Position Indicator model MFC-300/IP

Technical Manual
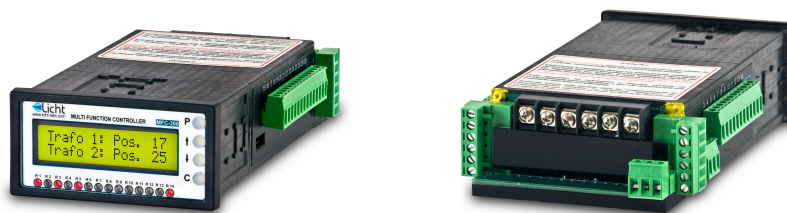
Licht

Contents

1 Introduction

The MFC-300/IP is a precise, highly reliable and versatile microcontrolled system designed to read, display and retransmit tap changer position values, as read from potentiometric sensors. The MFC-300/IP can be supplied in configurations featuring up to 6 compensated 3-wire inputs and up to 6 configurable current loop outputs. Versions with BCD, current loop or DC voltage inputs can also be supplied on special order. Each MFC-300/IP also features 1 isolated RS-485 port, which can be used for communication using the MODBUS or DNP3 protocols.

The MFC-300/IP shares its form factor with other Licht controllers for transformers, such as the MFC-300/R voltage regulator and the MFC-300/P parallelism controller. All signals that enter and exit the indicator are pairwise galvanically isolated, preventing potentially damaging noise and transients from being transferred between subcircuits or retransmitted to other devices.


Figure 1.1   MFC-300/IP Indicator

2 Front panel indication

During operation, the MFC-300/IP alternates each input's position indication. This indication depends on the correct configuration of the potentiometric sensor's parameters, described in the Programmable Parameters section.

If more than 2 inputs are used, a timer automatically changes the channels on display. The user may manually alter the currently displayed channel (skipping the alternation timer) by pressing the ↑ or ↓ keys.
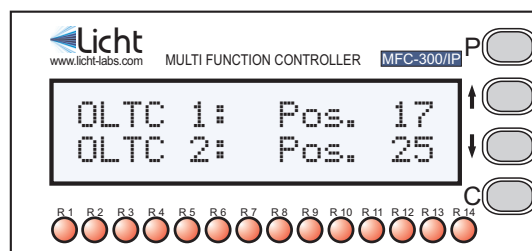
Figure 2.1   Front Panel

3 Error indication

The MFC-300/IP's last relay (relay 14) is reserved for indicating failures. It is normally open, and closes if the MFC-300/IP loses power or if:

▷ No potentiometric sensor is detected.

▷ A position is measured with an error of 20% or more in relation to its ideal resistance value. This typically indicates the incorrect configuration of the tap changer's number of positions or resistance per position, but could also indicate potentiometric sensor failure. Note that the MFC-300/IP automatically compensates cable lengths.

▷ A position larger than the **Number of Positions** parameter is read.

▷ Inconsistencies are detected in the measurement circuit.

The front panel LED corresponding to relay 14 is normally on, and turns off under the scenarios listed above. The installation of this relay is optional, and the controller will perform all its functions normally, even without this component.

To determinate possible position errors, the MFC-300/IP features two internal timers, which are designed to prevent line transients from being interpreted as errors.

If a measurement deviation is detected, a 5 second timer is activated. If this deviation persists until the timer expires, the controller will recognize it as a error, closing the failure relay and turning off its corresponding front panel LED.

If the MFC-300/IP is indicating a failure and its causing deviation disappears, a 30 second timer is initiated, and the instrument only returns to its initial condition if no new deviations occur until the countdown expires.

4 Manual commands

The MFC-300/R allows one to issue manual raise/lower commands to the on-load tap changer.

To issue a manual command, press **P** to enter the configuration mode, and choose the "Manual Command" option. The device will then prompt for a raise or lower command, which can be issued by pressing ↑ or ↓.

After ↑ or ↓ is pressed, the corresponding LED will light up, indicating that the command was executed.

The implementation of manual command is optional, because it requires the installation of additional relays.

5 Configuration

Parameterization

The MFC-300/IP features 4 keys to access its functions. The procedure to configure any parameter is as follows:

1. Press the **P** key to enter the parameters menu.
2. Enter the currently configured 4 letter password one letter at a time, using the ↑ and ↓ keys to select each letter and **P** to advance between letters. The default password is AAAA.
3. Using the ↑ and ↓ keys, choose the desired parameter.
4. Press **P** to confirm the parameter's selection.
5. Choose the desired value with the ↑ and ↓ keys.
6. Confirm pressing **P**.

By holding down the ↑ or ↓ keys it is possible to advance through the options faster.

The configuration sequence can be cancelled at any time by pressing **C**.

5.1 Parameter reset

The MFC-300/IP can be reset to factory settings. This procedure also resets its password to AAAA. To do so, power up the device while pressing **C**.

6 Programmable parameters

The MFC-300/IP was developed to provide the user with the greatest possible flexiblity, such that all supervision and configuration can be executed on-site or remotely through the existing communication channels.

We define all user-configurable parameters below.

6.1 Potentiometric disc

Parameter: Number of Positions
Options: 2 to 50.
Description: the quantity of tap changer positions.

Parameter: Resistance per Position
Options: 3.0 to 20.0 Ω, in increments of 0.1 Ω.
Description: the potentiometric sensor's resistance per position.

Parameter: Indication Type
Options: position, resistance.
Description: type of values indicated on the MFC-300's front panel.

Parameter: Number of Active Sensors
Options: 1 to 6.
Description: quantity of installed sensors.

Parameter: Indication format
Options: 1 ... n ; -x ... +y ; +y ... -x ; xL ... N ... yR ; xR ... N ... yL.
Description: defines how the position is shown in the device's display.

  ▷ 1 ... n: positions are numbered from 1 to the maximum.
  ▷ -x ... +y: positions are indicated relative to the neutral (positions below neutral are negative).
  ▷ +x ... -y: positions are indicated relative to the neutral (positions below neutral are positive).
  ▷ xL ... N ... yR: positions below neutral are suffixed with L, positions above neutral are suffixed with R, and the neutral is indicated as N.
  ▷ xR ... N ... yL: positions below neutral are suffixed with R, positions above neutral are suffixed with L, and the neutral is indicated as N.

Parameter: Neutral position

Options: 1 to 50.

Description: defines the neutral position.

6.2 Current outputs (option)

Parameter: Output Scale

Options: 0-1, 0-5, 0-10, 0-20, 4-20 mA

Description: refers to the various configurable current loop scales.

6.3 MODBUS protocol

Parameter: Baud Rate

Options: 9600, 19200, 38400, 57600, 115200 bps.

Description: baud rate for the RS-485 link.

Parameter: Format

Options: 8N1, 8E1, 8O1, 8N2.

Description: symbol transmission format, where:

- 8N1: 8 data bits, no parity, 1 stop bit.
- 8E1: 8 data bits, even parity, 1 stop bit.
- 8O1: 8 data bits, odd parity, 1 stop bit.
- 8N2: 8 data bits, no parity, 2 stop bits.

Parameter: Address

Options: 1 to 247.

Description: MODBUS address for the MFC-300/IP.

6.4 DNP3 protocol (option)

Parameter: Baud Rate

Options: 9600, 19200, 38400, 57600, 115200 bps.

Description: baud rate for the RS-485 link.

Parameter: Format

Options: 8N1, 8E1, 8O1, 8N2.

Description: symbol transmission format, where:

- ○ 8N1: 8 data bits, no parity, 1 stop bit.
- ○ 8E1: 8 data bits, even parity, 1 stop bit.
- ○ 8O1: 8 data bits, odd parity, 1 stop bit.
- ○ 8N2: 8 data bits, no parity, 2 stop bits.

Parameter: Address

Options: 0x0000 to 0xFFEF.

Description: DNP3 outstation address in hexadecimal notation.

Parameter: Application Layer Confirmation

Options: Only when transmitting events or multi-fragment responses, Always.

Description: Selects when the MFC-300/IP outstation should request application layer confirmations.

Parameter: Maximum Inter-Octet Gap

Options: 2 to 100 ms.

Description: The DNP3 specification states that frames should not have inter-octet gaps. In accordance, the MFC-300/IP never inserts inter-octet gaps when transmitting data. However, we allow the option to tolerate gaps in incoming transmissions. Frames featuring inter-octet gaps larger than the Maximum Inter-Octet Gap will be quietly dropped.

Parameter: Backoff Delay (Fixed)

Options: 1 to 100 ms.

Description: See description for Backoff Delay (Random).

Parameter: Backoff Delay (Random)

Options: 1 to 100 ms.

Description: The MFC-300/IP is designed for multi-drop scenarios where more than one outstation may transmit over the same line. To handle collision avoidance, a backoff scheme is implemented. Before transmitting, the MFC-300/IP always waits for the line to become idle. Once that happens, it waits for $T_{delay} = T_{fixed} + T_{random}$ ms, where T_{fixed} is the fixed backoff delay and T_{random} is a random value, uniformly distributed between 0 and the random backoff delay parameter. If after T_{delay} ms the line is still idle, then the MFC-300/IP begins transmission.

Parameter: Insert Inter-frame Gap

Options: Never, Always.

Description: The DNP3 specification states that no inter-frame gaps are required. However, some masters have been observed to drop frames when no inter-frame gaps are provided. This option allows communicating with such non-compliant devices. We discourage its use, given that the forced inter-frame gap implies a forced backoff-delay.
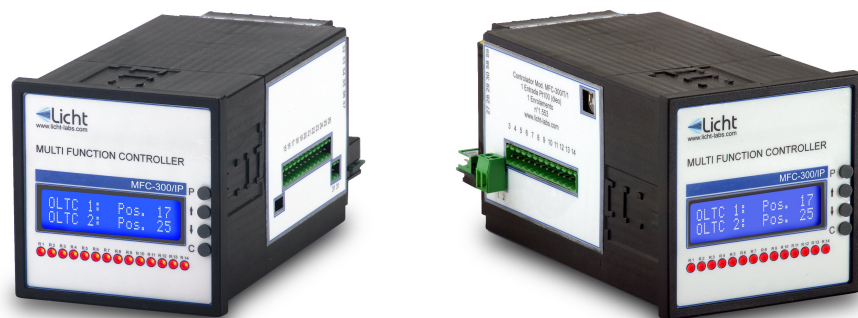
6.5 Language

Parameter: Language
Options: Portuguese (PT_BR), English (EN_US).
Description: Language of the messages and menus displayed on the MFC-300/IP's front panel.

7 Additional versions
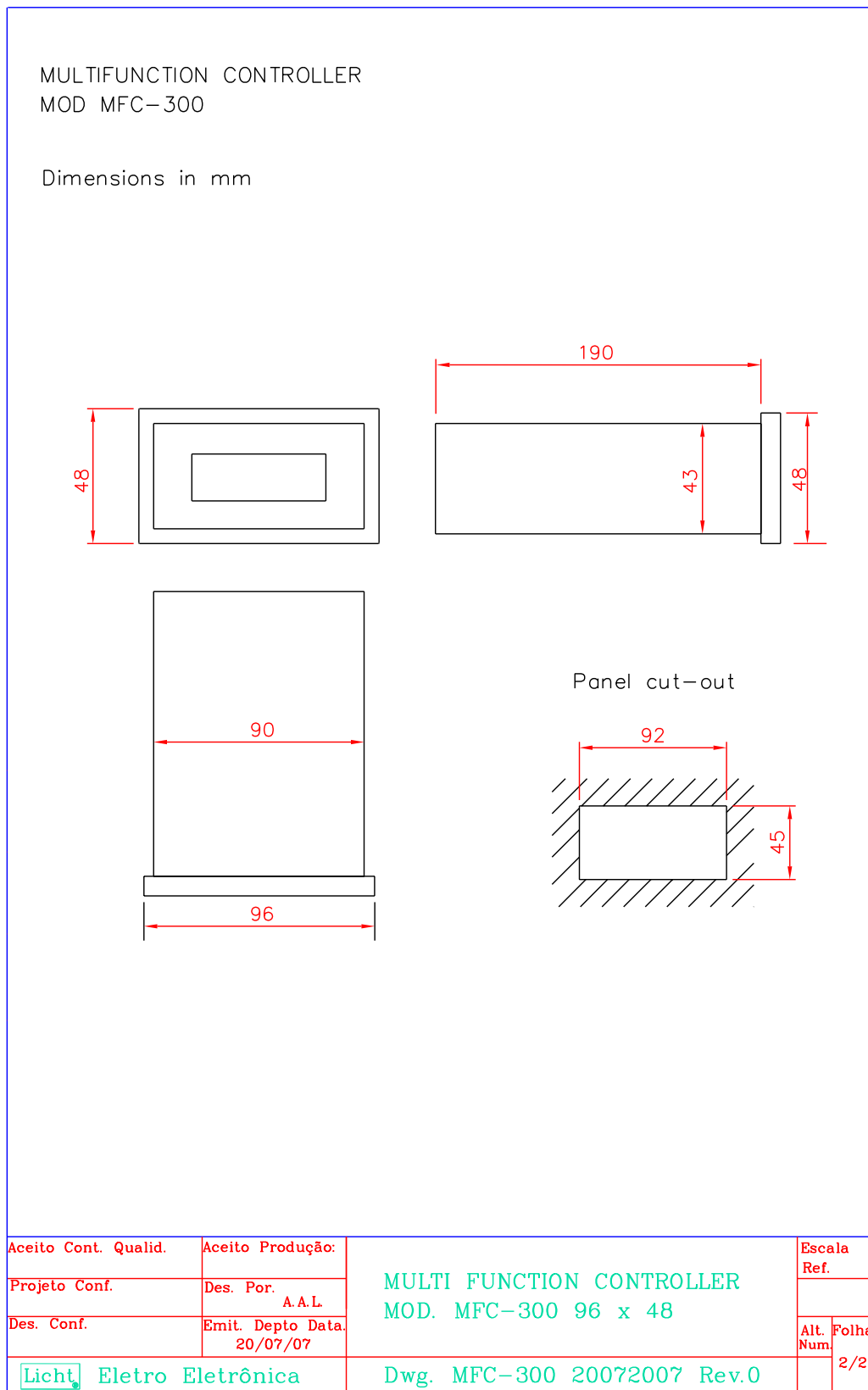

Figure 7.1   MFC-300/IP Indicator (96x96 version)

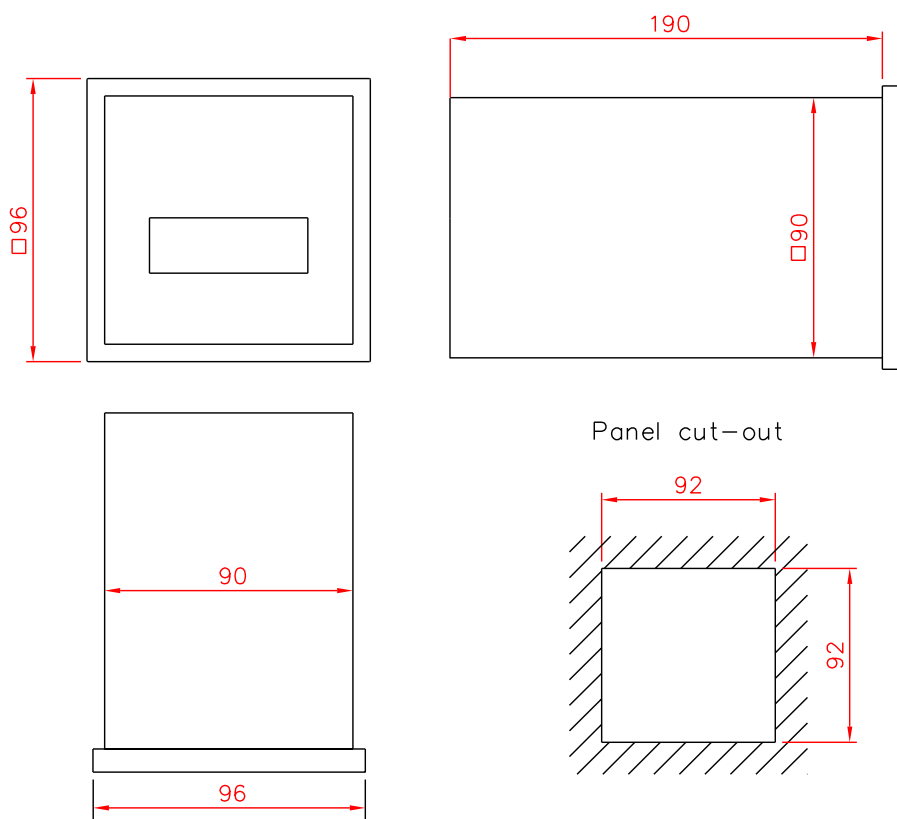**Figure 7.2**   MFC-300/IP Indicator (with weatherproof enclosure)

A Specifications

Power Supply	Isolated, 80-260 Vac/Vdc.
Power Consumption	8 W
Operating Temperature	-10 to 70 °C (LCD display) -40 to 70 °C (VFD display)
Enclosure Rating	IP20 (96x48 and 96x96 formats) IP65 (with weatherproof enclosure)
Mounting Options	Panel-mounted
Dimensions	96 x 96 x 190 mm or 96 x 48 x 190 mm
Weight	550 g
DC Inputs	Types: potentiometric, current, voltage Error/Non-linearity: 0.2% + 0.1% / 10 °C
Current Outputs	Scales: 0-1, 0-5, 0-10, 0-20, 4-20 mA Error/Non-linearity: 0.2% + 0.1% / 10 °C

Galvanic Isolation (60 Hz, 1 min.)

Sensors	2.0	kV
Outputs	2.0	kV
Communication	2.0	kV

Communication	RS-485 - MODBUS RTU or DNP3 9600, 19200, 38400, 57600, 115200 bps 8N1, 8E1, 8O1, 8N2
Displays	2 lines with 16 characters each (5 mm). LCD with backlight or VFD.
Relays	10 A @ 250 Vac, 0.5 A @ 125 Vdc Galvanic Isolation: 2.0 kV, 60 Hz, 1 min.

B Housing diagrams

MULTIFUNCTION CONTROLLER
MOD MFC−300
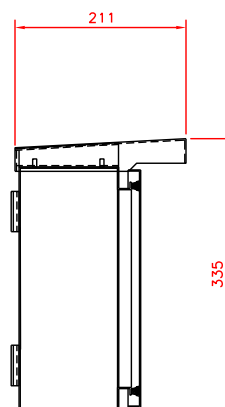
Dimensions in mm

190

48

43

48

90

96

Panel cut−out

92

45

Aceito Cont. Qualid.	Aceito Produção:		Escala Ref.	
Projeto Conf.	Des. Por. A.A.L.	MULTI FUNCTION CONTROLLER MOD. MFC−300 96 x 48		
Des. Conf.	Emit. Depto Data. 20/07/07		Alt. Num.	Folha 2/2
Licht Eletro Eletrônica		Dwg. MFC−300 20072007 Rev.0		

MULTIFUNCTION CONTROLLER
MOD MFC-300

Dimensions in mm

190

□96

□90

Panel cut-out

90

92

92

96

Aceito Cont. Qualid.	Aceito Produção:		Escala Ref.	
Projeto Conf.	Des. Por. A. A. L.	MULTI FUNCTION CONTROLLER MOD. MFC-300 96 x 96		
Des. Conf.	Emit. Depto Data. 20/07/07		Alt. Num.	Folha 1/2
Licht Eletro Eletrônica		Dwg. MFC-300 20072007 Rev.0		

Frontal View

B-B' Cross-section

A-A' Cross-section

WINDOW

DOOR
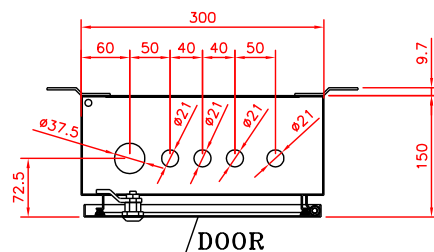
Material: Steel Plate
Thickness: 1,25 mm
Paint: 40 micron epoxy power coating, RAL 7032 color
Rating: IP 65

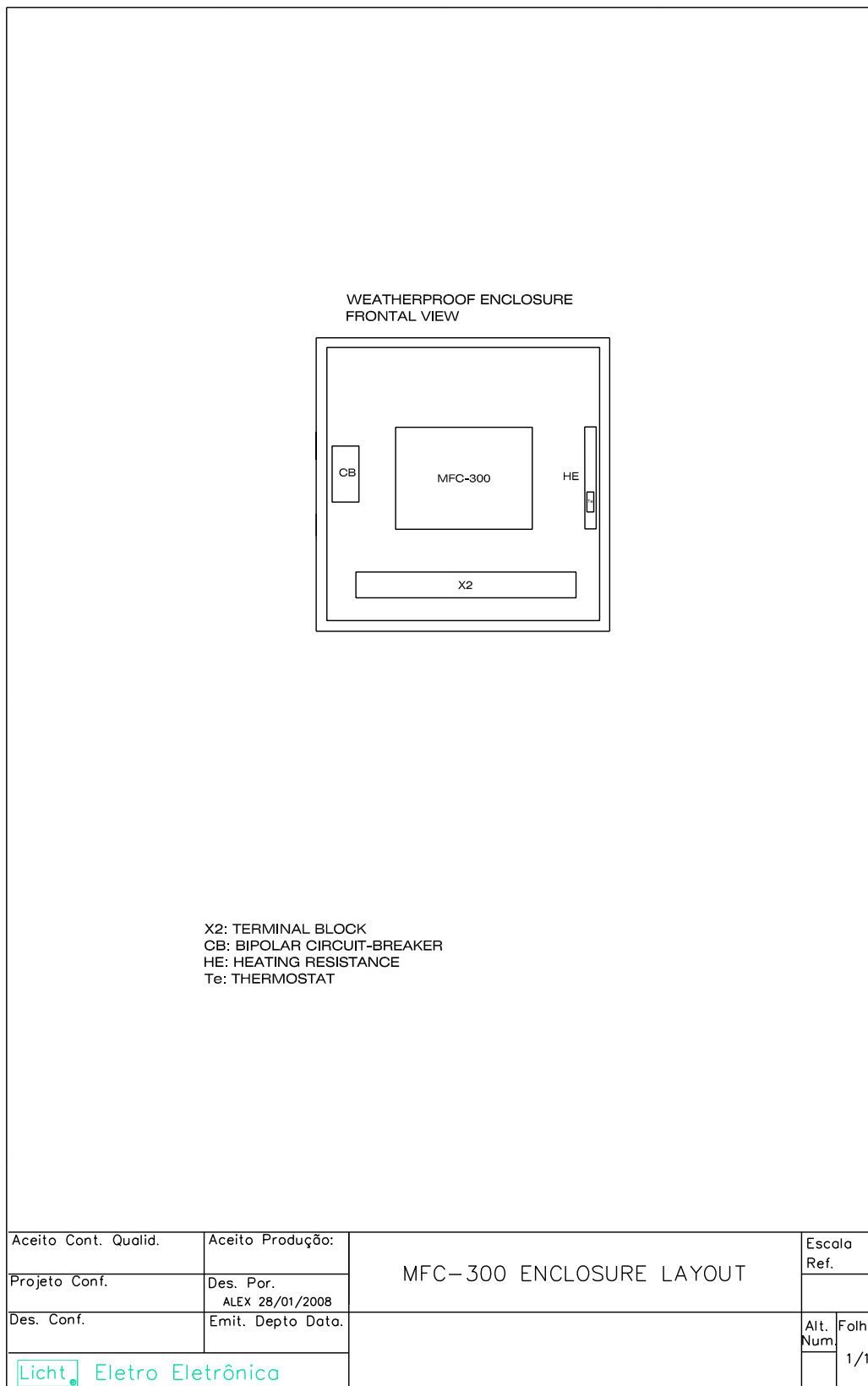| Aceito Cont. Qualid.	Aceito Produção:	MFC-300 HOUSING WEATHERPROOF ENCLOSURE	Escala S/ ESC.	
Projeto Conf.	Des. Por. ALEX 28/01/08			
Des. Conf.	Emit. Depto Data.		Alt. Num	Folha 1/1
Licht Eletro Eletrônica				

C Weatherproof enclosure layout

WEATHERPROOF ENCLOSURE
FRONTAL VIEW

CB	MFC-300	HE

X2

X2: TERMINAL BLOCK
CB: BIPOLAR CIRCUIT-BREAKER
HE: HEATING RESISTANCE
Te: THERMOSTAT

Aceito Cont. Qualid.	Aceito Produção:	MFC—300 ENCLOSURE LAYOUT	Escala Ref.	
Projeto Conf.	Des. Por. ALEX 28/01/2008			
Des. Conf.	Emit. Depto Data.		Alt. Num.	Folha 1/1
Licht ® Eletro Eletrônica				

D   Connection diagrams
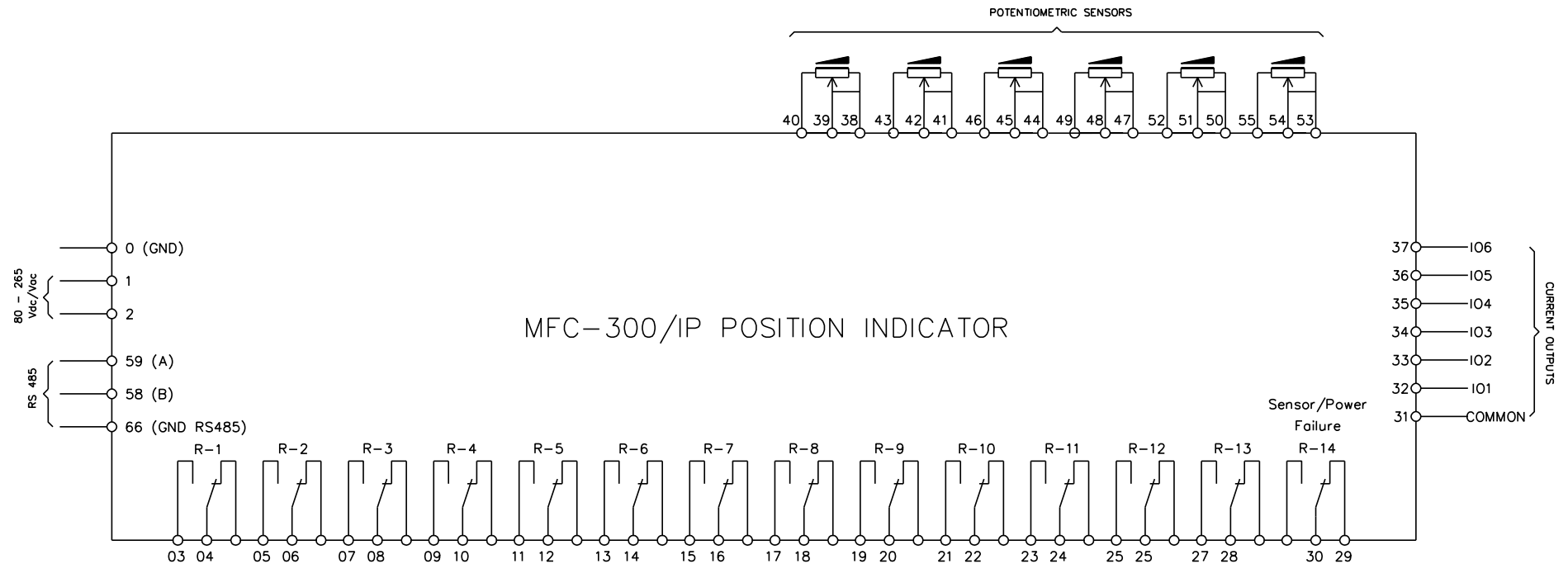
Important considerations

The installation of electronic devices in substations should conform with the recommendations given by recent international standards. The most recent and detailed guide for installations is IEC 61000-5-2:1997, which was based on decades of laboratory and field research. We summarize below some of the guidelines contained in IEC 61000-5-2:1997. For further reading, we recommend the articles and application notes available on our web site.

a. Shielded cables must be used for connecting potentiometric sensors, current loop outputs, RS-485 links and the auxiliary supply.

b. Cables must be segregated in trays, ducts or conduits according to their functions. In particular, power cables must never be routed in the proximity of signal cables, even if these are shielded. The minimum distances which must be observed are described in IEC 61000-5-2:1997 and in articles available on-line at this product's web page.

c. The electrical continuity of cables, ducts, trays and conduits must be preserved up to frequencies in the order of MHz, over all their extension, including curves and junctions. In order to guarantee this continuity, joints and bonds should present electrical contact along each cable, duct or tray's transversal section. In particular, trays should be bonded with seam-welded joints (best), U-brackets with multiple fixings (ok) and never with wires.

d. Shielded cables should present no gaps in their screens along their lengths. 360° bonding should be performed instead.

e. Should there be unshielded sections (for example, near terminal block connections), these should be short as possible.

f. Trays, ducts and conduits must be electrically continuous, and must be grounded at both ends. In this configuration, trays, ducts and conduits provide shielding and also perform as parallel earth conductors.

g. Shielded cables should also have their screens bonded at both ends. It is extremely important that the tray, duct or conduit which contains each cable is also grounded at both ends, allowing it to perform as a parallel earth conductor. In the absence of a parallel earth condutor, the cable screens will be exposed to extremely high currents which will severely compromise their operation.

h. RS-485 pairs must be terminated at both ends by 120 Ω resistors.

i. RS-485 devices must be connected in a bus topology. No other network topology (tree, star, ring, etc.) is acceptable.

j. Dry contact inputs (if applicable) must free of potentials.

E MODBUS registers

The MFC-300 implements the *Read Holding Register* (0x03), *Write Single Register* (0x06) and *Write Multiple Register* (0x10) MODBUS RTU functions. A frame referring to any other function will be answered with an "unsupported function code" exception.

We present below a table of remotely accessible registers, considering a device with 6 input channels. Not all registers may be accessible in some devices, given that not all channels or relays may be installed. For example, a device with 4 channels will return an "illegal data address" exception whenever registers corresponding to channels 5 or 6 are accessed.

Holding Register	Description	Values	Multiplier
201	Number of Positions	2 to 50	1
202	Resistance per Position	3.0 to 20.0 Ω	10
203	Indication Type	0: position 1: resistance	1
204	Number of Active Sensors	1 to 6	1
205	Indication Mode	0: 1 ... n 1: -x ... +y 2: +x ... -y 3: xL ... N ... yR 4: xR ... N ... yL	1
206	Neutral position	1 to 50	1
301	Current Loop - Output Scale	0: 0-1 mA 1: 0-5 mA 2: 0-10 mA 3: 0-20 mA 4: 0-20 mA	1
501	Sensor 1 Position	2 to 50	1
502	Sensor 1 Resistance	0.0 to 255.0 Ω	10
503	Sensor 2 Position	2 to 50	1
504	Sensor 2 Resistance	0.0 to 255.0 Ω	10
505	Sensor 3 Position	2 to 50	1
506	Sensor 3 Resistance	0.0 to 255.0 Ω	10
507	Sensor 4 Position	2 to 50	1
508	Sensor 4 Resistance	0.0 to 255.0 Ω	10

Holding Register	Description	Values	Multiplier
509	Sensor 5 Position	2 to 50	1
510	Sensor 5 Resistance	0.0 to 255.0 Ω	10
511	Sensor 6 Position	2 to 50	1
512	Sensor 6 Resistance	0.0 to 255.0 Ω	10