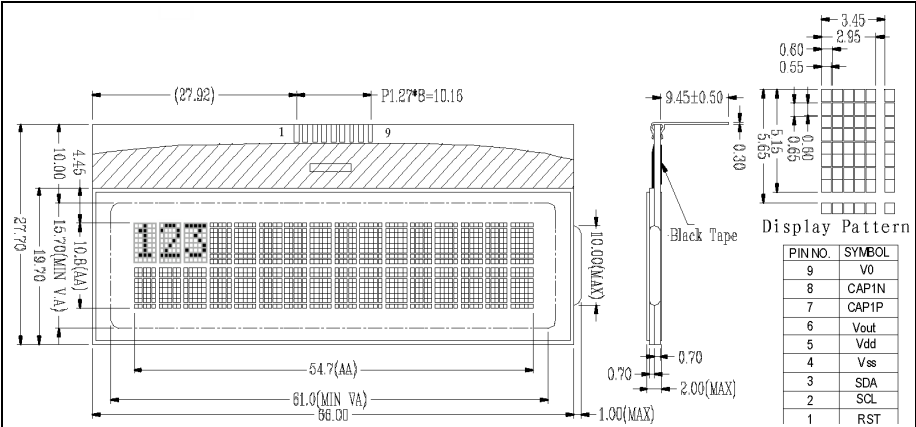


ZETTLER DISPLAYS

AQM1602XA-RN-GBW

I 2 C 接続 薄型 16 文字 × 2 行 液晶
Sitronix ST7032 CONTROLLED

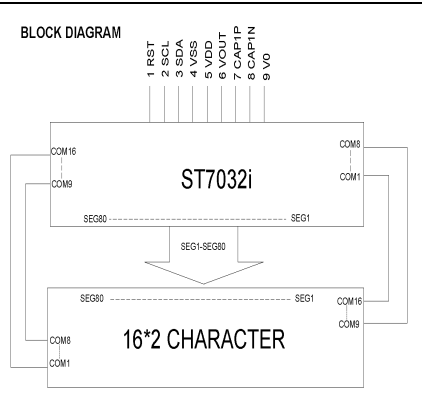
- ◆66mmX27.7mmX2.0mmの薄型サイズです。
(画面54.7mmX10.6mm、8mm)
- ◆画面コントラストはコマンドで設定しますので、外付けVRが不要です。
- ◆電源電圧は3.1V~5.5Vで、Arduino等との接続が可能です。
- ◆接続に便利な2.54mmピッチへの変換基板付きです。
(セットによっては、変換基板は付属しない場合があります)
- ◆低消費電流です：1mA@3.3V
(液晶本体のみの消費電流 変換基板使用時のプルアップ 抵抗消費分を除く)



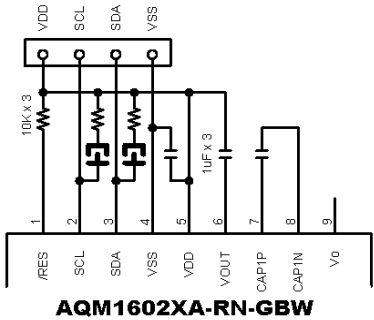
●LCDモジュールのピンを上側にして、左から1~9ピンになります。

PIN ASSIGNMENT

Pin No.	Symbol	Function
1	/RES	Reset signal
2	SCL	Clock input
3	SDA	Data input
4	VSS	Ground
5	VDD	Power Supply
6	VOUT	Voltage converter input/output pin
7	CAP1P	Capacitor 1 positive connection pin for voltage converter
8	CAP1N	Capacitor 1 negative connection pin for voltage converter
9	V0	Power supply for LCD drive



◆接続回路例（変換基板回路図）



GENERAL SPECS

1. Display Format	16*2 Character
2. Power Supply	3.3V
3. Overall Module Size	66.0mm(V) x 27.7mm(H) x max 2.0mm(D)
4. Viewing Area(W*H)	61.0mm(V) x 15.7mm(H)
5. Dot Size (W*H)	0.55mm(V) x 0.60mm(H)
6. Dot Pitch (V*H)	0.60mm(V) x 0.65mm(H)
7. Character Size (W*H)	2.95mm(V) x 5.15mm(H)
8. Character Pitch (W*H)	3.45mm(V) x 5.65mm(H)
9. Viewing Direction	6:00 O'Clock
10. Driving Method	1/16Duty, 1/5Bias
11. Controller IC	ST7032i-0D or compatible
12. LC Fluid Options	STN(GRAY)/Positive/Reflective
13. Backlight Options	NA
14. Operating temperature	-20°C ~ 60°C
15. Storage temperature	-30°C ~ 70°C
16. RoHS	RoHS compliant

ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Min	Typ	Max	Unit
Operating temperature	Top	-20	-	60	°C
Storage temperature	Tst	-30	-	70	°C
Input voltage	Vin	0.3	--	Vdd+0.3	V
Supply voltage for logic	Vdd- Vss	-0.3	-	6.0	V
Supply voltage for LCD driving	V0-Vss	Vss-0.3	-	7.0-Vss	V

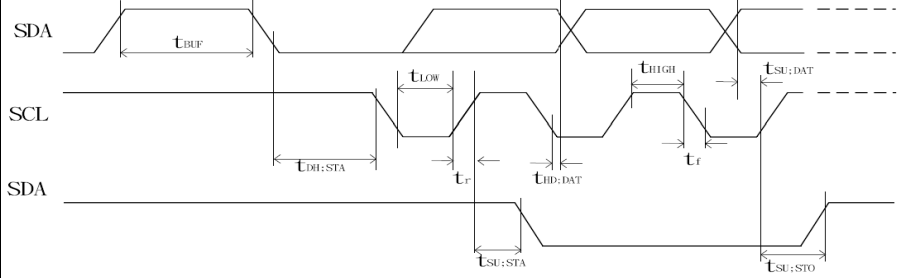
Electrical Characteristics Of LCM

Item	Symbol	Condition	Min	Typ	Max	Unit
Power Supply Voltage	Vdd	25°C	3.1	3.3	3.5	V
Power Supply Current	Idd	Vdd=3.3V	--	0.5	1.0	mA
Input voltage (high)	Vih	Pins(SDA,SCL,RST)	1.9	--	Vdd	V
Input voltage (low)	Vil	Vdd=3.3V	-0.3	--	0.8	V
Recommended Driving Voltage	LC V0-Vss	-20°C	--	--	--	V
		25°C	4.3	4.5	4.7	V
		70°C	--	--	--	V

CHARACTER PATTERNS

b7-b4 b3-b0	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
0000	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0001	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G
0010	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H
0011	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I
0100	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J
0101	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K
0110	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L
0111	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M
1000	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1001	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1010	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1011	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1100	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1101	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1110	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1111	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U

● I2C interface TIMING CHARACTERISTICS



(Ta = -30°C to 85°C)

Item	Signal	Symbol	Condition	VDD=2.7 to 4.5V Rating		VDD=4.5 to 5.5V Rating		Units
				Min.	Max.	Min.	Max.	
SCL clock frequency	SCL	f _{SCLK}	—	DC	400	DC	400	KHz
SCL clock low period	SCL	t _{LOW}	—	1.3	—	1.3	—	us
SCL clock high period	SCL	t _{HIGH}	—	0.6	—	0.6	—	us
Data set-up time	SI	t _{SU,DAT}	—	180	—	100	—	ns
Data hold time	SI	t _{HD,DAT}	—	0	0.9	0	0.9	us
SCL,SDA rise time	SCL, SDA	t _r	—	20+0.1C _L	300	20+0.1C _L	300	ns
SCL,SDA fall time	SCL, SDA	t _f	—	20+0.1C _L	300	20+0.1C _L	300	ns
Capacitive load represent by each bus line		C _b	—	—	400	—	400	pf
Setup time for a repeated START condition	SI	t _{SU,STA}	—	0.6	—	0.6	—	us
Start condition hold time		t _{HD,STA}	—	0.6	—	0.6	—	us
Setup time for STOP condition		t _{SU,STO}	—	0.6	—	0.6	—	us
Bus free time between a Stop and START condition	SCL	t _{BUF}	—	1.3	—	1.3	—	us

DISPLAY INSTRUCTION TABLE

- instruction table at “Extension mode”
(when “EXT” option pin connect to Vss, the instruction set follow below table)

Instruction	Instruction Code										Description	Instruction Execution Time		
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		OSC= 380KHz	OSC= 540kHz	OSC= 700KHz
Clear Display	0	0	0	0	0	0	0	0	0	1	Write "20H" to DDRAM, and set DDRAM address to "00H" from AC Set DDRAM address to "00H" from AC and return cursor to its original position if shifted. The contents of DDRAM are not changed.	1.08 ms	0.76 ms	0.59 ms
Return Home	0	0	0	0	0	0	0	0	1	x		1.08 ms	0.76 ms	0.59 ms
Entry Mode Set	0	0	0	0	0	0	0	1	I/D	S	Sets cursor move direction and specifies display shift. These operations are performed during data write and read.	26.3 us	18.5 us	14.3 us
Display ON/OFF	0	0	0	0	0	0	1	D	C	B		26.3 us	18.5 us	14.3 us
Function Set	0	0	0	0	1	DL	N	DH	*0	IS	D=1:entire display on C=1:cursor on B=1:cursor position on DL: interface data is 8/4 bits N: number of line is 2/1 DH: double height font IS: instruction table select	26.3 us	18.5 us	14.3 us
Set DDRAM address	0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0		Set DDRAM address in address counter	26.3 us	18.5 us
Read Busy flag and address	0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Whether during internal operation or not can be known by reading BF. The contents of address counter can also be read.	0	0	0
Write data to RAM	1	0	D7	D6	D5	D4	D3	D2	D1	D0		Write data into internal RAM (DDRAM/CGRAM/ICONRAM)	26.3 us	18.5 us
Read data from RAM	1	1	D7	D6	D5	D4	D3	D2	D1	D0	Read data from internal RAM (DDRAM/CGRAM/ICONRAM)	26.3 us	18.5 us	14.3 us

Note *: this bit is for test command , and must always set to “0”

Instruction table 0(IS=0)														
Cursor or Display Shift	0	0	0	0	0	1	S/C	R/L	x	x	S/C and R/L: Set cursor moving and display shift control bit, and the direction, without changing DDRAM data.	26.3 us	18.5 us	14.3 us
Set CGRAM	0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0	Set CGRAM address in address counter	26.3 us	18.5 us	14.3 us

Instruction table 1(IS=1)														
Internal OSC frequency	0	0	0	0	0	1	BS	F2	F1	F0	BS=1:1/4 bias BS=0:1/5 bias F2~0: adjust internal OSC frequency for FR frequency.	26.3 us	18.5 us	14.3 us
Set ICON address	0	0	0	1	0	0	AC3	AC2	AC1	AC0	Set ICON address in address counter.	26.3 us	18.5 us	14.3 us
Power/ICON control/Contrast set	0	0	0	1	0	1	Ion	Bon	C5	C4	Ion: ICON display on/off Bon: set booster circuit on/off C5,C4: Contrast set for internal follower mode.	26.3 us	18.5 us	14.3 us
Follower control	0	0	0	1	1	0	Fon	Rab2	Rab1	Rab0	Fon: set follower circuit on/off Rab2~0: select follower amplified ratio.	26.3 us	18.5 us	14.3 us
Contrast set	0	0	0	1	1	1	C3	C2	C1	C0	Contrast set for internal follower mode.	26.3 us	18.5 us	14.3 us

◆データとコマンドのWRITE方法

- LCDに対しては、書き込み（WRITE）のみが出来ます。読み込み（READ）はできません。（I2CのACKはありません）。
- READが不可なのでBusyフラグ、内部のDDRAMアドレスカウンタは読み取る事ができません。
- スレーブアドレスは0x7C（7bitアドレス）です。「アドレス0111110+0（RW）」（READが不可なので、RWは常に0になります）Arduino表現では0x3Eになります。
- スレーブアドレスに続くコマンドワードは「コントロールバイト+データバイト」で構成され、複数のコマンドワードが送られる場合のCo=1で、最終コマンドワードのCo=0です。
- コントロールバイトで「Co（連続コマンドワード/最終コマンドワードの指定）」と「RS（液晶のインストラクションコード/液晶のデータ指定）」を送信します。
- コントロールバイトの後に続くデータバイトが「液晶のインストラクションコード」の場合RS=0、「液晶の表示データ」あるいは「CGRAMのデータ」の場合はRS=1になります。

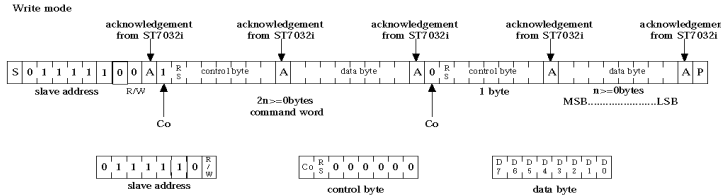


Figure 5. 2-line Interface protocol

Co	0	Last control byte to be sent. Only a stream of data bytes is allowed to follow. This stream may only be terminated by a STOP condition.
	1	Another control byte will follow the data byte unless a STOP condition is received.

RS	R/W	Operation
L	L	Instruction Write operation (MPU writes instruction code into IR)
H	L	Data Write operation (MPU writes data into DR)

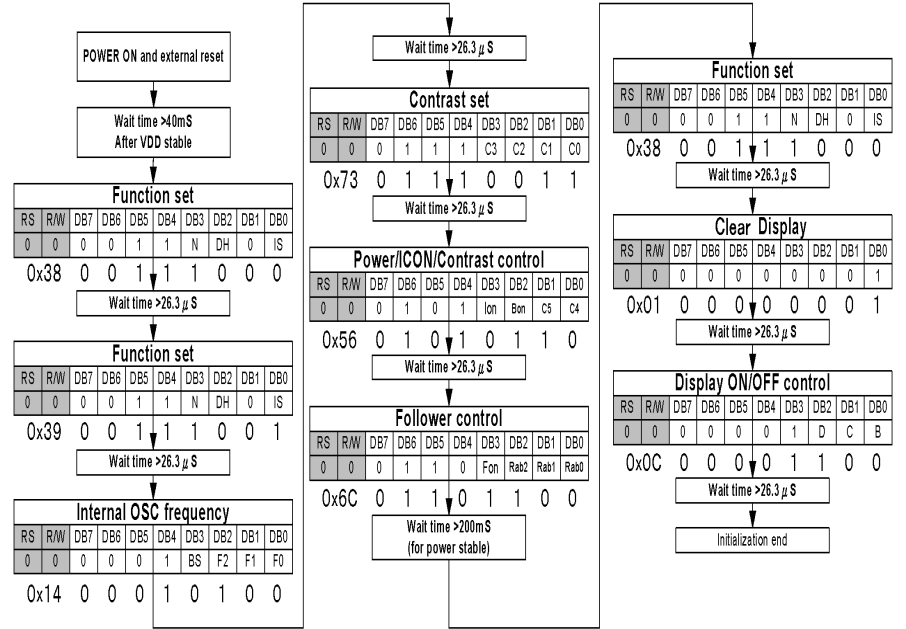
◆使い方

- 接続はI2C接続です。SDA、SCLをマイコン等と接続してください。（VDDは3.1V～5.5Vです。SDA、SCLはVDD以下の電圧でご使用ください）
- 基本的なコマンドは、一般的なパラレル接続のSC1602と同じです。Arduinoでお使いの場合は、Wireコマンドをお使いください。
- コントラストは、外付けVRではなく、拡張コマンドで設定します。設定前は表示が出ません。（パラレル接続のSC1602の様な■の連続も出ません）
- コントラスト調整などの拡張コマンド（前掲DISPLAY INSTRUCTION TABLEのIS=1の表）が追加されています。拡張コマンドを使用する場合は「Function Set」で「IS=1」に指定します。拡張コマンド使用後は「Function Set」で「IS=0」に戻します。
- I2C端子のSDA、SCLはプルアップする必要があります。変換基板をお持ちの場合は溶ダジャンパーを使用してプルアップしていただくか、あるいは基板外部にプルアップ抵抗を接続してください。
- 変換基板を使用しない場合は接続回路例に示すようにVOU（6番ピン）、CAP1N、CAP1P（7、8番ピン）には、コンデンサを付ける必要があります。
- コントラスト調整は、拡張コマンド「Power/ICONcontrol/Contrast set」のC5、C4と「Contrast set」のC3～C0を使用し、64段階で設定します。VDD=5Vの場合、C5=1、C4=0、C3=0、C2=0、C1=1、C0=1で少し濃目ぐらいです。
- 拡張コマンド「Power/ICONcontrol/Contrast set」の「Ion」ビットはアンテナやバッテリーなどのアイコン表示のためのビットです。この液晶にはアイコンがありませんので、0に設定してください。

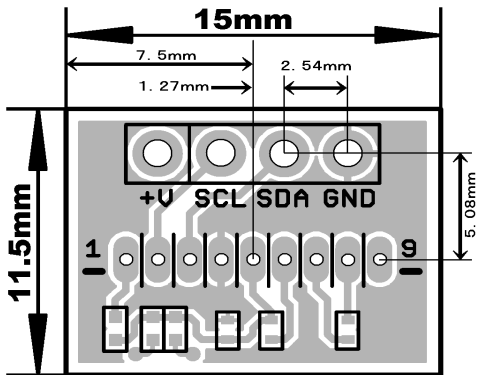
◆液晶表示 DDRAMアドレス(液晶画面の表示アドレスです) 16進表記

1行目	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
2行目	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F

◆初期化の例

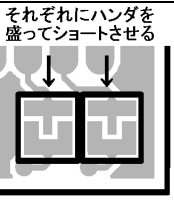


◆変換基板外形図（セットによっては基板は付属していません）
ピンヘッダ穴径0.9mm、LCDモジュールピン穴径0.6mm



◆変換基板裏面
ハンダジャンパーパッドの説明

SCL、SDA信号線に、この基板上的プルアップ抵抗（10kΩ）を接続する場合は、右図のバッド2箇所にはハンダを盛ってショートさせてください。（この2ヶ所同士はショートしないようお気を付け下さい）
変換基板外部にプルアップ抵抗を接続する場合は出荷時のままにしておいてください。
ハンダジャンパーは不要です。



◆インストラクション（液晶への命令）

● Clear Display

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	0	0	0	1

Clear all the display data by writing "20H" (space code) to all DDRAM address, and set DDRAM address to "00H" into AC (address counter). Return cursor to the original status, namely, bring the cursor to the left edge on first line of the display. Make entry mode increment (I/D = "1").

● Return Home

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	0	0	1	X

Return Home is cursor return home instruction. Set DDRAM address to "00H" into the address counter. Return cursor to its original site and return display to its original status, if shifted. Contents of DDRAM do not change.

● Entry Mode Set

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	0	1	I/D	S

Set the moving direction of cursor and display.

- **I/D : Increment / decrement of DDRAM address (cursor or blink)**
When I/D = "High", cursor/blink moves to right and DDRAM address is increased by 1.
When I/D = "Low", cursor/blink moves to left and DDRAM address is decreased by 1.
* CGRAM operates the same as DDRAM, when read from or write to CGRAM.
- **S: Shift of entire display**
When DDRAM read (CGRAM read/write) operation or S = "Low", shift of entire display is not performed. If S = "High" and DDRAM write operation, shift of entire display is performed according to I/D value (I/D = "1": shift left, I/D = "0": shift right).

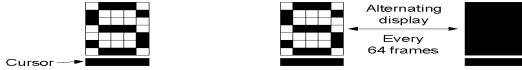
S	I/D	Description
H	H	Shift the display to the left
H	L	Shift the display to the right

● Display ON/OFF

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	1	D	C	B

Control display/cursor/blink ON/OFF 1 bit register.

- **D : Display ON/OFF control bit**
When D = "High", entire display is turned on.
When D = "Low", display is turned off, but display data is remained in DDRAM.
- **C : Cursor ON/OFF control bit**
When C = "High", cursor is turned on.
When C = "Low", cursor is disappeared in current display, but I/D register remains its data.
- **B : Cursor Blink ON/OFF control bit**
When B = "High", cursor blink is on, that performs alternate between all the high data and display character at the cursor position.
When B = "Low", blink is off.



● Cursor or Display Shift

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	1	S/C	R/L	X	X

- **S/C: Screen/Cursor select bit**
When S/C="High", Screen is controlled by R/L bit.
When S/C="Low", Cursor is controlled by R/L bit.
- **R/L: Right/Left**
When R/L="High", set direction to right.
When R/L="Low", set direction to left.
Without writing or reading of display data, shift right/left cursor position or display. This instruction is used to correct or search display data. During 2-line mode display, cursor moves to the 2nd line after 40th digit of 1st line. Note that display shift is performed simultaneously in all the line. When displayed data is shifted repeatedly, each line shifted individually. When display shift is performed, the contents of address counter are not changed.

S/C	R/L	Description	AC Value
L	L	Shift cursor to the left	AC=AC-1
L	H	Shift cursor to the right	AC=AC+1
H	L	Shift display to the left. Cursor follows the display shift	AC=AC
H	H	Shift display to the right. Cursor follows the display shift	AC=AC

● Function Set

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	DL	N	DH	0	IS

- **DL : Interface data length control bit**
When DL = "High", it means 8-bit bus mode with MPU.
When DL = "Low", it means 4-bit bus mode with MPU. So to speak, DL is a signal to select 8-bit or 4-bit bus mode.
When in 4-bit bus mode, it needs to transfer 4-bit data by two times.
- **N : Display line number control bit**
When N = "High", 2-line display mode is set.
When N = "Low", it means 1-line display mode.
- **DH : Double height font type control bit**
When DH = "High" and N = "Low", display font is selected to double height mode(5x16 dot), RAM address can only use 00H~27H.
When DH = "High" and N = "High", it is forbidden.
When DH = "Low", display font is normal (5x8 dot).
- **IS : normal/extension instruction select**
When IS = "High", extension instruction be selected (refer extension instruction table)
When IS = "Low", normal instruction be selected (refer normal instruction table)

● Set CGRAM Address

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0

Set CGRAM address to AC.

This instruction makes CGRAM data available from MPU.

● Set DDRAM Address

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0

Set DDRAM address to AC.

This instruction makes DDRAM data available from MPU.

When 1-line display mode (N = 0), DDRAM address is from "00H" to "4FH".

In 2-line display mode (N = 1), DDRAM address in the 1st line is from "00H" to "27H", and DDRAM address in the 2nd line is from "40H" to "67H".

◆Arduinoとの接続

- 基本的なWireコマンドで制御できます。• I2Cアドレスは0x3Eです
- ArduinoのA4、A5、5V、GNDを、液晶のSDA、SCL、VDD、GNDと接続します。

```
#include <Wire.h>
#define LCD_ADDR 0x3E
char moji[] = "AQM1602XA-RN-GBW";
//SCL=A5=LCDNo2 SDA=A4=LCDNo3
void setup() {
  Wire.begin();
  init_LCD();
}
void loop() {
  for(int i = 0; i < 16; i++) {
    writeData(moji[i]);
  }
  writeCommand(0x40+0x80); // 2LINE TOP
  for(int i = 0; i < 16; i++) {
    writeData(i+0xb1);
  }
  while(1){} //stop
}
//----main end----
```

```
//データ書き込み
void writeData(byte t_data)
{
  Wire.beginTransmission(LCD_ADDR);
  Wire.write(0x40);
  Wire.write(t_data);
  Wire.endTransmission();
  delay(1);
}
//コマンド書き込み
void writeCommand(byte t_command)
{
  Wire.beginTransmission(LCD_ADDR);
  Wire.write(0x00);
  Wire.write(t_command);
  Wire.endTransmission();
  delay(10);
}
```

```
//液晶初期化
void init_LCD() {
  delay(100);
  writeCommand(0x38);
  delay(20);
  writeCommand(0x39);
  delay(20);
  writeCommand(0x14);
  delay(20);
  writeCommand(0x73);
  delay(20);
  writeCommand(0x56);
  delay(20);
  writeCommand(0x6C);
  delay(20);
  writeCommand(0x38);
  delay(20);
  writeCommand(0x01);
  delay(20);
  writeCommand(0x0C);
  delay(20);
}
```

★液晶に内蔵のコントロールIC「ST7032i」の詳しい資料は、弊社ホームページのAQM1602のページに参考pdf資料がございます。