I

MANUAL

BEACON CONTROL UNIT

NEWSON NV
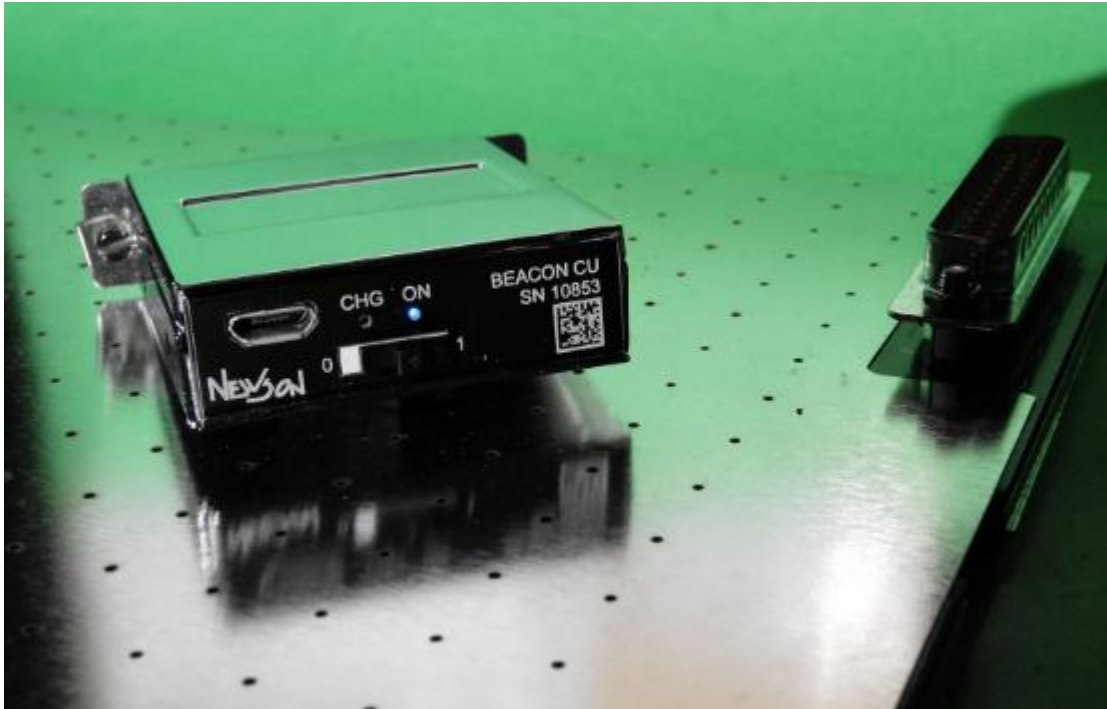
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1 OVERVIEW

1.1 PRODUCT DESCRIPTION

The BEACON™ Control Unit is a module offering high-levels of efficiency during calibration process of laser deflection systems.

The majority of deflector based laser system use two deflection motors and a flat field focal lens to position a laser spot on a working area. Due to linearity and or projection errors, such a system needs to be calibrated before it can be used.
The concept and algorithms used for this calibration are built around counter steering measured deviations.
To compensate those errors the physical system target coordinates are altered inside the steering control through transformation mathematics. To find the proper transformation parameters, the errors of the laser system need to be measured accurately.

Mostly this is done by marking an array of crosses or circles equally distributed over the marking field size. Based on desired accuracy and available math the number of rows and columns are determined. After laser process, the error offsets of the marking positions are measured using a camera and image processing software. These offsets will then be used to update the compensation logic inside the steering board. This method uses consumables and is slow as it involves physically moving marked panels between camera system and laser machine.

BEACON™ calibration system combines both the marking process and image processing process and therefore allows field calibration without the need of a camera and image processing software. There are no consumables and there is no need to move around marked panels.

BEACON™ calibration systems are able to calibrate nearly all laser based systems by measuring the energy of the laser beam in focus at the target positions.
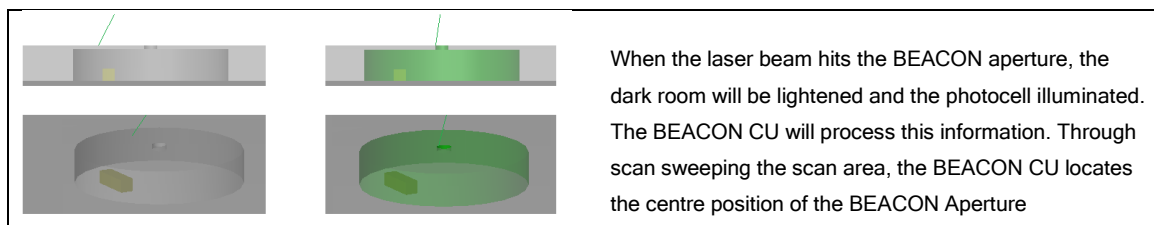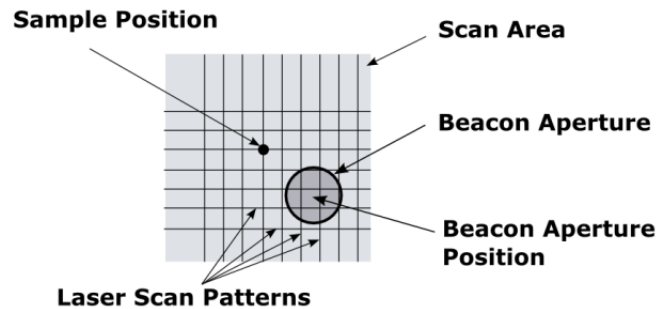
1.2 DESCRIPTION OF OPERATION

A BEACON™ calibration device consists of a control unit, called "BEACON CU" (BEACON Control Unit) and an application dependent array of measuring cells called "BG" (BEACON Grid). A measuring cell is basically a photodiode mounted in a small "dark" room.

BEACON CU
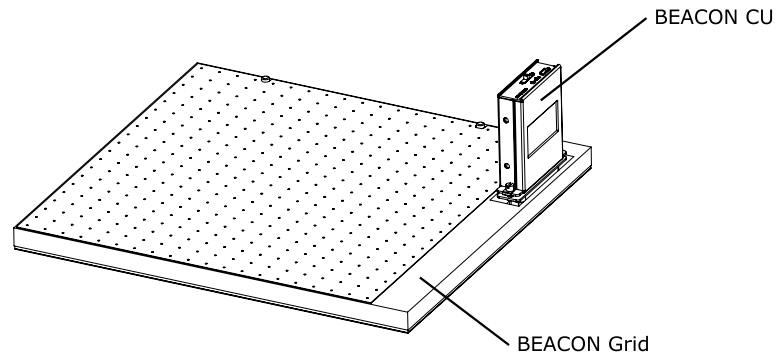
BEACON Grid

On the top side of this room there is a small circular window facing the deflection system, called "BA" (Beacon Aperture). The shape, layout and size of this room may differ but in general the BEACON CU uses the measuring cells of the BEACON Grid to measure laser energy.

The measuring process is done by scanning the laser spot (using low laser energy not to damage the BA) around a certain sample position. When the laser beam passes through the window of a measuring cell, the laser beam will illuminate the photocell inside the dark room and the BEACON CU will log the illumination profile.

After acquiring enough samples, the BEACON CU will process the profiles to calculate the offset position of the sample position towards the centre of the BEACON Aperture using the coordinate system of the deflector.

Sample Position

Scan Area

Beacon Aperture

Beacon Aperture Position

Laser Scan Patterns

When the laser beam hits the BEACON aperture, the dark room will be lightened and the photocell illuminated. The BEACON CU will process this information. Through scan sweeping the scan area, the BEACON CU locates the centre position of the BEACON Aperture

1.3 PRODUCT DETAILS

1.3.1 BEACON CU
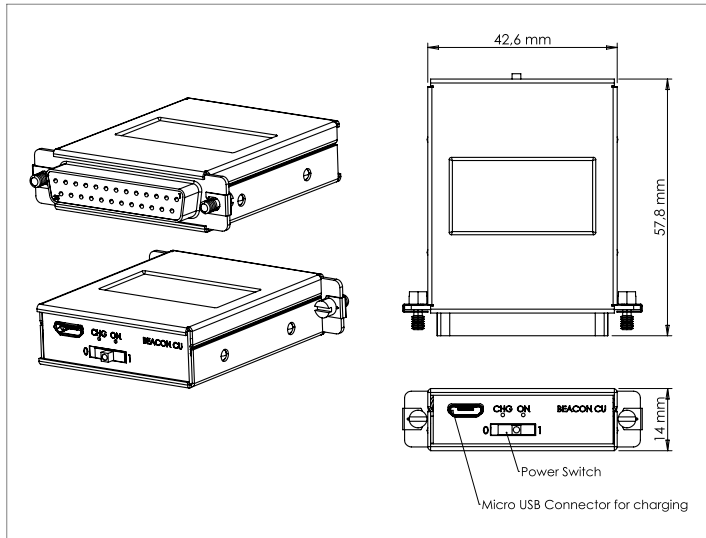
1.3.1.1 General

Interface	Bluetooth
Common Charging Solution	Micro USB-B
2x LED	Indication Power ON/OFF
	Indication Charging YES/NO

1.3.1.2   Internal scheme
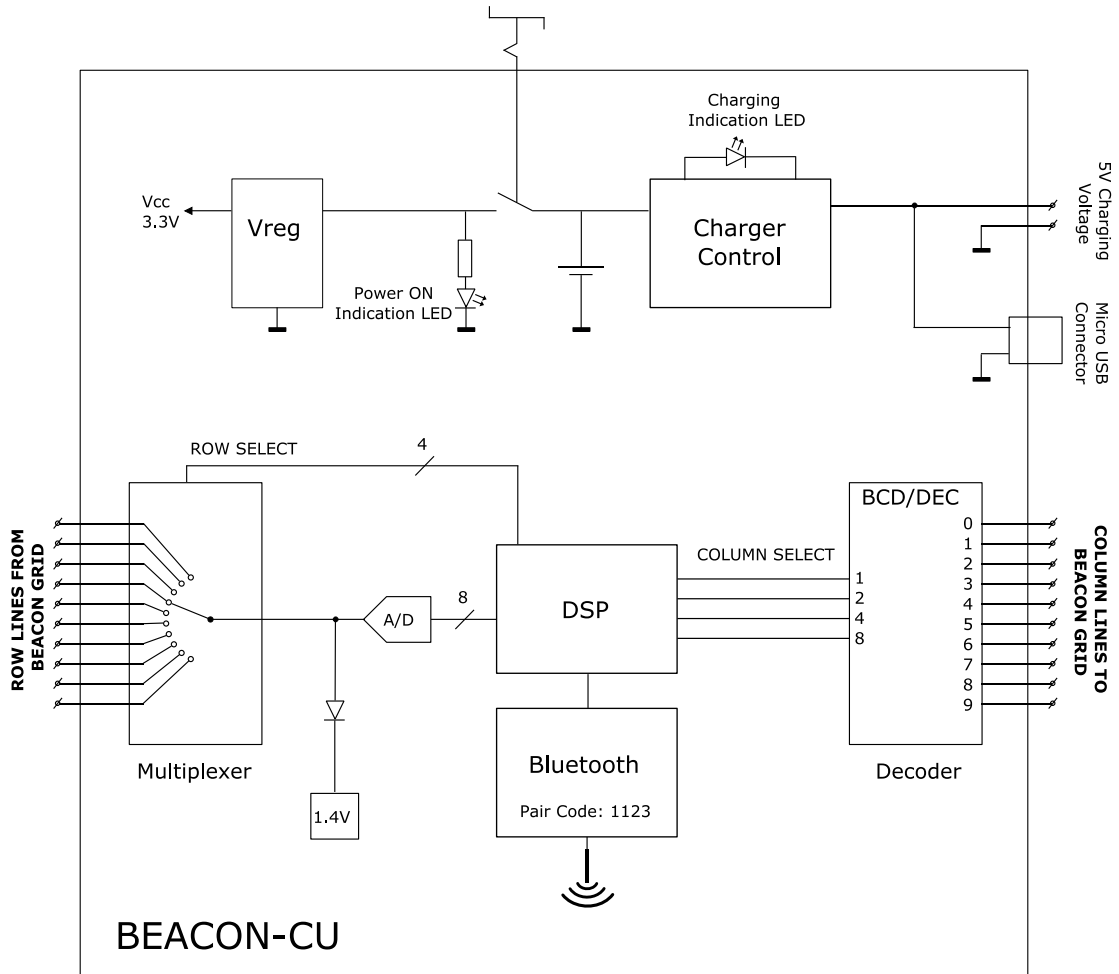
1.3.1.3   Pin assignment (DB-25 socket)

| Pin No.	Name	Description	Pin No.	Name	Description
1	DC0V	Power charge input	14	DC0V	Power charge input
2	DC+5V	Power charge input	15	DC+5V	Power charge input
3			16	RS09	Row select: row 9
4	RS08	Row select: row 8	17	RS07	Row select: row 7
5	RS06	Row select: row 6	18	RS05	Row select: row 5
6	RS04	Row select: row 4	19	RS03	Row select: row 3
7	RS02	Row select: row 2	20	RS01	Row select: row 1
8	RS00	Row select: row 0	21	CS09	Column select: column 9
9	CS08	Column select: column 8	22	CS07	Column select: column 7
10	CS06	Column select: column 6	23	CS05	Column select: column 5
11	CS04	Column select: column 4	24	CS03	Column select: column 3
12	CS02	Column select: column 2	25	CS01	Column select: column 1
13	CS00	Column select: column 0			

1.3.2   BEACON Grid (BG)

Typically a BG consists out of a top plate containing the BEACON Apertures, a PCB containing the photodiodes, a plate for dividing the space into small rooms and a bottom plate to close the bottom of the rooms.

The BG has a number of column and row wires with a diode-photodiode pair at every intersection. In total up to 100 addressable photodiodes can be connected in this fashion with the BEACON Control Unit. Therefore the BEACON CU has an analogue multiplexer that allows connection for up to 10 rows.

A 20x20 BEACON Grid is available as a standard of the shelf calibration tool. In this grid the apertures have a 10 mm spacing. The apertures are grouped in four to match the 400 BEACON Apertures within the addressing range of the BEACON CU.

When the laser system is equipped with a XY-table, this table can be used for calibration together with a BEACON calibration tool. Then the BG only needs one optical sensor which is moved mechanically towards the sample position using the XY table. In this fashion, the deflection system will be calibrated on the axis system of the XY-table. After calibration both axis systems (deflection system and XY-table) are parallel with flawless stitching as a result.

1.3.2.1   PCB Sensor Grid Design – 10x10 sensors

Diode: BAS116

Photodiode: BPW 34 BS (OSRAM Opto Semiconductors)
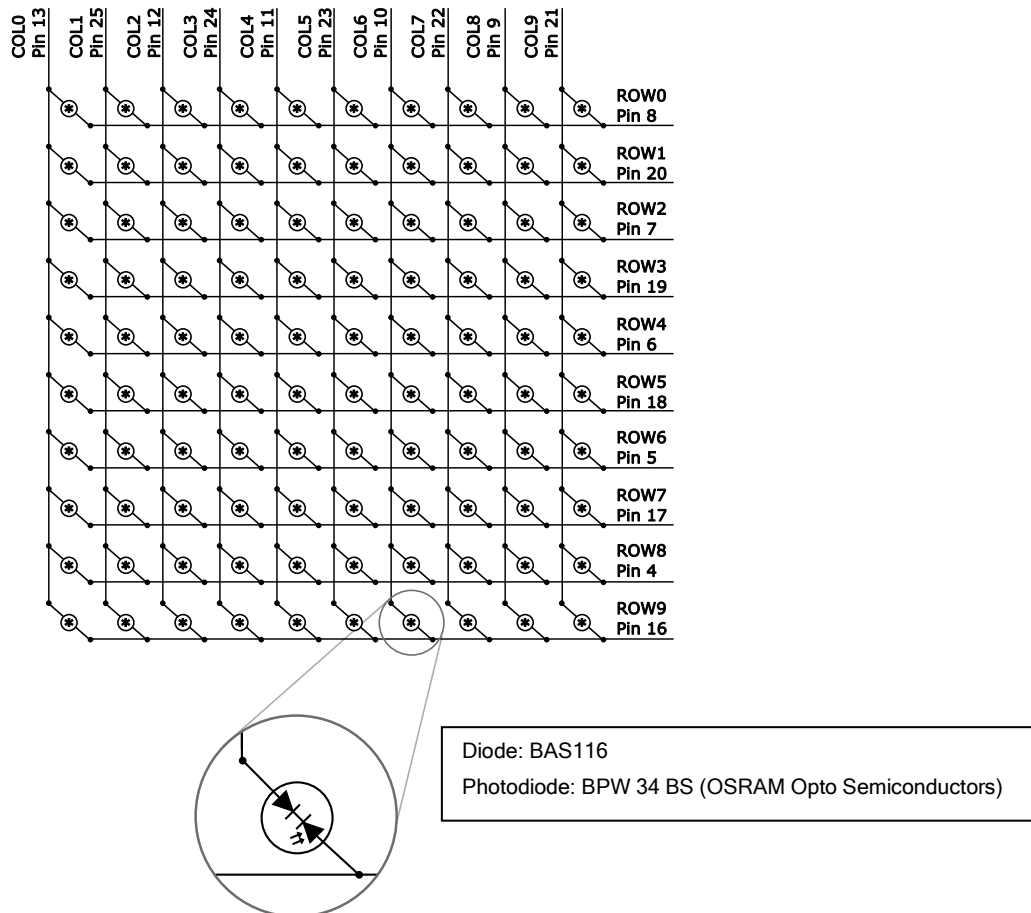
1.3.2.2 Measure Room Design

The BEACON Measure rooms or also called "dark rooms" are created by 3 different parts: A 10mm thick alu plate creating the room, A PCB with photodiodes at the bottom and a top plate with BEACON Apertures.

Top plate with
BEACON Apertures

BEACON Grid
with room array

PCB with
photodiode grid
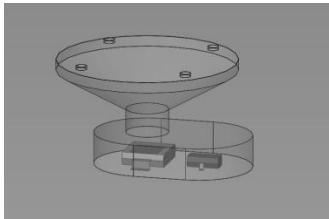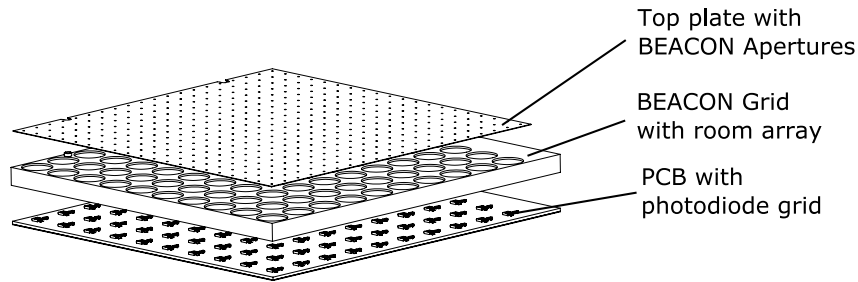
IMPRESSION OF A BEACON MEASURE ROOM   TOP AND BOTTOM IMPRESSION OF THE BEACON GRID PLATE
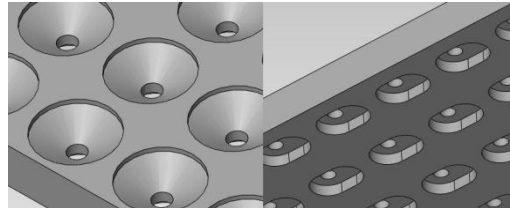
Below the mechanical information to contruct the rooms inside the BEACON gride plate. (all units in mm)
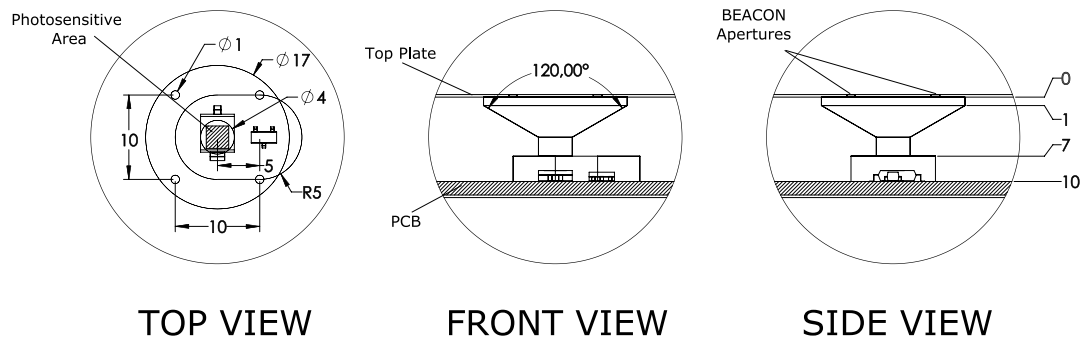
TOP VIEW   FRONT VIEW   SIDE VIEW

1.3.2.3 Top Plate Design

The top plate of the BEACON Grid can be created by laser drilling a metal sheet with 1mm diameter holes. Thickness of the sheet should be around 0.25 mm

2   SETUP BEACON CU

2.1   CHARGE BEACON CU

The BEACON is a battery powered device. Nominal battery voltage is 3.7 volt. However a fully charged BEACON CU will give more than 4 Volt. When full charged the BEACON CU can do about 4000 measuring cycles.
Charge the BEACON CU device using the micro USB connector. Charging an empty device will take approximately 3 hours.

2.2   INSTALL BLUETOOTH DEVICE (WINDOWS8)

Bluetooth wireless technology provides short range wireless communication between pc and device without physical cable connection. Bluetooth networking hardware comes pre-installed in a lot of computers. If not pre-installed hardware is available, you can add Bluetooth hardware using a Bluetooth USB dongle.

Before you can use the BEACON CU you must establish a Bluetooth connection with your PC. Depending on your Operating System the connection process may vary. Below you can find the setup process for Windows8:

1. Power on the BEACON CU device.
2. From the start screen, type "Bluetooth" to open the Search charm.
3. Select "**Bluetooth settings**" from the search results.
4. On the "**PC and devices**" screen ensure the Bluetooth slider is set on "**On**"
   Windows searches and discovers all Bluetooth devices. The "Beacon CU" device should appear in the device list.
5. Select this device from the list and click "**Pair**".
6. The BEACON CU device will require verification before you can add it. Enter the pairing code "**1123**" and click "**Next**" to pass verification.
7. Wait while Windows configures the device. Windows will create virtual COM ports which will be used to communicate with the BEACON CU device.
8. To make sure the device finished installing correctly, from the Start screen, type "devices and printers" to open the Search charm.
9. Select "**Devices and Printers**" from the search results. The BEACON CU device should be in the Device list

In the device manager you should see now the two Bluetooth COM ports created by the BEACON CU device. It is important to note down the Outgoing Port number as this will be the port used when talking with the BEACON CU device.

REMARK: The BEACON CU can only be paired with one host at the time.

2.3   VERIFY COMMUNICATION

To verify if the BEACON CU is paired and connected successfully and working properly you can connect to the device using a terminal software like Putty, Hyperterminal, AccessPort, …

Ensure you enter the correct Serial Port Settings.
Once connected successfully with the BEACON CU device it sends a identifier string to the host. This string contains its type and firmware version. You should see this string appear in your Terminal software.

You can now send string commands to the device.

3 SOFTWARE CONTROL

3.1 GENERAL

Application software can access the BEACON CU over the assigned COM port. Communication is done by sending ASCII strings to the device. All commands and replies need to be (are) terminated with a carriage return (ASCII 13) and line feed (ASCII 9) character. The BEACON CU does not reply on unknown commands.

The BEACON CU has some parameters which can be modified by sending a "Set Command" string to the BEACON CU. Parameters define the current measuring cell (current row and column) and also define the measuring process. (scanning size, trigger level, diameter). A current parameter profile can be stored as default by sending the command "STORE<cr,lf>".

3.2 MEASURING PROCESS

Gathering offset data on each sample point is done in a "query and execute" style process:

- The measurement starts by putting the aperture on the position to be measured. The application starts the measurement by sending a "START<cr,lf>" query command to the "Beacon CU".
- BEACON CU replies with a "JUMP xx yy<cr,lf>" command.
- After positioning the laser beam to the supplied target position the application send a "NEXT<cr,lf>" query
- BEACON CU replies with a "LINE xx yy<cr,lf>" command. At this point the "BCU" is gathering data. The application performs a linear movement (sweep) with activated laser towards the target position. During this movement the laser light passes or does not pass over the aperture.
- When the target position is reached, the application fetches the next action by sending "NEXT<cr,lf>".
- The BEACON CU stops logging and returns with a "JUMP xx yy<cr,lf>" to a next target command.
- This query and execute cycle needs to be repeated by the application until the "Beacon CU" returns either the offset values or an error code.

All coordinates send to the application by the BEACON are relative to the centre position of the sample point.

FLOWCHART:

```
        Measure Position (x1, y1)
                  │
                  ▼
       Send commands SROW and
       SCOL to select appropriate
           measuring cell
                  │
                  ▼
         Send string "START"
                  │
                  ▼
          Switch Reply  ◄───────  Send string "NEXT"  ◄──────┐
                  │                                            │
                  ▼                                            │
          Case Format          True    Move deflection system to
          "JUMP xx yy"  ──────────►    position (x1+xx, y1+yy) with ──┤
                  │                         laser off              │
                  │ False                                          │
                  ▼                                                │
          Case Format          True    Move deflection system to   │
          "LINE xx yy"  ──────────►    position (x1+xx, y1+yy) with ─┘
                  │                         laser on (low power)
                  │ False
                  ▼
          Case Format          True
          "OFFS xx yy"  ──────────►    Return offset result (xx, yy)
                  │
                  │ False
                  ▼
          Case Format          True
          "ERR"        ──────────►    Return failure
```

3.3 MEASURING CONSIDERATIONS

To achieve good measurement results some limitations apply:

- There is no absolute accuracy needed for calibration but the deflection system in use needs to have good repetitive accuracy.
- The marking speeds with which the "LINE" commands are executed need to be the same for all sweeps during the sampling of a position.
- Target a 1msec to 10msec "in hole" time. This is the time the laser passes through the aperture during a sweep over its centre.
- The laser frequency needs to be chosen as high as possible, preferably above 20kHz. Lower laser frequencies will be picked up by the photodiode and influence the measurement.
- The signal of the photocell is amplified by a logarithmic amplifier before being processed. This allows a large dynamic range for the lasers optical output energy. However, to maximise the lifetime of the apertures the laser power level must be chosen as low as possible.
- The laser needs optical stability during the sweeps.

3.4 COMMAND SYNTAX

3.4.1 RS-232 Configuration Details

Parameter	Value
Baud rate	9600
Data Bits	8
Stop Bits	1
Parity	none
Handshake	none
Termination character (*)	\r\n

(*): All commands must be terminated with a carriage return (0x0D) and a linefeed (0x0A) character.

All return values are terminated with a carriage return (0x0D) and a linefeed (0x0A) character.

3.4.2 Set Command Syntax

The set format takes the form:

XXXX=nn<cr,lf>

Where XXXX is the set command and nn is the parameter value

Syntax	Description	units	factory
SROW=nn<cr,lf> [nn = 0 to 9]	Set Row This command sets sensor row selection nn = row number		0
SCOL=nn<cr,lf> [nn = 0 to 9]	Set Column This command sets sensor row selection nn = column number		0
DIAM=nn<cr,lf> [nn = 1 to 32768]	Set Diameter This command sets diameter of the BEACON aperture nn = distance	µm	1000
SIZE=nn<cr,lf> [nn = 1 to 32768]	Set Scanning Size This command sets the size of the scanning area nn = size	µm	10000
TRIG=nn<cr,lf> [nn = 5 to 255]	Set Trigger Level This command sets the start sample light intensity level nn = intensity level		40

3.4.3 Get/Query Command Syntax

The query format takes the form:

XXXX<cr,lf>

If the command is accepted it returns

nn<cr,lf>

Syntax	Description	Units
SROW<cr,lf>	**Get Row** This command gets current selected sensor row Returns row number	
SCOL<cr,lf>	**Get Column** This command gets current selected sensor column Returns column number	
SVAL<cr,lf>	**Get Live Sensor Value** This command gets the live light intensity measured by the BEACON-CU. Return value in the range 0 to 255	
DIAM<cr,lf>	**Get Diameter Size** This command gets the diameter of the BEACON aperture Returns size	µm
TRIG<cr,lf>	**Get Trigger Level** This command gets start sample light intensity level Returns intensity level	
SMAX<cr,lf>	**Get Maximum** This call returns the maximal level of intensity measured during last sweep Return value in the range 0 to 255	
VBAT<cr,lf>	**Get Battery Voltage** This call returns the battery voltage. Nominal battery voltage is 3.7 volt	V

3.4.4   Control Command Syntax

The store format takes the form:

XXXX<cr,lf>

Syntax	Description
PWRD<cr,lf>	**Power Down System** This command switches off the BEACON-CU. To restart, the on/off switch of the BEACON-CU needs to be cycled.
STORE<cr,lf>	**Store** This command stores parameters SROW, SCOL, DIAM, SIZE and TRIG to system flash Next time the system is switched on, the parameters are loaded automatically

3.4.5   Measurement Command Syntax

The measurement format takes the form:

XXXX<cr,lf>

Syntax	Description
START<cr,lf>	**Start Measurement** This function starts the measurement During the measurement the application should query, using the "NEXT" command, the system for actions to perform. The command START resets the state machine and returns the first action. see "Return values measurement functions".
NEXT<cr,lf>	**Request Next Action** After the required action is processed call "NEXT" again until processed.

Return values measurement functions	
Following strings are returned by the BEACON-CU as a reply on a " NEXT" command.	
JUMP xx yy<cr,lf>	**Jump Request** The application should jump (with laser off) to target position. The target position should be calculated by adding the received relative values ('xx' and 'yy') with the coordinates of the point that is being calibrated. [xx = "relative x coordinate"] [yy = "relative y coordinate"]
LINE xx yy<cr,lf>	**Line Request** The application should execute a lineair movement with laser on. The position should be calculated by adding the relative values ('xx' and 'yy') with the coordinates of the point that is being calibrated. [xx = "relative x coordinate"] [yy = "relative y coordinate"] The speed of the movement can freely be chosen. Some things to take into consideration: • The speed must be the same for all line requests during a measurement. • Accuracy of the measurement is inversely proportional to speed. Reducing the speed will increase the laser energy the system needs to absorb during the measurement, resulting in degradation of the calibration plate A good guideline is to set the speed so that the "in hole" time is between 1 to 10 msec. example: DIAM=1000 The range value for marking speed 100 to 1000mm/sec
OFFS xx yy<cr,lf>	**Offset Result** The BEACON CU has finished the measurement cycle. It returns the offset coordinates. The return values 'xx' and 'yy' indicate the position of the laser spot relative to the position of the sample aperture. [xx = "relative x coordinate"] [yy = "relative y coordinate"]
ERR<cr,lf>	**Error, Measurement Failed** A error has occurred, the BEACON CU returns "the ERR<cr,lf>" string. Main sources of errors: no or insufficient laser light during "LINE" execution. none of the sweeps passed through the BEACON Aperture window. faulty setting of "SCOL" and/or "SROW" parameter.