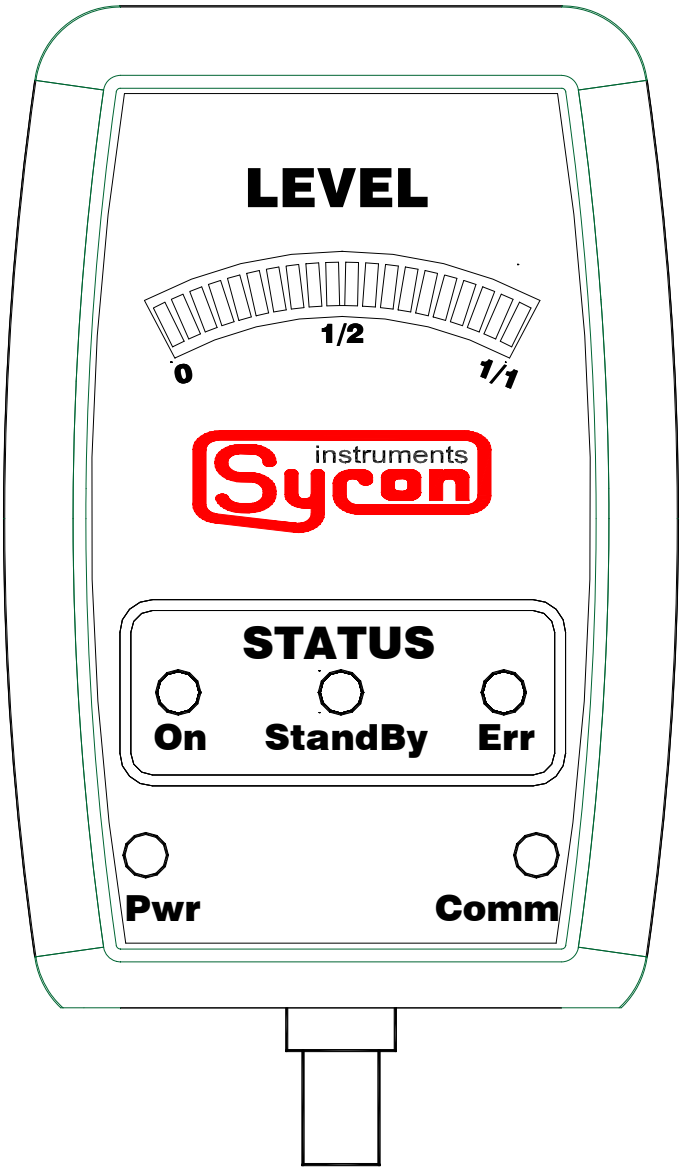
# SLL-N2

## *Liquid Nitrogen Level Monitor/Controller*




User's Manual

518-038 Revision A, March 2009

# Warranty

## Sycon Instruments, Inc.

Sycon Instruments, Inc. (Sycon) warrants that all electronic instrumentation equipment manufactured by Sycon shall be free from defects in materials and workmanship for a period of 1 year from date of shipment. Mechanical vacuum components such as feedthroughs, sensors, cables, and shutters shall be warranted for a period of six months from the date of shipment. For the duration of the warranty period Sycon will, at its option, either repair or replace any part which is defective in materials or workmanship without charge to the purchaser. The foregoing shall constitute the exclusive and sole remedy of the purchaser for any breach by Sycon of this warranty.

This warranty does not apply to any equipment which has not been used in accordance with the specifications recommended by Sycon for the proper and normal use of the equipment. Sycon shall not be liable under any circumstances for consequential or incidental damages in connection with, or arising out of the sale, performance, or use of the equipment covered by this warranty.

This warranty is in lieu of all other warranties by Sycon, expressed or implied, including the implied warranty of merchantability, the implied warranty of fitness for a particular purpose, and warranty against infringement of any patent.

## Equipment Return

Before returning any equipment to Sycon contact the Product Service Department. You must obtain a Return Authorization (RA) number from Sycon Instruments and indicate this number on all shipping cartons and correspondence. Ship all items in suitable containers with adequate protection from outside damage. Also include a short description of the problem or condition to facilitate processing.


**Sycon Instruments, Inc.**
**6757 Kinne Street**
**Syracuse, NY**
**13057-1215**

**P (315) 463-5297**

**F (315) 463-5298**

**www.sycon.com**

# Preface

Sycon Instruments, Inc. reserves the right to change any information contained in this manual without notice.

# Table of Contents

# List of Figures



# List of Tables

# SECTION 1

*General Information*

# General Information

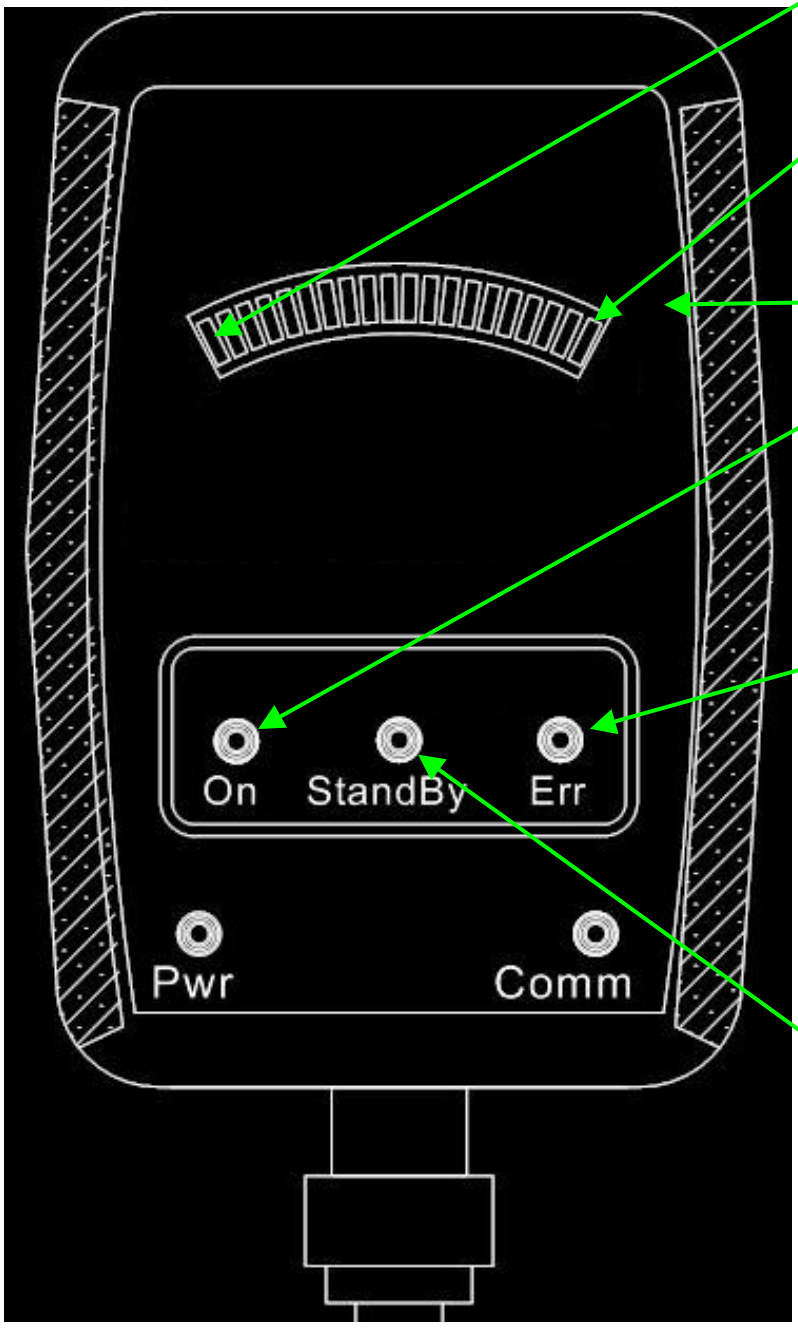
## SLL-N2 Specifications

| | |
|---|---|
| Relay contact rating (1) | 2A@30VDC, 0.5A@125VAC |
| Relay contact maximum ratings (1) | 60W, 65VA, 2A,or 125VAC (load must not exceed any of these ratings) |
| Current consumption | 360ma (Bar mode) 160 ma (needle mode) (@5V) |
| Input voltage | 4.3V-5.1V |
| Sensor minimum capacitance | 50pF |
| Sensor maximum capacitance | 6500pF |
| SLL-N2 resolution | .15pF |
| Minimum sensor length (2) | 8.25in |
| Maximum sensor length (2) | 64FT |
| Liquid Level Resolution (2) | .15cm |
| Level Accuracy (3) | 5% display, 2% or better via computer interface |
| Fill operation delay | Programmable 0..32 seconds in .321s increments |
| Fill timeout | Programmable up to 5:47:54 (H:MM:SS) in .321second increments, or no timeout |
| Serial port | Dual mode RS232/RS485 |
| Serial bauds | 9600, 115200 |
| Ambient Operating Temperature (SLL-N2) | 0…50 Degrees C |

1: Relay contacts are not protected. If driving inductive loads such as a solenoid you must protect the relay with a MOV/TVS (AC), capacitor (AC/DC), or diode (DC).
2: Using Sycon sensor in LN2 (2.28pF/cm in air or N2 gas, 3.28pF/cm in LN2, for a sensitivity of 1pF per cm of fill)
3: Since display has 20 graduated bars, 5% is level accuracy when viewing SLL-N2. Through the computer interface, level readings may be acquired to better accuracy. 2% accuracy is guaranteed through the operating temperature range. Variations in liquid temperature and pressure also have an impact on level reading, as the relative permittivity of the measured liquid changes with temperature and pressure.

Table 1.1: SLL-N2 Specifications

# User Interface Quick Reference




**If this LED is flickering**, the SLL-N2 has lost the low level calibration. Re-calibrate the SLL-N2.

**If this LED is flickering**, the SLL-N2 has lost the high level calibration. Re-calibrate the SLL-N2.

**Flashing LEDs** in the LED BAR show the level low and level high set-points

**If this LED is blinking**, the SLL-N2 is in the "force fill on" mode. The fill will be requested on regardless of the level. **If this light is on solid**, the fill is being requested because the level is below the low level set-point.

**If this LED is blinking** the SLL-N2 cannot obtain a reading. Possible causes: The sensor is disconnected or damaged, or the liquid is incompatible with the sensor. **If this LED is on solid**, the SLL-N2 has obtained a reading but this reading is out of range (<-20% or >120% full). Possible causes: SLL-N2 needs to be calibrated.

**If this LED is blinking**, the SLL-N2 is in the "force fill off" mode. This mode can be initiated by the user, or can be caused automatically by a 'fill timeout'. The fill will be requested off regardless of the level. **If this light is on solid**, the fill is being requested off because the level is above the high level set-point.

Figure 1.1: Front Panel LEDs

## Definition of flicker, flash, and blink:

- Flickering means the LED turns on and off very quickly, too quickly to count
- Flashing means the LED "inverts" briefly (about ¼ second) every 2 seconds. Inverting means to turn off it it was on or on if it was off.
- Blinking means the the LED is on for a ½ second and off for a ½ second; in other words, the LED turns on and off at a steady pace

# SECTION 2

*Operation*

# Operation

## Front Panel Description

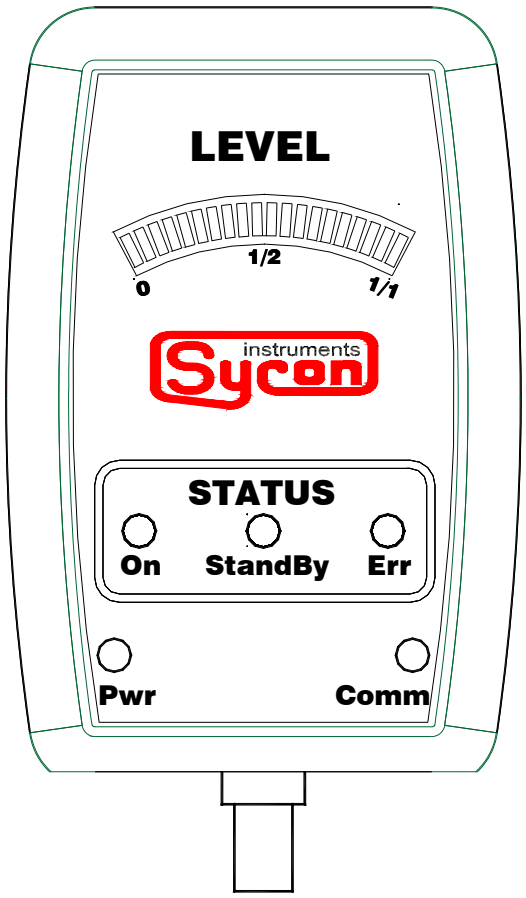



Figure 2.1: Front Panel

The SLL-N2 front panel houses the various display LEDs.

**LED Bar:**
The LED bar displays Nitrogen level, and other information during start-up.

**"On" Indicator:**
The "On" indicator LED lights to indicate filling or forced filling.

**"Standby" Indicator:**
The "Standby" indicator lights to indicate standby status (no filling) or forced standby status.

**"Error" Indicator:**
The "Error" indicator LED lights to indicate an error condition (either a reading cannot be obtained, or the obtained reading is out of range).

**“Power” Indicator:**
The “Power” indicator LED lights to indicate unit power is on.

**“Comm” Indicator:**
The “Comm” indicator LED lights to communication is taking place via the RS-232 port.

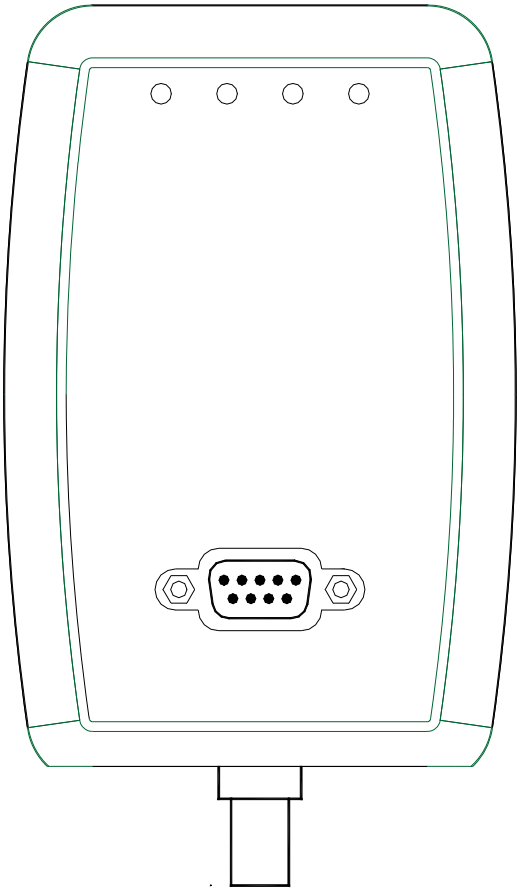


Figure 2.2: Back Panel

The SLL-N2 back panel houses the RS-232 DB-9 connector, and the four pushbutton switches used for performing various operations (calibration, level set point changing, etc.)

## Power-up:

On power-up, the SLL-N2 first does an **LED test**, where all of the LEDs are lit for 2.5 seconds and then go off for 1 second. After this lamp test, the SLL-N2 displays **dipswitch settings and software version** for 2.5 seconds (this is called the POST-2 screen/mode). During the 2.5 seconds POST-2 screen, pressing any button will extend the duration of this screen to up to 25 seconds.

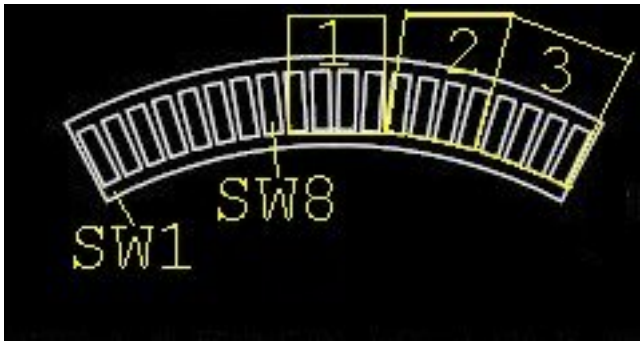



Figure 2.3: POST-2 screen legend

During the POST-2 screen, the first 8 LEDs (from the left as the user looks at the SLL-N2) show the dipswitch settings, where a lit LED means the switch is ON.

| Area (per legend above) | Description |
|---|---|
| Area 1 | Displays SLL-N2 'family', for vendor specific behavior. |
| Area 2 | Displays SLL-N2 software major version. |
| Area 3 | Displays SLL-N2 software minor version. |

Table 2.1: POST-2 screen legend information

| LED pattern (left to right, orange is ON) | Value |
|---|---|
| □□□□ | 0 |
| □□□■ | 1 |
| □□■□ | 2 |
| □□■■ | 3 |
| □■□□ | 4 |
| □■□■ | 5 |
| □■■□ | 6 |
| □■■■ | 7 |
| ■□□□ | 8 |
| ■□□■ | 9 |
| ■□■□ | 10 |
| ■□■■ | 11 |
| ■■□□ | 12 |
| ■■□■ | 13 |
| ■■■□ | 14 |
| ■■■■ | 15 |

Table 2.2: Decoding LED blocks for POST-2 screen areas 1-3

## SLL-N2 Programmable Parameters:

The SLL-N2 is designed to operate as a level indicator as well as a level controller. This SLL-N2 works as a controller for bulk filled (filled via a storage tank of the liquid) as well as condensation filled systems. The behavior of the SLL-N2 can be modified by changing programmable parameters (see table below):

| Data Item | Range | Default | Hash (hex) |
|---|---|---|---|
| Empty Calibration Frequency **(1)** | 4KHZ…176KHZ | 72KHZ | **A926** |
| Full Calibration Frequency **(1)** | 4KHZ…176KHZ | 56KHZ | **F89C** |
| Level Set-point Low **(2)(4)** | 0%…100% | 92% | **8BA1** |
| Level Set-point High **(2) (4)** | 0%…100% | 97% | **39E0** |
| Fill Relay Delay ON **(3)** | 0…100 measurements | 32 measurements | **99B2** |
| Fill Relay Delay OFF **(3)** | 0…100 measurements | 32 measurements | **E85C** |
| Fill Relay Timeout **(3)** | 0…65000 measurements | 0 (no timeout) | **C254** |
| Alarm Set-point Low **(2) (4)** | 0%…100% | 5% | **44D5** |
| Alarm Set-point High **(2) (4)** | 0%…100% | 100% | **D382** |

1: SLL-N2 enforces 1K minimum difference between calibration point frequencies, and enforces Empty frequency > Full frequency
2: SLL-N2 enforces a 2% minimum difference between low and high set-points (hysteresis) and enforces High set-point > Low set-point
3: 1 measurement = 321 milliseconds; 32 measurements ≈ 10 seconds.
4: For all percentage based settings, 0% = empty; 100% = full.

Table 2.3: SLL-N2 programmable parameters, ranges and defaults

# Operation

Pressing the buttons on the back of the SLL-N2 can perform normal operations on the SLL-N2. These operations include calibration, level set point changing, etc. In order to perform one of these operations, simply press the button (or buttons in combination) for about ½ second. When the LEDs in the LED bar flash, the SLL-N2 has performed the selected operation. Note that these operations can be locked out (by turning on one of the switches on the internal dip switch). If the operation is locked via the switch, or is disabled because the reading is in error, the SLL-N2 will not 'flash' the LED bar.

| Key Sequence | Description | Lock SW | Operation |
|---|---|---|---|
| ❶○○○ | Low Level Calibrate **(1)** | S1 | Make the current frequency reading the empty calibration point |
| ○❷○○ | High Level Calibrate **(1)** | S1 | Make the current frequency reading the full calibration point |
| ❶❷○○ | Restore factory calibration | S1 | Restores calibration points to the factory default. |
| ○○❸○ | Force Fill On | S2 | Forces activation of fill relay , places gauge in "force fill on" mode. Note the fill relay is still subject to the fill relay timeout. |
| ○○○❹ | Force Fill Off | S2 | Forces de-activation of fill relay, places gauge in "force fill off" mode. |
| ○○❸❹ | Remove Forces | S2 | Restores normal operation of fill relay. |
| ❶○❸○ | Fill Set-point Low set **(2)** | S3 | Makes the current level the fill level low set-point. |
| ○❷○❹ | Fill Set-point High Set **(2)** | S3 | Makes the current level the fill level high set-point. |
| ○❷❸○ | Restore factory fill set-points | S3 | Restores fill low and fill high set-points to their factory default. |
| ❶○○❹ | Restore all factory settings | S4 | Same as above but also erases calibration and removes forces. **Ignores S1, S2, and S3 lock settings!** |

**1: This operation not allowed if error LED is blinking.**
**2: This operation not allowed if error LED is blinking or on solid.**
**NOTE: Button '1' is far left button and button 4 is the far right button, when looking at the back of the SLL-N2.**

Table 2.4: SLL-N2 operations accessible via back panel pushbuttons

## Dip switch settings description:

Inside the SLL-N2 there is an 8-position dipswitch. To access the switch, remove the 2 screws on the back panel and remove the front cover. Dipswitches are ON when pointing "down" (see arrow on switch).

| SW# | Description | Behavior when SW removed or off | Behavior when switch installed and ON |
|---|---|---|---|
| SW1 | Calibrate lockout | Calibration unlocked and therefore allowed | Calibration locked; cannot be performed. **(3)** |
| SW2 | Forces lockout | Forces unlocked and therefore allowed. | Forces locked; cannot be performed. **(3)** |
| SW3 | Set-point lockout | Set-point changes unlocked and therefore allowed. | Set-point locked; cannot be changed. **(3)** |
| SW4 | Factory Restore lockout | Factory restore allowed. | Factory restore not allowed. **(3)** |
| SW5 | Needle Display | "Bar" mode. | "Needle" mode |
| SW6 | Fast baud | 9600 Baud. | 115,200 baud |

| SW7 | SW8 | SMDP Address | Mode |
|---|---|---|---|
| ON | ON | 0xF0 | RS232**(1)** |
| OFF | ON | 0xF1 | RS485**(2)** |
| ON | OFF | 0xF2 | RS485**(2)** |
| OFF/Removed | OFF/Removed | 0xF3 | RS485**(2)** |

**1: Make sure internal jumper J3 is removed for proper RS-232 operation**
**2: Internal jumper J3 may be installed for RS-485 line termination.**
**3: Switches SW1-SW4 only disable the actions from the pushbuttons on the SLL-N2 itself. All features of calibration and set-point changing are still allowed through the computer interface.**

Table 2.5: Dipswitch definitions

# SECTION 3

*Installation*

# Installation

The SLL-N2 can be installed by connecting it directly to the sensor probe via the BNC connector. For remote mounting, a coaxial M/F cable may be used. Calibration must be performed with the cable in place, as changes in cable length affect calibration.

The SLL-N2 requires 5VDC power for operation. This can be provided using an optional wall power adaptor (SPN 398-061), which plugs into the bottom of the SLL-N2 case, or via an optional power supply/relay board (SPN 502-263), connected via the DB-9 connector on the back cover.

# SECTION 4

*Calibration and Theory*

# Calibration and Theory

## Theory of operation:

The sensor acts as capacitor, whose capacitance changes with the average dielectric constant of the material surrounding it. The SLL-N2 measures this capacitance to determine the level based on the calibration settings. The capacitance of the sensor is a function of the ratio of the dielectric constant of the liquid to the dielectric constant of the vapor. Therefore, in order to measure liquid level, the main assumption is that the dielectric constant of the liquid is different than the dielectric constant of the vapor.

**Use of liquid measurement for materials other than $LN_2$**

To use the SLL-N2 to measure materials other than $LN_2$, you need to consider the following:

- Compatibility of the sensor with the liquid and tank (corrosive, reactive, high pressure, and other conditions are challenging and sometimes impossible for the sensor). Sycon does not guarantee the fitness of our sensors with any liquid other than $LN_2$ at low pressure.
- Variations of the dielectric constant of the liquid with changes in pressure and temperature of the liquid can cause reading fluctuations.
- **Sycon does not allow use of the SLL-N2 or sensors in explosive environments!**
- The dielectric constant of the liquid and surrounding vapor affects the maximum sensor length and SLL-N2 sensitivity (resolution). See equations below for details.

**Formula for maximum sensor length:**

***Lmax = Cg/(Ks * Rl)***

Where:

Lmax is sensor maximum length in cm
Cg is maximum measurable capacitance of the SLL-N2 in pF (6500 for this SLL-N2)
Ks is sensor constant [in pf/cm in dry air], (2.2814 for standard Sycon sensor)
Rl is relative permittivity (also called dielectric constant) of the liquid to be measured.

For example, if you'd like to use the SLL-N2 to measure water level, determine the maximum active length of the sensor (water has a relative permittivity of 80)
Lmax = 6500/2.2814 * 80 ≈ 35cm ≈ 13 in.

**Formula for level resolution in cm:**

***Res = Rc / (Ks * ( Rl – Rv))***

Res = resolution in cm (the minimum change in level the SLL-N2 can measure)

Where:

Rc = SLL-N2 resolution in pF (0.15 pF per count for this SLL-N2)
Ks and Rl are defined above
Rv is the relative permittivity of the vapor surrounding the sensor, usually the vapor form of the liquid to be measured.

Note that in this equation, if Rl = Rv (the dielectric constants of the liquid and the vapor surrounding the SLL-N2) are equal, the result is "infinity"; that is to say, the SLL-N2 cannot measure any change.

## Calibration Procedure for use with LN2:

Performing a calibration allows the SLL-N2 to 'know' the liquid level inside the tank. The calibration is what allows the SLL-N2 to work with different length sensors. Once the SLL-N2 is calibrated with the sensor, the liquid level can be displayed and controlled accurately.

1. Make sure SW1 is off.
2. Perform 'empty' (low level) calibrate. Connect the sensor to the SLL-N2, and with the sensor in dry air or nitrogen, press and hold the '1' button until the LEDs flash on the front. At this point you should notice the far left LED on the LED bar has stopped blinking.
3. Next, to perform full (highest level) calibrate. Place the sensor in the LN2 up to the maximum level (active length). With the sensor submerged to it's active length, press and hold the '2' button until the LEDs flash on the front. At this point you should notice the far right LED on the LED bar has stopped blinking.
4. (Highly recommended) Turn SLL-N2 off, remove cover, and turn SW1 and SW4 ON. This prevents the calibration data from being accidentally erased when performing other functions.
5. (Optional) With the Low and High-level SLL-N2 calibration performed, it would be a good idea to capture the settings using the included LabVIEW program. This way, if the calibration is lost it can be restored without following this procedure.

## Set-point adjustment procedures

The set-points control the level in the tank by controlling the fill relay at certain liquid levels. If the liquid level exceeds the high level set-point, the fill relay will be turned off (deactivated or opened). If the liquid level is below the low level set-point, the fill relay will be turned on (activated or closed).

- Set-point adjustment procedure 1 (easiest):
  1. Connect the SLL-N2 to a computer and establish communication the included LabVIEW software.
  2. Using the included software, adjust the SLL-N2 minimum and maximum level set-points under 'set point control'.

- Set-point adjustment procedure 2:

This procedure can be performed without a computer, and steps 2 + 3 need not be performed in order (may be swapped):

1. Make sure SW3 is off.
2. With the liquid level at the desired high level, press and hold the '2' and '4' buttons until the LEDs flash on the front.
3. With the liquid level at the desired low level, press and hold the '1' and '3' buttons until the LEDs flash on the front.
4. (Highly recommended) Turn SLL-N2 off, remove cover, and turn SW3 and SW4 ON. This prevents the calibration data from being accidentally erased when performing other functions.

# SECTION 5

*Troubleshooting*

# Troubleshooting

The SLL-N2 indicates errors via the front panel LEDs. Error indications can be interpreted using the information presented in the “User Interface Quick Reference” section in Chapter 1.

# APPENDIX A

*Serial Communications*

# Serial Communications:

The SLL-N2 comes with the most flexible communications in the industry. The SLL-N2 uses Sycon's "SMDP" protocol, including IEC commands subset. For more information on this protocol and packet formats, see the SMDP specification manual.

The SLL-N2 comes standard with a dual mode serial port, capable of RS-232 and RS-485 (2-wire) communication. Use the RS-232 for easy connectivity to a host computer. Use RS-485 for long cable runs (1000ft) and/or for multi-drop applications (connecting 2 or more SLL-N2s on the same network).

| Hash code (hex) | Type | Description |
|---|---|---|
| A676 | Integer, Read only | System error code |
| 8425 | Boolean, Read only | TRUE if SLL-N2 has been "full" calibrated |
| 1BBD | Boolean, Read only | TRUE if SLL-N2 has been "empty" calibrated |
| 91C5 | Boolean | True if SLL-N2 is in "force fill on" mode |
| 1ECB | Boolean | True if SLL-N2 is in "force fill off" mode |
| F268 | Integer, Read only | Level in % |
| 695B | Integer, Read only | Freq in HZ |
| 5D5B | Integer, Read only | Measurement serial number |
| 1B76 | Integer, Read only | Level in percent, encoded as 32 bit float |
| 2F8A | Integer, Read only | 32 assorted Boolean values (see table below) |
| 5BF8 | Integer, Read only | 32 bits representing the user interface, see table below |
| 303D | Integer, Write reset | Minimum level seen since power up. Writing any value to this variable resets it to the current level. |
| 0F64 | Integer, Write reset | Minimum level seen since power up. Writing any value to this variable resets it to the current level. |

Table A.1: Other assorted variables available through serial interface

| D31…D24 | D23 | D22 | D21 | D20 | D19 | D18…D1 | D0 |
|---|---|---|---|---|---|---|---|
| 0 | Standby LED | Fill LED | Comm LED | Error LED | LED Bar far Right | LEDs on LED bar, right to left | LED bar, far left |

Note: a '1' on the bit cell means the LED is ON

Table A.2: Key for "5BF8" variable query

| D15 **(2)** | D14 …**(2)** D9 | D8 **(2)** | D7 **(2)** | D6 **(2)** | D5 **(2)** | D4 **(2)** | D3 **(3)** | D2 **(3)** | D1 **(1)** | D0 **(1)** |
|---|---|---|---|---|---|---|---|---|---|---|
| DIP SW8 | SW7 … SW2 | DIP SW1 | PB SW4 (right) | PB SW3 | PB SW2 | PB SW1 (left) | Cal error | Freq error | Alarm relay | Fill relay |

1: A '1' in the bit cell means the relay is energized
2: A '1' in the bit cell means the switch is pressed or 'ON'
3: A '1' in the bit cell means the condition exists

Table A.3: Key for "5F8A" status query Bits D0-D15

| D31…D20 | D19 | D18 | D17 | D16 |
|---|---|---|---|---|
| 0 | Alias for 1ECB | Alias for 91C5 | Alias for 1BBD | Alias for 8425 |

Table A.4: Key for "5F8A" status query Bits D16-D31

# APPENDIX B

*External Connections*

## External connections:

The SLL-N2 has a DB9 connector for interfacing to the plant. On this connector are connections for 2 relays (normally open dry contact), serial communication, and power. See table below:

| DB9 Pin# | Name | Function | Notes |
|---|---|---|---|
| 1 | RLY_COM | Relays COM pin common | |
| 2 | RxD/B+ | RS232 receive/RS485 non-inverting | |
| 3 | TxD/B- | RS232 transmit/RS485 inverting | |
| 4 | GND | Ground for power | Pins 4+5 connected together internally |
| 5 | GND | Ground for communications | |
| 6 | RLY1_NO | Relay 1 (alarm) normally open contact connection | |
| 7 | RLY2_NO | Relay 2 (fill) normally open contact connection | |
| 8 | VCC_ALT | +4.5-5VDC External power input. | Pins 8+9 connected together internally |
| 9 | VCC_ALT | +4.5-5VDC External power input. | |

Table B.1: DB-9 pin-out

## Relay 1 (alarm relay) operation:

This relay is activated (closed) when any of the following conditions occur:

- The liquid level is lower than the alarm low set-point;
- The liquid level is higher than the alarm high set-point;
- The SLL-N2 cannot obtain a reading from the sensor (error LED blinking)
- The sensor reading is out of range (error LED on solid)

## Relay 2 (fill relay) operation:

**This relay is activated when** the measured liquid level is below the low level set-point for n measurements in a row, where n is the programmed “Fill Relay Delay ON” parameter. **This relay is deactivated when** the measured liquid level gets above the high level set-point for n measurements in a row, where n is the programmed “Fill Relay Delay OFF” parameter. **Also, this relay may be forced activated/deactivated** by the push button switches (see table 3) or computer interface, placing the SLL-N2 in the force fill on or force fill off mode. If the error LED is on or blinking (indicating a damaged sensor or gauge) the fill relay retains its last state.

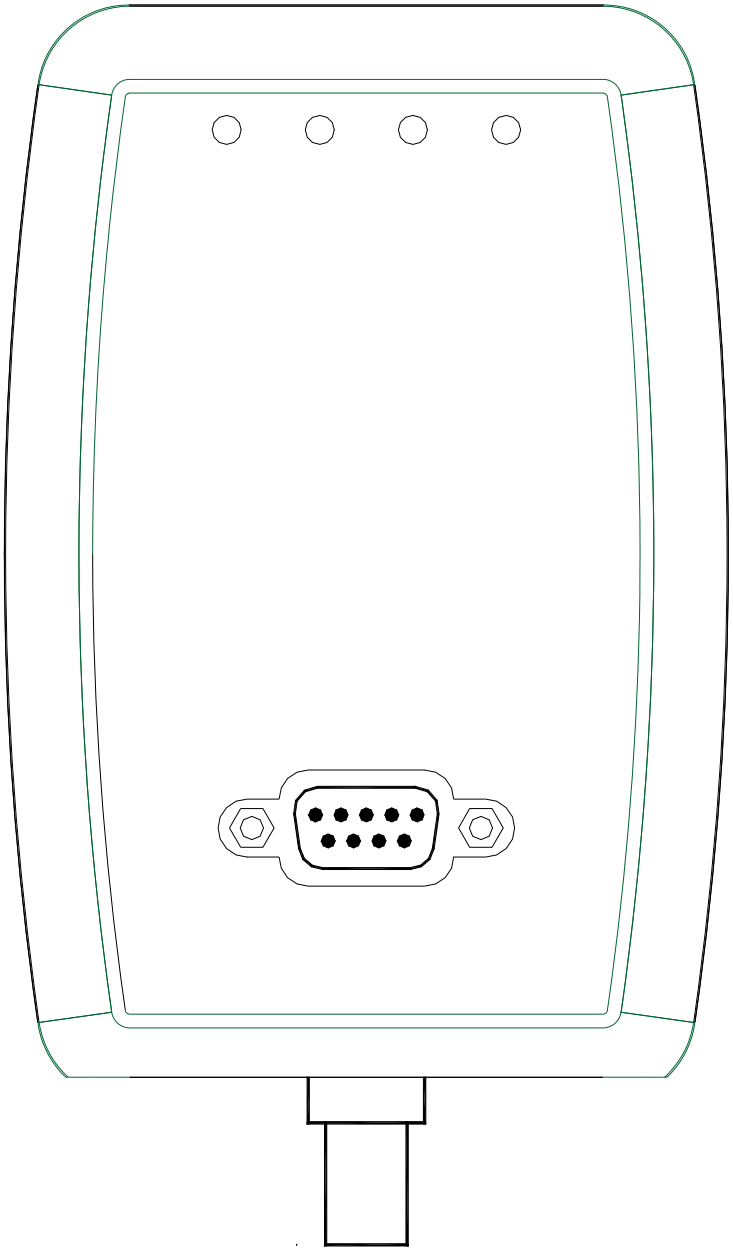
## Relay 2 (fill relay) timeout:

Furthermore, this relay is forced de-activated (the SLL-N2 is placed into the ‘force fill off mode’) if this relay has been activated for longer than the Fill Relay Timeout. The ‘Fill Relay Timeout’ takes priority even over the ‘Force Fill ON’ mode.

Note: For OEM customers, relay operation, parameter defaults, and SLL-N2 operation can be customized. Contact Sycon at 315-463-5297 (US) for more information.

# INDEX

# Index



Made in the U.S.A

Sycon Instruments
6757 Kinne Street
East Syracuse, New York 13057-1215
V (315) 463-5297 F (315) 463-5298 info@sycon.com