

I²C GLCD Adapter for KS0108 128x64 Manual (1.4)

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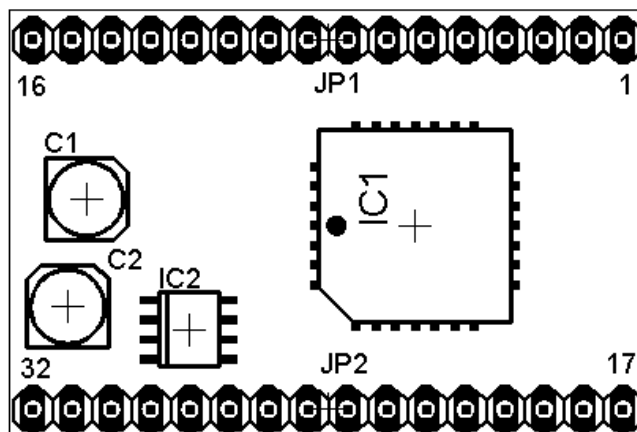
1. General discription

The I²C LC-Display Adapter enables easy interfacing a graphic LC-Display (KS0108 128x64) to an I²C-Bus (two wire serial interface). Communication between a host and the I²C GLCD takes places via the two wire bi-directional serial interface. It is possible to connect up to 128 devices (theoretical) on the same bus. Slave addresses are programmable via controller EEPROM.

Features:

- 5 V supply voltage
- Low-level input voltage (SCL,SDA only): min. $-0.5V$ - max. $0.3V_{DD}$
- High-level input voltage (SCL,SDA only): min. $0.7 V_{DD}$ - max. $5.5V$
- 400 kHz byte-wide I2C-bus communication port

2. Pinning Information



Pin	Description
1	N.C. Not connected
2	N.C. Not connected
3	CS2 Chip select
4	N.C. Not connected
5	CS1 Chip select
6	E Chip enable signal
7	RW Read / Write mode
8	DI Register selection Input
9	DB7 Data Bit 7
10	DB6 Data Bit 6
11	DB5 Data Bit 5
12	DB4 Data Bit 4
13	DB3 Data Bit 3
14	DB2 Data Bit 2
15	DB1 Data Bit 1
16	DB0 Data Bit 0

Pin	Description
17	N.C. Not connected
18	N.C. Not connected
19	SCL serial clock line
20	SDA serial data line
21	N.C. Not connected
22	N.C. Not connected
23	IO1 In/Out-pin 1
24	IO2 In/Out-pin 2
25	N.C. Not connected
26	N.C. Not connected
27	GND 0V Ground
28	RST Reset
29	GND 0V Ground
30	GND 0V Ground
31	GND 0V Ground
32	V _{DD} 5V Supply voltage

3.2 Address of the circuit

This circuit operates in slave mode. Each circuit must be provided with a physical address on order to discern this circuit from other ones on the I²C-bus. This address is coded on 7 bits and one bit is hardwired to '1', so that it is possible to connect 64 different circuits on the same bus. The address is always 0xFE at delivery.

3.3 The I²C Bus specification

3.3.1 Start and Stop conditions

Within the procedure of the I²C bus, unique situations arise which are defined as START (S) and STOP (P) conditions.

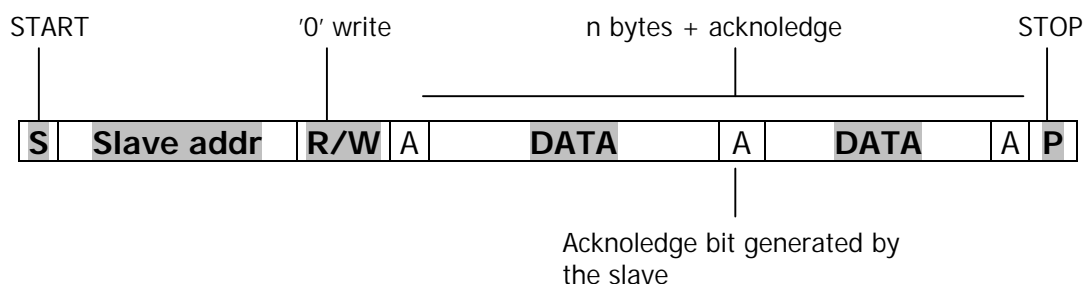
- A HIGH to LOW transtion on the SDA line while SCL is HIGH defines a Start condition.
- A LOW to HIGH transtion on the SDA line while SCL is HIGH defines a Stop condition.

Start and Stop conditions are always generated by the master. The bus is considered to be busy after a START condition. The bus is considered to be free again a certain time after a STOP condition.

3.3.1 Write data to I²C GLCD Controller

Writing data to a device on the I²C-Bus is agreed as follow:

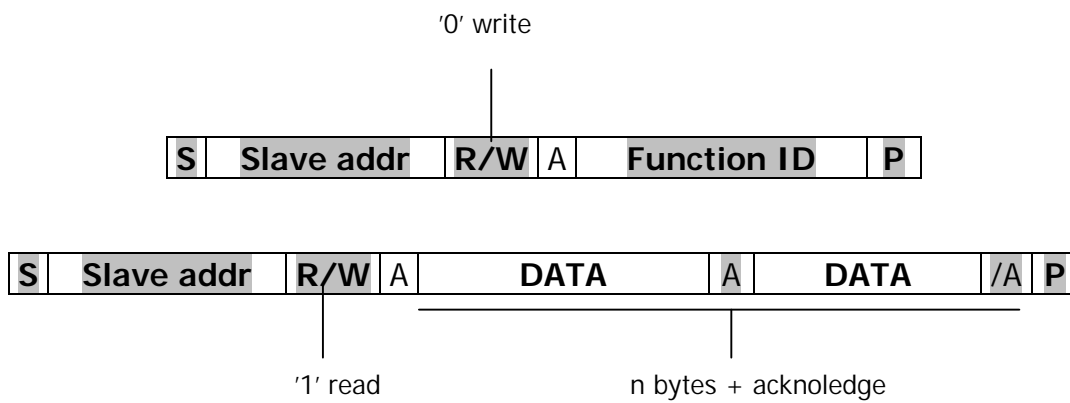
After the START condition, a slave address is sent. This address is 7 bits long followed by an eight bit which is a data direction bit ('0'=write, '1'=read) and an acknowledge bit. Any further data byte is followed by an acknowledge bit. A data transfer is always terminated by a STOP condition.



3.3.1 Read data from I²C GLCD Controller

Reading data from a device on the I²C-Bus is agreed as follow and it consists of two sequences:

1. The first sequence consists of four bytes of data. The first byte is the slave address and write bit. The second consists of the function ID (or more) which reads the data from the RAM of the GLCD and stores them in an internal register of the I²C GLCD Controller.
2. The second sequence consists of the slave address and the read bit. Then the master can read the data. After each byte of data the master has to acknowledge correct data reception. The last byte is not to acknowledge by the master and therefore the slave knows the end of transmission.



For further information about the I²C-Bus specification please visit philips semiconductors on the internet at <http://www.semiconductors.philips.com> and download the datasheet.

4. Commands description

4.1 Command Overview

Command	Function	Command Byte
CMDToGLCD	Sends a command to the GLCD	0x41
DatToGLCD	Sends a data byte to the GLCD	0x42
nDatToGLCD	Sends up to 254 data bytes to the GLCD	0x40
SetSLine	Sets the start line	0x43
DispON	Enable / Disable Display (ON / OFF)	0x44
SetTxtPos	Sets cursor position (Row, Column)	0x45
SendByte	Sends a byte to GLCD	0x46
SendnBytes	Sends up to 254 Bytes to GLCD	0x47
ReSetPixel	Set/Reset one Pixel	0x48
InvByte	Read, reverse and write a byte to GLCD	0x49
InvPage	Read, reverse and write a page to GLCD	0x4A
InvDisp	Display reverse	0x4B
FillDisp	Fills display with a certain byte	0x4C
FillRect	Draws a solid rectangle	0x4D
VLine	Draws a vertical line	0x4E
HLine	Draws a horizontal line	0x4F
Rectangle	Draws a rectangle	0x50
RoundRectangle	Draws a round rectangle	0x51
Circle	Draws a circle	0x52
CharToGLCD6x8	Writes a 6x8 character on GLCD	0x53
StringToGLCD6x8	Writes up to 254 6x8 characters on GLCD	0x54
CharToGLCD8x8	Writes a 8x8 character on GLCD	0x55
StringToGLCD8x8	Writes up to 254 8x8 characters on GLCD	0x56
ReadByte	Reads a Byte at X,Y position	0x57
ReSetIO1	Sets or resets IO-Pin 1	0x60
ReSetIO1	Sets or resets IO-Pin 2	0x61
ReadIOs	Reads the state of IO-Pins 1 and 2	0x62
SetSlvAdr	Changes slave address	0x73

4.2 Command Description

4.2.1 CMDToGLCD

Some times it is necessary to a single command to the LCD. In order to send a command to GLCD issue the following command by the master.

CMDToGLCD command (0x41)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	M1	0
1	CMDToGLCD	0	1	0	0	0	0	0	1
2	cmd byte	GLCD command							
3	Controller (CS)	x	x	x	x	x	x	CS (1:0)	

CS		comment
0	0	Controller 1 selected (default)
0	1	Controller 2 selected
1	0	Controller 1 and 2 selected
1	1	Default controller selected

x	Do not care
---	-------------

4.2.2 DatToGLCD

In order to send a data byte to GLCD issue the following command by the master

DatToGLCD command (0x42)									
Byte	Content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	M1	0
1	DatToGLCD	0	1	0	0	0	0	1	0
2	data byte	GLCD data byte							
3	Controller (CS) *	x	x	x	x	x	x	CS (1:0)	

4.2.3 nDatToGLCD

In order to write an array of bytes (up to 254 bytes) send the following command:

nDatToGLCD command (0x40)									
Byte	Content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	M1	0
1	nDatToGLCD	0	1	0	0	0	0	0	0
2	Controller (CS) *	x	x	x	x	x	x	CS (1:0)	
3	Byte 1	Data byte 1							
4	Byte 2	Data byte 2							
...							
n	Byte n	Data Byte n (up to 254 bytes)							

4.2.4 SetSLine

In order to set the start line issue the following command

SetSLine command (0x43)									
Byte	Content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	M1	0
1	SetSLine	0	1	0	0	0	0	1	1
2	Start Line	Start Line							
3	Controller (CS) *	x	x	x	x	x	x	CS (1:0)	

4.2.5 DispON

To turn the display ON / OFF issue the following command

DispON command (0x44)									
Byte	Content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	M1	0
1	CharToLCD	0	1	1	0	0	1	0	0
2	ON / OFF	x	x	x	x	x	x	x	ON
3	Controller (CS) *	x	x	x	x	x	x	CS (1:0)	

ON	comment
0	Display OFF
1	Display ON

4.2.6 SetTxtPos

A KS0108 GLCD contains 8 Rows (0x00 – 0x07) and 128 Columns (0x00 – 0x7F Pixels). In order to set the Position of the Cursor issue the following command:

SetTxtPos command (0x45)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	M1	0
1	SetTxtPos	0	1	0	0	0	1	0	1
2	Column	x	(7:0) 0x00 – 0x7F (128 Pixels)						
3	Row	x	x	x	x	x	(3:0) 0x00 – 0x07		

4.2.7 SendByte

In order to send a data byte to the GLCD issue this command.

SendByte command (0x46)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	M1	0
1	SendByte	0	1	0	0	0	1	1	0
2	Column	x	(7:0) 0x00 – 0x7F (128 Pixels)						
3	Row	x	x	x	x	x	(3:0) 0x00 – 0x07		
4	Data byte	Data byte							
5	Type	x	x	x	x	x	(3:0) Type		

Type			comment
0	0	0	Replace
0	0	1	Inverse Replace
0	1	0	Set
0	1	1	Clear
1	0	0	Inverse
else			Replace

4.2.8 SendnBytes

In order to write an array of bytes (up to 254 bytes) send the following command:

SendnBytes command (0x47)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	M1	0
1	SendnBytes	0	1	0	0	0	1	1	1
2	Type	x	x	x	x	x	(3:0) Type		
3	Byte 1	Data byte 1							
4	Byte 2	Data byte 2							
...							
n	Byte n	Data Byte n (up to 254 bytes)							

4.2.9 ReSetPixel

Sets, clears or inverse a pixel.

ReSetPixel command (0x48)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	M1	0
1	ReSetPixel	0	1	0	0	1	0	0	0
2	Coordinate X	x	(7:0) 0x00 – 0x7F (128 Pixels)						
3	Coordinate Y	x	x	(6:0) 0x00 – 0x3F (64 Pixels)					
4	Type	x	x	x	x	x	(3:0) Type *		

Type *			comment
0	1	0	Set
0	1	1	Clear
1	0	0	Inverse
else			Set

4.2.10 InvByte

This command is provided by the master to reverse a byte at a certain position on GLCD.

InvByte command (0x49)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	M1	0
1	InvByte	0	1	0	0	1	0	0	1
2	Column	x	(7:0) 0x00 – 0x7F (128 Pixels)						
3	Row	x	x	x	x	x	(3:0) 0x00 – 0x07		

4.2.11 InvPage

This command is provided by the master to reverse a whole page on GLCD.

InvPage command (0x4A)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	M1	0
1	InvByte	0	1	0	0	1	0	1	0
2	Controller (CS)	x	x	x	x	x	x	x	CS
3	Page	x	x	x	x	x	(3:0) 0x00 – 0x07		

4.2.12 InvDisp

In order to reverse the whole content of the display issue the following command:

InvDisp command (0x4B)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	M1	0
1	InvDisp	0	1	0	0	1	0	1	1

4.2.13 FillDisp

To fill the display with a certain byte send the following command. e.g. if you issue this command and send the byte 0x00 then the display will be cleared.

FillDisp command (0x4C)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	M1	0
1	FillDisp	0	1	0	0	1	1	0	0
2	Data byte	Data byte							

4.2.14 FillRect

The following command is provided by the master to draw a solid rectangle on GLCD. Position X,Y is the upper left corner of a rectangle.

FillRect command (0x4D)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	M1	0
1	FillRect	0	1	0	0	1	1	0	1
2	Coordinate X	0	(7:0) 0x00 – 0x7F (128 Pixels)						
3	Coordinate Y	0	0	(6:0) 0x00 – 0x3F (64 Pixels)					
4	Height	0	0	(6:0) 0x00 – 0x3F (64 Pixels)					
5	Width	0	(7:0) 0x00 – 0x7F (128 Pixels)						
6	Type	x	x	x	x	x	(3:0) Type*		

4.2.15 VLine

Issue this command to draw a vertical line starting at position X,Y.

VLine command (0x4E)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	M1	0
1	VLine	0	1	0	0	1	1	1	0
2	Coordinate X	0	(7:0) 0x00 – 0x7F (128 Pixels)						
3	Coordinate Y	0	0	(6:0) 0x00 – 0x3F (64 Pixels)					
4	Length	0	0	(6:0) 0x00 – 0x3F (64 Pixels)					
5	Type	x	x	x	x	x	(3:0) Type*		

4.2.16 HLine

Issue this command to draw a horizontal line starting at position X,Y.

HLine command (0x4F)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	M1	0
1	HLine	0	1	0	0	1	1	1	1
2	Coordinate X	0	(7:0) 0x00 – 0x7F (128 Pixels)						
3	Coordinate Y	0	0	(6:0) 0x00 – 0x3F (64 Pixels)					
4	Length	0	(7:0) 0x00 – 0x7F (128 Pixels)						
5	Type	x	x	x	x	x	(3:0) Type*		

4.2.17 Rectangle

The following command is provided by the master to draw a rectangle on GLCD. Position X,Y is the upper left corner of a rectangle.

Rectangle command (0x50)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	M1	0
1	Rectangle	0	1	0	1	0	0	0	0
2	Coordinate X	0	(7:0) 0x00 – 0x7F (128 Pixels)						
3	Coordinate Y	0	0	(6:0) 0x00 – 0x3F (64 Pixels)					
4	Height	0	0	(6:0) 0x00 – 0x3F (64 Pixels)					
5	Width	0	(7:0) 0x00 – 0x7F (128 Pixels)						
6	Type	x	x	x	x	x	(3:0) Type*		

4.2.18 RoundRectangle

The following command is provided by the master to draw a round rectangle on GLCD. Position X,Y is the upper left corner of a rectangle.

RoundRectangle command (0x51)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	M1	0
1	RoundRectangle	0	1	0	1	0	0	0	1
2	Coordinate X	0	(7:0) 0x00 – 0x7F (128 Pixels)						
3	Coordinate Y	0	0	(6:0) 0x00 – 0x3F (64 Pixels)					
4	Height	0	0	(6:0) 0x00 – 0x3F (64 Pixels)					
5	Width	0	(7:0) 0x00 – 0x7F (128 Pixels)						
6	Radius	0	0	0	(5:0) 0x00 – 0x1F **				
7	Type	x	x	x	x	x	(3:0) Type*		

***) Radius <= Height/2 AND Radius <= Width/2

4.2.19 Circle

Issue this command to draw a circle with a center at position X,Y.

Circle command (0x52)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	M1	0
1	Circle	0	1	0	1	0	0	1	0
2	Coordinate X	0	(7:0) 0x00 – 0x7F (128 Pixels)						
3	Coordinate Y	0	0	(6:0) 0x00 – 0x3F (64 Pixels)					
4	Radius	0	0	0	(5:0) 0x00 – 0x1F				
5	Type	x	x	x	x	x	(3:0) Type*		

Type *			comment
0	1	0	Set
0	1	1	Clear
1	0	0	Inverse
else			Set

4.2.20 CharToGLCD6x8

To write a 6x8 pixel character on the GLCD issue the following command

CharToGLCD6x8 command (0x53)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	M1	0
1	CharToGLCD6x8	0	1	0	1	0	0	1	1
2	character	character							
3	Type	x	x	x	x	x	(3:0) Type		

4.2.21 StringToGLCD6x8

In order to write a String (up to 254 6x8 pixel characters) send the following command:

StringToGLCD6x8 command (0x54)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	M1	0
1	StringToGLCD6x8	0	1	0	1	0	1	0	0
2	Type	x	x	x	x	x	(3:0) Type		
3	Character 1	character 1							
4	Character 2	Character 2							
...							
n	Character n	character n (up to 254 character)							

4.2.22 CharToGLCD8x8

To write a 8x8 pixel character on the GLCD issue the following command

CharToGLCD8x8 command (0x55)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	M1	0
1	CharToGLCD8x8	0	1	0	1	0	1	0	1
2	character	character							
3	Type	x	x	x	x	x	(3:0) Type		

4.2.23 StringToGLCD8x8

In order to write a String (up to 254 8x8 pixel characters) send the following command:

StringToGLCD8x8 command (0x56)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	M1	0
1	StringToGLCD8x8	0	1	0	1	0	1	1	0
2	Type	x	x	x	x	x	(3:0) Type		
3	Character 1	character 1							
4	Character 2	Character 2							
...							
n	Character n	character n (up to 254 character)							

Type			comment
0	0	0	Replace
0	0	1	Inverse Replace
0	1	0	Set
0	1	1	Clear
1	0	0	Inverse
else			Replace

4.2.24 ReadByte

This function returns two bytes: 1. the slave address of the selected device and 2. a data byte from the position (column,row) of the GLCD.

ReadByte command (0x57)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	M1	0
1	ReadByte	0	1	0	1	0	1	1	1
2	Column	x	(7:0) 0x00 – 0x7F (128 Pixels)						
3	Row	x	x	x	x	x	(3:0) 0x00 – 0x07		

ReadByte Response									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address (W)	M7	M6	M5	M4	M3	M2	1	1
1	Slave address	Slave address of the selected device							
2	Register content	Data byte from the selected RAM address							

4.2.25 ReSetIO1

Issue the following command to set or reset GPIO 1.

ReSetIO1 command (0x60)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	M1	0
1	ReSetIO1	0	1	1	0	0	0	0	0
2	State	x	x	x	x	x	x	x	ST

4.2.26 ReSetIO2

Issue the following command to set or reset GPIO 2.

ReSetIO2 command (0x61)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	M1	0
1	ReSetIO2	0	1	1	0	0	0	0	1
2	State	x	x	x	x	x	x	x	ST

ST	comment
0	IO Low
1	IO High

x	Do not care
---	-------------

4.2.27 ReadIOs

This function returns two bytes: 1. the slave address of the selected device and 2. data byte is the state of IO-Pins 1 and 2.

ReadIOs command (0x62)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	M1	0
1	ReadIOs	0	1	1	0	0	0	1	0

ReadIOs Response									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address (W)	M7	M6	M5	M4	M3	M2	M1	1
1	Slave address	Slave address of the selected device							
2	State	x	x	x	x	x	x	ST2	ST1

IO	comment	
ST1	0	IO Low
	1	IO High
ST2	0	IO Low
	1	IO High

4.2.28 SetSlvAdr

In order to change the slave address issue this command and then send the new slave address. Bit 1 is hardwired.

SlvAdr command (0x73)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	M1	0
1	WriteSlvAdr	0	1	1	1	0	0	1	1
2	Slave Address	upper 6 bits of Slave address (7:2)						x	x

x	Do not care
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