LED Driver IC

IK2108A

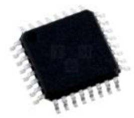
Description

The IK2108A are anode-grid LED display drives 5.0V~18.0V with output size – 8 digits x 14 segments to 12 digits x 10 segments and addition key scan function.
Serial interface provides connection with microprocessor.

Features

- Operation voltage for digital part: 3.0V ~ 5.5V
- Operation voltage for output LEDs: 5.0V ~ 18.0V
- 7-step individual dimming control for each grid
- OSC: built in (with external resistor) 500kHz @ R=12.1kΩ
- Pulse segment current: 27mA @ 8 digits x 14 segments
  39mA @ 12 digits x 10 segments
- Key scanning: 10x3 matrix
- Serial Interface
- Operation Temperature : -40 ~ 85°C

SOP-32



LQFP-32

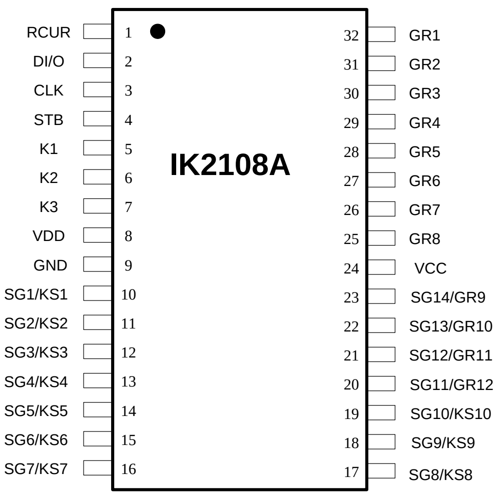
Application

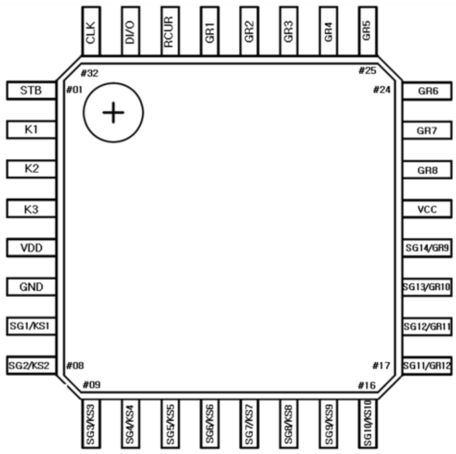
- Washing machine,refregerator, microwave oven, conditioner and other

ORDERING INFORMATION

Device	Operating Temperature Range	Package	Shipping
IK2108ADW	T_A = -40° to 85° C	SOP 32	Tube
IK2108ADWT		SOP 32	Tape&Reel
IK2108ALQ		LQFP-32	Tape&Reel

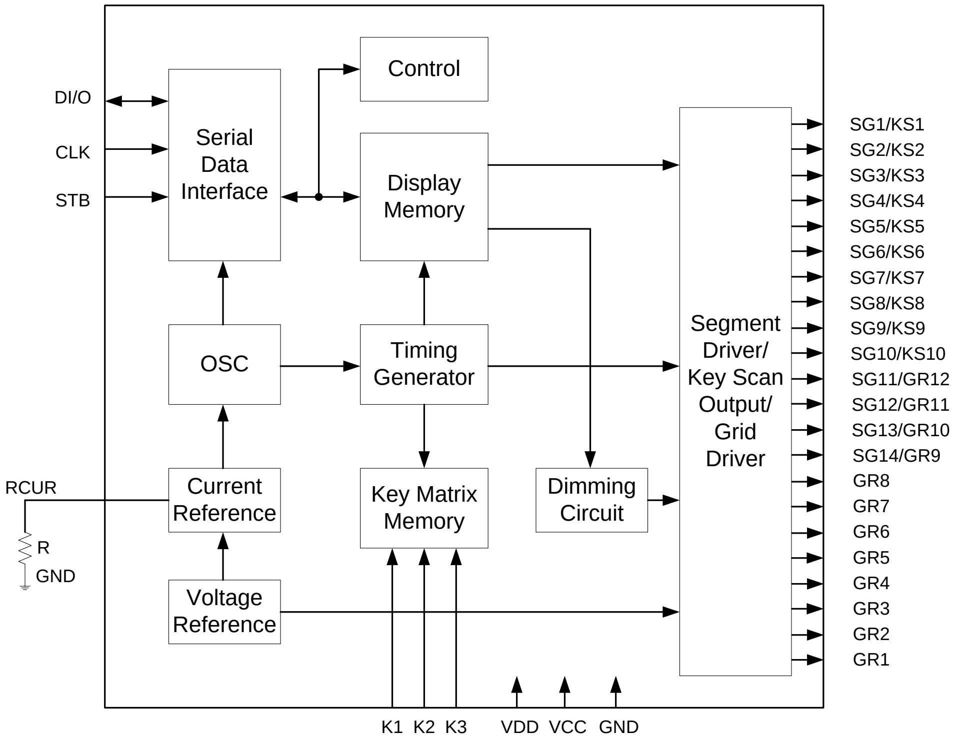
Pin Description IK2108A (32Pins)





Pin Name	I/O	Description	Pin №	
			SOP-32	LQFP-32
RCUR	I/O	A resistor is connected to this pin to determine the output currents and oscillation frequency.	1	30
DI/O	I/O	Data Input - Output Pin This pin inputs serial data at the rising edge of the shift clock (starting from the bit) Data Output Pin - N-Channel, Open-Drain This pin outputs serial data at the falling edge of the shift clock	2	31
CLK	I	Clock Input Pin This pin reads serial data at the rising edge and output data at the falling edge.	3	32
STB	I	Serial Interface Strobe Pin The data input after the STB has fallen is processed as a command. When this pin is HIGH, CLK is ignored.	4	1
K1 to K3	I	Key Data Input Pins The data sent to these pins are latched at the end of the display cycle. (Internal Pull-Up Resistor)	5-7	2-4
VDD	-	Power Supply for Digital Part	8	5
VCC	-	Power Supply for Output Part	24	21
SG1/KS1 to SG10/KS10	O	Segment Output Pins (N-channel open drain) Also acts as the Key Source	10-19	7-16
SG11/GR12 to SG14/GR9	O	Segment / Grid Output Pins	20-23	17-20
GR8 to GR1	O	Grid Output Pins (P-Channel, Open Drain)	25-32	22-29
GND	-	Ground Pin	9	6

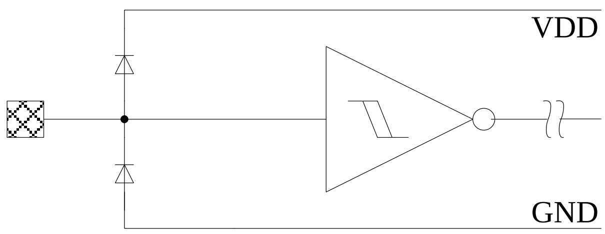
BLOCK DIAGRAM



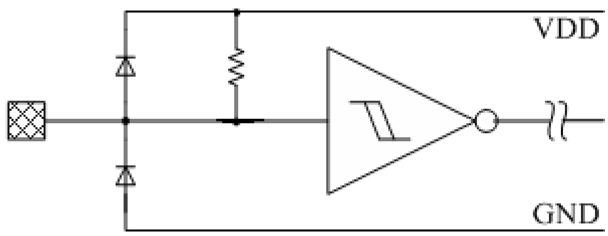
INPUT / OUTPUT CONFIGURATIONS

The schematic diagrams of the input and output circuits of the logic section are shown below.

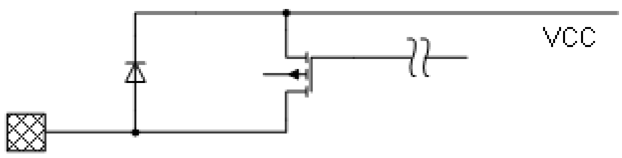
Input Pins: CLK, STB



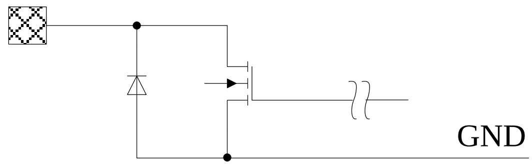
Input Pins: K1, K2, K3



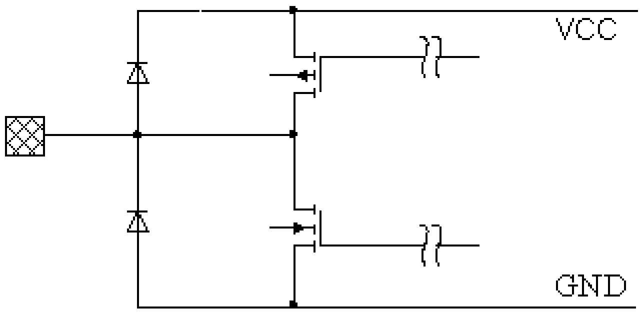
Output Pins: GR1 to GR8



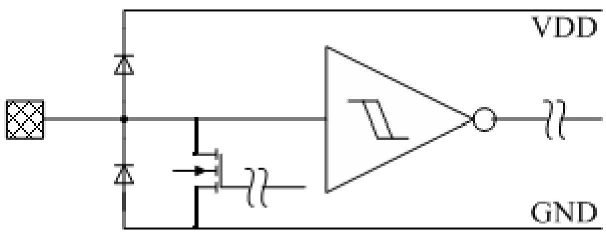
Output Pins: SG1/KS1 to SG10/KS10



Output Pins: SG11/GR12 to SG14/GR9



Input-Output Pin: DI/O



FUNCTIONAL DESCRIPTION

Commands

A command is the first byte (b0 to b7) inputted to IK2108A via DI/O Pin after STB Pin has changed from ”HIGH” to “LOW” state. If for some reason the STB Pin is set “HIGH” while data or commands are being transmitted, the serial communication is initialized, and the data commands being transmitted are considered invalid.

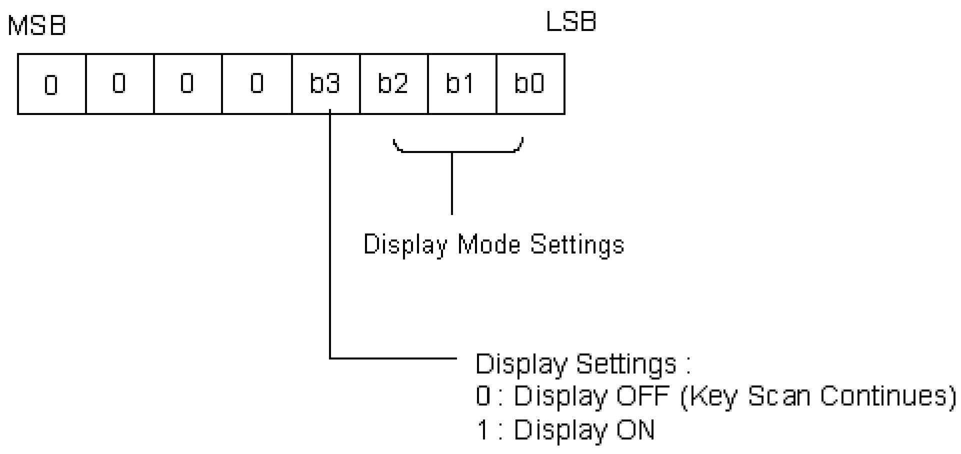
COMMAND 1: DISPLAY MODE SETTING COMMANDS

IK2108A provides 5 display modes setting as shown in the diagram below. As stated earlier a command is the first one byte (b0 to b7) transmitted to IK2108A via the DI/O Pin when STB is “LOW”. However, for these commands, Bit 5 to Bit 8 (b4 to b7) are given a value of “0”.

The Display Mode Setting Commands determine the number of segments and grids are used (14 to 10 segments, 8 to 12 grids). A display commands “ON” must be executed in order to resume display. If the same mode setting is selected, no command execution is take place, therefore, nothing happens.

The Display Mode Setting Commands are also used to turn ON or OFF the display. Please refer to the diagram below.

When the power is turned ON, the display is turned OFF (b3 is “0”) and the mode 111 is selected (b2 to b0 are “1”).

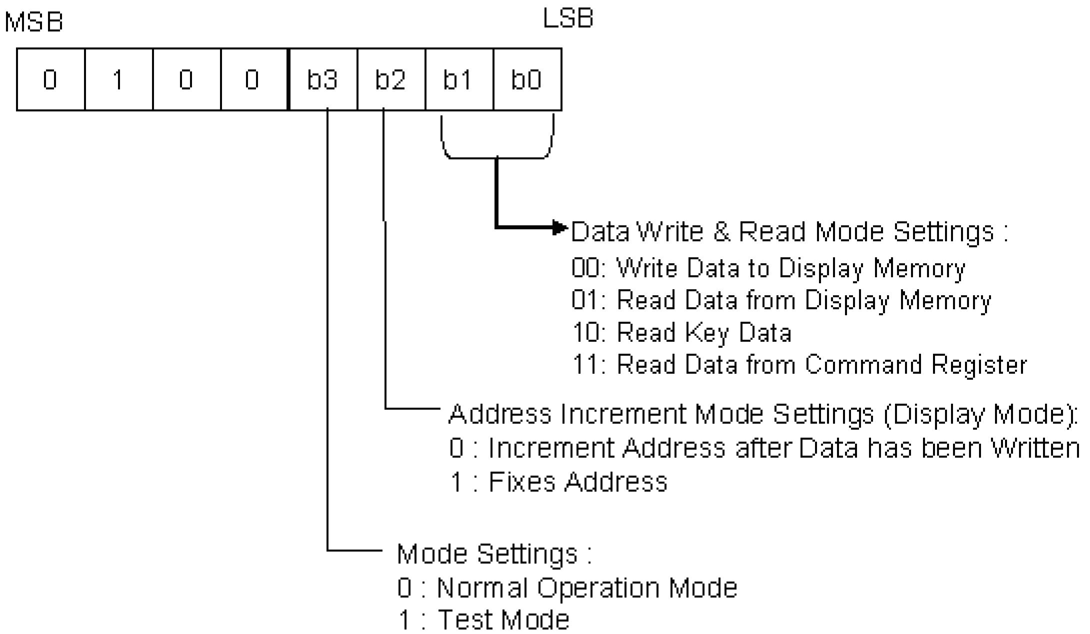


Display Mode Settings:
011: 12 Grids, (10 Segments)
100: 11 Grids, (11 Segments)
101: 10 Grids, (12 Segments)
110: 9 Grids, (13 Segments)
111: 8 Grids, (14 Segments)

COMMAND 2: DATA SETTING COMMANDS

The Data Setting Commands executes the Data Write Mode for IK2108A. The Data Setting Command, the bits5 and 6 (b4, b5) are given the value of “0”. , bit7 (b6) is given the value of “1” while bit8 (b7) is given the value of “0”. Please refer to the diagram below.

When power is turned ON, bit 4 to bit 1 (b3 to b0) are given the value of “0”.



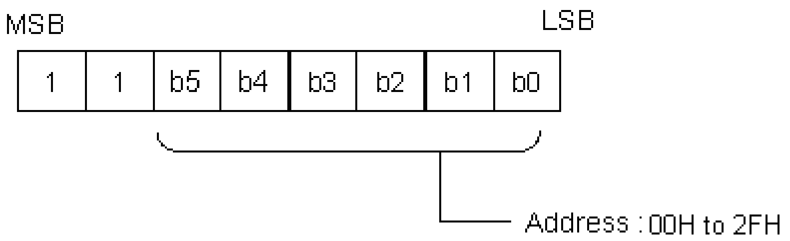
Read Data from Command Register:

	1st byte								2nd byte							
DOUT	b0	b1	b2	b3	b4	b5	b6	b7	b0	b1	b2	b3	b4	b5	b6	b7
	b0-b3 of command1				b0-b3 of command2				b0-b5 of command3						don’t care	

COMMAND 3: ADDRESS SETTING COMMANDS

Address Setting Commands are used to set the address of the display memory. The address is considered valid if it has a value of “00H” to 2FH”. If the address is set to 30H or higher, the data is ignored until a valid address is set. When power is turned ON, the address is set at “00H”.

Please refer to the diagram below.



Display Mode and RAM Address

Data transmitted from an external device to IK2108A via the serial interface are stored in the Display RAM and are assigned addresses. When the power is turned ON, the memory is set at “0”. The RAM Addresses of IK2108A are given below in 8 bit unit.

	dimming		SG1 SG4	SG5 SG8	SG9 SG14	
GR1	$00H_L$	$00H_U$	$01H_L$	$01H_U$	$02H_m$	03
GR2	$04H_L$	$04H_U$	$05H_L$	$05H_U$	$06H_m$	07
GR3	$08H_L$	$08H_U$	$09H_L$	$09H_U$	$0AH_m$	0B
GR4	$0CH_L$	$0CH_U$	$0DH_L$	$0DH_U$	$0EH_m$	0F
GR5	$10H_L$	$10H_U$	$11H_L$	$11H_U$	$12H_m$	13
GR6	$14H_L$	$14H_U$	$15H_L$	$15H_U$	$16H_m$	17
GR7	$18H_L$	$18H_U$	$19H_L$	$19H_U$	$1AH_m$	1B
GR8	$1CH_L$	$1CH_U$	$1DH_L$	$1DH_U$	$1EH_m$	1F
GR9	$20H_L$	$20H_U$	$21H_L$	$21H_U$	$22H_m$	23
GR10	$24H_L$	$24H_U$	$25H_L$	$25H_U$	$26H_m$	27
GR11	$28H_L$	$28H_U$	$29H_L$	$29H_U$	$2AH_m$	2B
GR12	$2CH_L$	$2CH_U$	$2DH_L$	$2DH_U$	$2EH_m$	2F

b0 b3	b4 b7	b0 b3	b4 b7	b0 b5	b0 b7
xxH_L	xxH_U	xxH_L	xxH_U	xxH_m	xx
Lower 4 bits	Higher 4 bits	Lower 4 bits	Higher 4 bits	Lower 6 bits	8 bits

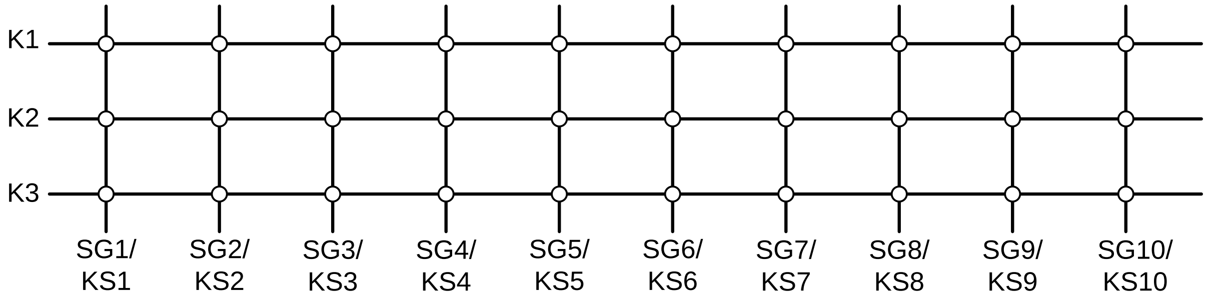
<table>
<tr><td></td><td colspan="8">1’st byte</td><td colspan="8">2’nd byte</td><td colspan="8">3’rd byte</td><td colspan="8">4’th byte</td></tr>
<tr><td>DIN</td><td>b0</td><td>b1</td><td>b2</td><td>b3</td><td>b4</td><td>b5</td><td>b6</td><td>b7</td><td>b0</td><td>b1</td><td>b2</td><td>b3</td><td>b4</td><td>b5</td><td>b6</td><td>b7</td><td>b0</td><td>b1</td><td>b2</td><td>b3</td><td>b4</td><td>b5</td><td>b6</td><td>b7</td><td>b0</td><td>b1</td><td>b2</td><td>b3</td><td>b4</td><td>b5</td><td>b6</td><td>b7</td></tr>
<tr><td></td><td colspan="3">dimming</td><td colspan="5">don’t care</td><td colspan="8">data for SG1-SG8</td><td colspan="6">data for SG9-SG14</td><td colspan="10">don’t care</td></tr>
</table>

Dimming Quantity Settings:

b2	b1	b0	Pulse width
0	0	0	1/16
0	0	1	2/16
0	1	0	3/16
0	1	1	5/16
1	0	0	7/16
1	0	1	10/16
1	1	0	14/16
1	1	1	reserved

KEY MATRIX & KEY INPUT DATA STORAGE RAM

Key Matrix consists of 10 x 3 array as shown below:



Each data entered by each key (or any combination of keys) is stored as follows and read by a READ Command, starting from the last significant bit. When the most significant bit of the data (b0) has been read, the least significant bit of the next data (b7) is read.

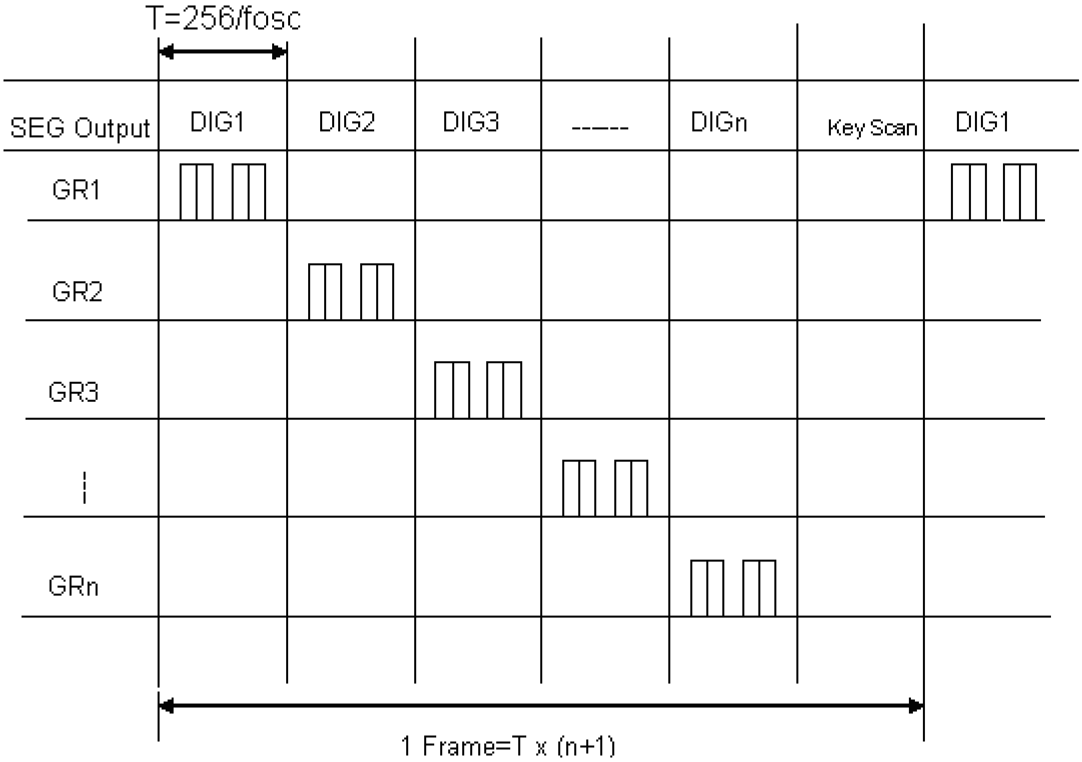
K1 K2 K1 K2
K3 K3

SG1/KS1	SG2/KS2	x	1'st byte read
SG3/KS3	SG4/KS4	x	2'nd byte read
SG5/KS5	SG6/KS6	x	3'rd byte read
SG7/KS7	SG8/KS8	x	4'th byte read
SG9/KS9	SG10/KS10	x	5'th byte read

b0 b1 b3 b4 b6
b2 b5 b7

Key press="1", Key no press="0" read.

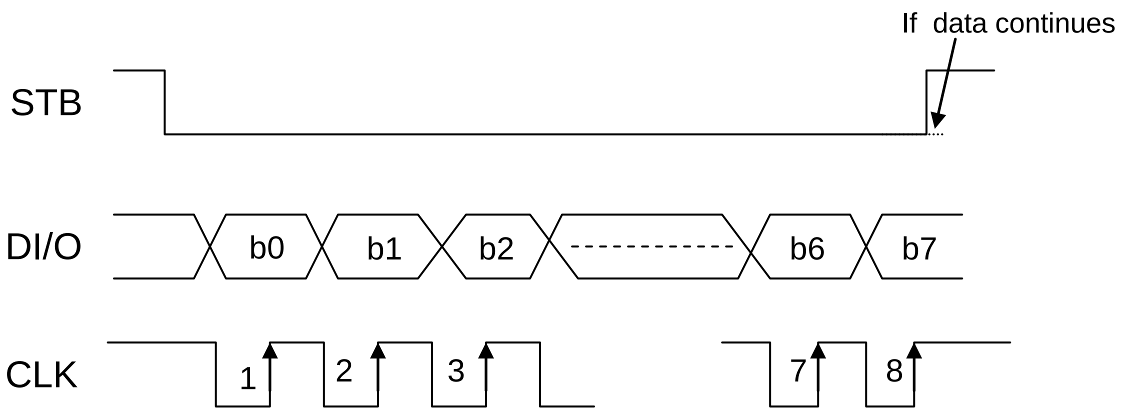
SCANNING AND DISPLAY TIMING



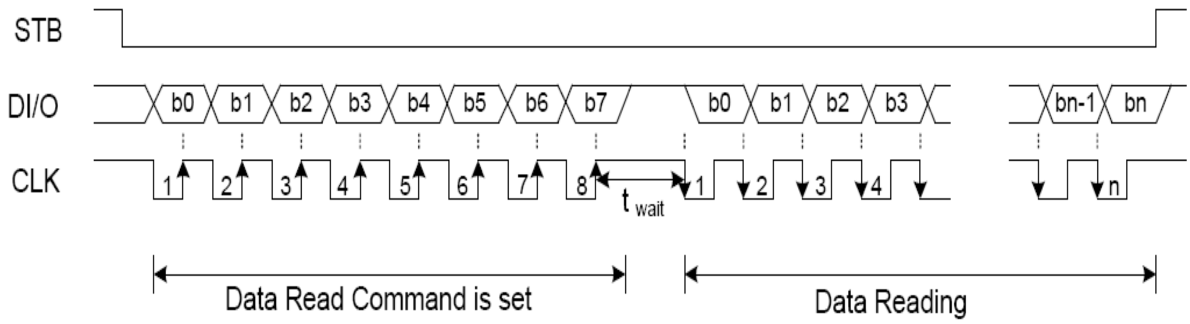
SERIAL COMMUNICATION FORMAT

The following diagram shows the serial communication format.

Reception (Data/Command Write)



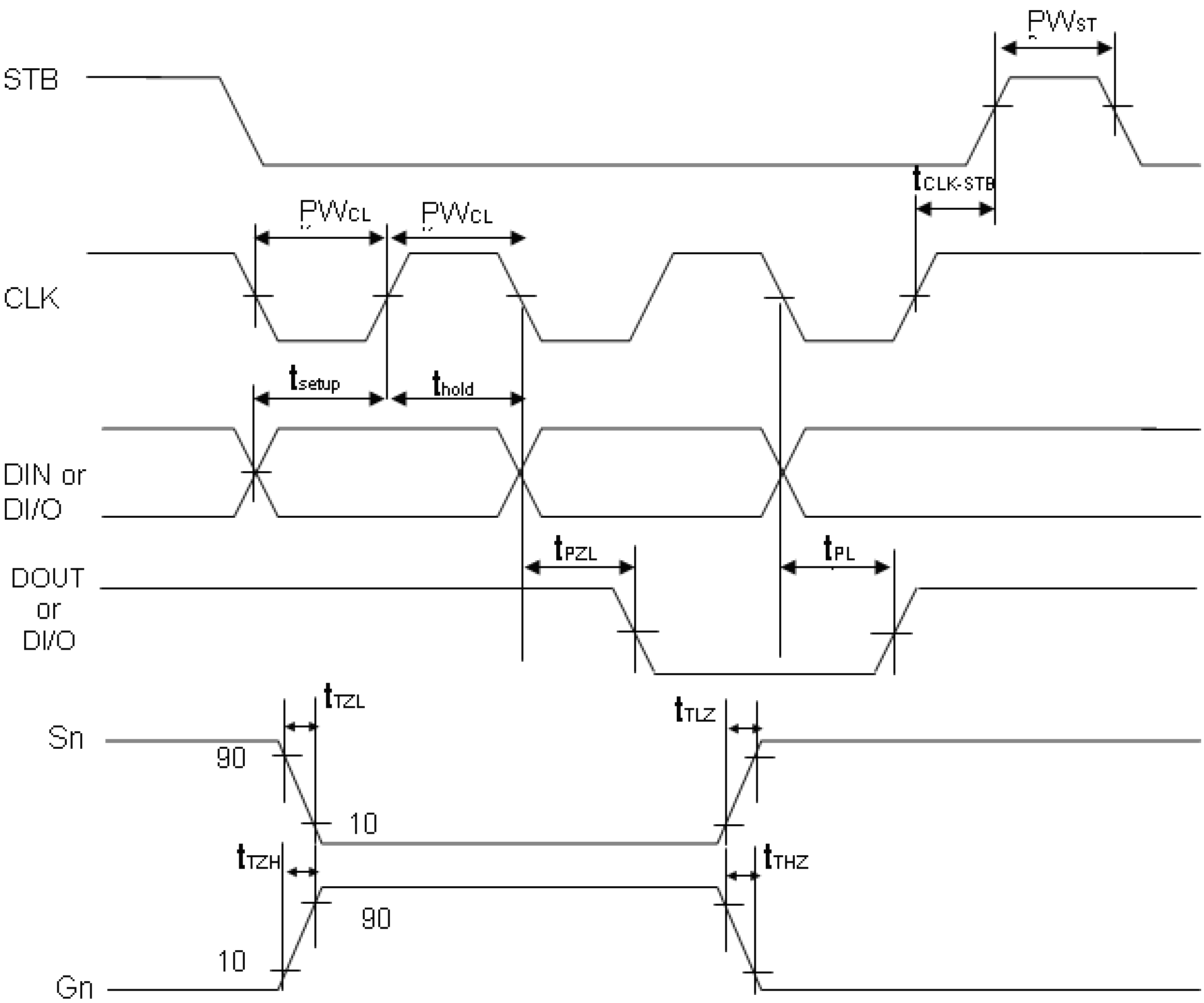
Transmission (Data Read)



Where: t_{wait} (waiting time) ≥ 1µs

SWITCHING CHARACTERISTIC WAVEFORM

Switching Characteristics Waveform is given below.

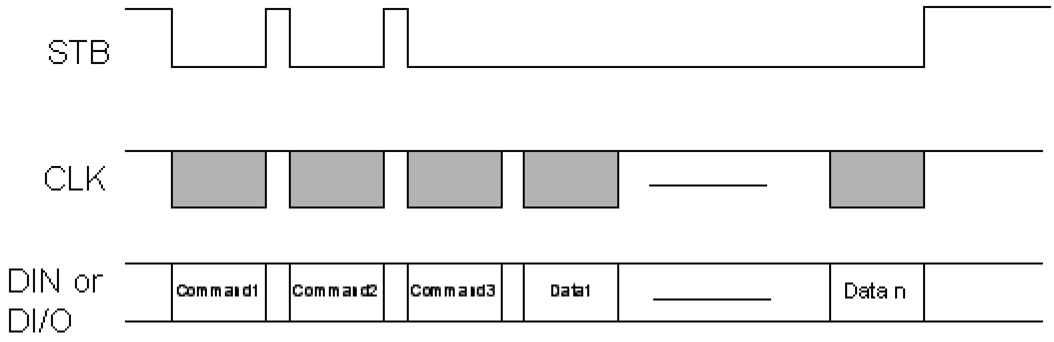


PW $_{CLK}$ (Clock Pulse Width) ≥400ns
t setup (Data Setup Time) ≥ 100ns
t $_{CLK-STB}$ (Clock - Strobe Time) ≥ 1㎲
t $_{TZH}$ (Rise Time) ≤ 1㎲
t $_{TZL}$ <1㎲

PW$_{STB}$ (Strobe Pulse Width) ≥ 1㎲
thold (Data Hold Time) ≥ 100ns
t $_{THZ}$ (Fall Time) ≤ 10㎲
fosc = Oscillation Frequency
t $_{TLZ}$ <10㎲

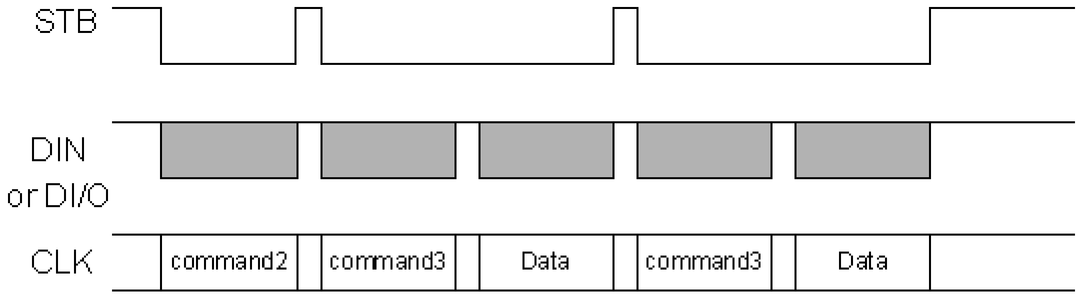
APPLICATIONS

Display memory is updated by incrementing addresses. Please refer to the following diagram.



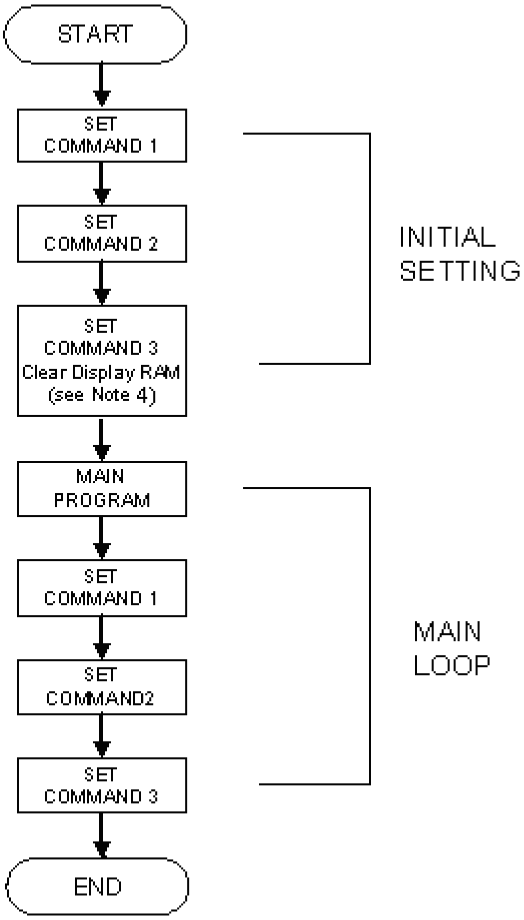
Where: Command 1: Display Mode Setting
Command 2: Data Setting Command
Command 3: Address Setting Command
Data 1 to n : Transfer Display Data (48 Bytes max.)

The following diagram shows the waveforms when updating specific addresses.



Where: Command 2 -- Data Setting Command
Command 3 -- Address Setting Command
Data -- Display Data

RECOMMENDED SOFTWARE PROGRAMMING FLOWCHART



Note: 1. Command 1: Display Mode Setting

2. Command 2: Data Setting Commands

3. Command 3: Address Setting Commands

4. When IC power is applied for the first time, the contents of the Display RAM are not defined: thus, it is strongly suggested that the contents of the Display RAM must be cleared during the initial setting.

ABSOLUTE MAXIMUM RATINGS

(Unless otherwise stated, Ta=25°C, GND=0V)

Parameter	Symbol	Rating	Units
Supply Voltage	Vcc	-0.5 to +18.0	V
Supply Voltage	V_{DD}	-0.5 to +6.0	V
Logic Input Voltage	V_I	-0.5 to V_{DD}+0.5	V
Driver Output Current/Pin	I_{OHGR}	-468	mA
	I_{OLSG}	46.8	mA
Maximum Driver Output Current/Total	I_{TOTAL}	470	mA
Operation Temperature	Topr	-40 ~ +85	℃
Storage Temperature	Tstg	-65 ~ 150	℃

* Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device.
These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied.
Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

RECOMMENDED OPERATING RANGE

(Unless otherwise stated, Ta= -40 to +85°C, GND=0V)

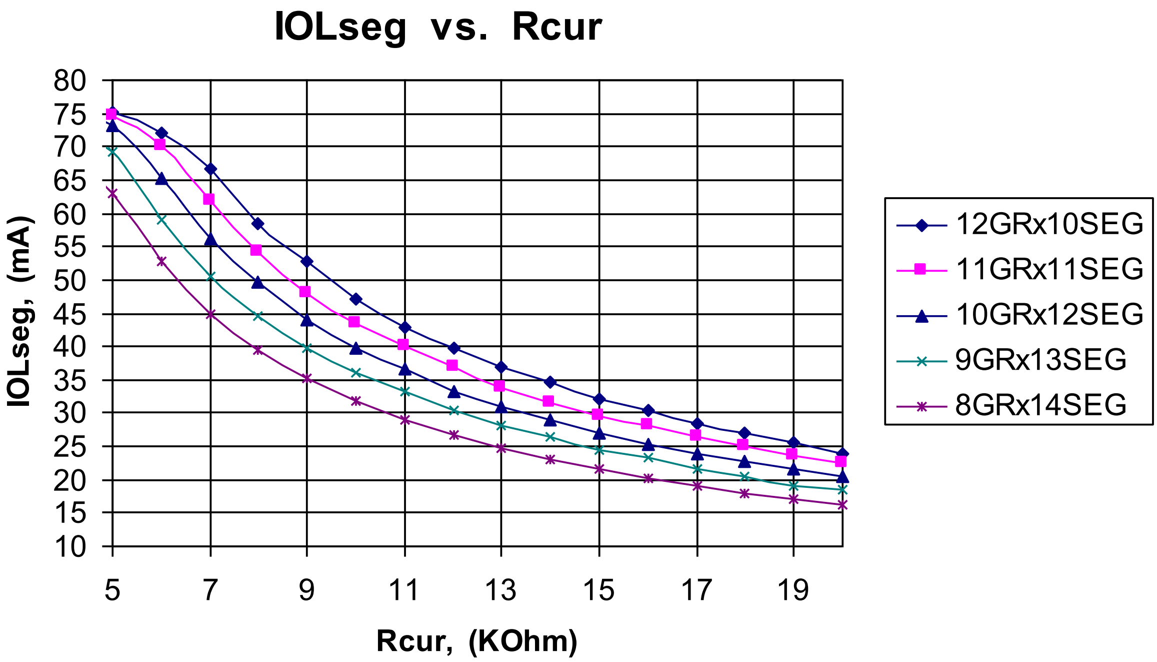
Parameter	Symbol	Min	Typ	Max	Unit
Supply Voltage	Vcc	5.0	12.0	15.0	V
Logic Supply Voltage	V_{DD}	3.0	5.0	5.5	V
High-Level Input Voltage	V_{IH}	0.7V_{DD}	.	V_{DD}	V
Low-Level Input Voltage	V_{IL}	0	.	0.3 V_{DD}	V

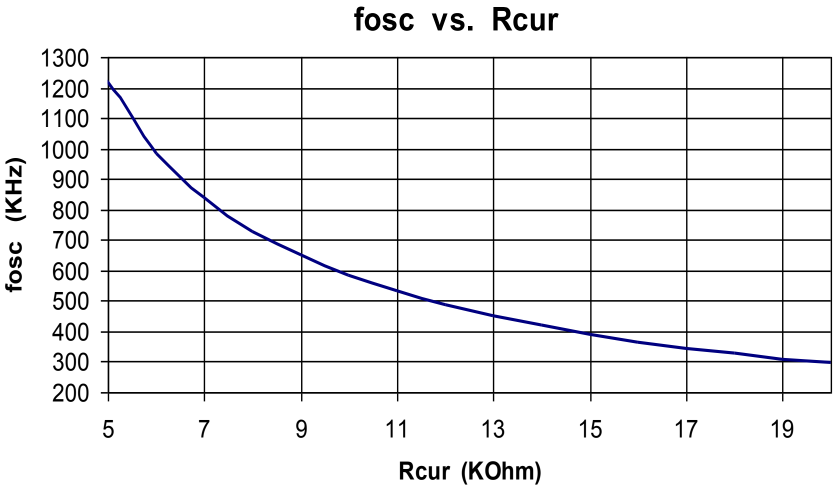
ELECTRICAL CHARACTERISTICS

(Unless otherwise stated, Vcc=5.0~18.0V, V_{DD}=3.3~5.5V, GND=0V, Ta=-40 ~ 85°C)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Low-Level Output Current	I_{OLSG}	Vo=1.0V SG1/KS1 to SG10/KS10 SG11/GR12 to SG14/GR9 display 8digitsx14segments	21.6	27	32.4	mA
		Vo=0.9V SG1/KS1 to SG10/KS10 display 12digitsx10segments	31.2	39	46.8	
High-Level Output Current	I_{OHGR}	Vo=Vcc-1.0V R = 12.1KOhm GR1 to GR8 display 8digitsx14segments	-302.4	-378	-453.6	mA
		Vo=Vcc-1.1V R = 12.1KOhm GR1 to GR8 SG11/GR12 to SG14/GR9 display 12digitsx10segments	-312	-390	-468	
Dynamic Current	I_{DDdyn}	-	-	-	1.2	mA
Digital Input Current	I_{DG}	-	-1	-	+1	uA
Low-Level Digital Output Current	I_{OLDOUT}	V_O = 0.4V DOUT	4	-	-	mA
Segment Low-Level Output Current Tolerance	I_{TOLSG}	Vo=1.0V SG1/KS1 to SG10/KS10 SG11/GR12 to SG14/GR9 display 8digitsx14segments	-	-	±5	%
		Vo=0.9V SG1/KS1 to SG10/KS10 display 12digitsx10segments	-	-	±5	
High-Level Input Voltage for DI/O	V_{IH}	-	0.7V_{DD}	-	V_{DD}	V
Low-Level Input Voltage for DI/O	V_{IL}	-	0	-	0.3V_{DD}	V
Oscillation Frequency	f_{OSC}	(V_{DD}=3.3 ~5.5V) R = 12.1kOhm	400	500	600	kHz
K1 to K3 Pull Up Resistor	R_{PU}	K1 to K3 V_{DD} =5.0V	22.5	30.0	37.5	KΩ

APPLICATION NOTE





1. The graph of I_{OLSG} vs. R_{CUR} is given for the case when only one segment is turn on. Choosing the external resistor R_{CUR} for the setting I_{OLSG}, make sure, that current

$$I_{OHGR}=(\text{number of segments})*I_{OLSG} \leq 390\text{mA}$$

2. The cell of Display Memory has a dead time zone. If the software program is not correct, it is possible the blinking of display. The blinking frequency for the single segment is:

$$F_{BLINK}^{MAX} = \frac{F_{COMMAND\,2}}{256 * G}(1 + 0.5 * \frac{F_{OSC}}{F_{CLK}})$$, (less value is better),

where $F_{COMMAND2}$ – frequency of the use of the command2 (Write Data to Display Memory);

G– number of grids in used mode;

F_{OSC}– frequency of internal OSC;

F_{CLK} – clock frequency.

So, main rule for update the Display Memory is do it if it really need. Don't do it continually with high speed, but if it something like movie you can. Or another way is turn off the display while the command of Write Data to Display Memory is executed.

3. To determine the Average Consumption Current of IK2108A, you should use the next formula (the current value during key scan period is ignored as this value is very small in compare with segment's current):

Itotal(avrg) = (N* I_{OLSG} *Dimming)*(M/(M+1)),

where N is segment's number;

M is grid's number;

Dimming is Dimming value (see p.7);

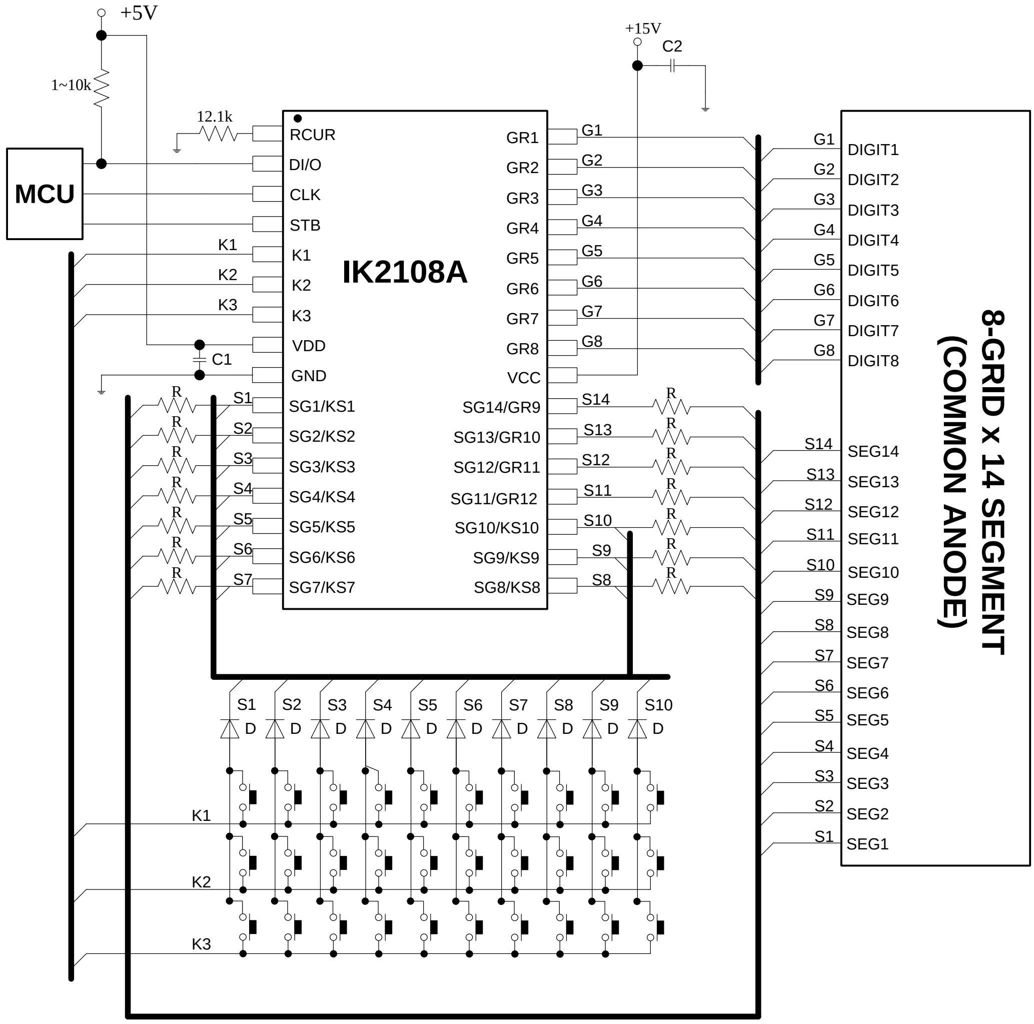
I_{OLSG} is output segment's current (see table Electrical Characteristics).

Therefore different display configurations will have different current consumption. Let's consider the maximum case, when Dimming is 14/16 and all segments and grids are used:

8 grids x 14 segments display: Itotal(avrg)=(14*27mA(typical value)*14/16)*(8/9)=294mA;

12 grids x 10 segments display: Itotal(avrg)=(10*39mA(typical value)*14/16)*(12/13)=315mA.

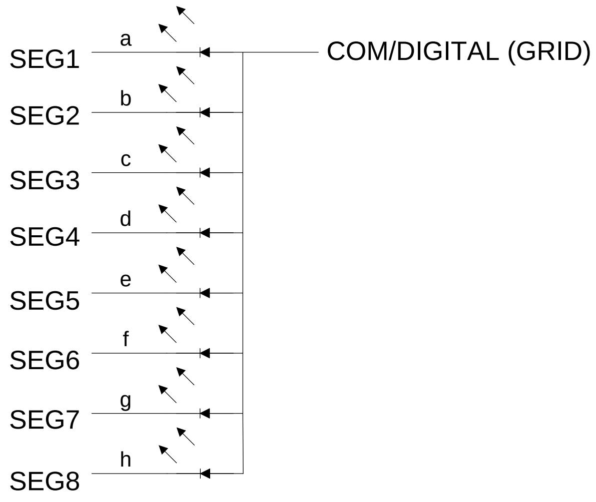
APPLICATION CIRCUIT
(FOR 8GRID x 14SEGMENT DISPLAY)

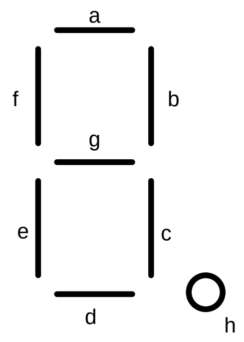


Recommend value:

C1&C2	0.1uF-ceramics
R	160Ohm 0.5W (if one diode is connected)
	110Ohm 0.25W (if two diodes are connected)

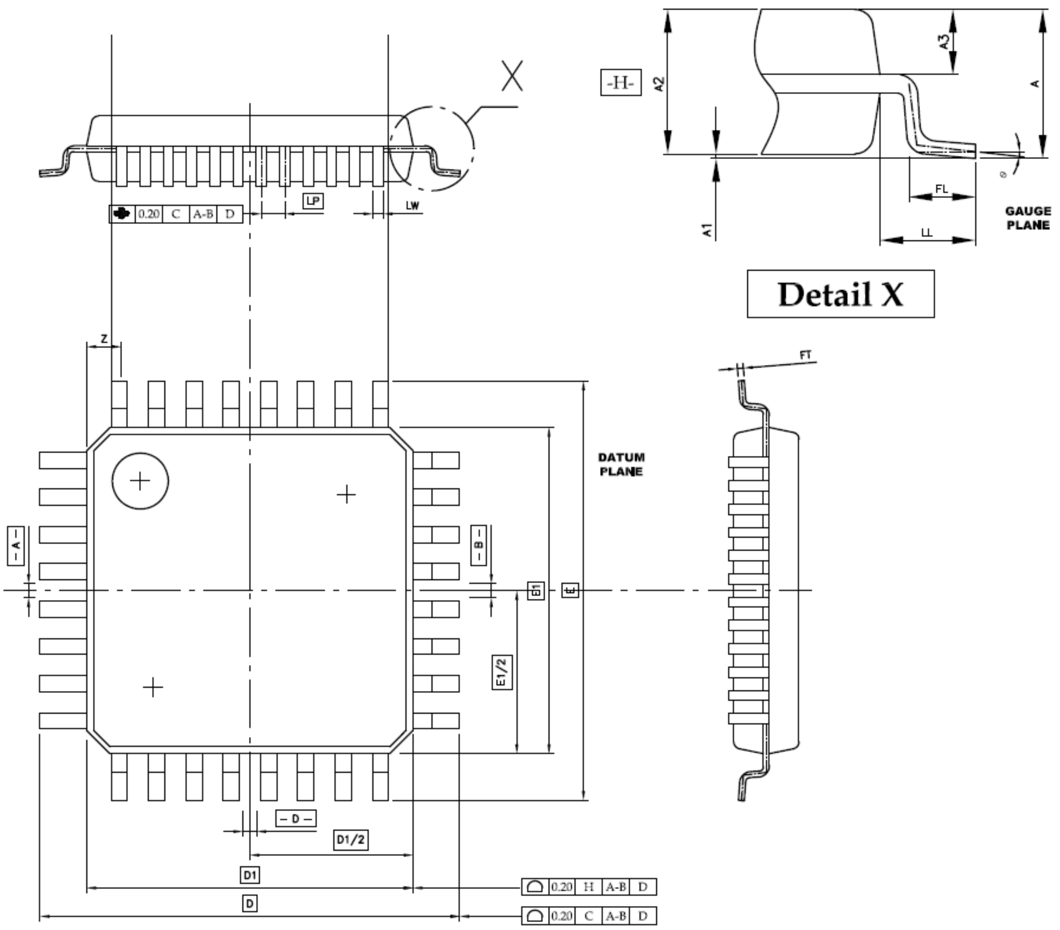
COMMON ANODE TYPE LED PANEL





Package Dimension

LQFP-32



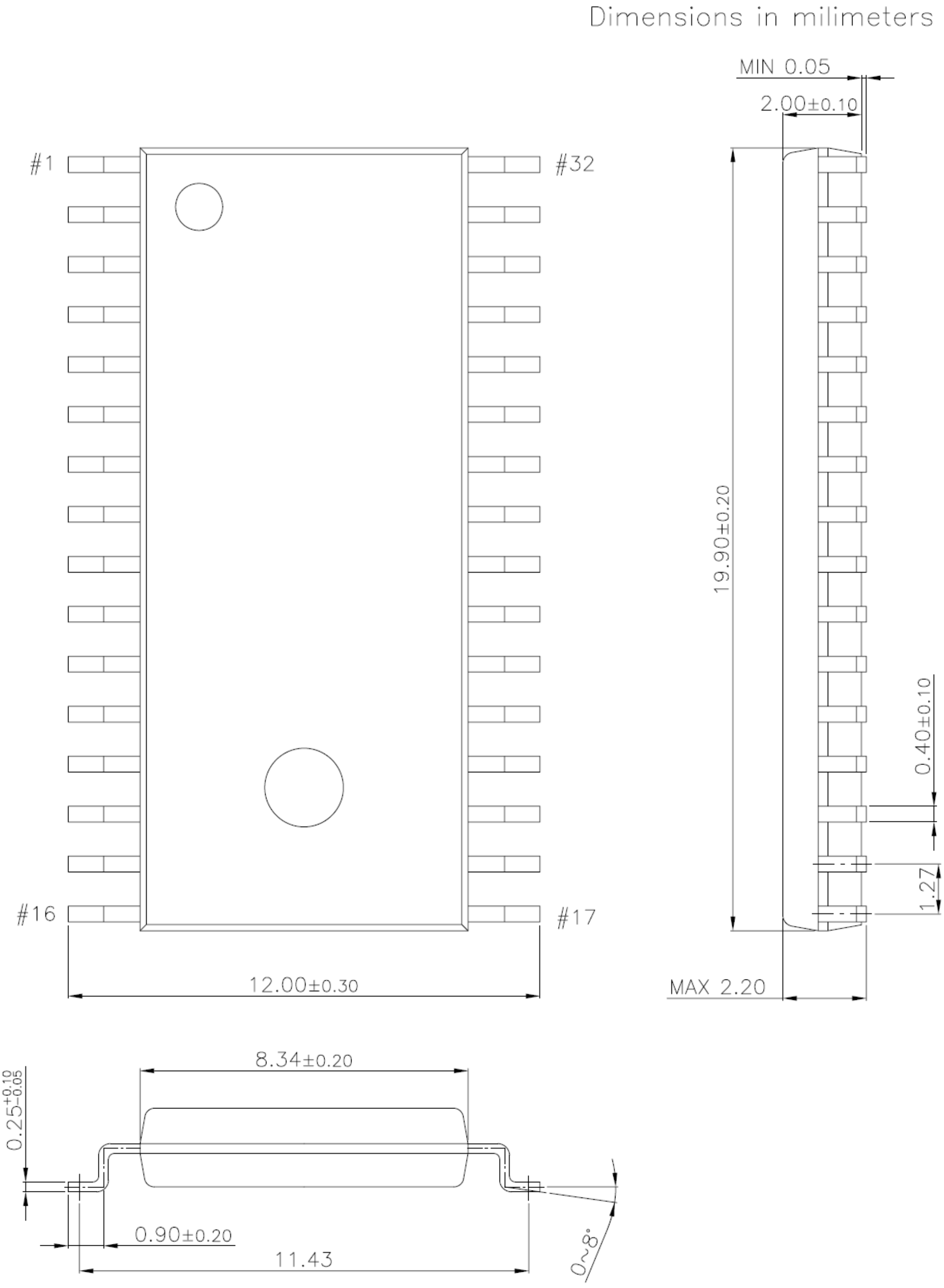
Dimensions

Unit	D1	E1	D/E [TL]	FT	LP	LW	A max.	A1	A2	A3	LL	FL	θ	Z
mm	7.10 6.90	7.10 6.90	9.20 8.80	0.127 BSC	0.80	0.390 0.310	1.60	0.15 0.05	1.45 1.35	(0.64)	1.00	0.75 0.45	8 0	0.75

Notes

1. All Dimensions are in Millimeters.
2. Dimensions Do Not include Burrs, Mold Flash, and Tie-bar Extrusions.
3. JEDEC References : MS-026

32-SOP-450A



Dimensions in milimeters
MIN 0.05
2.00±0.10
#1
#32
#16
#17
19.90±0.20
0.40±0.10
1.27
12.00±0.30
MAX 2.20
8.34±0.20
0.25+0.10-0.05
0.90±0.20
11.43
0~8°