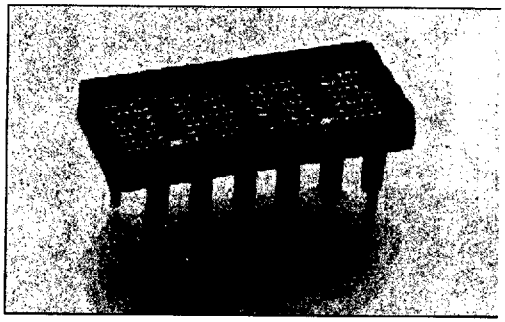
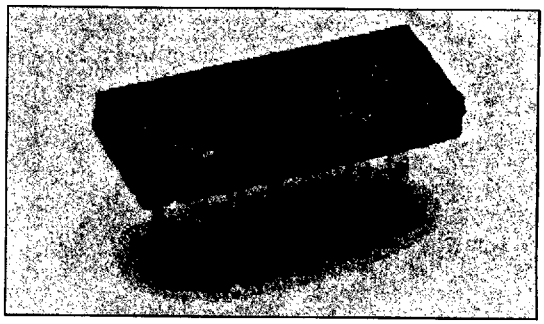
SIEMENS

RED MSD2010/2310 TXVB
YELLOW MSD2011/2311/2351 TXVB
HIGH EFFICEINCY RED MSD2012/2312/2352 TXVB
HIGH EFF. GREEN MSD2013/2313/2353 TXVB
RED ISD2010/2310
YELLOW ISD2011/2311/2351
HIGH EFFICEINCY RED ISD2012/2312/2352
HIGH EFFICEINCY GREEN ISD2013/2313/2353

4-Character 5x7 Dot Matrix
Serial Input Alphanumeric Industrial/HI-REL Display
Sunlight Viewable: MSD235X, ISD235X



MSD201X



MSD231X/235X

FEATURES

- **Four Dot Matrix Characters**
- **Character Height**
  MSD201X — 0.150"
  MSD231X/235X — 0.200"
- **MSD/ISD201X/231X, Four Colors: Red, Yellow, High Efficiency Red, High Efficiency Green**
- **MSD/ISD235X, Three Colors: Yellow, High Efficiency Red, High Efficiency Green**
- **Wide Viewing Angle**
- **Built-in CMOS Shift Registers with Constant Current LED Row Drivers**
- **Shift Registers Allow Custom Fonts**
- **Easily Cascaded for Multiple Displays**
- **TTL Compatible**
- **End Stackable**
- **HI-REL Operating Temperature Range: –55°C to +100°C**
- **Categorized for Luminous Intensity**
- **Ceramic Package, Hermetically Sealed Flat Glass Window**
- **MSD Process Conforms to MIL-D-87157 Quality Level A Test Tables I and II and also can meet Groups B and C Testing Specified in MIL-D-87157**
- **MSD TXVB Conforms to MIL-D-87157 Quality Level A Test Tables I, II, III and IVa (See High Reliability Test Tables)**

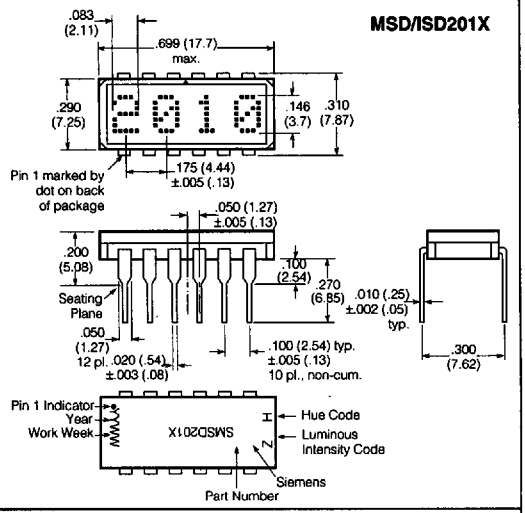
DESCRIPTION

The MSD201X/231X/235X TXVB, ISD201X/231X/235X are four digit 5x7 dot matrix serial input alphanumeric displays. The displays are available in red, yellow, high efficiency red, or high efficiency green. The package is a standard twelve-pin hermetic DIP with glass lens. The display can be stacked horizontally or vertically to form messages of any length.

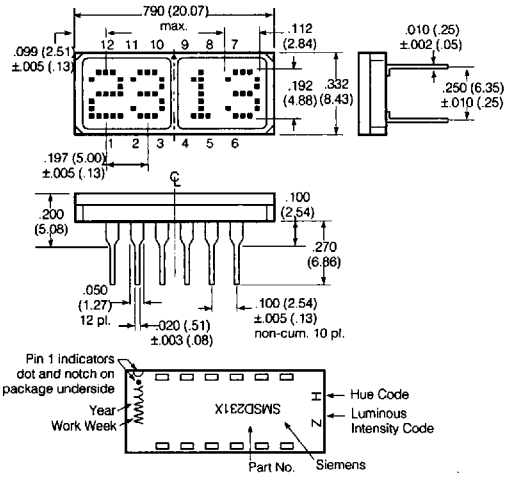
—continued

Package Dimensions in Inches (mm)

MSD/ISD201X



MSD/ISD231X/235X



Pin	Function	Pin	Function
1	Column 1	7	Data Out
2	Column 2	8	V_B
3	Column 3	9	V_{CC}
4	Column 4	10	Clock
5	Column 5	11	Ground
6	No connection	12	Data In

DESCRIPTION (continued)

These displays have two fourteen-bit CMOS shift registers with built-in row drivers. These shift registers drive twenty-eight rows and enable the design of customized fonts. Cascading multiple displays is possible because of the Data In and Data Out pins. Data In and Out are easily input with the clock signal and displayed in parallel on the row drivers. Data Out represents the output of the 7th bit of digit number four shift register The shift register is level triggered. The like columns of each character in a display cluster are tied to a single pin (see Block Diagram). High true data in the shift register enables the output current mirror driver stage associated with each row of LEDs in the 5x7 diode array.

The TTL compatible VB input may either be tied to VCC for maximum display intensity or pulse width modulated to achieve intensity control and reduce power consumption.

In the normal mode of operation, input data for digit four, column one is loaded into the seven on-board shift register locations one through seven. Column one data for digits 3, 2, and 1 is shifted into the display shift register locations. Then column one input is enabled for an appropriate period of time, T. A similar process is repeated for columns 2, 3, 4, and 5. If the decode time and load data time into the shift register is t, then with five columns, each column of the display is operating at a duty factor of:

$$DF = \frac{T}{5(T+t)}$$

T+t, allotted to each display column, is generally chosen to provide the maximum duty factor consistent with the minimum refresh rate necessary to achieve a flicker free display. For most strobed display systems, each column of the display should be refreshed (turned on) at a minimum rate of 100 times per second.

With columns to be addressed, this refresh rate then gives a value for the time T+t of: 1/[5x(100)]=2 msec. If the device is operated at 5.0 MHz clock rate maximum, it is possible to maintain t<<T. For short display strings, the duty factor will then approach 20%.
See Appnote 44 for application information and Appnotes 18, 19, 22, 23 for additional information.

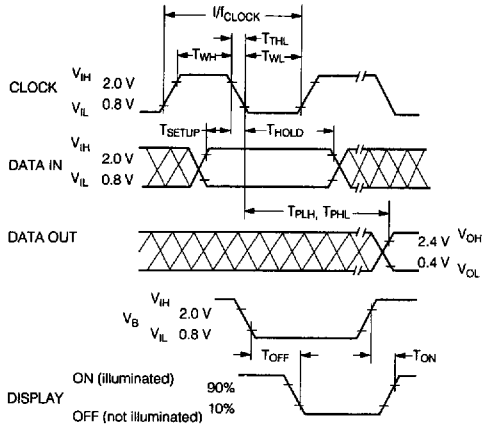
See Appnote 44 for application information and Appnotes 18, 19, 22, 23 for additional information.

Maximum Ratings

Supply Voltage V_{CC} to GND .....–0.5 V to + 7.0 V
Inputs, Data Out and V_B .....–0.5 V to VCC + 0.5 V
Column Input Voltage, V_{COL} .....–0.5 V to + 6.0 V
Operating Temperature Range ..... –55°C to +100°C
Storage Temperature Range .....–65°C to + 125°C
Maximum Solder Temperature, 0.063" (1.59 mm) below Seating Plane, t<5 sec ..... 260°C
Maximum Allowable Power Dissipation, T_A=25 C°[2]
MSD/ISD2010 ..... 0.91 W
MSD/ISD2011/2/3 ..... 0.86 W
MSD/ISD231X ..... 1.1 W
MSD/ISD235X ..... 1.35 W

Notes
1. Operation above +100°C ambient is possible if the following conditions are met. The junction should not exceed T_J=125°C and the case temperature (as measured at pin 1 or the back of the display) should not exceed TC = 100°C.
2. Maximum allowable dissipation is derived from V_{CC}=5.25 V, V_B=2.4 V, V_{COL}=3.5 V 20 LEDs on per character, 20% DF.

Figure 1. Timing Characteristics



AC Electrical Characteristics
(V_{CC}=4.75 to 5.25 V, T_A=–55°C to 100°C)

Symbol	Description	Min.	Typ.	Max-(1)	Units	Fig.
T_{SETUP}	Setup Time	50	10		ns	1
T_{HOLD}	Hold Time	25	20		ns	1
T_{WL}	Clock Width Low	75	45		ns	1
T_{WH}	Clock Width High	75	45		ns	1
$F_{(CLK)}$	Clock Frequency			5	MHz	1
T_{THL} T_{TLH}	Clock Transition Time		75	200	ns	1
T_{PHL} T_{PLH}	Propagation Delay Clock to Data Out		50	125	ns	1

Notes
1. All typical values specified at VCC=5.0 V and T_A=25°C unless otherwise noted.
2. V_B Pulse Width Frequency — 50 KHz (max.)

Figure 2a. Maximum Allowable Power Dissipation vs. Temperature, MSD/ISD201X

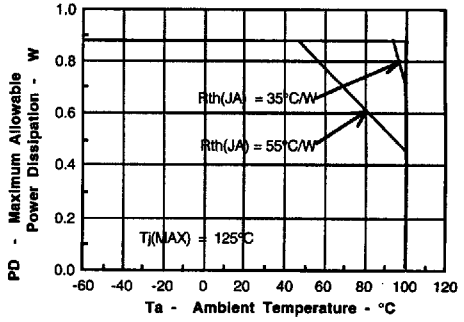


Figure 2b. Maximum Allowable Power Dissipation vs. Temperature, MSD/ISD231X

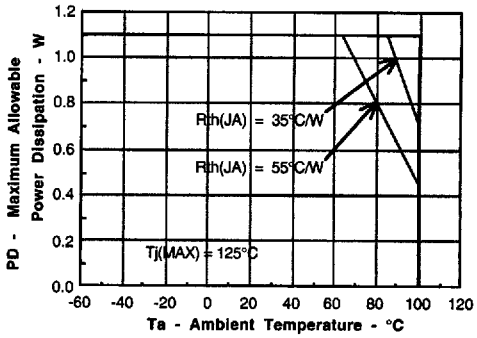
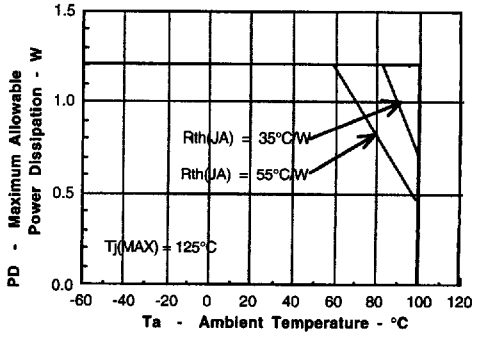


Figure 2c. Maximum Allowable Power Dissipation vs. Temperature, MSD/ISD235X



Recommended Operating Conditions (Guaranteed over operating temperature range)

Parameter	Symbol	Min.	Nom.	Max.	Units
Supply Voltage	V_{CC}	4.75	5.0	5.25	V
Data Out Current, Low State	I_{OL}				mA
Data Out Current, High State	I_{OH}				mA
Column Input Voltage, Column On (1)	V_{COL}	2.75		3.5	V
Setup Time	T_{SETUP}	70	45		ns
Hold Time	T_{HOLD}	30			ns
Width of Clock	$T_{W(CLK)}$	75			ns
Clock Frequency	T_{CLK}			5	MHz
Clock Transition Time	T_{THL}			200	ns
Free Air Operating Temperature Range	T_A	–55		+100	°C

Note: 1. See Figure 3, Peak Column Current vs. Column Voltage

Optical Characteristics
Red MSD/ISD2010, MSD/ISD2310

Description		Symbol	Min.	Typ.(4)	Max.	Units	Test Conditions
Peak Luminous Intensity per LED (1,3) (Character Average)	MSD/ ISD2010	I_{VPEAK}	105	200		µcd	V_{CC}=5.0 V, V_{COL}=3.5 V T_J(5)=25°C, V_B=2.4 V
	MSD/ ISD2310		220	370			
Peak Wavelength		λ_{VPEAK}		655		nm	
Dominant Wavelength(2)		λ_D		639		nm	

Yellow MSD/ISD2011, MSD/IDS2311, MSD/ISD2351

Description		Symbol	Min.	Typ.(4)	Max.	Units	Test Conditions
Peak Luminous Intensity per LED (1,3) (Character Average)	MSD/ ISD2011	I_{VPEAK}	400	750		µcd	V_{CC}=5.0 V, V_{COL}=3.5 V T_J(5)=25°C, V_B=2.4 V
	MSD/ ISD2311		650	1140			
	MSD/ ISD2351		2400	3400			
Peak Wavelength		λ_{VPEAK}		655		nm	
Dominant Wavelength(2)		λ_D		639		nm	

Optical Characteristics

High Efficiency Red MSD/IDS2012, MSD/ISD2312, MSD/IDS2352

Description		Symbol	Min.	Typ.(4)	Max.	Units	Test Conditions
Peak Luminous Intensity per LED (1,3) (Character Average)	MSD/ ISD2012	I_{VPEAK}	400	1430		µcd	V_{CC}=5.0 V, V_{COL}=3.5 V T_J(5)=25°C, V_B=2.4 V
	MSD/ ISD2312		650	1430			
	MSD/ ISD2352		853	2500			
Peak Wavelength		λ_{VPEAK}		655		nm	
Dominant Wavelength(2)		λ_D		639		nm	

High Efficiency Green MSD/IDS2013, MSD/ISD2313, MSD/IDS2353

Description		Symbol	Min.	Typ.(4)	Max.	Units	Test Conditions
Peak Luminous Intensity per LED (1,3) (Character Average)	MSD/ ISD2013	I_{VPEAK}	850	1550		µcd	V_{CC}=5.0 V, V_{COL}=3.5 V T_J(5)=25°C, V_B=2.4 V
	MSD/ ISD2313		1280	2410			
	MSD/ ISD2353		2400	3000			
Peak Wavelength		λ_{VPEAK}		655		nm	
Dominant Wavelength(2)		λ_D		639		nm	

Notes

1. The displays are categorized for luminous intensity with the intensity category designated by a letter code on the bottom of the package.
2. Dominant wavelength (λD) is derived from the CIE chromaticity diagram and represents the single wavelength which defines the color of the device
3. The luminous sterance of the LED may be calculated using the following relationships:
   L_V (cd/m^2) = I_V (Candela)/A (Meter)^2
   L_V (Footlamberts) = πI_V (Candela)/A (Foot)^2
   A = 5.3 x 10^{-8} M2 = 5.8 x 10^{-7} (Foot)^2
4. All typical values specified at V_{CC} = 5.0 V and T_A = 25°C unless otherwise noted.
5. The luminous intensity is measured at T_A = T_J = 25°C. No time is allowed for the device to warm up prior to measurement.

Figure3a. Peak Column Current vs. Column Voltage—MSD201X

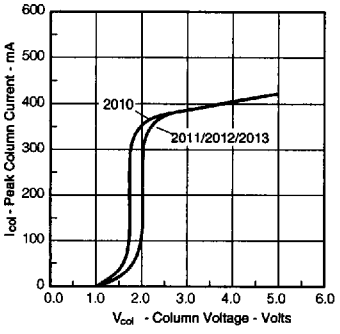


Figure3a. Peak Column Current vs. Column Voltage—MSD231X

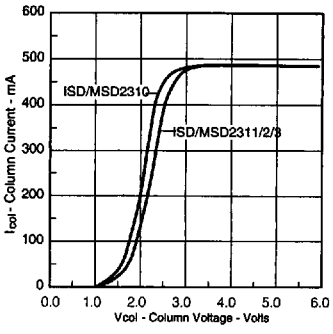
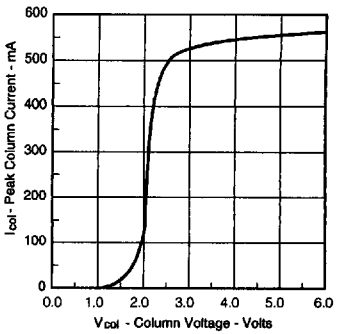


Figure3a. Peak Column Current vs. Colúmn Voltage—MSD235X

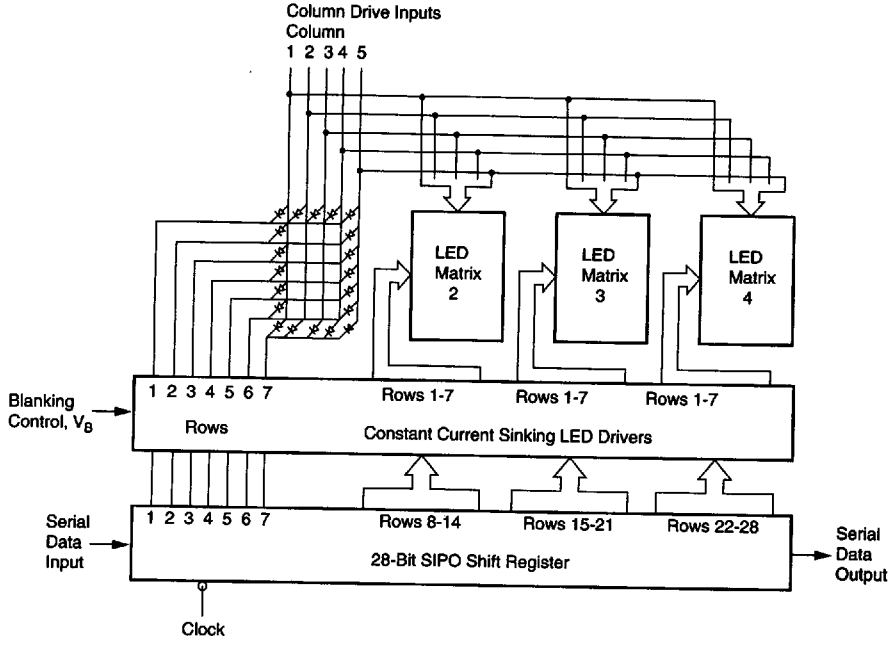


Electrical Characteristics (–55°C to +100°C, unless otherwise specified)

Description	Symbol	Min.	Typ.(1)	Max.	Units	Test Conditions	
Supply Current (quiescent)	I_{CC}			5.0	mA	V_B=0.4 V	V_{CC}=5.25 V V_{CLK}=V_{DATA}=2.4 V All SR Stages=Logical 1
				5.0		V_B=2.4 V	
Supply Current (operating)	I_{CC}			10.0	mA	F_{CLK}=5 MHz	
Column Current at Any Column Input(2)	I_{COL}			10	µA	V_B=0.4 V	V_{CC}=5.25 V V_{COL}=3.5 V All SR Stages=Logical 1
Column Current at Any Column Input(2) MSD/ISD2010, red MSD/ISD2011/2/3: yellow, HER, green MSD/ISD231X: red, yellow, HER, green MSD/ISD235X: yellow, HER, green	I_{COL}		 350 335 380 550	 435 410 520 650	mA		
V_B, Clock or Data Input Threshold Low	V_{IL}			0.8	V	V_{CC}=4.75 V–5.25 V	
V_B, Clock or Data Input Threshold High	V_{IH}	2.0			V		
Data Out Voltage	V_{OH}	2.4	3.6		V	I_{OH}=0.5 mA	V_{CC}=5.25 V I_{COL}=0 mA
	V_{OL}					I_{OL}=1.6 mA	
Input Current Ogical 0, V_B only	I_{IL}	–30	–110	–300	µA	V_{CC}=4.75 V–5.25 V, V_{IL}=0.8 V	
Input Current Ogical 0, Data, Clock	I_{IL}						
Power Dissipation per Package MSD/ISD201X MSD/ISD231X MSD/ISD235X	PD	 0.44 0.52 0.74			W	V_{CC}=5.0 V, V_{COL}=3.5 V, 17.5% DF 15 LEDs on per character, V_B=2.4 V	
Thermal Resistance IC, Junction-to-Pin MSD/ISD201X MSD/ISD231X MSD/ISD235X	$R\theta_{J\text{-}PIN}$		 30 20 25		°C/W/ Device		

Notes
1. All typical values specified at V_{CC}=5.0 V and T_A=25°C unless otherwise noted.
2. See Figure 3-Peak Column Current vs. Column Voltage

Figure 4. Block Diagram



Contrast Enhancement Filters for Sunlight Readability

Display Color	Filter Color	Marks Polarized Corp.*	Optical Characteristics of Filter
Red, HER	Red	MPC 20-15C	25% at 635 nm, Circular Polarizer
Yellow	Amber	MPC 30-25C	25% at 583 nm, Circular Polarizer
Green	Yellow/Green	MPC 50-122C	22% at 568 nm, Circular Polarizer
Multiple Colors High Ambient Light	Neutral Gray	MPC 80-10C	10% Neutral, Circular Polarizer
Multiple Colors	Neutral Gray	MPC 80-37C	37% Neutral, Circular Polarizer

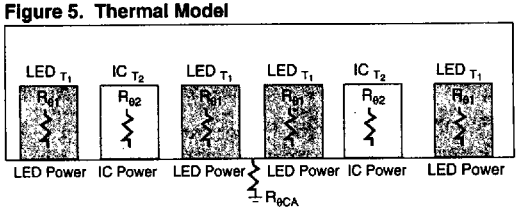
* Marks Polarized Corp.
25-B Jefryn Blvd. W.
Deer Park, NY 11729
516/242-1300
FAX 516/242-1347
Marks Polarized Corp. manufactures to MIL-1-45208 inspection system.

The small alphanumeric displays are hybrid LED and CMOS assemblies that are designed for reliable operation in commercial, industrial, and military environments. Optimum reliability and optical performance will result when the junction temperature of the LEDs and CMOS ICs are kept as low as possible.

Thermal Modeling

MSD/ISD displays consist of two driver ICs and four 5x7 LED matrixes. A thermal model of the display is shown in Figure 5. It illustrates that the junction temperature of the semiconductor = junction self heating + the case temperature rise + the ambient temperature. Equation 1 shows this relationship.

Figure 5. Thermal Model



See Equation 1 below.

The junction rise within the LED is the product of the thermal impedance of an individual LED (37°C/W, DF=20%, F=200 Hz), times the forward voltage, $VF_{(LED)}$, and forward current IF(LED), of 13 - 14.5 mA. This rise averages $TJ_{(LED)}$=1°C. The table below shows the $V_{F(LED)}$ for the respective displays.

Model Number	VF		
	Min.	Typ.	Max.
MSD/ISD2010 MSD2310	1.6	1.7	2.0
MSD/ISD2011/2/3 MSD/ISD2311/2/3 MSD/ISD2351/2/3	1.9	2.2	3.0

The junction rise within the LED driver IC is the combination of the power dissipated by the IC quiescent current and the 28 row driver current sinks. The IC junction rise is given in Equation 2.

A thermal resistance of 28°C/W results in a typical junction rise of 6°C.

See Equation 2 below.

For ease of calculations the maximum allowable electrical operating condition is dependent upon the aggregate thermal resistance of the LED matrixes and the two driver ICs. All of the thermal management calculations are based upon the parallel combination of these two networks which is 15°C/W. Maximum allowable power dissipation is given in Equation 3.

Equation 3.

$$P_{DISPLAY} = \frac{T_{J(MAX)} - T_A}{R_{\theta JC} + R_{\theta CA}}$$

$$P_{DISPLAY} = 5\ V_{COL}\ I_{COL}\ (n/35)\ DF + V_{CC}\ I_{CC}$$

For further reference see Figures 2, 7, 8, 9, 10 and 11 .

KEY TO EQUATION SYMBOLS

DF	Duty factor
I_{CC}	Quiescent IC current
I_{COL}	Column current
n	Number of LEDs on in a 5 x 7 array
P_{CASE} under	Package power dissipation excluding LED consideration
P_{COL}	Power dissipation of a column
PD_{ISPLAY}	Power dissipation of the display
P_{LED}	Power dissipation of an LED
$R_{\theta CA}$	Thermal resistance case to ambient
RqJC	Thermal resistance junction to case
T_A	Ambient temperature
$T_{J(IC)}$	Junction temperature of an IC
$T_{J(LED)}$	Junction temperature of a LED
$TJ_{(MAX)}$	Maximum junction temperature
V_{CC}	IC voltage
V_{COL}	Column voltage
$V_{F(LED)}$	Forward voltage of LED
$Z_{\theta JC}$	Thermal impedance junction to case

Equation 1.

$$T_{J(LED)} = P_{LED}\ Z_{\theta JC} + PC_{ASE}\ (R_{\theta JC} + R_{\theta CA}) + T_A$$

$$T_{J(LED)} = [(I_{COL}/28)\ V_{F(LED)}\ Z_{\theta JC}] + [(n/35)\ I_{COL}\ DF\ (5\ V_{COL}) + V_{CC}\ I_{CC}]\ \Sigma\ [R_{\theta JC} + R_{\theta CA}] + T_A$$

Equation 2.

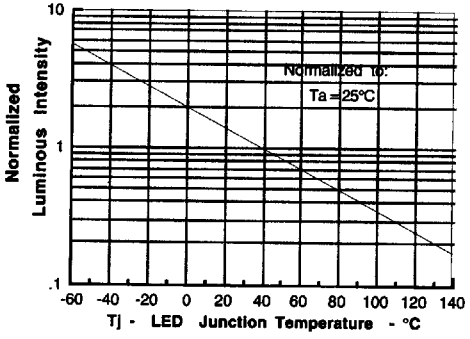
$$T_{J(IC)} = P_{COL}\ (R_{\theta JC} + R_{\theta CA}) + TA$$

$$T_{J(IC)} = [5\ (V_{COL} - V_{F(LED)}) \bullet (I_{COL}/2) \bullet (n/35)\ DF + V_{CC} \bullet I_{CC}] \bullet [R_{\theta JC} + R_{\theta CA}] + T_A$$

Optical Considerations

The light output of the LEDs is inversely related to the LED diode's junction temperature as shown in Figure 6. For optimum light output, keep the thermal resistance of the socket or PC board as low as possible.

Figure 6. Normalized Luminous Intensity vs. Junction Temperature



When mounted in a 10°C/W socket and operated at Absolute Maximum Electrical conditions, the HDSP230XLP will show anLED junction rise of 17°C. If T_A=40°C, then the LED's TJ will be 57°C. Under these conditions Figure 7 shows that the IV will be 75% of its 25°C value.

Figure 7. Max. LED Junction Temperature vs. Socket Thermal Resistance

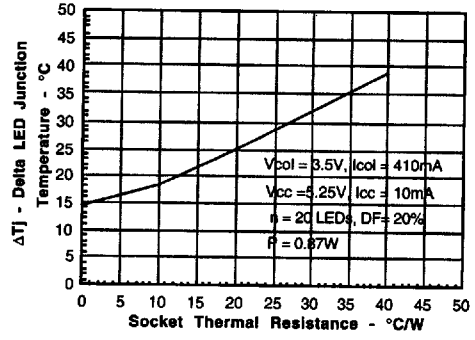


Figure 8a. Max. Package Power Dissipation, MSD/ISD201X

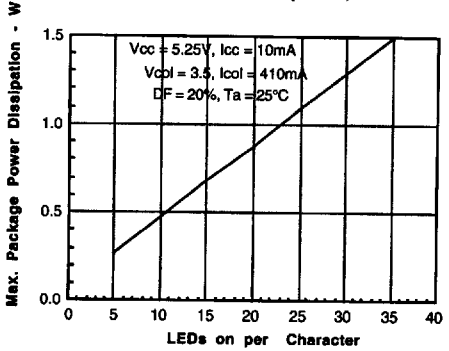


Figure 8b. Max. Package Power Dissipation, MSD/ISD231X

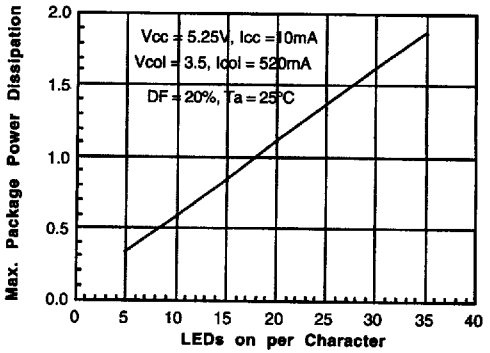


Figure 8c. Max. Package Power Dissipation, MSD/ISD235X

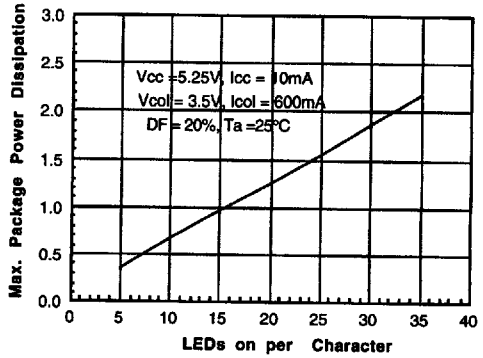


Figure 9a. Package Power Dissipation, MSD/ISD201X

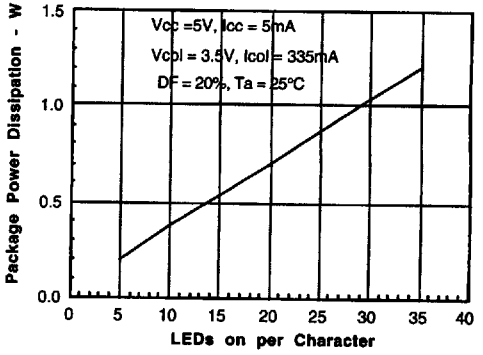


Figure 9b. Max. Package Power Dissipation, MSD/ISD231X

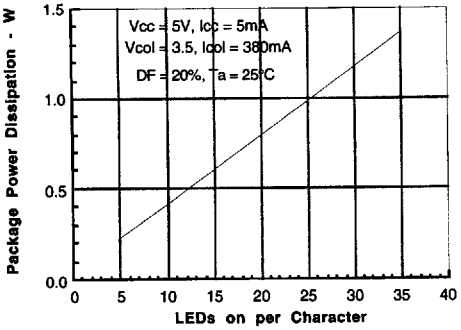


Figure 9c. Max. Package Power Dissipation, MSD/ISD235X

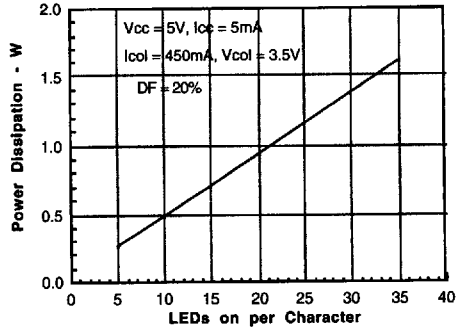


Figure 10a. Max. Character Power Dissipation, MSD/ISD201X

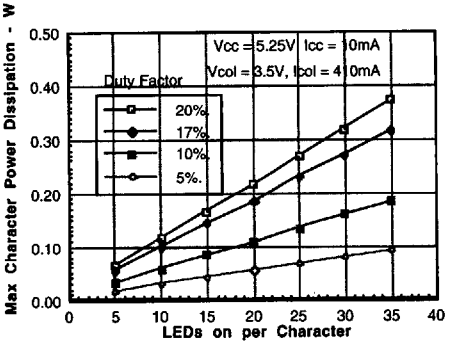


Figure 10b. Max. Character Power Dissipation, MSD/ISD231X

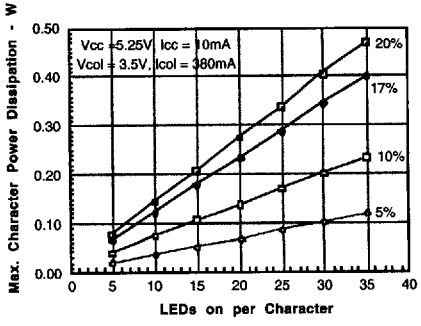


Figure 10c. Max. Character Power Dissipation, MSD/ISD235X

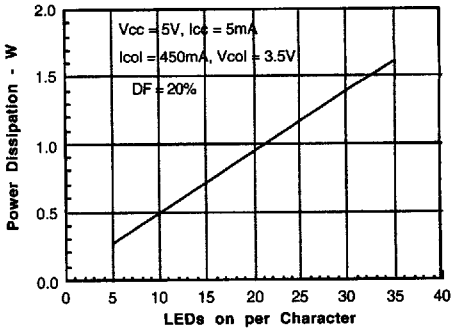


Figure 11a. Character Power Dissipation, MSD/ISD201X

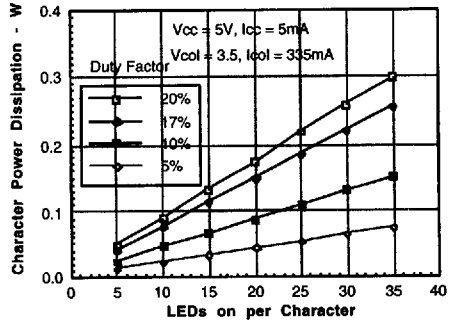


Figure 11b. Character Power Dissipation, MSD/ISD231X

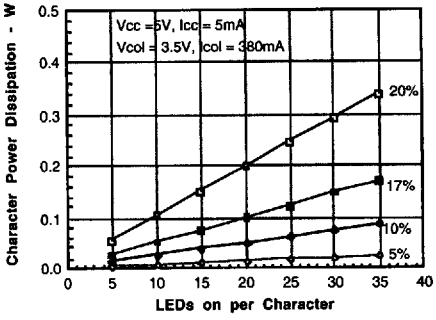


Figure 11c. Character Power Dissipation, MSD/ISD235X