Level Monitor
model MFC-300/N

Technical Manual

Licht

Contents

1 Introduction

The MFC-300/N is a precise, highly reliable and versatile microcontrolled system designed to read, display and retransmit multiple channels containing level information. The MFC-300/N can be supplied in configurations with up to 6 input channels and 12 independently configurable relays. Each relay may be associated with any input, and has a configurable setpoint, hysteresis and activation delay.

The MFC-300/N features 6 compensated resistive sensor inputs, 1 isolated RS-485 port, 12 configurable relays, 6 isolated configurable current loop outputs and up to 2 failure indication relays.

The MFC-300/N 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 controller are pairwise galvanically isolated, preventing potentially damaging noise and transients from being transferred between subcircuits or retransmitted to other devices.

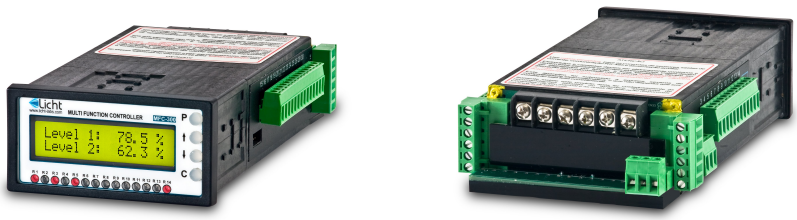


Figure 1.1 MFC-300/N Controller

2 Front panel indication

During operation, the MFC-300/N alternates each channel's level indication, presented as a percentage value. This indication depends on the calibration performed by the user before commisioning.

A timer automatically changes the channel on display. The user may manually alter the currently displayed channel (skipping the alternation timer) by pressing the ↑ or ↓ keys.

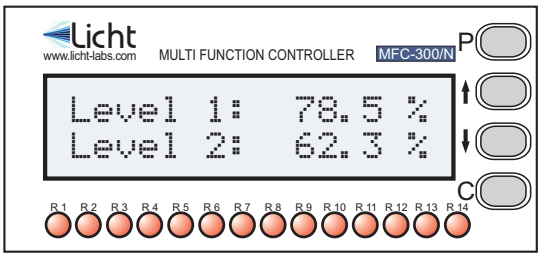


Figure 2.1 Front Panel

3 Configuration

Parameterization

The MFC-300/N 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. Using the ↑ and ↓ keys, choose the desired parameter.
3. Press **P** to confirm the parameter's selection.
4. Choose the desired value with the ↑ and ↓ keys.
5. Confirm by pressing **P**.

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

The configuration menu is protected by a 4 letter password, designed to discourage unauthorized reconfiguration attempts. The default password is AAAA. If the password is ever lost, it may be reset along with all other parameters by powering the device while pressing the **C** key. This procedure does not reset the sensor calibration.

Calibration

Each MFC-300/N is pre-calibrated to the potentiometric sensors expected to be used by each client. Recalibration can be easily performed by following these steps:

1. Power up the device while pressing the ↑ or ↓ key.
2. The indication Min Channel 1 will appear on the display, along with a raw sensor readout between 0 and 65535. Manually move the level sensor to its minimum position (corresponding to the 0% excursion). The readout will reflect this position.
3. Press P to store this minimum value.
4. The indication Max Channel 1 will appear on the display, along with a raw sensor readout between 0 and 65535. Manually move the level sensor to its maximum position (corresponding to the 100% excursion). The readout will reflect this position.
5. Press P to store this maximum value.
6. Continue this procedure to calibrate the remaining channels.

4 Programmable parameters

The MFC-300/N 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 as follows:

Parameter: Set Point[1-12]
Options: 0 to 100%, in 1% increments.
Description: Set point for relays 1-12.

Parameter: Hysteresis[1-12]
Options: 1 to 50%, in 1% increments.
Description: Hysteresis for the activation/deactivation of relays 1-12. A hysteresis value of at least 1% is required to prevent relays from switching on and off intermittently whenever the indication remains over an activation threshold.

Parameter: Delay[1-12]
Options: 0.1 to 25.5 minutes, in 0.1 minute increments.
Description: Activation delay for relays 1-12.

Parameter: Forced Activation[1-12]
Options: Normal, Activated.
Description: Selects if a relay responds to level variations (Normal) or if it is constantly activated (Activated).

Parameter: Activation Logic[1-12]
Options: Normal, Inverted.
Description: Defines whether a relay's activation logic is Normal (relay closes when its set point is exceeded) or Inverted (relay opens when its set point is exceeded).

Parameter: Associated Channel[1-12]
Options: 1 to 6.
Description: Input associated with a particular relay.

4.1 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.

4.2 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/N.

4.3 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/R 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/R 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/R 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/R 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/R 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.

5 Additional versions

Figure 5.1 MFC-300/N Controller (96x96 version)

Figure 5.2 MFC-300/N Controller (with weatherproof enclosure)

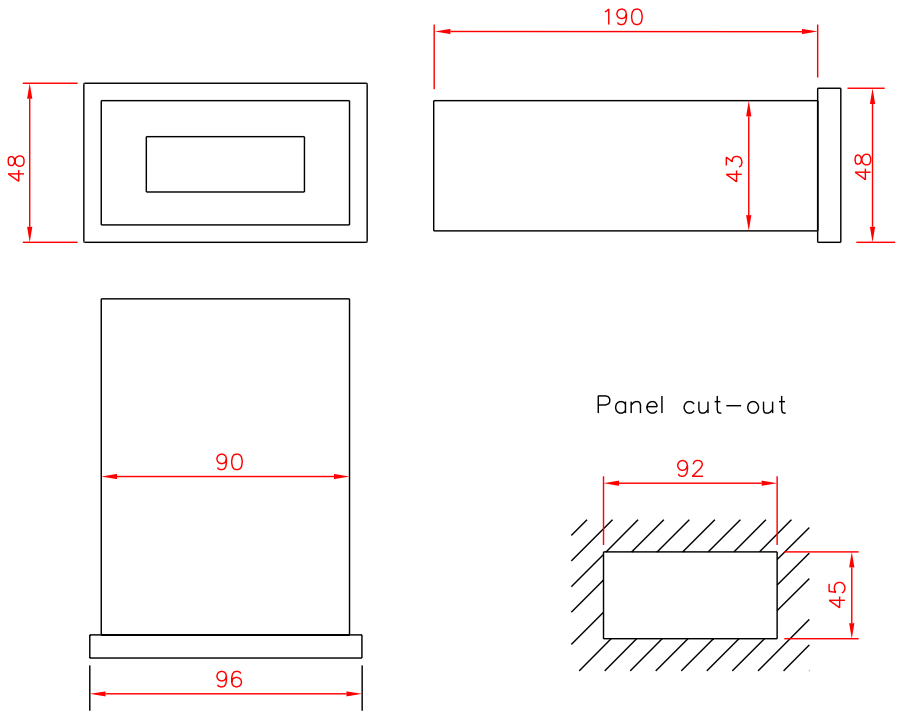
A Specifications

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	Potentiometric, current loop or 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.)	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

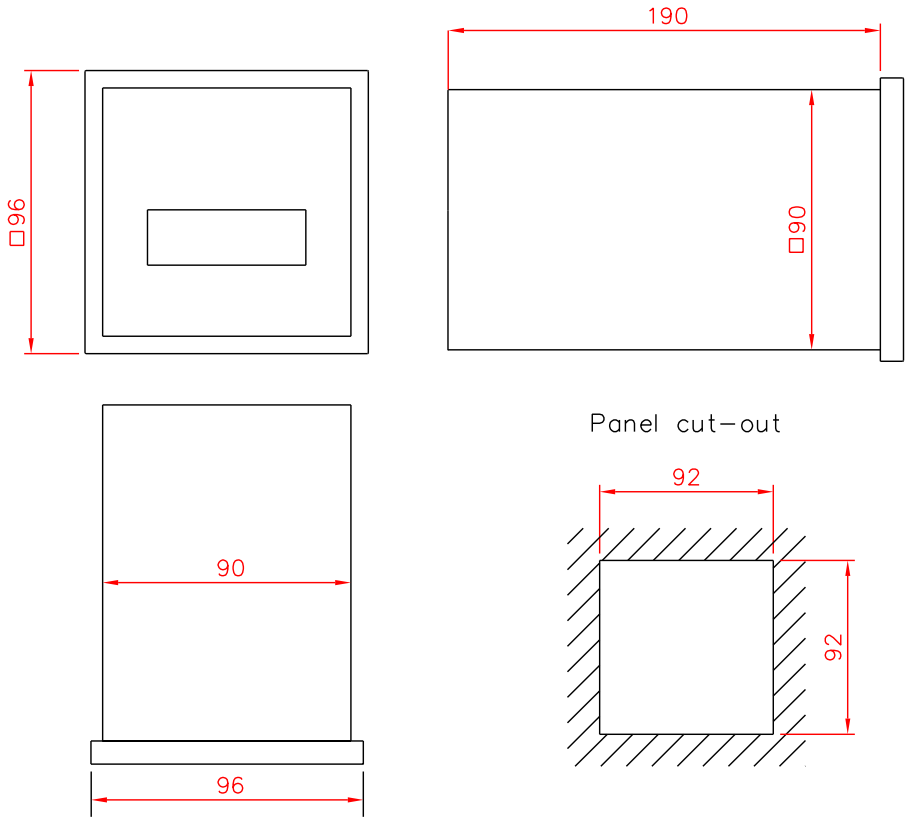
Dimensions in mm



Aceito Cont. Qualid.	Aceito Produção:	MULTI FUNCTION CONTROLLER MOD. MFC-300 96 x 48	Escala Ref.
Projeto Conf.	Des. Por. A.A.L.		
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



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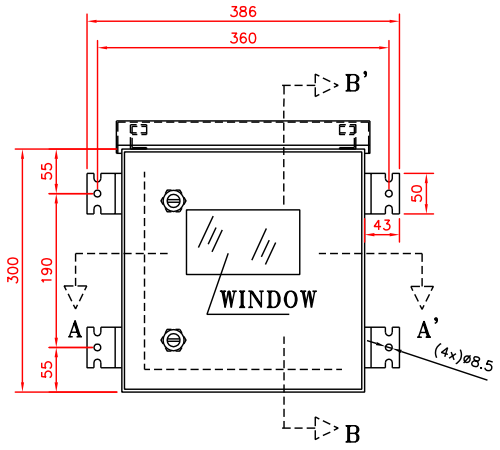
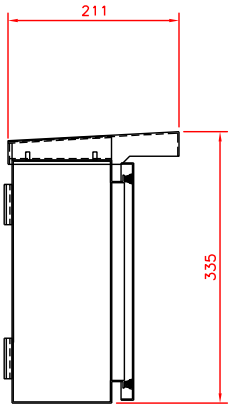
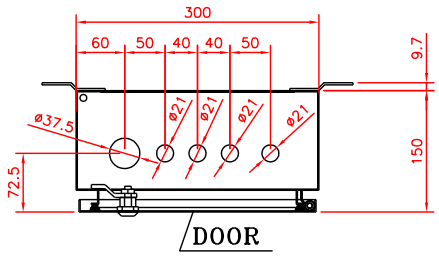
Projeto Conf.	Des. Por. A.A.L.		
Des. Conf.	Emit. Depto Data. 20/07/07		Alt. Num. / Folha 1/2
Licht Eletro Eletrônica	Dwg. MFC-300 20072007 Rev.0		



Frontal View



B–B' Cross–section



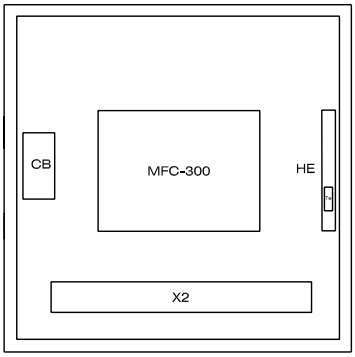
A–A' Cross–section

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

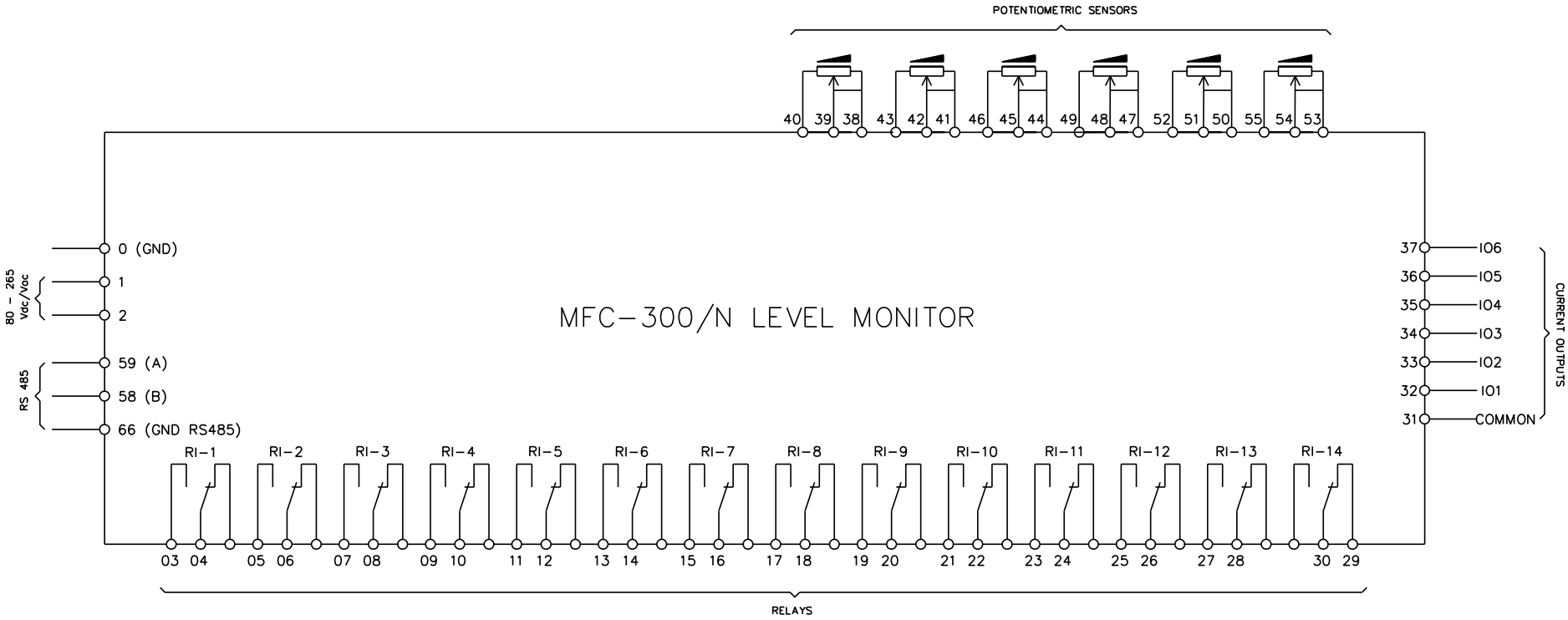
WEATHERPROOF ENCLOSURE
FRONTAL VIEW



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 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 Configuration sheet

Parameter	Possible Settings	Selected Setting
Current Output	0-1, 0-5, 0-10, 0-20, 4-20 mA	
Baud Rate	9600, 19200, 38400, 57600, 115200	
Format	8N1, 8E1, 8O1, 8N2	
Address	1-247	

Parameter	Possible Settings	Selected Setting
Relay	1 to 12	
Set Point	0 to 100%	
Hysteresis	1 to 50%	
Delay	0.1 to 25.5 min.	
Associated Channel	1 to 6	
Forced Activation	Normal, Activated	
Activation Logic	Normal, Inverted	
Relay	1 to 12	
Set Point	0 to 100%	
Hysteresis	1 to 50%	
Delay	0.1 to 25.5 min.	
Associated Channel	1 to 6	
Forced Activation	Normal, Activated	
Activation Logic	Normal, Inverted	
Relay	1 to 12	
Set Point	0 to 100%	
Hysteresis	1 to 50%	
Delay	0.1 to 25.5 min.	
Associated Channel	1 to 6	
Forced Activation	Normal, Activated	
Activation Logic	Normal, Inverted	

F 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 and 12 relays. 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. Similarly, a device with only 6 relays will return "illegal data address" if registers corresponding to channels 7-12 are accessed.

Holding Register	**Description**	**Values**	**Multiplier**
1-12	Set Point [1-12]	0 to 100%	1
21-32	Hysteresis [1-12]	1 to 50%	1
41-52	Delay [1-12]	0.1 to 25.5 min.	10
61-72	Associated Channel [1-12]	0 to 5	1
81-92	Forced Activation [1-12]	0: disabled 1: enabled	1
101-112	Activation Logic[1-12]	0: normal 1: inverted	1
121	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
201-206	Level [1-6]	0.0 to 100.0%	10
221-232	Relay State [1-12]	0: disabled 1: enabled	1