MANUFACTURER DOCUMENT PACKAGE

Manufacturer's Manual

SIEMENS SIMATIC S7

6DL3100-8AA

ADDFEM PROFIBUS FRONT-END MODULE

Applicable product family: SIMADYN D and TELEPERM XP systems

OFFICIAL SOURCE

6DL3100-8AA_official.pdf

The following pages are selected from the supplied manufacturer document and retain their original page content.

SIEMENS

Add 7
AddFEM (Front End Module)

Manual Edition 07/2012

Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

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⚠ WARNING

indicates that death or severe personal injury **may** result if proper precautions are not taken.

⚠ CAUTION

indicates that minor personal injury can result if proper precautions are not taken.

NOTICE

indicates that property damage can result if proper precautions are not taken.

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Preface

Product family Add 7

The Add-on products of the Add 7 product family provide a cost-effective solution for the specific high-performance requirements in the field of process control and automation engineering. The design of these products is based on many years of experience in the field of process engineering, and on solid expertise with respect to the current system generation in the Siemens “Totally Integrated Automation“ program.

As part of the Add 7 product family, the AddFEM Front End Module satisfies the special requirements of high-speed turbine control systems (different signal types, redundancy, high-speed detection and signal preparation etc.)

Enhancement to module type 6DL3100-8AC compared to 6DL3100-8AA

6DL3100-8AC offers the option of operating the AddFEM in redundant mode (module redundancy), and/or to process signal preparation functions on the AddFEM.

The AddFEM 6DL3100-8AC can be programmed in RUN using DPV1 services.

Further support

If you have any questions about the use of the products described in this manual and do not find the right answers, please contact your Siemens partner at your local Siemens Office or Agencies.

CE Label

Our products are compliant with EC Directive 2004/108/EC “Electromagnetic Compatibility, EC Directive 73/23/EEC “Low-voltage Directive”, and the European Harmonized Standards specified in those directives (EN).

CE

You can view the EC Declaration of Conformity in the appendix. It is available to responsible authorities, according to the EC Directives mentioned earlier, at:

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1.1 Classification and features

The add-on products of the Add 7 product family provide solutions for specific and high-performance applications in the field of process control and automation engineering.

The Front End Module of the Add 7 product family is tailored to the special requirements of high-speed turbine control systems (different signal types, redundancy, high-speed acquisition and preparation of process data, etc.) AddFEM supports the implementation of loop control systems in the gas-, steam- and water-driven and industrial turbines sector. The AddFEM is also suitable for integrated automation and loop control applications where the emphasis is set on high-speed system reaction times.

The AddFEM offers highly versatile combination options. It supports integration in SIMATIC S7 and SIMATIC PCS 7 systems, and in SPPA-T3000 or SIMADYN D. The AddFEM operates in DP standard slave mode, and is controlled via PROFIBUS DP. The loop control and automation functions are handled as usual by the automation processor.

Signal inputs and outputs

The AddFEM is equipped with analog and digital IOs, including counter inputs for the acquisition of velocity control data.
Due to the optimized composition of signals, and based on an organization by the various signal types, smaller applications can be easily handled by a single AddFEM module. More complex applications, of course, can be handled by integrating several modules.

Each AddFEM provides the following signal inputs and outputs:

- 12 analog inputs, of which six may be operated as current inputs, while the remaining six may be configured in SIMATIC Manager or COM-PROFIBUS for operation as current or voltage inputs
- 8 analog outputs
- 15 digital inputs, of which three are available as counting pulse inputs for the acquisition of velocity control data with and without detection of the rotational direction
- 16 digital outputs, optionally operable as digital inputs

Due to the design of its analog IO measuring ranges, the AddFEM does not require any additional signal transducers when operated in turbine loop control systems. In addition to the usual measuring ranges 0 mA to 20 mA, 4 mA to 20 mA and ±20 mA, the module provides a ±30 mA measuring range. An additional ±50 mA measuring range at the analog outputs supports the control of final control element with higher current consumption, such as fuel control valves, without additional signal amplifier.

All analog and digital outputs are short circuit-proof and monitored, and can be wired in parallel with other outputs. The analog and digital circuits are electrically isolated.

For further technical specifications of the IO, refer to section 4.

Higher availability due to redundancy

Redundancy in this context refers to the integration of a "1 of 2" structure. Availability is enhanced by means of parallel operation of two AddFEM modules. If one AddFEM fails as a result of error, the standby module automatically takes over the functions.

Redundancy of an AddFEM 6DL3100-8AA is controlled by the integrated functions in the automation processor configuration. In contrast, this redundancy control is integrated in the system performance of an AddFEM 6DL3100-8AB/-8AC. The redundancy coupling function on this module is implemented by a fiber optic interface which is used to transfer the status and update data. The extensive, integrated redundancy mechanisms and self-diagnostics functions of AddFEM support automatic error detection and redundant changeover, without any user intervention.

Redundant PROFIBUS DP connection

The AddFEM is equipped with two PROFIBUS DP interfaces (DP A and DP B) which operate in parallel which support the implementation of redundant system structures. All process input data are routed to both PROFIBUS DP interfaces, whereas only the process output data of the currently active DP interface are passed to the output pins. The process output data of the currently passive DP interface are analyzed for the purpose of monitoring. The master standby status of both DP interfaces, i.e. the definition of which DP interface is active or passive with respect to the output data can be set by the automation processor.

Preparation functions

Certain partial automation functions, such as the position control of turbine loop control circuits, can be swapped to the AddFEM as preparation functions. These functions are referred to as front-end function (FEF.)

GSD file

The PROFIBUS DP parameters and properties of the IO (measuring ranges, filtering, for example) of an AddFEM operated on SIMATIC S7 and SIMATIC PCS 7 systems can be set in SIMATIC Manager using HW Config. When operated on a SIMADYN-D system, the corresponding settings are programmed using the COM-PROFIBUS software package.

For information on using the GSD file, refer to the “readme.pdf“ on your AddFEM CD.

Module power supply

The AddFEM power supply is designed to operate at a rated voltage of 24 V DC, and at a typical current consumption of 20 W. Voltage dips with a duration of at least 10 ms are buffered. The inrush current is limited to 3 A.
The AddFEM is equipped with an internal 24 V DC power supply for the analog outputs. The 24 V DC load voltage for the digital outputs must be generated by an external power supply which is wired to the X7 connectors.

Design

The AddFEM enclosure is made of stainless steel, and is prepared for screw-mounting or rail mounting.

The signal state of the digital IO is indicated by signal LEDs.

The operating and error states of AddFEM are indicated at 12 separate LEDs. The mode of operation is set by means of a key switch and slider.

The AddFEM front panel features eight 10-pin connectors (total of 80 IO pins) for the connection of process IO signals.

Certifications

In addition to the CE label, the AddFEM is also certified to UL/CSA.

1.1.1 Enhancement of 6DL3100-8AC variant (compared to -8AA/-8AB)

The enhanced DPV1 services of AddFEM are in particular suitable to provide dynamic parameter data (in acyclic mode) to the front-end functions (FEF.) These enhanced functions also support configuration changes in Run (= CiR = Configuration in RUN). CiR lets you reconfigure AddFEM parameters, such as enabling unused channels, or editing the parameters of active channels when using sensors with different technical specifications. The functionality also includes an option of reporting alarms with implicit acknowledgment mechanism for use by the front-end functions.

3.1 General functions

Introduction

Disruptions or errors should be detected, localized and reported within the shortest possible time. The AddFEM performs a full self-test after POWER ON (Run Up Self Test), and periodically in normal cyclic operation (Cycle Self Test.)
(see "Technical specifications", section 4.2)

Self-tests/inherent monitoring function:

Components and functions included in the test:
- RAM test
- RAM checksum test (calibration data, program code)
- FEPROM checksum test (calibration data, program code)

Self-tests in cyclic mode

Certain self-test operations must be synchronized with the I/O cycle, and are thus part of this cycle.
Self-tests within the IO cycle:
- RAM test
- PROFIBUS functionality
- Data transfer host <-> AddFEM
- Data transfer <-> redundant AddFEMs
- Cycle times
- Power supply
- Channel errors of process IO
- Coprocessor monitoring by master processor

Delayed shutoff

After a brief host failure or loss of PROFIBUS DP communications, the process outputs will be shut down if a programmable tolerance time is exceeded.
This tolerance time can be set within a range from 10 ms to 3 s.
The default is 0.5 s.
(see section 5.6.1 "Adjustable parameters”)

Analog input signal filters

The analog input signals can be filtered digitally. The system provides 50 Hz, 60 Hz, 16 $^{2/3}$ Hz and 500 Hz* line filters. The filter parameters are set separately for each analog input (channel-specific) in the parameter frame. Options:

- no filtering
- 50 Hz
- 60 Hz
- 16 $^{2/3}$ Hz
- 500 Hz*

Default is "Turned off", which means no filtering.

* Configurable as of version 14 of 6DL3100-8AC

3.2 Operating principle of 2-channel speed monitoring with detection of the rotational direction

Channels 1 and 2 of AddFEM 6DL3100-8AA version 8 or higher, or ADFEM 6DL3100-8AB/-8AC version 7 or higher can be operated in frequency counting mode with detection of the rotational direction. This function requires the connection of a suitable (dual-channel) encoder to channels 1 and 2. The leading signal is connected to channel 1, and the lagging signal to channel 2.

Channel 3 can be used as separate, additional single-channel monitoring function, without detection of the rotational direction.

The (signed) frequency recorded in dual-channel mode is indicated at both channels 1 and 2 as follows:

The system calculates the value of the indicated frequency separately for each channel, based on the pulses of the connected encoder. The sign (rotational direction) is determined by the phase offset of both channels and assigned to the channels accordingly.

Reaction to the failure of one of the two encoders:

If one of the two signals is lost, the velocity value of the faulty channel is stepped down to zero as in single-channel recording mode (see section 4 "Technical specifications".) The system freezes the sign status according to its value prior to the error. This method upholds the detection of the velocity at a single channel after an error has occurred. However, reversals of the rotational direction can no longer be detected.

Wire breaks can be detected by means of a parity check of the channel signals, for example. However, allowances must be made in this parity check for differences between the channel signals caused by mechanical inaccuracy in the velocity sensor (tooth edges) and acceleration (see the next section.) Due to the many possible applications, the channel-specific wire break detection cannot be configured on the module, but rather in plant-specific parameters on the host system.

Information about refreshing and possible velocity differences of both channels:

The internal algorithm of the module always calculates the frequency (for measuring the period) based on signal transitions, and thus at different times at the two "phase-shifted" encoders.
Velocity changes will therefore cause a slight deviation of the values indicated at channels 1 and 2, because one of the channels will always return (in alternating mode) the more recent value. The timeliness and accuracy can be increased in particular in the lower velocity range by forming an average of both channel values.

Allowances must be made for the following velocity difference (nf) between both channels caused by acceleration actions:

$\Delta f = \sqrt{(f^2 + a)} - f$ (at frequencies ≤ 125 Hz)
(a = acceleration, f = frequency)

$\Delta f = a * 2\ ms$ (at frequencies > 125 Hz)

Note: Simplified formula for encoders with detection of the rotational direction and channels operating at a phase shift of 90°.

3.3 Operating modes

System configurations

The AddFEM can be configured for operation in stand-alone or redundant mode on one or two PROFIBUS DP channels. There are four available system configurations. The configuration must be programmed. See also 5.6.1 “Adjustable parameters”.

The AddFEM module does not automatically detect and adapt a configuration. The mode of operation is set up on the AddFEM using a PROFIBUS DP parameter frame, and is determined by the required system configuration.

Note:
The basic setting selected for the AddFEM redundancy mode supports the replacement of a 6DL3100-8A**A** module with a 6DL3100-8A**B**/-8A**C** module without conversion of the configuration.

Setting the mode of operation

When using SIMATIC S7, you can configure the PROFIBUS DP parameters in HW-Config of SIMATIC Manager. Use the COM-PROFIBUS software package to make the corresponding settings for other systems.

Mode	Host	AddFEM	PROFIBUS
0	single-channel	single-channel	1 PROFIBUS DP segment
1	redundant	single-channel	2 PROFIBUS DP segments
2	single-channel	Redundant	1 PROFIBUS DP segment
3	redundant	Redundant	2 PROFIBUS DP segment

Note

After POWER ON, the AddFEM holds the STARTUP (LED RUN flashes) state until its operating mode parameters are set (see section 5.6.1).

System configurations

Mode 0

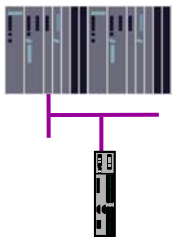

Fig. 3-1 Mode 0

- SIMATIC AS-400, stand-alone with CPU 416,CPU 417
- AddFEM in non-redundant mode
- PROFIBUS DP integration only via PROFIBUS DP interface X3**A**

Mode 1

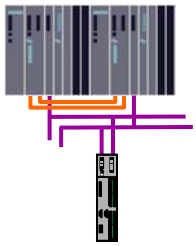

Fig. 3-2 Mode 1

- SIMATIC AS-400, redundant with CPU 417-H
- AddFEM in non-redundant mode
- PROFIBUS DP connection via PROFIBUS DP interface X3**A** and PROFIBUS DP interface X3**B**

Mode 2

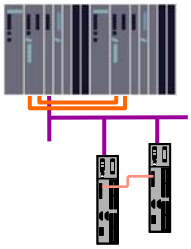

Fig. 3-3 Mode 2

- SIMATIC AS-400, stand-alone (CPU 416, CPU 417) or ....
- SIMATIC AS-400, redundant with CPU 417-H
- AddFEM with redundant connection via fiber optic cable
- PROFIBUS DP integration of each only via PROFIBUS DP interface X3**A**

Mode 3

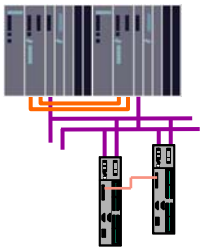

Fig. 3-4 Mode 3

- SIMATIC AS-400, redundant with CPU 417-H
- AddFEM with redundant connection via fiber optic cable
- PROFIBUS DP integration with PROFIBUS DP interface X3**A** and PROFIBUS DP interface X3**B**

Digital inputs (channels 17 to 32) Depending on the configuration, the pins of connector X7 can be operated as digital output or as digital inputs (channels 17 to 32). Below are the technical specifications of these pins when used as digital inputs.	
Number of inputs	16
Type of input to IEC 61131-2	Type 1
Voltage range	- 30 V to + 30 V DC
0 signal level	- 30 V to + 5 V
1 signal level	+ 11 V to + 30 V
48 V contact voltage	no
Connection of BEROs supported	no
Input current	~0.34 mA at 11 V / ~0.84 mA at 24 V
Delay time (TID)	50 µs at 0 to 1 signal transition 50 µs at 1 to 0 signal transition
Displays	Front panel LEDs indicate the converted values read by the internal microcontroller unit.
Terminal assignments	See appendix A.1, connector X7, page A-2

Count pulse inputs [1] (channels 1 to 3)	
Number of inputs	3
Type of input to IEC 61131-2	Type 1 / 2
Voltage range	- 28 V DC to + 28 V DC
0 signal level	- 28 V to + 3 V
1 signal level	+ 8 V to + 28 V
Demand factor when operated at a voltage > 26 V	The count pulse inputs are also specifically designed to handle low input voltages (high signal detection => 8 V.) To limit power losses, either the input voltage must be limited to 26 V, or a 60% pulse/pause ratio with a maximum pulse width of 1 minute must be maintained, or only two of the three inputs may be set high at any given time.
Load	1 kΩ to 3 kΩ
Current/ voltage profile across the working range	See Fig. 4-1!
Dealy time (TID)	50 µs at 0 > 1 signal transition 50 µs at 1 > 0 signal transition
Cyclic evaluation of all signals	2 ms Noise pulses < 10.667 µs are suppressed by filtering. Additional hardware evaluation by counters.
Input frequency (f_{in})	0 kHz to 20 kHz
Counter resolution	32 bit
Measuring accuracy	better than 10^{-4} of measrued value
Refresh interval	2 ms
Measuring time at frequencies < 800 Hz	20 ms
Filter	At each refresh scan cycle point, the system recalculates the frequency based on a mean value derived from the count pulses logged within the last 20 ms.
Detection of the rotational direction	The rotational direction can be determined by coupling channels 1 and 2. See section 3.2 (supported as of version 8 of 6DL3100-8AA, version 7 of 6DL3100-8AB, and by all versions of 6DL3100-8AC)
Displays	Front panel LEDs; indicate the converted values read by the internal microcontroller unit.
Terminal assignments	See appendix A, connector X6, page A-2

[1] Count pulse inputs may also be used as digital inputs!

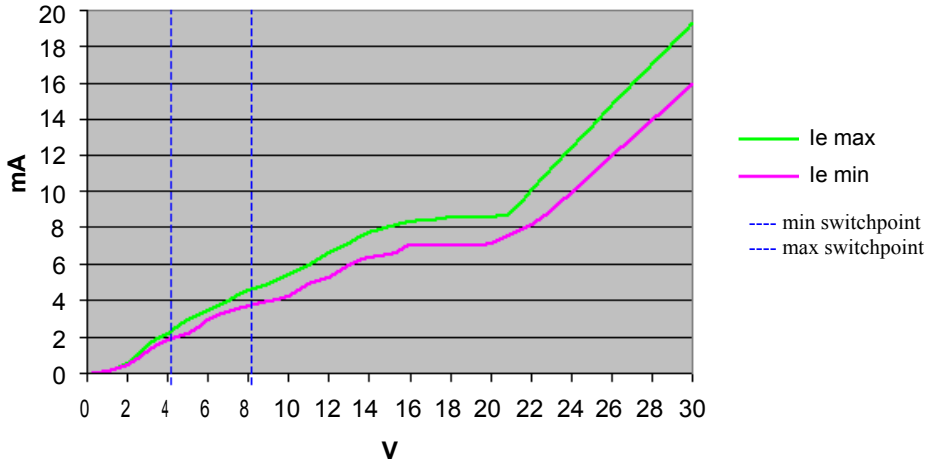

Fig. 4-2 Count pulse inputs, current-/voltage diagramm including tolerances of input current Ie

Reaction of the count pulse/rotational direction detection functions to interruption of the pulses (due to wire break, for example)

A) Single-channel mode (without rotational direction detection)
(applies to 6DL3100-8AA/-8AB version 7 or higher, and to all 6DL3100-8AC)

Frequency output will be limited according to the period of the last recorded pulse if no more count pulses are received. The limit frequency F is derived from the period T since the last pulse by the formula

F= 1/(T-dead time) * 1.5

The dead time of 0 ms to max. 2 ms is derived from the detection cycle time.

In practical life, we derive the limit frequencies from the output limit (see the table below), provided the original frequency measured prior to the pulse failure was higher.

The value will be set to zero on expiration of 10 s. (frequencies below 0.1 Hz are not recorded.)

Interval T since last pulse	Limiting of frequency output to the values listed below
0 ms to max. 2 ms	Old frequency is retained. At a detection cycle =< 2 ms, a missing pulse can not be detected.
2 ms to max. 4 ms	Limiting to max. 750 Hz
4 ms to max. 6 ms	Limiting to max. 375 Hz
8 ms to max. 10 ms	Limiting to max. 187.5 Hz
18 ms to max. 20 ms	Limiting to max. 83.3 Hz
48 ms to max. 50 ms	Limiting to max. 31.3 Hz
98 ms to max. 100 ms	Limiting to max. 15.3 Hz
0.998 s to max. 1 s	Limiting to max. 1.5 Hz
9.998 s to max 10 s	Limiting to max. 0.15 Hz
> 10 s	Output will be set to 0, i.e. frequencies below 0.1 Hz will not be recorded, or always set to 0.

B) Reaction of the dual-channel count pulse / velocity detection

(with detection of the rotational direction) to channel failure:
(applies to 6DL3100-8AA version 8 or higher; 6DL3100-8AB version 7 or higher, and all 6DL3100-8AC)

If one of the two channels fails, the velocity value is stepped down to zero as in single-channel detection. The sign is frozen at the state it had prior to the error event. It is thus still possible to detect the velocity using only one channel, however, without detection of any changes in the rotational direction.

Note

For information on wire break monitoring, refer to section 3.2, ”Operating principle of 2-channel speed monitoring with detection of the rotational direction"

WARNING

False signal acquisition when using old firmware versions and a wire break occurs

If modules with obsolete versions for count pulse/speed measurement with detection of rotational direction (e.g., for use of water turbines) are used, in the event of a sensor failure or wire break the speed and rotational direction may no longer be correctly detected at times.

This may cause property damage depending on the process control.

For speed measurement and rotational direction detection, use only modules with the following versions (or later):

6DL3100-8AA: Version 8
6DL3100-8AB: Version 7
6DL3100-8AC: All versions are permissible

Digital outputs [1]	
Number of outputs	16 digital semiconductor outputs
Rated output voltage	DC 24 V
Output voltage at 0 signal	< 1 V
Output voltage at 1 signal	supply voltage – 2 V
Max. output current	500 mA Parallel wiring of outputs for higher currents is supported.
Output current at 100% demand factor	500 mA
Cumulative output current	8 A
Effect of repeated overload on multi-circuit modules	none
Monitoring of short-circuit to M	yes
Short circuit-proof	yes
Max. lamp load per output	5 W
Inductive loads Typical values: Max. inductivity at I ≤ 500 mA and f ≤ 1 Hz Max. inductivity at I < 250 mA and any f Max. inductivity with external suppression diode	Connection of inductive loads is supported. Compared to standard suppression diodes, the suppression voltage of integrated suppression diodes is increased by 39 V, and accelerate the shutoff of the current and, thus, of the final control element. However, the maximum suppression power (1 W) may not be exceeded. 8 H (without external suppression diode) unlimited unlimited
Output delay (TQD, Totzeit) between command output and response of the output (start of current rise)	20 µs at 0 > 1 signal transitions 20 µs at 1 to 0 signal transitions
Output response time (TQT) between command output and transient state of the output current at 500 mA	50 µs at 0 > 1 signal transitions 50 µs at 1 > 0 signal transitions
Reaction to the interruption of runtime controlled by the master processing unit	Shutoff of the outputs
Reaction to dips and interruption of the power supplies L1+ or L2+ at X7/1 or X7/11	The output voltage follows the supply voltage.
Displays	The voltage level of the digital outputs is logged by the internal digital inputs of the module, and is then converted and read by the internal microcontroller unit. The microcontroller unit outputs the read states to the front panel LEDs.
Terminal assignments	See appendix A.1, connector X7, page A-2

[1] Digital outputs may also be used as digital inputs!

Analog outputs	
Number of analog outputs	8
Max. error at 25°C	± 0.15 %
Temperature coefficient	± 100 ppm / K
Max. error across the temperature range	± 0.4 %
Value of the least significant bit (LSB)	13 bit + sign
Value of the least significant bit (LSB)	8 µA
Total system transfer time (TAQD + TAQT)	1 ms
Transient time across the full range	0.6 ms
Overshoot	0.2 %
Max. short-term offset during any defined electrical error test	See EMC data (section 4.2)
Terminal assignments	See appendix A.1, connector X4, page A-1
Max. permitted inductive load	1 H
Power Off operations	Buffer time up to 10 ms. With prolonged failure, power on is determined by software functions
Conversion method	parallel conversion of all 8 output channels
Current output range unipolar / overflow range / load	0 ... 20 mA / ± 23.5 mA / 480 Ω 4 ... 20 mA / – 4,96 bis + 22,96 mA /480 Ω
Current output range bipolar / overflow range / load	± 20 mA / ± 23.5 mA / 480 Ω ± 30 mA / ± 35.55 mA / 300 Ω
Current output bipolar (only channels 1 to 4) [1)]	± 50 mA / ± 59.26 mA / 150 Ω
Output current monitoring tolerance	4 %
Cross-talk between channels at: DC 50 Hz 60 Hz	 ≤ 60 dB ≤ 60 dB ≤ 60 dB
Non-linearity	± 0.1 %
Output ripple	± 0.1 %

1) In order to protect the module, the analog outputs 1 to 4 are limited to an average load of 40 mA. The extension of the current range of those outputs to 50 mA / 59.26 mA is only intended for the control of final control elements with integral action. A max. current of 59,26 mA is provided to this purpose for a limited time.
The current is monitored by the software and limited as follows.
Mean value limiting: At a current output programmed for operation at ±50 mA, the mean value of the output current is calculated based on a delay element of the first order which has a time constant of 10 s. If the current exceed a mean value of 40 mA, both the output current and its mean value will be limited to ±40 mA.