

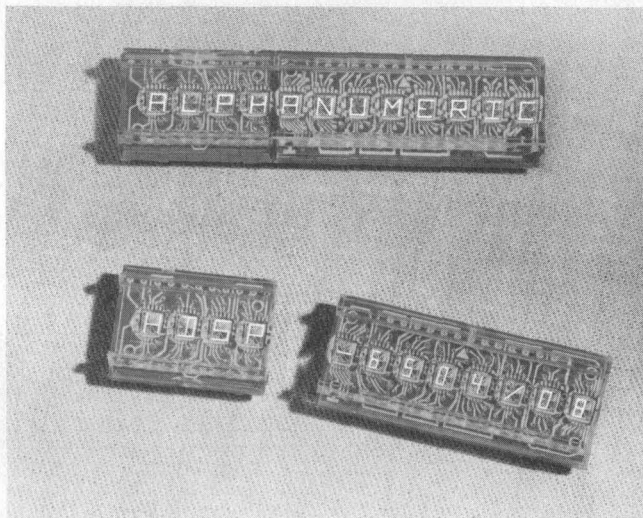
16 SEGMENT SOLID STATE ALPHANUMERIC DISPLAY

HDSP-6504
HDSP-6508

TECHNICAL DATA DECEMBER 1977

Features

- **ALPHANUMERIC**
Displays 64 Character ASCII Set and Special Characters
- **16 SEGMENT FONT PLUS CENTERED D.P. AND COLON**
- **3.81mm (0.150") CHARACTER HEIGHT**
- **APPLICATION FLEXIBILITY WITH PACKAGE DESIGN**
4 and 8 Character Dual-In-Line Packages
End Stackable-On Both Ends for 8 Character and On One End for 4 Character
Sturdy Gold-Plated Leads on 2.54mm (0.100") Centers
Environmentally Sealed Package
Common Cathode Configuration
- **LOW POWER**
As Low as 1.0-1.5mA Average
Per Segment Depending on Peak Current Levels
- **EXCELLENT CHARACTER APPEARANCE**
Continuous Segment Font
High On/Off Contrast
6.35mm (0.250") Character Spacing
Excellent Character Alignment
Excellent Readability at 2 Metres
- **SUPPORT ELECTRONICS**
Can Be Driven With ROM Decoders and Drivers
Easy Interfacing With Microprocessors and LSI Circuitry
- **CATEGORIZED FOR LUMINOUS INTENSITY**
Assures Uniformity of Light Output From Unit to Unit Within a Single Category



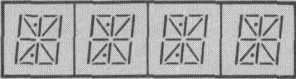
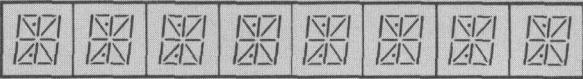
Description

The HDSP-6504 and HDSP-6508 are 3.81mm (0.150") sixteen segment GaAsP red alphanumeric displays mounted in 4 character and 8 character dual-in-line package configurations that permit mounting on PC boards or in standard IC sockets. The monolithic light emitting diode character is magnified by the integral lens which increases both character size and luminous intensity, thereby making low power consumption possible. The rugged package construction offers extended environmental capabilities compared to the standard PC board/lens type of display package. Its temperature cycling capability is the result of the environmentally sealed air gap which exists between the semiconductor chip/wire bond assembly and the lens. Moisture resistance is assured by the epoxy encapsulant on the bottom of the package. In addition to the sixteen segments, a centered D.P. and colon are included. Character spacing yields 4 characters per inch.

Applications

These alphanumeric displays are attractive for applications such as computer peripherals and terminals, computer base emergency mobile units, automotive instrument panels, desk top calculators, in-plant control equipment, hand-held instruments and other products requiring low power, display compactness and alphanumeric display capability.

Device Selection Guide

Characters Per Display	Configuration		Part No. HDSP-
	Device	Package	
4		(Figure 6)	6504
8		(Figure 7)	6508

Absolute Maximum Ratings

Symbol	Parameter	Min.	Max.	Units
I _{PEAK}	Peak Forward Current Per Segment or DP (Duration $\leq 312\mu\text{s}$)		200	mA
I _{AVG}	Average Current Per Segment or DP [1]		7	mA
P _D	Average Power Dissipation Per Character [1,2]		138	mW
T _A	Operating Temperature, Ambient	-40	85	°C
T _S	Storage Temperature	-40	100	°C
V _R	Reverse Voltage		5	V
	Solder Temperature at 1.59mm (1/16 inch) below seating plane, t ≤ 3 Seconds		260	°C

NOTES:

- Maximum allowed drive conditions for strobed operation are derived from Figures 1 and 2. See electrical section of operational considerations.
- Derate linearly above T_A = 50°C at 2.17mW/°C. P_D Max. (T_A = 85°C) = 62mW.

Electrical/Optical Characteristics at T_A = 25°C

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Units
I _V	Luminous Intensity, Time Average, Character Total with 16 Segments Illuminated [3,4]	I _{PEAK} = 30mA 1/16 Duty Factor	0.45	1.65		mcd
V _F	Forward Voltage Per Segment or DP	I _F = 30mA (One Segment On)		1.6	1.9	V
λ_{PEAK}	Peak Wavelength			655		nm
λ_d	Dominant Wavelength [5]			640		nm
I _R	Reverse Current Per Segment or DP	V _R = 5V		10		μA
$\Delta V_F / \Delta^\circ\text{C}$	Temperature Coefficient of Forward Voltage			-2		mV/°C

NOTES:

- The luminous intensity ratio between segments within a digit is designed so that each segment will have the same luminous sterance. Thus each segment will appear with equal brightness to the eye.
- Operation at peak currents of less than 7mA is not recommended.
- The dominant wavelength, λ_d , is derived from the C.I.E. chromaticity diagram and represents that single wavelength which defines the color of the device, standard red.

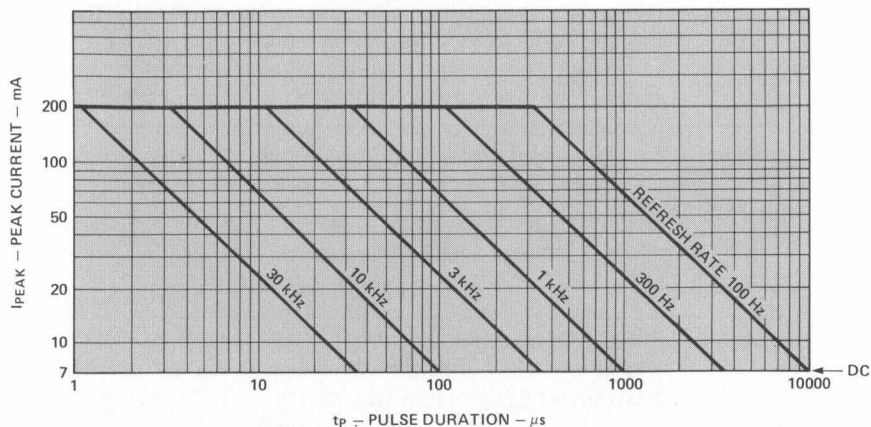


Figure 1. Maximum Allowed Peak Current vs. Pulse Duration. Derate derived operating conditions above $T_A = 50^\circ\text{C}$ using Figure 2.

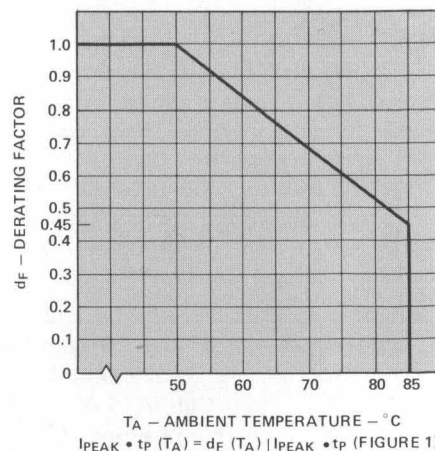


Figure 2. Temperature Derating Factor For Operating Conditions When T_A Exceeds 50°C .

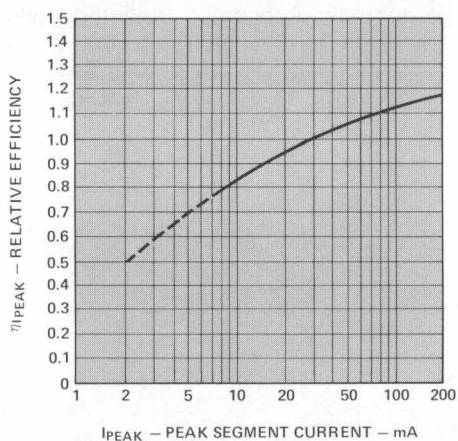


Figure 3. Relative Luminous Efficiency (Luminous Intensity Per Unit Current) vs. Peak Segment Current.

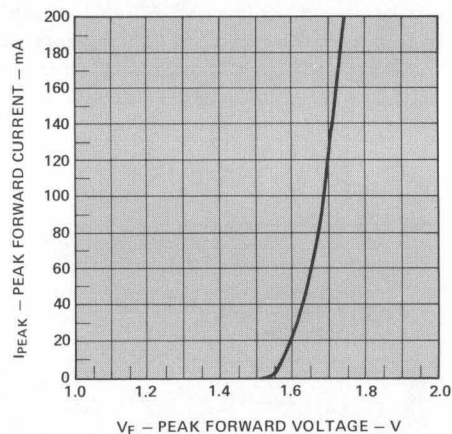


Figure 4. Peak Forward Segment Current vs. Peak Forward Voltage.

		A ₃ A ₂ A ₁ A ₀															
A ₅	A ₄	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	0	P	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
0	1	P	Q	R	S	T	U	V	W	X	Y	Z	[\]	^	<
1	0		!	"	#	\$	%	&	'	<	>	*	+	,	-	.	/
1	1	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?

Figure 5. Typical 64 Character ASCII Set.

□ 1 2 3 4 5 6 7 8 9 √ ÷ Σ
 △ □ P V >

Additional Character Font

Package Dimensions

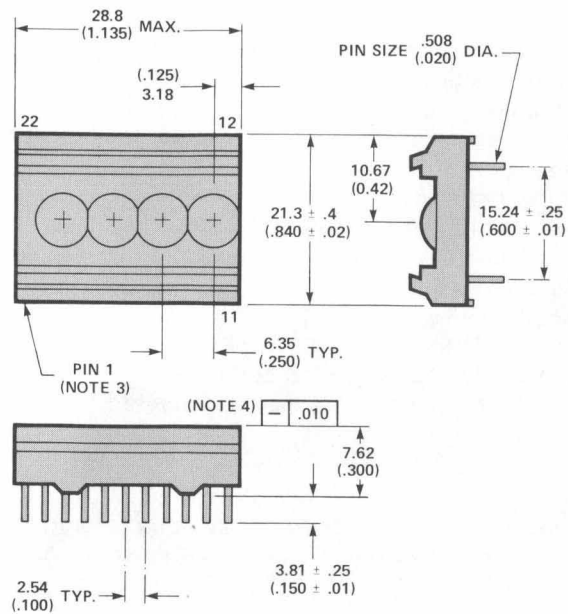


Figure 6. HDSP-6504

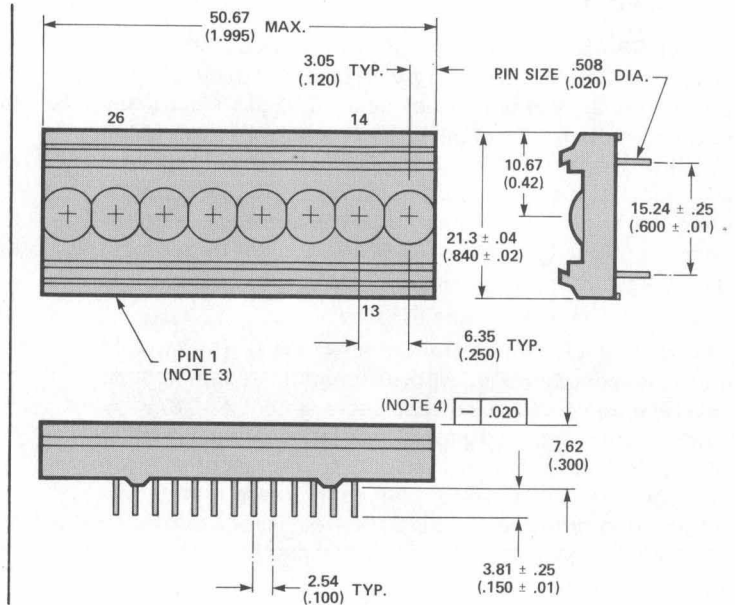


Figure 7. HDSP-6508

- NOTES:
1. ALL DIMENSIONS IN MILLIMETRES AND (INCHES).
 2. ALL UNTOLERANCED DIMENSIONS ARE FOR REFERENCE ONLY.
 3. PIN 1 IDENTIFIED BY INK DOT ADJACENT TO LEAD.
 4. DEVICE PACKAGE IS STRAIGHT WITHIN INDICATED LIMIT.

Magnified Character Font Description

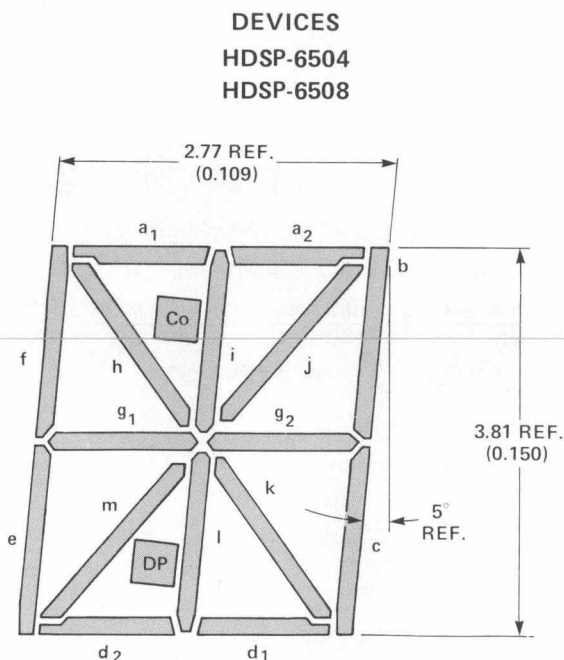


Figure 8.

Device Pin Description

Pin No.	Function			
	HDSP-6504		HDSP-6508	
1	Anode	Segment g ₁	Anode	Segment g ₁
2	Anode	Segment DP	Anode	Segment DP
3	Cathode	Digit 1	Cathode	Digit 1
4	Anode	Segment d ₂	Anode	Segment d ₂
5	Anode	Segment l	Anode	Segment l
6	Cathode	Digit 3	Cathode	Digit 3
7	Anode	Segment e	Anode	Segment e
8	Anode	Segment m	Anode	Segment m
9	Anode	Segment k	Anode	Segment k
10	Cathode	Digit 4	Cathode	Digit 4
11	Anode	Segment d ₁	Anode	Segment d ₁
12	Anode	Segment j	Cathode	Digit 6
13	Anode	Segment C _O	Cathode	Digit 8
14	Anode	Segment g ₂	Cathode	Digit 7
15	Anode	Segment a ₂	Cathode	Digit 5
16	Anode	Segment i	Anode	Segment j
17	Cathode	Digit 2	Anode	Segment C _O
18	Anode	Segment b	Anode	Segment g ₂
19	Anode	Segment a ₁	Anode	Segment a ₂
20	Anode	Segment c	Anode	Segment i
21	Anode	Segment h	Cathode	Digit 2
22	Anode	Segment f	Anode	Segment b
23			Anode	Segment a ₁
24			Anode	Segment c
25			Anode	Segment h
26			Anode	Segment f

Operational Considerations

ELECTRICAL

The HDSP-6504 and -6508 devices utilize large monolithic 16 segment GaAsP LED chips with centered decimal point and colon. Like segments of each digit are electrically interconnected to form an 18 by N array, where N is the quantity of characters in the display. In the driving scheme the decimal point or colon is treated as a separate character with its own time frame. A detailed discussion of character font capabilities, ASCII code to 16 segment decoding and display drive techniques will appear in a forthcoming application bulletin.

These displays are designed specifically for strobed (multiplexed) operation, with a minimum recommended time average forward current per segment of 0.875mA. Under normal operating situations the maximum number of illuminated segments needed to represent a given character is 10. Therefore, except where noted, the information presented in this data sheet is for a maximum of 10 segments illuminated per character.*

The typical forward voltage values, scaled from Figure 4, should be used for calculating the current limiting resistor values and typical power dissipation. Expected maximum V_F values for the purpose of driver circuit design may be calculated using the following V_F model:

$$\begin{aligned} V_F &= 1.85V + I_{PEAK} (1.8\Omega) \\ \text{For: } 30mA \leq I_{PEAK} \leq 200mA \\ V_F &= 1.58V + I_{PEAK} (10.7\Omega) \\ \text{For: } 10mA \leq I_{PEAK} \leq 30mA \end{aligned}$$

Pulsed operating conditions on a per segment basis are derived from Figure 1 and are temperature derated using Figure 2. Figure 1 relates maximum allowed segment peak current, I_{PEAK} , to the maximum allowed pulse duration, t_p , for various strobing refresh rates, f . To most effectively utilize Figure 1, perform the following steps:

1. Determine desired duty factor, DF.
Example: Sixteen characters, $DF = 1/16$
2. Determine desired refresh rate, f . Use duty factor to calculate pulse duration, t_p . Note: $DF = ft_p$
Example: $f = 1kHz$, $t_p = 62.5\mu s$
3. Enter Figure 1 at the calculated t_p . Move vertically to the refresh rate line and record the corresponding value of I_{PEAK} .
Example: At $t_p = 62.5\mu s$ and $f = 1kHz$, $I_{PEAK} = 100mA$
 $I_{AVG} = I_{PEAK} \cdot DF = (100mA) (1/16) = 6.25mA$
4. The maximum allowed operating conditions, not temperature derated, are now known. If the operating ambient temperature is above $50^\circ C$, the operating conditions derived from Figure 1 must be temperature derated.

Figure 2 derates the product $I_{PEAK} \cdot t_p$ with ambient temperature. The designer has the option of maintaining either t_p or I_{PEAK} and derating I_{PEAK} or t_p . The choice of derating I_{PEAK} results in a lower power

dissipation with the least loss of light output. To obtain the temperature derated operating conditions perform the following steps.

5. Determine maximum operating ambient temperature.
Example: $T_A = 70^\circ C$
6. Multiply $I_{PEAK} \cdot t_p$.
Example: $(100mA) (62.5\mu s) = 6250mA - \mu s$
7. From Figure 2 determine derating factor, d_F . Multiply above $I_{PEAK} \cdot t_p$ product by d_F .
Example: At $T_A = 70^\circ C$, $d_F = 0.69$
 $d_F (I_{PEAK} \cdot t_p) = (0.69) (6250) = 4312.5mA - \mu s$
8. Calculate derated operating conditions.
Example: Maintain $t_p = 62.5\mu s$ and derate I_{PEAK}

$$I_{PEAK} = \frac{4312.5mA - \mu s}{62.5\mu s} = 69mA \text{ peak current}$$

The maximum allowed operating conditions, temperature derated to an ambient of $70^\circ C$ are now determined.

Example: $f = 1kHz$, $t_p = 62.5\mu s$, $I_{PEAK} = 69mA$ and $I_{AVG} = 4.31mA$.

The above calculations determine the maximum allowed strobing conditions. Operation at a reduced combination of peak current and pulse width may be desirable to adjust display light output to match ambient light levels and/or to insure even more reliable operation.

Refresh rates of 1kHz or faster provide the most efficient operation resulting in the maximum possible light output for long character strings.

The time average luminous intensity may be calculated using the relative efficiency characteristic of Figure 3, $\eta_{I_{PEAK}}$, and correcting for operating ambient temperature. The time average luminous intensity at $T_A = 25^\circ C$ is calculated as follows:

$$\begin{aligned} I_V \text{ TIME AVG} &= \left[\frac{I_{PEAK} \cdot DF}{1.875mA} \right] [\eta_{I_{PEAK}}] [I_V \text{ DATA SHEET}] \\ \text{Example: } I_V \text{ TIME AVG} &= \left[\frac{(69mA) (1/16)}{1.875mA} \right] [1.10] [1.65mcd] \\ I_V \text{ TIME AVG} &= 4.17mcd/\text{digit, total for 16 segments, } T_A = 25^\circ C \end{aligned}$$

This time average luminous intensity is corrected for temperature by the following exponential equation:

$$\begin{aligned} I_V (T_A) &= I_V (25^\circ C) e^{[-0.0188^\circ C (T_A - 25^\circ C)]} \\ \text{Example: for } T_A &= 70^\circ C, & 1.79mcd/\text{digit} \\ I_V (70^\circ C) &= (4.17mcd) e^{[-0.0188 (70 - 25^\circ C)]} = & \text{total for 16 segments} \end{aligned}$$

OPTICAL AND CONTRAST ENHANCEMENT

Each large monolithic chip is positioned under a separate element of a plastic aspheric magnifying lens, producing a magnified character height of 3.810mm (.150 inch). The aspheric lens provides wide included viewing angles of 76 degrees horizontal and 80 degrees vertical with low off axis distortion. These two features, coupled with the very

*More than 10 segments may be illuminated in a given character, provided the maximum allowed character power dissipation, temperature derated, is not exceeded.

high segment luminous sterance, provide to the user a display with excellent readability in bright ambient light for viewing distances in the range of 2 metres. Effective contrast enhancement can be obtained by employing any of the following optical filter products: Panelgraphic: Ruby Red 60, Dark Red 63 or Purple 90; SGL Homalite: H100-1605 Red or H100-1804 Purple, Plexiglas 2423. For very bright ambients, such as indirect sunlight, the 3M Light Control Film is recommended: Red 655, Violet, Purple or Neutral Density.

For those applications requiring only 4 or 8 characters, a secondary barrel magnifier, HP part number HDSP-6505 (four character) and -6509 (eight character), may be inserted into support grooves on the primary magnifier. This secondary magnifier increases the character height to 4.45mm (.175 inch) without loss of horizontal viewing angle (see below).

MECHANICAL

These devices are constructed by LED die attaching and wire bonding to a high temperature PC board substrate. A precision molded plastic lens is attached to the PC board and the resulting assembly is backfilled with a sealing epoxy to form an environmentally sealed unit.

The four character and eight character devices can be end stacked to form a character string which is a multiple of a basic four character grouping. As an example, one -6504 and two -6508 devices will form a 20 character string. These devices may be soldered onto a printed circuit board or inserted into 24 and 28 pin DIP LSI sockets. The socket spacing must allow for device end stacking.

The absolute maximum allowed LED junction temperature, T_{jmax} , is 110°C. The maximum power ratings have been established so as not to exceed this limit. For most reliable operation, it is recommended that the PC board thermal resistance to ambient be less than 108°C/W/character. This will then establish a maximum thermal resistance LED junction-to-ambient of 340°C/W/character.

Optimum wave soldering is accomplished by using a good quality RMA rosin or organic acid flux and setting the solder wave temperature and dwell time at 245°C for 1-1/2 to 2 seconds. For device cleaning in a vapor cleaning process, only mixtures of Freon (F113) and alcohol is recommended with an immersion time in the vapors for less than 2 minutes. Suggested cleaning solvents are Freon TE, Genesolv DI-15 or DE-15, Arklone A or K. Room temperature cleaning may be accomplished with Freon T-E35 or T-P35, Ethanol, Isopropanol or water with a mild detergent.

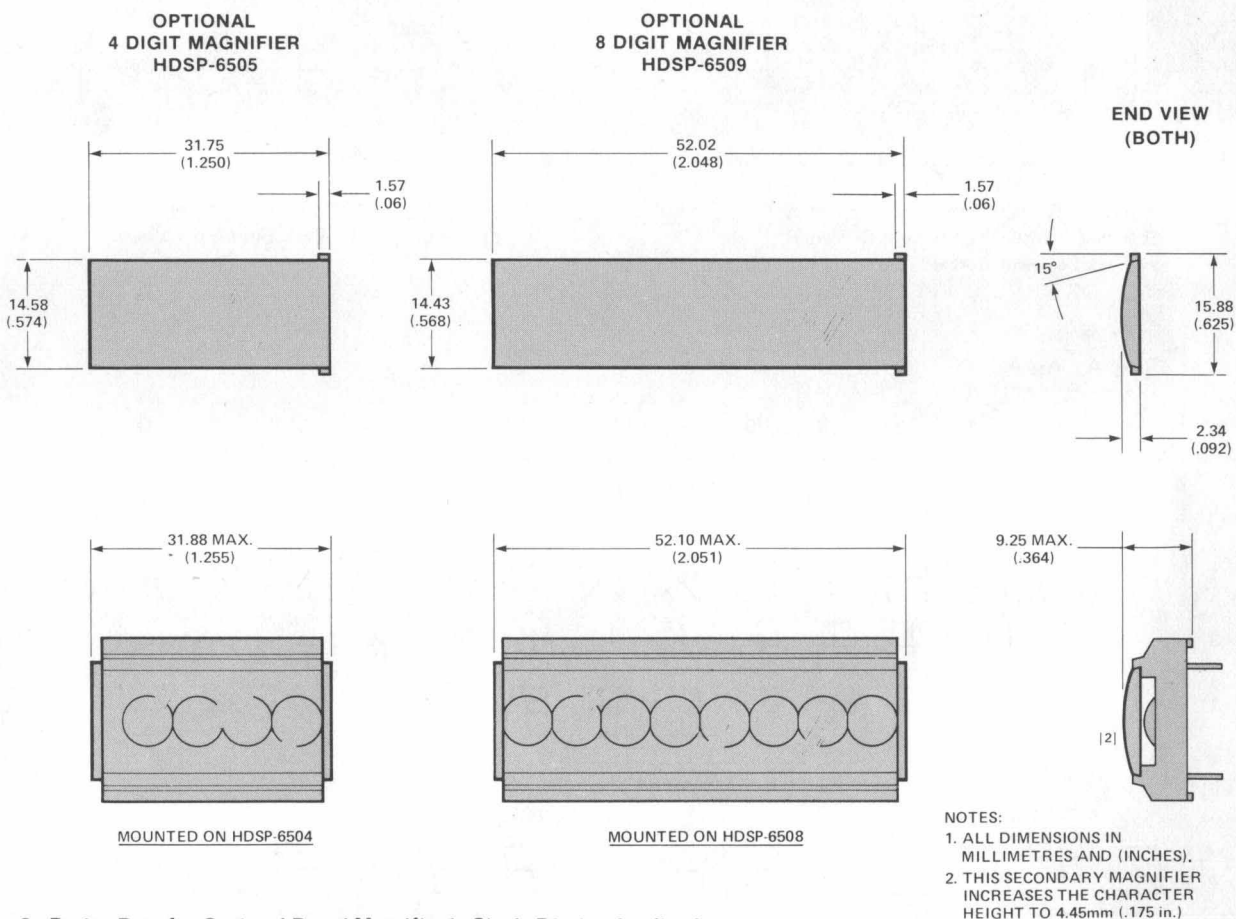


Figure 9. Design Data for Optional Barrel Magnifier in Single Display Applications.