ALPHANUMERIC DOT MATRIX MODULES

STANDARD MODULE SELECTION

BASE MODEL	DISPLAY FORMAT char x lines	PIXEL SIZE (W x H) mm	CHARACTER SIZE (H x W) mm	VIEWING AREA (W x H) mm	DRIVING DUTY	PCB SIZE (W x H) mm
DEM08171	8 x 1	0.83 x 0.93	7.93 x 4.43	44.00 x 13.00	1/8	60.00 x 33.00
DEM08172	8 x 1	1.25 x 1.30	10.75 x 6.45	61.00 x 15.80	1/8	84.00 x 44.00
DEM16101	16 x 1	0.60 x 0.70	5.95 x 3.20	63.50 x 13.80	1/16	80.00 x 36.00
DEM16102	16 x 1	0.55 x 0.90	7.90 x 3.15	61.00 x 15.80	1/16	80.00 x 36.00
DEM16211	16 x 2	0.56 x 0.66	5.63 x 3.00	61.00 x 19.00	1/16	84.00 x 40.00
DEM16212	16 x 2	0.56 x 0.66	5.63 x 3.00	61.00 x 19.00	1/16	84.00 x 40.00
DEM16213	16 x 2	0.55 x 0.50	4.35 x 2.95	63.50 x 13.80	1/16	80.00 x 36.00
DEM16214	16 x 2	0.75 x 0.90	7.76 x 4.07	80.00 x 20.50	1/16	100.00 x 42.00
DEM16215	16 x 2	1.00 x 1.15	9.55 x 5.20	99.00 x 24.00	1/16	122.00 x 44.00
DEM16216	16 x 2	0.55 x 0.65	5.55 x 2.95	61.00 x 15.80	1/16	80.00 x 36.00
DEM16217	16 x 2	0.55 x 0.65	5.55 x 2.95	61.00 x 15.80	1/16	84.00 x 44.00
DEM16219	16 x 2	0.55 x 0.65	5.55 x 2.95	61.00 x 15.80	1/16	85.00 x 32.50
DEM16220	16 x 2	0.55 x 0.55	5.55 x 2.95	61.00 x 15.80	1/16	80.00 x 36.00
DEM16481	16 x 4	0.55 x 0.55	4.75 x 2.95	61.80 x 25.20	1/16	87.00 x 60.00
DEM20121	20 x 1	1.30 x 1.30	11.50 x 6.70	155.10 x 16.00	1/8	182.00 x 33.50
DEM20231	20 x 2	0.60 x 0.65	5.55 x 3.20	83.00 x 18.60	1/16	116.00 x 37.00
DEM20232	20 x 2	0.90 x 0.95	8.30 x 4.90	123.20 x 23.00	1/16	146.00 x 43.00
DEM20234	20 x 2	0.60 x 0.65	5.55 x 3.20	83.00 x 18.60	1/16	116.00 x 37.00
DEM20485	20 x 4	0.55 x 0.55	4.75 x 2.95	76.30 x 25.0	1/16	98.00 x 60.00
DEM20486	20 x 4	0.65 x 0.75	6.35 x 3.45	85.00 x 30.50	1/16	98.00 x 60.00
DEM20487	20 x 4	0.93 x 1.11	9.23 x 4.85	123.00 x 42.50	1/16	146.00 x 62.50
DEM24251	24 x 2	0.50 x 0.65	5.55 x 2.70	83.00 x 18.60	1/16	116.00 x 37.00
DEM40271	40 x 2	0.60 x 0.65	5.69 x 3.28	155.10 x 16.00	1/16	182.00 x 33.50
DEM40491	40 x 4	0.5 x 0.55	4.89 x 2.78	143.80 x 26.70	1/16	190.00 x 54.00

General features for display® Alphanumerical Modules

- In the meantime most of our modules operate within wide temperature range (-20°C to +70°C) without negative voltage. Therefore a contrast-voltage of approx. 4,5 Volt is required (against Vdd).
- The twist of 240° causes excellent contrast and improved viewing cone.
- We use a 16 pin version PCB with optional pins for the LED-backlight (A/K)
- Our modules have the LED-limit-resistances already on board. This resistors can be changed or bridged easily. If neccessary the power consumption and brightness can be optimized as per customers request.
- LED-polarity can be changed. To swop the LED-polarity our boards provide this possibility.
- The metallbezel is set on ground. If neccessary our boards are prepared for disconnection.

New technical concepts allow us to achieve wide temperature range modules without price increase. We are always interested in very good availability. If you do not find a product which can fit in your application we have the possibility to make a custom- or semicustom design already at low volumes and economical price level.

ORDERING INFORMATION

DEM 1 6 2 1 6 S Y H - P Y - _ _ / V

- Number of character columns: 16
- Number of character rows: 2
- engineering number: 16
- F: FSTN / S: STN / T: TN: S
- **STN MODE**: Y: Yellow-Green; G: Grey (neutral); B: Blue (negative): Y
- **OPERATING TEMPERATURE OPTION**: Blank: 0°C to +50°C; H: -20°C to +70°C: H
- **BACKLIGHT OPTION**: E: EL (Electroluminescent lamp); P: LED Lightguide/Lightpipe (indirect light); L: LED Lightbox (direct light): P
- **BACKLIGHT COLOR**: Y: Yellow-Green; G: Pure Green; R: Red; A: Amber; B: Blue; W: White: Y
- **DISPLAY MODE**: Blank: Positive; N: Negative: _
- **VIEWING DIRECTION**: Blank: 6 o'clock; 12: 12 o'clock: _
- internal information: V

DEFINITION OF TERMINALS

(valid for all modules except DEM 16223/16224/40491)

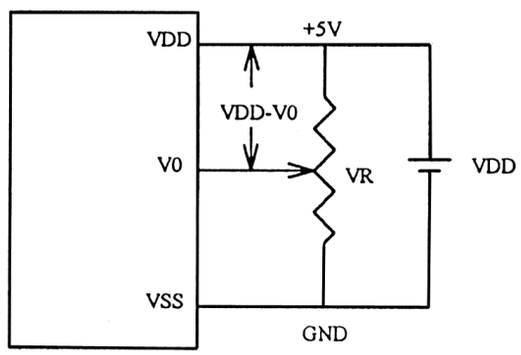
PIN NO.	SYMBOL	FUNCTION
1	V_{SS}	Ground terminal of module
2	V_{DD}	Supply terminal of module +5V
3	V_O	Power supply for Liquid crystal Drive
4	RS	Register Select RS = 0 ... Instruction Register RS = 1 ... Data Register
5	R/W	Read/Write R/W = 1 ... Read R/W = 0 ... Write
6	E	Enable
7 - 14	DB0–DB7	Bi-directional Data Bus, Data Transfer is performed once, thru DB0-DB7, in the case of interface data. Length is 8-bits; and twice, thru DB4-DB7, in the case of interface data length is 4-bits. Upper four bits first then lower four bits.
15 16	L- L+	LED or EL lamp power supply terminals.

OPERATING SPECIFICATIONS

	NORMAL TEMP
Operating temperature range	0°C to +50°C
Storage temperature range	-10°C to +60°C
Operating relative humidity	90% max
	WIDE TEMP
Operating temperature range	-20°C to +70°C
Storage temperature range	-30°C to +75°C
Operating relative humidity	90% max

POWER SUPPLY REQUIREMENTS

- **Normal Temperature and Wide Temperature Range**
  - Only 5 Volt (V_{DD}) - FLUID SOLUTION



V_{DD} - V_O: LCD Driving Voltage

Vr: 10K - 20K

Please note:
Older module technologies may require negative voltage.

ELECTRICAL CHARACTERISTICS (To = +25°C)

PARAMETER		SYMBOL	CONDITION	MIN	TYP	MAX	UNIT
Supply voltage		V_{DD}		4.5	5.0	5.5	V
LCD Drive Voltage		V_{DD}-V_0 (V_{LCD})		4.2	4.5	4.8	V
Supply Current [1] 1 x 16 DMM 2 x 16 DMM 1 x 20, 2 x 20 DMM 4 x 20, 2 x 40 DMM		I_{DD}	V_{DD} = 5V V_0 = 0V min	 – – – –	 1.0 1.0 1.5 2.5	 2.0 2.0 3.0 4.0	 mA mA mA mA
Input voltage [2]		V_{IL} V_{IH}		0 2.2	– –	0.6 V_{DD}	V V
Output voltage [3]		V_{OL} V_{OH}	I_{OL} = 1.6 mA I_{OH} = 0.2 mA	– 2.4	– –	0.4 –	V V
LED Current	DEM08171XXX-LY	I_{LED}	Pin 15 / Pin 16= 5V or L+ / L- = 5V		92		mA
	DEM08172XXX-PY				33		mA
	DEM16102XXX-LY				97		mA
	DEM16102XXX-PY				33		mA
	DEM16211XXX-LY [4]				135		mA
	DEM16211XXX-PY [4]				87		mA
	DEM16212XXX-LY [4]				129		mA
	DEM16212XXX-PY [4]				80		mA
	DEM16214XXX-LY				55		mA
	DEM16215XXX-LY				192		mA
	DEM16216XXX-LY				97		mA
	DEM16216XXX-PY				33		mA
	DEM16217XXX-LY				116		mA
	DEM16217XXX-PY				33		mA
	DEM16219XXX-PY				56		mA
	DEM16220XXX-PY				35		mA
	DEM16481XXX-LY				105		mA
	DEM20121XXX-LY [4]				190		mA
	DEM20231XXX-PY				65		mA
	DEM20232XXX-LY				245		mA
	DEM20485XXX-LY				203		mA
	DEM20486XXX-LY				200		mA
	DEM20487XXX-LY				213		mA
	DEM24251XXX-PY				68		mA
	DEM40271XXX-LY				108		mA
	DEM40491XXX-LY				194		mA

DRIVE VOLTAGE (V_{LCD}) IS NOT IDENTICAL FOR LCD MODULES MANUFACTURES. ACCEPTABLE RESULTS CAN BE OBTAINED BY ADJUSTING V_{LCD}. IF THIS DOES NOT WORK, DISPLAY CAN MODIFY DISPLAY TO MEET CUSTOM NEEDS.

Note:
1. Applies to DB0 - DB7, E, RS and R/W
2. Applies to DB0 - DB7
3. Supply current may slightly exceed MAX. Rating if SAMSUNG controller is used without pull-up resistor for DB0 - DB7.
4. Without R_{LED}

INSTRUCTION SET

INSTRUCTION	CODE										DESCRIPTION	TYPICAL EXECUTION TIME
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Clear display	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	1	Clears display and returns the cursor to home position (Address Ø). Sets I/D = 1 of Entry Mode.	1.64 ms
Return home	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	1	●	Return the cursor to the home position (Address Ø). Also returns the display being shifted to the original position. DD RAM contents remain unchanged. Set DD RAM addresses to zero.	1.64 ms
Entry mode set	Ø	Ø	Ø	Ø	Ø	Ø	Ø	1	I/D	S	Set the cursor move direction and specifies or not to shift the display. These operations are performed during data write and read of DD RAM/CG RAM, FOR NORMAL OPERATION, SET S TO Ø	40 µs
Display ON/OFF control	Ø	Ø	Ø	Ø	Ø	Ø	1	D	C	B	Set ON/OFF all display (D), cursor ON/OFF (C), and blink of cursor postion character (B).	40 µs
Cursor or display shift	Ø	Ø	Ø	Ø	Ø	1	S/C	R/L	●	●	Moves the cursor and shifts the display without changing DD RAM contents.	40 µs
Function set	Ø	Ø	Ø	Ø	1	DL	N	F	●	●	Sets interface data length(DL), number of display lines(N) and character font (F).	40 µs
Set the CG RAM address	Ø	Ø	Ø	1	MSB ACG					LSB	Sets the CG RAM address. CG RAM data is sent and received after this setting.	40 µs
Set the DD RAM address	Ø	Ø	1	MSB ADD						LSB	Sets the DD RAM address. DD RAM data is sent and received after this setting.	40 µs
Read busy flag & address	Ø	1	BF	MSB AC						LSB	Reads busy flag (BF) indicating internal operation is being performed and reads address counter contents.	40 µs
Write data to CG or DD RAM	1	Ø	MSB							LSB	Writes data into DD RAM or CG RAM.	40 µs
Read data from CG or DD RAM	1	1	MSB							LSB	Reads data from DD RAM or CG RAM	40 µs
	S = 1: Accompanies display shift when data is written, for normal operation, set to Ø I/D = 1: Increment DL = 1: 8 bits I/D = Ø: Decrement DL = Ø: 4 bits S/C = 1: Display shift N = 1: 2 (1) line S/C = Ø: Cursor move N = Ø: 1 line R/L = 1: Shift to the right F = 1: 5 x 10 dots R/L = Ø: Shift to the left F = Ø: 5 x 7 dots BF = 1: Internally operating BF = Ø: Can accept instruction										DD RAM: Display data RAM CG RAM: Character generator RAM ACG: CG RAM address ADD: DD RAM address corresponds to cursor address AC: Address counter used for both DD and CG RAM adress B: 1 = ON Ø = OFF (Blinking cursor) C: 1 = ON Ø = OFF (Cursor) D: 1 = ON Ø = OFF (Display) ● Don't Care	

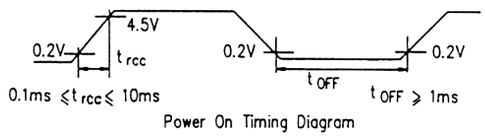
INITIALIZATION

The module automatically performed initialization when powered on (using internal reset circuit). The following instructions are executed during initialization:

1. CLEAR DISPLAY
   The Busy Flag is kept in the Busy State (BF = 1) unit initialization ends.
   The time is 15 ms.
2. FUNCTION SET ---------- DL = 1: 8-bits long interface data
   N = Ø: 1 line display
3. DISPLAY ON/OFF CONTROL ---------- D = Ø: Display OFF
   C = Ø: Cursor OFF
   B = Ø: Blink OFF
4. ENTRY MODE SET ---------- I/D = 1: +1 (INCREMENT)
   S = Ø: NO SHIFT
5. DD RAM IS SELECTED

Power O Initialization depends on rise time of the supply when it is turned on. The following time relationship must be satisfied.

ITEM	SYMBOL	STANDARD TIME			UNIT
		MIN	TYP	MAX	
Power Supply Rise Time	t_{rcc}	0.1	–	10	ms
Power Supply Off Time	t_{OFF}	1.0	–	–	ms



Power On Timing Diagram

NOTE:
When the above power supply condition is not satisfied, the internal reset circuitry does not operate correctly, in this case, perform the needed initialization by sending function set instructions thrice from MPU after turning the power on, e.g., to designate a 8-bits data length, send the following instructions thrice:

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

When this ends, the module enters 8-bits data length mode without fail, then enter 4-bits data length instruction for 4-bits data length interface.

SOFTWARE EXAMPLE - 8-bit operation (8-bits 2 lines)

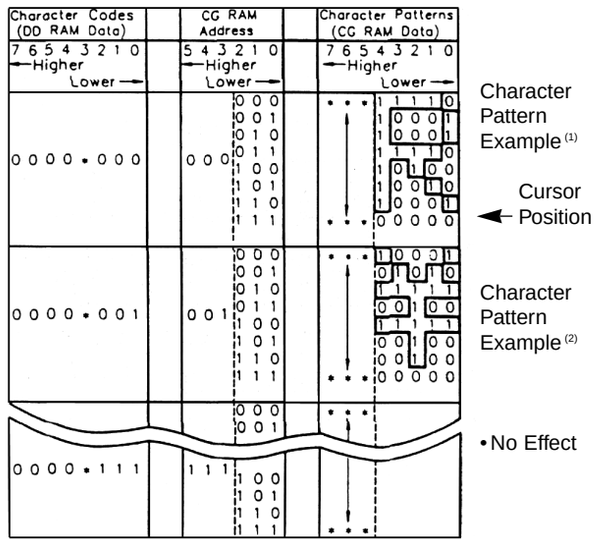
FUNCTION	RS	R/W	D7	D6	D5	D4	D3	D2	D1	DØ	DISPLAY	DESCRIPTION
Power on delay												Initialization. No display appears.
Function set	Ø	Ø	Ø	Ø	1	1	Ø	Ø	X	X		Sets to 8-bit operation and selects 2-line display and 5 x 7 dots character font (Note: Number of display lines and character fonts cannot be changed after this).
Display OFF	Ø	Ø	Ø	Ø	Ø	Ø	1	Ø	Ø	Ø		Turn off display.
Display ON	Ø	Ø	Ø	Ø	Ø	Ø	1	1	1	Ø	_	Turn on display and cursor.
Entry mode set	Ø	Ø	Ø	Ø	Ø	Ø	Ø	1	1	Ø	_	Set mode to increment the address by one and to shift the cursor to the right, at the time of write, to the DD/CG RAM display is not shifted.
Write data to CG/DD RAM	1	Ø	Ø	1	Ø	Ø	Ø	1	Ø	Ø	D _	Write "D". Cursor incremented by one and shift to right.
Write data to CG/DD RAM	1	Ø	Ø	1	Ø	Ø	1	Ø	Ø	1	DI_	Write "I". Cursor incremented by one and shift to right.
Write data to CG/DD RAM					• • •						DISPLAY_	Write "S", "P", "L", "A" and "Y".
Set DD RAM address	Ø	Ø	1	1	Ø	Ø	Ø	Ø	Ø	Ø	DISPLAY _	Set RAM address so that the cursor is propositioned at the head of the second line.
Write data to CG/DD RAM					• •						DISPLAY EL_	Write "E" and "L".
Cursor or display shift	Ø	Ø	Ø	Ø	Ø	1	Ø	Ø	X	X	DISPLAY EL	Shift only the cursor position to the left.
Write data to CG/DD RAM					• •						DISPLAY ELEKTRON_	Write "E", "K", "T", "R", "O" and "N".
Entry mode set	Ø	Ø	Ø	Ø	Ø	Ø	Ø	1	1	1	DISPLAY ELEKTRON_	Set display mode shift at the time during writing operation.
Write data to CG/DD RAM	1	Ø	Ø	1	Ø	Ø	1	Ø	Ø	1	ISPLAY LEKTRONI_	Write "D". Cursor incremented by one and shift to right (The display move to the left).
Write data to CG/DD RAM					• • •							Write other characters.
Return home	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	1	Ø	DISPLAY ELEKTRONI	Return both display and cursor to the original position (Set address to zero).

SOFTWARE EXAMPLE - 4-bit operation (4-bits 1 line)

FUNCTION	RS	R/W	D7	D6	D5	D4	DISPLAY	DESCRIPTION
Power on delay								Initialization. No display appears.
Function set	Ø	Ø	Ø	Ø	1	Ø		Sets to 4-bit operation. In this case, operation is handled as 8-bits by initialization, and only this instruction completes with one write.
Function set	Ø Ø	Ø Ø	Ø Ø	Ø Ø	1 X	Ø X		Sets 4-bit operation and selects 1-line display and 5 x 7 dot character font on and resettting is needed (number of display lines and character fonts cannot be changed hence after).
DisplayON/ OFF Control	Ø Ø	Ø Ø	Ø 1	Ø 1	Ø 1	Ø Ø	_	Turn on display and cursor.
Entry mode set	Ø Ø	Ø Ø	Ø Ø	Ø 1	Ø 1	Ø Ø	_	Set mode to increment the address by one and to shift the cursor to the right, at the time of write, to the DD/CG RAM display is not shifted.
Write data to CG/DD RAM	1 1	Ø Ø	Ø Ø	1 1	Ø Ø	Ø Ø	D _	Write "D". Cursor incremented by one and shift to the right.
Same as 8-bit operation								

DOT CHARACTER PATTERNS

For 5 x 7 Dot Character Patterns



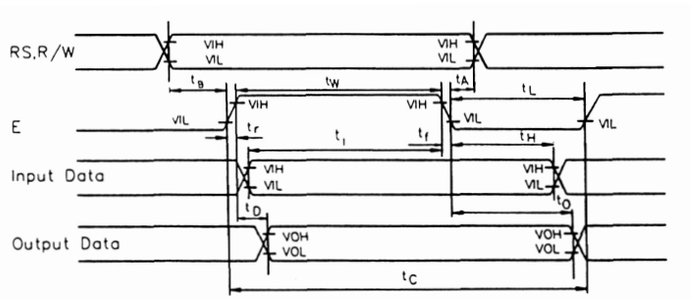
NOTE:
Character code bits 0.2
Correspond to CG RAM
address bits 3.5
(3 bits : 8 types)

TIMING CHARACTERISTICS FOR CONTROLLER CHIPS

CONTROLLERS CHIPS / PARAMETERS		SAMSUNG KS0066 (or equ.)	RECOMMENDED TIMING	UNIT
Enable Cycle Time	tC (min)	1000	1000	nS
Enable Pulse Width High Level Low Level	 tW (min) tL (min)	 450 450	 450 450	 nS nS
E. Raise Time	tr (max)	25	25	nS
E. Fall Time	tf (max)	25	25	nS
Set-up Time	tB (min)	140	140	nS
Data Set-up Time	tI (min)	195	195	nS
Data Delay Time	tD (max)	320	320	nS
Address Hold Time	tA (max)	10	10	nS
Hold Time Input Data Output Data	 tH (min) tO (min)	 10 20	 10 20	 nS nS

NOTE:
INITIALIZATION BY POWER–ON RESET INVOLVES MANY UNSTABLE FACTORS CAUSED BY POWER SUPPLY FLUCTUATIONS.
THEREFOR, INITIALISING BY INSTRUCTIONS IS STRONGLY RECOMMENDED

TIMING DIAGRAM

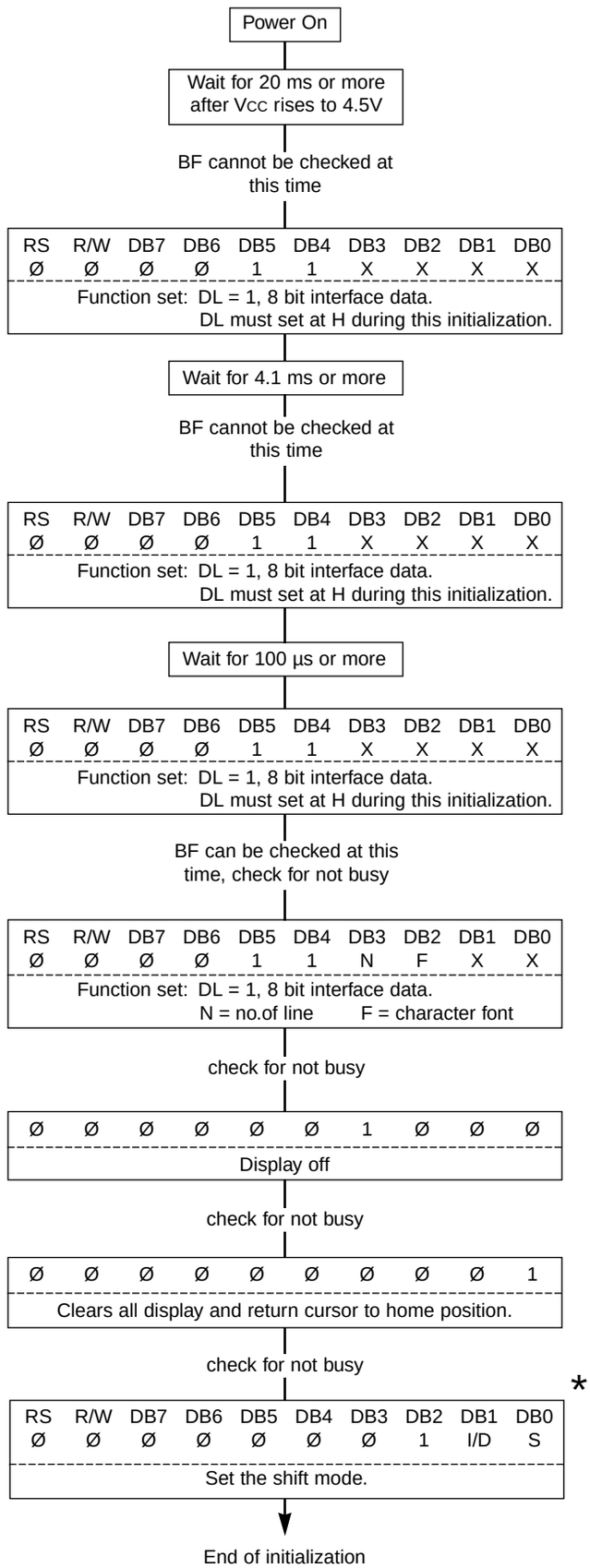


STANDARD CHARACTER CODE MAP

(others on request)

INITIALIZATION

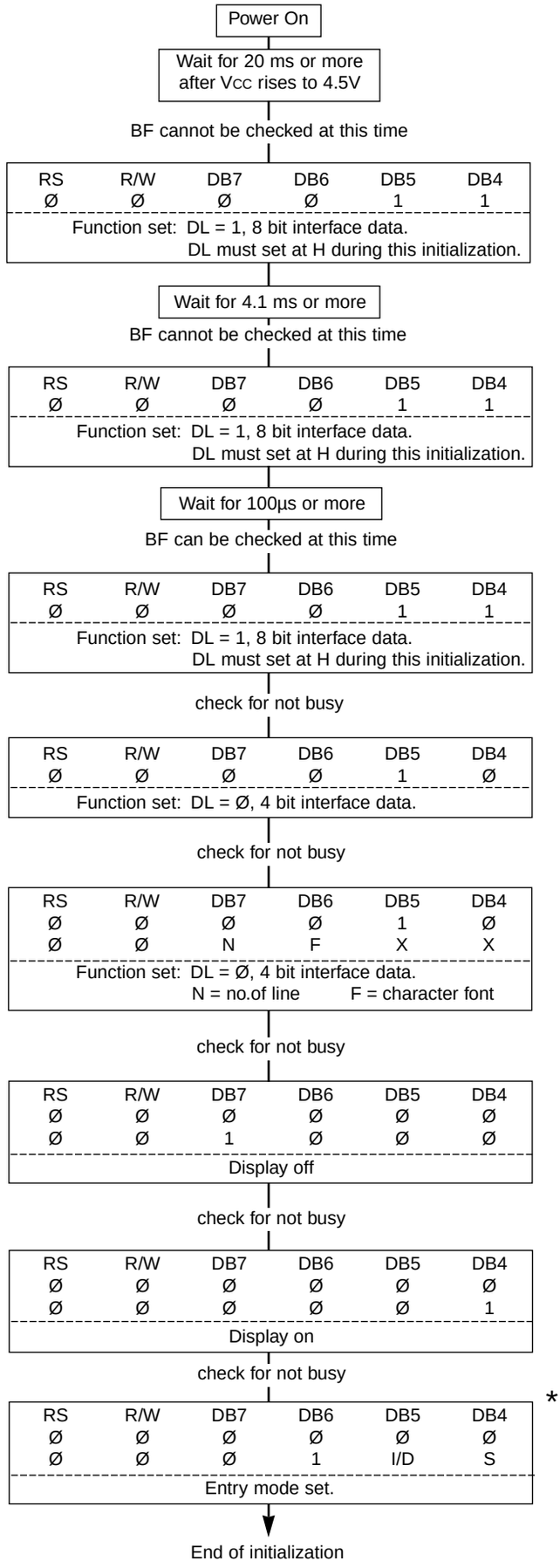
FOR 8 BIT DATA
INTERFACING



* NOTE: IN NORMAL OPERATION; SET S TO Ø

INITIALIZATION

FOR 4 BIT DATA
INTERFACING



* NOTE. IN NORMAL OPERATION, SET S TO Ø

DISPLAY CHARACTER POSITION AND DD RAM ADDRESS

1 x 8 DMM, 1/8 MUX

N = Ø: 1-LINE DISPLAY F = Ø: 5 x 7 DOTS

	1	2	3	4	5	6	7	8	
									← DISPLAY POSITION
FIRST LINE	ØØ	Ø1	Ø2	Ø3	Ø4	Ø5	Ø6	Ø7	← DD RAM ADDRESS

WHEN THE DISPLAY SHIFT OPERATION IS PERFORMED, THE DD RAM ADDRESS MOVED AS FOLLOW:

AFTER THE LEFT SHIFT INSTRUCTION

1	2	3	4	5	6	7	8	
								← DISPLAY POSITION
Ø1	Ø2	Ø3	Ø4	Ø5	Ø6	Ø7	Ø8	← DD RAM ADDRESS

AFTER THE RIGHT SHIFT INSTRUCTION

1	2	3	4	5	6	7	8	
								← DISPLAY POSITION
4F	ØØ	Ø1	Ø2	Ø3	Ø4	Ø5	Ø6	← DD RAM ADDRESS

1 x 16 DMM, 1/16 MUX

N = 1: 2-LINE DISPLAY F = Ø: 5 x 7 DOTS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
																	← DISPLAY POSITION
FIRST LINE	ØØ	Ø1	Ø2	Ø3	Ø4	Ø5	Ø6	Ø7	4Ø	41	42	43	44	45	46	47	← DD RAM ADDRESS

WHEN THE DISPLAY SHIFT OPERATION IS PERFORMED, THE DD RAM ADDRESS MOVED AS FOLLOW:

AFTER THE LEFT SHIFT INSTRUCTION

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
																← DISPLAY POSITION
Ø1	Ø2	Ø3	Ø4	Ø5	Ø6	Ø7	Ø8	41	42	43	44	45	46	47	48	← DD RAM ADDRESS

AFTER THE RIGHT SHIFT INSTRUCTION

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
																← DISPLAY POSITION
27	ØØ	Ø1	Ø2	Ø3	Ø4	Ø5	Ø6	67	4Ø	41	42	43	44	45	46	← DD RAM ADDRESS

1 x 16 DMM, 1/8 MUX

N = Ø: 1-LINE DISPLAY F = Ø: 5 x 7 DOTS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
																	← DISPLAY POSITION
FIRST LINE	ØØ	Ø1	Ø2	Ø3	Ø4	Ø5	Ø6	Ø7	Ø8	Ø9	ØA	ØB	ØC	ØD	ØE	ØF	← DD RAM ADDRESS

1 x 20 DMM, 1/8 MUX

N = Ø: 1-LINE DISPLAY F = Ø: 5 x 7 DOTS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
																					← DISPLAY POSITION
FIRST LINE	ØØ	Ø1	Ø2	Ø3	Ø4	Ø5	Ø6	Ø7	Ø8	Ø9	ØA	ØB	ØC	ØD	ØE	ØF	1Ø	11	12	13	← DD RAM ADDRESS

1 x 40 DMM, 1/11 MUX

N = Ø: 1-LINE DISPLAY F = Ø: 5 x 10 DOTS

	1	2	3	4	5	6	7	8	9	10	11	12	13		33	34	35	36	37	38	39	40	
																							← DISPLAY POSITION
FIRST LINE	ØØ	Ø1	Ø2	Ø3	Ø4	Ø5	Ø6	Ø7	Ø8	Ø9	ØA	ØB	ØC	-----	2Ø	21	22	23	24	25	26	27	← DD RAM ADDRESS

DISPLAY CHARACTER POSITION AND DD RAM ADDRESS (CONTINUE)

2 x 16 DMM, 1/16 MUX

N = 1: 2-LINE DISPLAY F = Ø: 5 x 7 DOTS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
																	← DISPLAY POSITION
FIRST LINE	ØØ	Ø1	Ø2	Ø3	Ø4	Ø5	Ø6	Ø7	Ø8	Ø9	ØA	ØB	ØC	ØD	ØE	ØF	← DD RAM ADDRESS
SECOND LINE	4Ø	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	

WHEN THE DISPLAY SHIFT OPERATION IS PERFORMED, THE DD RAM ADDRESS MOVED AS FOLLOW:

AFTER THE LEFT SHIFT INSTRUCTION

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
																← DISPLAY POSITION
Ø1	Ø2	Ø3	Ø4	Ø5	Ø6	Ø7	Ø8	Ø9	ØA	ØB	ØC	ØD	ØE	ØF	1Ø	← DD RAM ADDRESS
41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	5Ø	

AFTER THE RIGHT SHIFT INSTRUCTION

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
																← DISPLAY POSITION
27	ØØ	Ø1	Ø2	Ø3	Ø4	Ø5	Ø6	Ø7	Ø8	Ø9	ØA	ØB	ØC	ØD	ØE	← DD RAM ADDRESS
67	4Ø	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	

2 x 20 DMM, 1/16 MUX

N = 1: 2-LINE DISPLAY F = Ø: 5 x 7 DOTS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
																					← DISPLAY POSITION
FIRST LINE	ØØ	Ø1	Ø2	Ø3	Ø4	Ø5	Ø6	Ø7	Ø8	Ø9	ØA	ØB	ØC	ØD	ØE	ØF	1Ø	11	12	13	← DD RAM ADDRESS
SECOND LINE	4Ø	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	5Ø	51	52	53	

4 x 40 DMM, 1/16 MUX *
2 x 40 DMM, 1/16 MUX

N = 1: 2-LINE DISPLAY F = Ø: 5 x 7 DOTS

	1	2	3	4	5	6	7	8	9	10	11	12	13		33	34	35	36	37	38	39	40	
																							← DISPLAY POSITION
First + Third Line	ØØ	Ø1	Ø2	Ø3	Ø4	Ø5	Ø6	Ø7	Ø8	Ø9	ØA	ØB	ØC	----------	2Ø	21	22	23	24	25	26	27	← DD RAM ADDRESS
Second + Fourth Line	4Ø	41	42	43	44	45	46	47	48	49	4A	4B	4C	----------	6Ø	61	62	63	64	65	66	67	

* First + Second Line Control by Enable 1, Third + Fourth Line Control by Enable 2

4 x 16 DMM, 1/16 MUX

N = 1: 2-LINE DISPLAY F = Ø: 5 x 7 DOTS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
																	← DISPLAY POSITION
FIRST LINE	ØØ	Ø1	Ø2	Ø3	Ø4	Ø5	Ø6	Ø7	Ø8	Ø9	ØA	ØB	ØC	ØD	ØE	ØF	← DD RAM ADDRESS
SECOND LINE	4Ø	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	
THIRD LINE	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F	
FOURTH LINE	50	51	52	53	54	55	56	57	58	59	5A	5B	5C	5D	5E	5F	

4 x 20 DMM, 1/16 MUX

N = 1: 2-LINE DISPLAY F = Ø: 5 x 7 DOTS

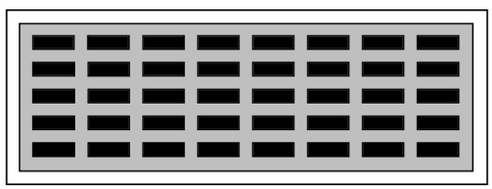
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
																					← DISPLAY POSITION
FIRST LINE	ØØ	Ø1	Ø2	Ø3	Ø4	Ø5	Ø6	Ø7	Ø8	Ø9	ØA	ØB	ØC	ØD	ØE	ØF	1Ø	11	12	13	← DD RAM ADDRESS
SECOND LINE	4Ø	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	5Ø	51	52	53	
THIRD LINE	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F	2Ø	21	22	23	24	25	26	27	
FOURTH LINE	54	55	56	57	58	59	5A	5B	5C	5D	5E	5F	6Ø	61	62	63	64	65	66	67	

BACKLIGHT TYPES

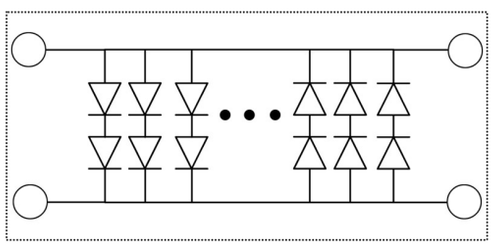
	EL (electro luminescent)	CCFL (cold cathode fluorescent lamps)	LED (light emitted diode)
DESCRIPTION	The EL-lamp is a thin structure type of backlight illumination. It is formed by organic membrane, high conductive fluorescence substance, transparent electrode and use AC power to drive.	The CCFL is a uniformly, light weight and energy efficient backlight. Used in larger modules like grafic types.	The LED-backlight is the most popular type of backlight. Very long lifetime and brilliant characteristics brings high brightness at low power consumption. There are two different reasonable types: lightbox and lightpipe (guide) for different application reasons.
CHARACTERISTICS	- High, uniform brightness. - Low power consumption. - Cold backlight (no heat dissipation). - Light weight. - Very thin. - Plenty selection of colors. - Lifetime (~3000h -5000h).	- High, uniform brightness. - Emitted color is white. - Long lifetime (~15000h).	- Brightness justable by resistor. - Low voltage (DC power to drive). - Most popular backlight type. - Very long lifetime (>50000h). **>> LED-LIGHTBOX:** - Direct light. LED-chips are distributed over the hole viewing area. - High brightness. - Uniform brightness. **>> LIGHTPIPE** (LIGHTGUIDE) - Indirect light. LED-chips are mounted on the edges of the viewing area. A diffusor guides the light to the front. - Lower thickness. - Lower power consumption. -

LED-LIGHTBOX: (example)

(mechanical schematic)

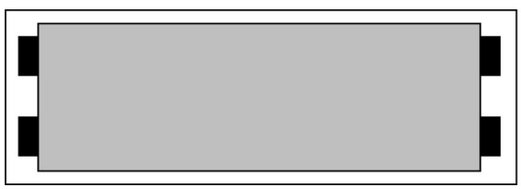


(electrical schematic)



LED-LIGHTPIPE (lightguide): (example)

(mechanical schematic)



(electrical schematic)