

Current Indicator/Transducer models MFC-300/I-IAC and I-IDC



Technical Manual



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1 Introduction

The MFC-300/I-IAC and I-IDC are precise, highly reliable and versatile microcontrolled devices designed to read, display and retransmit AC or DC current values. They feature one isolated RS-485 port, which can be used for communication using the MODBUS or DNP3 protocols.

Signals that enter and exit the indicator are galvanically isolated, preventing potentially damaging noise and transients from being transferred between subcircuits or retransmitted to other devices.

The device is responsible for activating relays based on predefined current setpoints. There are 10 user-programmable current setpoints, corresponding to 10 relays. Each relay may be associated with any of the current measurements.



Figure 1.1 MFC-300/I-IAC and MFC-300/I-IDC Indicators

2 Front panel indication

During operation, the MFC-300/I-IAC and MFC-300/I-IDC alternates between each input's current indication. The presented value is equal to the measured current multiplied by the **Sampling Factor** parameter.

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 \uparrow or \downarrow keys.

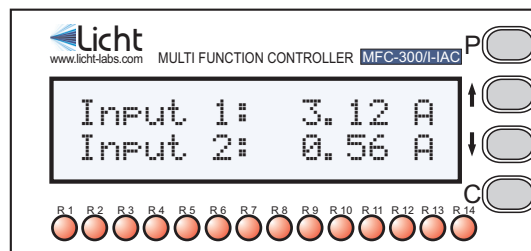


Figure 2.1 Front Panel

3 Configuration

Parameterization

The MFC-300/I-IAC and MFC-300/I-IDC feature 4 keys to access their 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**.

3.1 Parameter reset

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

4 Programmable parameters

The MFC-300/I-IAC and MFC-300/I-IDC were developed to provide the user with the greatest possible flexibility, 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.

4.1 General parameters

Parameter: Active Inputs

Options: 1 to 3.

Description: quantity of current inputs considered to be valid.

Parameter: Sampling Factor

Options: 1 to 1000.

Description: ratio between the current displayed by the MFC-300/I-IAC or MFC-300/I-IDC and the sampled current.

Parameter: AC frequency

Options: 60 Hz, 50 Hz.

Description: input current frequency (only applicable to the MFC-300/I-IAC).

Parameter: Set Point (%) [1-10]

Options: 0 to 150 %, in increments of 1 %.

Description: Current set point for relays 1-10.

Parameter: Hysteresis (%) [1-10]

Options: 1 to 100 %, in increments of 1 %.

Description: Current hysteresis for the activation/deactivation of relays 1-10.

Parameter: Timeout [1-10]

Options: 1 to 255 seconds, in increments of 1 second.

Description: Delay for the activation of relays 1-10.

Parameter: Associated Channel [1-10]

Options: Channel 1, channel 2, channel 3.

Description: Channel associated with each relay.

Parameter: Forced Activation[1-10]

Options: Normal, Activated.

Description: Selects if a relay responds to current variations (Normal) or if it is permanently activated (Activated).

Parameter: Activation Logic[1-10]

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).

4.2 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.

Parameter: Full Scale

Options: 0.01 to 10.00 A, in increments of 0.01 A.

Description: input current corresponding to the current loop's full scale output. For example, if Full Scale = 5.00 A and Output Scale = 4-20 mA, the current loop output will be 4 mA for a 0.00 A input and 20 mA for a 5.00 A input.

4.3 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/I-IAC or MFC-300/I-IDC.

4.4 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 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 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 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 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 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.

4.5 Language

Parameter: Language

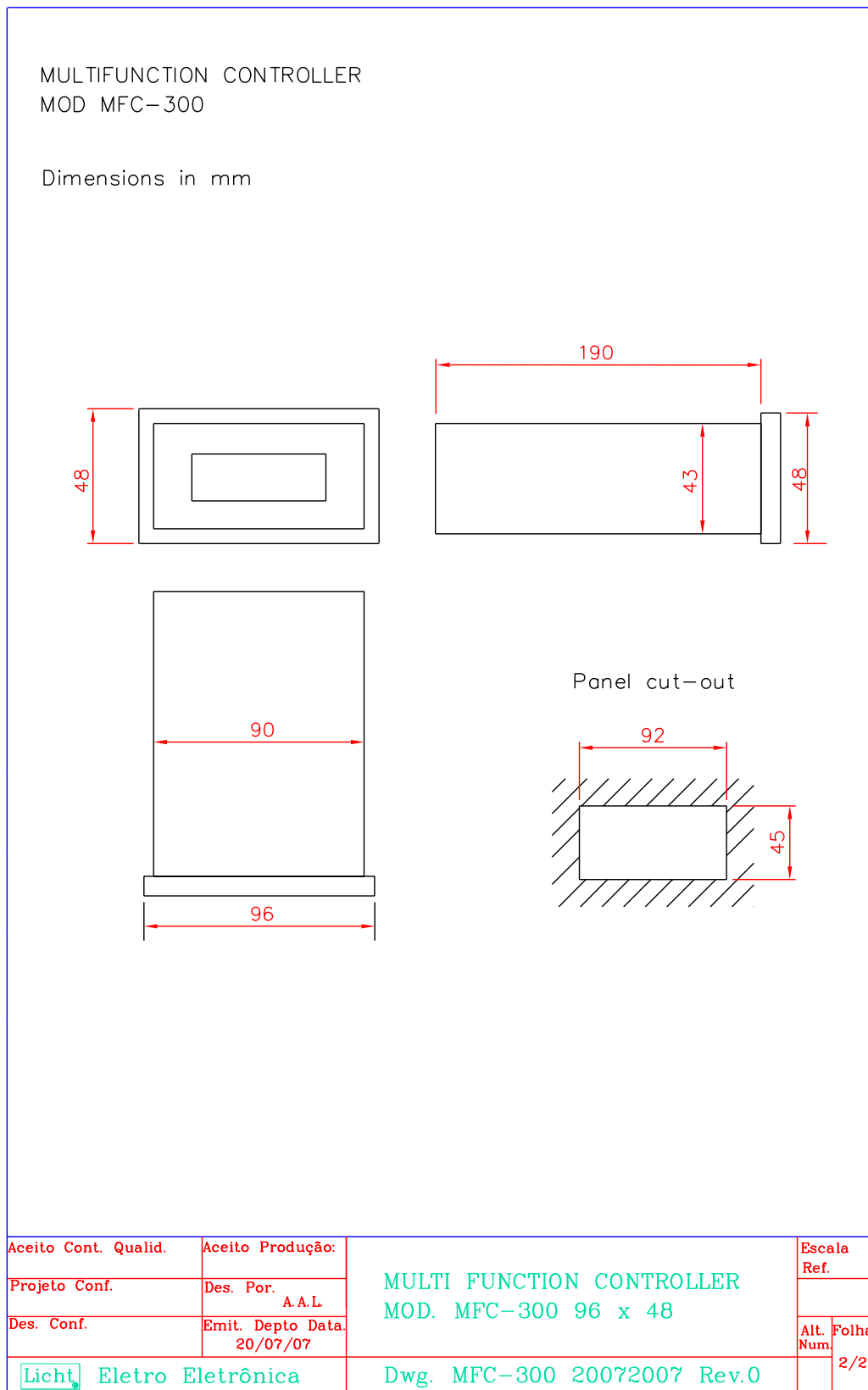
Options: Portuguese (PT_BR), English (EN_US).

Description: Language of the messages and menus displayed on the MFC-300's front panel.

A Specifications

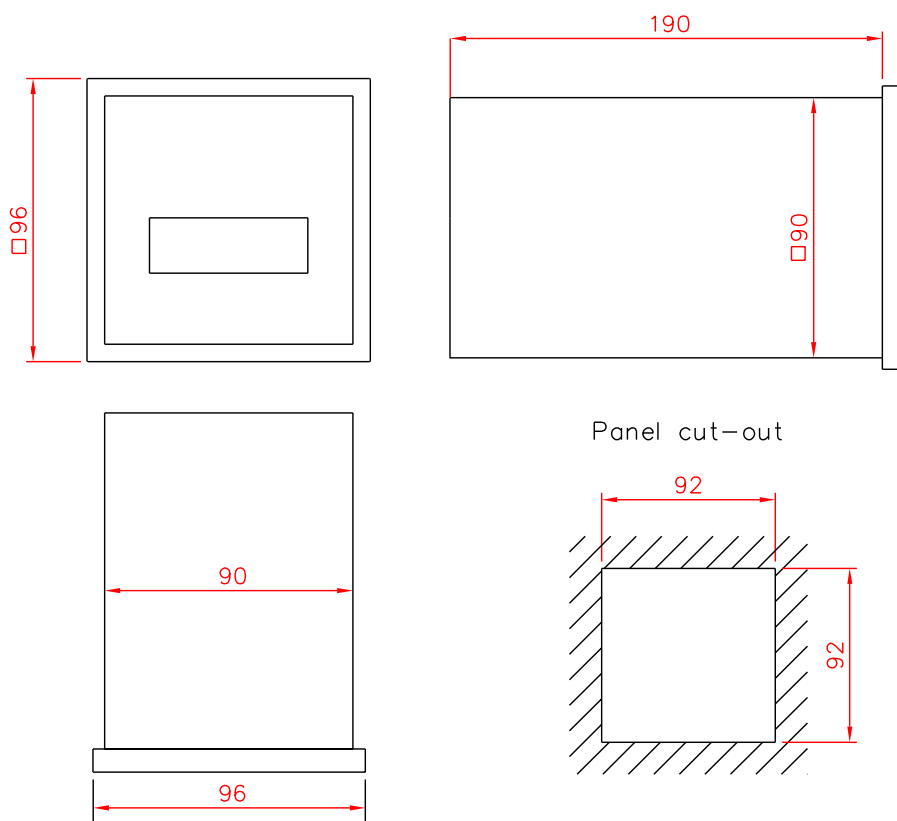
Power Supply	Isolated, 80-260 Vac/Vdc.		
Power Consumption	5 W		
Operating Temperature	-10 to 70 °C (LCD display) -40 to 70 °C (VFD display)		
Enclosure Rating	IP20 (96x48 and 96x96 formats)		
Mounting Options	Panel-mounted		
Dimensions	96 x 96 x 190 mm or 96 x 48 x 190 mm		
Weight	550 g		
DC Input	Scale: specifiable Error/Non-linearity: 0.2% + 0.1% / 10 °C		
AC Input	Scale: specifiable Error/Non-linearity: 0.5% + 0.1% / 10 °C		
Current Output	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.)	DC Input	2.0	kV
	AC Input	2.0	kV
	Current outputs	2.0	kV
	Communication	2.0	kV
	Auxiliary power	2.0	kV
	All terminals - Ground	2.0	kV
	Relay outputs	3.0	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: 3.0 kV, 60 Hz, 1 min.		

B Housing diagrams



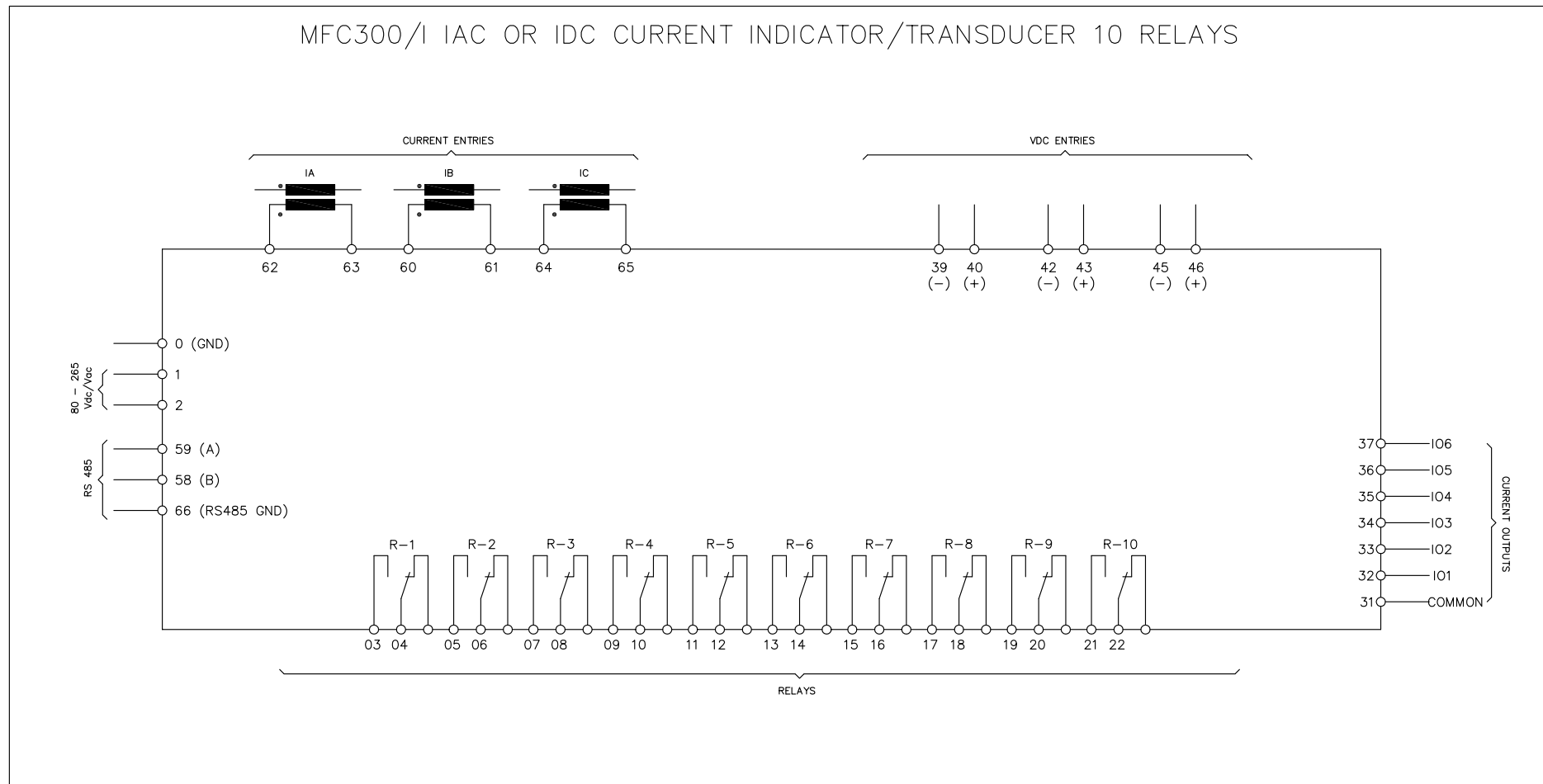
MULTIFUNCTION CONTROLLER
MOD MFC-300

Dimensions in mm



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

C 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 conductor, 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.

D 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 the table of remotely accessible registers.

Holding Register	Description	Values	Multiplier
1-10	Set Point (%) [1-10]	0 to 150 %	1
21-30	Hysteresis (%) [1-10]	0 to 100 %	1
41-50	Timeout [1-10]	0 to 255 seconds.	1
61-70	Associated Channel [1-10]	0: Channel 1 1: Channel 2 2: Channel 3	1
81-90	Forced Activation [1-10]	0: disabled 1: enabled	1
101-110	Activation Logic [1-10]	0: disabled 1: inverted	1
201	Active channels	0: One Channel 1: Two Channels 2: Three Channels	1
202	Sampling Factor	1 to 1000	1
203	AC frequency	0: 60 Hz 1: 50 Hz	1
301	Current Loop - Output Scale	0: 0-1 mA 1: 0-5 mA 2: 0-10 mA 3: 0-20 mA 4: 4-20 mA	1
302	Current Loop - Full Scale	0.01 to 10.00 A	100
501-503	Measured Current in the [1-3] channel	0.000 to 10.000 A	1000



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