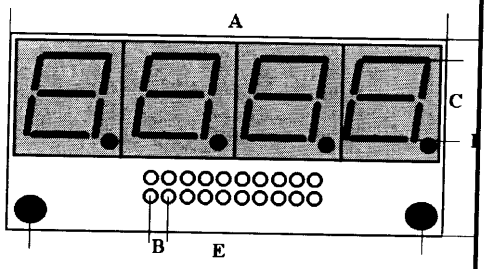
Nexus Machines	4 digit 7 segment LED displays with Cascadable Serial driver			
	B14SC04	**B20SC04**	**B25SC04**	**B38SC04**

General Description

The B14SCM04, B20SC04, B25SC04 and B38SC04 displays are 4 digit seven segment LED displays combined with an 8 digit, multiplexed drive, integrated circuit with a cascadable serial interface. Four digits are mounted with the driver on to the PCB which also has connections for the BM multiplexed display family allowing expansion to 8 digits. The devices are available in high efficiency red, green and yellow colour variants. Each of the standard displays has a right hand decimal point in each digit. LED sizes include 14mm (0.56inch), 20mm (0.8inch) 25mm (1inch) and 38mm (1.5inch) display areas.

The on board driver chip has a serial input format that features serial data, clock and chip enable. A single 5 volt supply is required. The serial bus signals interface is HCMOS levels and the format is compatible with SPI, QSPI and MICROWIRE. It features slew rate limiting for reduced EMI. Included on chip is a BCD code B decoder and digit ram. An undedecoded mode is also available. The chip can be programmed to display from 1 to 8 digits using the scan limit register. Only one external resistor is required to set the maximum brightness that can then be digitally dimmed in 16 levels. A test mode forces all LED's on. Low power shutdown reduces current to 150uA.

Configuration



Dimensions

Dim (mm)	B14	B20	B25	B38
A	58.5	75.0	97.0	121.0
B	2.54	2.54	2.54	2.54
C	14.0	20.0	25.0	38.0
D	37.0	38.0	44.0	54.0
E	51.5	68.5	90.0	115.5
Depth	16.0	18.0	18.0	18.0

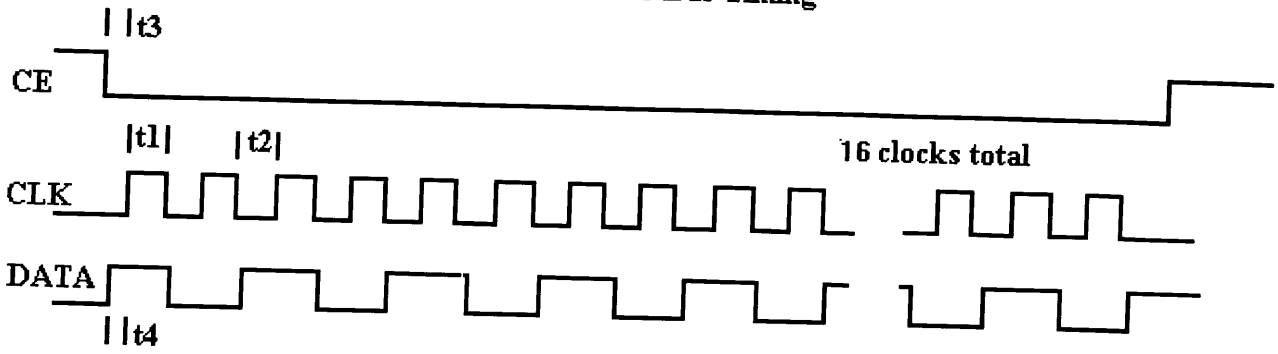
Pinout

1	3	5	7	9	11	13	15	17	19
+5V	CS	CLK	0V	SEGA	SEGC	SEGE	SEGG	DIG1	DIG3
DOUT	DIN	0V	+5V	SEGB	SEGD	SEGF	SEGDP	DIG2	DIG4
2	4	6	8	10	12	14	16	18	20

Electrical Characteristics

Parameter	Min	Typ	Max	Units	Conditions
Supply voltage	4.0	5.0	5.5	V	
Shutdown supply current			150	uA	All leds off
Power supply current		330		mA	All segs on
Display scan rate	500	800	1300	Hz	8 digits scanned
Input voltage logic 0 (VL)	-0.3		0.8	V	Vcc=5.0 volts
Input voltage logic 1 (VH)	3.5			V	Vcc=5.0 volts
Segment drive current(seg off)			1	uA	
Segment drive current(seg on)	-30	-40	-45	mA	
Segment matching		3		%	
Output sink current (digit off)			10	uA	Vdig=10 volts
Output sink current (digit on)	320			mA	Vout=0.65
Clock High time	50			ns	tr = tf = 20ns
Clock Low time	50			ns	
Clock period	100			ns	
CS fall to SCLK rise setup	25			ns	
Clk rise to CS rise hold time	0			ns	
Din setup time	25			ns	
Din hold time	0			ns	
Output data prop delay			25	ns	
Load rising edge to next clk rising edge	50			ns	
Minimum CS or load pulse high time	50			ns	
Data input to seg delay	2.5			ns	
Data input hold time	300			ns	
Brightness setting resistor		9.53		k ohms	Vdd=5V +/- 10%
Operating temperature	0		70	deg C	Vdd=5V 4 LED's on

LED Driver Bus Timing



typical timing LED driver bus

Pin Functions

+5v **Pin 1,8**
+5 volts power supply to LED

Data output **Pin 2**
Serial data output -the data into DIN is valid at DOUT 16.5 clock cycles later. This pin is used to daisy chain devices

Chip enable **Pin 3**
Chip select - this pin must be low for a data transfer to occur. he last 16 bits of serial data are latched on CS rising edge.

Data input **Pin 4**
Serial data input -data is loaded into the internal 16 bit register on the clocks rising edge.

Clock **Pin 5**
Clock line - On clocks rising edge data is shifted into the internal shift register. On clocks falling edge data is shifted out of Dout.

0 Volts **Pin 6,7**
The chip and LED's 0 volts line.

Digit 4,5,6,7 **Pin 9,10,11,12**
Digit lines 4 through 7 drive line that sinks current from the common cathode LED. These can be used to drive an external 4 digit 7 segment LED display(BM series). Digit lines 0 to 3 are connected to the "internal" display. Digit 0 is the LSB on the right hand side.

Segments A,B,C,D,E,F,G and DP **Pins 13,14,15,16,17,18,19,20**
Seven Segment drives and decimal point Drive that source current to the display

Serial Data Format (16 bits)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
X	X	X	X	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0

Register Address Map

Register	D15-D12	A3	A2	A1	A0	Hex code
No operation	X	0	0	0	0	X0
Digit 0	X	0	0	0	1	X1
Digit 1	X	0	0	1	0	X2
Digit 2	X	0	0	1	1	X3
Digit 3	X	0	1	0	0	X4
Digit 4	X	0	1	0	1	X5
Digit 5	X	0	1	1	0	X6
Digit 6	X	0	1	1	1	X7
Digit 7	X	1	0	0	0	X8
Decode mode	X	1	0	0	1	X9
Intensity	X	1	0	1	0	XA
Scan limit	X	1	0	1	1	XB

Shutdown	X	1	1	0	0	XC
Display test	X	1	1	1	1	XF

Display command Register Functions

Shutdown register Format (address Xch)

Mode	Address	D7	D6	D5	D4	D3	D2	D1	D0
Shutdown Mode	XCh	X	X	X	X	X	X	X	0
Normal Operation	XCh	X	X	X	X	X	X	X	1

Decode Mode Register: Setting this register sets BCD code (0-9,E,H,L,P and -) or no decode operation for each digit. Each bit in the register corresponds to one digit. A logic 1 selects Code B decoding whereas a logic 0 enables non decode mode. In decode mode bits 0-3 correspond to the BCD data for the digit and bit D7 is the decimal point. In non decode mode data bits 0 to 7 correspond to the segment lines as outlines in the table below.

Decode Mode register examples

Decode Mode	D7	D6	D5	D4	D3	D2	D1	D0	Hex code
No decode for digits 7-0	0	0	0	0	0	0	0	0	00
Code B decode for digit 0 and no decode for digits 7-1	0	0	0	0	0	0	0	1	01
Code B decode for digits 3-0 and no decode for digits 7-4	0	0	0	0	1	1	1	1	0Fh
Code B decode for digits 7-0	1	1	1	1	1	1	1	1	FFh

Decode Mode

7 Seg character	D7	D6-D4	D3	D2	D1	D0
0	DP 0n =1	Dont care	0	0	0	0
1	DP 0n =1	Dont care	0	0	0	1
2	DP 0n =1	Dont care	0	0	1	0
3	DP 0n =1	Dont care	0	0	1	1
4	DP 0n =1	Dont care	0	1	0	0
5	DP 0n =1	Dont care	0	1	0	1
6	DP 0n =1	Dont care	0	1	1	0
7	DP 0n =1	Dont care	0	1	1	1
8	DP 0n =1	Dont care	1	0	0	0
9	DP 0n =1	Dont care	1	0	0	1
-	DP 0n =1	Dont care	1	0	1	0
E	DP 0n =1	Dont care	1	0	1	1
H	DP 0n =1	Dont care	1	1	0	0
L	DP 0n =1	Dont care	1	1	0	1
P	DP 0n =1	Dont care	1	1	1	0
Blank	DP 0n =1	Dont care	1	1	1	1

Non Decode Mode

	D7	D6	D5	D4	D3	D2	D1	D0
Segment line	DP	A	B	C	D	E	F	G

The LED current is set to a maximum value via an on board resistor. This provides the maximum
level of brightness. The LED display controller also features a facility to Digitally set the display brigtness from the host microcontroller. This control allows the on board pulse width modulator to control the segment current and thus the brightness.

Intensity Register Format

Duty Cycle	D7-D4	D3	D2	D1	D0	Hex code
1/32 (min)	Dont care	0	0	0	0	X0h
3/32	Dont care	0	0	0	1	X1h
5/32	Dont care	0	0	1	0	X2h
7/32	Dont care	0	0	1	1	X3h
9/32	Dont care	0	1	0	0	X4h
11/32	Dont care	0	1	0	1	X5h
13/32	Dont care	0	1	1	0	X6h
15/32	Dont care	0	1	1	1	X7h
17/32	Dont care	1	0	0	0	X8h
19/32	Dont care	1	0	0	1	X9h
21/32	Dont care	1	0	1	0	XAh
23/32	Dont care	1	0	1	1	XBh
25/32	Dont care	1	1	0	0	XCh
27/32	Dont care	1	1	0	1	XDh
29/32	Dont care	1	1	1	0	XEh
31/32	Dont care	1	1	1	1	XFh

The display also features a scan limit register that sets how many digits are displayed from 1 to 8.These are displayed in a multiplexed manner with a typical display scan rate of 800Hz. Since the number of digits displayed affects the overall display intensity the scan limit registers should not be used to provide leading zero suppression.

WARNING: DO NOT select less than 3 scanned digits (there are 4 leds on the display so it should be set to 4) otherwise excessive power dissipation will occur in the driver chip.

Scan Limit Register format

Scan Limit	D7-D3	D2	D1	D0	Hex code
Digit 0	Dont care	0	0	0	X0h
Digit 0,1	Dont care	0	0	1	X1h
Digit 0,1,2	Dont care	0	1	0	X2h
Digit 0,1,2,3	Dont care	0	1	1	X3h
Digit 0,1,2,3,4	Dont care	1	0	0	X4h
Digit 0,1,2,3,4,5	Dont care	1	0	1	X5h
Digit 0,1,2,3,4,5,6	Dont care	1	1	0	X6h
Digit 0,1,2,3,4,5,6,7	Dont care	1	1	1	X7h

LED display characteristics

The Led display provides excellent output brightness verses forward current with intensity matching of better than 10% and a long operating life with minimal display degradation. The LED's on the driver PCB are termed "Internal" LED's, whilst those that can be attached to the driver chip via a cable (not longer than 10 inches) are termed external. Note that additional LED displays may require greater supply decoupling. It is recommended that 10uf of capacitance be added for every additional LED digit. A 10 volt electrolytic is suitable.

EMC: The displays are designed with slew limited drivers to ensure minimal EMC emmissions. However the cable that is wired to the display is a large source of unwanted emissions. Care should be taken to ensure minimal cable lengths are used where ever possible and a ferrite ring should be added to the cable to provide additional attenuation. The LED's draw quite a high instantaneous current and the power supply and its wiring should be designed to carry the current whilst providing a low impedance path. Additional capacitance may be required at the display. The end product must be complient with the relevant criteria and the user should check that the display is connected such that it is so.

Display LED format

Digit 7	Digit 6	Digit5	Digit 4	Digit 3	Digit 2	Digit 1	Digit 0
Ext LHS	Ext LHM	Ext RHM	Ext RHS	Int LHS	Int LHM	Int RHM	Int RHS

LED brightness Min/Typ (mCd)

Color	14mm	20mm	25mm	38mm
Green	0.9 / 2.4	1.0 / 2.55	1.3 / 3.3	1.3 / 3.6
HE Red	0.9 / 2.4	1.0 / 2.55	1.4 / 3.6	1.4 / 3.6
Yellow	0.9 / 2.4	1.0 / 2.55	1.3 / 3.2	1.3 / 3.2

Cascading displays: The displays are cascadable by connecting the Dout pin from the first display to the Din pin on the next display in line. The other signals (chip enable and clock) are common to all displays. The number of data bits remains the same for each display hence if 4 displays are cascaded then 64 bits are required to alter the displayed value ON ANY DISPLAY. The command set allows for a NO OPERATION which leaves the addressed display with the previous register values.

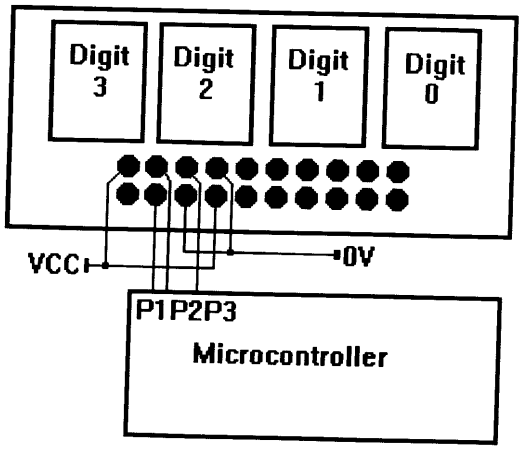
MAXIMUM RATINGS: THE USER IS DIRECTED TOWARDS THE MAXIMUM VALUES OUTLINED IN THE ELECTRICAL CHARACTERISTICS. OPERATION OUTSIDE OF THESE LIMITS MAY AFFECT PERMANENT DAMAGE TO THE LED DISPLAY OR THE DRIVER CHIP.

Additional Information: The user is directed towards the Maxim Integrated Products data sheet for the MAX7219/MAX7221 for information regarding the serial interface and further display driver commands.

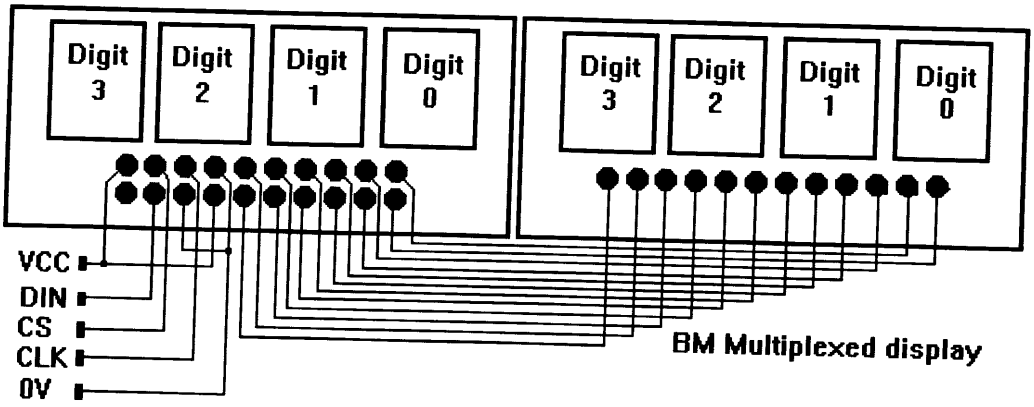
All Trade marks acknowledged.

Typical Applications

Simple 4 digit display to microcontroller interface.

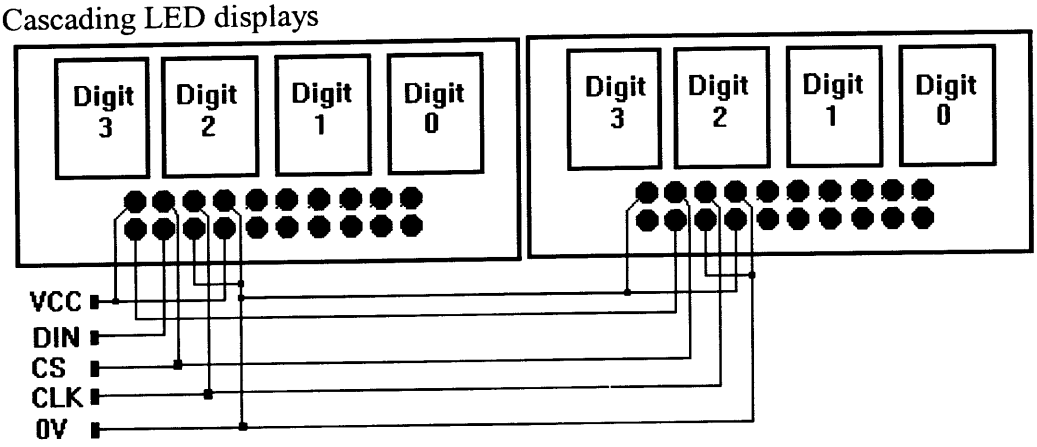


Driving an additional 4 digit displays from a SC LED/driver module



Typical Connections to external multiplexed LED

Cascading LED displays



Typical connection for cascading BxxSC04 displays