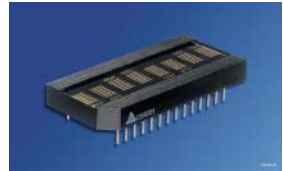


## 0.200" 8-Character 5x7 Dot Matrix Parallel Input Alphanumeric Intelligent Display® Devices

### Lead (Pb) Free Product - RoHS Compliant

Red	HSDP2110S
Yellow	HSDP2111S
High Efficiency Red	HSDP2112S
Green	HSDP2113S
High Efficiency Green	HSDP2114S
Soft Orange	HSDP2115S



#### DESCRIPTION

The HDSP2110S (Red), HDSP2111S (Yellow), HDSP2112S (High Efficiency Red), HDSP2113S (Green), HDSP2114S (High Efficiency Green), and HDSP2115S (Soft Orange) are eight digit, 5 x 7 dot matrix, alphanumeric Intelligent Display devices. The 0.20 inch high digits are packaged in a rugged, high quality, optically transparent, 0.6 inch lead spacing, 28 pin plastic DIP.

The on-board CMOS has a built-in 128 character ROM. The HDSP211XS also has a user definable character (UDC) feature, which uses a RAM that permits storage of 16 arbitrary characters, symbols or icons that are software-definable by the user. The character ROM itself is mask programmable and easily modified by the manufacturer to provide specified custom characters.

The HDSP211XS is designed for standard microprocessor interface techniques, and is fully TTL compatible. The Clock I/O and Clock Select pins allow the user to cascade multiple display modules.

#### FEATURES

- Eight 0.200" Dot Matrix Characters in Red, Yellow, High Efficiency Red, Green, High Efficiency Green, or Soft Orange
- Built-in 128 Character ROM, Mask Programmable for Custom Fonts
- Readable from 8 Feet (2.5 meters)
- Built-in Decoders, Multiplexers and Drivers
- Wide Viewing Angle, X Axis  $\pm 55^\circ$ , Y Axis  $\pm 65^\circ$
- Programmable Features:
  - Individual Flashing Character
  - Full Display Blinking
  - Multi-Level Dimming and Blanking
  - Clear Function
  - Self Test
- Internal or External Clock
- End Stackable Dual-In-Line Plastic Package
- Read/Write Capability
- 16 User Definable Characters

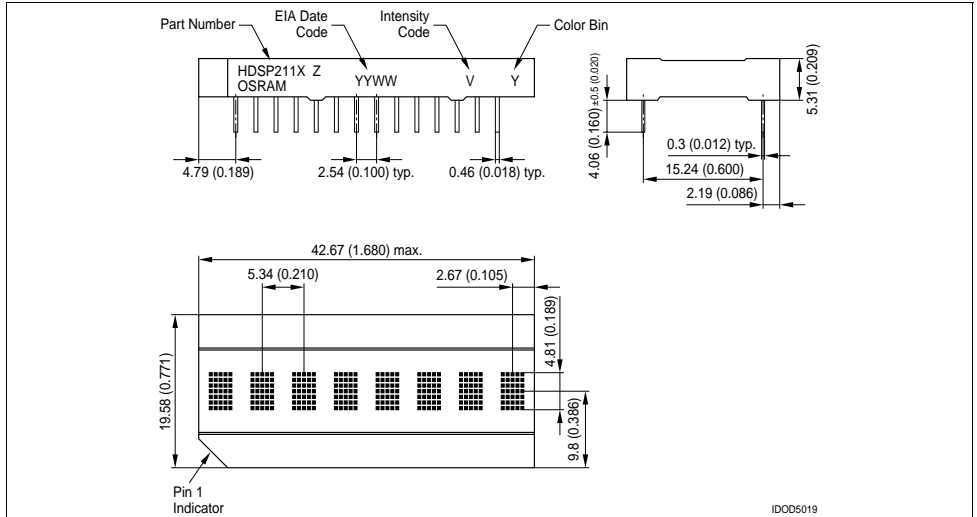
**ESD Warning:** Standard precautions for CMOS handling should be observed.

**Ordering Information**

Type	Color of Emission	Character Height [inch] ([mm])	Ordering Code
HSDP2110S	red	0.200 (5.10)	Q68000A8560
HSDP2111S	yellow		Q68000A8561
HSDP2112S	high efficiency red		Q68000A8562
HSDP2113S	green		Q68000A8563
HSDP2114S	high efficiency green		Q68000A8564
HSDP2115S	soft orange		Q68000A8907

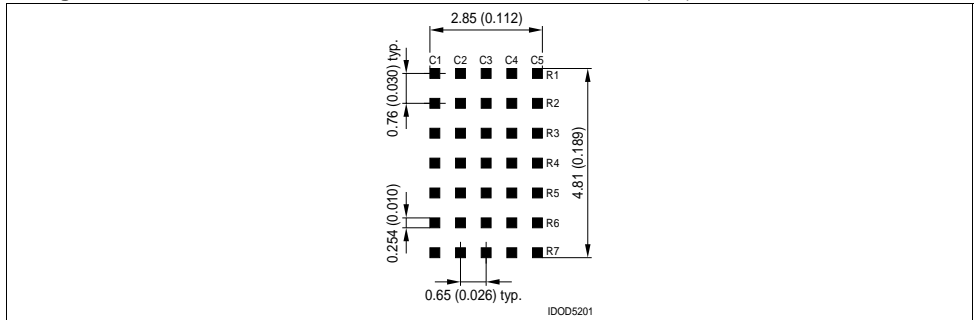
**Package Outlines**

Dimensions in inch (mm)



**Enlarged Character Font**

Dimensions in inch (mm)



**Maximum Ratings at 25°C**

Parameter	Symbol	Value	Unit
Operating temperature range	$T_{op}$	- 40 ... + 85	°C
Storage temperature range	$T_{stg}$	- 40 ... + 100	°C
DC Supply Voltage, $V_{CC}$ to GND (max. voltage with no LEDs on)	$V_{CC}$	-0.3 to + 7.0	V
Input Voltage Levels All inputs		-0.3 to $V_{CC} + 0.3$	V
Operating Voltage, $V_{CC}$ to GND (max. voltage with 20 dots/digits on)		+ 5.5	V
Solder temperature 063" (1.59 mm) below seating plane, $t < 5.0$ s	$T_S$	260	°C
Relative Humidity at 85°C (non-condensing)		85	%
ESD (100 pF, 1.5 kΩ), each pin	$V_Z$	4.0	kV

**Optical Characteristics at 25°C**

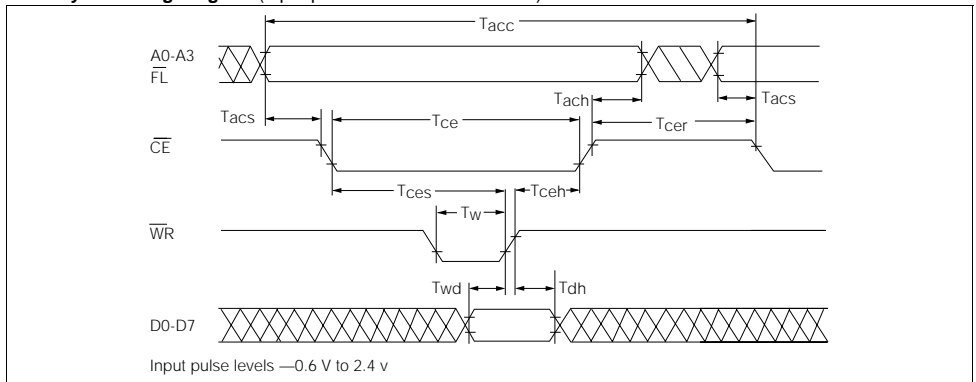
( $V_{LL} = V_{CC} = 5.0$  V at 100% brightness level, viewing angle: X axis  $\pm 55^\circ$ , Y axis  $\pm 65^\circ$ )

Description	Symbol	Values						Unit
		Red HSDP2110S	Yellow HSDP2111S	High Efficiency Red HSDP2112S	Green HSDP2113S	High Efficiency Green HSDP2114S	Soft Orange HSDP2115S	
Peak Luminous Intensity (min.) (typ.)	$I_{vpeak}$	70 90	130 210	150 330	150 260	200 510	150 270	$\mu\text{cd/dot}$ $\mu\text{cd/dot}$
Peak Wavelength (typ.)	$\lambda_{peak}$	660	583	630	565	568	610	nm
Dominant Wavelength (typ.)	$\lambda_{dom}$	639	585	620	570	574	604	nm

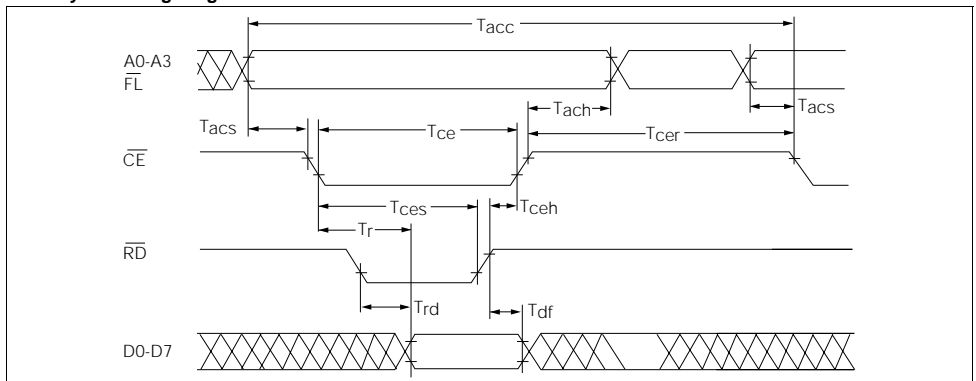
Note:

<sup>1)</sup> Peak luminous intensity is measured at  $T_A = T_J = 25^\circ\text{C}$ . No time is allowed for the device to warm up prior to measurement.

**Write Cycle Timing Diagram** (Input pulse levels -0.6 V to 2.4 V)



**Read Cycle Timing Diagram**



**Switching Specifications**

(over operating temperature range and  $V_{CC}=4.5\text{ V}$ )

Symbol	Description	Min.	Units	Symbol	Description	Min.	Units
$T_{acc}$	Display Access Time—Write	210	ns	$T_{dh}$	Data Write Time	20	ns
$T_{acc}$	Display Access Time—Read	230	ns	$T_r$	Chip Enable Active Prior to Valid Data	160	ns
$T_{acs}$	Address Setup Time to $\overline{CE}$	10	ns	$T_{rd}$	Read Active Prior to Valid Data	95	$\mu$ s
$T_{ce}$	Chip Enable Active Time—Write	140	ns	$T_{df}$	Read Data Float Delay	10	ns
$T_{ce}$	Chip Enable Active Time—Read	160	ns	$T_{rc}$	Reset Active Time	300	ns
$T_{ach}$	Address Hold Time to CE	20	ns	$T_w$	Write Active Time	100	ns
$T_{ces}$	Chip Enable Active Prior to Rising Edge—Write	140	ns	$T_{wd}$	Data Valid Prior to Rising Edge of Write Signal	50	ns
$T_{ces}$	Chip Enable Active Prior to Rising Edge—Read	160	ns	$T_{ceh}$	Chip Enable Hold to Rising Edge of Read/Write Signal	0	ns
$T_{cer}$	Chip Enable Recovery Time	60	ns				

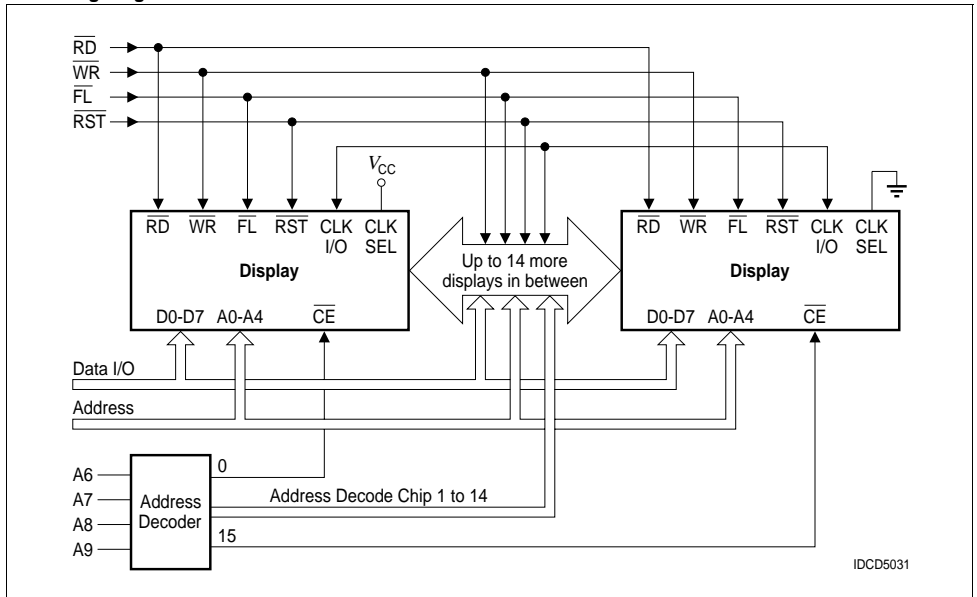
**Cascading Displays**

The HSDP211XS oscillator is designed to drive up to 16 other HSDP211XSs with input loading of 15 pF each.

The following are the general requirements for cascading 16 displays together:

- Determine the correct address for each display.
- Use CE from an address decoder to select the correct display.
- Select one of the Displays to provide the clock for the other displays. Connect CLKSEL to  $V_{CC}$  for this display.
- Tie CLKSEL to ground on other displays.
- Use  $\overline{RTS}$  to synchronize the blinking between the displays.

**Cascading Diagram**



**Electrical Characteristics at 25°C**

Parameters	Limits				Conditions
	Min.	Typ.	Max.	Units	
$V_{CC}$	4.5	5.0	5.5	V	—
$I_{CC}$ Blank	—	0.65	1.0	mA	$V_{CC}=5.0\text{ V}$ , $V_{IN}=5.0\text{ V}$
$I_{CC}$ 12 dots/digit on <sup>(1)</sup> <sup>(2)</sup>	—	185	255	mA	$V_{CC}=5.0\text{ V}$ , "V" in all 8 digits
$I_{CC}$ 20 dots/digit on <sup>(1)</sup> <sup>(2)</sup>	—	284	370	mA	$V_{CC}=5.0\text{ V}$ , "#" in all 8 digits
$I_{ILP}$ (with pull-up) Input Leakage	-18	-11	-5.0	$\mu\text{A}$	$V_{CC}=5.0\text{ V}$ , $V_{IN}=0\text{ V}$ to $V_{CC}$ , ( $\overline{WR}$ , $\overline{CE}$ , $\overline{FL}$ , $\overline{RST}$ , $\overline{RD}$ , $\overline{CLKSEL}$ )
$I_{IL}$ (no pull-up) Input Leakage	-1.0	—	+1.0	$\mu\text{A}$	$V_{CC}=5.0\text{ V}$ , $V_{IN}=0-5\text{ V}$ , ( $\overline{CLK}$ , $A0-A3$ , $D0-D7$ )
$V_{IH}$ Input Voltage High	2.0	—	$V_{CC}+0.3$	V	$V_{CC}=4.5\text{ V}$ to $5.5\text{ V}$
$V_{IL}$ Input Voltage Low	GND -0.3	—	—	V	$V_{CC}=4.5\text{ V}$ to $5.5\text{ V}$
$V_{OL}$ (D0–D7), Output Voltage Low	—	—	0.4	V	$V_{CC}=4.5\text{ V}$ , $I_{OL}=1.6\text{ mA}$
$V_{OL}$ (CLK), Output Voltage Low	—	—	0.4	V	$V_{CC}=4.5\text{ V}$ , $I_{OL}=40\text{ }\mu\text{A}$
$V_{OH}$ Output Voltage High	2.4	—	—	V	$V_{CC}=4.5\text{ V}$ , $I_{OH}=-40\text{ }\mu\text{A}$
$\theta_{JC}$ Thermal Resistance, Junction to Case	—	25	—	$^{\circ}\text{C/W}$	—
Clock I/O Frequency	28	57.34	81.14	kHz	$V_{CC}=4.5$ to $5.5\text{ V}$
FM, Digit Multiplex Frequency	125	256	362.5	Hz	$V_{CC}=4.5$ to $5.5\text{ V}$
Blinking Rate	0.98	2.0	2.83	Hz	—
Clock I/O Buss Loading	—	—	2.40	pF	—
Clock Out Rise Time	—	—	500	nsec	$V_{CC}=4.5\text{ V}$ , $V_{OH}=2.4\text{ V}$
Clock Out Fall Time	—	—	500	nsec	$V_{CC}=4.5\text{ V}$ , $V_{OH}=0.4\text{ V}$

Notes:

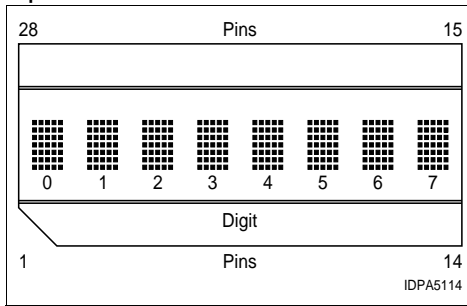
<sup>1)</sup>  $I_{CC}$  is an average value.

<sup>2)</sup>  $I_{CC}$  is measured with the display at full brightness. Peak  $I_{CC}=^{28}I_{15} I_{CC}$  average (#displayed).

**Recommended Operating Conditions ( $T_A=-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ )**

Parameter	Symbol	Min.	Max.	Units
Supply Voltage	$V_{CC}$	4.5	5.5	V
Input Voltage Low	$V_{IL}$	—	0.8	V
Input Voltage High	$V_{IH}$	2.0	—	V
Output Voltage Low	$V_{OL}$	—	0.4	V
Output Voltage High	$V_{OH}$	2.4	—	V

Top View



Pin Assignment

Pin	Function	Definition	Pin	Function	Definition
1	$\overline{RST}$	Used to initialize a display and synchronize blinking for multiple displays	15	GND supply	Analog Ground for LED drivers
2	$\overline{FL}$	Low input accesses the Flash RAM	16	GND logic	Digital Ground for internal drivers
3	A0	Address input LSB	17	$\overline{CE}$	Enables access to the display
4	A1	Address input	18	$\overline{RD}$	A low will read data from the display if $\overline{CE}$ is low. If read from display is not required,
5	A2	Address input MSB	19	D0	Data input LSB
6	A3	Mode selector	20	D1	Data input
7	$V_{CC}$	Optional connection to positive power supply input.	21	No pin	—
8	$V_{CC}$		22	No pin	—
9	$V_{CC}$		23	D2	Data input
10	A4	Mode Selector	24	D3	Data input
11	$\overline{CLKSEL}$	Selects internal/high clock source	25	D4	Data input
12	CLK I/O	Outputs master clock or inputs external clock	26	D5	Data input
13	$\overline{WR}$	A low will write data into the display if $\overline{CE}$ is low	27	D6	Data input
14	$V_{CC}$	Positive power supply input	28	D7	Data input MSB, selects ROM, page 1 or 2

Character Set

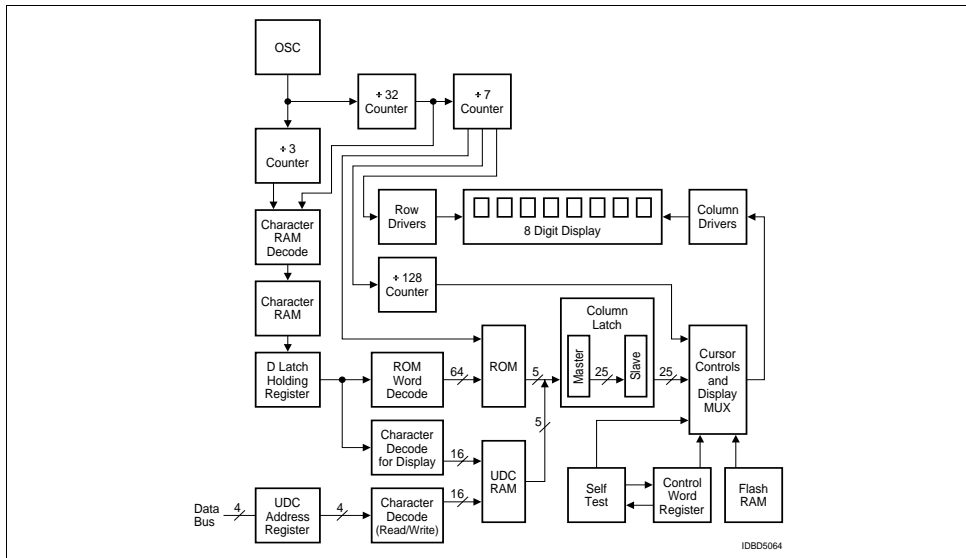
ASCII CODE				D0	L	H	L	H	L	H	L	H	L	H	L	H	L	H		
				D1	L	L	H	H	L	L	H	H	L	L	H	H	L	L	H	H
				D2	L	L	L	L	L	H	H	H	H	L	L	L	H	H	H	H
				D3	L	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H
D7	D6	D5	D4	HEX	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
L	L	L	L	0																
L	L	L	H	1																
L	L	H	L	2																
L	L	H	H	3																
L	H	L	L	4																
L	H	L	H	5																
L	H	H	L	6																
L	H	H	H	7																
H	X	X	X	8	UDC 0	UDC 1	UDC 2	UDC 3	UDC 4	UDC 5	UDC 6	UDC 7	UDC 8	UDC 9	UDC 10	UDC 11	UDC 12	UDC 13	UDC 14	UDC 15

IDCS5086

Notes:

1. Upon power up, the device will initialize in a random state.
2. X=don't care.

Block Diagram



Functional Description

The display's user interface is organized into five memory areas. They are accessed using the Flash Input, FL, and address lines, A3 and A4. All the listed RAMs and Registers may be read or written through the data bus. See Table „Memory Selection“. Each input pin is described in Pin Definitions.

Five Basic Memory Areas

Character RAM	Stores either ASCII (Katakana) character data or an UDC RAM address
Flash RAM	1 x 8 RAM which stores Flash data
User-Defined Character RAM (UDC RAM)	Stores dot pattern for custom characters
User-Defined Address Register (UDC Address Register)	Provides address to UDC RAM when user is writing or reading custom character
Control Word Register	Enables adjustment of display brightness, flash individual characters, blink, self test or clearing the display

RST can be used to initialize display operation upon power up or during normal operation. When activated, RST will clear the Flash RAM and Control Word Register (00H) and reset the internal counter. All eight display memory locations will be set to 20H to show blanks in all digits.

FL pin enables access to the Flash RAM. The Flash RAM will set (D0=1) or reset (D0=0) flashing of the character addressed by A0–A2.

The 1 x 8 bit Control Word Register is loaded with attribute data if A3=0.

The Control Word Logic decodes attribute data for proper implementation.

Character ROM is designed for 128 ASCII characters. The ROM is Mask Programmable for custom fonts.

The Clock Source could either be the internal oscillator (CLKSEL=1) of the device or an external clock (CLKSEL=0) could be an input from another HDSP211X display for the synchronization of blinking for multiple displays.

The Display Multiplexer controls the Row Drivers so no additional logic is required for a display system.

The Display has eight digits. Each digit has 35 LEDs clustered into a 5 x 7 dot matrix.

**Memory Selection**

FL	A4	A3	Section of Memory	A2–A0	Data Bits Used
0	X	X	Flash RAM	Character Address	D0
1	0	0	UDC Address Register	Don't Care	D3–D0
1	0	1	UDC RAM	Row Address	D4–D0
1	1	1	Character RAM	Character Address	D7–D0
1	1	0	Control Word Register	Don't Care	D7–D0

**Theory of operation**

The HDSP211XS Programmable Display is designed to work with all major microprocessors. Data entry is via an eight bit parallel bus. Three bits of address route the data to the proper digit location in the RAM. Standard control signals like  $\overline{WR}$  and  $\overline{CE}$  allow the data to be written into the display.

D0–D7 data bits are used for both Character RAM and control word data input. A3 acts as the mode selector.

If A3=1, character RAM is selected. Then input data bit D7 will determine whether input data bits D0–D6 is ASCII coded data (D7=0) or UDC data (D7=1). See section on UDC Address Register and RAM.

For normal operation  $\overline{FL}$  pin should be held high. When  $\overline{FL}$  is held low, Flash RAM is accessed to set character blinking.

The seven bit ASCII code is decoded by the Character ROM to generate Column data. Twenty columns worth of data is sent out each display cycle, and it takes fourteen display cycles to write into eight digits.

The rows are multiplexed in two sets of seven rows each. The internal timing and control logic synchronizes the turning on of rows and presentation of column data to assure proper display operation.

**Power Up Sequence**

Upon power up display will come on at random. Thus the display should be reset on power-up. The reset will clear the Flash RAM, Control Word Register and reset the internal counter. All the digits will show blanks and display brightness level will be 100%.

The display must not be accessed until three clock pulses (110  $\mu$ seconds minimum using the internal clock) after the rising edge of the reset line.

**Microprocessor interface**

The interface to a microprocessor is through the 8-bit data bus (D0–D7), the 4-bit address bus (A0–A3) and control lines  $\overline{FL}$ ,  $\overline{CE}$  and  $\overline{WR}$ .

To write data (ASCII/Control Word) into the display  $\overline{CE}$  should be held low, address and data signals stable and  $\overline{WR}$  should be brought low. The data is written on the low to high transition of  $\overline{WR}$ .

The Control Word is decoded by the Control Word Decode Logic. Each code has a different function. The code for display brightness changes the duty cycle for the column drivers. The peak LED current stays the same but the average LED current diminishes depending on the intensity level.

The character Flash Enable causes 2.0 Hz coming out of the counter to be ANDED with column drive signal and makes the column driver to cycle at 2.0 Hz. Thus the character flashes at 2.0 Hz.

The display Blink works the same way as the Flash Enable but causes all twenty column drivers to cycle at 2.0 Hz thereby making all eight digits to blink at 2.0 Hz.

The Self Test function of the IC consists of two internal routines which exercise major portions of the IC and illuminates all the LEDs.

Clear bit clears the character RAM and writes a blank into the display memory. It however does not clear the control word.

ASCII Data or Control Word Data can be written into the display at this point. For multiple display operation, CLK I/O must be properly selected. CLK I/O will output the internal clock if CLKSEL=1, or will allow input from an external clock if CLKSEL=0.

**Character RAM**

The Character RAM is selected when  $\overline{FL}$ , A4 and A3 are set to 1,1,1 during a read or write cycle. The Character RAM is a 8 by 8 bit RAM with each of the eight locations corresponding to a digit on the display. Digit 0 is on the left side of the display and digit 7 is on the right side of the display. Address lines, A2–A0 select the digit address with A2 being the most significant bit and A0 being the least significant bit. The two types of data stored in the Character RAM are the ASCII coded data and the UDC Address Data. The type of data stored in the Character RAM is determined by data bit, D7. If D7 is low, then ASCII coded data is stored in data bits D6–D0. If D7 is high, then UDC Address Data is stored in data bit D3–D0.

The ASCII coded data is a 7 bit code used to select one of 128 ASCII characters permanently stored in the ASCII ROM.

The UDC Address data is a 4 bit code used to select one of the UDC characters in the UDC RAM. There are up to 16 characters available. See Table „Character RAM Access Logic“ (page 11).

**UDC Address Register and UDC RAM**

The UDC Address Register and UDC RAM allows the user to generate and store up to 16 custom characters. Each custom character is defined in 5 x 7 dot matrix pattern. It takes 8 write cycles to define a custom character, one cycle to load the UDC Address Register and 7 cycles to define the character. The contents of the UDC Address Register will store the 4 bit address for one of the 16 UDC RAM locations. The UDC RAM is used to store the custom character.

## UDC Address Register

The UDC Address Register is selected by setting  $\overline{FL}=1$ , A4=0, A3=0. It is a 4 bit register and uses data bits, D3–D0 to store the 4 bit address code (D7–D4 are ignored). The address code selects one of 16 UDC RAM locations for custom character generation.

## UDC RAM

The UDC RAM is selected by setting  $\overline{FL}=1$ , A4=0, A3=1. The RAM is comprised of a 7 x 5 bit RAM. As shown in Table „Flash RAM Access Logic“ (page 12), address lines, A2–A0 select one of the 7 rows of the custom character. Data bits, D4–D0 determine the 5 bits of column data in each row. Each data bit corresponds to a LED. If the data bit is high, then the LED is on. If the data bit is low, the LED is off. To create a character, each of the 7 rows of column data need to be defined. See Tables „UDCAddress Register and UDC Character RAM“ (page 11) and „UDC Character Map“ (page 12) for logic.

## Flash RAM

The Flash RAM allows the display to flash one or more of the characters being displayed. The Flash Ram is accessed by setting  $\overline{FL}$  low. A4 and A3 are ignored. The Flash RAM is a 8 x 1 bit RAM with each bit corresponding to a digit address. Digit 0 is on the left side of the display and digit 7 is on the right side of the display. Address lines, A2–A0 select the digit address with A2 being the most significant digit and A0 being the least significant digit. Data bit, D0, sets and resets the flash bit for each digit. When D0 is high, the flash bit is set and when D0 is low, it is reset. See Table „Flash RAM Access Logic“ (page 12).

## Control Word

The Control Word is used to set up the attributes required by the user. It is addressed by setting  $\overline{FL}=1$ , A4=1, A3=0. The Control Word is an 8 bit register and is accessed using data bits, D7–D0. See Table „Control Word Access Logic“ (page 12) and Figure „Control Word Data Definition“ (page 13) for the logic and attributed control. The Control Word has 5 functions. They are brightness control, flashing character enable, blinking character enable, self test, and clear (Flash and Character RAMS only).

## Brightness Control

Control Word bits, D2–D0, control the brightness of the display with a binary code of 000 being 100% brightness and 111 being display blank. See Figure „Control Word Data Definition“ (page 13) for brightness level versus binary code. The average  $I_{CC}$  can be calculated by multiplying the 100% brightness level  $I_{CC}$  value by the display's brightness level. For example, a display set to 80% brightness with a 100% average  $I_{CC}$  value of 200 mA will have an average  $I_{CC}$  value of 200 mA x 80%=160 mA.

## Flash Function

Control Word bit, D3, enables or disables the Flash Function. When D3 is 1, the Flash Function is enabled and any digit with its corresponding bit set in the Flash RAM will flash at approximately 2.0 Hz. When using an external clock, the flash rate can be determined by dividing the clock rate by 28,672. When D3 is 0, the Flash Function is disabled and the contents of the Flash RAM is ignored. For synchronized flashing on multiple displays, see the Reset Section (page 12).

## Character RAM Access Logic

RST	CE	WR	RD	FL	A4	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0
1	0	0	1	1	1	1	Character Address for Digits 0–7			0 7 bit ASCII code for a Write Cycle							
1	0	1	0	1	1	1	Character Address for Digits 0–7			0 7 bit ASCII code read during a Read Cycle							
1	0	0	1	1	0	0	Character Address for Digits 0–7			1 D3–D0=UDC address for a Write Cycle							
1	0	1	0	1	0	0	Character Address for Digits 0–7			1 D3–D0=UDC address for Read Data							

## UDC Address Register and UDC Character RAM

RST	CE	WR	RD	FL	A4	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0	
1	0	0	1	1	0	0	Not used for UDC Address Register			D3–D0=UDC RAM Address Code for Write Cycle								UDC Address Register
1	0	1	0	1	0	0	Not used for UDC Address Register			D3–D0=UDC RAM Address Code for Read Cycle								
1	0	0	1	1	0	1	A2–A0=Character Row Address			D4–D0=Character Column Data for Write Cycle								UDC RAM
1	0	1	0	1	0	1	A2–A0=Character Row Address			D4–D0=Character Column Data read during a Read Cycle								

**Blink Function**

Control Word bit, D4, enables or disables the Blink Function. When D4 is 1, the Blink Function is enabled and all characters on the display will blink at approximately 2.0 Hz. The Blink Function will override the Flash Function if both functions are enabled. When D4 is 0, the Blink Function is disabled. When using an external clock, the blink rate can be determined by dividing the clock rate by 28,672. For synchronized blinking on multiple displays, see the Reset Section.

**Self Test**

Before starting Self Test, Reset must first be activated. Control Word bits, D6 and D5, are used for the Self Test Function. When D6 is 1, the Self Test is initiated. Results of the Self Test are stored in bits D5. Control Word bit, D5, is a read only bit. When D5 is 1, Self Test passed is indicated. When D5 is 0, Self Test failed is indicated. The Self Test function of the IC consists of two internal routines which exercise major portions of the IC and illuminates all of the LEDs. The first routine cycles the ASCII decoder ROM through all states and performs a check sum on the output. If the check sum agrees with the correct value, D5 is set to a 1.

**UDC Character Map**

Row Data				Column Data					
A2	A1	A0	Row #	C1	C2	C3	C4	C5	
				D4	D3	D2	D1	D0	
0	0	0	1	5 x 7 Dot Matrix Pattern					
0	0	1	2						
0	1	0	3						
0	1	1	4						
1	0	0	5						
1	0	1	6						
1	1	0	7						

The second routine provides a visual test of the LEDs using the drive circuitry. This is accomplished by writing checkered and inverse checkered patterns to the display. Each pattern is displayed for approximately 2.0 seconds. During the self test function the display must not be accessed. The time needed to execute the self test function is calculated by multiplying the clock time by 262,144 (typical time = 4.6 sec.). At the end of the self test function, the Character RAM is loaded with blanks; the Control Word Register is set to zeroes except D5, and the Flash RAM is cleared and the UDC Address Register is set to all 1.0 s.

**Clear Function** (see Table „Clear Function“ (page 13) and Figure „Control Word Data Definition“ (page 13))

Control Word bit, D7 clears the character RAM to 20 hex and the flash RAM to all zeroes. The RAMs are cleared within three clock cycles (110 µs minimum, using the internal clock) when D7 is set to 1. During the clear time the display must not be accessed. When the clear function is finished, bit 7 of the Control Word RAM will be reset to a “0”.

**Reset Function**

The display should be reset on power up of the display (RST=LOW). When the display is reset, the Character RAM, Flash RAM, and Control Word Register are cleared.

The display’s internal counters are reset. Reset cycle takes three clock cycles (110 µseconds minimum using the internal clock).The display must not be accessed during this time.

To synchronize the flashing and blinking of multiple displays, it is necessary for the display to use a common clock source and reset all the displays at the same time to start the internal counters at the same place.

While RST is low, the display must not be accessed by RD nor WR.

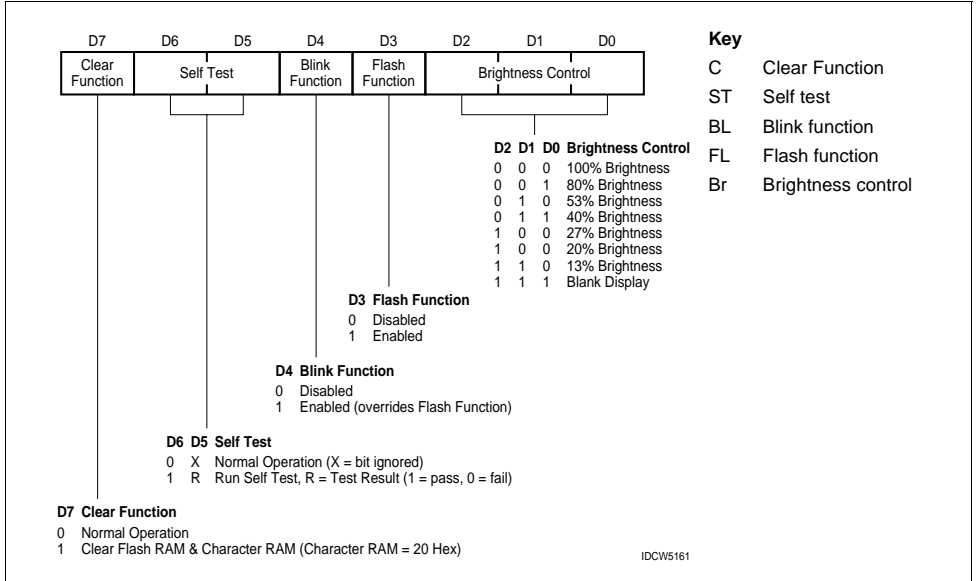
**Flash RAM Access Logic**

RST	CE	WR	RD	FL	A4	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0
1	0	0	1	0	X	X	Flash RAM Address for Digits 0–7			D0=Flash Data, 0=Flash Off and 1=Flash On (Write Cycle)							
1	0	1	0	0	X	X	Flash RAM Address for Digits 0–7			D0=Flash Data, 0=Flash Off and 1=Flash On (Read Cycle)							

**Control Word Access Logic**

RST	CE	WR	RD	FL	A4	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0
1	0	0	1	1	1	0	Not used for Control Word			Control Word data for a Write Cycle, see Figure „Control Word Data Definition“ (page 13)							
1	0	1	0	1	1	0	Not used for Control Word			Control Word data for a Read during a Read Cycle							

**Control Word Data Definition**



**Clear Function**

CE	WR	FL	AL	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0	Operation
0	0	1	1	0	X	X	X	0	X	X	X	X	X	X	X	Clear disabled
0	0	1	1	0	X	X	X	1	X	X	X	X	X	X	X	Clear user RAM, page RAM, flash RAM and display

X=don't care

**Display Cycle Using Built-in ROM Example**

Display message "Showtime." Digit 0 is leftmost—closest to pin 1.  
Logic levels: 0=Low, 1=High, X=Don't care

RST	CE	WR	RD	FL	A4	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0	Operation	Display
0	X	1	1	1	X	X	X	X	X	X	X	X	X	X	X	X	X	Reset. No Read/Write Within 3 Clock Cycles	All Blank
1	0	0	1	1	1	0	X	X	X	0	0	X	0	0	0	1	1	53% Brightness Selected	All Blank
1	0	0	1	1	1	1	0	0	0	0	1	0	1	0	0	1	1	Write "S" to Digit 0	S
1	0	0	1	1	1	1	0	0	1	0	1	0	0	1	0	0	0	Write "H" to Digit 1	SH
1	0	0	1	1	1	1	0	1	0	0	1	0	0	1	1	1	1	Write "O" to Digit 2	SHO
1	0	0	1	1	1	1	1	0	1	0	1	0	1	0	1	1	1	Write "W" to Digit 3	SHOW
1	0	0	1	1	1	1	1	0	0	0	1	0	1	0	1	0	0	Write "T" to Digit 4	SHOWT
1	0	0	1	1	1	1	1	0	1	0	1	0	0	1	0	0	1	Write "I" to Digit 5	SHOWTI
1	0	0	1	1	1	1	1	1	0	0	1	0	0	1	1	0	1	Write "M" to Digit 6	SHOWTIM
1	0	0	1	1	1	1	1	1	1	0	1	0	0	0	1	0	1	Write "E" to Digit 7	SHOWTIME

## Displaying User Defined Character Example

Load character "A" into UDC-5 and then display it in digit 2  
 Logic levels: 0=Low, 1=High, X=Don't care

RST	CE	WR	RD	FL	A4	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0	Operation	Display
0	X	1	1	1	X	X	X	X	X	X	X	X	X	X	X	X	X	Reset. No Read/Write Within 3 Clock Cycles	All Blank
1	0	0	1	1	0	0	X	X	X	X	X	X	X	0	1	0	1	Select UDC-5	All Blank
1	0	0	1	1	0	1	0	0	0	X	X	X	0	1	1	1	0	Write into Row 1 of UDC-5	All Blank
1	0	0	1	1	0	1	0	0	1	X	X	X	1	0	0	0	1	Write into Row 2 of UDC-5	All Blank
1	0	0	1	1	0	1	0	1	0	X	X	X	1	0	0	0	1	Write into Row 3 of UDC-5	All Blank
1	0	0	1	1	0	1	0	1	1	X	X	X	1	1	1	1	1	Write into Row 4 of UDC-5	All Blank
1	0	0	1	1	0	1	1	0	0	X	X	X	1	0	0	0	1	Write into Row 5 of UDC-5	All Blank
1	0	0	1	1	0	1	1	0	1	X	X	X	1	0	0	0	1	Write into Row 6 of UDC-5	All Blank
1	0	0	1	1	0	1	1	1	0	X	X	X	1	0	0	0	1	Write into Row 7 of UDC-5	All Blank
1	0	0	1	1	1	1	0	1	0	1	X	X	X	0	1	0	1	Write UDC-5 into Digit 2	(Digit 2) A

## Electrical and Mechanical Considerations

### Voltage Transient Suppression

For best results power the display and the components that interface with the display to avoid logic inputs higher than  $V_{CC}$ . Additionally, the LEDs may cause transients in the power supply line while they change display states. The common practice is to place a parallel combination of a 0.01  $\mu F$  and a 22  $\mu F$  capacitor between  $V_{CC}$  and GND for all display packages.

### ESD Protection

The input protection structure of the HDSP211XS provides significant protection against ESD damage. It is capable of withstanding discharges greater than 2.0 kV. Take all the standard precautions, normal for CMOS components. These include properly grounding personnel, tools, tables, and transport carriers that come in contact with unshielded parts. If these conditions are not, or cannot be met, keep the leads of the device shorted together or the parts in antistatic packaging.

### Soldering Considerations

The HDSP211XS can be hand soldered with SN63 solder using a grounded iron set to 260°C.

Wave soldering is also possible following these conditions:

Preheat that does not exceed 93°C on the solder side of the PC board or a package surface temperature of 85°C. Water soluble organic acid flux (except carboxylic acid) or rosin-based RMA flux without alcohol can be used.

Direct contact with alcohol or alcohol vapor will cause degradation of the package.

Wave temperature of 245°C  $\pm$ 5°C with a dwell between 1.5 sec. to 3.0 sec. Exposure to the wave should not exceed temperatures above 260°C for five seconds at 0.063" below the seating plane. The packages should not be immersed in the wave.

### Post Solder Cleaning Procedures

The least offensive cleaning solution is hot D.I. water (60°C) for less than 15 minutes. Addition of mild saponifiers is acceptable. Do not use commercial dishwasher detergents.

For faster cleaning, solvents may be used. Exercise care in choosing solvents as some may chemically attack the nylon package. Maximum exposure should not exceed two minutes at elevated temperatures. Acceptable solvents are TF (trichlorofluorethane), TA, 111 Trichloroethane, and unheated acetone.<sup>(1)</sup>

Note:

<sup>1)</sup> Acceptable commercial solvents are: Basic TF, Arklone, P. Genesolv, D. Genesolv DA, Blaco-Tron TF and Blaco-Tron TA.

Unacceptable solvents contain alcohol, methanol, methylene chloride, ethanol, TP35, TCM, TMC, TMS+, TE, or TES. Since many commercial mixtures exist, contact a solvent vendor for chemical composition information. Some major solvent manufacturers are: Allied Chemical Corporation, Specialty Chemical Division, Morristown, NJ; Baron-Blakeslee, Chicago, IL; Dow Chemical, Midland, MI; E.I. DuPont de Nemours & Co., Wilmington, DE.

For further information refer to Appnotes 18 and 19 at [www.osram-os.com](http://www.osram-os.com)

An alternative to soldering and cleaning the display modules is to use sockets. Naturally, 28 pin DIP sockets .600" wide with .100" centers work well for single displays. Multiple display assemblies are best handled by longer SIP sockets or DIP sockets when available for uniform package alignment. Socket manufacturers are Aries Electronics, Inc., Frenchtown, NJ; Garry Manufacturing, New Brunswick, NJ; Robinson-Nugent, New Albany, IN; and Samtec Electronic Hardware, New Albany, IN.

For further information refer to Appnote 22 at [www.osram-os.com](http://www.osram-os.com)

## Optical Considerations

The .200" high character of the HDSP211XS gives readability up to eight feet. Proper filter selection enhances readability over this distance.

Using filters emphasizes the contrast ratio between a lit LED and the character background. This will increase the discrimination of different characters. The only limitation is cost. Take into consideration the ambient lighting environment for the best cost/benefit ratio for filters.

Incandescent (with almost no green) or fluorescent (with almost no red) lights do not have the flat spectral response of sunlight. Plastic band-pass filters are an inexpensive and effective way to strengthen contrast ratios. The HDSP2110/2112S are red/high efficiency red displays and should be matched with long wavelength pass filter in the 570 nm to 590 nm range. The HDSP2113S should be matched with a yellow-green band-pass filter that peaks at 565 nm. For displays of multiple colors, neutral density grey filters offer the best compromise.

Additional contrast enhancement is gained by shading the displays. Plastic band-pass filters with built-in louvers offer the next step up in contrast improvement. Plastic filters can be improved further with anti-reflective coatings to reduce glare. The trade-off is fuzzy characters. Mounting the filters close to the display reduces this effect. Take care not to overheat the plastic filter by allowing for proper air flow.

Optimal filter enhancements are gained by using circular polarized, anti-reflective, band-pass filters. The circular polarizing further enhances contrast by reducing the light that travels through the filter and reflects back off the display to less than 1%.

Several filter manufacturers supply quality filter materials. Some of them are: Panelgraphic Corporation, W. Caldwell, NJ; SGL Homalite, Wilmington, DE; 3M Company, Visual Products Division, St. Paul, MN; Polaroid Corporation, Polarizer Division, Cambridge, MA; Marks Polarized Corporation, Deer Park, NY, Hoya Optics, Inc., Fremont, CA.

One last note on mounting filters: recessing displays and bezel assemblies is an inexpensive way to provide a shading effect in overhead lighting situations. Several bezel manufacturers are: R.M.F. Products, Baklava, IL; Nobody Components, Griffith Plastic Corp., Burningly, CA; Photo Chemical Products of California, Santa Monica, CA; I.E.E.-Atlas, Van Nuys, CA.

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Page	Subjects (major changes since last revision)	Date of change
all	Lead free device	2006-01-23

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