

# I<sup>2</sup>C-BUS LCD MIT 3x12 ZEICHEN, SUPERFLACH



EA T123A-I2C



EA T123W-I2C

Abmessungen:  
46x33x2,65mm

## TECHNISCHE DATEN

- \* 3x12 ZEICHEN I<sup>2</sup>C BUS INTERFACE: 100kHz
- \* CHIP-ON-GLAS TECHNIK: NUR 2,85mm FLACH
- \* 5x7 MATRIX, 6° BLICKRICHTUNG
- \* DURCH GEDREHTEN ZEICHENSATZ AUCH FÜR 12° BLICKRICHTUNG
- \* VERSORGUNG SINGLE SUPPLY +5@ 700µA ODER
- \* VERSORUNG +2,5V/-4,5V BIS +6V/-1V @ 100µA
- \* PCF 2116-C ON BOARD
- \* KOMPATIBEL ZU OPTREX OEG3231493, C51573, PHILIPS LPH3827
- \* TRANSFLEKTIV: KANN VON HINTEN BELEUCHTET WERDEN (LED/EL-FOLIE)
- \* ZEICHENHÖHE 4,7mm
- \* SICHTFENSTER 32 x 17mm
- \* AUSSENABMESSUNGEN 46 x 33 mm
- \* ZUBEHÖR: LED-BELEUCHTUNG
- \* BETRIEBSTEMPERATUR -20... +70°C
- \* LAGERTEMPERATUR -25... +80°C

## BESTELLBEZEICHNUNG

3x12st. DOTMATRIX MIT I <sup>2</sup> C-BUS EINGANG, STN GRAU	<b>EA T123A-I2C</b>
WIE OBEN, ABER IN FSTN SCHWARZ/WEIß	<b>EA T123W-I2C</b>
LED- BELEUCHTUNGSKÖRPER IN GELB/GRÜN 5V / 90mA	<b>EA LG40X21-A</b>

### Programming of mux 1 : 32 displays with PCF2114X

To drive a 2-line by 24 characters mux 1 : 32 display, use instruction Function Set M, N to 0, 1. Note that the right half of the display needs mirrored column connection compared to a display driven by a PCF2116X.

To drive a 4-line by 12 characters mux 1 : 32 display the PCF2116 operating instructions apply. There is no functional difference between the two chips in this mode. For such an application set M, N to 1,1 with the Function Set instruction.

### Reset function

The PCF2116 automatically initializes (resets) when power is turned on. After reset the chip has the following state.

Table 2 State after reset.

STEP	DESCRIPTION		
1	Display clear.		
2	Function set.	DL = 1	8-bit interface
		M, N = 0	1-line display
		G = 0	voltage generator; $V_{LCD} = V_0$
3	Display on/off control.	D = 0	display off
		C = 0	cursor off
		B = 0	blink off
4	Entry mode set.	I/D = 1	+1 (increment)
		S = 0	no shift
5	Default address pointer to DDRAM. The busy flag (BF) indicates the busy state (BF = logic 1) until initialization ends. The busy state lasts 2 ms. The chip may also be initialized by software. See Figs 28 and 29.		
6	I <sup>2</sup> C-bus interface reset.		

### INSTRUCTIONS

Only two PCF2116 registers, the instruction register (IR) and the data register (DR) can be directly controlled by the MPU. Before internal operation, control information is stored temporarily in these registers to allow interface to various types of MPUs which operate at different speeds or to allow interface to peripheral control ICs. The PCF2116 operation is controlled by the instructions shown in Table 3 together with their execution time. Details are explained in subsequent sections.

Instructions are of 4 categories, those that:

1. Designate PCF2116 functions such as display format, data length, etc.
2. Set internal RAM addresses.
3. Perform data transfer with internal RAM.
4. Others.

In normal use, category 3 instructions are used most frequently. However, automatic incrementing by 1 (or decrementing by 1) of internal RAM addresses after each data write lessens the MPU program load. The display shift in particular can be performed concurrently with display data write, enabling the designer to develop systems in minimum time with maximum programming efficiency.

During internal operation, no instruction other than the busy flag/address read instruction will be executed.

Because the busy flag is set to logic 1 while an instruction is being executed, check to make sure it is on logic 0 before sending the next instruction or wait for the maximum instruction execution time, as given in Table 3. An instruction sent while the busy flag is HIGH will not be executed.

Table 3 Instructions (note 1).

INSTRUCTION	RS	R $\overline{W}$	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	DESCRIPTION	REQUIRED CLOCK CYCLES <sup>(2)</sup>
NOP	0	0	0	0	0	0	0	0	0	0	no operation	0
Clear display	0	0	0	0	0	0	0	0	0	1	Clears entire display and sets DDRAM address 0 in address counter.	165
Return Home	0	0	0	0	0	0	0	0	1	0	Sets DDRAM address 0 in address counter. Also returns shifted display to original position. DDRAM contents remain unchanged.	3
Entry mode set	0	0	0	0	0	0	0	1	I/D	S	Sets cursor move direction and specifies shift of display. These operations are performed during data write and read.	3
Display control	0	0	0	0	0	0	1	D	C	B	Sets entire display on/off (D), cursor on/off (C) and blink of cursor position character (B).	3
Cursor/display shift	0	0	0	0	0	1	S/C	R/L	0	0	Moves cursor and shifts display without changing DDRAM contents.	3
Function set	0	0	0	0	1	DL	N	M	G	0	Sets interface data length (DL), number of display lines (N, M) and voltage generator control (G).	3
Set CGRAM address	0	0	0	1	A <sub>CG</sub>						Sets CGRAM address	3
Set DDRAM address	0	0	1	A <sub>DD</sub>						Sets DDRAM address	3	
Read Busy Flag and Address Counter	0	1	BF	A <sub>C</sub>						Reads busy flag (BF) indicating internal operation is being performed and reads address counter contents.	0	
Read data	1	1	read data						Reads data from CGRAM or DDRAM.			3
Write data	1	0	write data						Writes data to CGRAM or DDRAM.			3

## Notes

1. In the I<sup>2</sup>C-bus mode the DL bit is don't care. 8-bit mode is assumed.

In the I<sup>2</sup>C-bus mode a control byte is required when RS or R/W is changed; control byte: Co, RS, R/W, 0, 0, 0, 0, 0; command byte: DB7 to DB0.

2. Example:  $f_{osc} = 150 \text{ kHz}$ ,  $T_{cy} = \frac{1}{f_{osc}} = 6.67 \mu\text{s}$ ; 3 cycles = 20  $\mu\text{s}$ , 165 cycles = 1.1 ms.

Table 4 Command bit identities.

BIT	0	1
I/D	decrement	increment
S	display freeze	display shift
D	display off	display on
C	cursor off	cursor on
B	character at cursor position does not blink	character at cursor position blinks
S/C	cursor move	display shift
R/L	left shift	right shift
DL	4 bits	8 bits
G	voltage generator: $V_{LCD} = V_0$	voltage generator: $V_{LCD} = V_0 - 0.8V_{DD}$
N, (M = 0)		
PCF2116	1 line × 24 characters; mux 1 : 16	2 lines × 24 characters; mux 1 : 32
PCF2114	2 line × 12 characters; mux 1 : 16	2 lines × 24 characters; mux 1 : 32
N, (M = 1)	reserved	4 lines × 12 characters; mux 1 : 32
BF	end of internal operation	internal operation in progress
Co	last control byte, only data bytes to follow	next two bytes are a data byte and another control byte

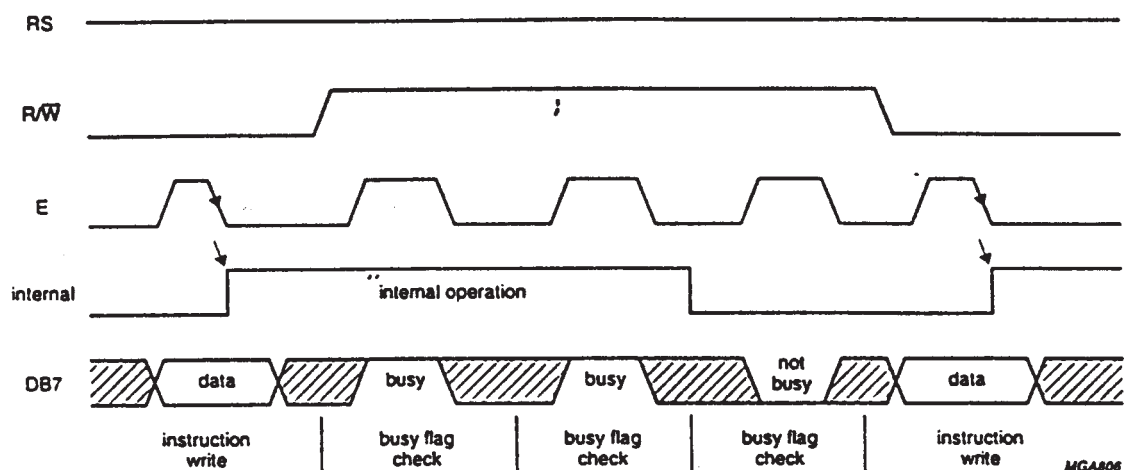


Fig.20 Example of busy flag check timing sequence.

## Clear display

Clear Display writes space code 20 (hexadecimal) into all DDRAM addresses (The character pattern for character code 20 must be blank pattern). Sets the DDRAM address counter to logic 0. Returns display to its original position if it was shifted. Thus, the display disappears and the cursor or blink position goes to the left edge of the display (the first line if 2 or 4 lines are displayed). Sets entry mode I/D = logic 1 (increment mode). S of entry mode does not change.

The instruction Clear Display requires extra execution time. This may be allowed for by checking the busy-flag (BF) or by waiting until 2 ms has elapsed. The latter must be applied where no read-back options are foreseen, as in some chip-on-glass (COG) applications.

## Return Home

Return Home sets the DDRAM address counter to logic 0. Returns display to its original position if it was shifted. DDRAM contents do not change. The cursor or blink position goes to the left of the display (the first line if 2 or 4 lines are displayed). I/D and S of entry mode do not change.

## Entry mode set

### ID

When I/D = logic 1 (0) the DDRAM or CGRAM address increments (decrements) by 1 when data is written into or

read from the DDRAM or CGRAM. The cursor or blink position moves to the right when incremented and to the left when decremented. The cursor and blink are inhibited when the CGRAM is accessed.

### S

When S = logic 1, the entire display shifts either to the right (I/D = logic 0) or to the left (I/D = logic 1) during a DDRAM write. Thus it looks as if the cursor stands still and the display moves. The display does not shift when reading from the DDRAM, or when writing into or reading out of the CGRAM. When S = logic 0 the display does not shift.

## Display on/off control

### D

The display is on when D = logic 1 and off when D = logic 0. Display data in the DDRAM are not affected and can be displayed immediately by setting D to logic 1.

### C

The cursor is displayed when C = logic 1 and inhibited when C = logic 0. Even if the cursor disappears, the display functions I/D, etc. remain in operation during display data write. The cursor is displayed using 5 dots in the 8<sup>th</sup> line (see Fig.12).

**B**

The character indicated by the cursor blinks when B = logic 1. The blink is displayed by switching between display characters and all dots on with a period of 1 second when  $f_{osc} = 150 \text{ kHz}$  (Fig.12). At other clock frequencies the blink period is equal to  $150 \text{ kHz}/f_{osc}$ . The cursor and the blink can be set to display simultaneously.

**Cursor or display shift**

Cursor or Display Shift moves the cursor position or the display to the right or left without writing or reading display data. This function is used to correct a character or move the cursor through the display. In 2 or 4-line displays, the cursor moves to the next line when it passes the last position (40 or 20 decimal) of the line. When the displayed data is shifted repeatedly all lines shift at the same time; displayed characters do not shift into the next line. The address counter (AC) content does not change if the only action performed is shift display, but increments or decrements with the cursor shift.

**Function set****DL (PARALLEL MODE ONLY)**

Sets interface data width. Data is sent or received in bytes (DB7 to DB0) when DL = logic 1 or in two nibbles (DB7 to DB4) when DL = logic 0. When 4-bit width is selected, data is transmitted in two cycles using the parallel bus<sup>(1)</sup>.

Function set from I<sup>2</sup>C-interface: DL bit can not be set to 0 from the I<sup>2</sup>C-interface. If bit DL has been set to 0 via the parallel bus, programming via the I<sup>2</sup>C-interface is complicated.

**N, M**

Sets number of display lines.

**G**

Controls the  $V_{LCD}$  voltage generator characteristic.

**Set CGRAM address**

Set CGRAM Address sets bit 0 to 5 of the CGRAM address ACG into the address counter (binary

$A_5A_4A_3A_2A_1A_0$ ). Data can then be written to or read from the CGRAM.

Only bits 0 to 5 of the CGRAM address are set by the set CGRAM address command. Bit 6 can be set using the set DDRAM address command or by using the auto-increment feature during CGRAM write. All bits 0 to 6 can be read using the read BF and address command.

**Set DDRAM address**

Set DDRAM Address sets the DDRAM address into the address counter (binary  $A_6A_5A_4A_3A_2A_1A_0$ ). Data can then be written to or read from the DDRAM.

**Hexadecimal address ranges.**

ADDRESS	FUNCTION
00 to 4F	1-line by 24; 2116
00 to 0B and 0C to 4F	2-line by 12; 2114
00 to 27 and 40 to 67	2-line by 24; 2114/2116
00 to 13, 20 to 33, 40 to 53 and 60 to 73	4-line by 12; 2114/2116

**Read busy flag and address**

Read Busy Flag and Address reads the busy flag (BF). BF = logic 1 indicates that an internal operation is in progress. The next instruction will not be executed if BF = 1. Check the BF status before sending the next instruction.

At the same time, the value of the address counter expressed in binary  $A_6$  to  $A_0$  is read out. The address counter is used by both CGRAM and DDRAM, and its value is determined by the previous instruction.

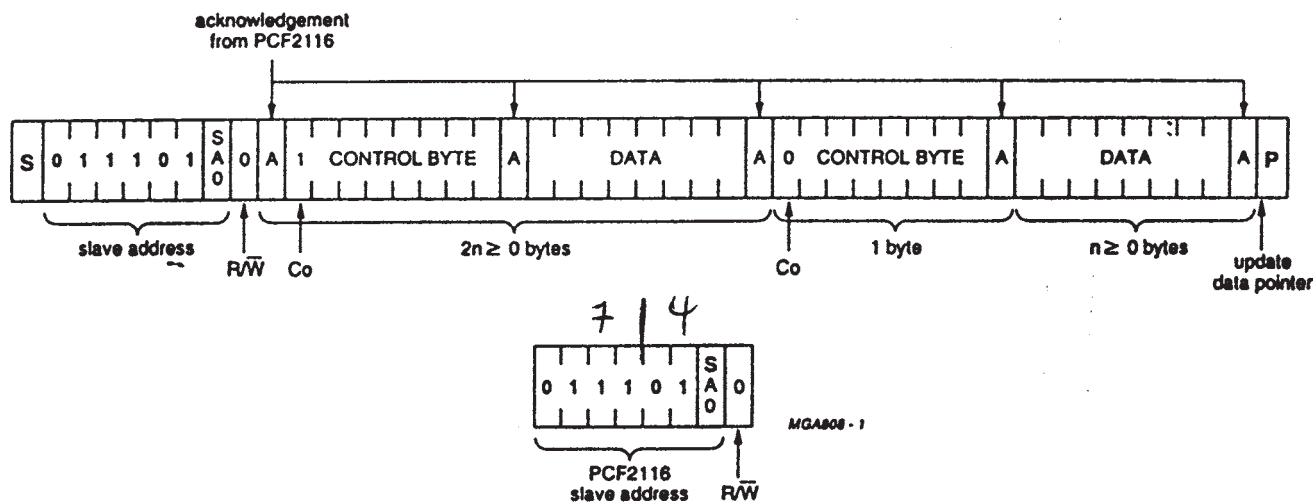
**Write data to CGRAM or DDRAM**

Writes binary 8-bit data  $D_7$  to  $D_0$  to the CGRAM or the DDRAM.

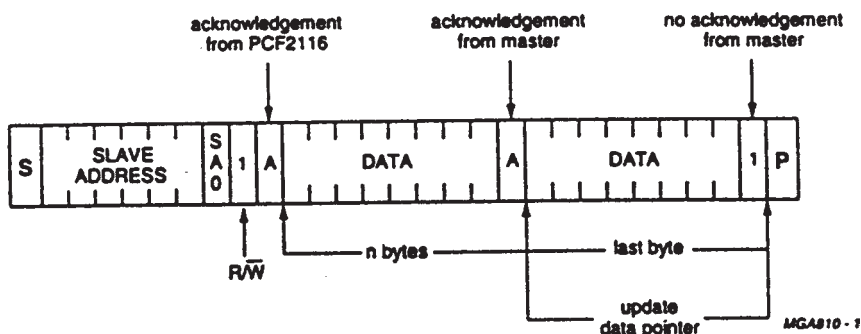
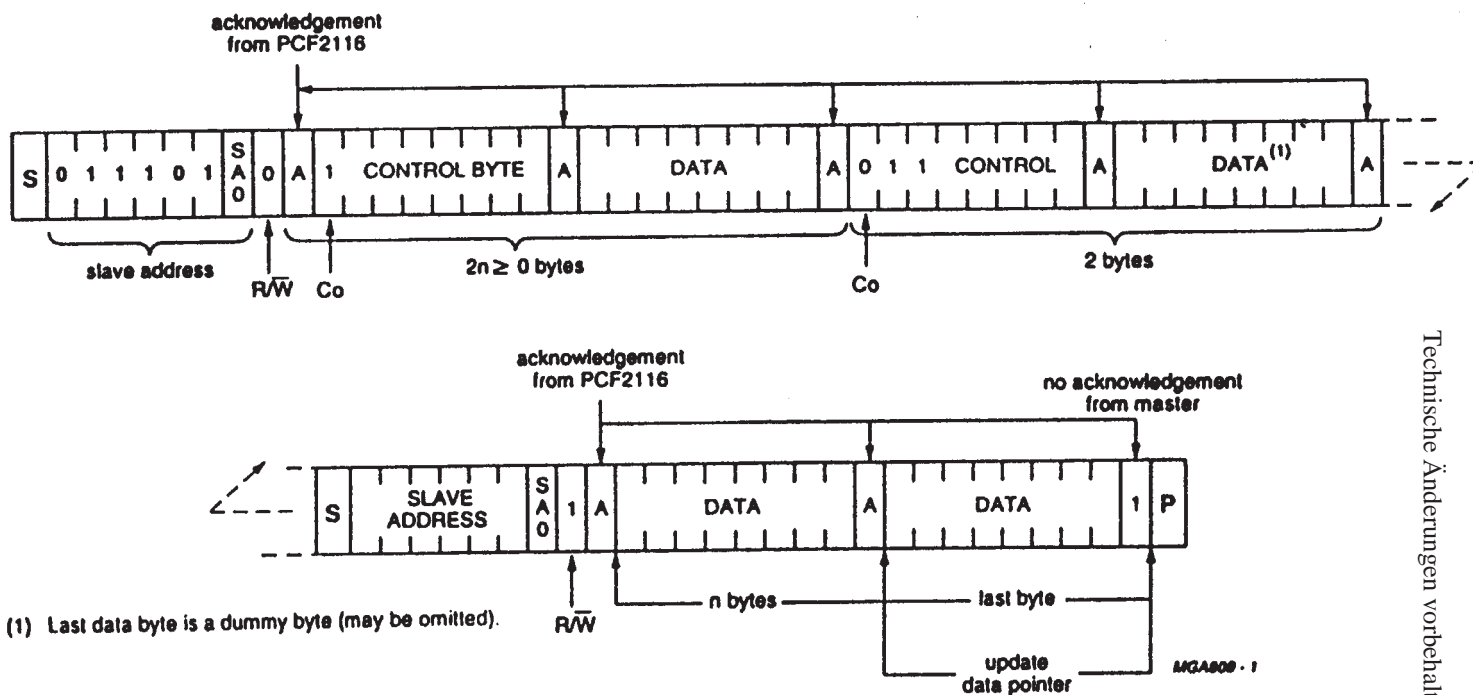
Whether the CGRAM or DDRAM is to be written into is determined by the previous specification of CGRAM or DDRAM address setting. After writing, the address automatically increments or decrements by 1, in accordance with the entry mode. Only bits  $D_0$  to  $D_4$  of CGRAM data are valid, bits  $D_5$  to  $D_7$  are 'don't care'.

(1) In a 4-bit application DB3 to DB0 are left open (internal pull-ups). Hence in the first function set instruction after power-on G and H are set to 1. A second function set must then be sent (2 nibbles) to set G and H to their required values.





Master transmits to slave receiver; WRITE mode.



Master reads slave immediately after first byte; READ mode (RS previously defined).

## FONT TABELLE CHARACTERSET -C

upper 4 bits lower 4 bits		0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
xxxx 0000	CG RAM 1	L	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E
xxxx 0001	2	L	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E
xxxx 0010	3	L	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E
xxxx 0011	4	L	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E
xxxx 0100	5	L	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E
xxxx 0101	6	L	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E
xxxx 0110	7	L	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E
xxxx 0111	8	L	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E
xxxx 1000	9	L	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E
xxxx 1001	10	L	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E
xxxx 1010	11	L	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E
xxxx 1011	12	L	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E
xxxx 1100	13	L	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E
xxxx 1101	14	L	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E
xxxx 1110	15	L	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E
xxxx 1111	16	L	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E

MLB895

Character set 'C' in CGROM; PCF2116C;

**Table 8** Example of I<sup>2</sup>C operation; 1-line display (using internal reset, assuming SA0 = V<sub>SS</sub>; note 1).

STEP	I <sup>2</sup> C BYTE										DISPLAY	OPERATION
1	I <sup>2</sup> C start											Initialized. No display appears.
2	Slave address for write											During the acknowledge cycle SDA will be pulled-down by the PCF2116.
	SA6	SA5	SA4	SA3	SA2	SA1	SA0	R $\overline{W}$	Ack			
	0	1	1	1	0	1	0	0	1			
3	Send a control byte for function set											Control byte sets RS and R $\overline{W}$ for following data bytes.
	Co	RS	R $\overline{W}$						Ack			
	0	0	0	X	X	X	X	X	1			
4	Function set											Selects 4-line display and V <sub>LCD</sub> = V <sub>O</sub> ; SCL pulse during acknowledge cycle starts execution of instruction.
	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Ack			
	0	0	1	X	1	1	0	0	1			
5	Display on/off control											Turns on display and cursor. Entire display shows character hex 20 (blank in ASCII-like character sets).
	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Ack			
	0	0	0	0	1	1	1	0	1			
6	Entry mode set											Sets mode to increment the address by 1 and to shift the cursor to the right at the time of write to the DDRAM or CGRAM. Display is not shifted.
	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Ack			
	0	0	0	0	0	1	1	0	1			
7	I <sup>2</sup> C start											For writing data to DDRAM, RS must be set to 1. Therefore a control byte is needed.
8	Slave address for write											
	SA6	SA5	SA4	SA3	SA2	SA1	SA0	R $\overline{W}$	Ack			
	0	1	1	1	0	1	0	0	1			
9	Send a control byte for write data											
	Co	RS	R $\overline{W}$						Ack			
	0	1	0	X	X	X	X	X	1			
10	Write data to DDRAM											Writes 'P'. The DDRAM has been selected at power-up. The cursor is incremented by 1 and shifted to the right.
	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Ack			
	0	1	0	1	0	0	0	0	1	P <sub>—</sub>		

October 1994



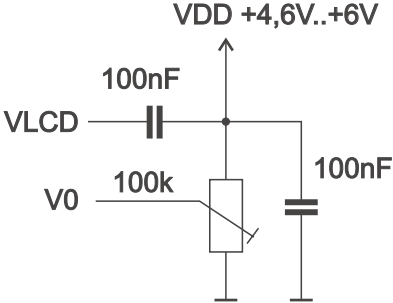
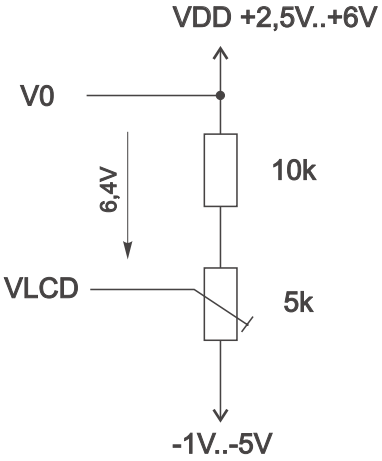
STEP	I <sup>2</sup> C BYTE	DISPLAY	OPERATION
11	Write data to DDRAM DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0 Ack 0 1 0 0 1 0 0 0 1 PH_		Writes 'H'.
12 to 15		     	
16	Write data to DDRAM DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0 Ack 0 1 0 1 0 0 1 1 1 PHILIPS_		Writes 'S'.
17	(optional I <sup>2</sup> C stop) I <sup>2</sup> C start + slave address for write (as step 8) PHILIPS_		
18	Control byte Co RS R $\bar{W}$ Ack 1 0 0 X X X X 1 PHILIPS_		--
19	Return Home DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0 Ack 0 0 0 0 0 1 0 1 PHILIPS		Sets DDRAM address 0 in address counter. (also returns shifted display to original position. DDRAM contents unchanged). This instruction does not update the Data Register (DR).
20	Control byte for read Co RS R $\bar{W}$ Ack 0 1 1 X X X X 1 PHILIPS		DDRAM content will be read from following instructions. The R $\bar{W}$ has to be set to 1 while still in I <sup>2</sup> C-write mode.
21	I <sup>2</sup> C start PHILIPS		
22	Slave address for read SA6 SA5 SA4 SA3 SA2 SA1 SA0 R $\bar{W}$ Ack 0 1 1 1 0 1 0 1 1 PHILIPS		During the acknowledge cycle the content of the DR is loaded into the internal I <sup>2</sup> C interface to be shifted out. In the previous instruction neither a Set Address nor a Read Data has been performed. Therefore the content of the DR was unknown.
23	Read data: 8 x SCL + master acknowledge; note 2 DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0 Ack X X X X X X X 0 PHILIPS		8 x SCL; content loaded into interface during previous acknowledge cycle is shifted out over SDA. MSB is DB7. During master acknowledge content of DDRAM address 01 is loaded into the I <sup>2</sup> C interface.

STEP	I <sup>2</sup> C BYTE	DISPLAY	OPERATION
24	Read data: 8 x SCL + master acknowledge; note 2 DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0 Ack 0 1 0 0 1 0 0 0 0	PHILIPS	8 x SCL; code of letter 'H' is read first. During master acknowledge code of 'I' is loaded into the I <sup>2</sup> C interface.
25	Read data: 8 x SCL + no master acknowledge; note 2 DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0 Ack 0 1 0 0 1 0 0 1 1	PHILIPS	No master acknowledge; After the content of the I <sup>2</sup> C interface register is shifted out no internal action is performed. No new data is loaded to the interface register, Data Register (DR) is not updated, Address Counter (AC) is not incremented and cursor is not shifted.
26	I <sup>2</sup> C stop	PHILIPS	

Notes

- 1. X = don't care.
- 2. SDA is left at high-impedance by the microcontroller during the READ acknowledge.
- 3. Depending on power supply initialisation (step 4, bit "G") may be different. See also page 11 for contrast adjustment.

KONTRASTEINSTELLUNG

Single supply	Dual power
	
Function set: Bit G=1 (generator on) Bit M=1 (3-4 lines) Bit N=1 (3-4 lines)	Function set: Bit G=0 (generator off) Bit M=1 (3-4 lines) Bit N=1 (3-4 lines)

## ABMESSUNGEN



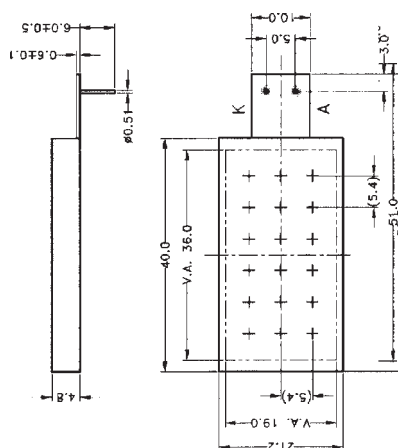
*EA T123-I2C must not be soldered direct onto pcb. Keep a distance of 5mm in minimum between pcb and lcd to avoid damage by soldering heat.*

**Achtung !**  
Handhabungs-  
vorschriften  
beachten

Elektrostatisch  
gefährdete  
Bauelemente



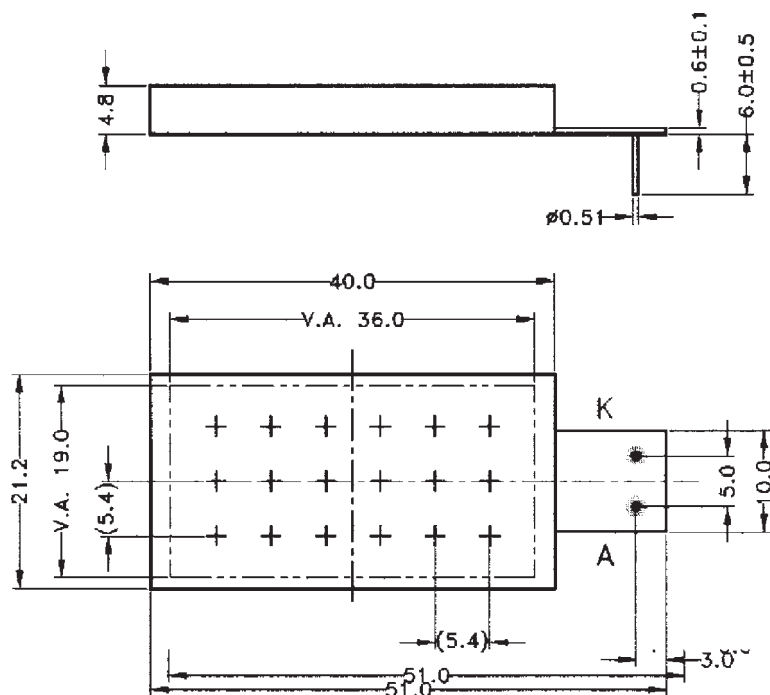
LED-Beleuchtung gelb/grün EA LG40x21-A



# LED-LEUCHTKÖRPER 2x9 LEDs

## 36 x 19mm LEUCHTFLÄCHE

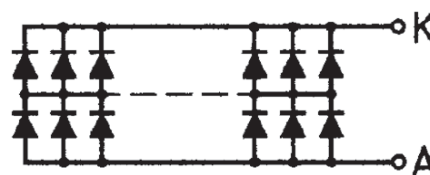
passt zu  
EA 7123-12C  
3x12



alle Masse in mm

### TECHNISCHE DATEN

- \* LIGHTBOX
- \* 2x9=18 LEDs
- \* LEUCHTFARBE GELB/GRÜN



Absolute Maximum Ratings (Ta = 25°C)				
Parameter	Symbol	Conditions	Rating	Unit
Reverse Voltage	Vr min	Ir=900uA	8	V
Peak Forward Current	Ip max	1ms, 10% duty	450	mA
Operating Temperature Range	Topr		-20 ~ +75	°C
Storage Temperature Range	Tstg		-25 ~ +85	°C
Electrical / Optical Characteristics (Ta = 25°C, If=90mA)				
Color	Wavelength [nm]	Operating Voltage [V]	Maximum allowable Power dissipation [mW]	Forward Current [mA]
Yellow-Green	568	4.1	900	90

### BESTELLBEZEICHNUNG

LED-Leuchtkörper, 2x9 LEDs gelb/grün

EA LG40x21-A

**ELECTRONIC**  
**ASSEMBLY** GMBH

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