Rockwell

10937 and 10957
Alphanumeric Display Controller

DESCRIPTION

The 10937 and 10957 Alphanumeric Display Controllers, two of the Rockwell Intelligent Display Controller products, are MOS/LSI general purpose display controllers designed to interface to segmented displays (vacuum fluorescent, or LED).

The 10937 or 10957 will drive displays with up to 16 characters with 14 or 16 segments plus a decimal point and comma tail. Segment decoding within each device provides for the ASCII character set (upper case only). No external drive circuitry is required for displays that operate on 20 ma of drive current up to 50 volts. A 16 x 64-bit segment decoder provides internal ASCII character set decoding for the display.

The 10937 and 10957 are identical with the exception that the 10957 has two additional decodings for the decimal point and comma tail.

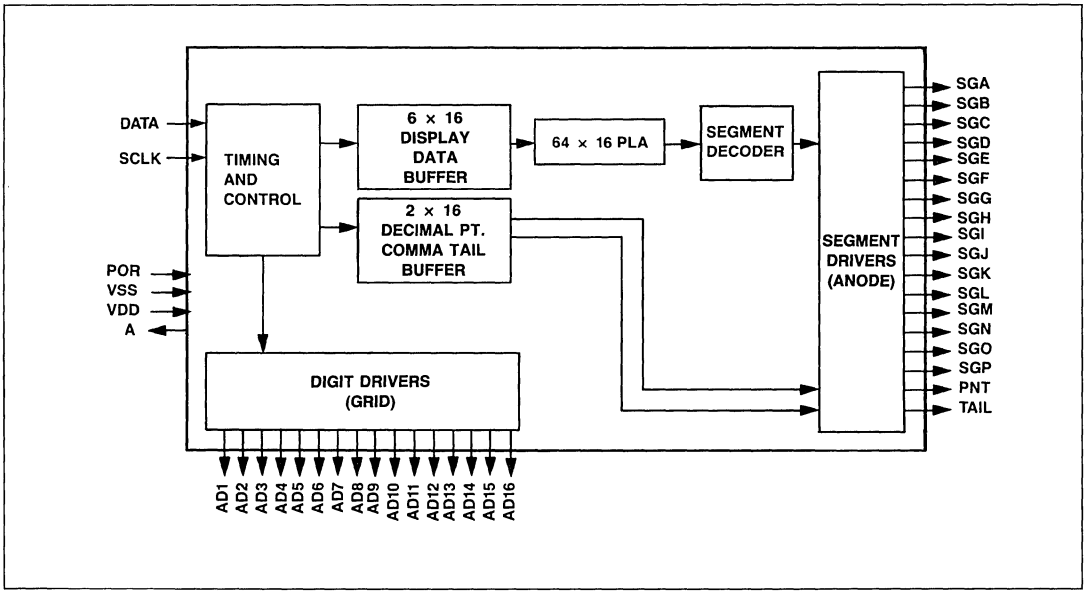
FEATURES

- 16 character display driver with decimal point and comma tail
- 14 or 16 segment drivers
- Up to 66 kHz data rate
- Direct digit drive of 20 ma at 50 volts
- Supports vacuum fluorescent, or LED displays
- 64 x 16-bit PLA provides segment decoding for ASCII character set (all caps only)
- Serial data input for 8-bit display and control data words.
- 40-Pin DIP

ORDERING INFORMATION

Part Number	Package Type	Drive Voltage	Temperature Range (°C)
109X7P-40	Plastic	40V	0 to +70
109X7P-50	Plastic	50V	0 to +70
109X7PE-40	Plastic	40V	−40 to +85
109X7PE-50	Plastic	50V	−40 to +85

Note: X = 3 or 5



10937 and 10957 Block Diagram

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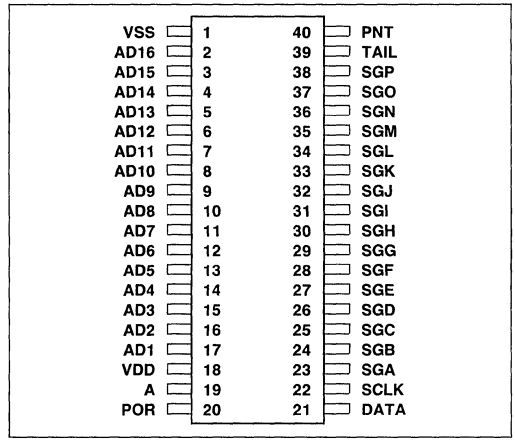
INTERFACE DESCRIPTION

Pin Functions

Signal Name	Pin No.	Function
VSS	1	Power and signal reference
AD16–AD1	2–17	Digits 16 through 1 driver outputs
VDD	18	DC power connection
A	19	A clock output used for testing
POR	20	Power-on reset input
DATA	21	Serial data input
SCLK	22	Serial data clock input
SGA–SGP	23–38	Segments A through P driver outputs
TAIL	39	Comma tail driver output
PNT	40	Decimal point driver output



Pin Configuration

SPECIFICATIONS

MAXIMUM RATINGS*

All voltages are specified relative to V_{SS}.

Parameter	Symbol	Min	Max	Unit
Supply Voltage	V_{DD}	+0.3	−20	V
Input Voltage	V_{IN}	+0.3	−20	V
Output Voltage	V_{OUT}	+0.3	−50	V
Operating Current	I_{DD}		7	mA
Output Current Digits	I_{SD}		20	mA
Output Current Segments	I_{SS}		10	mA
Operating Temperature				
Commercial	T_C	0	+70	°C
Industrial	T_I	−40	+85	°C
Storage Temperature	T_{STG}	−55	+125	°C
Input Capacitance	C_{IN}		5	pF
Output Capacitance	C_{OUT}		10	pF

***NOTE:** Stresses above those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this document is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

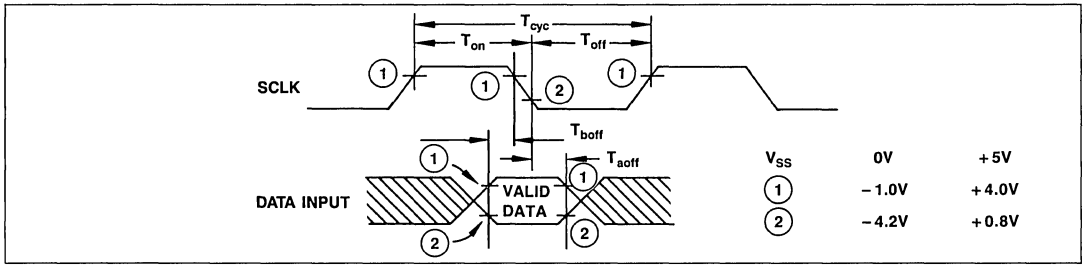
DC CHARACTERISTICS

Parameter	Limits (V_{SS} = 0) Min.	Typ.	Max.	Limits (V_{SS} = +5V) Min.	Typ.	Max.	Conditions	Unit
Supply Voltage (V_{DD})	−16.5	−15.0	−13.5	−11.5	−10.0	−8.5		V
Power dissipation		40	100		40	100		mW
Input DATA, SCLK,								V
Logic "1"	−1.0		+0.3	+4.0		+5.3		V
Logic "0"	V_{DD}		−4.2	V_{DD}		+0.8		
Input POR								
Logic "1"	−3.0		+0.3	+2.0		+5.3		
Logic "0"	V_{DD}		−10.0	V_{DD}		−5.0		
Output Digit and Segment Strobes								
Driver On								
Commercial			−1.5			+3.5	At 10 mA	V
Industrial			−1.7			+3.3		V
Driver Off 109X7-40			−40			−35	Actual value determined by external circuit	V
Driver Off 109X7-50			−50			−45		V
Output Leakage			10			10	Per driver when driver is off	μA
Input Leakage			10			10		μA

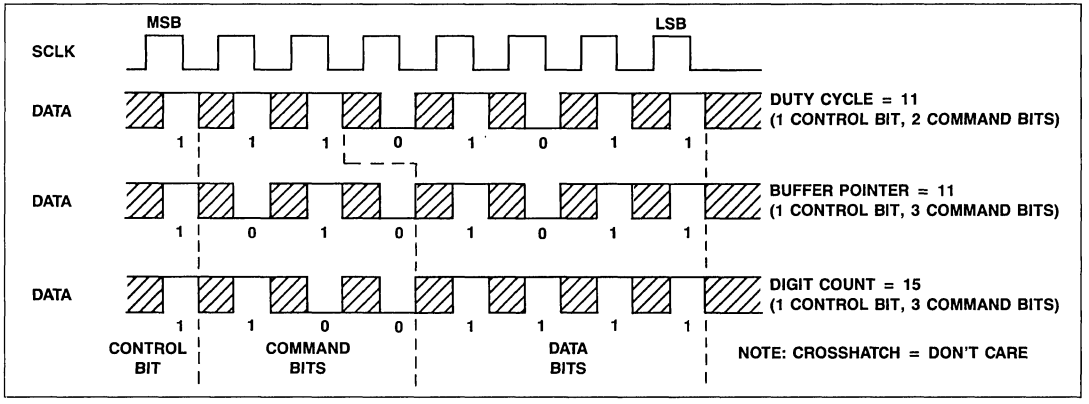
Notes: All outputs require pulldown resistors. X = 3 or 5 depending on device.

AC CHARACTERISTICS

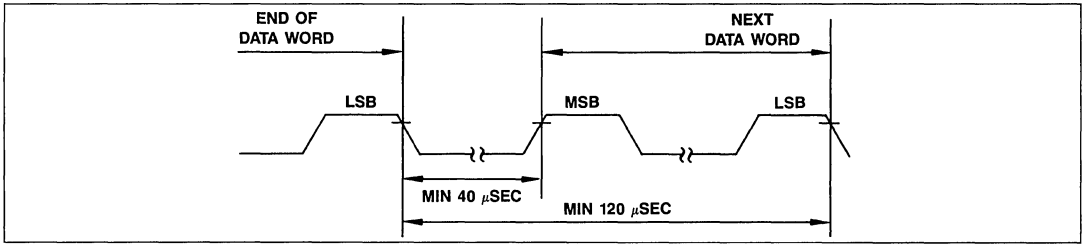
Parameter	Symbol	Min	Typ	Max	Unit
SCLK Clock					
On Time	T_{on}	1.0		20.0	μs
Off Time	T_{off}	1.0			μs
Data Input Sample Time					
Before SCLK Clock Off	T_{boff}	200			ns
After SCLK Clock Off	T_{aoff}	100			ns



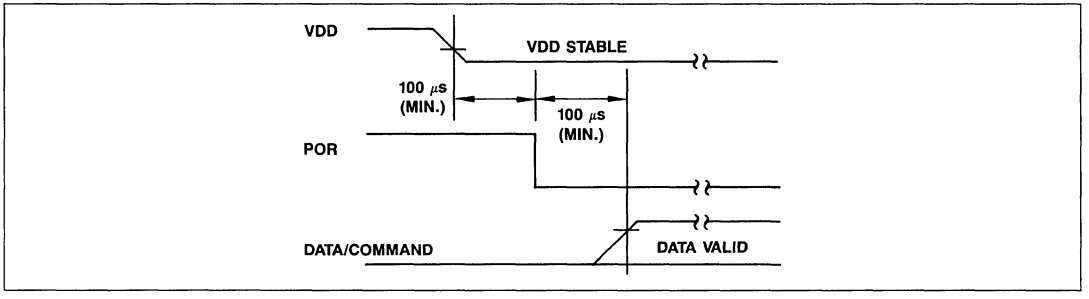
SCLK and Serial Data Timing



SCLK and Serial Data (Control Word) Examples



Data Word LSB/MSB Timing



Power-On Reset Timing

FUNCTIONAL DESCRIPTION

The 10937 or 10957 is a general purpose display controller for multiplexed, segmented displays with up to 16 character positions and 14 or 16 segments, plus decimal point and comma tail. No external drive circuitry is needed for displays requiring up to 20 ma of drive current up to 50 volts. All timing signals required to control the display are generated in the 10937 or 10957 device without any refresh input from the host processor.

Input data is loaded into the Display Data Buffer via the Serial Data Input (Data) channel. Internal timing and control blocks synchronize the segment and digit output signals to provide the proper timing for the multiplexing operation. A 16 x 64-bit PLA is provided for segment decoding for the full ASCII character set (upper case only).

Input data is loaded into the 10937 or 10957 ADC as a series of 8-bit words with the most significant bit (MSB), bit 7, first. If bit 7 of any word loaded is a logic 1 (this bit is referred to as the control bit C), the loaded word is a control data word. If the C bit of any word is a logic 0, the loaded word is a display data word. The following paragraphs describe the format and functions of these control and display data words.

INPUT CONTROL DATA WORDS

When the C-Bit (bit 7) of the 8-bit input word is a logic 1, bits 5 and 6 are decoded into one of four control commands while data associated with the command are extracted from bits 0 – 4 (see Table 1). The four control codes perform the following display functions:

- Load the Display Data Buffer pointer,
- Load the Digit Counter,
- Load the Duty Cycle register,
- Enable the Test Mode.

Table 1 lists the control codes and their functions.

Buffer Pointer Control

The Buffer Pointer Control code allows the Display Data Buffer pointer to be set to any digit position so that individual characters may be modified. The Buffer Pointer is loaded with a decimal equivalent value 2 less than the desired value (i.e., to point to the digit controlled by AD6 of the display, a value of 4 is entered). See Table 2 for a complete list of the Buffer Pointer values.

Table 2. Buffer Pointer Control Codes

Hex Code	Pointer Value	Character Controlled By
A0	0	AD2
A1	1	AD3
A2	2	AD4
A3	3	AD5
A4	4	AD6
A5	5	AD7
A6	6	AD8
A7	7	AD9
A8	8	AD10
A9	9	AD11
AA	10	AD12
AB	11	AD13
AC	12	AD14
AD	13	AD15
AE	14	AD16
AF	15	AD1

Digit Counter Control

The Digit Counter Control code is normally used only during initialization routines to define the number of character positions to be controlled. This code maximizes the duty cycle for any display. If 16 characters are to be controlled, enter a value of 0 (zero). Otherwise, enter the value desired.

Duty Cycle Control

The Duty Cycle Control code is used to turn the display on and off, and to adjust display brightness. As shown in the block diagram, the time slot for each character is 32 clock cycles. The segment and digit drivers for each character are on for a maximum of 31 cycles with a 1 cycle inter-digit off-time. The Duty Cycle Control code contains a 5-bit numeric field which modifies the on-time for the driver outputs from 0 to 31 cycles. A duty cycle of 0 puts both the segment and digit drivers into the off state.

Test Mode Enable

The Test Mode Enable code is a device test function only. If executed, it will lock the device in the Test Mode. Once locked in, the device can only be removed from Test Mode by performing a power-on reset.

If this mode is activated, the digit time is reduced from 32 to 4 clock cycles to speed up the output driver sequencing time for ease in testing.

INPUT DISPLAY DATA WORDS

Display data words are loaded as 8-bit ASCII format codes. The 64 codes available (with the C-bit set to 0 to indicate a display data word) are shown in Table 3 with their corresponding ASCII characters.

Table 1. Control Data Words

8-Bit Control Word		Function
C-Bit (Bit 7)	7-Bit Code (Bits 6 – 0)	
1	010NNNN(1)	BUFFER POINTER CONTROL (Position of character to be changed)
1	100NNNN(1)	DIGIT COUNTER CONTROL (Number of characters to be output)
1	11NNNNN(2)	DUTY CYCLE CONTROL (On/off and brightness control)
1	00NNNNN(3)	TEST MODE ENABLE (Not a user function)

Notes: 1. NNNN is a 4-bit binary value representing the digit number to be loaded.
2. NNNNN is a 5-bit binary value representing the number of clock cycles each digit is on.
3. This code is a device test function only. If executed it will lock the device in the test mode. Once locked in, the device can only be removed from Test Mode by performing a power-on reset.

Sixteen display data words must be entered to completely load the Display Data Buffer. The Buffer Pointer is automatically incremented before each data word is stored in the Display Buffer except for decimal point and comma words. These do not cause the Buffer Pointer to increment and thus are always associated with the previous character entered. To select the next character position to be loaded out of the normal sequence, use the Buffer Pointer Control command before entering the display data word. It is not necessary to use the Buffer Pointer Control command to cycle back to position 1 when less than 16 character positions are being used.

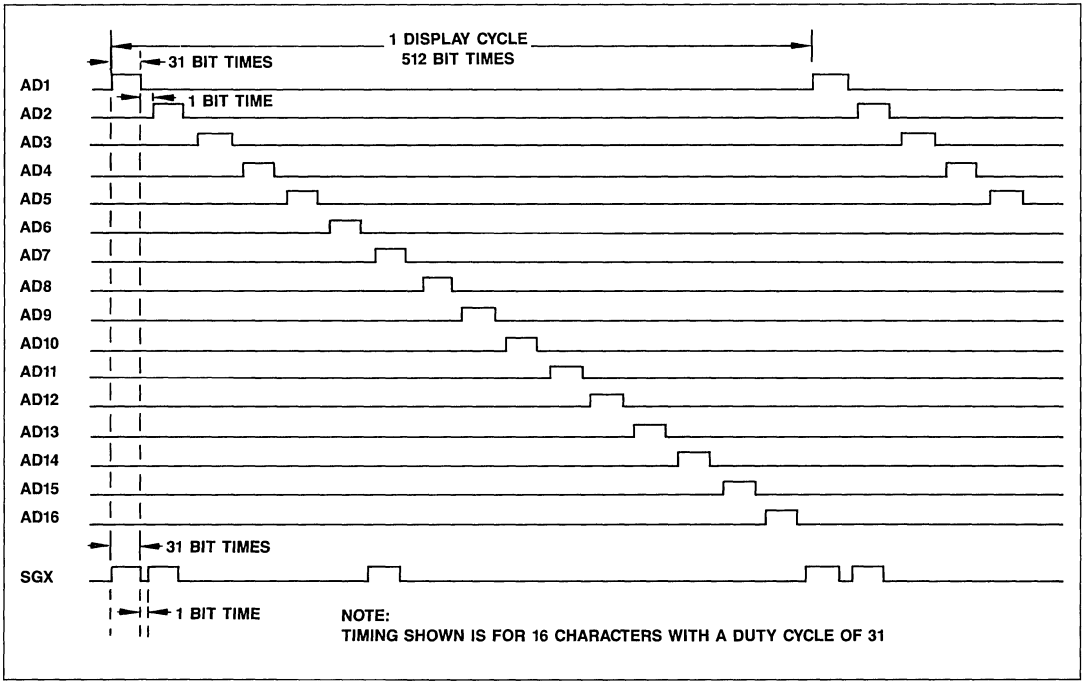


Figure 1. Display Scan Timing Diagram (Duty Cycle)

Table 3. Character Assignments for Display Data Words

DATA WORD		CHARACTER	DATA WORD		CHARACTER	DATA WORD		CHARACTER	DATA WORD		CHARACTER
BINARY	HEX		BINARY	HEX		BINARY	HEX		BINARY	HEX	
0X000000	00	@	0X010000	10	P	0X100000	20		0X110000	30	0
0X000001	01	A	0X010001	11	Q	0X100001	21	!	0X110001	31	1
0X000010	02	B	0X010010	12	R	0X100010	22	"	0X110010	32	2
0X000011	03	C	0X010011	13	S	0X100011	23	#	0X110011	33	3
0X000100	04	D	0X010100	14	T	0X100100	24	$	0X110100	34	4
0X000101	05	E	0X010101	15	U	0X100101	25	%	0X110101	35	5
0X000110	06	F	0X010110	16	V	0X100110	26	&	0X110110	36	6
0X000111	07	G	0X010111	17	W	0X100111	27	'	0X110111	37	7
0X001000	08	H	0X011000	18	X	0X101000	28	(	0X111000	38	8
0X001001	09	I	0X011001	19	Y	0X101001	29	)	0X111001	39	9
0X001010	0A	J	0X011010	1A	Z	0X101010	2A	*	0X111010	3A	:
0X001011	0B	K	0X011011	1B	[	0X101011	2B	+	0X111011	3B	;
0X001100	0C	L	0X011100	1C	/	0X101100	2C	'	0X111100	3C	<
0X001101	0D	M	0X011101	1D	]	0X101101	2D	—	0X111101	3D	=
0X001110	0E	N	0X011110	1E	∧	0X101110	2E	•	0X111110	3E	>
0X001111	0F	O	0X011111	1F	-	0X101111	2F	\	0X111111	3F	?

Note: X means this bit (bit 7) is a "don't care" bit except for PNT and TAIL on 10957 only. The hex codes shown assume bit 7 is a zero.

POWER-ON RESET (POR)

The Power-On Reset (POR) initializes the internal circuits of the 10937 or 10957 ADC when power (V_{DD}) is applied. The following conditions are established after a Power-On Reset:

a. The Digit Drivers (AD1 – AD16) are in the off state (floating).
b. The Segment Drivers (SGA – SGP) are in the off state (floating). This includes PNT and Tail.
c. The Duty Cycle is set to 0.
d. The Digit Counter is set to 16 (a bit code value of 0).
e. The Buffer Pointer points to the character controlled by AD1.

DIGIT DRIVERS (AD1–AD16)

The sixteen Digit Drivers (AD1 – AD16) are used to select each of the display digits sequentially during a refresh scan. Display segments will be illuminated when both the Digit Drivers and Segment Drivers for a particular character are energized simultaneously. The timing characteristics of both the digits and segments are shown in Figure 1. See POR for the Power-On Reset state of these drivers.

Table 4. Comparison of 10957 with 10937

Input Data	10937 Character	10957 Character
2C	;	;
2E	.	.
6C	;	.
6E	.	

SEGMENT DRIVERS (SGA–SGP)

Sixteen (16) Segment Drivers are provided (SGA – SGP), plus the decimal point (PNT) and comma tail (TAIL). The segment outputs are internally decoded from the 8-bit characters in the Display Data Buffer by means of a 64 x 16-bit PLA. The Segment Driver Allocations are shown in Figure 2. Data codes and their corresponding segment patterns are shown in Figure 3. Timing characteristics for the segment outputs are shown in Figure 1. See POR for the Power-On Reset state of these drivers.

NOTE

For 14-segment displays, SGA is used for the top segment and SGF is used for the bottom segment. SGB and SGE can be floated.

TYPICAL SYSTEM HOOK-UP

Figure 4 shows the 10937 or 10957 as it would be connected to a V-F display when driven by a host system. E_K is determined by the V-F display specifications and R_C is selected to provide proper biasing current for zeners. Pull down resistors R_A and R_G are determined by the interconnection capacitance between the device and the display.

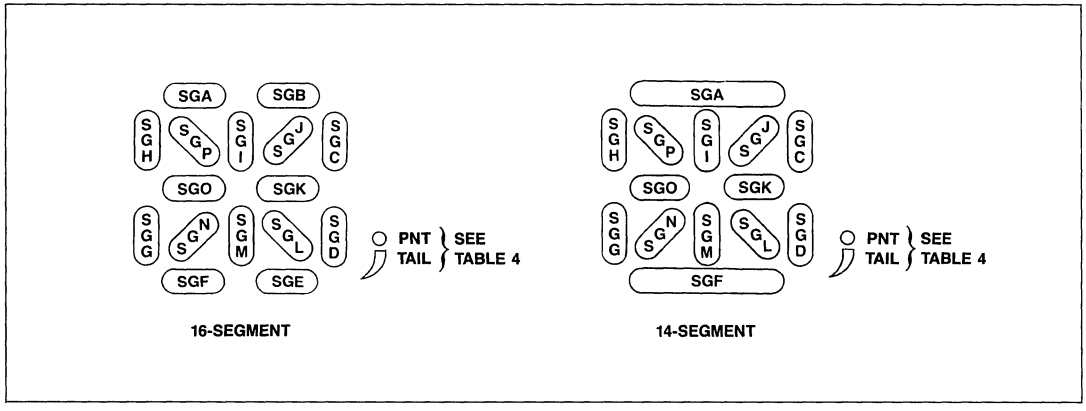
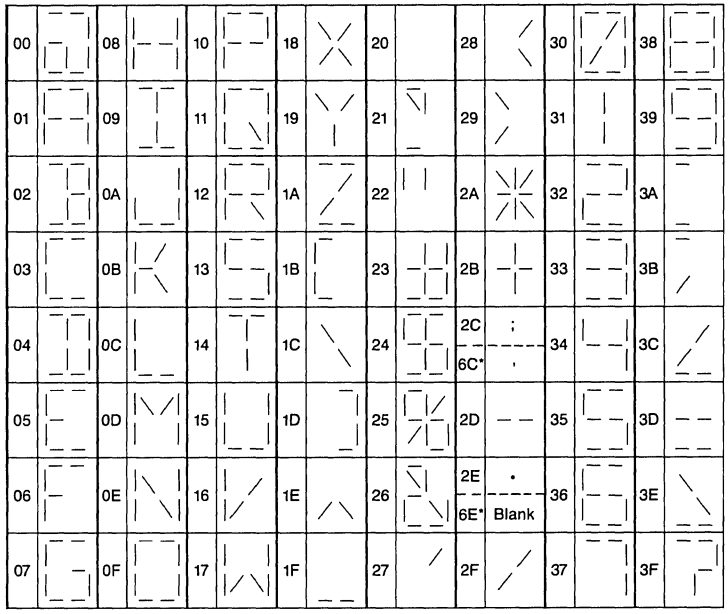
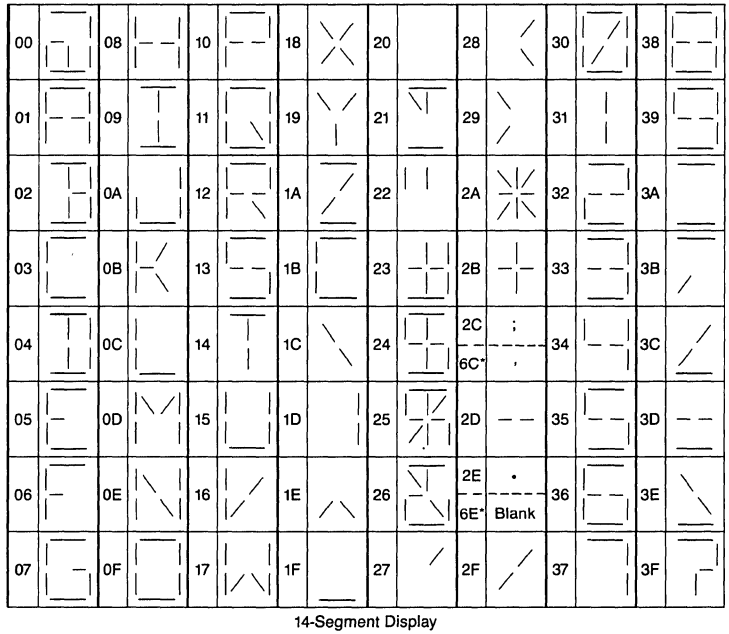


Figure 2. Segment Driver Allocations



16-Segment Display



14-Segment Display

Notes: Bit 7 of the data byte is a "don't care" bit except for PNT and TAIL on 10957. Data byte hex codes shown assume bit 7 is a zero.
* = 10957 only.

Figure 3. Display Segment Driver Character Patterns

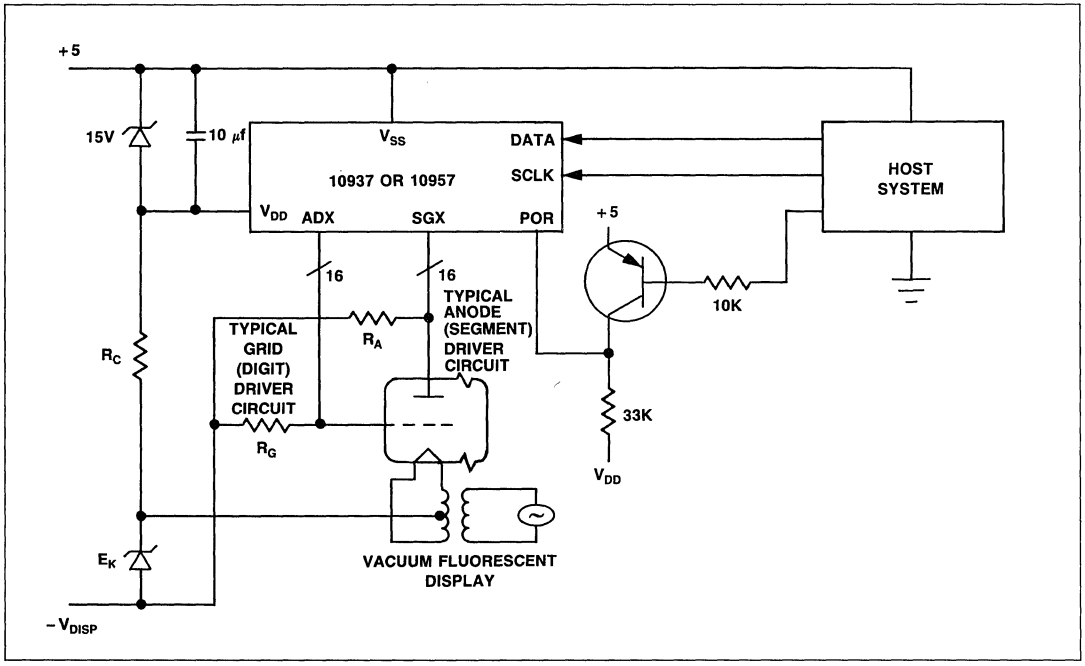


Figure 4. Partial System Schematic