMMABLE GAME SET	The "8900" chip set provides the basis for a user-programmed game series for up to eight players and featuring: up to eight user-controlled moving objects, up to 512 characters in ROM or RAM library, up to 240 programmable background locations, movable background field, and display in up to 14 colors plus black and white.	CP1610	60
		AY-3-8900	60
		AY-3-8900-1	60
		RO-3-9500	60
		RO-3-9501	60
		RA-3-9600	60
GIMINI MID RANGE "8950" PROGRAMMABLE GAME SET	The "8950" chip set provides the basis for a user-programmed game series which does not require moving objects but which offers extensive flexibility in character library and on-screen character positioning.	CP1610	61
		AY-3-8950	61
		AY-3-8950-1	61
		RO-3-9500	61
		RO-3-9501	61



GIMINI Economy "8600" Programmable Game Set

The G.I. Economy "8600" programmable game set is a series of T.V. games made available with a main console and a variety of plug-in cartridges all compatible with the console.

DESCRIPTION

The console consists of a resident AY-3-8615 game/color processor, an R.F. video modulator, a calculator type keyboard for game selection, a set of three skill select switches, and a game reset switch. Attached to the console are the player controllers which can consist of joysticks or a variety of controls suited to the game.

The console need never be opened once in operation; all changes to the system are plugged in externally. The cartridges and controls are the only items that are altered to give the Economy 8600 system new game characteristics.

The block diagram shows the basic system with its expandability.

SECTION A

There are three switches that will allow skill selections. These skills will be determined by the specific game cartridge and will control speeds, sizes and shapes of objects in any particular game cartridge.

SECTION B

The game selections will be made by a maximum of ten momentary switches similar to the calculator keyboard. Again the number of games is determined by the cartridge.

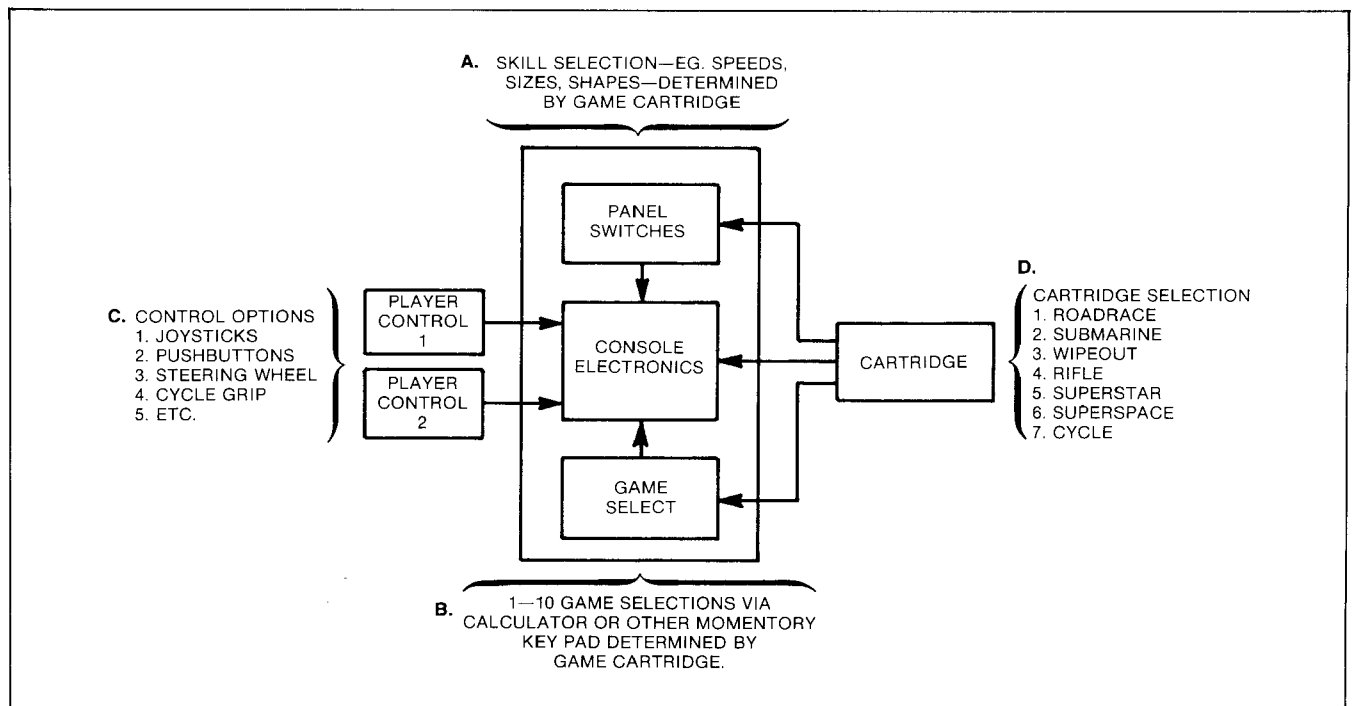
SECTION C

The controls are always in pairs to allow for two players. Depending on the game cartridge, a variety of controls may be used. Basically most games can be controlled by resistance joysticks. If controls are remote, the connectors used should be a minimum of six pins each to allow for game flexibility.

Name of Game & Part No.	No. of Game Selections	Skill Selections	Controls to be used (#)
Roadrace AY-3-8603-1	1 and 2	none	Joystick (2) or steering wheel (2)
Submarine AY-3-8605-1	1 and 2	none	Joystick (2) or push button switches (2)
Wipeout AY-3-8606-1	1 thru 4	1. Color squares 2. Ball size 3. Bat size	Joystick (2)
Rifle AY-3-8607-1	1 thru 4		Momentary switches in external rifle.
Superstar AY-3-8610-1	1 thru 10	1. Ball speed 2. Rt. bat size 3. Left bat size	Joysticks (2)
Superspace AY-3-8750-1			
Cycle AY-3-8765	1 thru 4	1. Pro/AM	Joystick (1) or cycle grips (1)

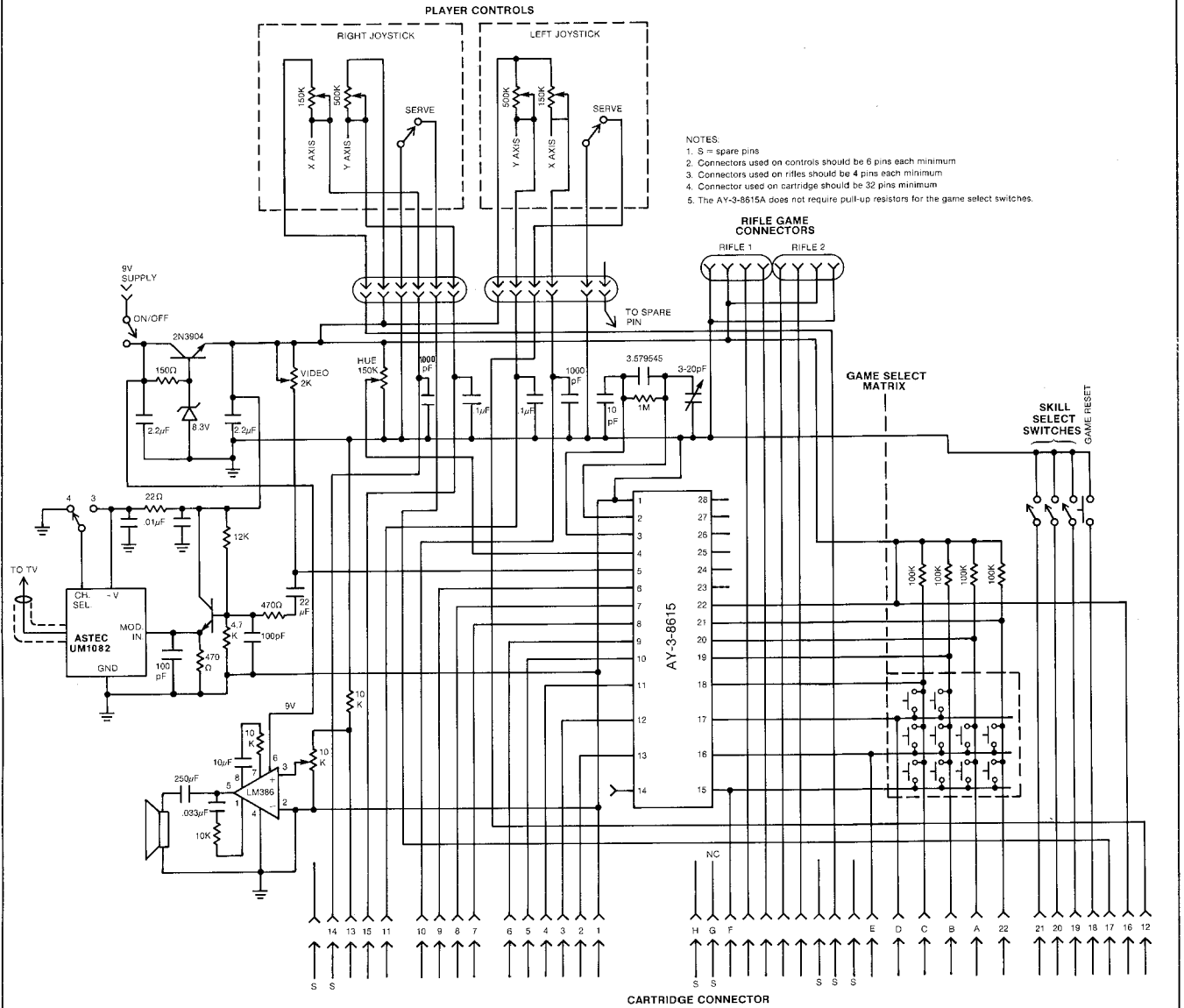
SECTION D

The cartridges will all be compatible with the console and a variety as shown will be offered. Each cartridge will give the game a completely new objective. The cartridge should have a minimum of 34 pins to allow for special connections such as sound effects, etc., and remain compatible with the system.





BASIC CONSOLE SCHEMATIC



- NOTES:
1. S = spare pins
 2. Connectors used on controls should be 6 pins each minimum
 3. Connectors used on rifles should be 4 pins each minimum
 4. Connector used on cartridge should be 32 pins minimum
 5. The AY-3-8615A does not require pull-up resistors for the game select switches.

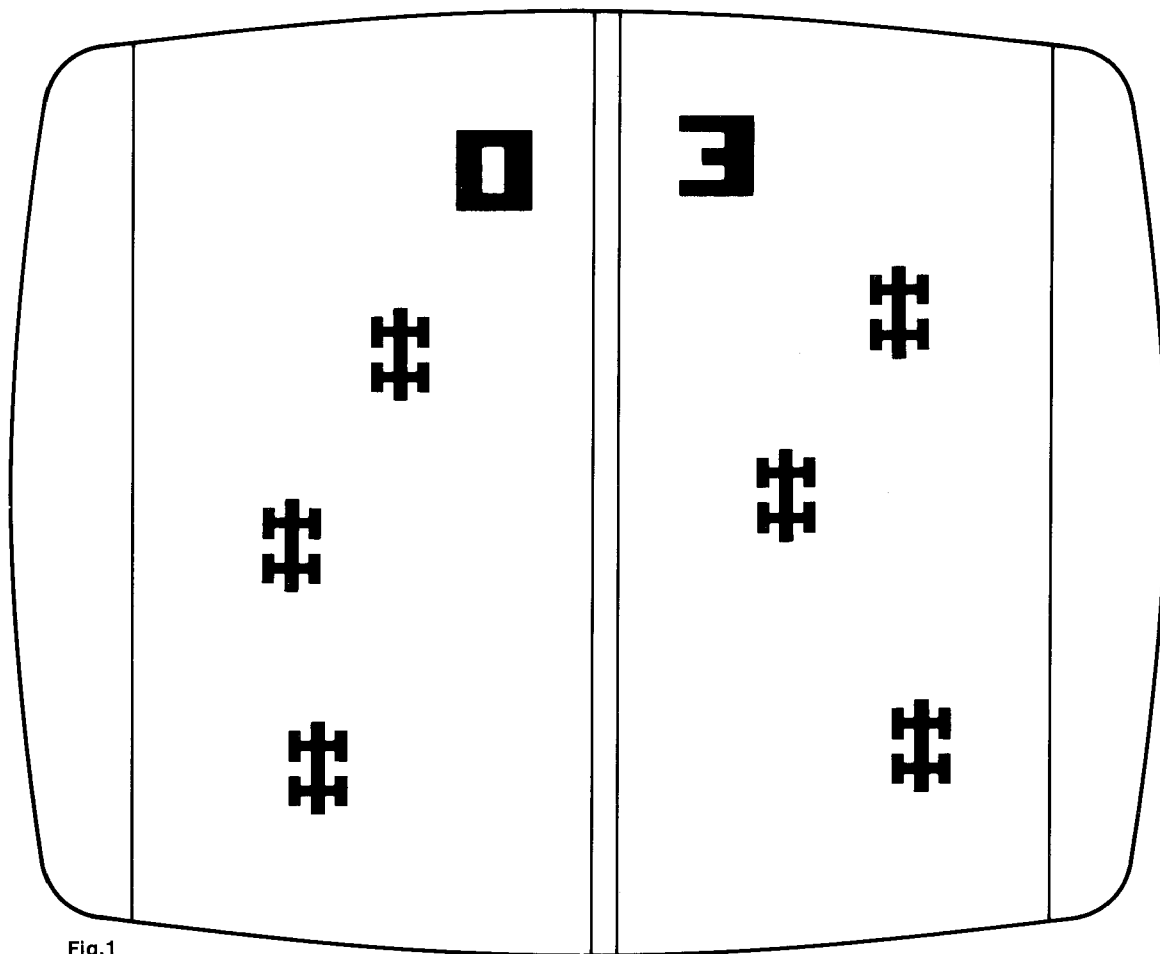


Fig.1

Roadrace Cartridge (AY-3-8603-1)

A typical T.V. screen display for the game is shown in Figure 1. One driver for each car located at the bottom of each track controls his horizontal position only. After the game is reset the game starts a race where each driver must maneuver his car around the other cars on the track. Both tracks have the same random obstacle, car pattern with two visible per track, the pattern on the right is 24 lines ahead of the left pattern. This produces random cars on both tracks at one time with the same degree of difficulty for each driver. Video speeds increase every two seconds up to a maximum of seven speeds forward or until either player crashes his car into an obstacle car. Upon a crash, the video motion will stop and a crash sound will be generated. When the game restarts, the forward motion will start from slow and progress in speeds once again.

Simulated engine sound is produced during the game. The engine starts from low and increases in pitch at four second intervals during motion to simulate shift points during the game progress. Every crash scores one point for the opponent. Scores are shown over each track.

The one-player game selection removes the car image on the right track and left player plays. A point is scored for the driver after passing every eight consecutive obstacle cars. Every crash gives the game, (right track) score one point. The first player or game to score 15 ends the game in either one or two player selection.

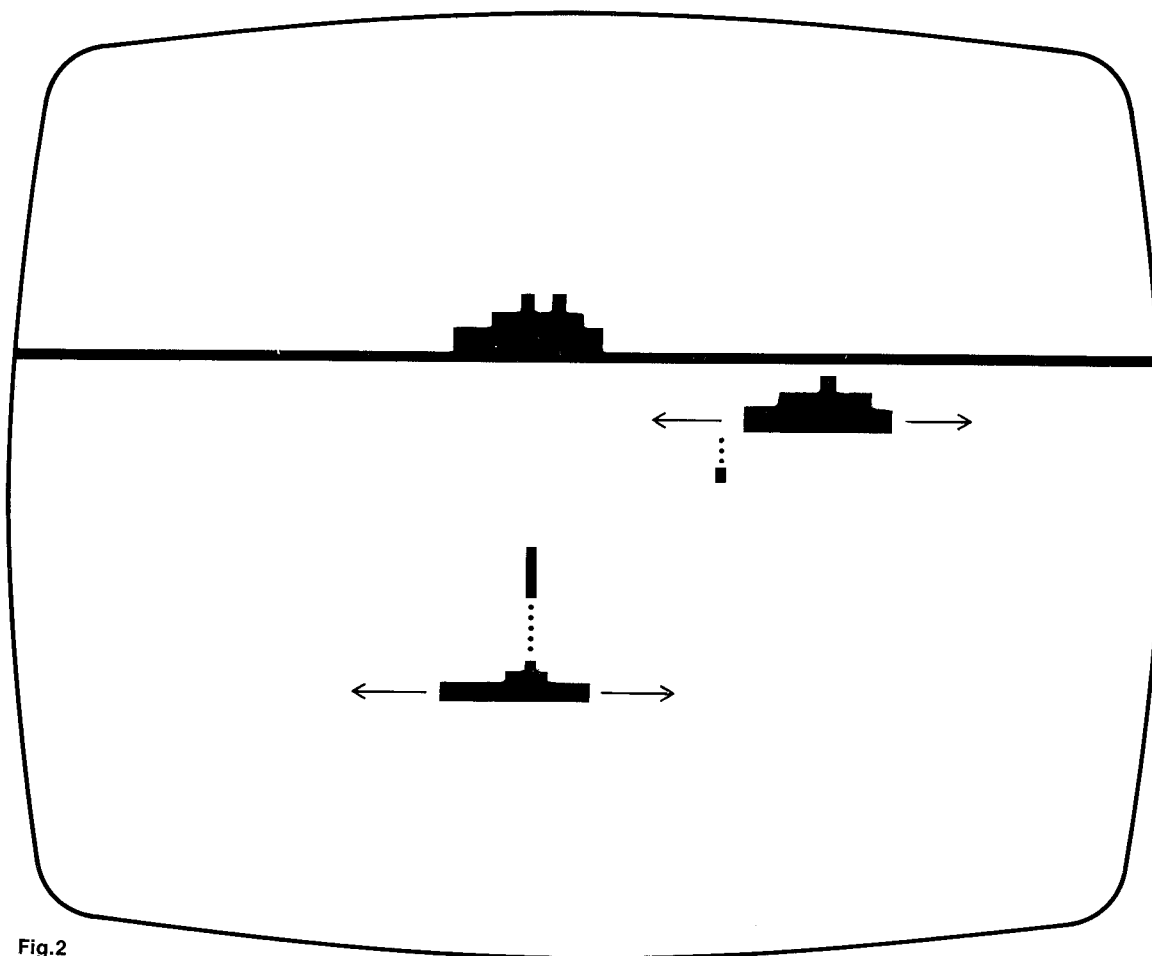


Fig.2

Submarine Cartridge (AY-3-8605-1)

A typical T.V. screen display for the game is shown in Figure 2. One player for the submarine and one for the destroyer each controls his horizontal position only. After the game is reset the game starts as the picture produced simulates ships moving across the sea at various speeds. One player controlling the destroyer must protect the ships and depth charge the submarine while the submarine controller tries to torpedo the ships and/or the destroyer.

The destroyer and the submarine are each controlled horizontally by a single pole double throw center off switch. The destroyer moves at twice the speed of the submarine, with the control switch in the center position the vessel controlled stops all movement.

The submarine and the destroyer can only fire torpedoes and depth charges respectively at one shot per four second maximum. Torpedo movement is only in the vertical upward

direction and depth charge movement is only vertically down. All depth charge hits on the submarine are counted as two points for the destroyer. The submarine scores 1 point for hitting a cargo ship, 2 points for a premium (capital) ship, and 5 points for the destroyer.

Both submarine and destroyer stop movement for 2 seconds when hit by opponents. The cargo ships disappear when hit.

Upon a hit the explosion output envelope from the chip goes to a zero level and gates the white noise on with external circuitry. Sonar sound is emitted throughout game play.

The one-player game selection makes the destroyer move continuously back and forth dropping depth charges at the maximum rate. Each hit for the destroyer (game) is recorded in the same manner as the two-player game. The first player or game to score 15 points ends and wins the game.

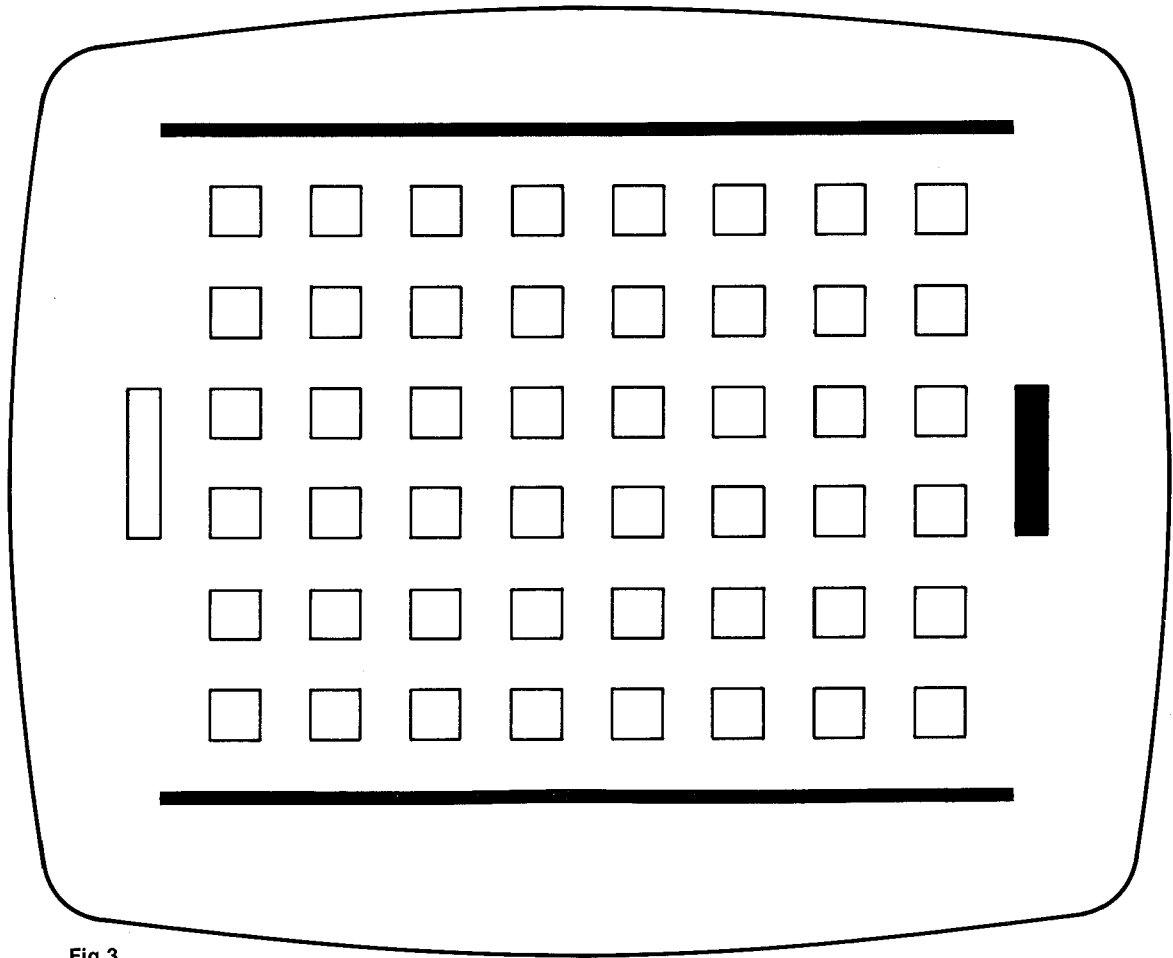


Fig.3

Wipeout Cartridge (AY-3-8606-1)

This game cartridge contains 10 different games with variable skill selections for one or two players. The object of this set of games is to 'wipe out' more objects than the opponent by scoring the highest number of points without letting the ball out of the playing area. Premium scoring is effective at the start of the game; each time the ball leaves the playing area the premium scoring decreases.

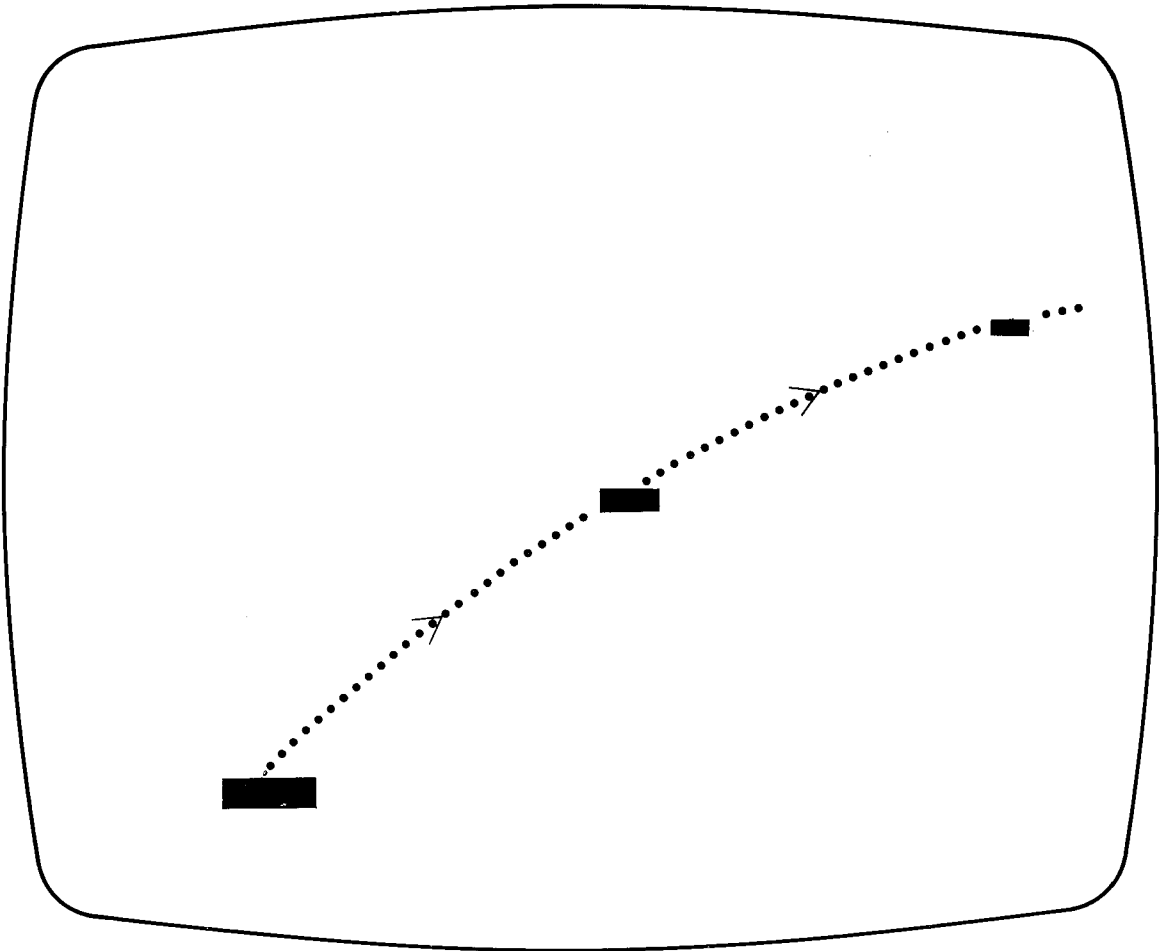


Fig.4

**Rifle Cartridge
(AY-3-8607-1)**

The AY-3-8607-1 Rifle game cartridge contains four different games with multiple skill selections. The object of this set of games is to shoot at skeet moving across the screen. The skeet move continuously from foreground to background. Realistic sounds are built in.

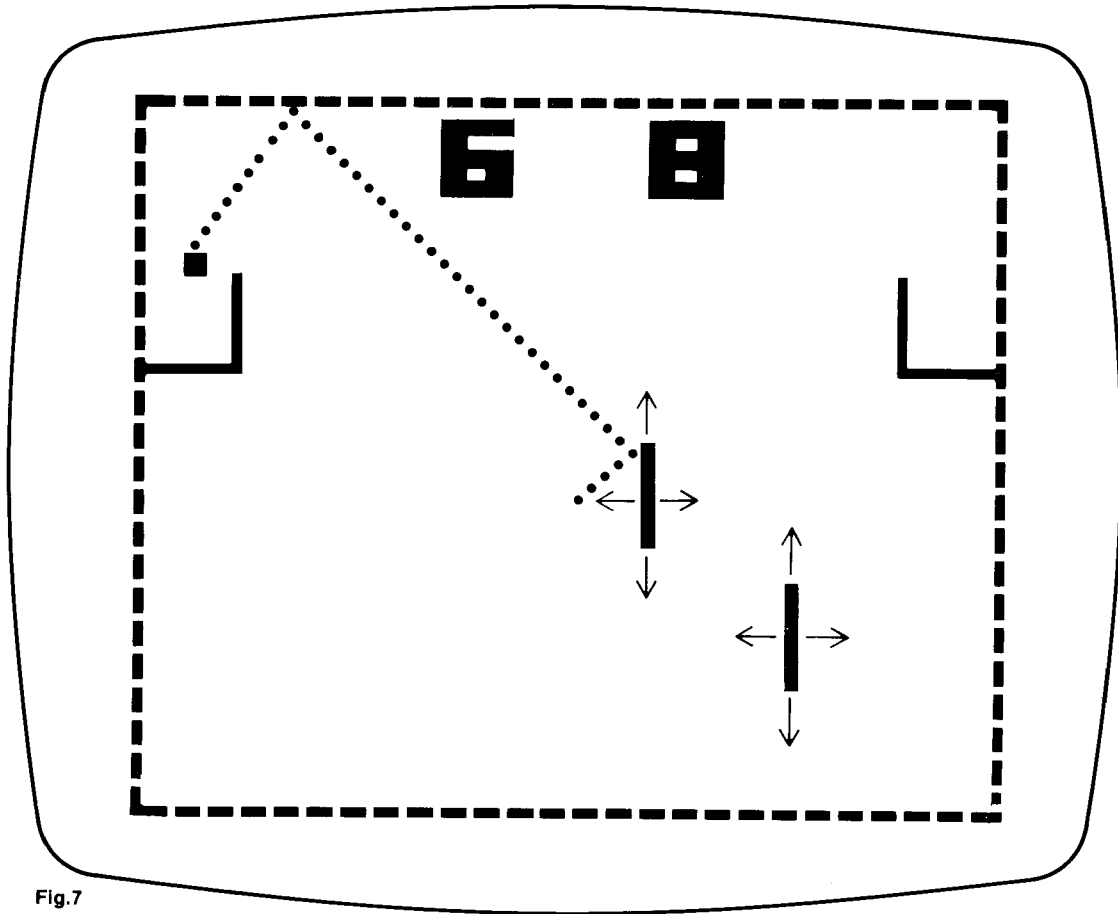


Fig.7

Superstar Cartridge (AY-3-8610-1)

The AY-3-8610 Superstar game cartridge contains ten selectable games for one or two players: tennis, hockey, soccer, squash, practice, gridball, basketball, basketball practice, target I, and target II, with realistic game rules, ball serving, and scoring. The two target games do not require extra circuitry or a pistol. Sound generation on hits, boundary and score.

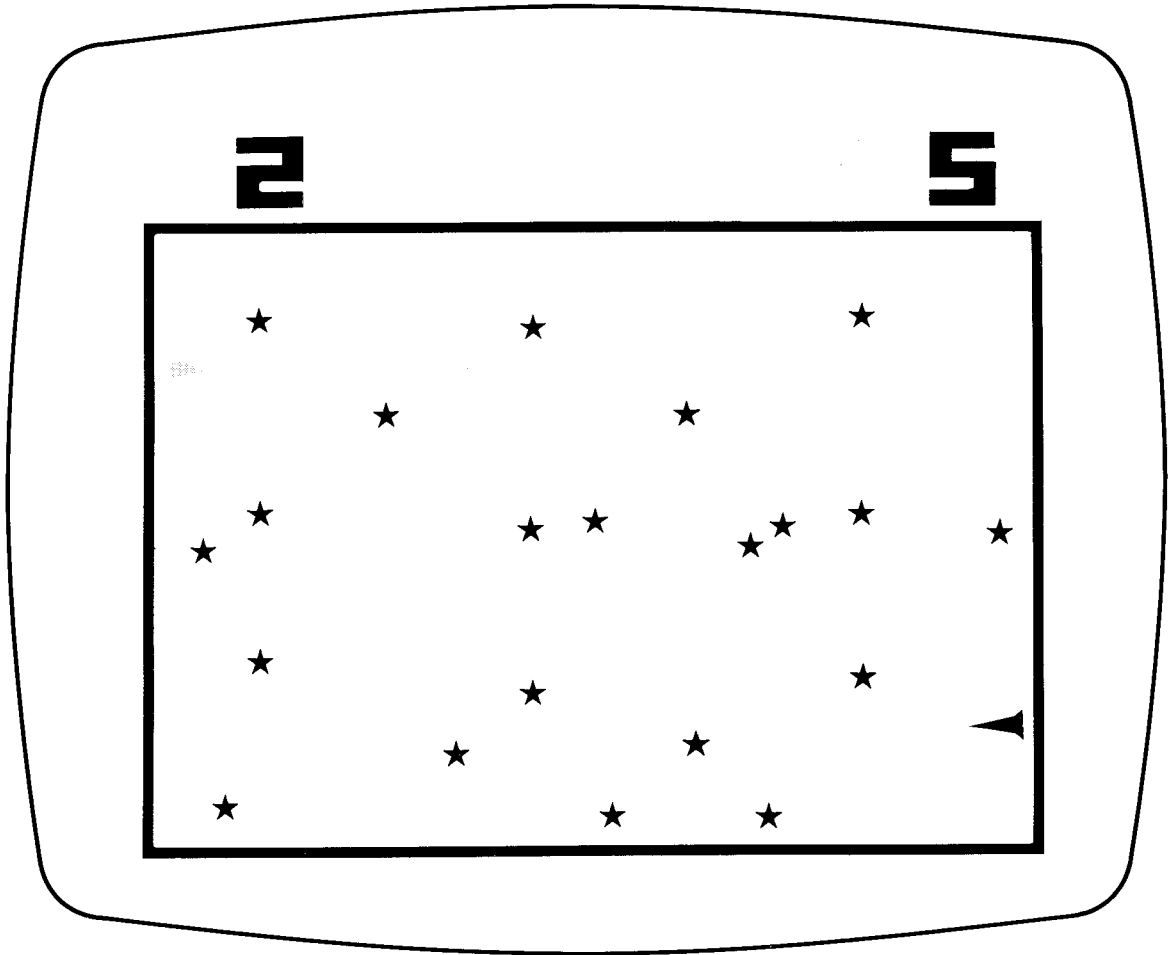


Fig.6

Superspace Cartridge (AY-3-8750-1)

The AY-3-8750-1 Superspace game cartridge consists of multi-games with variable skill selection. The object of these two player space battle games is to simulate spaceship battles with synthesized sounds to add to the entertainment.

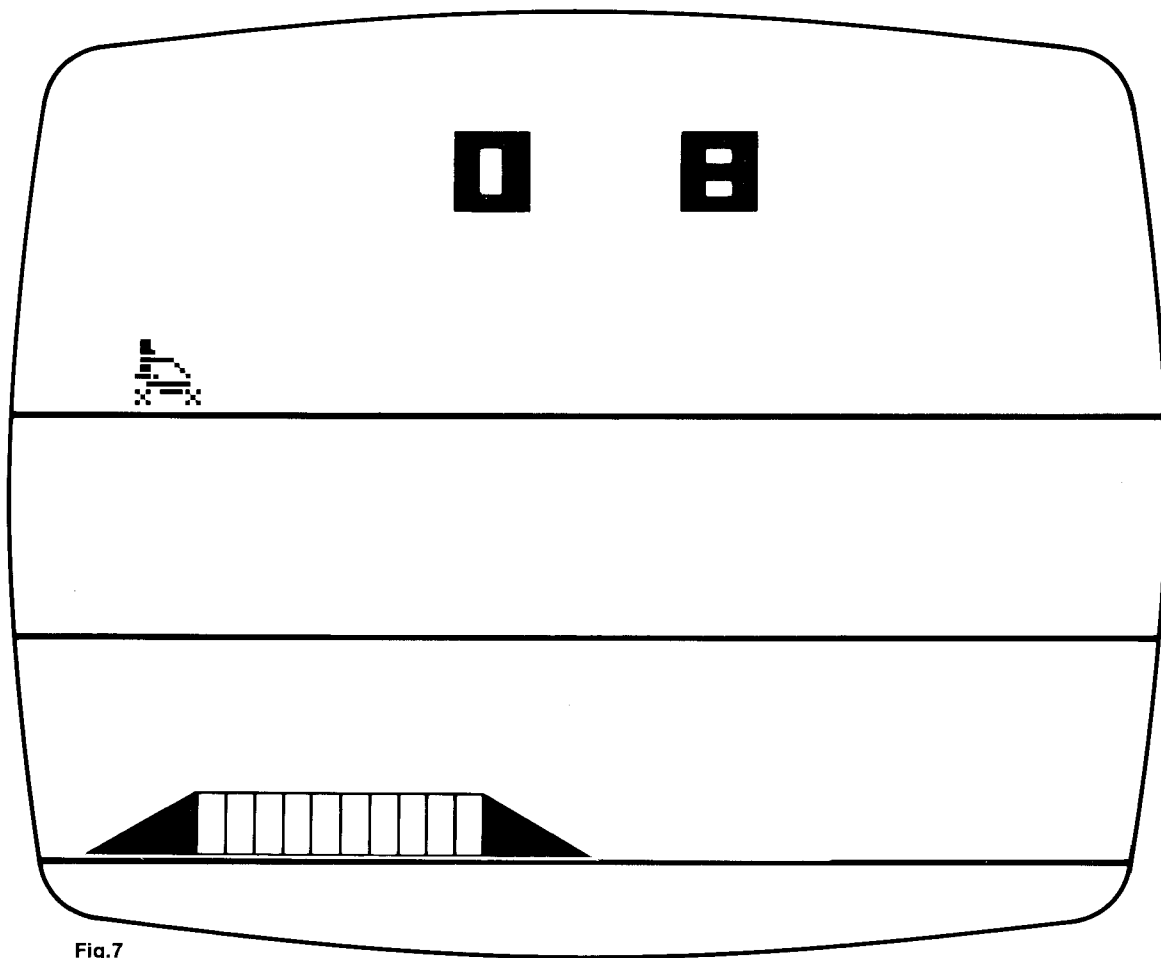


Fig.7

Cycle Cartridge (AY-3-8765)

The AY-3-8765 Cycle cartridge game consists of a cycle game with variable skill selection. The object of this set of games is to simulate cycle jumping, racing and tricks. For one player only. Special sound effects add to the entertainment.



GIMINI Full Range "8900" Programmable Game Set

FEATURES

- Infinite game selection
- Lowest cost expandable system
- Uses programmable 20K ROM
- Eight color selectable, coordinate addressable game objects on a grid of 160H by 96V.
- Resident library of 256 complex game objects, including full 64 character alpha numerics
- Full multicolor background capability
- Fifteen selectable color tones
- Program controllable moving background
- Two hundred and forty independently programmable background locations
- All signals necessary to produce composite color video.

DESCRIPTION

The GIMINI game system is based on two processors; one computes the game action against the stored program rules; and the second interprets a condensed memory area and uses this to generate the T.V. raster display. The second processor fetches moving and background pictures from the graphic picture storage and presents the data as a video output.

The set consists of five General Instrument supplied N-Channel circuits. The AY-3-8900-1 Standard Television Interface Circuit (STIC); the CP1610 GIMINI Microprocessor; an RO-3-9500 20K program ROM; a similar RO-3-9500 graphics picture ROM and an RA-3-9600 RAM. To complete the system the user supplies clocking and modulation circuitry plus any other peripheral control requirements.

SYSTEM COMPONENTS

CP1610 MICROPROCESSOR

The CP1610 is a modified General Instrument CP1600 optimized for video processing applications. All the architecture and program instruction data pertinent to the CP1610 game processor may be found in the reference literature. The clocking of the processor is limited to 1.79 MHz. The stored program is provided by the RO-3-9500 ROM.

TELEVISION INTERFACE

The STIC (AY-3-8900-1) circuit is the video processor which fetches, decodes and displays moving and background characters stored in the library for T.V. presentation under program control. During active picture time interactions between shapes are recorded for interrogation by the CP1610 on completion of the current frame. The picture generation of the STIC can be separated into the two areas of background objects and moving objects.

CARTRIDGE ROM (RO-3-9500)

The 20K program ROM is organized into 2048 10 bit words to control the CP1610 operation. In addition to the stored program function, the circuit contains a 16 bit latched output port which supplies an address bus to any standard memory circuits which may be added by the user. An example of this addition would be a buffer store for a cassette tape reader. The program also supplies enable and read/write signals for the standard memory.

On master reset or for the end of active picture interrupt, the program ROM supplies the interrupt address to the CP1610.

RESIDENT RAM (RA-3-9600)

The system RAM is an optimized structure device which allows maximum processor time for both game and graphics processors and it allows the user to run operational programs with only a single RAM package in the system. The RAM contains its own control decoding and address latch for both the CP1610 and the STIC. The two processors run on a semi-time shared basis with the RAM providing the data buffer.

The RAM is organized with 240 words holding the background picture data and 112 words being available to the CP1610 for general purpose scratchpad. The background storage area may be accessed by the CP1610 during the active picture time, which allows the user to run very complex, high density background displays.

RESIDENT ROM (RO-3-9500)

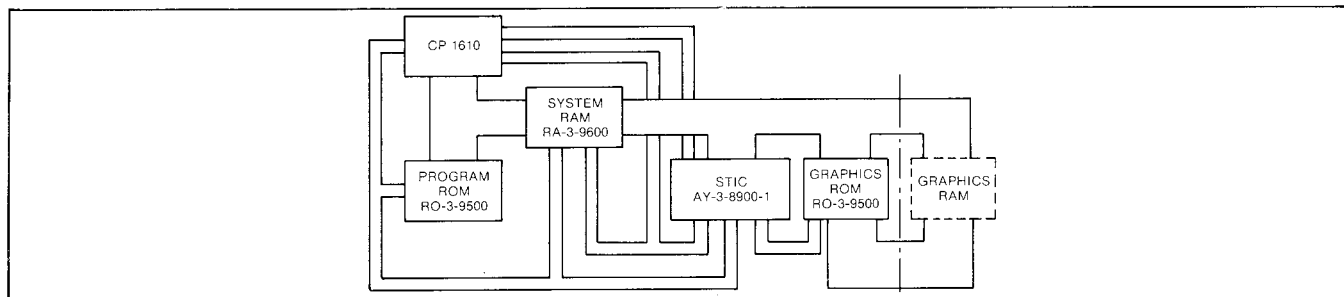
The 20K graphics ROM is a similar device to the program ROM, but is organized into 256 8x8 bit characters which are the dot patterns for background and moving objects. The set contains the full 64 character alpha-numeric and the other characters may be grouped by the user to have some program significance, although any character can be drawn in any mode.

The graphics ROM is accessed under two conditions, the moving objects and the background objects. For backgrounds, the RAM device sequentially outputs 14 bit words and 8 bits of this word defines one of the 256 stored characters. The STIC outputs a further 3 bits to define which line of the 8x8 bit matrix is being accessed. This 11 bit address is latched into the graphics ROM including a higher order bit which signifies if graphics ROM or RAM is to be accessed.

GRAPHICS RAM (Optional)

The user may add a RAM area to the graphics picture storage of the GIMINI games system and this will allow the user to load and modify the dot pattern of the pictures under program control. The additional RAM may be a second game RAM or some standard device. If a standard RAM is chosen, the 40 lead version of the graphics ROM is advised since it can provide the address bus for the graphics RAM.

Effects such as large background objects covering several 8x8 bit squares and individual background movement may be achieved with a graphics RAM system.





GIMINI Mid-Range "8950" Programmable Game Set

FEATURES

- User game design capability
- Completely software programmable
- Extensive game library availability in addition to custom software development
- Versatile game instruction set
- NTSC compatible T.V. sync generator
- Color circuitry
- Software controlled score and playfield placement capability

DESCRIPTION

The GIMINI Mid-Range "8950" Programmable Game Set is a multichip set which can accept different programming ROMs, programmed by the user or available from our extensive game library. The Game Set provides an unlimited number of games; including aggression games, racing games, gambling games, etc. The set consists of the CP1610 microprocessor, a 20K resident ROM game program chip (RO-3-9500/01), optional cartridge ROMs, graphics interface circuit (AY-3-8950-1) and two user supplied 256x4 bit static RAMs (2112A). Additional cartridge ROMs extend the users game options. The programmable game set can accept two or more player inputs, using remote control-units. These control-units provide communication between the players and the game set in the form of positional inputs or "YES" or "NO" selections. It is designed for operation in either color or black and white with standard domestic television receivers.

SYSTEM COMPONENTS

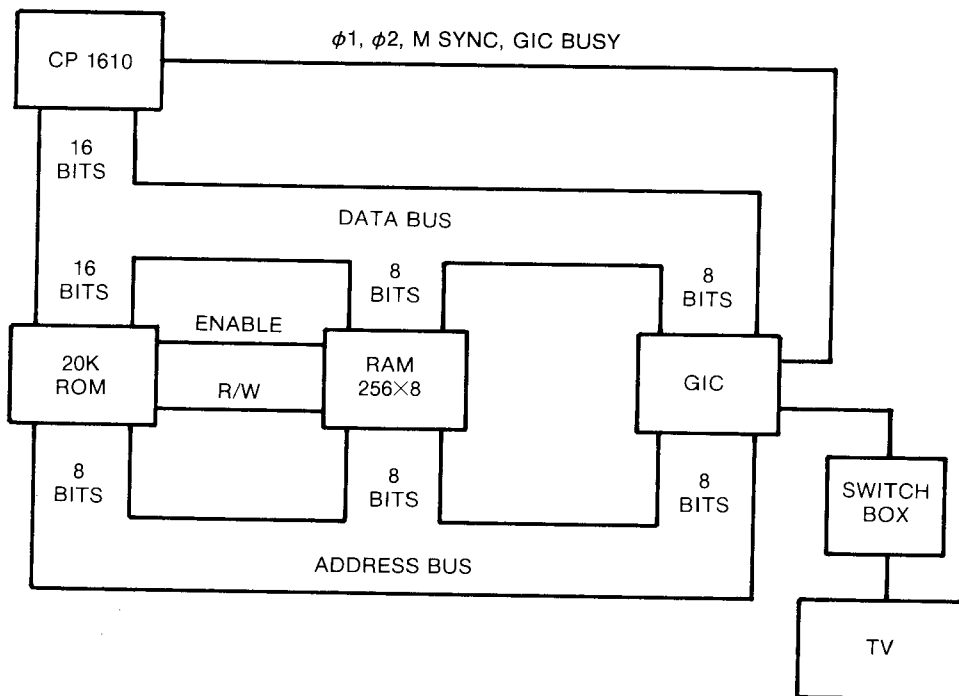
CP1610 Microprocessor: The CP1610 is a variant of the General Instrument CP1600 microprocessor and is designed for game operation. The chip is a 16 bit utilizing eight general purpose registers for fast and efficient processing of all game data. The processor operates only when picture data is not being presented and controls the addresses in both the program 20K ROM and the scratchpad memory according to the game rules.

20K ROM (RO-3-9500/01): The resident program ROM is organized as 2048x10 bit and contains all the game rules as well as the executive program. Since the set is organized on a data bus basis, additional satellite ROMs for various games may be added.

RAM: Two 256x4 bit RAMs are required in the system. These are standard units with a 320 nanosecond access time.

GIC (AY-3-8950-1): The Graphics Interface Circuit (GIC) is the TV display generator for the 8950-1 system. The GIC provides the video signals including sync and blanking in a non-interlaced pattern for the T.V. deriving its output from graphics data specified by the microprocessor and obtained from the program ROM. The unit is functional only during picture time and obtains new graphics data between picture frames. The video output will consist of two colors, black, white, sync, blanking and color burst. In addition, the GIC will provide an audio output signal for game sounds.

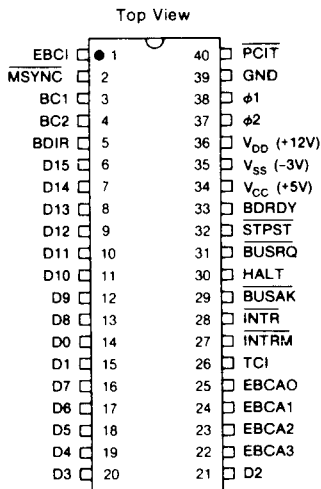
BLOCK DIAGRAM



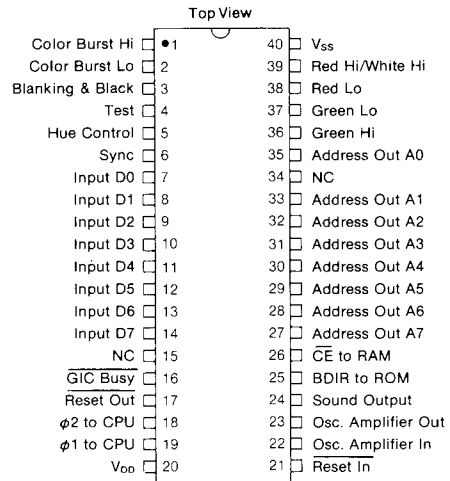


PIN CONFIGURATIONS

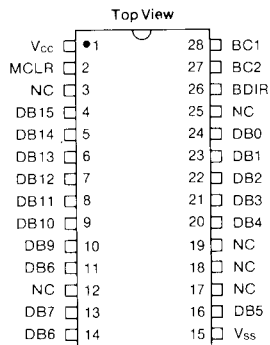
CP1610
40 LEAD DUAL IN LINE



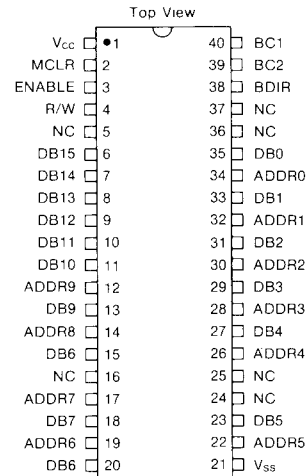
AY-3-8950/8950-1
40 LEAD DUAL IN LINE



RO-3-9500
28 LEAD DUAL IN LINE



RO-3-9501
40 LEAD DUAL IN LINE



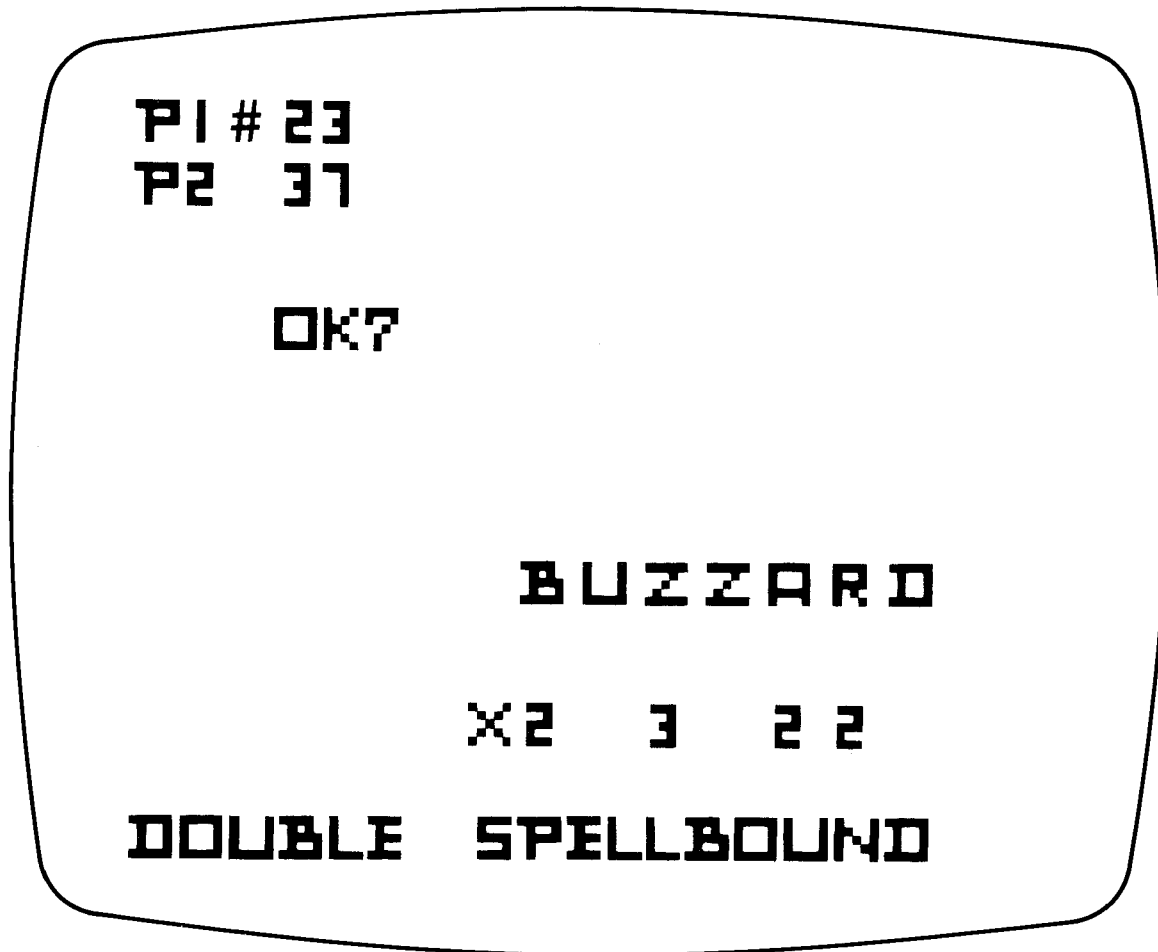


Fig.1

Spellbound Cartridge

Spellbound is a word game in which each of two players, in turn, is randomly dealt a "tray" of seven letters, on screen, by the computer. Using his control-unit, player #1, may elect to either form a word or discard any two of his letters when the message "DISCARD?" is displayed. If player #1 so chooses, he may discard by operating his "YES" button which causes the first (left-most) letter of his "tray" to flash. Operation of the "NO" button causes the next letter to flash and he may now decide to discard or retain it. This sequence continues until he has chosen two letters to discard. (The computer will provide two additional random letters after the second player's turn). After player #1's second discard, control reverts to player #2, who may elect to form a word or discard.

Points are awarded based on the letters used and their relative positions. The computer randomly assigns letter and word

multipliers for each round, keeping track of each player's score and displaying them in the upper left of the screen. In the example above, using a "Z" over the X3 awards 30 points instead of the single letter value of 10 for "Z". The word multiplier is also random and may be "SINGLE", "DOUBLE" or "TRIPLE". It appears in the lower left of the screen. In the example above, the word "BUZZARD" has a "DOUBLE" word score of 106 points. Prior to awarding the point value, the opposing player is asked to verify the assembled word. Upon verification, the player's score is adjusted and he is given the opportunity of discarding two of the letters in the assembled word. These two letters are replaced, randomly, by the computer after the opponent has concluded his round. The first player to accumulate 200 points wins the game.

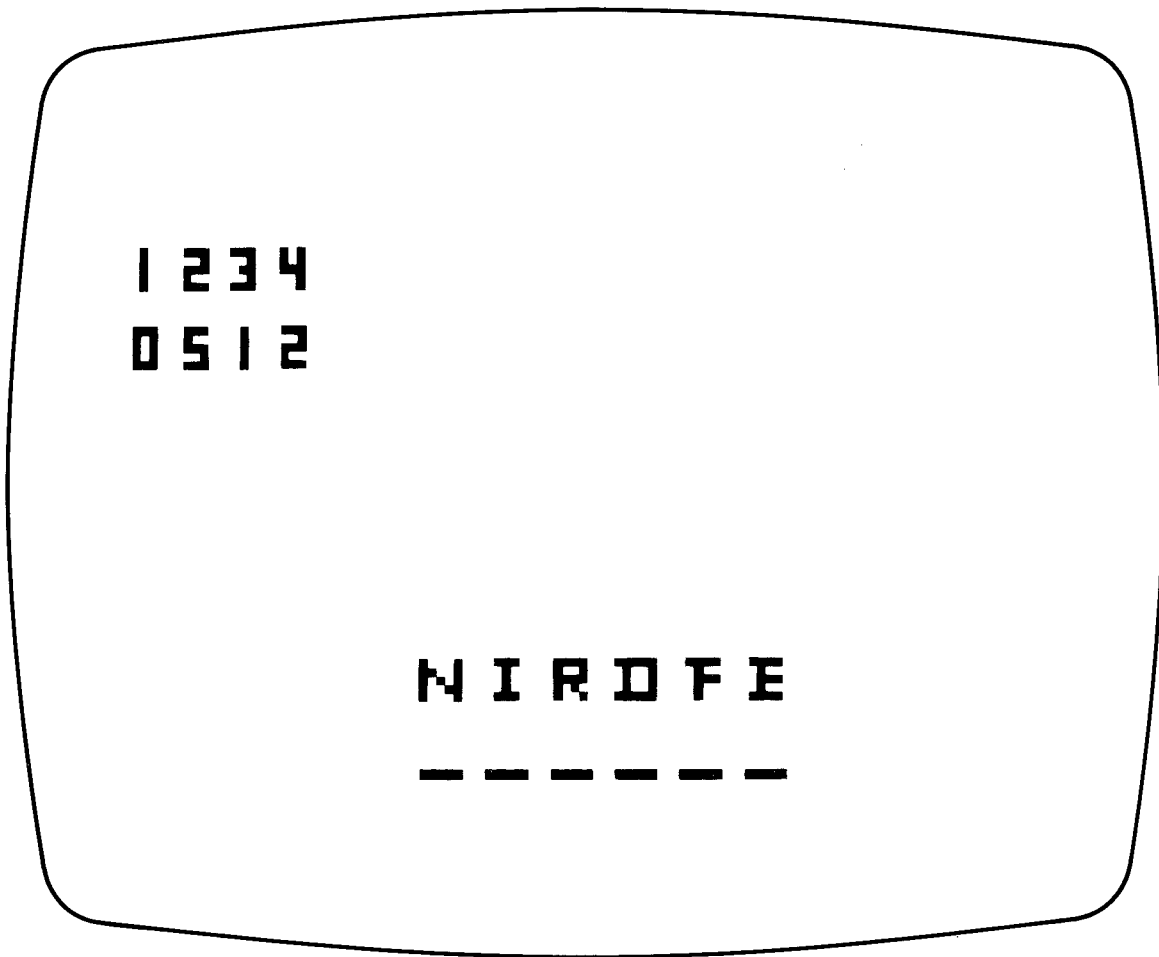


Fig.2

Jumble Cartridge

Jumble is a variation of the popular scrambled letters word guessing game. Words can be from four through six letters which are selected and jumbled by the computer randomly. Should the same word be selected by the computer at another time, it is likely to have the letters jumbled in a different order. The first player to unscramble the jumbled word will be awarded a variable number of points, with more points awarded for an early guess. The first player to reach ten points wins the game.

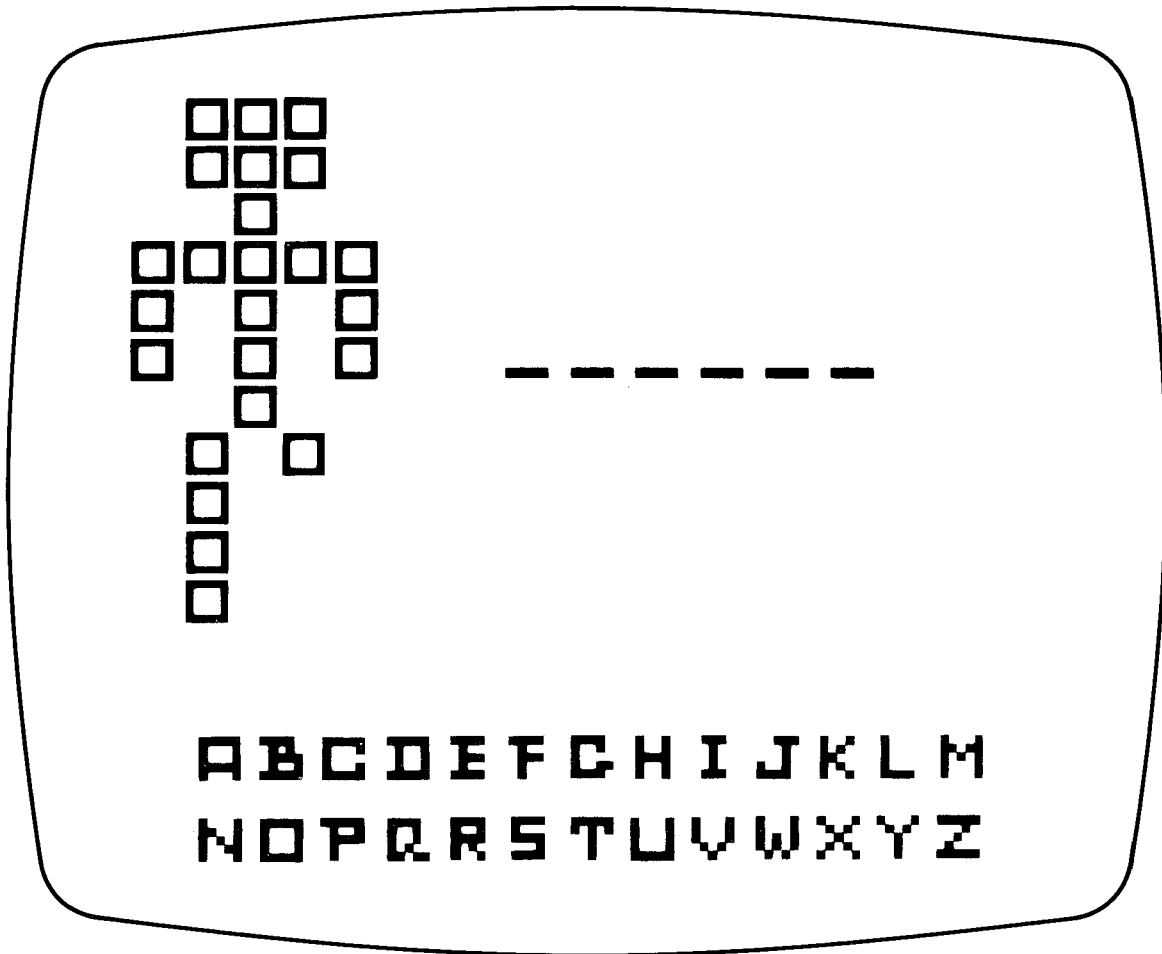


Fig.3

Hangman Cartridge

The object of Hangman is to guess a mystery word that the computer has chosen. The computer uses a 300 word dictionary comprised of 100 four-letter, 100 five-letter, and 100 six-letter words. At the start of the game, the computer displays the alphabet and 4, 5, or 6 dashes to indicate how many letters are in the mystery word. The player then selects a letter from the alphabet. If the chosen letter is in the mystery word, it is displayed in the correct position(s) and play continues. For every wrong letter guess, a different portion of a "man" is displayed on the left portion of the screen. Play continues until the mystery word is correctly spelled or until the "man" is completely displayed. Six wrong guesses will "hang the man."



Strategy Cartridge

Strategy is a 1-4 player dice game. If less than 4 players are selected, the computer may also play against the other players. The object of the game is to accumulate the highest score possible on your score card. The score card consists of 13 categories and a bonus section. The categories are as follows: ones, twos, threes, fours, fives, sixes, three of a kind, four of a kind, full house, small straight (i.e. 1, 2, 3, 4), large straight (i.e. 1, 2, 3, 4, 5), chance, and strategy (five of a kind).

Points are scored by rolling five dice (computer simulated) and totalling the resulting score in an unused category on your card. Players take turns "rolling dice" and scoring points until every category on the score card is filled. At the end of the game, scores are automatically totalled and displayed. Each player's turn consists of up to 3 rolls of the dice from 1 to 5 dice. Scoring for the categories is as follows:

Ones = Total of dice equal to 1
Twos = Total of dice equal to 2
Threes = Total of dice equal to 3

Fours = Total of dice equal to 4

Fives = Total of dice equal to 5

Sixes = Total of dice equal to 6

3 of a Kind = Total of the 3 dice (3 sixes = 18)

4 of a Kind = Total of the 4 dice

Full House = 25

Small Straight = 30

Large Straight = 40

Chance = Total of all dice

Strategy = 50

One hundred bonus points are scored for every "strategy" after the first one.

Bulcow Cartridge

Each player (you and the computer) tries to guess a 5-digit number thought up by opposing player. A bull is scored for each correct digit in the correct position and a cow for each correct digit out of position. For example:

Mystery number 51340

Your guess 21734 scores 1 bull and 2 cows

Battleship Cartridge

This game is played on a 13x5 matrix displayed on the TV screen as "A" thru "M" horizontally and "1" thru "5" vertically. Ships consist of 1 to 5 horizontal units: aircraft carrier = 5, battleship = 3, destroyer = 2, submarine = 1. 1 aircraft carrier, 2 battleships, 2 destroyers, and 4 subs are randomly placed invisibly in the matrix area. The game is initially played with 45 torpedoes. The player selects an area by a coordinate pair of digits and fires his torpedoes one at a time. A miss is recorded by placing a dash in the appropriate location on the screen; a hit places a zero. To win the game, all locations of a ship, and all ships must be hit before running out of torpedoes. A win message is displayed. If the player runs out of torpedoes before the last ship is totally destroyed, the game is over and a loss message is displayed.

Astro War I Cartridge

An enemy warship has sent 3 nuclear torpedoes directed for destruction of your vessel. Your only means of survival is destroyinrpdoes before they reach you. The only means of determining their exact location is thru magnetic directors. A salvo of 3 are launched in the direction of an incoming torpedo. When the directors pass by the incoming torpedo, a computer readout gives the sum of the (X, Y) coordinates of the distance of the miss. After the 3 "sums of the coordinates" are given, a determination must be quickly made on the exact location of the torpedo, and the torpedo destroyed before it reaches the vicinity of your vessel (a time-to-impact readout is given). All 3 torpedoes must be destroyed, one after the other.

If this is accomplished, your vessel goes on the offensive and you must destroy the enemy warship before he fires another salvo of torpedoes.

The game goes on and on until an enemy torpedo destroys your starship (a lose message is displayed), or the enemy is destroyed (a win message is displayed).



The following games introduce a new factor only possible with "computer" games. The computer actually "learns" by playing to effectively become a more skilled opponent.

Tic Tac Toe

Similar to the conventional game, but computer learns through successive plays.

Hex Pawn Cartridge

The game is played on a 3×3 grid, each player (you and the computer) has 3 pawns on his side of the grid. The pawns move in a similar manner to chess. The program learns by elimination of bad moves. This successfully makes the machine a better opponent. The philosophy behind this game leads to other cybernetic games in which the computer "learns" as it plays.

Even—Cybernetics Game Cartridge

An odd number of objects is placed in a row. You take turns with the computer picking up between one and four objects each turn. The game ends when there are no objects left, and the winner is the one with an even number of objects picked up. The computer starts out only knowing the rules of the game. Using techniques of artificial intelligence, it gradually learns to play from its mistakes until it plays a very good game. After approx. 20 games, the computer is a challenge to beat.

Munch Cartridge

Game for 1-4 players on a 12 (horizontal) × 5 (vertical) grid. A poison "P" square is positioned in the upper left-hand of the cookie grid. Each player, in turn, munches a piece of the cookie avoiding the poison square. To munch the cookie, the player selects a row and column after which all the squares on the row and column selected and the squares below and to the right of the selection disappear. The victor is the player that survives.

PART III

APPLICATION NOTES

PART NUMBER	TITLE	PAGE NUMBER
GENERAL	"World Television Systems"	71
	"Video Game FM Sound Generator"	74
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AY-3-8610-1	"A Ten Game Color Video System using the AY-3-8610-1"	84
AY-3-8615		
AY-3-8710-1	"A Tank 'Battle' TV Game using the AY-3-8710-1"	87
	"Wireless Remote Control of the AY-3-8710-1 Battle Game"	91

World Television Systems

*Staff
Astec International Ltd.*

This report describes, in chart form, the characteristics of television systems including line standards, channel frequency assignments, and other related information.

Characteristics of Television Systems

System	Number of lines	Channel width MHz	Vision bandwidth MHz	Vision/sound separation MHz	Vestigial side-band MHz	Vision Modulation	Sound Modulation
A	405	5	3	-3.5	0.75	Pos	AM
B	625	7	5	+5.5	0.75	Neg	FM
C	625	7	5	+5.5	0.75	Pos	AM
D	625	8	6	+6.5	0.75	Neg	FM
E	819	14	10	+11.15	2	Pos	AM
F	819	7	5	+5.5	0.75	Pos	AM
G	625	8	5	+5.5	0.75	Neg	FM
H	625	8	5	+5.5	1.25	Neg	FM
I	625	8	5.5	+6	1.25	Neg	FM
K	625	8	6	+6.5	0.75	Neg	FM
K'	625	8	6	+6.5	1.25	Neg	FM
L	625	8	6	+6.5	1.25	Pos	AM
M	525	6	4.2	+4.5	0.75	Neg	FM
N	625	6	4.2	+4.5	0.75	Neg	FM

Note: For all stations except those working on System M which has a field frequency of 60 per second, the field frequency is 50 per second.

Continental Europe (excl. France, Monaco, Italy and OIRT members): System B 625 lines

ch	MHz	ch	MHz
E-2	48.25/ 53.75	E-7	189.25/194.75
E-2A	49.75/ 55.25	E-8	196.25/201.75
E-3	55.25/ 60.75	E-9	203.25/208.75
E-4	62.25/ 67.75	E-10	210.25/215.75
E-5	175.25/180.75	E-11	217.25/222.75
E-6	182.25/187.75	E-12	224.25/229.75

United Kingdom. (UK): System A 405 lines.

ch	MHz	ch	MHz
B-1	45.00/ 41.50	B-8	189.75/186.25
B-2	51.75/ 48.25	B-9	194.75/191.25
B-3	56.75/ 53.25	B-10	199.75/196.25
B-4	61.75/ 58.25	B-11	204.75/ 201.25
B-5	66.75/ 63.25	B-12	209.75/206.25
B-6	179.75/176.25	B-13	214.75/211.25
B-7	184.75/181.25	B-14	219.75/216.25

France, Monaco: System E 819 lines.

ch	MHz	ch	MHz
F-2	52.40/ 41.25	F-8	186.55/175.40
F-4	65.55/ 54.40	F-9	190.30/201.45
F-5	164.00/175.15	F-10	199.70/188.55
F-6	173.40/162.25	F-11	203.45/214.60
F-7	177.15/188.30	F-12	212.85/201.70
F-8A	185.25/174.10		

Ireland: System I 625 lines and System A 405 lines.

System A: Same channels as United Kingdom. System I:

ch	MHz	ch	MHz
A	45.75/ 51.75	F	191.25/197.25
B	53.75/ 59.75	G	199.25/205.25
C	61.75/ 67.75	H	207.25/213.25
D	175.25/181.25	J	215.25/221.25
E	183.25/189.25		

Italy: System B 625 lines.

ch	MHz	ch	MHz
A	53.75/ 59.25	F	192.25/197.75
B	62.25/ 67.75	G	201.25/206.75
C	82.25/ 87.75	H	210.25/215.75
D	175.25/180.75	H-1	217.25/222.75
E	183.75/189.25		

Australia: System B 625 lines.

ch	MHz	ch	MHz
0	46.25/ 51.75	6	175.25/180.75
1	57.25/ 62.75	7	182.25/187.75
2	64.25/ 69.75	8	189.25/194.75
3	86.25/ 91.75	9	196.25/201.75
4	95.25/100.75	10	209.25/214.75
5	102.25/107.75	11	216.25/221.75
5A	138.25/143.75		

USSR and OIRT members (R) (exc. German Democratic Republic): System D 625 lines.

ch	MHz	ch	MHz
R-1	49.75/ 56.25	R-7	183.25/189.75
R-2	59.25/ 65.75	R-8	191.25/197.75
R-3	77.25/ 83.75	R-9	199.25/205.75
R-4	85.25/ 91.75	R-10	207.25/213.75
R-5	93.25/ 99.75	R-11	215.25/221.75
R-6	175.25/181.75	R-12	223.25/229.75

New Zealand (NZ): System B 625 lines.

ch	MHz	ch	MHz
1	45.25/ 50.75	6	189.25/194.75
2	55.25/ 60.75	7	196.25/201.75
3	62.25/ 67.75	8	203.25/208.75
4	175.25/180.75	9	210.25/215.75
5	182.25/187.75		

Morocco: System B 625 lines.

ch	MHz	ch	MHz
M-4	163.25/168.75	M-8	195.25/200.75
M-5	171.25/176.75	M-9	203.25/208.75
M-6	179.25/184.25	M-10	211.25/216.75
M-7	187.25/192.75		

French Overseas Territories: System K' 625 lines.

ch	MHz	ch	MHz
K'4	175.25/181.75	K'7	199.25/205.75
K'5	183.25/189.75	K'8	207.25/221.75
K'6	191.25/197.75	K'9	215.25/221.75

United States of America: System M 525 lines.

ch	MHz	ch	MHz
A-2	55.25/ 59.75	A-8	181.25/185.75
A-3	61.25/ 65.75	A-9	187.25/191.75
A-4	67.25/ 71.75	A-10	193.25/197.75
A-5	77.25/ 81.75	A-11	199.25/203.75
A-6	83.25/ 87.75	A-12	205.25/209.75
A-7	175.25/179.75	A-13	211.25/215.75

UHF Channels: USA

ch	MHz	ch	MHz
A-14	471.25/475.75	A-49	681.25/685.75
A-15	477.25/481.75	A-50	687.25/691.75
A-16	483.25/487.75	A-51	693.25/697.75
A-17	489.25/493.75	A-52	699.25/703.75
A-18	495.25/499.75	A-53	705.25/709.75
A-19	501.25/505.75	A-54	711.25/715.75
A-20	507.25/511.75	A-55	717.25/721.75
A-21	513.25/517.75	A-56	723.25/727.75
A-22	519.25/523.75	A-57	729.25/733.75
A-23	525.25/529.75	A-58	735.25/739.75
A-24	531.25/535.75	A-59	741.25/745.75
A-25	537.25/541.75	A-60	747.35/751.75
A-26	543.25/547.75	A-61	753.25/757.75
A-27	549.25/553.75	A-62	759.25/763.75
A-28	555.25/559.75	A-63	765.25/769.75
A-29	561.25/565.75	A-64	771.25/775.75
A-30	567.25/571.75	A-65	777.25/781.75
A-31	573.25/577.75	A-66	783.25/787.75
A-32	579.25/583.75	A-67	789.25/793.75
A-33	585.25/589.75	A-68	795.25/799.75
A-34	591.25/595.75	A-69	801.25/805.75
A-35	597.25/601.75	A-70	807.25/811.75
A-36	603.25/607.75	A-71	813.25/817.75
A-37	609.25/613.75	A-72	819.25/823.75
A-38	615.25/619.75	A-73	825.25/829.75
A-39	621.25/625.75	A-74	831.25/835.75
A-40	627.25/631.75	A-75	837.25/841.75
A-41	633.25/637.75	A-76	843.25/847.75
A-42	639.25/643.75	A-77	849.25/853.75
A-43	645.25/649.75	A-78	855.25/859.75
A-44	651.25/655.75	A-79	861.25/865.75
A-45	657.25/661.75	A-80	867.25/871.75
A-46	663.25/667.75	A-81	873.25/877.75
A-47	669.25/673.75	A-82	879.25/883.75
A-48	675.25/679.75	A-83	885.25/889.75

Japan: System M 525 lines

ch	MHz	ch	MHz
J-1	91.25/ 95.75	J-7	189.25/193.75
J-2	97.25/101.75	J-8	193.25/197.75
J-3	103.25/107.75	J-9	199.25/203.75
J-4	171.25/175.75	J-10	205.25/209.75
J-5	177.25/181.75	J-11	211.25/215.75
J-6	183.25/187.75	J-12	217.25/221.75

UHF Channels: Japan

ch	MHz	ch	MHz
33	591.25/595.75	43	651.25/655.75
34	597.25/601.75	44	657.25/661.75
35	603.25/607.75	45	663.25/667.75
36	609.25/613.75	46	669.25/673.75
37	615.25/619.75	47	675.25/679.75
38	621.25/625.75	48	681.25/685.75
39	627.25/631.75	49	687.25/691.75
40	633.25/637.75	50	693.25/697.75
41	639.25/643.75	51	699.25/703.75
42	645.25/649.75	52	705.25/709.75

UHF Channels: Japan

ch	MHz	ch	MHz
53	711.25/715.75	58	741.25/745.75
54	717.25/721.75	59	747.25/751.75
55	723.25/727.75	60	753.25/757.75
56	729.25/733.75	61	759.25/763.75
57	735.25/739.75	62	765.25/769.75

Television on VHF/UHF (Band IV/V)

Europe & Africa

VHF/UHF television systems for Band IV/V adopted by the European Broadcasting Conference Stockholm 1961, and by the African Broadcasting Conference, Geneva 1963 are 625 lines systems only. These can be grouped into 5 categories, here called Standards G to L.

Standard	Video Band-width (MHz)	Picture/Sound Separation (MHz)	Vestigial Sideband (MHz)	Picture modulation	Sound modulation	Frequency of chrominance subcarrier (MHz)	Power ratio picture/sound
G	5	5.5	0.75	Neg	FM	4.43	5:1
H	5	5.5	1.25	Neg	FM	4.43	5:1
I	5.5	6	1.25	Neg	FM	4.43	5:1
K	6	6.5	0.75	Neg	FM	4.43	5:1
L	6	6.5	1.25	Pos	AM	4.43	8:1

ch	Vision MHz	ch	Vision MHz	ch	Vision MHz
21	471.25	38	607.25	54	735.25
22	479.25	39	615.25	55	743.25
23	487.25	40	623.25	56	751.25
24	495.25	41	631.25	57	759.25
25	503.25	42	639.25	58	767.25
26	511.25	43	647.25	59	775.25
27	519.25	44	655.25	60	783.25
28	527.25	45	663.25	61	791.25
29	535.25	46	671.25	62	799.25
30	543.25	47	679.25	63	807.25
31	551.25	48	687.25	64	815.25
32	559.25	49	695.25	65	823.25
33	567.25	50	703.25	66	831.25
34	575.25	51	711.25	67	839.25
35	583.25	52	719.25	68	847.25
36	591.25	53	727.25	69	855.25
37	599.25				

The sound carrier frequency for each channel can be determined by adding the appropriate figure to the vision carrier frequency given above (5.5MHz for systems G, H; 6MHz for system I and 6.5MHz for systems K, L). In We. Germany ch38 is reserved for aeronavigation.

Hong Kong - 625 lines PAL colour System.

TVB	ch21	
	ch25	
RTV	ch23	ch44
	ch27	ch45
	ch42	ch53
	ch43	ch55

Video Game FM Sound Generator

Andy Sass

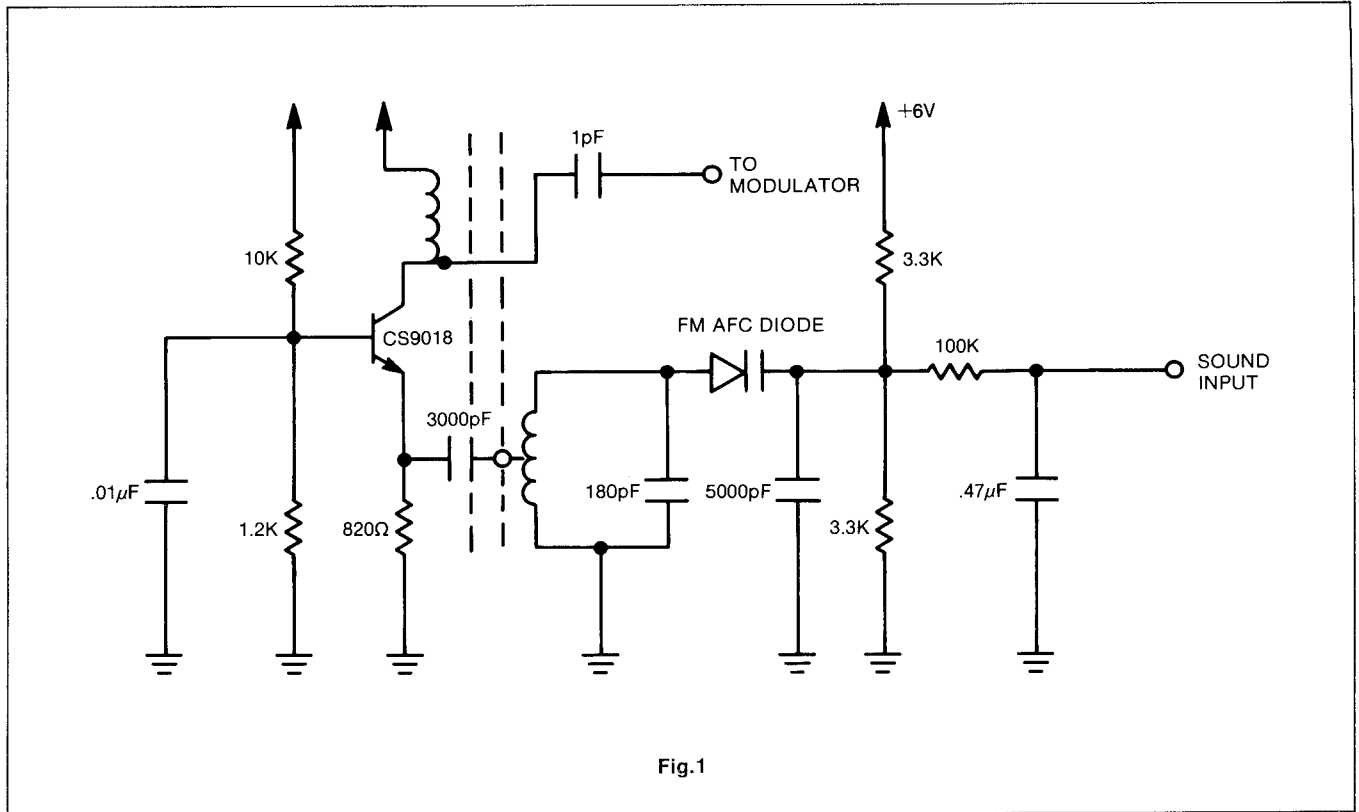
A circuit, which combines Video Game sound with video, so as to permit utilization of the TV sound system for game sounds, is described.

SYSTEM DESCRIPTION:

The circuit shown in Fig. 1 uses the Video Game sound output signal as the modulation on a TV sound carrier (4.5 MHz). The resultant frequency modulated signal is input to the RF modulator in conjunction with the video portion of Video Game signals (not shown). The TV receiver separates and processes the sound signal in a manner identical to the sound in a normal TV broadcast.

SUBSYSTEM DESCRIPTION:

- a. The circuit is a TV sound frequency oscillator. The right hand portion of the system is a tank circuit whose natural frequency is voltage controlled via a varactor diode. The tank is tuned to 4.5 MHz. The game sound input (hit, boundary, reflection and score) causes the varactor diode capacitance to vary at the frequency of the particular sound input. The tank frequency therefore is modulated by the particular sound frequency.
- b. The tank is coupled to the left hand amplifier circuit which inputs the FM signal into the RF Modulator.



Pal Colour Encoding Systems For The AY-3-8500 TV Game Circuit

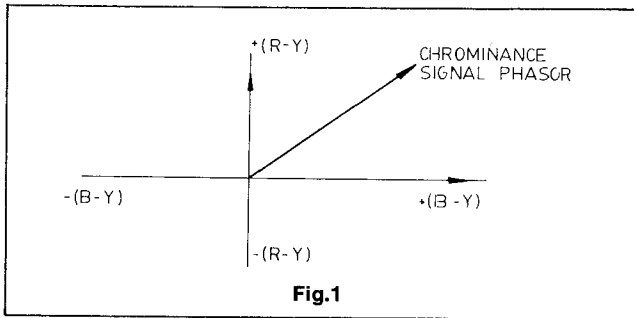
*Staff
Astec International Ltd.*

Following a brief description of the PAL system, two alternate circuits are described for colour encoding the AY-3-8500 CCIR standard TV game according to the PAL system.

PAL COLOUR TELEVISION SYSTEM

The PAL system is similar to the NTSC system in many respects, it uses a colour subcarrier the actual frequency of which is tailored to the CCIR 625 line standard. Two colour difference signals are derived to quadrature amplitude modulate this subcarrier. The principle difference between the two systems is the fact that in PAL one of the colour difference signals is reversed in phase every alternate horizontal line.

Two chrominance signal phasor diagrams are shown below. Fig. 1 is NTSC and Fig. 2 is PAL.



As can be seen from Fig. 2 it is the R-Y colour difference signal that is reversed on alternate lines. Relative positions of phasors for the primary colours and their complements are shown in Fig. 3 and Table 1 lists the details of a 100% amplitude and 100% saturated colour bar signal when colour difference signal weighting factors are employed.

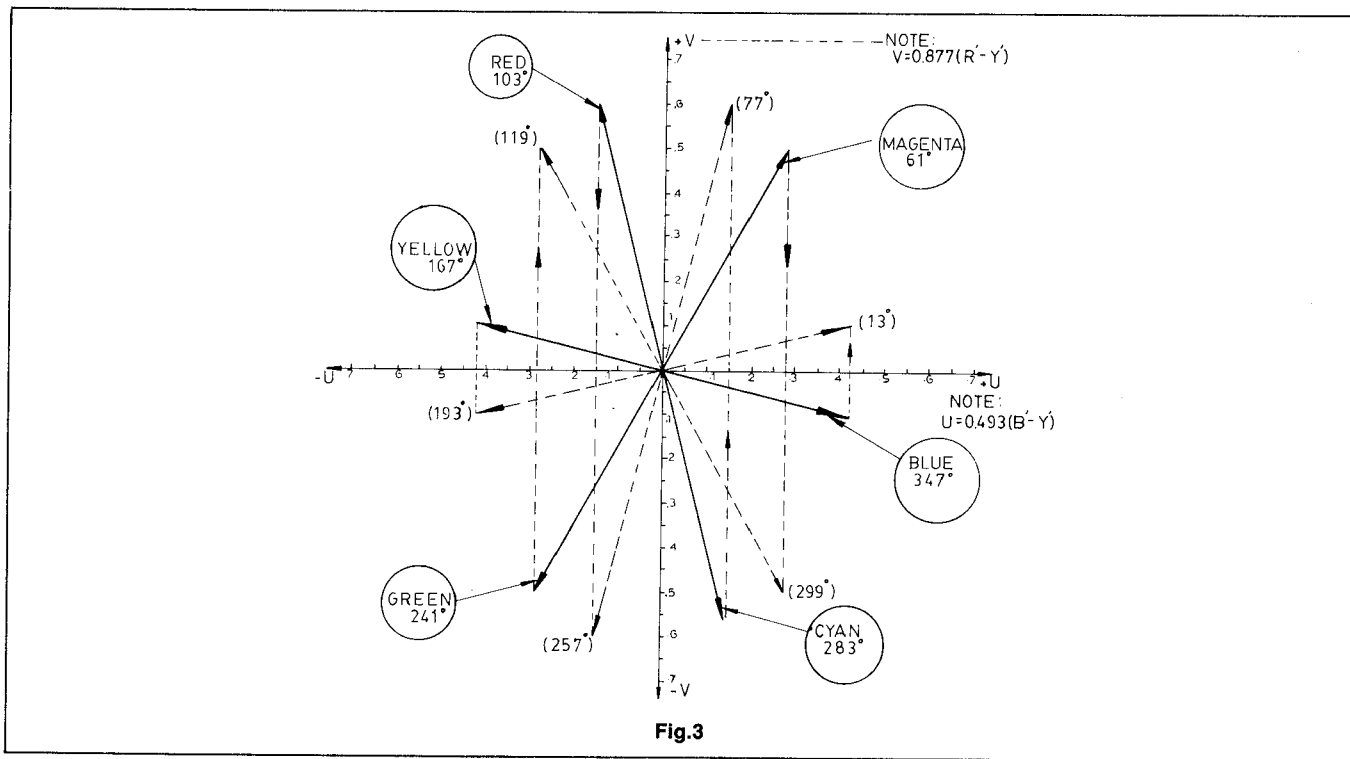
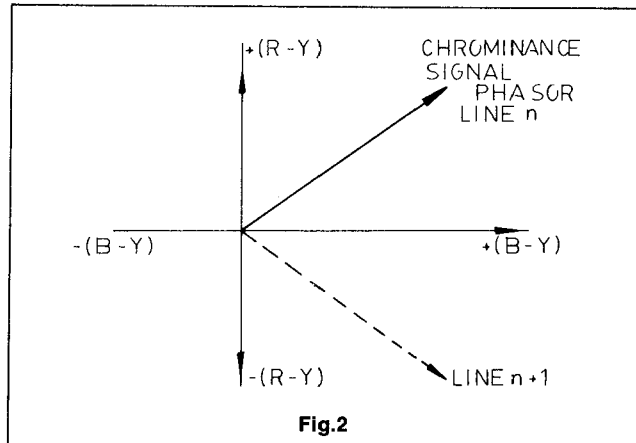


Table 1

COLOUR-BAR	Y'	(B'-Y')	(R'-Y')	U=0.493(B'-Y')	V=0.877(R'-Y')	CHROM. AMP $=\sqrt{U^2 + V^2}$	CHROM. PHASE ANGLE (°NTSC-LINE)
WHITE	1.0	0	0	0	0	0	—
YELLOW	0.89	-0.89	+0.11	-0.4388	0.0965	0.44	167°
CYAN	0.7	+0.3	-0.7	+0.1479	-0.6139	0.63	283°
GREEN	0.59	-0.59	-0.59	-0.2909	-0.5174	0.59	241°
MAGENTA	0.41	+0.59	+0.59	+0.2909	+0.5174	0.59	61°
RED	0.3	-0.3	+0.7	-0.1479	+0.6139	0.63	103°
BLUE	0.11	+0.89	-0.11	+0.4388	-0.0965	0.44	347°
BLACK	0	0	0	0	0	0	—

A COLOUR ENCODER FOR DIGITAL SIGNALS

Since the objective is to encode a set of given digital signals a different approach to that employed by broadcasting stations is adopted.

The basic encoder is shown in Fig. 4. Two CMOS quad analogue gates are used to switch the 4.433MHz colour subcarrier, one for blue, yellow and the reference burst, the other for red and green. Since the requirement is for digital encoding no provision is made for intermediate colours.

A transformer in the crystal oscillator circuit has a centre tapped winding, with the tap at the ground, two low impedance antiphase subcarrier voltages are available. One of these is nominated $\pm 0^\circ$ from a reinspection of Fig. 3 it is clear signals of this phase will be decoded by a colour television receiver as blue, likewise signals from the other output will be decoded as yellow. Since in PAL system the R-Y component of blue and yellow is very small at high saturation levels, no attempt has been made to follow the exact standard.

From the $\pm 180^\circ$ winding of the transformer two RC networks provide a leading $\pm 45^\circ$ and a trailing $\pm 45^\circ$ phase shift to drive the burst gate. It is essential that a swinging burst be provided because many television receivers detect the swing in the colour killer circuitry.

To provide a means to alternate the phase of red and green signals, two pairs of analogue transmission gates are connected across each phase of the transformer. The outputs of these gates drive a centre tapped coil and capacitor $\pm 90^\circ$ phase delay circuit, which particular gates that is conducting is determined by the 7.8kHz PAL switching signal.

The GI TV game chip AY-3-8500 does not provide all the digital signals necessary for a PAL colour system. However the few additional signals necessary are easy to generate using CMOS IC's. In Fig. 5 is shown the circuitry for driving the PAL colour encoder as well as the analogue mixing of the various components of the composite video waveform. Fig. 6 shows the special PAL switching signal generators.

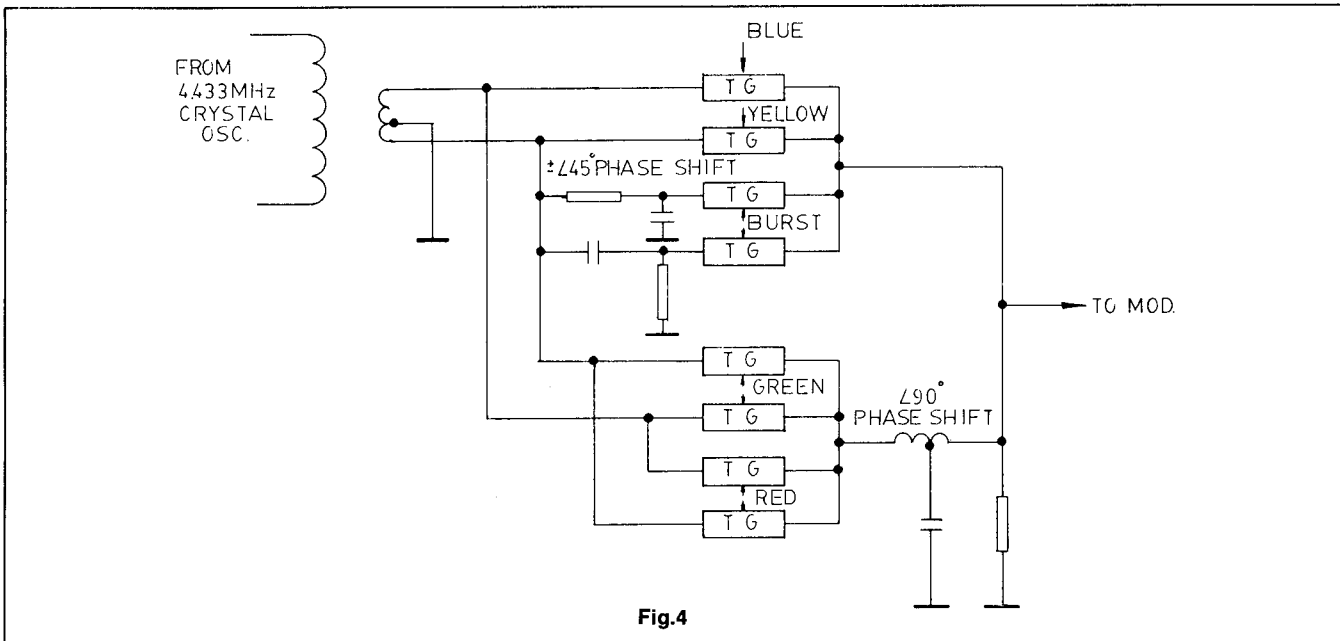


Fig.4

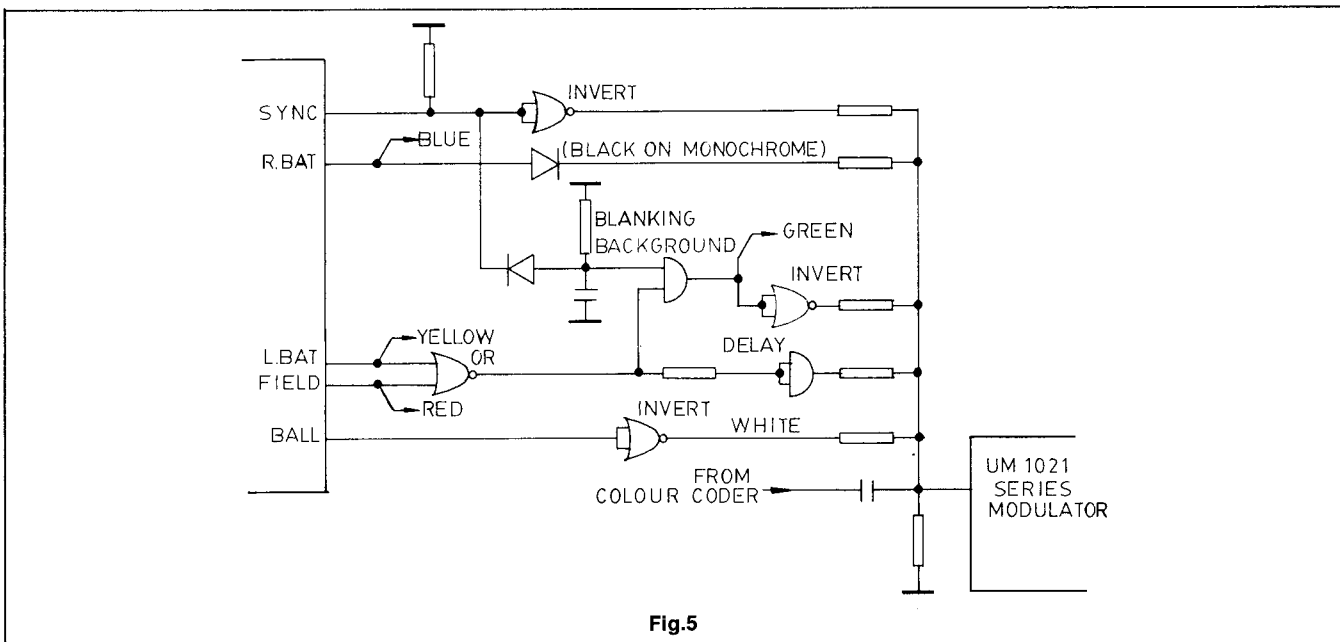


Fig.5

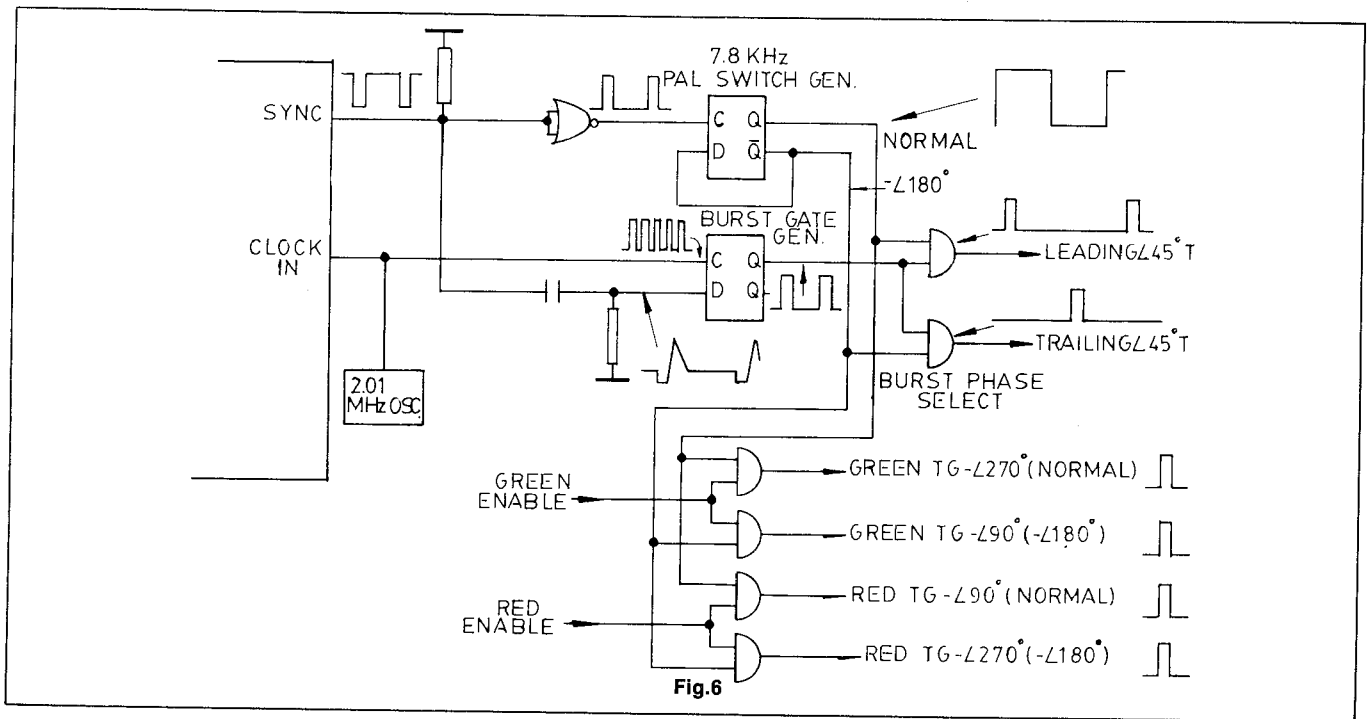


Fig.6

In order to simplify understanding of the circuit waveforms are shown at all points. In Fig. 5 the video/sync mixing is shown for an Astec International Modulator in the UM1021 series. This modulator requires a +2 Volt level for the sync tips and +0.6 Volt for peak white. In order to optimize the saturation of the blue in the right bat the monochrome level is close to black. Since the left bat is yellow or, on monochrome, white, this is a very acceptable feature.

Green has been chosen for the background and the enable signal is generated with a simple AND gate, which a diode integrator also generates line blanking. An invert gate is then used to increase the luminance level of the background. Again on monochrome receivers this will be a grey also a very desirable feature.

Since red strictly speaking should not have a high luminance value, for reasons of monochrome compatibility, the field is given the same luminance value as the left bat and the two signals are combined in an OR gate. White is chosen for the ball and to ensure a good clean white the modulator is driven into peak white compression thus preventing any bleeding through of stray subcarrier signals.

In Fig. 6, half of a dual D type CMOS Flip Flop is used in a divide by 2 mode to generate the 7.8kHz PAL switching signal. The Q output enables the normal or NTSC type lines and the \bar{Q} output enables the -180° or PAL lines.

The other half of the package is used as a clocked pulse amplifier and produces very clean burst gating pulses. The pulses into the D input are formed by differentiating the trailing edge of the sync pulse from the AY-3-8500. Two AND gates driven by the PAL switch gen and the burst gate gen are connected to provide the correctly phased pulses for the burst transmission gates.

Another package containing four AND gates is connected to provide the red and the green phasing requirements. The appropriate outputs being dependent on the phase of the PAL switch generator and the presence of enabling signals from the AY-3-8500.

A 4.433618MHz CRYSTAL OSCILLATOR

Although it might be simple to take two CMOS gates and a crystal and make an oscillator the performance of such an oscillator would not be at all adequate. With a supply voltage only around

6.5 Volts, CMOS will not give sufficient frequency stability. The frequency stability requirements are extremely tight. The typical pull in range of a television receivers colour APC circuit is $\pm 400\text{Hz}$, if the receivers reference oscillator is tuned slightly off nominal it can easily be seen how extremely tight the requirement for accurate frequency and high stability is. The circuit in Fig. 7 has proven reasonably reliable in bench tests but the alignability, voltage and temperature stability must be very carefully checked before committing to production.

A complete circuit of a PAL colour TV game using the AY-3-8500 is shown in Fig. 8. With regard to the 2.0MHz oscillator, it is necessary to ensure that this oscillator is exactly at the correct frequency. In more expensive PAL colour receivers a fixed delay line is used the delay of which is almost exactly the period of one horizontal line. If the sync timing is not correct, the effect on this type of receiver is to see two pictures not quite overlapping.

This effect is briefly due to the fact that in this type of receiver the chrominance signal is delayed by one line and then compared to the current line the process separating the U and V modulation components. If then the 2.00MHz clock frequency is too high then the delay line will cause a picture detail to appear slightly late when compared to the current line.

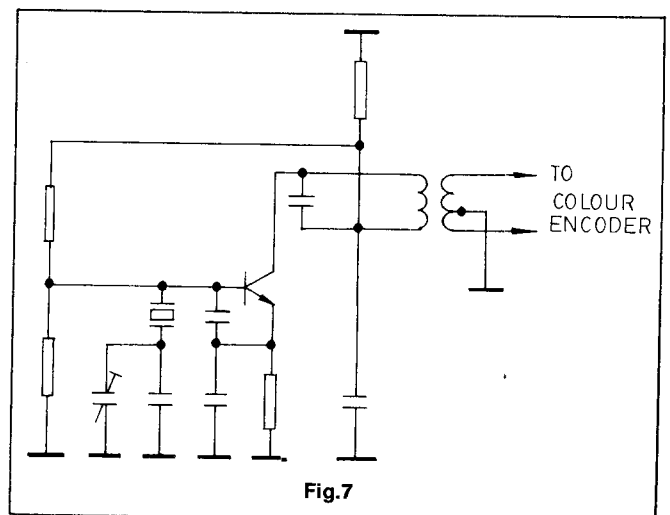
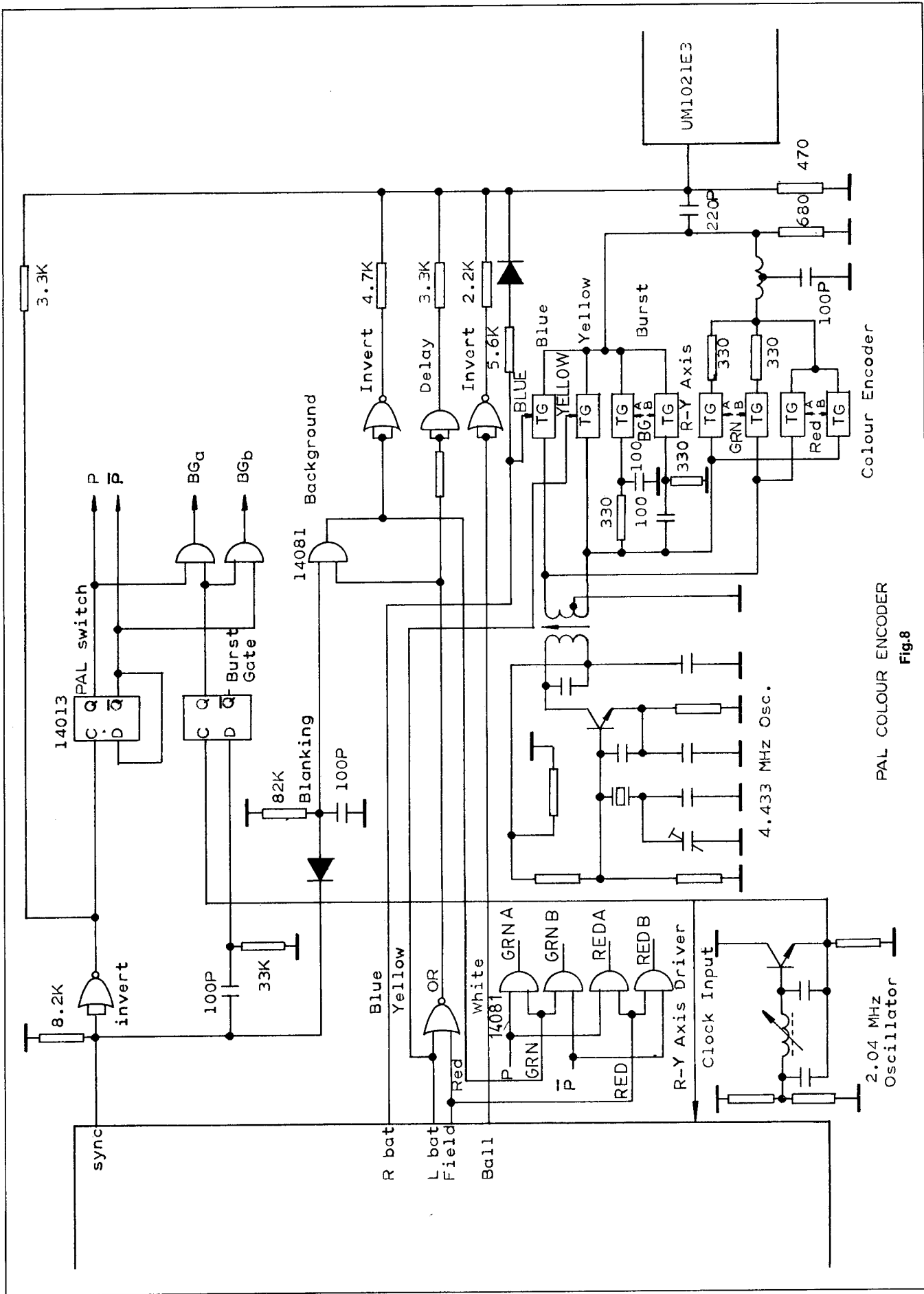


Fig.7



Colour Encoder

PAL COLOUR ENCODER

Fig.8

AN ALTERNATE COLOUR ENCODING SYSTEM

This application describes a PAL colour encoding system that only uses two CMOS packages and one discrete transistor as an interface between the GI TV game chip AY-3-8500 and the Astec colour encoder/modulator module UM1163.

SYSTEM OUTLINE

Fig. 9 shows the principal functional blocks in this system, a block by block description follows:

DIGITAL PROCESSING

This section is shown in detail in Fig. 10 and converts the outputs from the AY-3-8500 into signals suitable for the PAL colour coder module. These signals are:

- Sync Pulse.
- Blanking Pulse.
- Red, Green, Blue, Yellow Drive Signals.
- PAL switching.
- Composite Video.

As shown in Fig. 10, two CMOS packages are utilized. The type numbers being 4069 and 4075. The 4069 is a hex inverter and the 4075 is a triple three input OR gate.

Starting with Pin 16 of the 8500, IC1a buffers and inverts the sync pulse. IC1b together with diode integrator D1 R1 C1 stretches the sync pulse from P-16 to the width of a blanking pulse. This pulse is then buffered and inverted by IC1c. The module uses these two signals to internally generate a burst gating pulse.

IC2a and IC2b generate the R-Y axis chrominance drive signals, green occurs when both outputs are low, red occurs when both outputs are high. If both outputs are different the R-Y axis chrominance circuit is disabled. It follows then if all inputs to these two gates are low then the resultant output from the UM1163 will be green. Similarly when Pin 24 goes high (the boundary) then both IC2a and IC2b going high will create red and other inputs will cause an absence of either red or green.

In a very similar fashion IC2c and IC1d drive the B-Y axis chrominance circuit. Yellow occurs when both outputs are high and blue occurs when both are low. During the period when one is different from the other, the B-Y axis circuit is not enabled.

Since the design concept calls for the background to be green, the most natural colour, IC2a and IC2b receive inputs from Pin 9 (R. bat) Pin 10 (L. bat) and IC1b only when green is not desired. IC1e and IC1f provide a simple divide by 2 circuit for the PAL switching. Reliable division is ensured with steering diodes D3, D4 and biasing resistors R2 R3. The circuit changes state on the negative going edge of the pulse from IC1c. The pulse being differentiated by capacitors C2 C3. The outputs from IC1e IC1f are used by the colour encoder to switch the R-Y axis phase on alternate lines by 180°.

The last section of the digital processing part is the luminance summing network.

In order to obtain good monochrome compatibility luminance levels have been established so that blanking, blue, yellow and white are close to standard, red (pink) lighter and green darker. Luminance can be individually tailored if so desired in the summing network and buffered through Q1 to give a composite video output at Pin 8.

COLOUR ENCODER MODULE

A more detailed description is given in the product specification for the UM1163. Essentially the module provides for the following.

LUMINANCE FILTERING

Some filtering has been included to reduce the interference effects of an unrelated 2.00MHz system clock producing fast edges that beat with the chrominance subcarrier. There are two related problems associated - one indicated just above, the other due to minute variations in line to line period caused by the free running 2.00MHz system. The delay line in a PAL receiver does a very accurate comparison between consecutive lines, a minute variation in line period becomes quite a considerable variation in phase at 4.43MHz.

SUBCARRIER OSCILLATOR

A single transistor with an external standard TV type 4.43MHz crystal is used to generate the fundamental subcarrier frequency. Whilst the oscillator part of the circuit exhibits good stability for both voltage and temperature variation and presents minimum loading to the crystal.

A word of warning - the pull in range of the average colour television subcarrier oscillator is only about 400Hz. In order to minimize service problems, the subcarrier oscillator in the game should be aligned to 4.433619MHz with a maximum tolerance of ± 50 Hz. It is recommended that the subcarrier oscillator in a colour television tuned to a strong local colour broadcast be used as a master frequency reference.

PAL PHASE SWITCH

It is the essence of the PAL system that the R-Y axis or V component of the modulated subcarrier be switched in phase by 180° on every alternate line that is at a 7.8kHz rate.

QUADRATURE AMPLITUDE MODULATOR

As in the NTSC system a QAM process is used to encode two discrete signals on a single carrier.

SWINGING BURST

It is essential that the burst phase should be at 135° on 'normal' lines and at 225° on alternate lines in order for the receiver to identify which line is which - normal or PAL. The +ve sync and blanking inputs are combined in such a way as to produce a burst which switches $\pm 45^\circ$ around the B-Y axis. The manner in which this is done ensures no ambiguity in the truth table for the chrominance enabling inputs.

RF MODULATOR

- Two standard versions are available:
- VHF tuned to CH E3 (55.25MHz)
- UHF tuned to CH E36 (591.25MHz)

CONCLUSION

The system described is an economic method of providing colour for the European Market and other 'PAL' areas of the world.

It should be born in mind that the objective is to provide an adequate system for a consumer product at a consumer price. In order get the best performance the following points should be noted:

1. 4.43MHz alignment should be very accurate.
2. 2.000MHz system clock. A crystal oscillator is recommended and tuned to minimize interference patterns.

The two chip system described does not readily allow background colour changes, it may however be preferable to have a white boundary and red ball and can be easily attained by exchanging connections to pin 6 and 24 of the AY-3-8500. It should be understood that the vertical boundary lines are a series of single alternate lines which tend to become a different colour to the more solid portions of the boundary, and for this reason a more solid white boundary may be chosen.

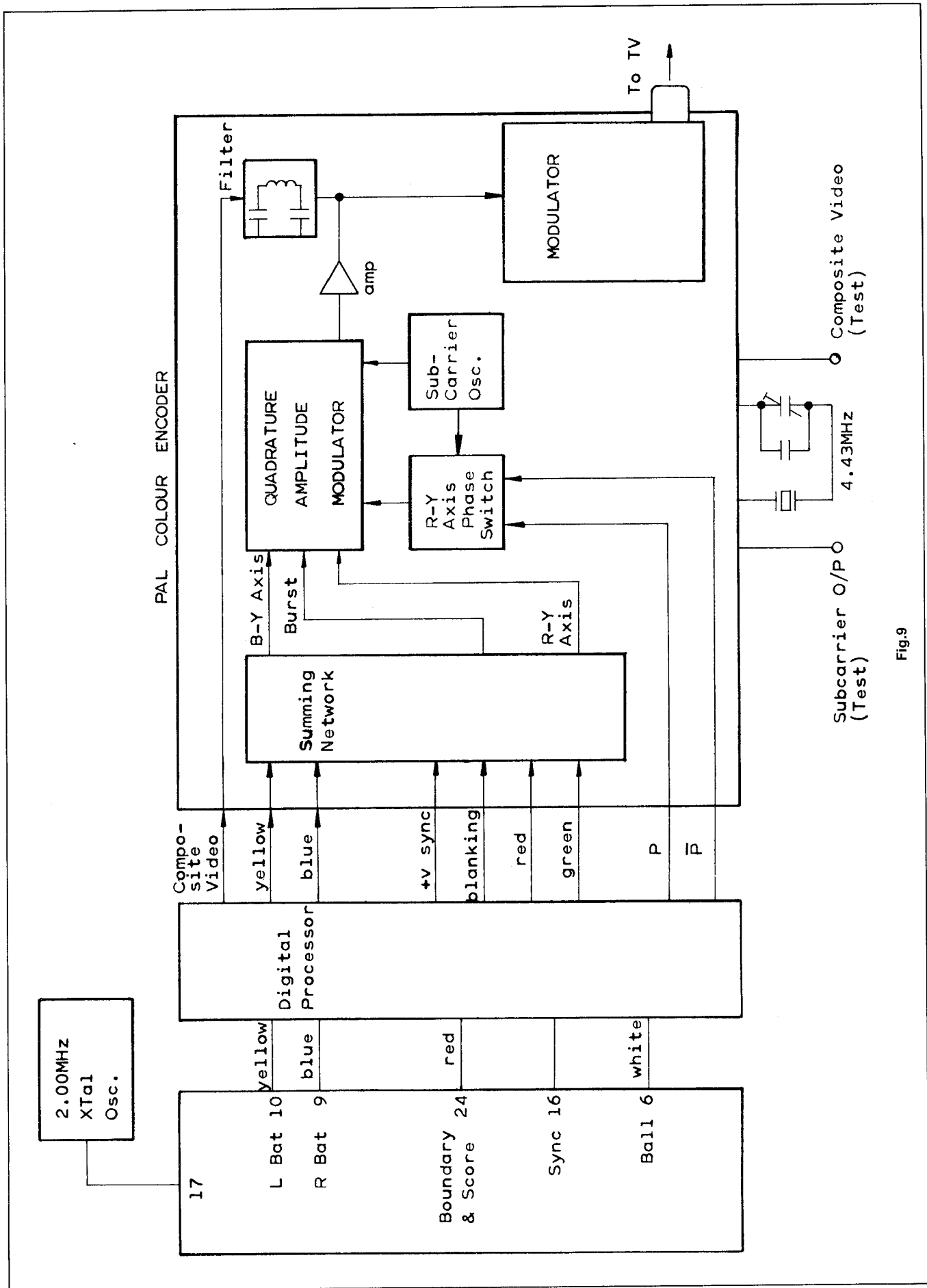


Fig.9

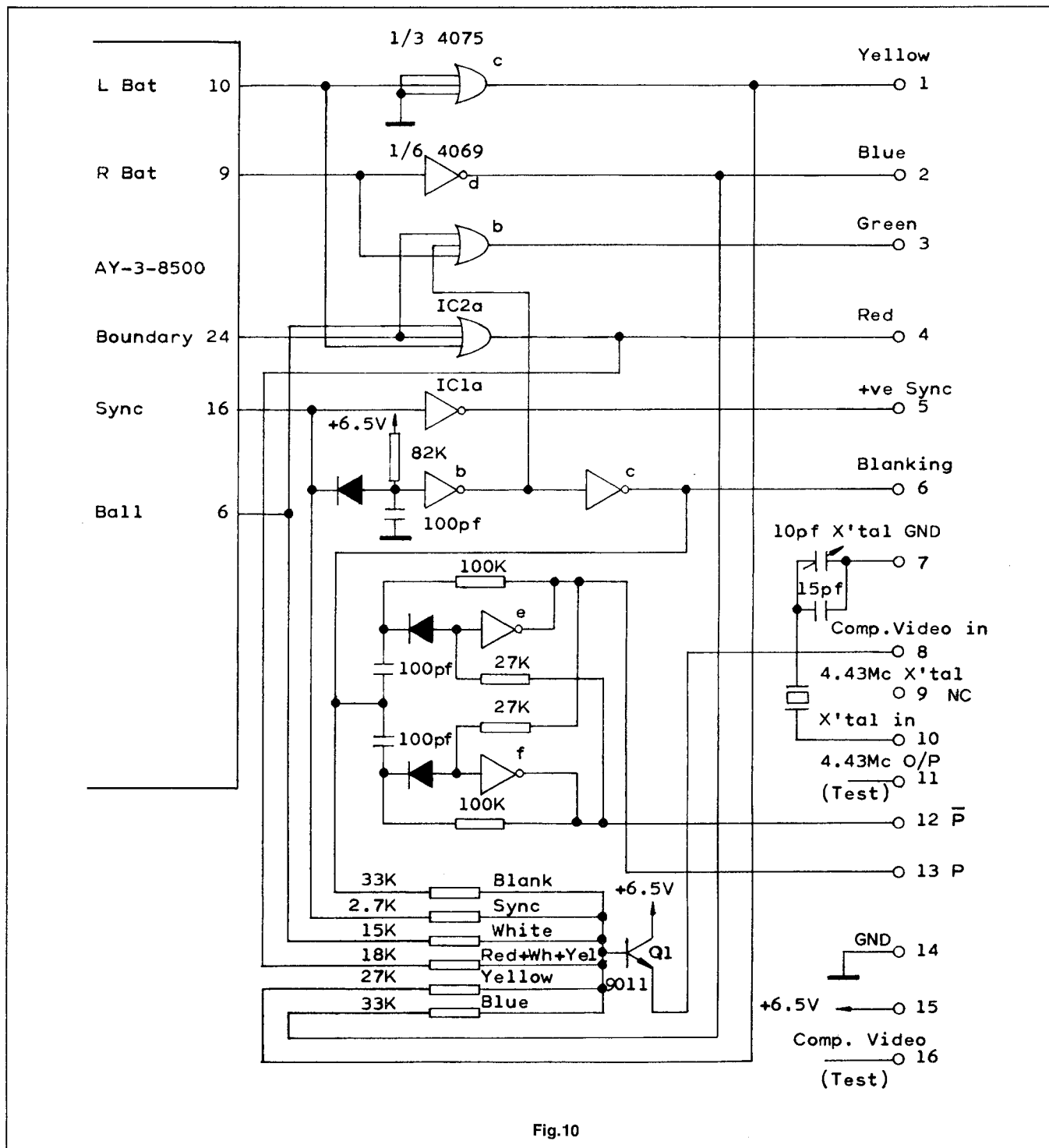


Fig.10

A Ten Game Color Video System Using the AY-3-8610-1

M.S. Sellars III

This system incorporates the GI AY-3-8610-1 Superstar Game and the AY-3-8615 color circuit. The system provides NTSC compatibility to operate with a standard 525 line color TV receiver. It is both cost effective in type and number of required components and is easily assembled with a minimum of adjustment.

SYSTEM DESCRIPTION

The complete system consists of three major components:

1. An AY-3-8610-1 TV game circuit
2. An AY-3-8615 Color Converter
3. An Astec RF Modulator UM1082

This system provides a color composite video signal with color burst and sync that simulates the N.T.S.C. standard which allows a standard 525 line color receiver to display a full color picture.

SUBSYSTEM DESCRIPTION

The system can be subdivided into three sections which provide the individual functions necessary for a TV game.

1. Controls
2. The I.C.'s
3. The Modulator with interface circuit.

SUBSYSTEM DETAILS

Controls

The controls for this TV game consist of 2 joysticks with variable resistances 90° from each other. This joystick control provides the player with vertical and horizontal movement in the game. Care must be used in choice of joysticks for maximum resistance variation. We have found that manufacturers differ on angle of pot movement and range used in the joystick controls. These joystick controls provide a variable R for the RC time constant required for the game circuit inputs.

The ten game select switches can be either momentary or fixed type. The game requires a minimum of 30 milliseconds of closure to make the game selection. Momentary switches can be as simple as calculator type PC board switches.

The right and left serve switches and the reset switches should be momentary ON type.

The right and left bat size and the ball speed switches should be the fixed type where selection will remain throughout the game play.

I.C.'s

The Integrated Circuits AY-3-8610-1 and AY-3-8615 should be connected as shown on the schematic. The 3.579545 MHz clock generator is of the fixed crystal type required for color stability and is connected directly to the AY-3-8615 color circuit. The AY-3-8610-1 is clocked by an output from the color circuit. The power supply for both I.C.'s is provided by the voltage regulator circuit. This voltage is about 6.3V D.C.

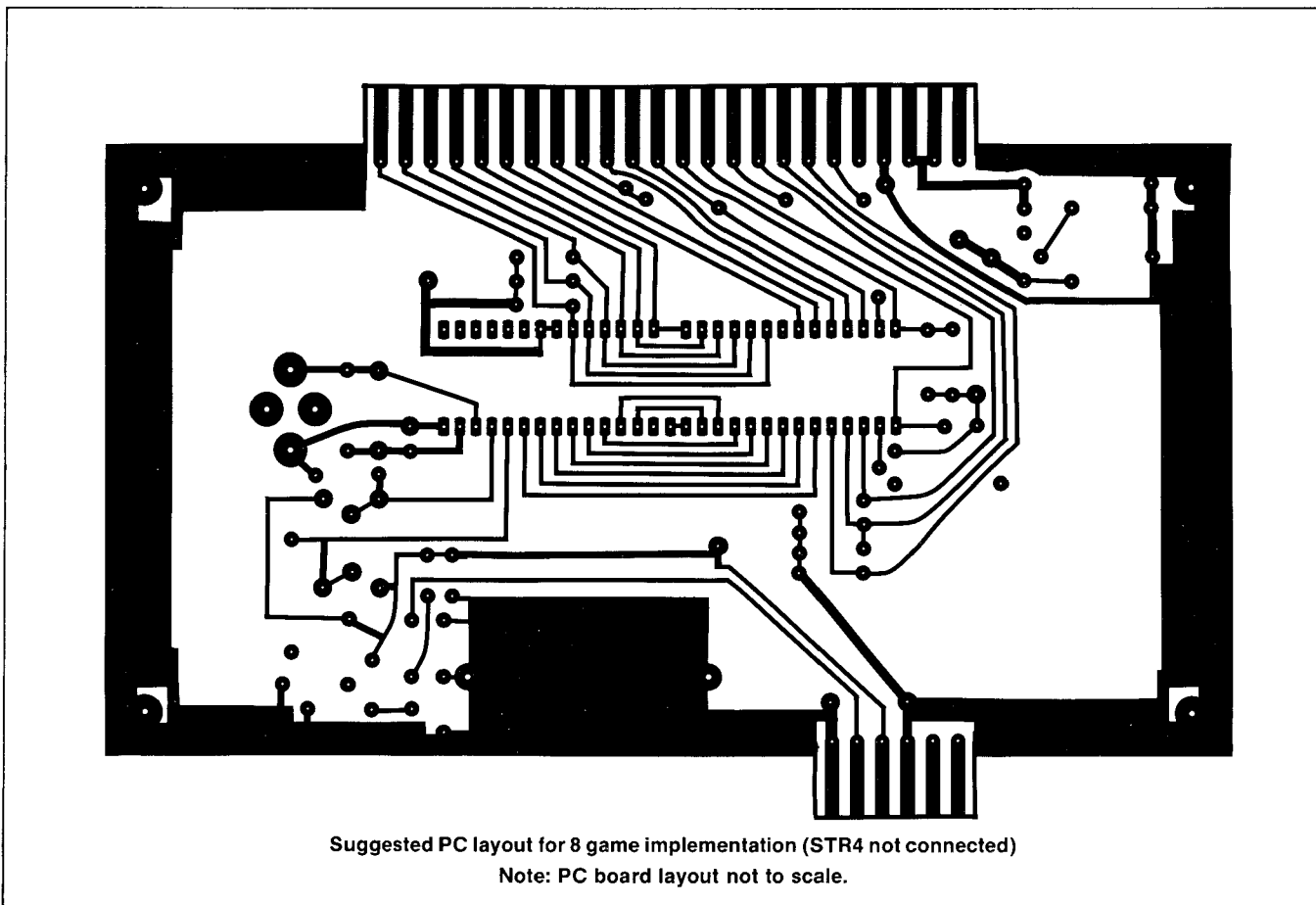
Modulator and Interface Circuit

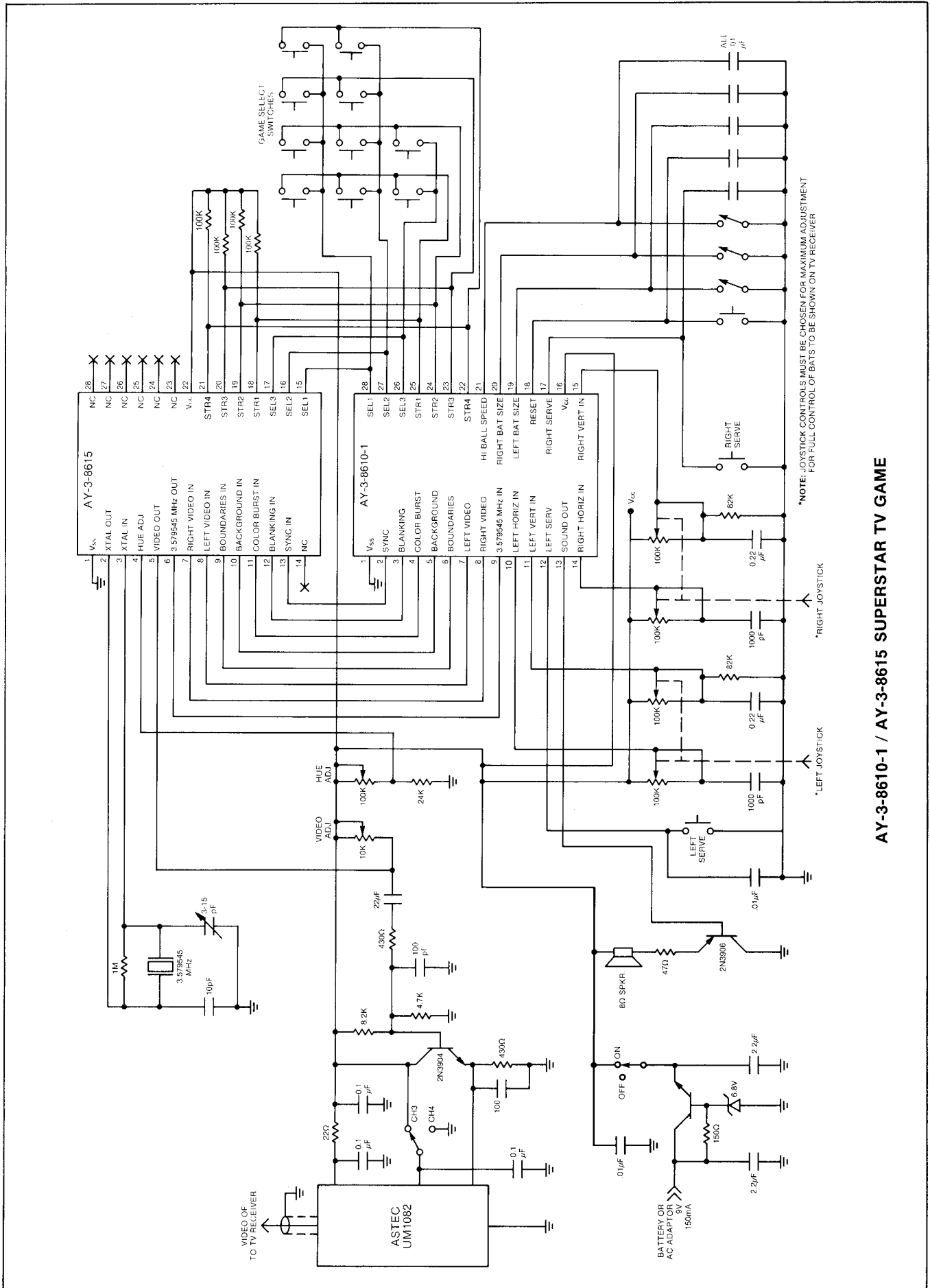
The modulator selected for this application is an ASTEC UM1082, which provides an RF output for either channel 3 or channel 4. The modulator is powered from the regulated supply with a filter network. The modulator input consists of a video output from the color I.C. which is adjusted with a 10K potentiometer pulling the output to the supply voltage and A.C. coupled to a transistor network to match the input impedance of the modulator. The Hue adjustment is a 100K potentiometer connected to the supply voltage and a 100K resistor to ground; this controls the phase shift in the AY-3-8615.

System Assembly and Operation

The AY-3-8610-1 and AY-3-8615 should be laid out in a similar manner to the schematic layout, with interconnections as short as possible. A printed circuit layout is also shown as an example.

The system operates with only two major adjustments — the video and hue controls. Video should be adjusted for a picture on the TV screen showing good black and white contrast. This control should be adjusted for maximum signal amplitude of 4.0V and a minimum amplitude of 2.0 volts. The Hue control adjusts the intensity of the color. This allows for the control of system variations.





AY-3-8610-1 / AY-3-8615 SUPERSTAR TV GAME

A Tank "Battle" TV Game Using the AY-3-8710-1

M.S. Sellars III

This TV game consists of a single integrated circuit which provides an NTSC compatible signal to operate with a standard 525 line TV receiver and produces a black and white picture. It is cost effective both in part type and total number of additional parts necessary. It is also easily assembled and tested with a minimum of adjustment.

SYSTEM DESCRIPTION

The Battle I system consists of two major components, an AY-3-8710-1 integrated circuit and an Astec UM1082 modulator. This system provides a composite video signal with sync that simulates the NTSC standard which allows a standard 525 line Black and White or color receiver to display black and white objects with a gray background.

SUBSYSTEM DESCRIPTION

The system can be broken down into sections which provide the individual functions necessary for a TV game.

1. Controls
2. The I.C. with a clock generator
3. Sound
4. Modulator with interface

SECTION DETAILS

Controls

The controls for this TV game consist of two sets of switches for tanks, one set for each player, and a game reset switch. The switches used for driving each tank are single pole double throw spring loaded to a center off position. Each player also controls the gun on his tank with a fire switch (single pole single throw normally open). Figure 1 shows the switch controls in a simplified form. Tank controls may alternately be derived from a keypad or a single joystick type of switch control.

Integrated Circuit

The AY-3-8710-1 integrated circuit is connected as shown in the schematic Figure 2 with a 4.0909 MHz clock generator utilizing two NAND gates from a CMOS 4011A circuit. The system is powered from an adjustable voltage regulator set between 6.5

and 8.0 volts. **Caution:** 4.0909 MHz clock is critical for exact frequency and output levels; picture will not appear if incorrectly adjusted.

Sound

An essential ingredient to add to the effects for a battle game is sound. The circuit consists of the two engine sound outputs from The AY-3-8710-1 circuit (Pins 21 and 23) being summed and fed into two NOR gates from a CMOS 4001A circuit biased as amplifiers and passed on to the speaker driver. The fire and explosion outputs, Pins 25 and 26, from the AY-3-8710-1 provide gating signals to pass the on-chip noise generator signal through two NOR gates and out to be summed with the engine sound. Typical waveforms of the fire and explosion sounds are shown in Figure 3. The sound circuit is powered from the voltage regulator circuit with the speaker driver fed through an R.C. network to prevent interference on the video outputs.

Modulator and Interface

The modulator selected for this application is an ASTEC UM1082 which provides an RF output for either channel 3 or channel 4 on a TV receiver. The modulator is powered from the voltage regulator circuit which is zener diode dropped down to 6.8V. The modulator input is a set of summing resistors from the video outputs of the AY-3-8710-1 fed into the base of a transistor circuit which matches the input impedance of the modulator. Other packaged or discrete modulators may be used, but the summing network may have to be changed for proper video on a TV receiver.

System Assembly and Operation

The AY-3-8710-1 as shown in the schematic Figure 2 should be laid out in an organized arrangement with the 4.0909 oscillator leads as short as possible. With the components shown there is no adjustment necessary except for the oscillator frequency.

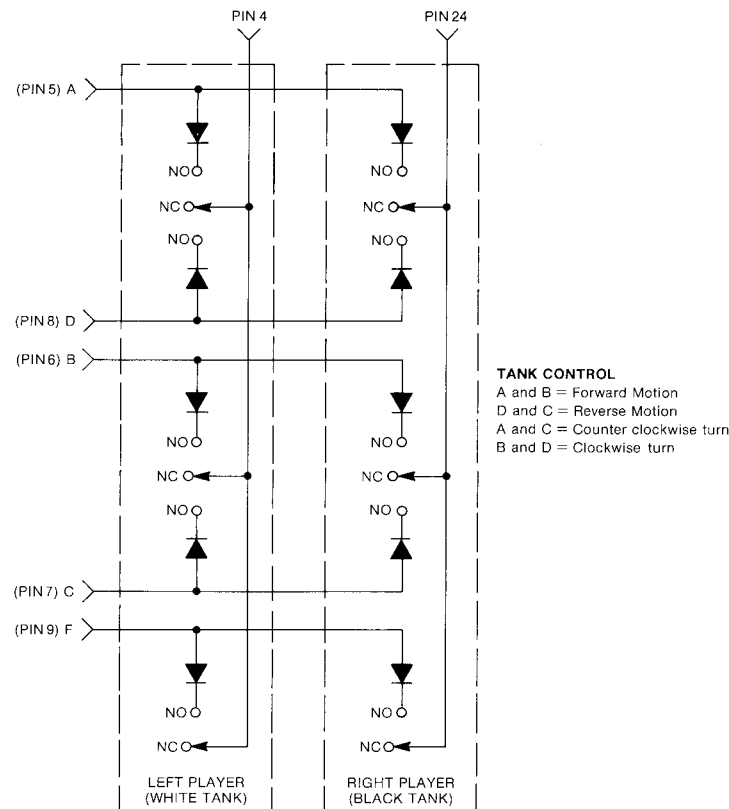


Fig.1

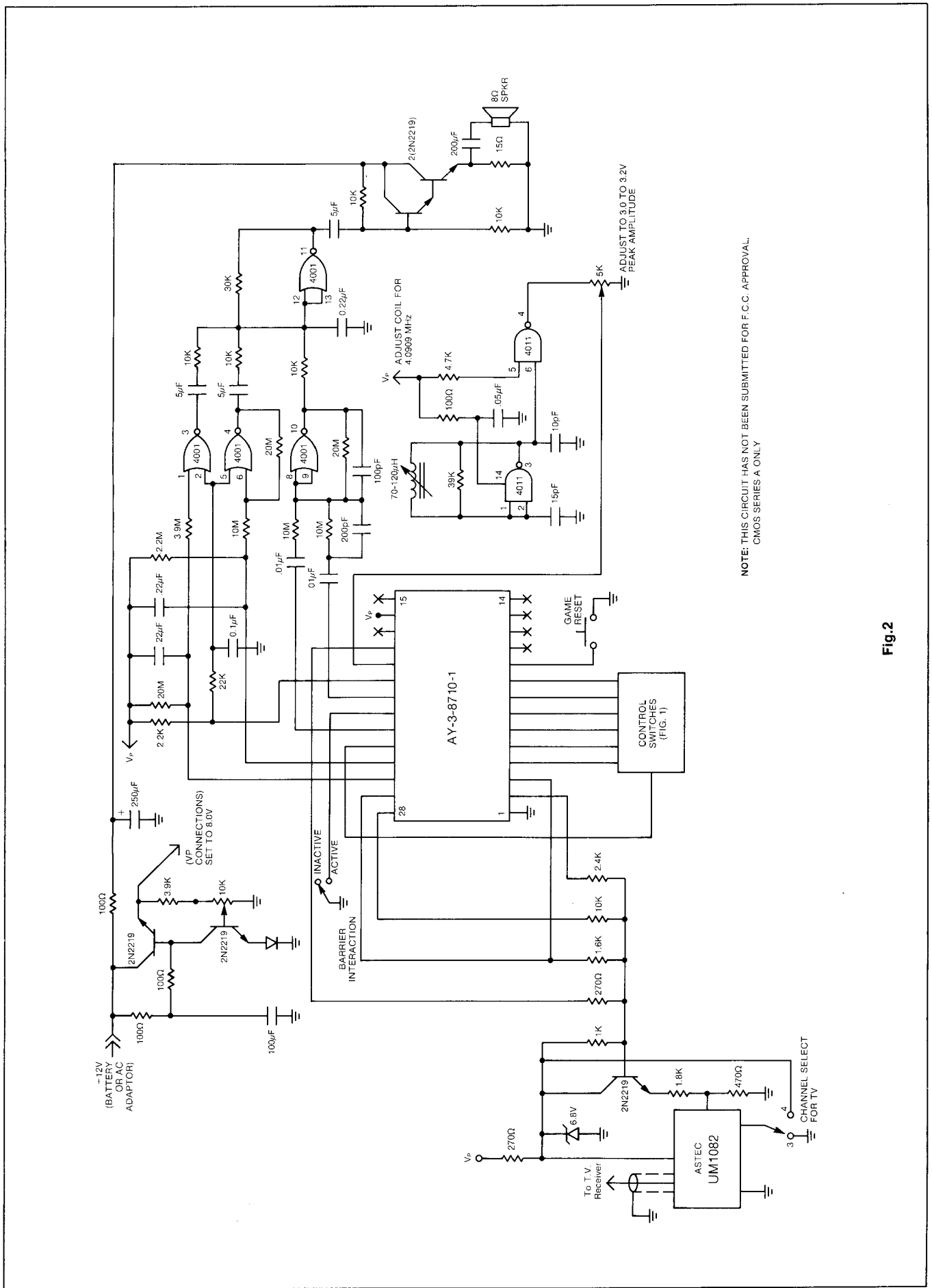


Fig.2

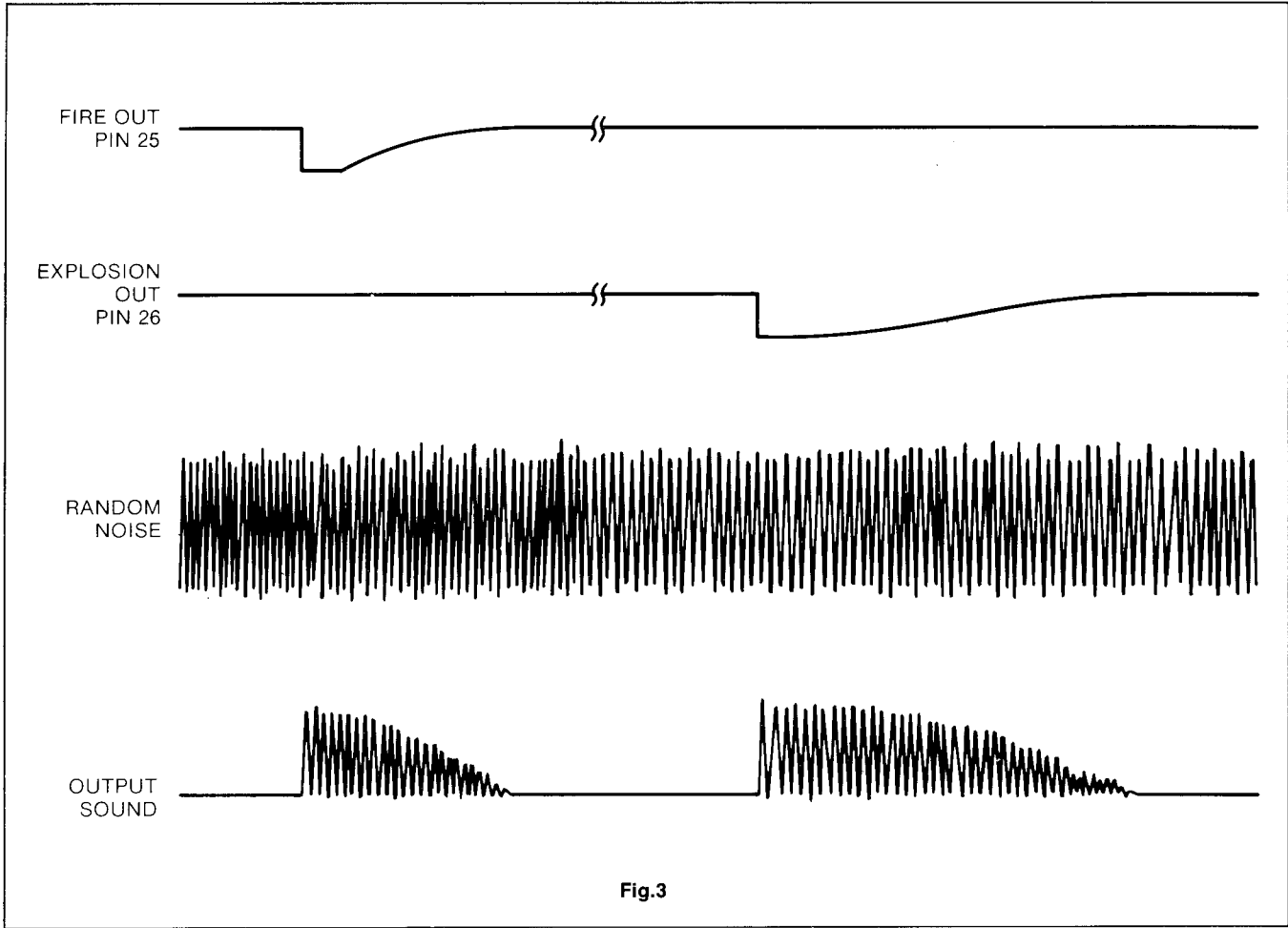


Fig.3

Wireless Remote Control Of The AY-3-8710-1 Battle Game

Andy Sass & Joe Minicozzi

This application note describes a method of and circuit information for remote control of the G.I. AY-3-8710-1 Battle TV Game. Remote control is ultrasonic, employing G.I.'s SAA 1024/1025 pair. In this application, two players control a battery operated transmitting unit, which is wireless remote from the receiver. The receiver interfaces to the battle game, which is connected to the TV in normal fashion.

A complete system block diagram is illustrated in Fig.1. Fig. 2 is the schematic diagram of the transmitter. Each player's controls consist of two SPDT, center off, momentary contact lever switches, for tank direction control, and a normally open pushbutton for firing the tank's cannon.

The Timing Chain, consisting of a 500 Hz oscillator, two divide-by-10's and one flip-flop, generates two alternate 200 ms time slots for strobing the two players' controls to the SAA 1024. The reset circuitry is responsible for diverting one time slot, on command of the reset switch, to implement remote control game reset. The two player multiplexer receives the first and second players' tank direction signals, A1-A4 and B1-B4, respectively, and the two time slots, $K_A + K_B$, from the timing chain and outputs time shared tank direction signals, D1-D4.

Direction signals D1-D4, time slots K_A and K_B , game reset signal R_{ST} , and tank cannon signals $F_{IR 1}$ and $F_{IR 2}$ are processed by the player encoding logic and output as negative logic signals acceptable to the SAA 1024. All conditions of tank operation, including the stationary condition are encoded. This causes the

SAA 1024 to continually transmit ultrasonic commands, thereby yielding high noise immunity at the expense of battery depletion. The SAA 1024 receives signals from player encoding logic and outputs an ultrasonic signal whose frequency corresponds to the code of the input signal. Fig. 3 is a table relating tank controls to SAA 1024 input signals (in negative logic), output frequency and to the received logic code output from the receivers' SAA 1025 (in positive logic). The output frequency is amplified and transmitted by an appropriate ultrasonic transducer.

Referring to Fig. 4, a schematic of the receiver, the detected ultrasonic signal is amplified and input to the SAA 1025. Upon meeting noise and time requirements, it is output as a 5-bit logic code. The 4.4 MHz oscillator supplies the SAA 1025's timing signal requirements.

The 5-bit code, output as 23 ms pulses occurring at 185 ms intervals are input to the decoding logic and output as four direction signals (LF, LR, RF, RR), two strobe signals (CK1 and CK2) and a game reset signal for the TV battle game.

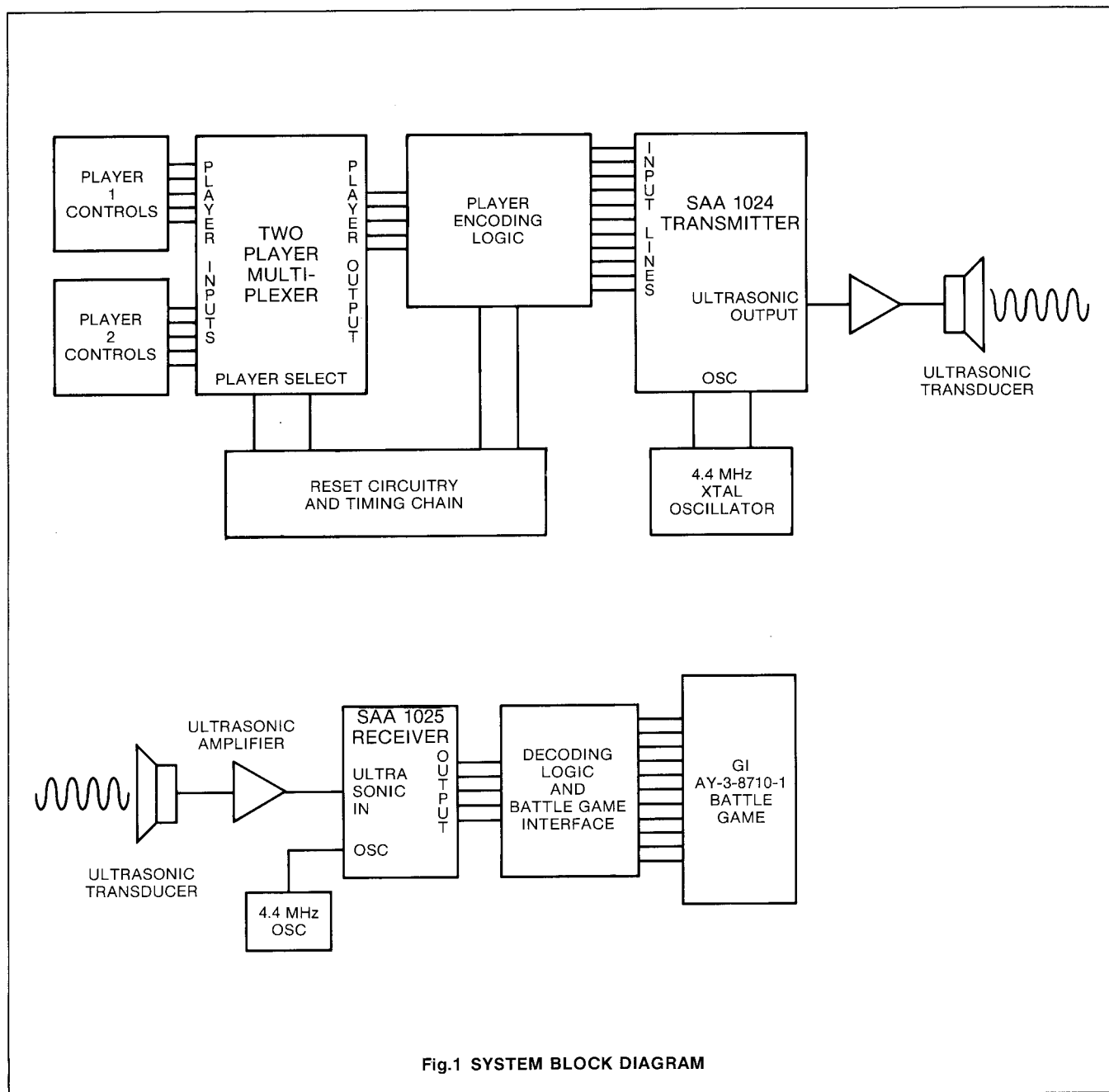


Fig.1 SYSTEM BLOCK DIAGRAM

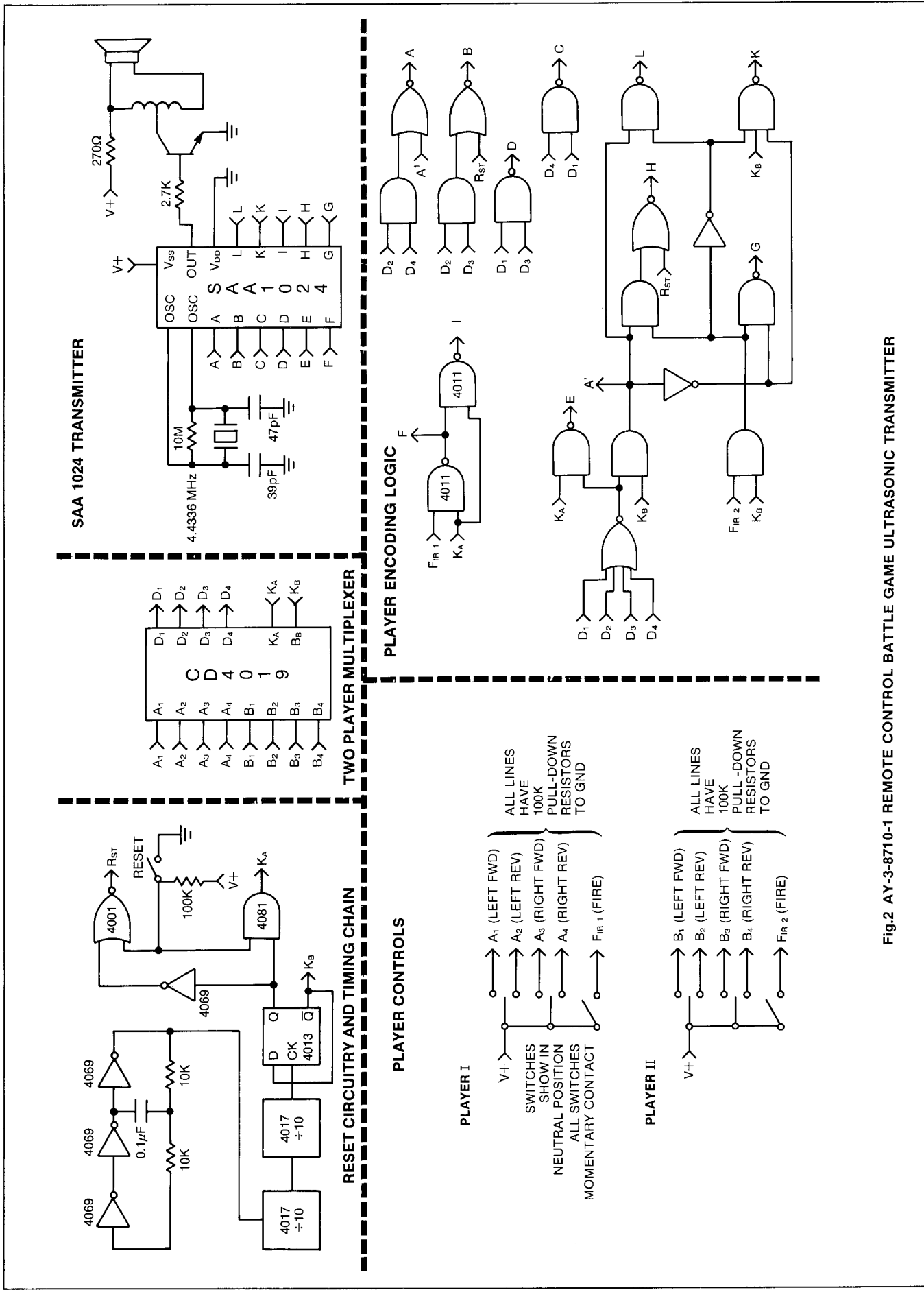


Fig.2 AY-3-8710-1 REMOTE CONTROL BATTLE GAME ULTRASONIC TRANSMITTER

PLAYER	TANK DIRECTION	TANK FIRING	SAA 1024 NEGATIVE LOGIC INPUT											ULTRASONIC FREQ. Hz	SAA 1025 POSITIVE LOGIC OUTPUT				
			A	B	C	D	E	F	G	H	I	K	L		D	C	B	A	E
One	Stopped	No	0	0	0	0	1	0	0	0	1	0	0	35,676	1	1	0	0	0
One	Stopped	Yes	0	0	0	0	1	1	0	0	0	0	0	35,330	1	1	0	0	1
One	Forward	No	0	0	0	1	0	0	0	0	1	0	0	38,447	1	0	0	0	0
One	Forward	Yes	0	0	0	1	0	1	0	0	0	0	0	38,101	1	0	0	0	1
One	Reverse	No	1	0	0	0	0	0	0	0	1	0	0	36,369	1	0	1	1	0
One	Reverse	Yes	1	0	0	0	0	1	0	0	0	0	0	36,023	1	0	1	1	1
One	Left Turn	No	0	1	0	0	0	0	0	0	1	0	0	37,062	1	0	1	0	0
One	Left Turn	Yes	0	1	0	0	0	1	0	0	0	0	0	36,715	1	0	1	0	1
One	Right Turn	No	0	0	1	0	0	0	0	0	1	0	0	37,755	1	0	0	1	0
One	Right Turn	Yes	0	0	1	0	0	1	0	0	0	0	0	37,408	1	0	0	1	1
One	Game Reset		0	1	0	0	0	0	0	1	0	0	0	42,257	0	0	1	0	1
Two	Stopped	No	1	0	0	0	0	0	0	0	0	0	1	41,911	0	0	1	1	0
Two	Stopped	Yes	1	0	0	0	0	0	0	1	0	0	0	41,565	0	0	1	1	1
Two	Forward	No	0	0	0	1	0	0	0	0	0	1	0	41,218	0	1	0	0	0
Two	Forward	Yes	0	0	0	1	0	0	1	0	0	0	0	40,872	0	1	0	0	1
Two	Reverse	No	1	0	0	0	0	0	0	0	0	1	0	39,140	0	1	1	1	0
Two	Reverse	Yes	1	0	0	0	0	0	1	0	0	0	0	38,794	0	1	1	1	1
Two	Left Turn	No	0	1	0	0	0	0	0	0	0	1	0	39,833	0	1	1	0	0
Two	Left Turn	Yes	0	1	0	0	0	0	1	0	0	0	0	39,486	0	1	1	0	1
Two	Right Turn	No	0	0	1	0	0	0	0	0	0	1	0	40,526	0	1	0	1	0
Two	Right Turn	Yes	0	0	1	0	0	0	1	0	0	0	0	40,179	0	1	0	1	1

Fig.3 REMOTE CONTROL FREQUENCIES/FUNCTIONS

The four direction signals are applied to the 74C174 hex latches where they are latched according to the two strobe signals. The latched signals are applied to CD 4066 bilateral switches which simulate the player controls of the transmitter. These switches connect to the player control lines to and from the AY-3-8710-1 battle game.

Power for the receiver is a single supply of 12-20V, capable of 30mA. However, a third power supply connection is generated at the SAA 1025 by the 5.1V zener diode. This is necessary because the logic output swing of the SAA 1025 is not sufficient to drive the associated CMOS circuitry. The ground point generated there is the negative power supply connection for all CMOS circuitry in the receiver and must be connected to the ground

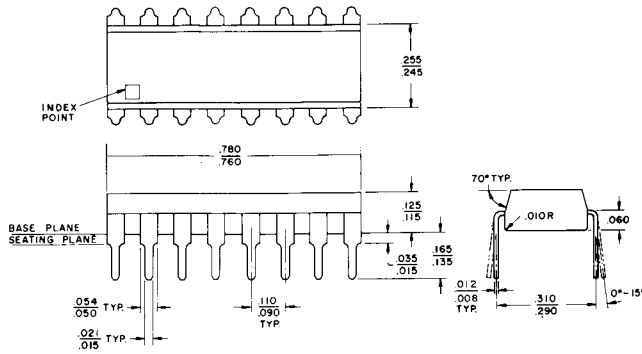
connection of the associated battle game. The power supply should be well bypassed to reduce the effects of a 320kHz beat between the 4.43MHz oscillator of the receiver and the 4.09MHz oscillator in the battle game.

Power for the ultrasonic transmitter is a single source of 9V at 30 mA. Battery operation is recommended for this part of the system, making it truly portable.

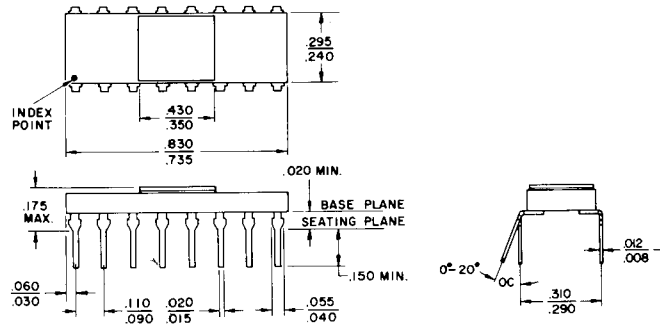
The performance of this ultrasonic system is primarily dependent upon the bandwidth of the transducers used. Ultrasonic signals for this system had to be chosen within the bandwidth of the transducers to provide adequate reception range. With the circuit shown, ranges of better than 20 feet can be expected.

PACKAGE OUTLINES (All dimensions in inches)

16 LEAD DUAL IN LINE

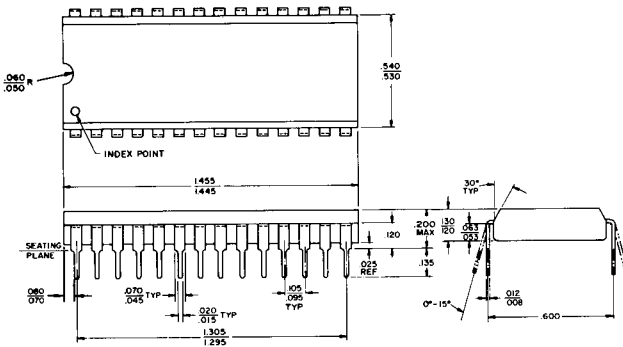


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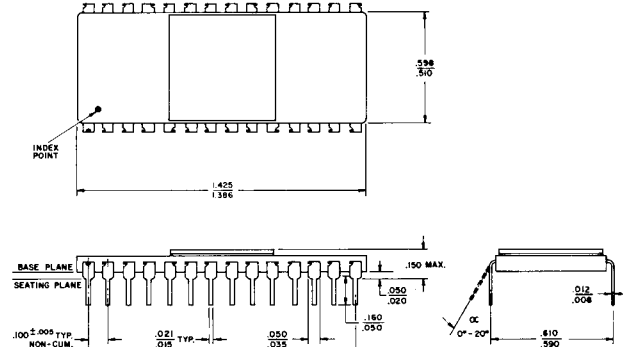


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28 LEAD DUAL IN LINE

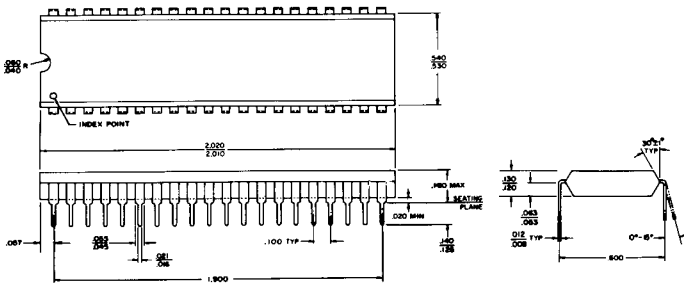


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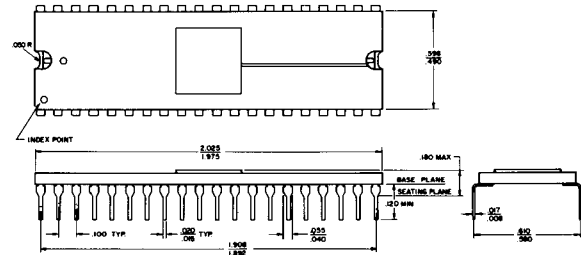


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40 LEAD DUAL IN LINE



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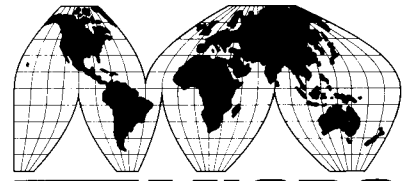
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