

PHILIPS



CALCULATOR PROGRAM INDOOR
Volume 1 SUMMARY

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CHAPTER 1 - GENERAL INTRODUCTION

The data processing group of LiDEC has developed an indoor lighting design and cost calculation program for use with a Hewlett-Packard HP-41CV pocket calculator (or HP41C with Quad module) equipped with a bar-code reading pen. The calculator can be used by sales representatives and lighting engineers alike, to perform complete lighting and cost calculations on the spot.

The program soft-ware is available in the form of bar-codes printed on a sheet. The luminaire data are also read from a

bar-code, which is printed on the photometric data sheet of the relevant luminaire (Fig. 1.1). In cases where no luminaire bar-code is available the luminaire data can also be typed in numerically. The data are then taken from the traditional utilization factor tables.

A summary of these instructions for use is contained in Volume 2 of this publication.

PROPOSAL

Date: 82-01-15

Customer name : Mr. J.F. Caminada

Project name : Rai - Amsterdam

Project number : 82001/2

Philips Ltg. engineer : Mr. J.H.C. v. Hemert

Philips Sales engineer : Mr. C. v. d. Broek

Room name and/or N°:

Room length

Room width

Luminaire mount

Room

Type of luminaire

Type of lamp

Luminous flux of lamp

Calculated number of luminaire

Selected number of luminaires

Colour rendering index

CRI

Light class

watts/m²

luminaire (l)

illumination

luminaire

units/l

ars)

PHILIPS

LUM-DATA

USER PRGM ALPHA

UN LUM LAMP

STS-CAL

ENTER INDOOR

SF CF

4 5 6

FIX 1 2 3

PHOTOMETRIC DATA

INDOOR LIGHTING

SDK 101
1 x SON 150 W

Technical data for bar-code reader

Uniformity

1.0

0.8

0.6

0.4

0.2

0.0

60° 90° 120° 150° 180°

diagram

120° 90°

Fig. 1.1

Principle

The well-known formula from which the number of luminaires necessary to obtain a certain illuminance level in a room can be calculated is:

$$N = \frac{E \times L \times W}{NL \times \phi_L \times UF \times M \times V} \quad (1)$$

in which: N = number of luminaires
E = required illuminance level
L = room length
W = room width
NL = number of lamps per luminaire
 ϕ_L = lamp flux
UF = utilization factor
M = maintenance factor
V = ventilation factor

The formula itself is straightforward enough, the problem is to find the utilization factor (UF). This depends not only on the light distribution characteristics of the luminaire, but also on the room dimensions and the reflective properties of the various surfaces within the room.

Until now indoor lighting calculations were mostly carried out by making use of utilization factor tables, which in turn were calculated via the lumen method. The calculation of the utilization factor is a complicated and time-consuming affair and can therefore hardly be done without the help of a computer.

Not so long ago the Data Processing Group of LiDEC Eindhoven developed a computer program, which can be stored in the memory of a programmable pocket calculator. With the aid of this program it is possible to calculate the utilization factor of a luminaire in a room of given dimensions and reflective properties. This was only made possible by using the most sophisticated pocket calculator with the highest memory capacity currently available, the Hewlett-Packard type 41CV.

The bar-code

The calculations are made according to the CIE-method for indoor calculations, described in CIE-reports nos. 40 and 52. The main data block needed for calculation of the utilization factor is the luminous intensity distribution of the luminaire. This, like all other data, has to be fed into the pocket calculator. In order to eliminate the cumbersome and repetitive task of having to type in a large number of digits, with the inherent risk of errors, the luminous intensity distribution characteristics have been coded in the form of a bar-code (see Fig. 1.2). This can be read by means of a bar-code reading pen, which is connected to the pocket-calculator.

TBS 300/236 L

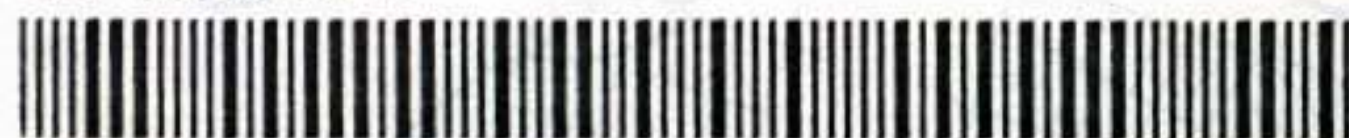


Fig. 1.2

The pen produces a narrow light beam by which the bar-code is scanned. The resulting variations in reflectance are

picked-up by a photocell and processed into data. Special codes at either end of the bar code permit it to be scanned from left to right as well as from right to left, giving the same result.

Apart from the luminous intensity distribution some additional information has been stored in the bar-code to permit of energy consumption and cost calculations, such as the number of lamps per luminaire and the luminaire wattage.

How calculations are carried out

Once having overcome the problem of creating a program by which the utilization factor could be calculated by means of a pocket calculator, it remained an easy task to adapt the same programme to calculate the required number of luminaires from a given illuminance level. This is done with formula (1).

The program is set-up in such a way that it can be started by simply pushing one button on the calculator. From then on it is virtually self-explanatory and asks for all relevant information in turn. When this information, including that contained in the luminaire bar-code, has been fed into the calculator, the utilization factor is calculated and then the required number of luminaires. The latter will mostly take the form of a decimal fraction, the designer himself has to decide upon the actual number of luminaires that most closely meets the geometry of the room as well as the required illuminance level. For example, if 24.67 luminaires are indicated as being the exact number required to produce the illuminance specified by the designer, this can be rounded off, either to 24 (6 rows of 4) or to 25 (5 rows of 5), depending on the length-width ratio of the room, and the maximum spacing-to-height ratio of the luminaire considered.

Advantages of the pocket-calculator program

An important feature of the program is that it allows different design proposals to be worked out without having to repeatedly specify the general information. Only the luminaire and/or lamp data have to be entered anew.

The program is built-up in such a way that it can easily be used in conjunction with a worksheet (page 23), which facilitates the comparison of different design solutions.

The cost calculation part of the program permits different proposals to be compared on a cost basis as well.

If desired, each step in the calculations can be automatically printed out on a paper tape (see Chapter 4).

Programming the calculator

The program soft-ware is available in the form of bar codes. The memory of the calculator is loaded by scanning a number of bar-codes using the bar-code reading pen. The program cannot be lost by switching off the machine or by temporarily removing the batteries (e.g. for changing). The program soft-ware is supplied free of charge by LiDEC Eindhoven.

The calculator is also a very useful tool for normal engineering work. For a description of how to use the calculator for this purpose, see the "Owners handbook and programming guide HP41C".

CHAPTER 2 - THE PROGRAM

Modules

The computer program is built-up from three modules:

- Module for general information.
The computer asks for data such as: room length, width, reflectance values, etc.
- Module for lighting calculations.
The computer asks for the luminaire and lamp data, then calculates the utilization factor and the number of luminaires required.
- Module for cost calculations.
The computer asks for the luminaire and lamp prices, installation costs etc. and makes the required cost calculations.

Building-up the program from modules has the advantage that different designs can easily be compared. The general information need not to be repeated each time.

Formulae

Room index (K)

$$K = \frac{L \cdot W}{H \cdot (L + W)}$$

Where:

- L = Room length (metres)
W = Room width (metres)
H = Difference between luminaire mounting height and work plane height (metres)

Number of luminaires (N)

$$N = \frac{E \cdot L \cdot W}{\phi_L \cdot NL \cdot M \cdot UF \cdot V}$$

where:

- E = Required illuminance (maintained) (lux)
L = Room length (metres)
W = Room width (metres)
 ϕ_L = Lamp flux (lumen)
NL = Number of lamps per luminaire
M = Maintenance factor
UF = Luminaire utilization factor
V = Ventilation factor

Investment (Inv)

$$Inv = N \cdot (LPR + INSTC + LAPR \cdot NRL)$$

where

- N = Number of luminaires
LPR = Luminaire price
INSTC = Installation costs per luminaire
LAPR = Lamp price
NL = Number of lamps per luminaire

Costs per year:

Energy (EN)

$$EN = N \cdot LWATT \cdot KWHPR \cdot BRNH / 1000.$$

where:

- N = Number of luminaires
LWATT = Total luminaire wattage
KWHPR = Kilowatt-hour price
BRNH = Burning hours per year

Capital investment (CC)

$$CC = (Inv - N \cdot NL \cdot LAPR) \cdot AF$$

where:

- Inv = Investment
AF = Annuity factor based on amortization period and interest rate (For N, NL, LAPR and AF, see below)

Lamps (LC)

$$LC = \frac{N \cdot NL \cdot LAPR}{RP}$$

where:

- N = Number of luminaires
NL = Number of lamps per luminaire
LAPR = Lamp price
RP = Relamping period (years)

Maintenance (MC)

$$MC = \frac{N \cdot MCL}{RP}$$

where:

- MC = Maintenance costs per year
N = Number of luminaires
MCL = Maintenance cost per luminaire
RP = Relamping period (years)

Total costs (TC)

$$TC = EN + CC + LC + MC$$

Note: The Annuity Factor is given as:

$$AF = \frac{R/100}{1 - \left(\frac{1}{1 + R/100} \right)^A}$$

where:

- AF = Annuity factor
R = Interest rate (%)
A = Amortization period (years)

CHAPTER 3 - RUNNING THE PROGRAM

Standard procedure

The keys used in the standard procedure are:

ON/USER
EEX
R/S
0-9,
Y and N

Start position: Calculator switched off.

- 1) Connect bar-code reader to the calculator
- 2) Switch on by pressing "ON"
- 3) Check that the word "USER" appears in the display. If it does not, press "USER".
- 4) Continue with steps 1 to 37 detailed in Fig. 3.2.

A complete run is performed by simply:

- a. Pressing the relevant key
- b. Specifying the information requested by the calculator
- c. Reading off the calculated values

The information requested by the calculator can be listed beforehand on a specially designed worksheet (see Appendix C). Fig. 3.1 shows an example of a completed worksheet.

The standard operating procedure, using the information contained in the worksheet for our input, is as follows:

Important: Do not touch the keys "PRGM" and "ALPHA" when running the program.

Fig. 3.1 - Example of a completed worksheet

Date: 5-4-82

Customer name : Mr. J.F. Caminada
Project name : RAI-Amsterdam
Project number : 82001/2
Philips representative : Mr. J.H. v. Hemert

Room name and/or no.:			
Room length	(metres)	21	12
Room width	(metres)	22	8
Luminaire mounting height above floor level	(metres)	23	3.25
Working plane height above floor level	(metres)	24	0.85
Ceiling reflectance (%)	normal 70%	25	80
Wall reflectance (%)	normal 50%	26	50
Working plane reflectance (%)	normal 20%	27	15
Required illuminance (lux)		28	750
Maintenance factor (clean: 0.85; normal: 0.8; dirty: 0.65)		29	0.85
Burning hours per year		30	2000
Amortization period (years)		31	15
Interest on investment (%)		32	12.5
Energy costs per kWh (currency)		33	0.30

- PROPOSAL -

			I	II	III
i	Luminaire type		TBS 300/236 ML1	TBS 300/236 L	
o	Calculated utilization factor	20	0.50	0.61	
i	Ventilation factor	44	1.03	1.03	
	Lamp type		TLD 36W/84	TLD 36W/84	
i	Lamp flux (lumens)	34	3450	3450	
o	Calculated number of luminaires	45	24.06	19.56	
i	Selected number of luminaires	** 35	25	20	
	Colour rendering index				
	CIE glare quality class				
o	Maintained average illuminance (lux)	38	779 Lux	767 Lux	
o	Initial average illuminance (lux)	37	917 Lux	902 Lux	
o	Installed power (watts/m ²)	36	23.96 W/m ²	19.17 W/m ²	
i	Luminaire price	39	fl. 137,50	fl. 110,-	
i	Installation costs per luminaire	40	fl. 25,-	fl. 25,-	
I	Lamp price	41	fl. 10,-	fl. 10,-	
i	Relamping and cleaning costs per luminaire	42	fl. 5,-	fl. 5,-	
i	Group relamping period (years)	43	3	3	
o	Investment		fl. 4563,-	fl. 3100,-	
o	Costs per year: Energy		fl. 1380,-	fl. 1104,-	
	: Capital investment		fl. 612,-	fl. 407,-	
	: Lamps		fl. 167,-	fl. 133,-	
	: Maintenance		fl. 42,-	fl. 33,-	
	: Total		fl. 2201,-	fl. 1678,-	

i = input data for pocket computer o = output data of pocket calculator

** = Based upon the calculated number of luminaires and the most suitable lay-out.

Fig. 3.2 – The standard operating procedure

	Step	Press key	On display	Specify	Read off
Program asks for room data	1	EEX	-PHILIPS- -INDOOR- LENGTH =	Room length	
	2	R/S	WIDTH =	Room width	
	3	R/S	HEIGHT =	Room height	
	4	R/S	WPL-HG =	Working plane height	
	5	R/S	CEIL-REFL =	Ceiling reflectance	
	6	R/S	WALL-REFL =	Wall reflectance	
	7	R/S	WPL-REFL =	Working plane reflectance	
	8	R/S	REQ. ILL =	Required illuminance	
	9	R/S	MAINT. F =	Used maintenance factor	
Cost calculations yes or no?	10	R/S	COSTCAL Y/N	N (no) or Y (yes)	
IF "yes" program asks for cost data	11	R/S	BURN. HOURS =	Burning hours per year	
	12	R/S	AMORT. PER. =	Installation amortization period	
	13	R/S	INTEREST =	Interest rate	
	14	R/S	KWH PRICE =	Kilowatthour price	
Program asks for lamp/luminaire data and calculates the utilization factor	15	R/S	LUM-DATA	Read barcoded luminaire data	
	16	R/S	UF = x.xx		Utilization factor
	17	R/S	VENT. FACT =	Ventilation factor or 1	
	18	R/S	LAMP-FLUX =	Used lamp flux	
Lighting calculations are carried out	19	R/S	N = xx.xx LUM		Calculated number of luminaires
	20	R/S	N-CHOSEN	Chosen number of luminaires	
	21	R/S	EM = xxx LUX		Maintained illuminance
	22	R/S	EO = xxx LUX		Initial illuminance
	23	R/S	P = xx.xx W/m ²		Installed watts/m ²
	24	R/S	READY		
Program asks for additional cost data (only if "Y")	25	R/S	LUM PRICE =	Luminaire price	
	26	R/S	INST. COST =	Installation cost	
	27	R/S	LAMP PRICE =	Lamp price	
	28	R/S	MAINT. PRICE =	Maintenance price	
	29	R/S	REL. PERIOD =	Relamping period	
Cost calculations are carried out	30	R/S	INV. = xxxx		Total Investment costs
	31	R/S	ANN COSTS:		
	32	R/S	ENER. = xxxx		Energy costs per year
	33	R/S	INV. = xxxx		Investment costs p. year
	34	R/S	LAMPS = xxxx		Lamp costs per year
	35	R/S	MAINT = xxxx		Maintenance costs p. year
	36	R/S	TOTAL = xxxx		Total costs per year
	37	R/S	READY		

The keys referred to in the above procedures can be printed on a special 'overlay' (Fig. 3.3), which is clipped in place over the calculator keyboard (blank overlays are supplied with the calculator).

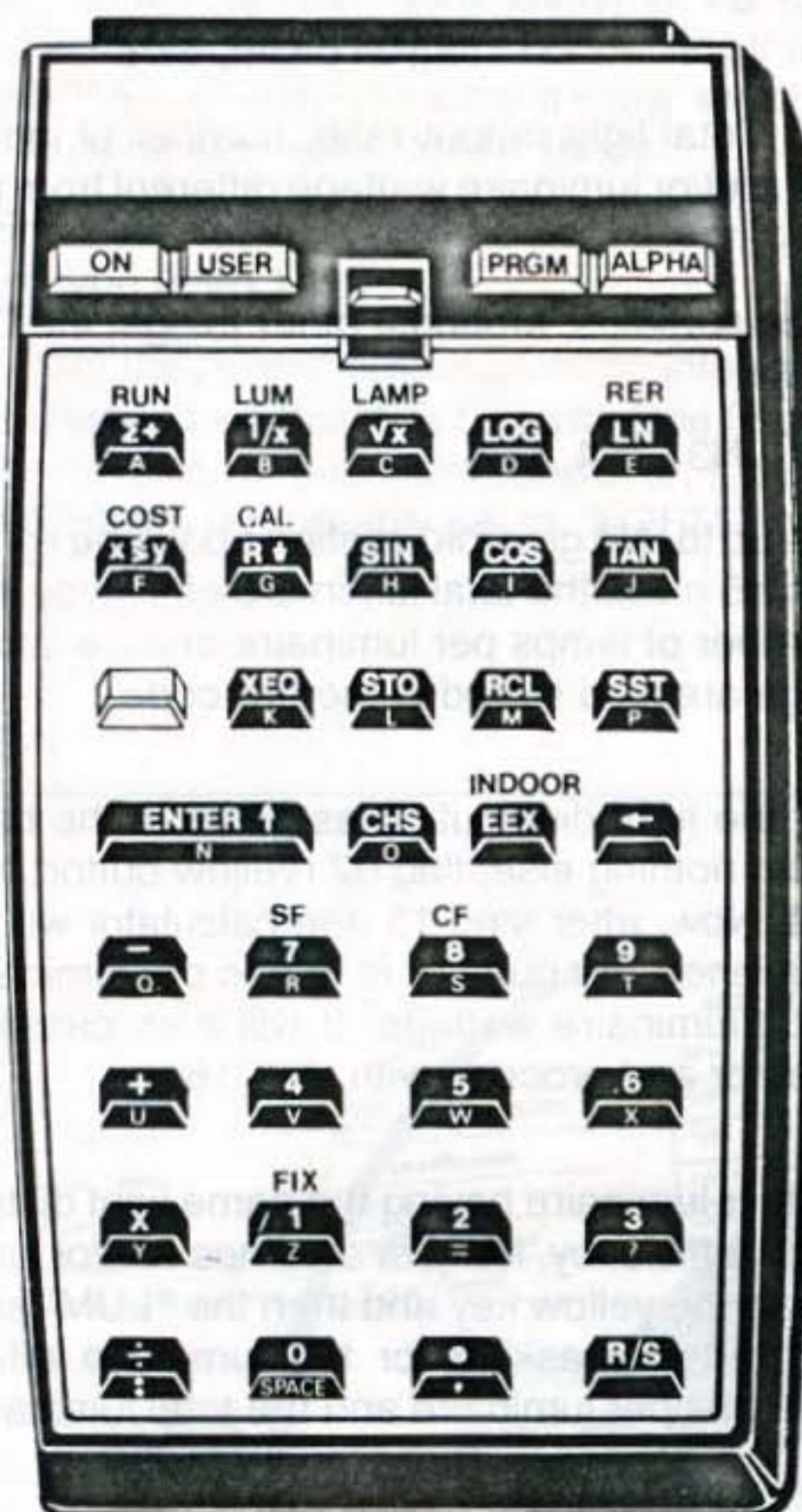


Fig. 3.3

Selecting the program entry point

From the 'standard procedure' described above it is clear that pressing the key 'EEX' starts the program at the very beginning. It is possible, however, to select the point at which the program is entered. This avoids having to re-enter information that is common to two or more design proposals, and allows previously entered information to be changed.

1. Changing luminaire data

If the data in steps 1 to 14 remain the same, but the luminaire/lamp combination has to be changed, the program can be restarted by pressing the "LUM" key (see Fig. 3.3).

The procedure will now start at step 15 (After pressing the key it may take some seconds before the appropriate listing appears in the display. Do not press any key in between.)

2. Changing the lamp data

If only the lamp flux has to be changed, press the "LAMP" key and the program will start at step 18.

3. Changing the cost data

If only the additional cost data have to be changed (steps 25 - 29), the program can be restarted by pressing the "COST" key.

The program will now start at step 25.

4. Repeating the cost calculations

If only the cost calculations have to be repeated and all prices remain the same, the program can be restarted by pressing the "CAL" key.

The program starts at step 30.

5. Changing individual input values

Each input value and some of the calculated values are stored in the calculator memory under their own memory numbers.

During the run all of these values keep their memory place. The memory place numbers are given in column 2 of the worksheet.

Recalling a value from the memory can be done by pressing key "RCL" followed by the memory number.

If an input value has to be changed, this can be done by storing a new value under the memory place number by specifying the new value, and pressing key "STO" followed by the memory number.

Example:

The room length is given as 12 metres and has to be changed to 15 metres.

First, to check the old value, proceed as follows:

Key	On display
RCL	RCL --
2	RCL2 -
1	12.00 (old value in memory 21)
<hr/>	
1	1 -
5	15 -
STO	STO -
2	STO2 -
1	15.00

Now the value "15" is stored in the calculator under memory place number 21.

Of course, the relevant calculations have now to be repeated. If a value specified in one of the steps 1-9 is changed, the program has to be restarted by pressing the "RUN" key. After a short pause, the program will start at step 15 i.e. LUM - DATA.

If the luminaire data remains unchanged, the program can be restarted by pressing the "RER" key instead of the "RUN" key. The program will then start calculating and arrive at step 16. The run can be continued from step 19 (steps 17 and 18 are omitted) by pressing the R/S key. The cost calculations (steps 25-29), are not automatically carried out, but can be included by pressing the "COST" key after step 24.

CHAPTER 4 - SPECIAL OPTIONS

The program has some special options built-in. Most of the options must be activated by setting the appropriate "flag" in the calculator's display. The keys for setting and clearing the flags are "YELLOW", "SF" and "CF" (see Fig. 3.3).

Option 1 Using utilization factor tables

The program enables calculations to be performed without making use of the bar-code, using instead the normal utilization factor tables. Instead of calculating the utilization factor, the computer calculates the room index and asks for the utilization factor, which is specified from the UF-table.

For this option "Flag 04" has first to be set as follows (before pressing the "INDOOR" key):

Key	On display
YELLOW	shift (lower part of display)
SF	SF --
0	SF 0 -
4	4 (lower part of display)
INDOOR	- PHILIPS -

Then proceed with run. The reflectances are not needed by the calculator, so this information is not asked by the program - steps 5, 6, 7.

Continue up to step 15, then:

Key	On display	Specify
R/S	K = x.xx UF =	Utilization factor
R/S	NR LAMP/LUM =	Number of lamps per luminaire
R/S	LUM. WATT =	Luminaire wattage

Press "R/S" key and continue program at step 17.

"Flag 04" is cancelled as follows:

Key	On display
YELLOW shift	(lower part of display)
CF	CF --
0	CF 0 -
4	flag 04 disappears

Option 2 Total light output ratio, number of lamps per luminaire and/or luminaire wattage different from bar-code data.

The bar-code contains, amongst other things, the CIE flux code given as:

.N1, .N2, .N3, .N4, .N5

in which .N1 up to .N4 give information about the light distribution, and .N5 gives the total luminaire efficiency. In addition, the number of lamps per luminaire and the total luminaire wattage are also stored in the bar-code.

To use just the light distribution as given in the bar-code (.N1-.N4), but nothing else, flag 02 (yellow button, "SF02") must be set. Now, after step 15, the calculator will ask for the total efficiency, the number of lamps per luminaire and also the total luminaire wattage. It will then calculate the utilization factor and proceed with step 16.

To use another luminaire having the same light distribution but a different efficiency, number of lamps and/or luminaire wattage, push the yellow key and then the "LUM" key. The program restarts by asking for the luminaire efficiency, number of lamps per luminaire and the total luminaire wattage.

Option 3 Use of a printer

The program has the possibility to produce a print-out of the relevant information (see Figs. 4.1 and 4.2).

This option automatically starts if the printer for the HP41CV is connected to the calculator. Before connecting the printer see that both the calculator and printer are switched off. The printer must be set in the "MAN" mode.

With the printer connected, it will be necessary to specify the luminaire type (step 14 a).

Please note that the printed output gives no information on input values changed via the "STO" facility (see Chapter 3). The changes may be made visible, however, if during the change the printer is temporarily set in "NORM" mode.

Fig. 4.1
Using a printer

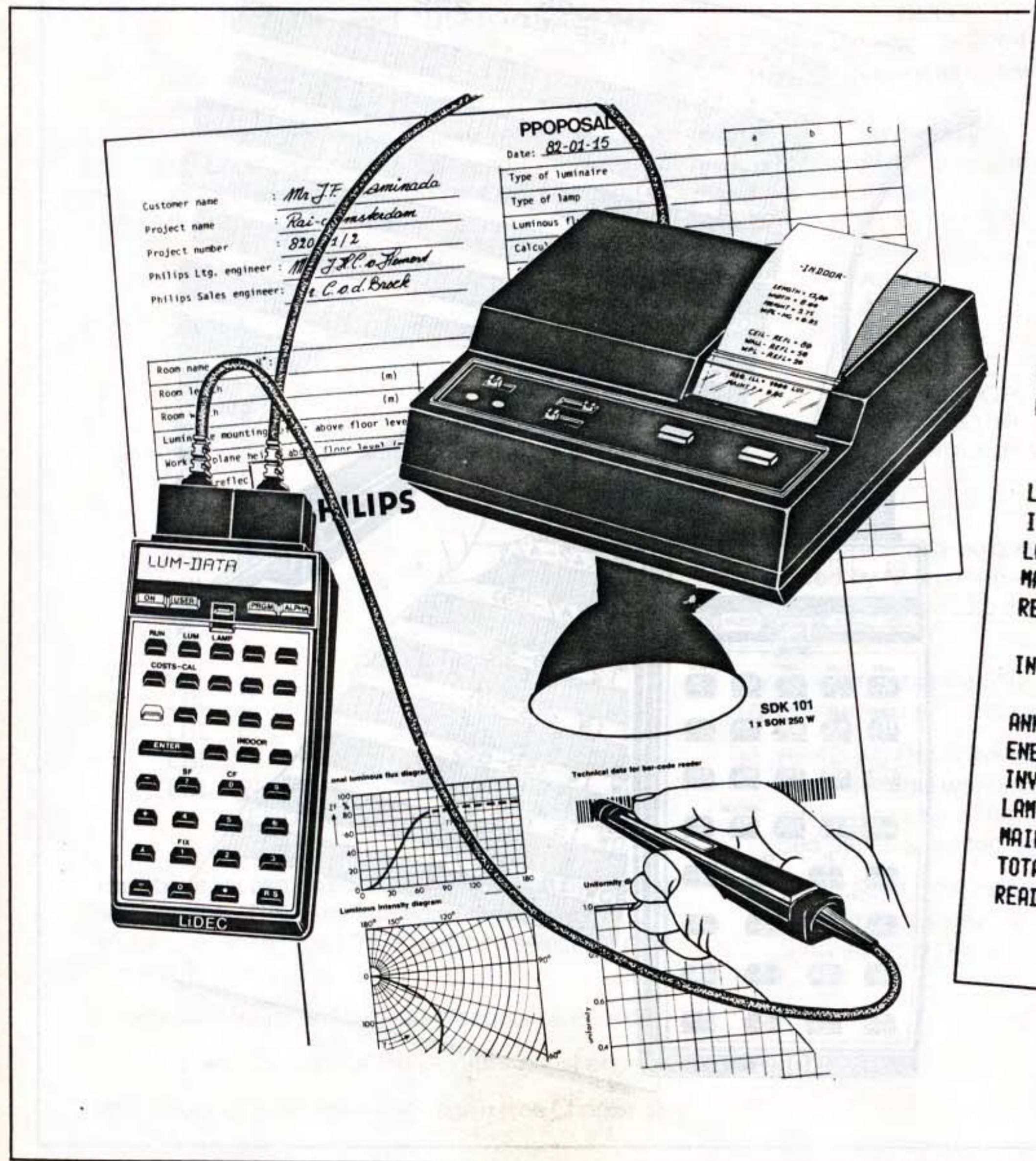


Fig. 4.2
Print-out produced
by printer

-PHILIPS-	
-INDOOR-	
LENGTH=12.00M	
WIDTH =8.00M	
HEIGHT=3.25M	
WPL-HG=0.85M	
CEIL-REFL=80%	
WALL-REFL=50%	
WPL -REFL=15%	
REQ. ILL=750 LUX	
MAINT.F=0.85	
BURN.HOURS=2000.00	
AMORT.PER.=15.00YEAR	
INTEREST =12.50%	
KWH PRICE =0.30	
LUM TYPE:TBS300L236	
UF=0.61	
VENT.FACT=1.03	
LAMP-FLUX =3400.00	
N=19.85 LUM	
N-CHOSEN=20.00	
EM=756 LUX	
E0=889 LUX	
P =19.17 W/M2	
READY	
LUM PRICE =110.00	
INST. COST =25.00	
LAMP PRICE =10.00	
MAINT.PRICE=5.00	
REL. PERIOD=3.00	
INV. =3100	
ANN COSTS:	
ENER.=1104	
INV. =407	
LAMPS=133	
MAINT=33	
TOTAL=1678	
READY	

CHAPTER 5 - LOADING THE PROGRAM

The program is loaded by reading special programming bar-codes with the aid of the bar-code reading pen. A general introduction to the bar-code reader can be found in the manual supplied with it.

Before loading the program the calculator must first be cleaned of all other programs. This is done as follows:

- Switch off the calculator.
- Push the "←" key and keep this button pressed while switching on again.
- Release key "←".

In the display appears:
"MEMORY LOST"

Now the proper memory size, "SIZE 046", has to be set. This is done by pressing the following keys:

Key	On display
XEQ	XEQ - -
ALPHA	XEQ -
S	XEQ S -
I	XEQ SI -
Z	XEQ SIZ
E	XEQ SIZE - -
ALPHA	SIZE - - -
0	SIZE 0 - -
4	SIZE 04 - -
6	SIZE 046 (briefly)

Now set the machine in "USER" mode by pressing the key "USER". The word "USER" appears in the display.

Now the bar-codes can be read.

Your calculator is now ready for use.

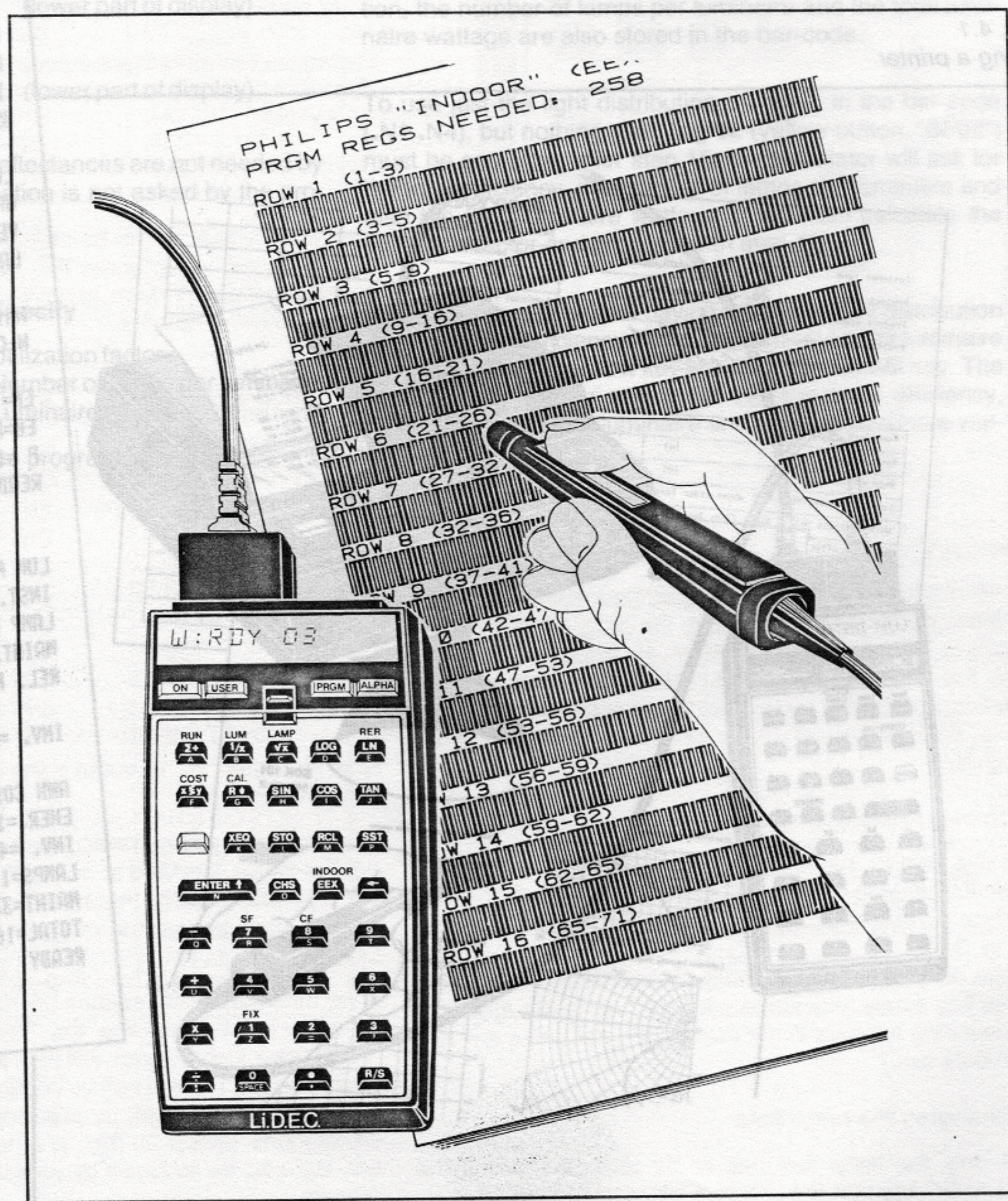


Fig. 5.1
Loading the program
via bar-codes

CHAPTER 6 - FAULT DIAGNOSIS

- If "BAT" appears in the display, replace the batteries. (see Chapter 2 of HP41CV users guide)
- An error in an input that is discovered before key "RS" is pressed can be corrected by pressing key "←" one or more times until the erroneous figure disappears from the display.
- DATA ERROR in the display
One or more of your input values are wrong. Press key "←", check the input and start the calculation again.
- ALPHA DATA in the display
One of your inputs are alpha characters instead of real values. Press key "←", check the input and start the calculation again.
- NON EXISTENT in the display.
 - a) Check that the bar-code reader is connected to the calculator.
 - b) Check "USER" is visible in the display; if not, press "USER" button! The word "USER" should now appear. Start again.
 - c) Press yellow key followed by "ENTER". The word "CAT-" now appears in the display. Next press key "1", which should cause the following to appear in the display in rapid succession (see also Section 4 of the HP41CV users guide):

```

LBL INDOOR
LBL Q
LBL K
LBL O
LBL P
LBL S
LBL S1
LBL T
LBL V
LBL M
LBL U
LBL R
LBL W
LBL X
LBL Y
LBL Z
LBL L
LBL ★
LBL ?

```

.END. REG 15

The above list can be checked item by item by quickly pressing the "R/S" key immediately after key "1". A double operation of key "R/S" will then select the next item on the list.

If nothing appears, or if the above sequence is incomplete, the whole or part of the program is lost and the whole program has to be loaded again (see Chapter 5).

- d) Push "STO" followed by 45.
If "NON EXISTENT" appears, set memory size to 46 by pressing:

```

XEQ
ALPHA
S
I
Z
E
ALPHA
0
4
6

```

Program fails to start when pressing the "INDOOR" key, and c) is satisfactory.

Press, and hold, key "INDOOR" (EEX).
In display should now appear:

```

INDOOR
NULL

```

Release key "INDOOR". If INDOOR does not appear, proceed as follows:

press:	on display:
yellow button	SHIFT (small in centre of display)
XEQ	ASN -
ALPHA	ASN - "ALPHA" appears in right-hand corner
I	ASN I- " " "
N	ASN IN- " " "
D	ASN IND- " " "
O	ASN INDO- " " "
O	ASN INDOO- " " "
R	ASN INDOOR- " " "
ALPHA	ASN INDOOR - ("ALPHA" disappears)
EEX	ASN INDOOR 43 (very briefly, followed by old display value)

Now press and hold key "INDOOR". INDOOR followed by NULL (see also Section 4 of the HP41CV users guide) should appear on the display. Release key "INDOOR".

- Errors made when reading the bar-code. (Also read Users Guide for bar-code reader)
 - a) READ AGAIN in the display
The bar-code was incorrectly read. Simply read it again. Take care that the luminance of the bar-coded paper is not too high.
 - b) W: CKSUM ERR followed by W: SCAN DATA or W: READY. Press key "←".
Start again with key "LUM".

APPENDIX A

How the Barcode is Built Up

A bar-code is a combination of thin bars and thick bars. The thick bar is twice the width of a thin bar and the spaces between the bars are equal to the width of a thin bar. The minimum width of a thin bar or space is 0,44 mm.

The bar code is divided in groups of eight binary bits. A thin bar represents a "0" and a thick bar a "1". The bar-code starts with two additional thin bars and ends with one thick and one thin bar to give the reading direction.

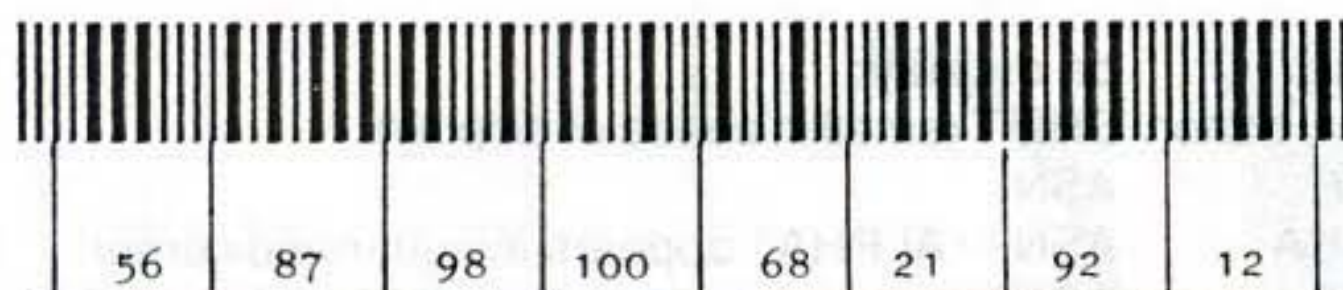
The utilization factor is calculated from the CIE flux code which, in turn, is calculated from the light distribution characteristics of the luminaire.

In the bar-code the CIE flux code is stored together with the number of lamps per luminaire and the total luminaire wattage (including ballast losses).

Example:

The bar-code for the luminaire TBS 300 2 x TLD 36W is as follows:

TBS 300/236 L



It contains the following information:

CIE flux code	56 87 98 100 68
Number of lamps per luminaire	2
Multiplication factor for total wattage	1
Total luminaire wattage	92
Check value	12

The "0" and "1" representation is as follows:

Decimal	Binary
56	00111000
87	01010111
98	01100010
100	01100100
68	01000100
21	00010101
92	01011100
12	00001100

The number of lamps and the multiplication factor are stored in 1 group of 8 bits.

APPENDIX B

Computer program in bar-codes

- Before reading-in the bar-codes please read the instructions as given in the owner's manual supplied with the bar-code reader.
- Take care that the luminance of the bar-coded paper is not too high.
- Make sure that your battery is not almost empty.
- To protect your bar-code, place one of the transparent sheets you received with the bar-code reader over the bar-code, glossy side down, before your begin scanning.
- Using a ruler makes reading in easier.

APPENDIX C

Worksheet

Date:

Customer name :

Project name :

Project number :

Philips representative :

Room name and/or no.:		
Room length	(metres)	21
Room width	(metres)	22
Luminaire mounting height above floor level	(metres)	23
Working plane height above floor level	(metres)	24
Ceiling reflectance (%)	normal 70%	25
Wall reflectance (%)	normal 50%	26
Working plane reflectance (%)	normal 20%	27
Required illuminance (lux)		28
Maintenance factor(clean:0.85;normal:0.8;dirty:0.65)		29
Burning hours per year		30
Amortization period (years)		31
Interest on investment (%)		32
Energy costs per kWh (currency)		33

- PROPOSAL -

I

II

III

i	Luminaire type			
o	Calculated utilization factor	20		
i	Ventilation factor	44		
	Lamp type			
i	Lamp flux (lumens)	34		
o	Calculated number of luminaires	45		
i	Selected number of luminaires **	35		
	Colour rendering index			
	CIE glare quality class			
o	Maintained average illuminance (lux)	38		
o	Initial average illuminance (lux)	37		
o	Installed power (watts/m ²)	36		
i	Luminaire price	39		
i	Installation costs per luminaire	40		
i	Lamp price	41		
i	Relamping and cleaning costs per luminaire	42		
i	Group relamping period (years)	43		
o	Investment			
o	Costs per year: Energy			
	: Capital investment			
	: Lamps			
	: Maintenance			
	: Total			

i = input data for pocket computer o = output data of pocket calculator

** = Based upon the calculated number of luminaires and the most suitable lay-out.