APPLICATION		REVISIONS			
NEXT ASSY	FINAL ASSY	LTR	DESCRIPTION	DATE	APPROVED
		—	Initial Release. E.O. 30328	94–07–26	B. Lo
		A	Correct typos \ E.O. 30353	94–08–05	M. Englehart
		B	Change Cable Part No. \ E.O. 30367	94–08–15	B. Lo
		C	Add –106 & –151 to Tables and Outlines, Revise Section 4, Correct Typo Sht. 40 \ E.O. 31107	95–07–31	M. Englehart
		D	Change -105 Current Ratings on Sht. 16 \E.O. 31186	95–11–15	B. Lo
		E	Add -120, -121, -130, -134 & -160 to Tables and Outlines, Revise Section 4.4 Sht 29 \ E.O. 32196	96-11-7	B. Lo
		F	Correct -105 Outline Dimensions \ E.O. 32330	96-12-4	B. Lo
		G	E.O. 32796	97-4-14	B. Lo
		H	E.O. 33653	98-4-3	B. Lo
		J	E.O. 34249	99-3-15	B. Lo
		K	E.O. 34831	99-11-23	B. Lo
		L	E.O. 34854	00-01-24	B. Lo
		M	E.O. 35324	00-05-30	B. Lo
		N	E.O. 35373	6-27-00	B. Lo

REV	M	G																							
SHEET	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	
REV	G	G	G	G	G	G	G	G	G	G	G	L	G	G	G	G	G	G	G	G	G	N	J	G	
SHEET	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	
REV	N	N	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	H	H	G	G	G	G	
SHEET	CVR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	

REVISION STATUS

PROJ. NO. 346

CONTRACT

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DRAWN	M. Englehart	07–26
CHECK	D. McCoy	07–26

APPROVED
B. Lo / 94–07–26

APPROVED

INDUSTRIAL ELECTRONIC ENGINEERS, INC.
VAN NUYS, CALIFORNIA

Specification, VFD, Century Series, Dot Matrix Modules

SIZE	**CODE IDENT NO.**	
A	**05464**	**S036X2**

SCALE	None	SHEET 1 OF 49

PRODUCT SPECIFICATION

Century Series Flip

Dot Matrix ASCII VFD Modules

REV. N

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DEFINITIONS AND CONVENTIONS

Conventions:

- ⇒ First Line, Column, Bit or Position is 0 or 00h.
- ⇒ Control Code names are *italicized.*
- ⇒ Upper case A with subscript from 0 to 7 indicates an address bit from LSB to MSB.
- ⇒ Upper case D with subscript from 0 to 7 indicates a data bit from LSB to MSB.
- ⇒ Counting order is left–to–right, top–to–bottom.
- ⇒ Hexadecimal notation is represented as XXh, where X is a numeric 0 – 9, or alpha A – F.
- ⇒ X = "Don't Care" or Variable Data

Definitions:

Attributes	Blink or Brightness Level.
Field	A display screen area consisting of one or more characters having attributes set.
Home	First line, first column; display screen position 00h.
Reset	Return display or function to its baseline (default condition).
Restore	Return display or function to a previously established state.

Abbreviations:

A	Amperes	LSB	Least Significant Bit
A_n	Address 'n'	mA	Milliamperes
AC or ac	Alternating Current	max	Maximum
ASCII	American Standard Code for Information Interchange	min	Minimum
^oC	Degrees Centigrade (Celsius)	mm	Millimeters
CG	Character Generator	Mot	Motorola
CG RAM	Character Generator RAM	MSB	Most Significant Bit
CR	Carriage Return	msec	Milliseconds
CS	Chip Select	nsec	Nanoseconds
D_n	Data Bit 'n'	oz	Ounces
DC or dc	Direct Current	RAM	Random Access Memory
DD RAM	Data Display RAM	RD	Read
E	Enable	RS	Register Select
EIA	Electronic Industries Association	RST	Reset
ft–L	Foot–Lamberts	μA	Microamps
g	Gravitational Units	μF	Microfarads
Hz	Hertz (Cycles per Second)	μsec	Microseconds
ID	Identity or Identification	UDC	User Defined Character
I/O	Input/Output	V	Volts
LCD	Liquid Crystal Display	VFD	Vacuum Fluorescent Display
LF	Line Feed	WR	Write

1.0 SCOPE

This document describes the complete performance and interface characteristics of the dot matrix family of Century Series Vacuum Fluorescent Displays (VFD). For the remainder of this document, the Century Series VFDs are referred to as the display.

2.0 APPLICABLE DOCUMENTS

The following documents form a part of this specification to the extent specified herein.

EIA–232	Interface Between Data Terminal Equipment and Data Communication Equipment Employing Serial Binary Data Interchange

3.0 CHARACTERISTICS

3.1 General

The following sections describe the basic or "Standard" Century Series Dot Matrix VFD. For a complete list of options and accessories, see Paragraph 5.0.

3.1.1 Environment

The display will operate properly following exposure to any combination of the listed environmental conditions:

Storage Temperature	–50°C to +85°C
Operating Temperature	–20°C to +70°C (Normal) -40°C to +85°C (Wide)
Relative Humidity	0 to 90% (Non–condensing)
Vibration	10 to 500 Hz, 2 mm Peak–to–Peak (any axis)
Shock	20 g (any axis)

3.1.2 Useful Life

The useful life of the displays ranges from 40,000 to 100,000 hours.

NOTE

Useful life for a vacuum fluorescent tube is defined as the period over which the light output decreases to half of its specified initial minimum brightness. Maximum useful life is achieved by display of random text messages. Users are encouraged to avoid fixed messages wherever possible, and to clear or blank the display when not in use. A screen saver mode is provided.

3.1.3 Display Functions

The dot matrix family of Century Series VFDs is able to simulate Intel 8041/42 series, Motorola 6821 and Hitachi 44780 interface characteristics as specified herein.

Critical interface lines are shown in the functional block diagrams, Figures 3–1, 3–2 and 3–3.

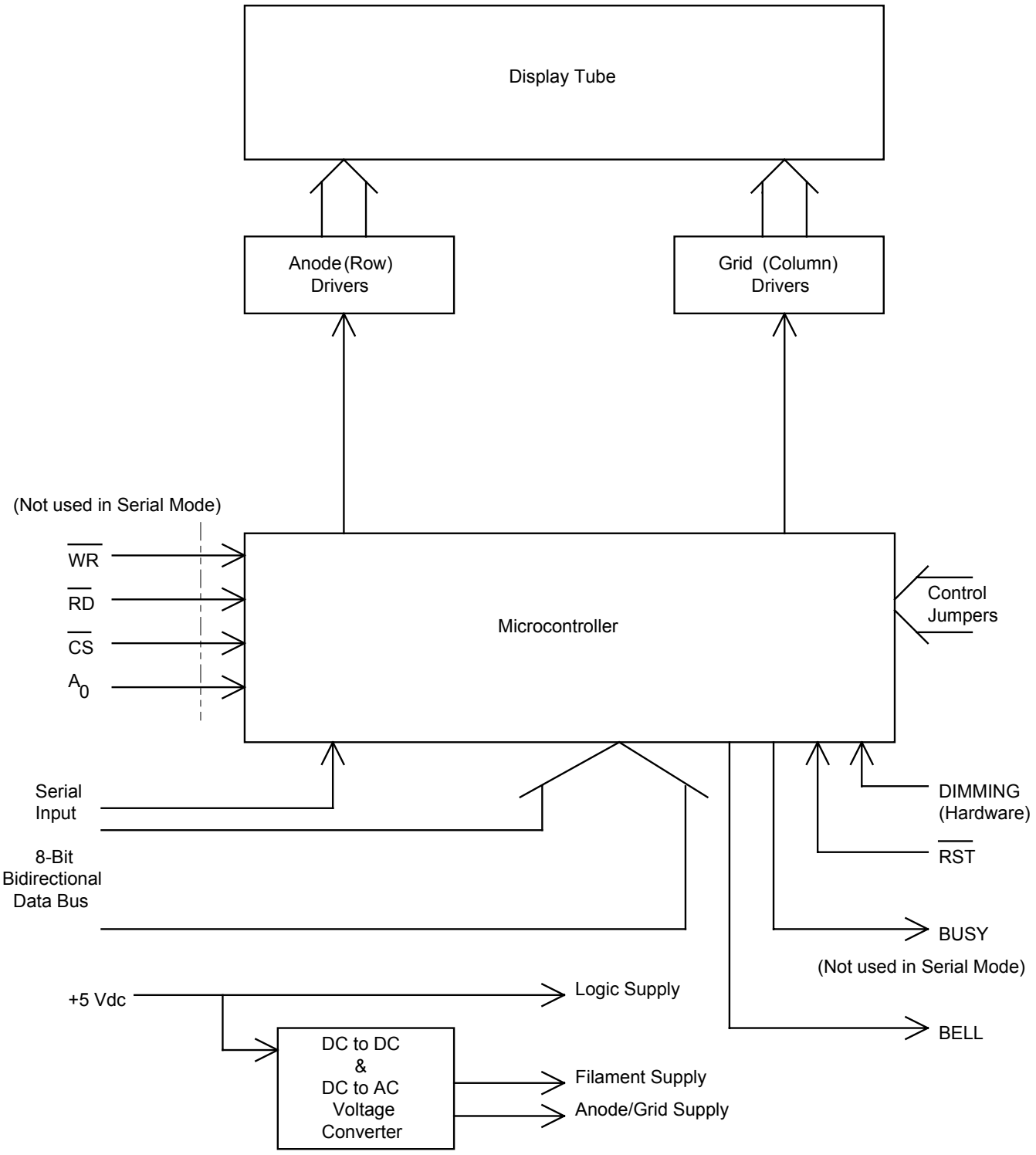


Figure 3–1

Functional Block Diagram, Intel Mode

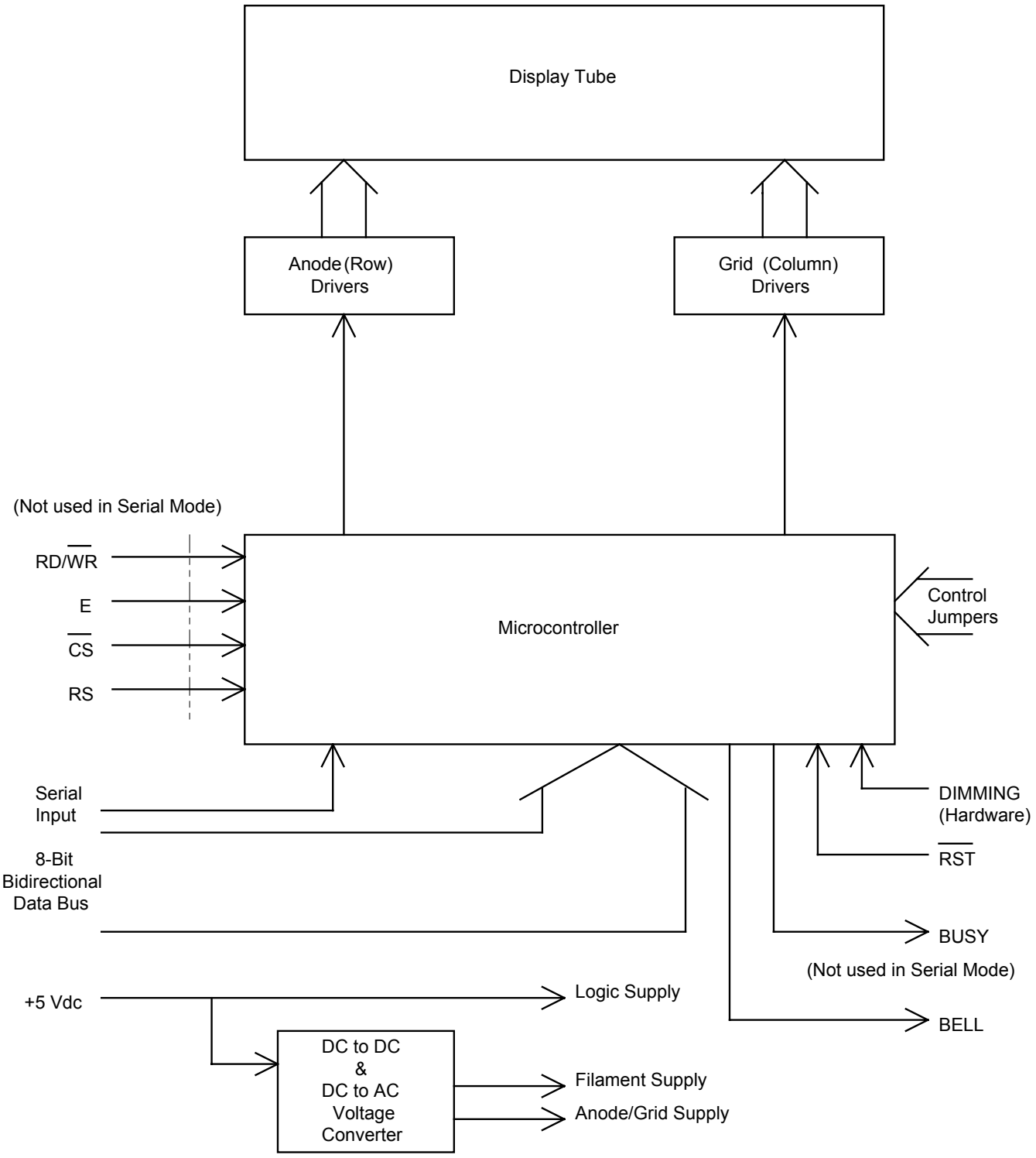


Figure 3–2

Functional Block Diagram, Motorola Mode

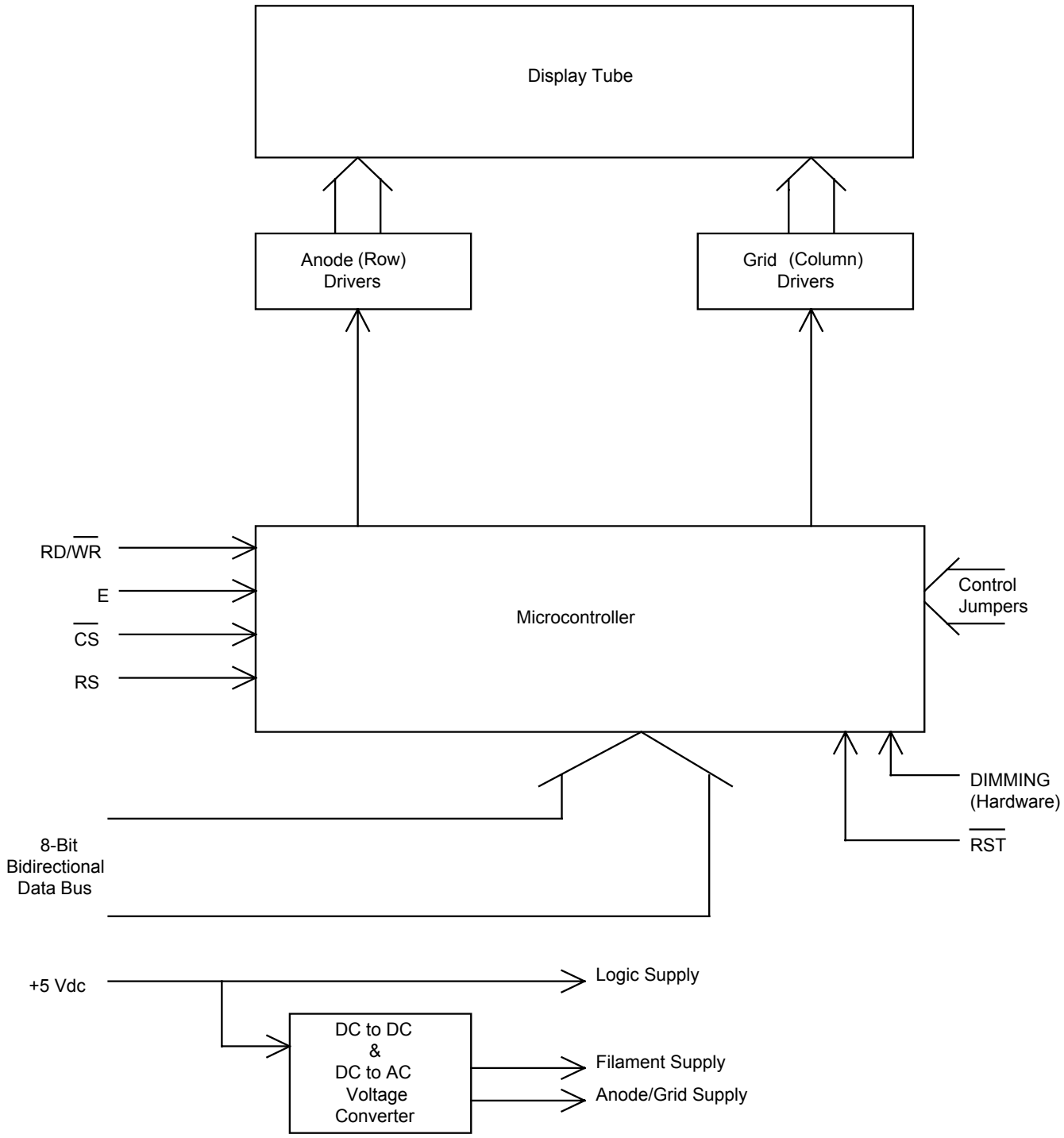


Figure 3–3

Functional Block Diagram, LCD Mode

Note: $\overline{CS}$ must be grounded when using LCD Mode.

3.1.4 Size and Weight

The physical dimensions of the displays vary with the size of the tube. The characteristics shown are for standard configuration display products, some options will affect these data.

Model	Tube Format	Length	Width	Depth	Weight (oz.)
036X2–100–05420	4 X 20	5.00 in.	2.78 in.	0.92 in.	6.5
036X2–105–05220	2 X 20	5.00 in.	2.25 in.	0.88 in.	4.0
036X2–106–04240	2 X 40	7.85 in	2.10 in.	1.00 in.	5.2
036X2–120–09120	1 X 20	8.05 in.	1.95 in.	0.80 in.	4.6
036X2–121–11120	1 X 20	9.60 in.	2.05 in.	0.86 in.	6.6
036X2–122–09220	2 X 20	7.75 in.	2.58 in.	1.00 in.	7.0
036X2–124–09420	4 X 20	7.75 in.	3.40 in.	1.00 in.	12.5
036X2–130–11220	2 X 20	9.90 in.	2.73 in.	0.95 in.	10.9
036X2–134–11420	4 X 20	9.48 in.	4.00 in.	1.29 in.	15.4
036X2–151–05240	2 X 40	9.50 in.	2.05 in.	1.00 in	8.0
036X2–160–05440	4 X 40	9.63 in.	2.88 in.	1.03 in.	11.3

Table 3–1

Physical Dimensions

3.1.5 Character Cell Features

Format — The display character cells utilize a 5 x 7 dot matrix to produce the available character sets.

Character Sets — The displays employ 5 built–in character tables. Four of the tables are for use with the Motorola and Intel modes and the fifth is for use in the Hitachi (LCD) mode.

Motorola/Intel Modes:

Each of the four Motorola/Intel character tables is comprised of the 96 character U.S. ASCII set, a 32 character scientific set, a 19 character set of special characters, a 10 character location for user definable characters and an embedded language specific character set. The embedded character sets occupy the address area between A0h and DFh and include a 64 character European set, a 33 character Cyrillic set, a 63 character Katakana set and a 27 character Hebrew set. The Motorola/Intel character tables are shown in Figures 3–4 through 3–8. Cells shown are exact representations of available characters and their hexadecimal locations. Locations are also shown for UDC's.

Always Present:	
20h – 7Fh	ASCII Character Set.
80h – 9Fh	Scientific Character Set.
E0h – F2h	Special Character Set
F6h – FFh	User Defined Character Locations.
Activated by Control Code:	
A0h – DFh	European Character Set.
A0h – C0h	Cyrillic Character Set.
A0h – DFh	Katakana Character Set.
A0h – BAh	Hebrew Character Set.

3.1.5 Character Cell Features (Cont.)

Hitachi (LCD) Mode:

The Hitachi (LCD) mode character table also includes the ASCII and scientific character sets and several user definable character locations. The “special charcater set” present in the Motorola/Intel mode is absent, and certain characters from the U.S. ASCII set are different. The address A0h through DFh locations mimic the Katakana character set while address E0h through FFh locations comprise a unique Hitachi set.

The Hitachi (LCD) mode offers 4 UDC's instead of the 10 available in the Motorola/Intel mode. The Hitachi (LCD) character table is shown in Figure 3–9. Cells shown are exact representations of available characters and their hexadecimal locations. Locations are also shown for UDC’s.

00h – 03h	User Defined Character Locations.
20h – 7Fh	ASCII Character Set.
80h – 9Fh	Scientific Character Set.
A0h – FFh	Hitachi Character Set.

Cursor Type The displays include a block format cursor indicator.

Color Blue–green, 5000 Angstroms peak.

Brightness Minimum 100 ft–L
Typical 175 ft–L

3.1.6 Character Font Data

The character font for each model of the dot matrix family of Century Series VFDs is described in the table below.

Model	Tube Format	Character Height	Character Width	Character Pitch
036X2–100–05420	4 X 20	5.00 mm	3.30 mm	4.75 mm
036X2–105–05220	2 X 20	5.05 mm	3.55 mm	4.75 mm
036X2–106–04240	2 X 40	4.70 mm	2.55 mm	4.25 mm
036X2–120–09120	1 X 20	9.00mm	6.30mm	8.30mm
036X2–121–11120	1 X 20	11.30mm	7.25mm	10.90mm
036X2–122–09220	2 X 20	9.20 mm	6.40 mm	5.10 mm
036X2–124–09420	4 X 20	9.10 mm	6.40 mm	8.30 mm
036X2–130–11220	2 X 20	11.30mm	7.25mm	10.90mm
036X2–134–11420	4 X 20	11.30mm	7.25mm	10.25mm
036X2–151–05240	2 X 40	5.00 mm	3.55 mm	4.75 mm
036X2–160–05440	4 X 40	5.00mm	3.30mm	4.9mm

Table 3–2

Display Character Fonts

Figure 3–4

ASCII Character Set
(with Scientific, Specials & UDC's)

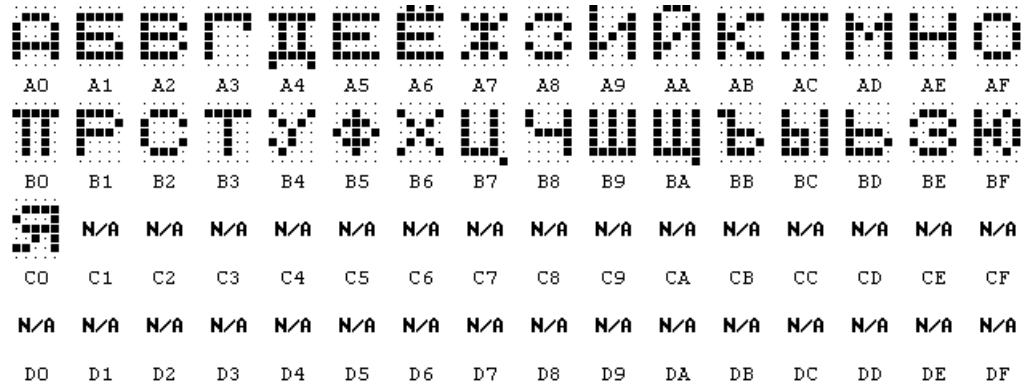


Figure 3–5

Cyrillic Character Set

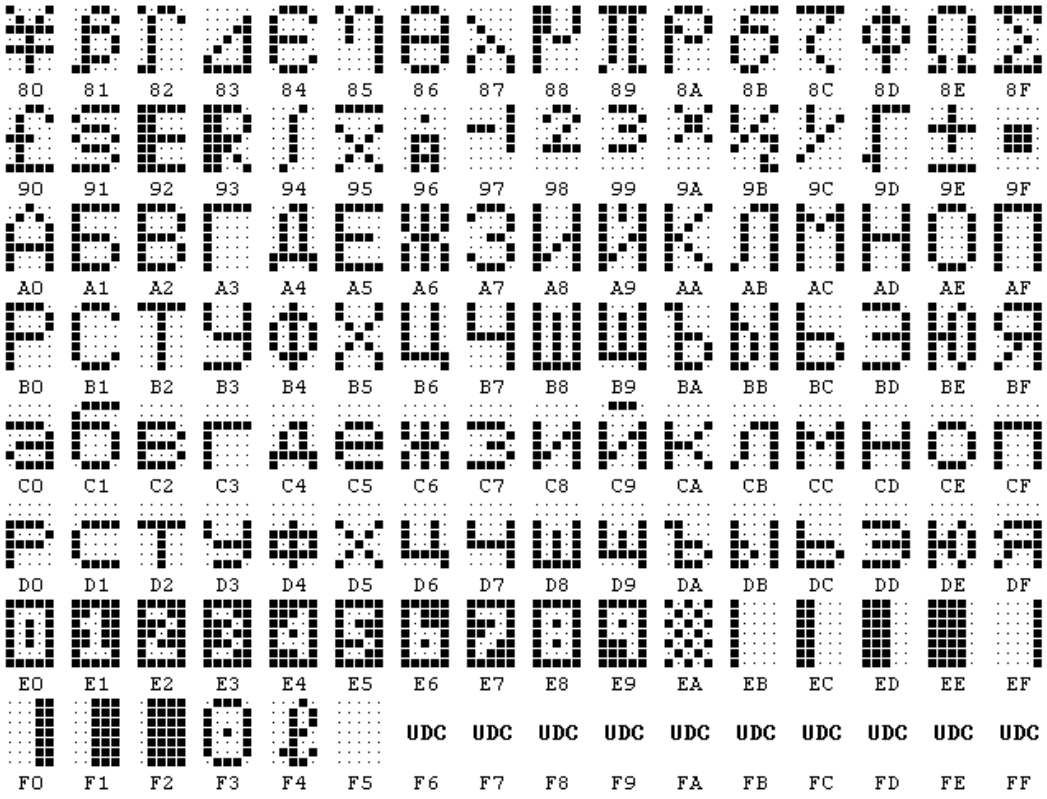


Figure 3–5A

Cyrillic Character Set

(036X2-160-05440 ONLY)

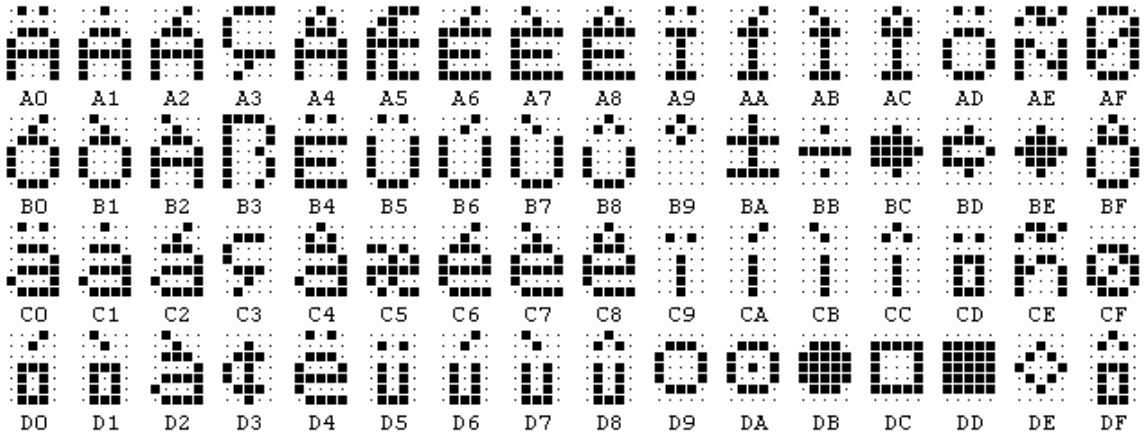


Figure 3–6

European Character Set

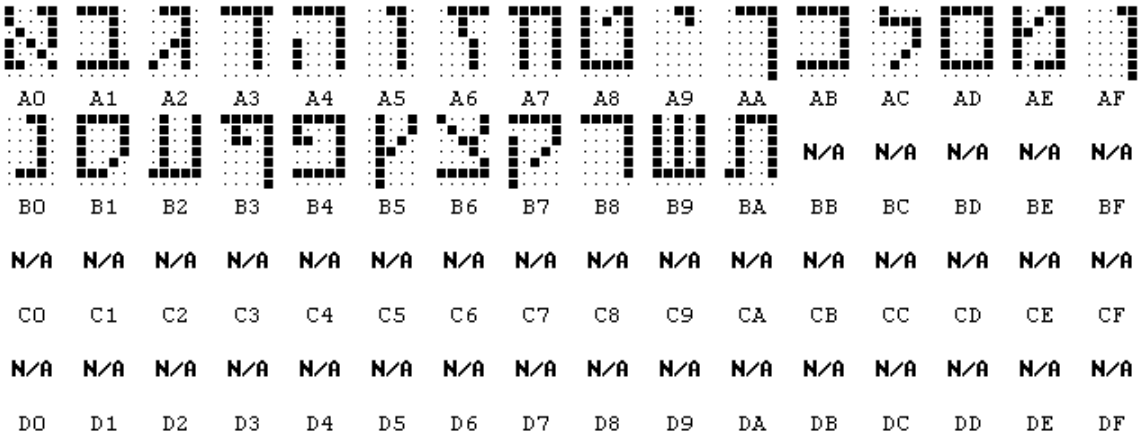


Figure 3–7

Hebrew Character Set

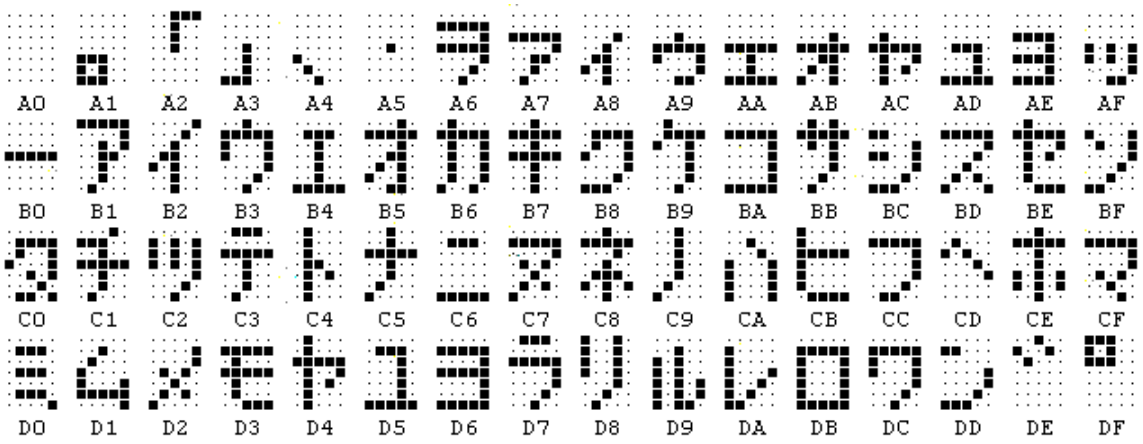


Figure 3–8

Katakana Character Set

Figure 3–9

Hitachi (LCD) Character Set

3.2 Interfaces

3.2.1 Power Interface

The display power converter is a Constant Power configuration.

Supply Voltage 5 Volts dc ± 5%.

WARNING

Damage may occur if the supply voltage exceeds 5.5 Volts dc or if data or control signals are applied prior to application of dc power.

Supply Rise Time 100 msec maximum.

Supply Current: Minimum = all dots OFF, 5.25 Vdc; Maximum = all dots ON, 4.75 Vdc

Model	Minimum	Typical	Maximum
036X2–100–05420	650 mA.	770 mA	890 mA.
036X2–105–05220	265 mA	385 mA	510 mA
036X2–106–04240	370 mA	400 mA	450 mA
036X2–120–09120	340mA	450 mA	570 mA
036X2–121–11120	450 mA	500 mA	570 mA
036X2–122–09220	510 mA	590 mA	675 mA
036X2–124–09420	1000 mA	1150 mA	1300 mA
036X2–130–11220	670 mA	890 mA	990 mA
036X2–134–11420	1240mA	1400 mA	1490 mA
036X2–151–05240	625 mA	750 mA	800 mA
036X2–160–05440	1100 mA	1250 mA	1400 mA

Table 3–3

Display Supply Current

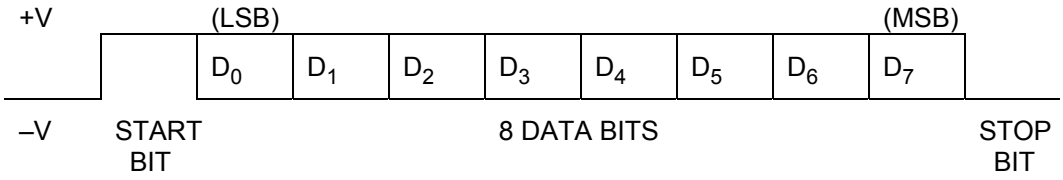
3.2.2 Data Interface

The displays accept either serial or parallel input data and control codes. Internal logic can interface to either Intel and Motorola processors and emulate equivalent Hitachi 44780 LCD features.

3.2.2.1 Serial

Input Levels	High (space/logic 0) Low (mark/logic 1)	+3 Volts to +15 Volts (Conforms to EIA-232 specification). –3 Volts to –15 Volts.
Baud Rate	Selectable—1200, 9600 or 19200. Maximum available baud rate depends on execution times. (See Table 3–5)	
Data Word	10 Bits. Eight Data Bits with start bit and 1 stop bit.	
Parity	None	
Error Indicator	If the operating software detects either speed or framing errors during data transmission, each error character received is replaced on the display screen with the symbol **#** (ASCII 23h).	

Format:

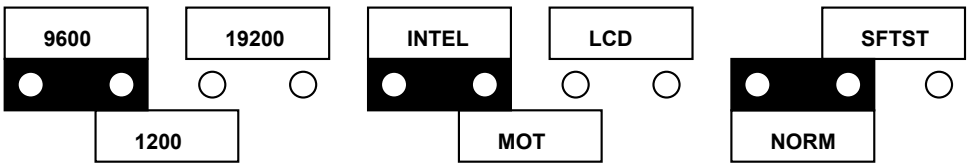


3.2.2.2 Parallel

Input Levels	High Low	≥ 3.5 Vdc @ 5.0 μA maximum ≤ 1.5 Vdc @ 0.5 mA maximum
Output Levels	High Low	≥ 4.6 Vdc @ 5 mA maximum ≤ 0.4 Vdc @ 5 mA maximum
Pull–ups	Parallel I/O lines are pulled up to +5 Vdc by internal 10 kΩ resistors.	

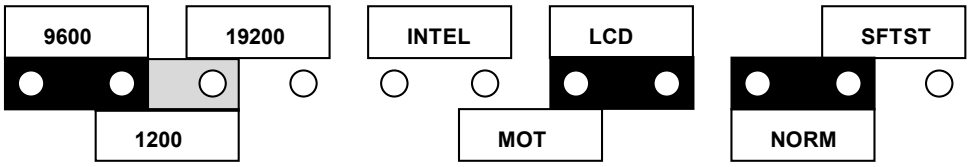
3.2.3 Personality Interface

A strip connector on the circuit card allows user selection of Baud Rate, Interface Mode and Start–up Mode. The illustration below matches the appearance of the jumper strip on the circuit card.



Jumpers positions are shown above for the default position. If not installed, the default setting is automatically selected.

3.2.3 Personality Interface (Continued)



Jumper positions are shown above for LCD mode. Filled positions are settings without Interface Converter. Baud rate jumper must be moved to 1200 (hatched) position if an Interface Converter is installed.

Figure 3–10

Personality Jumper Positions

3.2.4 Power/Data Connector

The Power/Data connector (J1) contact arrangement is shown in the illustration below. See Table 3–4 for pin assignments.

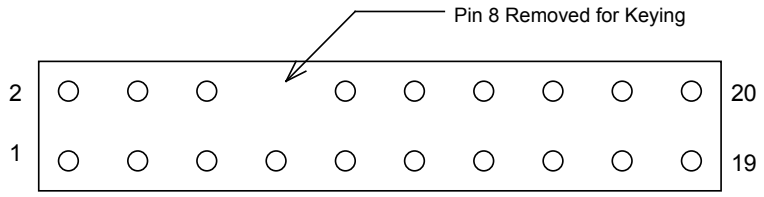


Figure 3–11

J1 Contact Arrangement

The 36X2-134 model has a separate power connector J2 and the pin assignments are:

J2-1 +5VDC
J2-2 NC
J2-3 NC
J2-4 COMMON (GND)
J2-5 NC
J2-6 NC

NOTE

IEE recommends that the user install a keying plug in the mating connector at the Pin 8 location. This will assure that the mating connector is always installed correctly and will avoid damage to the display.

IEE supplied accessory connectors are properly keyed.

Intel Mode

PIN NO.	FUNCTION	MNEM
J1–1	DATA BIT 7 (MSB)	D_7
J1–2	+5 VDC	
J1–3	DATA BIT 6	D_6
J1–4	+5 VDC	
J1–5	DATA BIT 5	D_5
J1–6	COMMON	
J1–7	DATA BIT 4	D_4
J1–8	REMOVED FOR KEYING	
J1–9	DATA BIT 3	D_3
J1–10	COMMON	
J1–11	DATA BIT 2	D_2
J1–12	BUSY	
J1–13	DATA BIT 1	D_1
J1–14	SERIAL INPUT	
J1–15	DATA BIT 0 (LSB)	D_0
J1–16	$\overline{\text{RESET}}$	$\overline{\text{RST}}$
J1–17	$\overline{\text{WRITE}}$	$\overline{\text{WR}}$
J1–18	$\overline{\text{CHIP SELECT}}$	$\overline{\text{CS}}$
J1–19	ADDRESS BIT 0	A_0
J1–20	$\overline{\text{READ}}$	$\overline{\text{RD}}$

Motorola / LCD Mode

PIN NO.	FUNCTION	MNEM
J1–1	DATA BIT 7 (MSB)	D_7
J1–2	+5 VDC	
J1–3	DATA BIT 6	D_6
J1–4	+5 VDC	
J1–5	DATA BIT 5	D_5
J1–6	COMMON	
J1–7	DATA BIT 4	D_4
J1–8	REMOVED FOR KEYING	
J1–9	DATA BIT 3	D_3
J1–10	COMMON	
J1–11	DATA BIT 2	D_2
J1–12	BUSY	
J1–13	DATA BIT 1	D_1
J1–14	SERIAL INPUT	
J1–15	DATA BIT 0 (LSB)	D_0
J1–16	$\overline{\text{RESET}}$	$\overline{\text{RST}}$
J1–17	READ/$\overline{\text{WRITE}}$	RD/$\overline{\text{WR}}$
J1–18	$\overline{\text{CHIP SELECT}}$	$\overline{\text{CS}}$
J1–19	REGISTER SELECT	RS
J1–20	ENABLE	E

Table 3–4

Connector Pin Assignments

3.3 Performance Characteristics

Processor Power–up Cycle 500 msec minimum

Part Number	4 X 20 036X2 –100	2 X 20 036X2 –105	2 X 40 036X2 –106	1X20 036X2 -120, -121	2 X 20 036X2 –122, -130	4 X 20 036X2 –124, -134	2 X 40 036X2 –151	4X40 03602 -160
Blink	300	170	176	123	290	470	181	350
Brightness	305	170	175	124	285	465	184	351
Send Character	315	170	171	126	285	460	179	350
Clear	2105	410	715	215	410	1210	746	1726
Cursor Locate	305	170	171	125	285	460	178	352
Home	300	170	171	123	285	460	176	347
Horizontal Scroll	1830	635	1224	755	585	1055	1260	2738
Reset	850	815	802	765	805	1000	780	711
Vertical Scroll	2510	410	901	270	410	1445	901	3504

Table 3–5

Execution Times (in μsec)

Brightness Control — Software or Hardware. Varies display brightness level in 8 discrete steps.

The Hardware brightness level control sets the upper brightness level limit. Software control cannot advance brightness level above the hardware set limit.

Viewing Angle — The displays are readable within a cone of 150^{o}.

Dedicated Interface Lines:

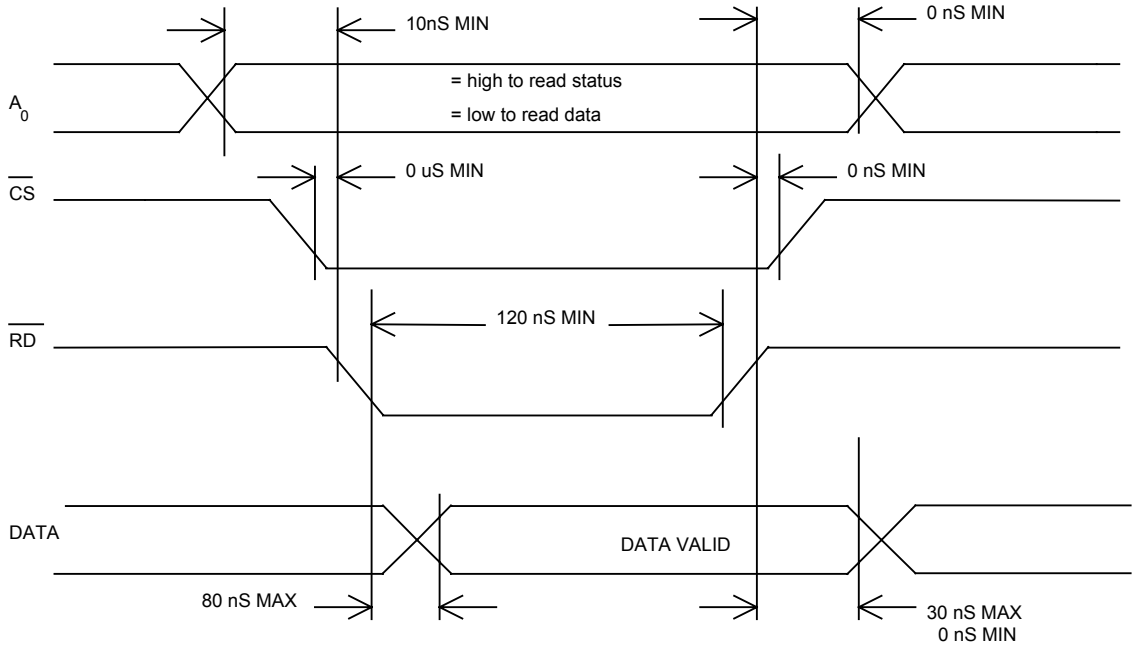
$\overline{\text{RESET}}$ — 15 msec (minimum) negative going pulse clears display and initializes processor power–up sequence.
(Requires current sink capable of discharging a 4.7 μF internal capacitor and a 10 kΩ resistor to V_{CC}.)

BUSY — High during write or hardware reset. Low when ready for data.
(Not used with serial data mode or LCD mode.)

DIMMING — 10 kΩ internal pull–up provides hardware brightness level control.
(A 100 kΩ potentiometer is recommended.)

BELL — Drive output for audible signalling device. A 160 msec wide output that can sink 0.2 A from a 5.0 Vdc source.

Read Timing



Write Timing

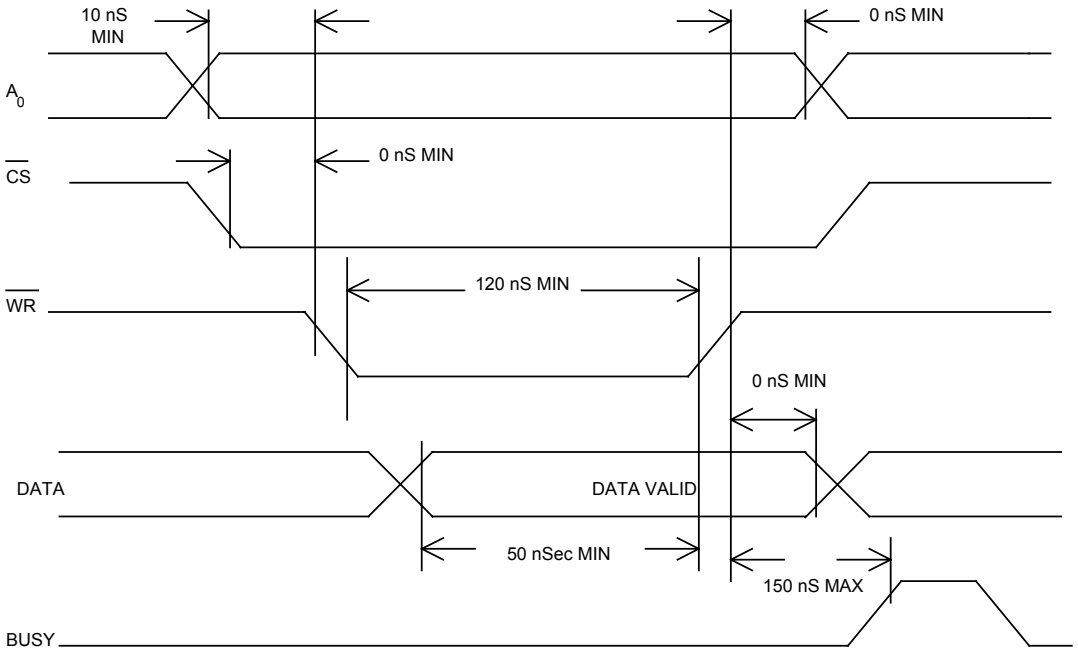
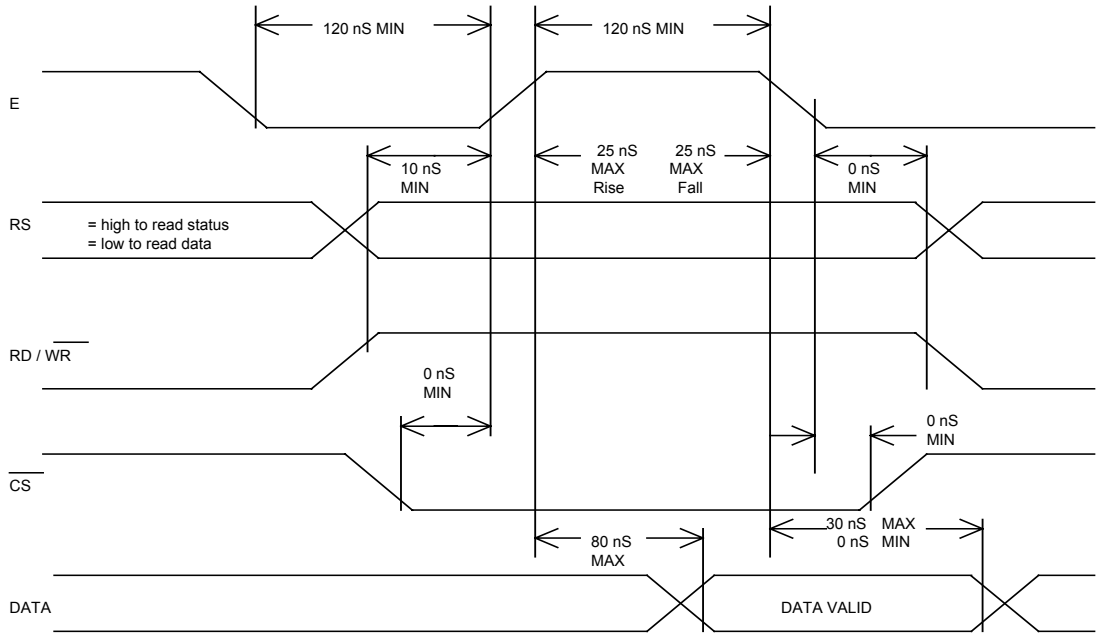


Figure 3–12

Timing Characteristics, Intel Mode

Read Timing



Write Timing

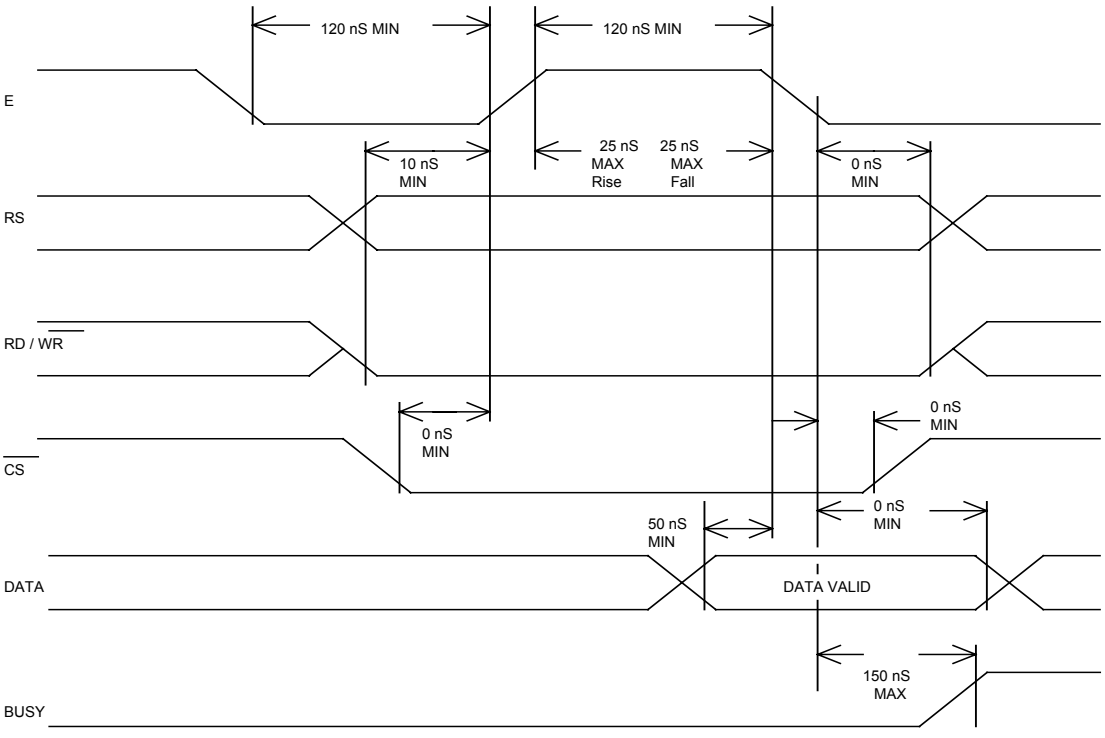
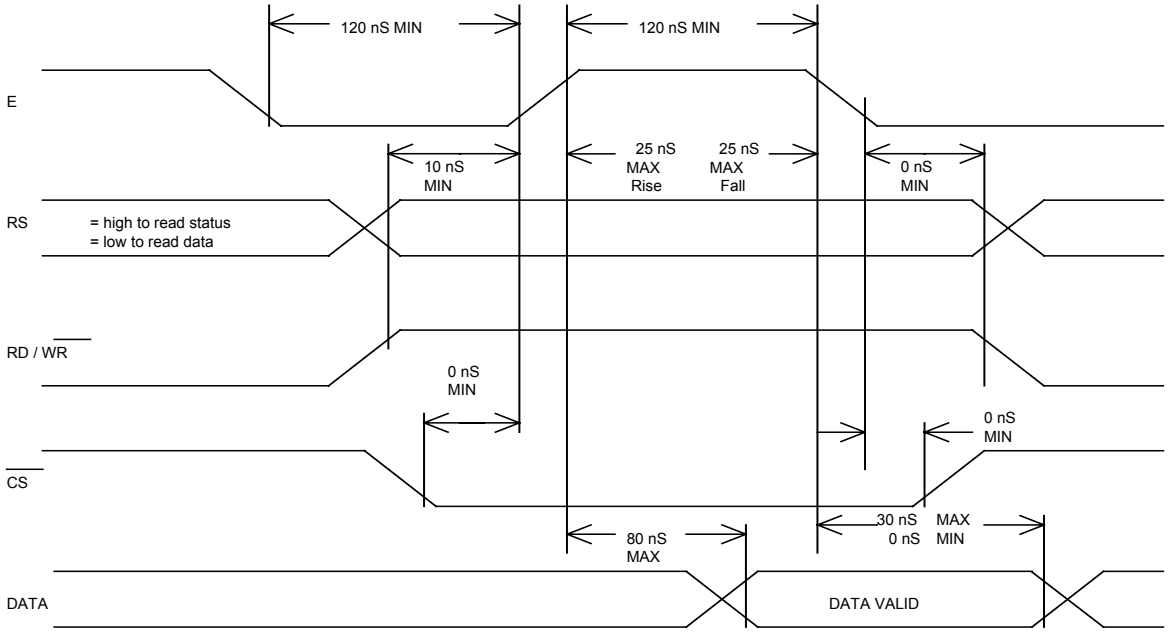


Figure 3–13

Timing Characteristics, Motorola Mode

Read Timing



Write Timing

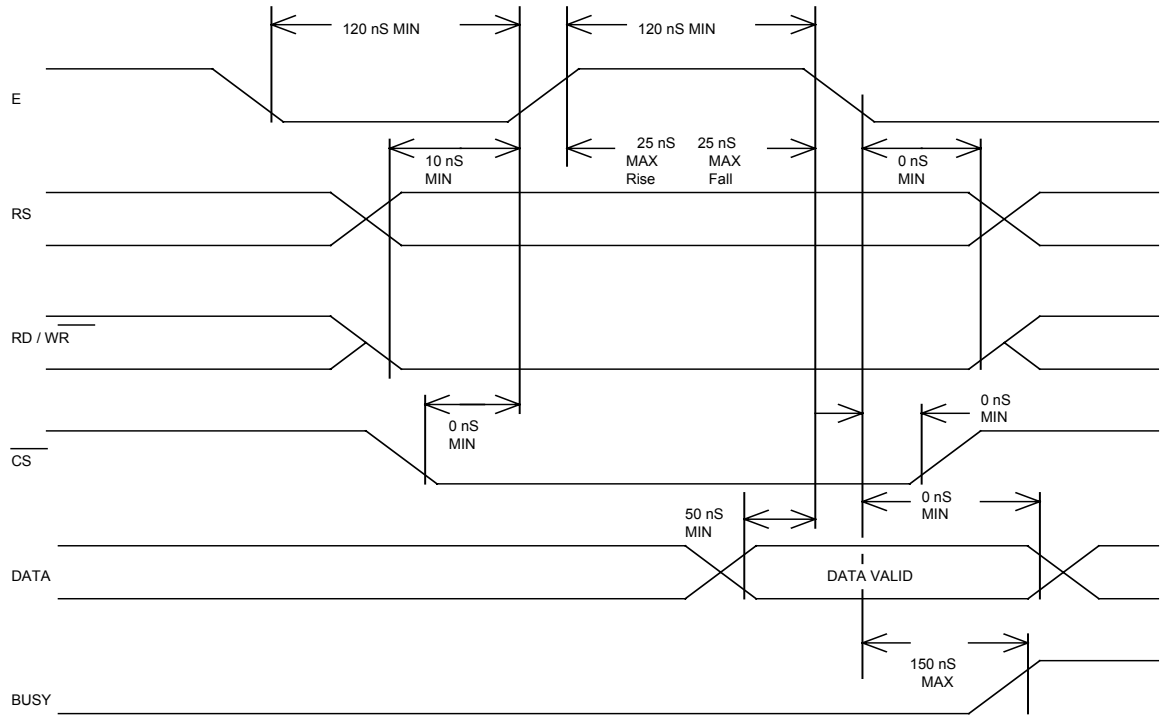


Figure 3–14

Timing Characteristics, LCD Mode

4.0 PROGRAMMING CODES

The Century Series control codes occupy two hexadecimal address blocks. The first block is comprised of 00h–1Fh, while the second overlays part of the character table at 30h–3Fh. Control codes shown in **Bold** typeface are power–on defaults.

4.1 Numeric Order Control Codes

[A_0 (RS) = Low for the following Control Codes]

Code	Name	Described in Section		
00h	*Null*	4.6	Miscellaneous Codes	
01h	*Prepare to Read Display Identification*	4.4	Prepare to Read Codes	
02h	*Prepare to Read Software Check sum*	4.4	Prepare to Read Codes	
03h	*Prepare to Read Cursor Location*	4.4	Prepare to Read Codes	
04h	*Prepare to Read Data at Cursor Location*	4.4	Prepare to Read Codes	
05h	*Prepare to Read Data at Cursor Location and Increment*	4.4	Prepare to Read Codes	
06h	Unassigned			
07h	*Bell/Alarm Output*	4.6	Miscellaneous Codes	
08h	*Backspace Cursor*	4.2	Cursor Control Codes	
09h	*Advance Cursor*	4.2	Cursor Control Codes	
0Ah	*Line Feed*	4.2	Cursor Control Codes	
0Bh	*Blink Block Cursor*	4.2	Cursor Control Codes	*
0Ch	*Underbar Cursor*	4.2	Cursor Control Codes	*
0Dh	*Carriage Return*	4.2	Cursor Control Codes	
0Eh	*Cursor Off*	4.2	Cursor Control Codes	
0Fh	***Cursor On***	4.2	Cursor Control Codes	
10h	*Scroll Line Lock*	4.6	Miscellaneous Codes	
11h	***Set Vertical Scroll Mode***	4.3	Data Display Codes	
12h	Unassigned			
13h	*Set Horizontal Scroll Mode*	4.3	Data Display Codes	
14h	*Software Reset*	4.6	Miscellaneous Codes	
15h	*Clear Display and Home Cursor*	4.2	Cursor Control Codes	
16h	*Home Cursor*	4.2	Cursor Control Codes	
17h	*Set Data Bit 7 High*	4.6	Miscellaneous Codes	
18h	*Begin User Defined Character*	4.3	Data Display Codes	
19h	*Set Address Bit 0 High*	4.6	Miscellaneous Codes	
1Ah	*Cursor up One Line*	4.2	Cursor Control Codes	
1Bh	*Move Cursor to Designated Location*	4.2	Cursor Control Codes	
1Ch	***Select European Character Set***	4.3	Data Display Codes	
1Dh	*Select Katakana Character Set*	4.3	Data Display Codes	
1Eh	*Select Cyrillic*	4.3	Data Display Codes	
1Fh	*Select Hebrew Character Set*	4.3	Data Display Codes	

* **Applies to 036X2–151–05240 & 036X2-160-05440 only. Unassigned for all other models.**

4.1 Numeric Order Control Codes (Cont.)

[A_0 (RS) = High for the following Control Codes]

Code	Name	Described in Section		
30h	*Set Display Screen or Column Brightness Level*	4.5	Screen Control Codes	
31h	*Begin Blinking Character(s)*	4.5	Screen Control Codes	
32h	*End Blinking Character(s*)	4.5	Screen Control Codes	
33h	*Blank Display Screen*	4.5	Screen Control Codes	
34h	*Unblank Display Screen*	4.5	Screen Control Codes	
+35h	Comma/Period/Triangle Function	4.5	Screen Control Codes	
36h	*Erase Line data With End Blink*	4.5	Screen Control Codes	
37h	*Set Carriage Return and Line Feed Definitions*	4.5	Screen Control Codes	
38h	*Underbar On*	4.2	Cursor Control Codes	*
39h	*Underbar Off*	4.2	Cursor Control Codes	*
3Ah	*Select Right to Left Data Entry*	4.5	Screen Control Codes	
3Bh	***Select Left to Right Data Entry***	4.5	Screen Control Codes	
3Ch	*Screen Saver On*	4.5	Screen Control Codes	
3Dh	***Screen Saver Off***	4.5	Screen Control Codes	
3Eh	*Execute Self–test*	4.6	Miscellaneous Codes	
3Fh	*Terminate Self–test*	4.6	Miscellaneous Codes	

*** Applies to 036X2–151–05240 & 036X2-160-05440 only. Unassigned for all other models.**

+ Applies to 036X2-121-11120 only. Unassigned for all other models.

While unassigned Control Codes have no function, they are viewed as activity if received by the display and will cause the Screen Saver function to reset.

CAUTION

While the display software will ignore erroneous single byte control codes, errors in multibyte commands will cause the software to "jump" out of the control mode.

4.2 Cursor Control Codes

[A_0 (RS) = Low for the following Control Codes]

08h *Backspace Cursor*
Moves the cursor one position left. (Right if 3Ah is selected.)
Functions only on current line, does not move cursor to previous line.

09h *Advance Cursor*
Moves the cursor one position right. (Left if 3Ah is selected.)

If the cursor is in the last position on a line (other than the last line of the display screen), it will move to the first position of the next line.

If the cursor is in the last position of the last line, it will be blanked and remain in the same location.

0Ah *Line Feed*
On single line displays, clears data from the display screen. Cursor remains in same column.

On multi–line displays, moves the cursor down one line with no change in horizontal position unless on the last line.

If on the last line, cursor unblanked, executes a vertical scroll with no change in horizontal position.

If on the last line, last position, cursor blanked, executes a vertical scroll with no change in horizontal position and cursor becomes visible.

The function of this command is described for the default setting and can be modified by using control code 37h.

0Bh *Blinking Block Cursor* *

Sets the cursor style to a blinking block cursor.

0Ch *Underbar Cursor* *

Sets the cursor style to an underbar cursor.

0Dh *Carriage Return*
Returns the cursor to the left most position on the current line. (Rightmost if 3Ah is selected.)

The function of this command can be modified by using control code 37h.

15h *Clear Display and Home Cursor*
Clears the display screen and sets the cursor to the home position.

16h *Home Cursor*
Sets the cursor to the home position.

1Ah *Cursor Up One Line*
Moves the cursor up 1 line on multi–line displays. No function on single line displays or on the top line of multi–line displays.

1Bh *Move Cursor to Designated Location*
Moves the cursor to a specific display screen location using a 2 byte command consisting of control code 1Bh and a position ID. Screen positions are numbered from left to right, top to bottom starting with 00h.

4.2 Cursor Control Codes (Cont.)

[A_0 (RS) = Low for the following Control Codes]

0Eh *Cursor Off*
Makes cursor invisible. Other cursor functions are not affected.

0Fh *Cursor On*
Makes cursor visible at 4 Hz blink rate. (Default)

*** Applies to 036X2–151–05240 & 036X2-160-05440 only. Unassigned for all other models.**

4.3 Data Display Mode Codes

The following control codes define the way the display behaves after the last character has been written to the screen.

[A_0 (RS) = Low for the following Control Codes]

11h *Set Vertical Scroll Mode*
Causes data to scroll up one line, upon receipt of a displayable character, after the last character is written to the last line of the display screen.
Generates automatic *Carriage Return* + *Line Feed*. (Default)

13h *Set Horizontal Scroll Mode*
Causes the last line of the display screen to scroll from right to left after the last character is written to the last line as successive characters are written.

18h *User Defined Character*
A 7 byte command which may be used to define up to 10 custom characters. Each character must be separately defined and stored in locations F6h – FFh. The command consists of the control code 18h, a location code and 5 bytes of character dot data.

18 XX PP PP PP PP PPXX = F6 – FF

PP = Dot data from tables below

0 = Dot Off
1 = Dot On

BYTE	DATA BIT (036X2-100,-105,-122,-124,-134,-130) 7	6	5	4	3	2	1	0
3	33	15	34	16	35	17	0	18
4	29	11	30	12	31	13	32	14
5	25	07	26	08	27	09	28	10
6	21	03	22	04	23	05	24	06
7	0	0	0	0	19	01	20	02

CHARACTER MATRIX				
1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25
26	27	28	29	30
31	32	33	34	35

BYTE	DATA BIT (036X2-106,-120,-121,-151,-116,-160) 7	6	5	4	3	2	1	0
3	29	20	11	02	28	19	10	01
4	31	22	13	04	30	21	12	03
5	33	24	15	06	32	23	14	05
6	35	26	17	08	34	25	16	07
7	0	0	0	0	0	27	18	09

Table 4–1

4.3 Data Display Mode Codes(Cont'd)

Dot Data for User Defined Characters

1Ch *Select European Character Set*
Selects character set shown in Figure 3–6. (Default)

1Dh *Select Katakana Character Set*
Selects character set shown in Figure 3–8.

1Eh *Select Cyrillic Character Set*
Selects character set shown in Figure 3–5.

1Fh *Select Hebrew Character Set*
Selects character set shown in figure 3–7.

4.4 Prepare To Read Codes

The following control codes allow data to be read from the display. All *Prepare To Read* commands must be followed by a **READ DATA** operation for each byte of output.

[A_0 (RS) = Low for the following Control Codes]

(See timing diagrams in Figures 3–12, 3–13 and 3–14 for read operation details.)

01h *Prepare to Read Firmware Identification Number & Display Format*
Outputs a 19 byte string representing the firmware ID number and line/column format.
e.g., IEE,35062–01,LXXCXX (for model: 036X2-100, -105, -122, -124, -130, -134)
e.g., IEE,35440-01,LXXCXX (for model: 036X2-106, -116, -120, -121, -151)
e.g., IEE,35973-01,L04C40 (for model: 036X2-160)

02h *Prepare to Read Software Check Sum*
Outputs a 4 byte string representing the hexadecimal check sum.

03h *Prepare to Read Cursor Location*
Outputs a 1 byte string representing the cursor location.

04h *Prepare to Read Data at Cursor Location*
Outputs a 1 byte string representing character data at current cursor location.

05h *Prepare to Read Data at Cursor Location and Increment*
Outputs a 1 byte string representing character data at current cursor location and generates an *Advance Cursor* command.

NOTE
Data cannot be read in serial mode.

Status Read Operation

[A_0 (RS) = High for the following Read Operation]

Status Returned to the Host on the Data Lines

Data Lines	
XXXX XXIO	O = 0 Output Buffer Empty (READY)
	O = 1 Output Buffer Full (BUSY)
	I = 0 Input Buffer Empty (READY)
	I = 1 Input Buffer Full (BUSY)

4.5 Screen Control Codes

[A_0 (RS) = High for the following Control Codes]

30h *Set Display Screen or Column Brightness Level*
Sets the display brightness level using a 3 byte command consisting of control code 30h, column ID, and brightness level. Column ID code FFh sets all columns. Brightness levels range from 00h (brightest) through 07h (dimmest). (Default is 00h)

> **Note**
>
> Brightness levels must be set by columns rather than by characters because of the construction of the vacuum fluorescent tube.

31h *Begin Blinking Character(s)*
Sets the start of blinking character(s) or underbar(s) and the blink rate using a 2 byte command consisting of control code 31h and blink code. Subsequent characters will blink until Control Code 32h is sent. (If a character is written at the current cursor location, that character will blink).

The "Underbar" and "Both" code sets apply only to 36X2–151–05240.

Character Code	Rate	Underbar Code	Rate	Both Code	Rate
00h	OFF (Default)	60h	OFF	80h	OFF
01h	1 Hz	61h	1 Hz	81h	1 Hz
02h	2 Hz	62h	2 Hz	82	2 Hz
04h	4 Hz	64h	4 Hz	84h	4 Hz

32h *End Blinking Character(s)*
Sets the end of blinking character(s) at the current cursor location. Subsequent characters will not blink until Control Code 31h is sent. (A character written to the current cursor location will not blink).

If a blinking character is overwritten by a non–blinking character, or if the *Erase Line* command is executed, the blink attribute is turned off.

33h *Blank Display Screen*
Sets the display screen to OFF. Data and attribute settings are not affected.

34h *Unblank Display Screen*
Returns the display screen to ON after 33h.

35h Comma/Period/Triangle Function

35-01-n: display character with period
n = display character 20-FF
35-02-n: display character with comma
n = display character 20-FF
35-03-n: display character with comma & period
n = display character 20-FF
35-04-n: display character with triangle
n = display character 20-FF

4.5 Screen Control Codes (Cont.)

[A_0 (RS) = High for the following Control Codes]

36h *Erase Line Data With End Blink*
Erases 1 or more lines of data (with blink) using a 2 byte command consisting of control code 36h and blink field/line data.

Bits 0 through 3 retain (0) or erase (1) lines 0 through 3 respectively.

For example:

Blink Field ON/OFF				Line Position				
D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	
X	X	X	X	0	0	0	1	Erase line 0, retain lines 1, 2, 3.
X	X	X	X	1	1	0	0	Erase lines 2 & 3, retain lines 0 & 1.

38h *Underbar On* *
Sets the underbar to ON at the current character position.

39h *Underbar Off* *
Sets the underbar to OFF at the current character position.

3Ch *Screen Saver On*
Sets the display screen to brightness level 07h (dimmest) after a 10 minute idle time.

(Any new control or data input resets the Screen Saver function for another 10 minute cycle, The Screen Saver function remains active.)

3Dh *Screen Saver Off*
Restores the screen display to previously established brightness level(s) and deactivates the Screen Saver function. (Default)

37h *Set Carriage Return and Line Feed Definitions*
Sets the functions of the Line Feed (0Ah) and Carriage Return (0Dh) commands using a 2 byte command consisting of control code 37h and the function ID.

Function ID	Definition	
00h	LF = LF	CR = CR (Default)
01h	LF = LF + CR	CR = CR
02h	LF = LF	CR = CR + LF
03h	LF = LF + CR	CR = CR + LF

3Ah *Set Right to Left Data Entry*
Reverses data entry mode for use with Hebrew Character Set.

3Bh *Set Left to Right Data Entry*
Restores data entry mode to normal ASCII. (Default)

* **Applies to 036X2–151–05240 & 036X2-160-05440 only. Unassigned for all other models.**

4.6 Miscellaneous Codes

[A_0 (RS) = Low for the following Control Codes]

00h *Null*
No operation. Sending a 00h to the display is viewed by software as activity, and will reset a Screen Saver code (3Ch).

07h *Bell/Alarm Output*
Activates 160 msec drive signal for alarm tone.

10h *Scroll Line Lock*
Sets 1 or more lines to be locked out from the Vertical Scroll function using a 2 byte command consisting of the control code 10h and a line ID.

Line ID	Function
00h	Locks line 0
01h	Locks lines 0 and 1
02h	Locks lines 0, 1 and 2
FFh	Cancel Line Lock

14h *Software Reset*
Clears the display screen, homes the cursor and resets modes and attributes to their default settings.

> **Note**
>
> If Hardware Self–test is programmed, sending control code 14h restarts self–test.
>
> If Self–test was called by sending control code 3Eh, sending control code 14h has no effect.

17h *Set Data Bit 7 High*
Sets data bit 7 high for the following data byte.

19h *Set Address Bit 0 High*
Sets address bit 0 (A_0) high for the following byte only. The following byte must be a control code.

(In Motorola Mode, replace A_0 with RS).

4.6 Miscellaneous Codes (Cont.)

[A_0 (RS) = High for the following Control Codes]

3Eh *Execute Self–test*
Displays the following data in sequence:

1. Software version number.

   S/W NUMBER :
   XXXXX–XX

2. Baud Rate selected.
   BAUD : NNNN

3. Interface Mode selected.
   INTERFACE:
   INTEL(MOTOROLA)[LCD]

4. Present (hardware) display brightness level.
   HARDWARE BRIGHTNESS
   LEVEL: N

5. Displays 8 brightness levels in a numeric representation of brightness levels.
   DIM LEVELS: 01234567

6. Displays the 3 blink rates in a numeric representation of blink rates.
   BLINK RATES :
   1Hz 2Hz 4Hz

7. Displays the entire character font with vertical scrolling.

(Single line displays scroll continuously in *Horizontal Scroll Mode*).

Self–test overrides the hardware brightness level control setting and displays information at the highest brightness level (level 0).

Self–test may be invoked by setting a jumper on the circuit card prior to power up.

Self–test runs continuously until terminated by 3Fh.

3Fh *Terminate Self–test*
Terminates either a hardware or software induced self–test and sets display screen to the highest brightness level.

4.7 **LCD Mode Control Codes** (Without Interface Converter)

[See Figure 3–10 on Sheet 18 for personality jumper settings]

RS	RD/$\overline{WR}$	Data	
0	0	0000 0001	Clear Display Clears display and homes cursor.
0	0	0000 001X	Home Cursor Sets cursor to the home position.
0	0	0000 1DCB	Display Controls D=0 Blank Display D=1 Unblank Display B=0 Blinking Block Cursor OFF B=1 Blinking Block Cursor ON C=0 Blinking Cursor OFF C=1 Blinking Cursor ON

Note

Bit "B" is used to control character blinking on models which have an underbar cursor. Bit "C" is used to control the underbar cursor on models which support that style. For models which support only the block cursor, either bit "C" or bit "B" will activate the block cursor.

0	0	0001 0D00	Cursor Position Controls D=0 Shift Cursor Left D=1 Shift Cursor Right
0	0	010A AAAA	Set CG RAM Address (up to 4 character patterns).
0	0	1AAA AAAA	Set DD RAM Address Sets cursor to address AAAAAAA, first address is 0.
1	1	XXXX XXDX	Read BUSY Flag ***(D=0, Ready; D=1, Busy)*** Returns BUSY flag on Bit 1. (***Standard LCD BUSY Flag is Bit 7 & RS = 0***).
1	0	DDDD DDDD	Write to DD RAM or CG RAM Writes data DDDDDDDD to display at current cursor location or CG RAM.
0	1	DDDD DDDD	Read from DD RAM or CG RAM Reads data DDDDDDDD from display at current location or from CG RAM, cursor does not advance. (***Standard LCD – RS = 1, cursor advances***).

4.8 **Unsupported LCD Control Codes** (Without Interface Converter)

Simultaneous Block and Underbar Cursors
Underbar Cursor
Entry Mode Set
Display Shift
Function Set

4.9 **LCD Mode Control Codes** (With Interface Converter)

[See Figure 3–10 on Sheet 18 for personality jumper settings]

RS	RD/$\overline{WR}$	Data	
0	0	0000 0001	Clear Display Clears display and homes cursor.
0	0	0000 001X	Home Cursor Sets cursor to the home position.
0	0	0000 1DCB	Display Controls D=0 Blank Display D=1 Unblank Display B=0 Blinking Block Cursor OFF B=1 Blinking Block Cursor ON C=0 Blinking Cursor OFF C=1 Blinking Cursor ON

Note

Bit "B" is used to control character blinking on models which have an underbar cursor. Bit "C" is used to control the underbar cursor on models which support that style. For models which support only the block cursor, either bit "C" or bit "B" will activate the block cursor.

0	0	0001 0D00	Cursor Position Controls D=0 Shift Cursor Left D=1 Shift Cursor Right
0	0	010A AAAA	Set CG RAM Address (up to 4 character patterns).
0	0	1AAA AAAA	Set DD RAM Address Sets cursor to address AAAAAAA, first address is 0.
0	1	DXXX XXXX	Read BUSY Flag ***(D=0, Ready; D=1, Busy)*** Returns BUSY flag on Bit 7.
1	0	DDDD DDDD	Write to DD RAM or CG RAM Writes data DDDDDDDD to display at current cursor location or CG RAM.
1	1	DDDD DDDD	Read from DD RAM or CG RAM Reads data DDDDDDDD from display at current location or from CG RAM, cursor does not advance.

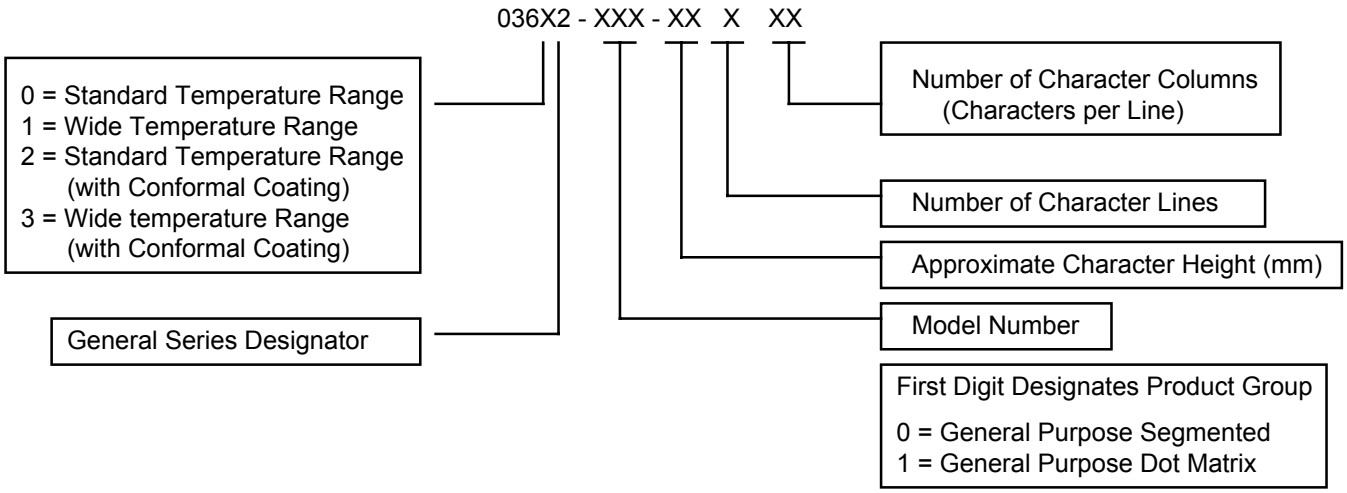
4.10 **Unsupported LCD Control Codes** (With Interface Converter)

Simultaneous Block and Underbar Cursors
Underbar Cursor
Entry Mode Set
Display Shift
Function Set

5.0 OPTIONS AND ACCESSORIES

The following sections list commonly available options and accessories to the Century Series of Vacuum Fluorescent Displays which can enhance performance or utility for specific applications.

5.1 Performance Options



Note

Spaces shown in Part Number above are for clarity only.

5.2 Accessories

ITEM	Part Number
Connector Key	43866–03
Mating Connector, Power/Data	43866–05
Mating Connector, Dimming	48272–02
Cable Assembly, Single Ended	35406–XX*
Cable Assembly, Double Ended	35407–XX*
Filters	35064–XXX**–NN***

* Dash number indicates cable length in whole inches.

** 3 Digit dash number (XXX) indicates Display Model Number.

*** 2 digit dash number (NN) indicates filter color.

–01 Neutral Gray
–02 Blue
–04 Aqua
–05 Neon
–07 Green
–09 Neutral(CP)
–10 Yellow(CP)

6.0 OUTLINE DRAWINGS

The following pages contain Outline Drawings of the available Century Series Dot Matrix Vacuum Fluorescent Displays. Each outline drawing includes:

1. Mounting and elevation dimensions to assist the user in packaging design.
2. Interface connector location, contact arrangement and keying.
3. Location and arrangement of personality jumpers.
4. Recommended panel cutout.

Note
The outline drawings which follow are **NOT** to scale. Refer to numeric dimensions for design data.

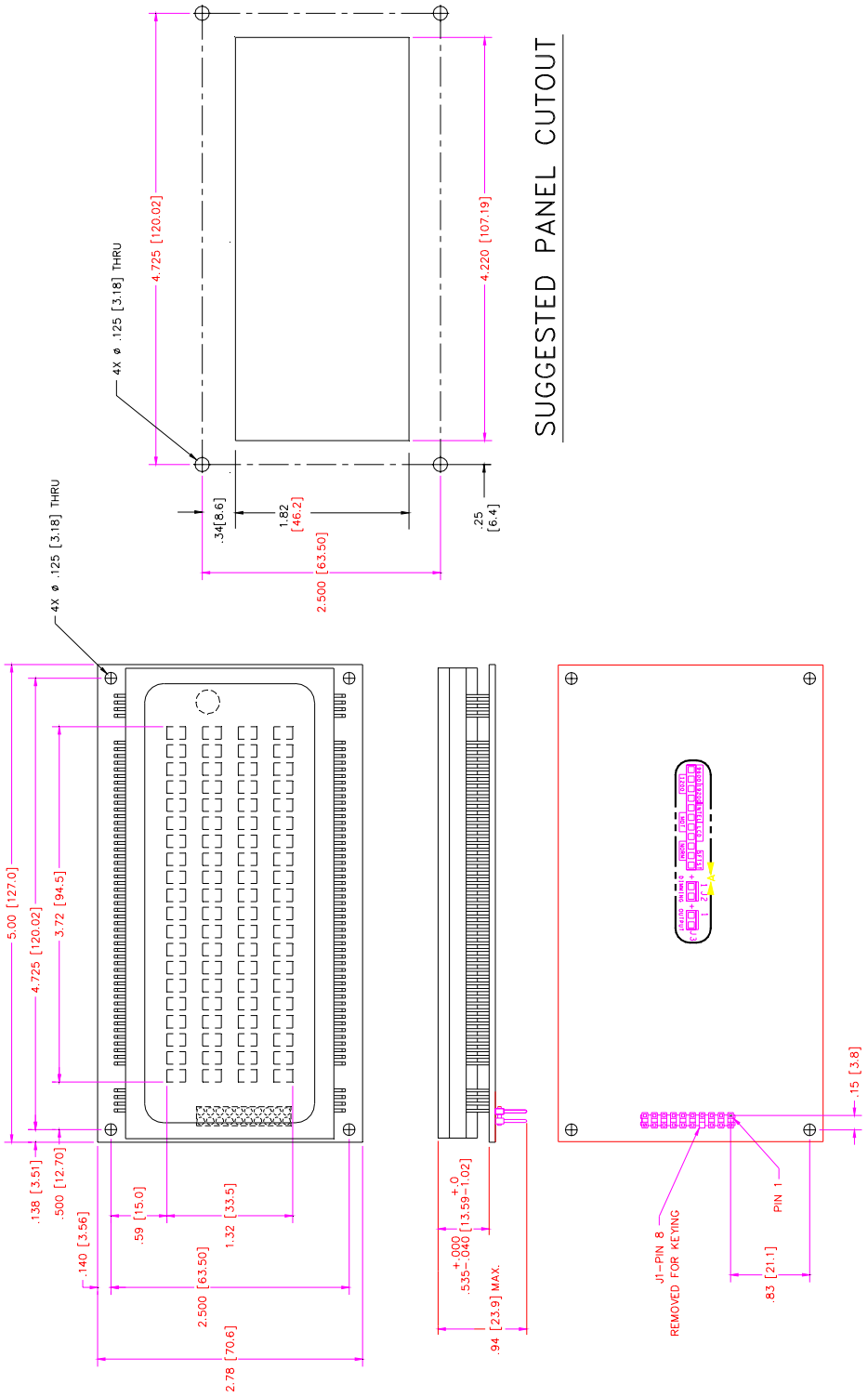


Figure 6–1

036X2–100–05420, 4X20 5mm

Industrial Electronic Engineers, Inc. **Van Nuys, California**	SIZE **A**	CODE IDENT NO. **05464**	**S036X2–XXX–XXXXX**
	SCALE N/A	REV **N**	SHEET 39 of 49

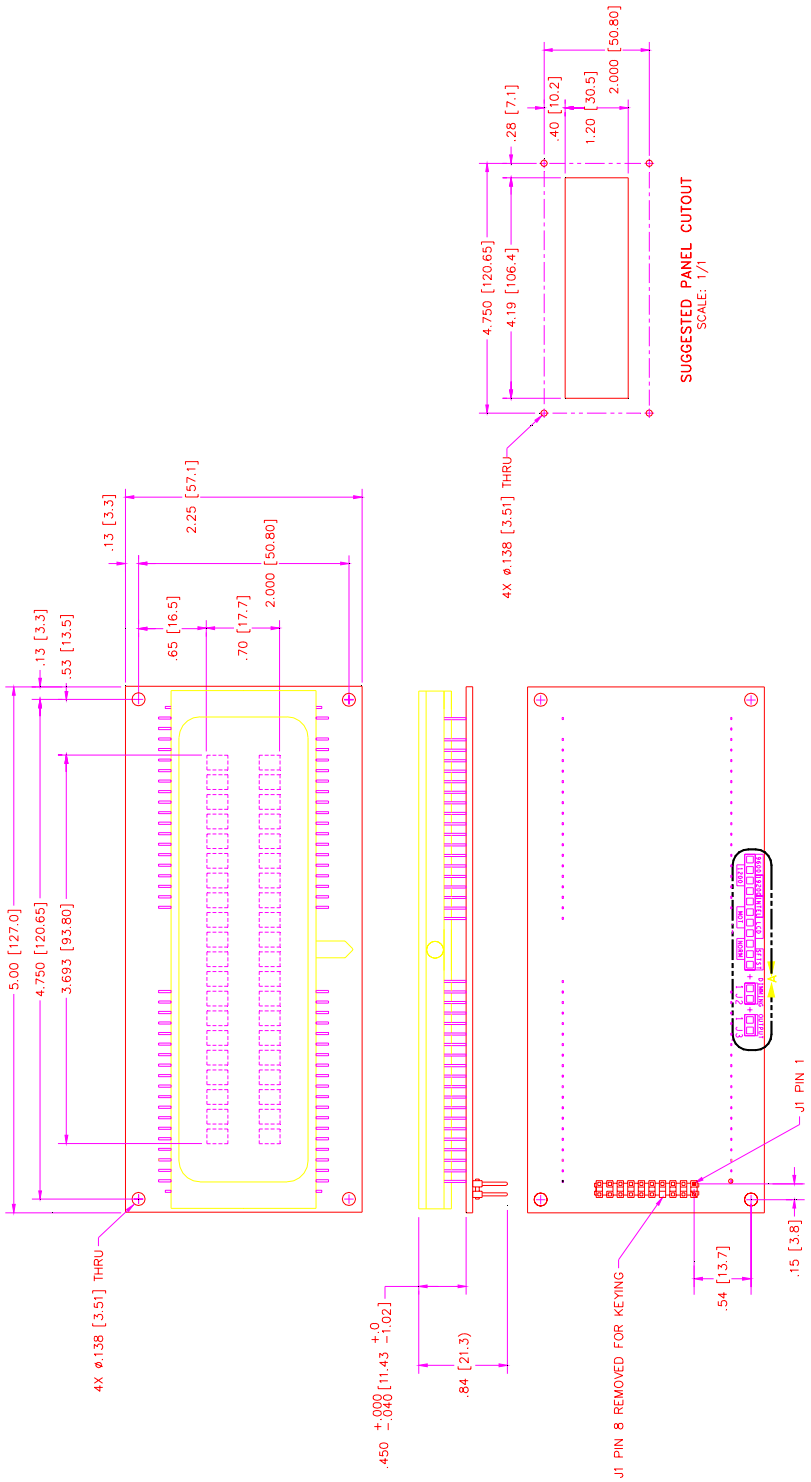


Figure 6–2

036X2–105–05220, 2X20 5mm

Industrial Electronic Engineers, Inc. **Van Nuys, California**	SIZE **A**	CODE IDENT NO. **05464**	**S036X2–XXX–XXXXX**
	SCALE N/A	REV **N**	SHEET 40 of 49

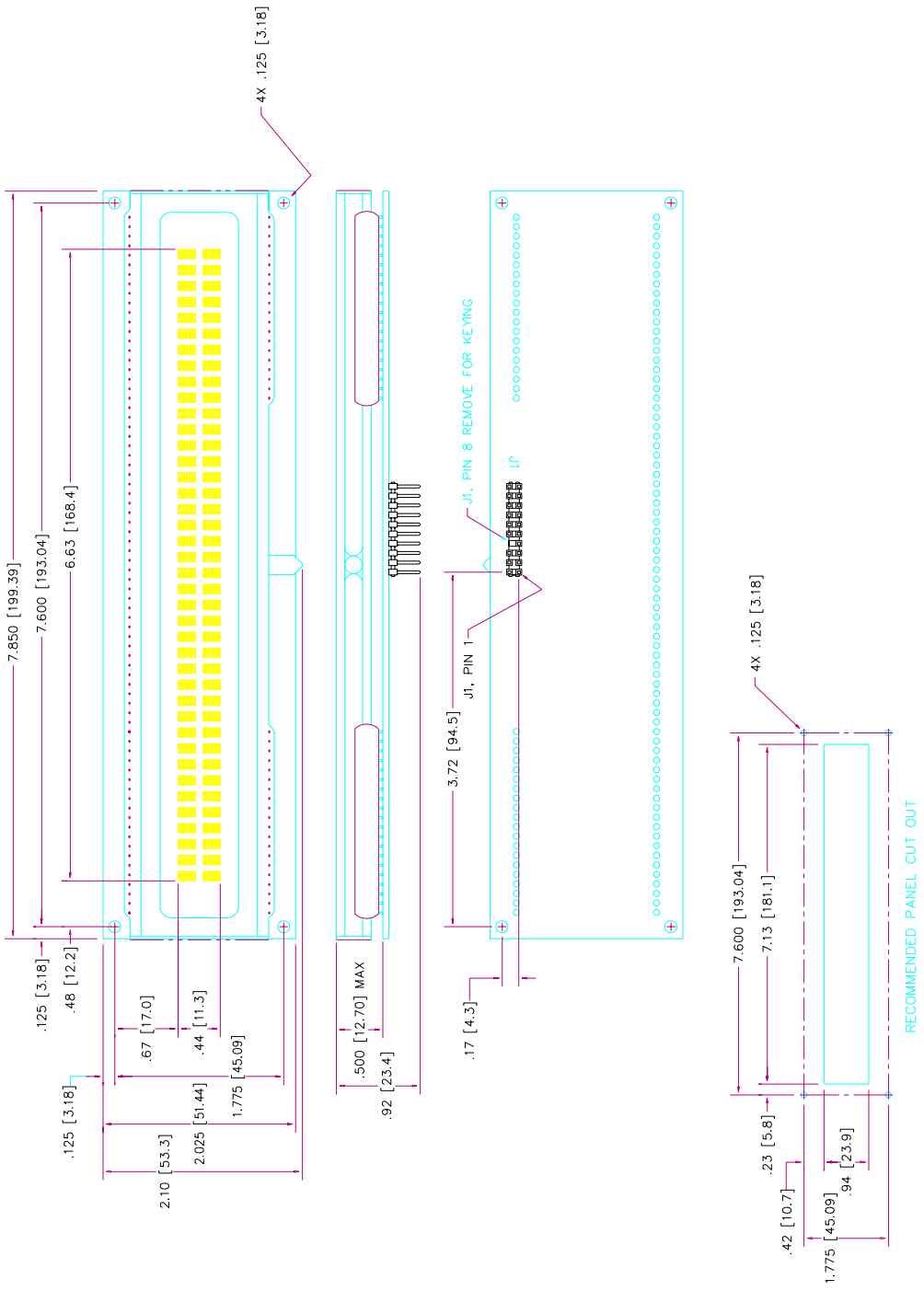


Figure 6–3

036X2–106–04240, 2X40 4.7mm

Industrial Electronic Engineers, Inc. **Van Nuys, California**	SIZE **A**	CODE IDENT NO. **05464**	**S036X2–XXX–XXXXX**
	SCALE N/A	REV **N**	SHEET 41 of 49

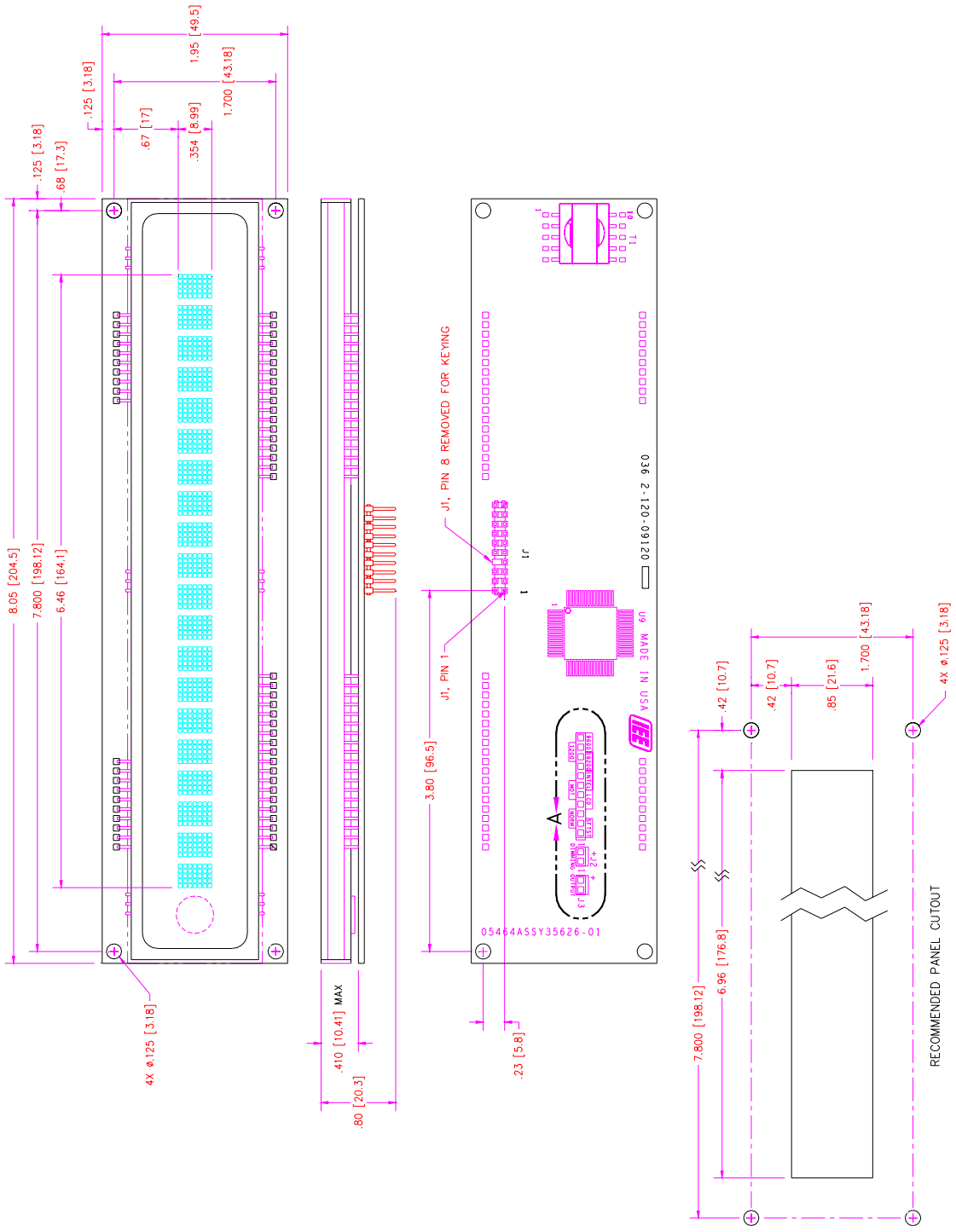


Figure 6–4

036X2–120–09120, 1X20 9mm

Industrial Electronic Engineers, Inc. **Van Nuys, California**	SIZE **A**	CODE IDENT NO. **05464**	**S036X2–XXX–XXXXX**
	SCALE N/A	REV **N**	SHEET 42 of 49

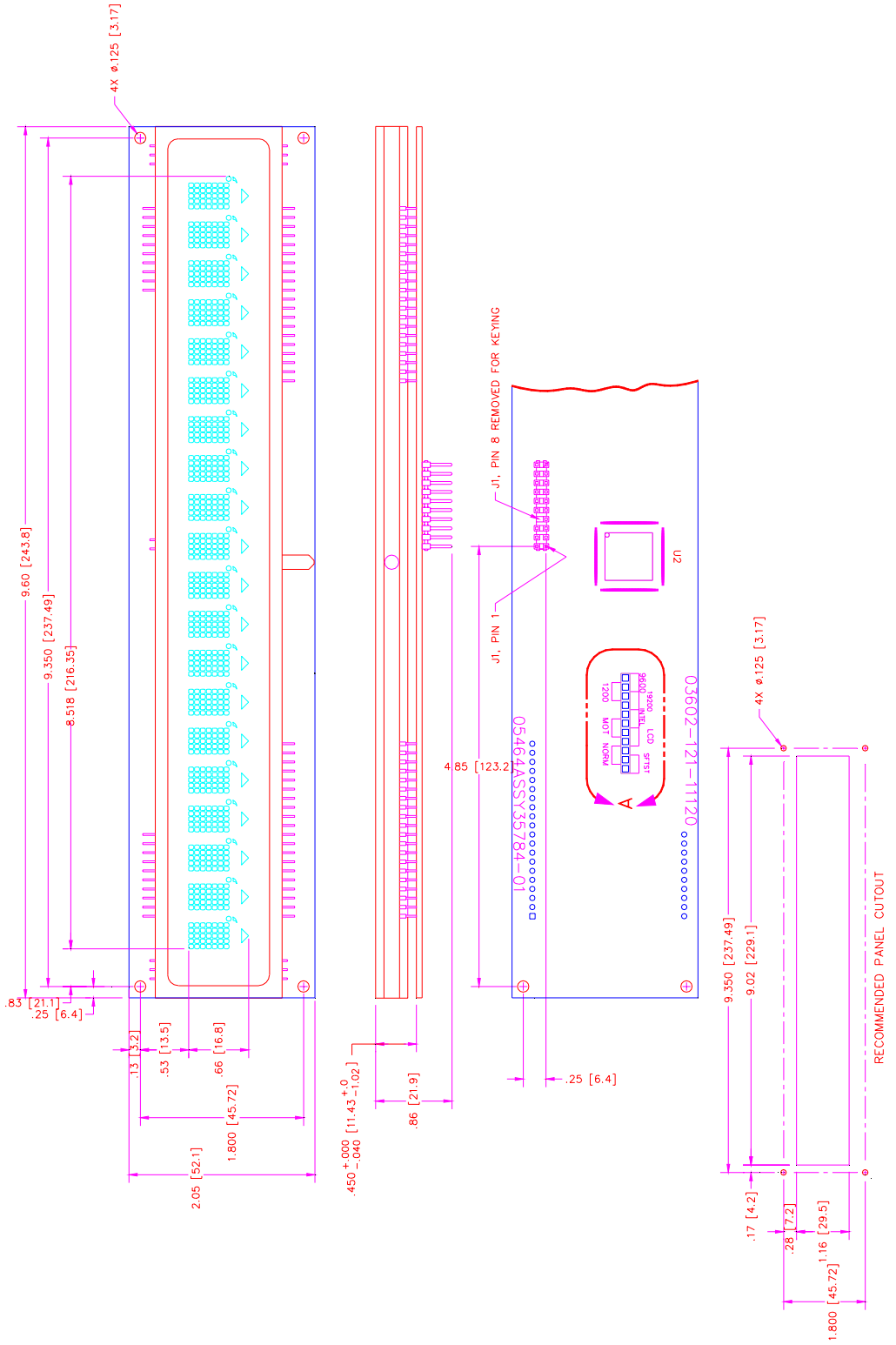


Figure 6–5

036X2–121–11120, 1X20 11mm

Industrial Electronic Engineers, Inc. **Van Nuys, California**	SIZE **A**	CODE IDENT NO. **05464**	**S036X2–XXX–XXXXX**
	SCALE N/A	REV **N**	SHEET 43 of 49

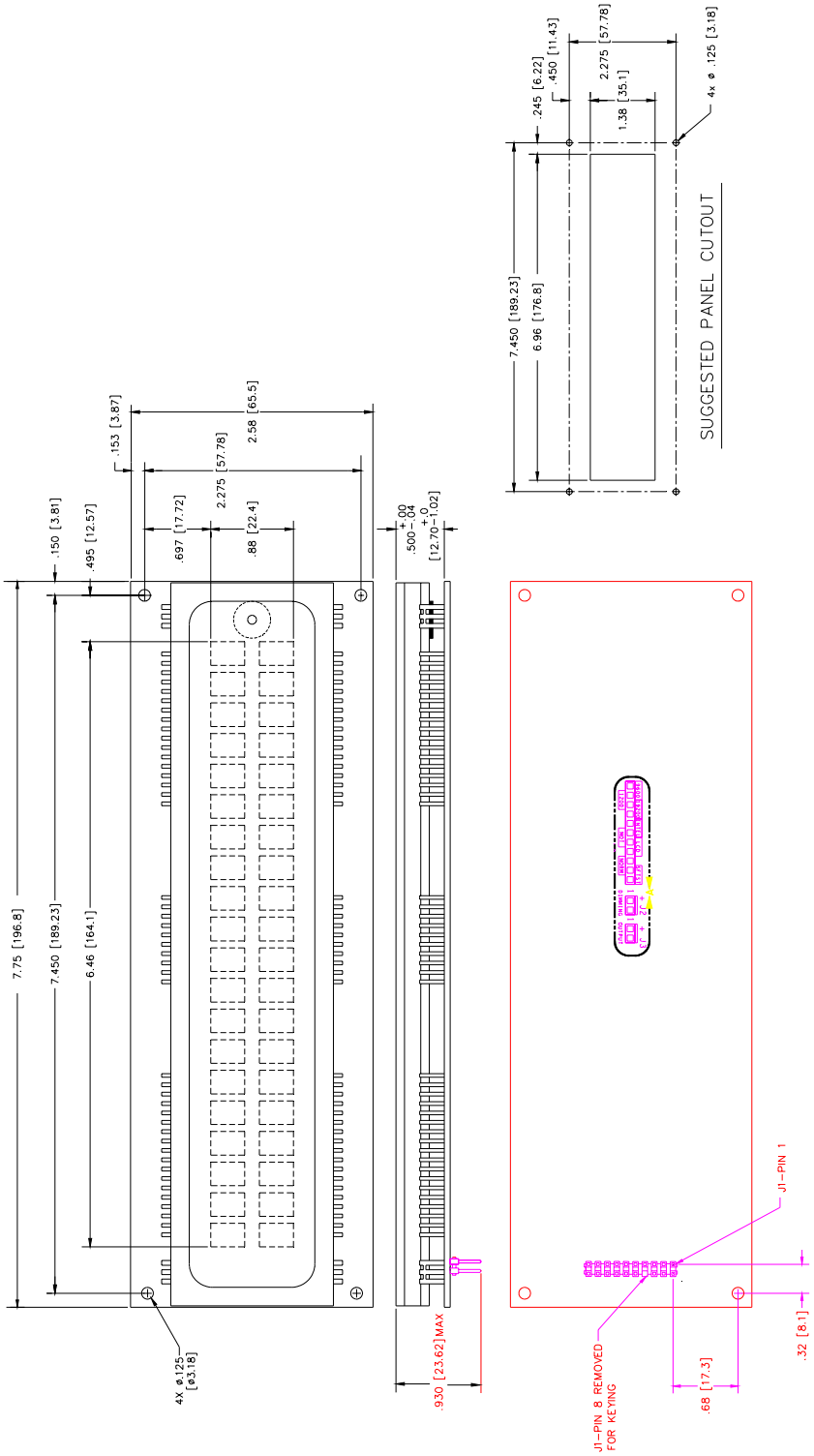
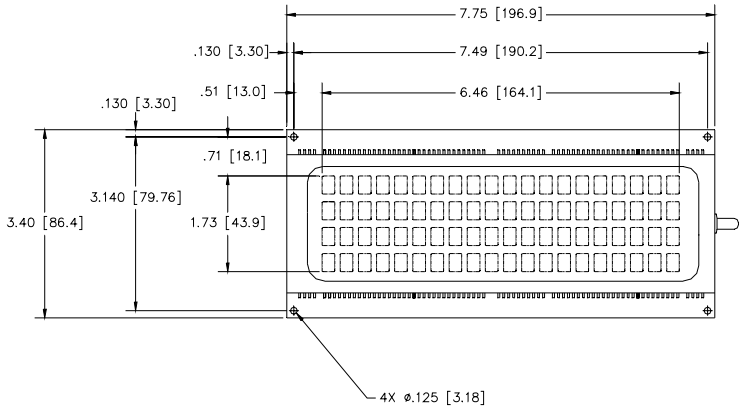
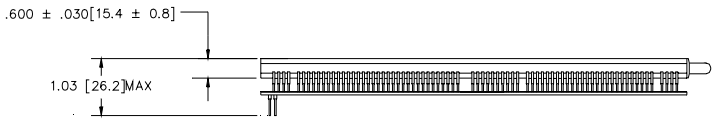


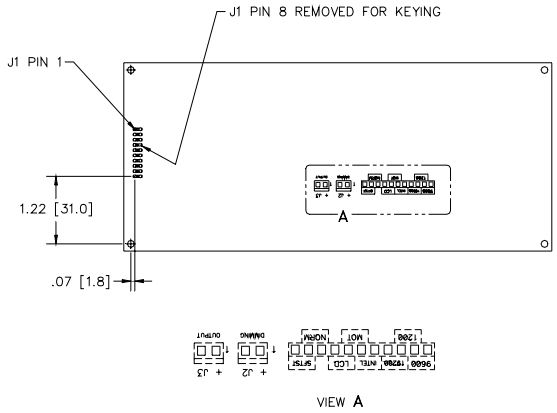
Figure 6–6

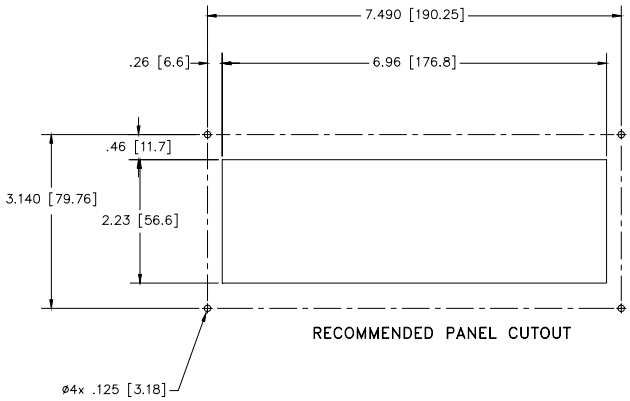
036X2–122–09220, 2X20 9mm

Industrial Electronic Engineers, Inc. **Van Nuys, California**	SIZE **A**	CODE IDENT NO. **05464**	**S036X2–XXX–XXXXX**
	SCALE N/A	REV **N**	SHEET 44 of 49









036X2–124–09420, 4X20 9mm

Industrial Electronic Engineers, Inc. **Van Nuys, California**	SIZE **A**	CODE IDENT NO. **05464**	**S036X2–XXX–XXXXX**
	SCALE N/A	REV **N**	SHEET 45 of 49

01/27/02

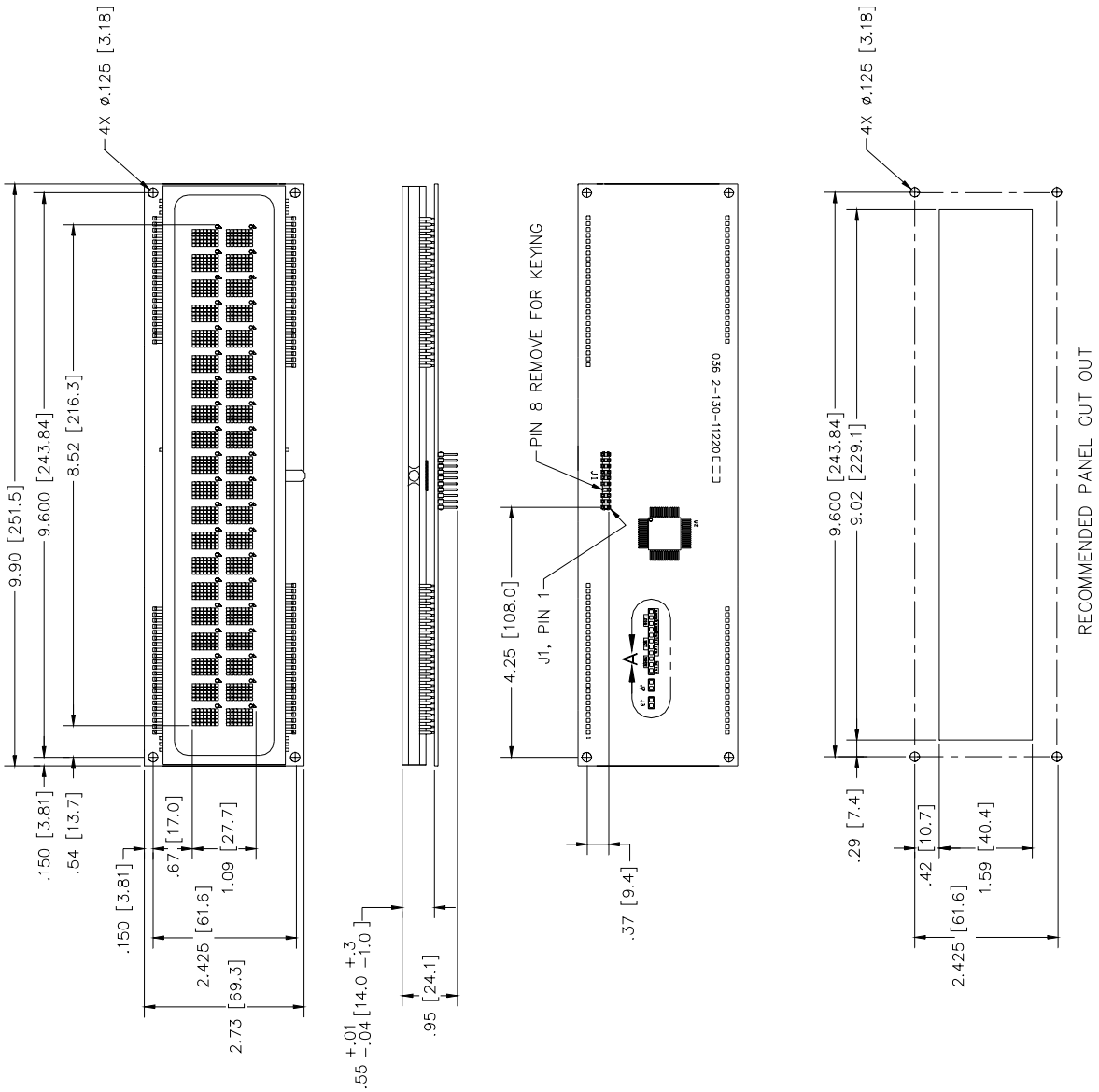


Figure 6–8

036X2–130–11220, 1X20 11mm

Industrial Electronic Engineers, Inc. **Van Nuys, California**	SIZE **A**	CODE IDENT NO. **05464**	**S036X2–XXX–XXXXX**
	SCALE N/A	REV **N**	SHEET 46 of 49

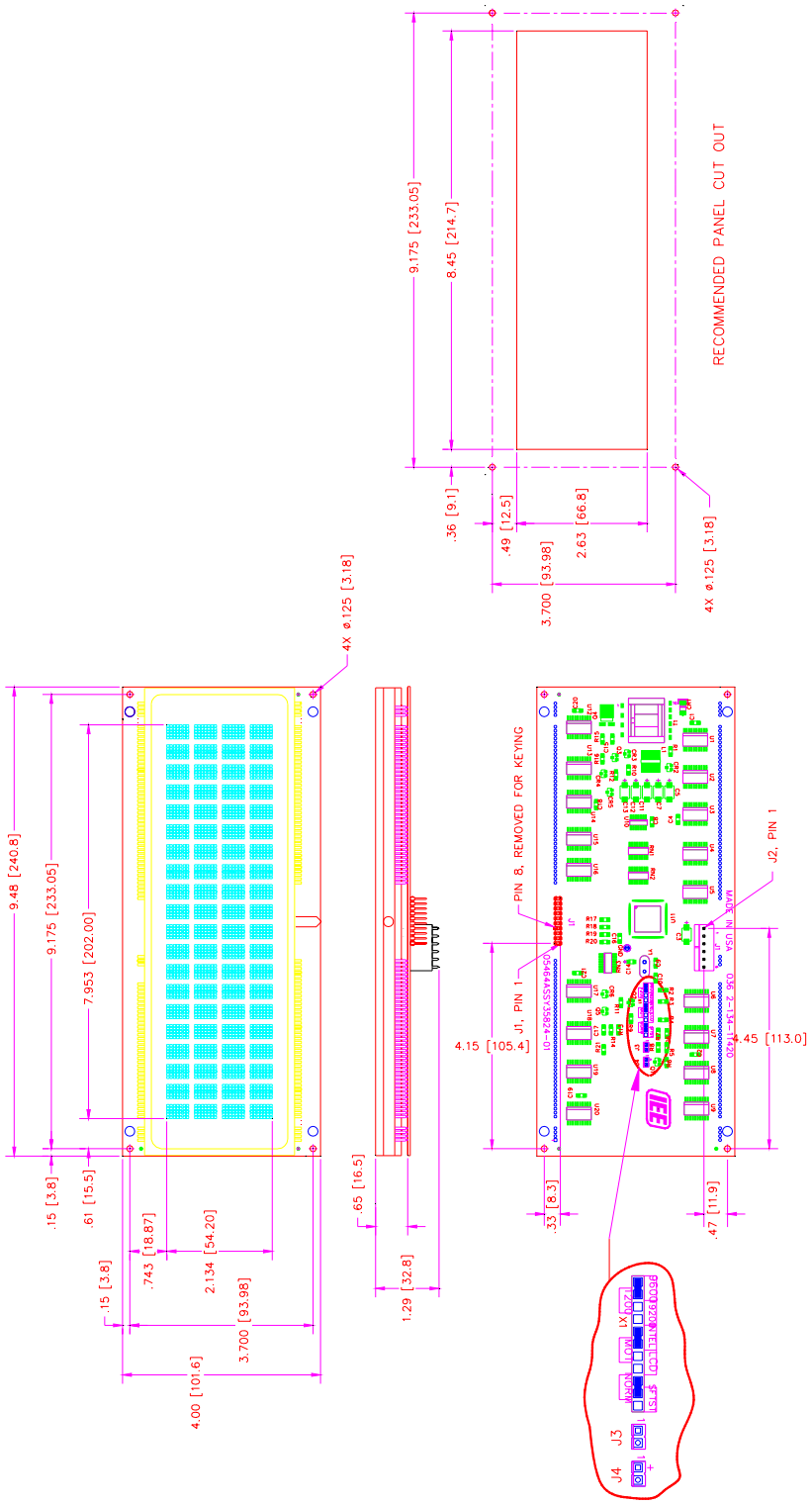


Figure 6–9
036X2–134–11420, 4X20 11mm

Industrial Electronic Engineers, Inc. **Van Nuys, California**	SIZE **A**	CODE IDENT NO. **05464**	**S036X2–XXX–XXXXX**
	SCALE N/A	REV **N**	SHEET 47 of 49

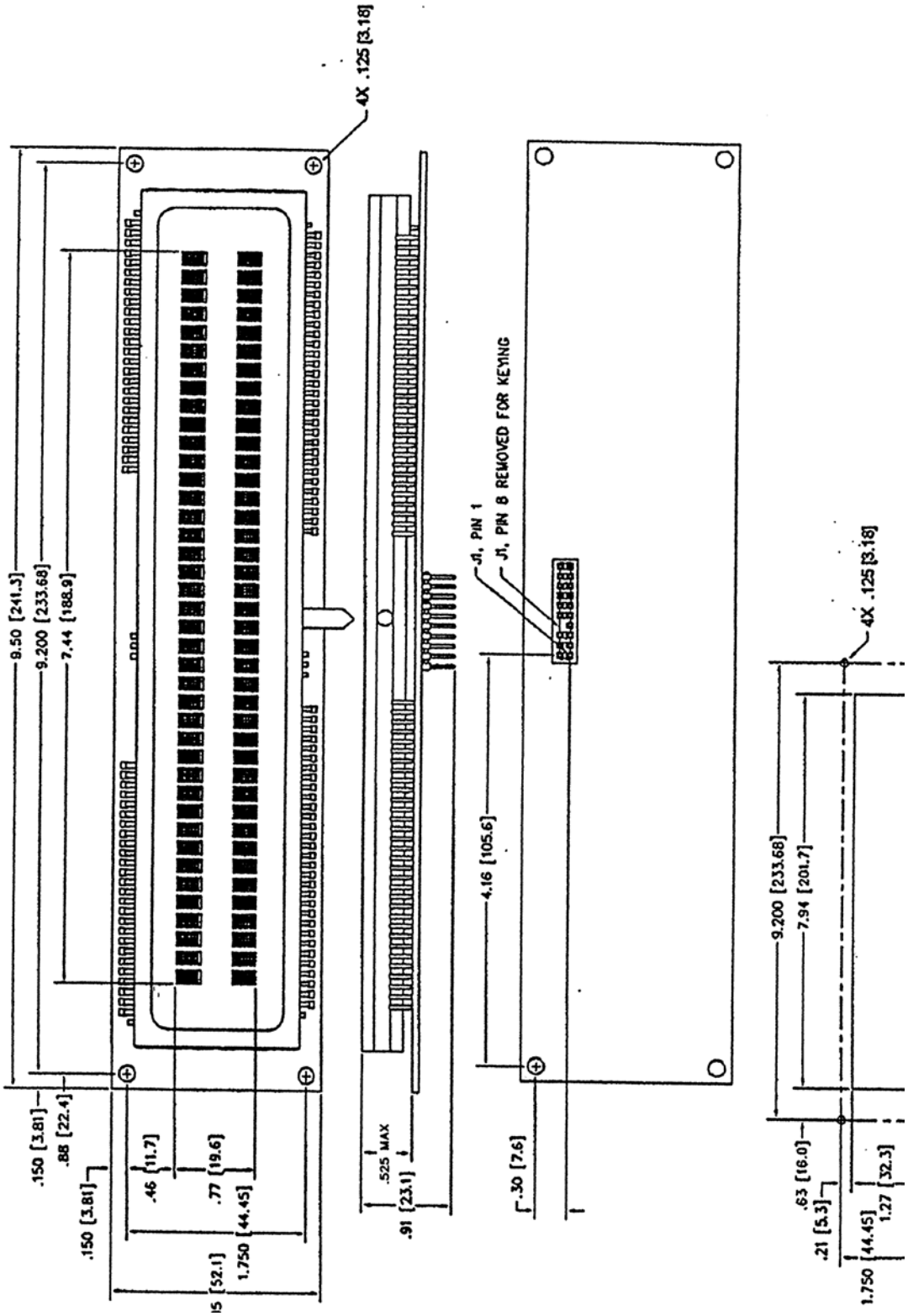


Figure 6–10

036X2–151–05240, 2X40 5mm

Industrial Electronic Engineers, Inc. **Van Nuys, California**	SIZE **A**	CODE IDENT NO. **05464**	**S036X2–XXX–XXXXX**
	SCALE N/A	REV **N**	SHEET 48 of 49

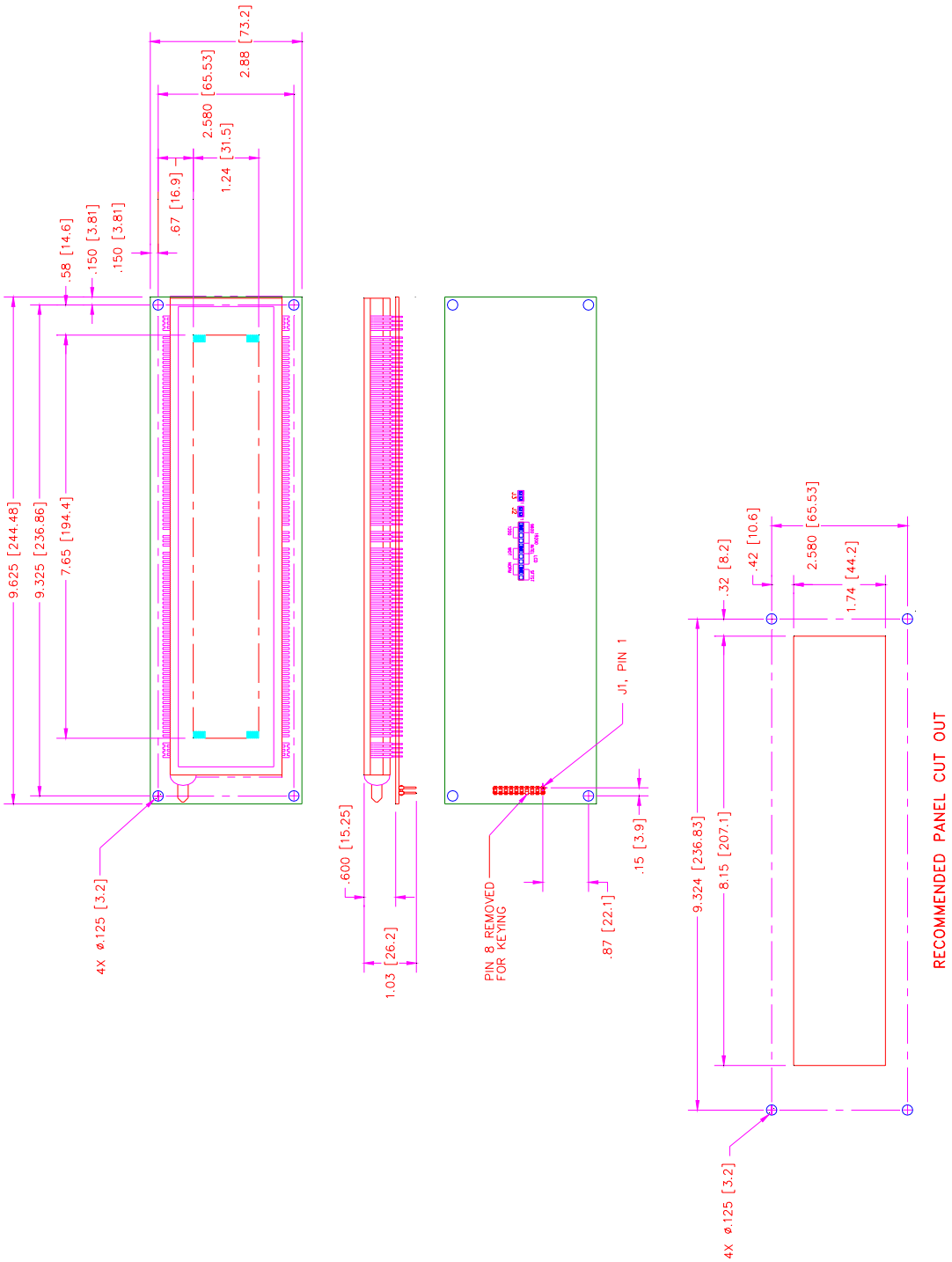


Figure 6–11

036X2–160–05440, 4X40 5mm

Industrial Electronic Engineers, Inc. **Van Nuys, California**	SIZE **A**	CODE IDENT NO. **05464**	**S036X2–XXX–XXXXX**
	SCALE N/A	REV **N**	SHEET 49 of 49