MiCOM C232

Compact Bay Unit for Control and Monitoring with Protection Functions

Version –302–401/402/403/404–603

Technical Manual

C232/EN M/A23

Volume 1.1

Compact Bay Unit for Control and Monitoring with integrated Protection Functions C232

Version -302-401/402/403/404-603

⚠ Warning

When electrical equipment is in operation, dangerous voltage will be present in certain parts of the equipment. Failure to observe warning notices, incorrect use, or improper use may endanger personnel and equipment and cause personal injury or physical damage.

Before working in the terminal strip area, the device must be isolated. Where stranded conductors are used, wire end ferrules must be employed.

Proper and safe operation of this device depends on appropriate shipping and handling, proper storage, installation and commissioning, and on careful operation, maintenance and servicing.

For this reason only qualified personnel may work on or operate this device.

Qualified Personnel

are individuals who

- are familiar with the installation, commissioning, and operation of the device and of the system to which it is being connected;
- are able to perform switching operations in accordance with safety engineering standards and are authorized to energize and de-energize equipment and to isolate, ground, and label it;
- are trained in the care and use of safety apparatus in accordance with safety engineering standards;
- are trained in emergency procedures (first aid).

Note

The operating manual for this device gives instructions for its installation, commissioning, and operation. However, the manual cannot cover all conceivable circumstances or include detailed information on all topics. In the event of questions or specific problems, do not take any action without proper authorization. Contact the appropriate AREVA technical sales office and request the necessary information.

Any agreements, commitments, and legal relationships and any obligations on the part of AREVA, including settlement of warranties, result solely from the applicable purchase contract, which is not affected by the contents of the operating manual.

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We

(Name des Anbieters / supplier's name)

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D-60528 Frankfurt
(Anschrift / address)

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erklären in alleiniger Verantwortung, daß das Produkt
declare under our sole responsibility that the product

Kompakte Feldeinheit für Steuerung und Überwachung
Compact Bay Unit for Control and Monitoring

MiCOM C232

alle Ausführungen
all versions

auf das sich diese Erklärung bezieht, mit den folgenden Normen oder den normativen Dokumenten übereinstimmt:
to which this declaration relates is in conformity with the following standards or normative documents:

DIN EN 60870-2-1, Juli 1997
DIN EN 61010 Teil 1, März 1994

Gemäß den Bestimmungen der Richtlinien / Following the provisions of Directives

89/336/EWG, Elektromagnetische Verträglichkeit
mit allen Änderungen bis einschließlich 93/68/EWG
89/336/EEC, EMC Directive, with all amendments up to and including 93/68/EEC

73/23/EWG, Elektrische Betriebsmittel zur Verwendung innerhalb bestimmter Spannungsgrenzen
mit allen Änderungen bis einschließlich 93/68/EWG
73/23/EEC, Low Voltage Directive, with all amendments up to and including 93/68/EEC

Frankfurt am Main, 19.08.2004

(Ort und Datum der Ausstellung / Place and date of issue)

Hauser | Bennauer

(Name und Unterschrift der Befugten / name and signature of authorized person)

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Certificate Nr 0059-2002-FR-COFRAC-QUA-05 Rév. 2

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Chassieu le 2004-02-05
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This certificate and annexe are valid until : 2005-01-10
For DET NORSKE VERITAS CERTIFICATION FRANCE

Jacques MANGON

President

Eric SALAÜN

General Manager

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Modifications After Going to Press

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1 Application and Scope

1 Application and Scope

The C232 bay unit integrates control and protection (model 4 only) into one single device (One-box solution).

The unit’s protection functions provide selective short-circuit protection in medium- and high-voltage systems. The systems can be operated as impedance-grounded, resonant-grounded, or isolated-neutral systems.

The control functions are designed for the control of up to six electrically operated switchgear units equipped with electrical check-back signaling located in the bay of a medium-voltage substation or a non-complex high-voltage station. External auxiliary devices are largely obviated by the integration of binary inputs and power outputs that are independent of auxiliary voltages, by the direct connection option for current and voltage transformers, and by the comprehensive interlocking capability. This simplifies the handling of switchbay protection and control technology from planning to commissioning.

During operation, the user-friendly interface makes it easy to set the unit and allows safe operation of the substation by preventing non-permissible switching operations.

The C232 has the following general functions:

Control functions

- ❑ Control and monitoring of up to six switchgear units
- ❑ Selection from over 200 pre-defined bay types
- ❑ Bay interlock
- ❑ Tap changer controller
- ❑ Local control and display via user-selected panels on the LCD display:
  - Bay Panel
  - Measured Value Panel
  - Signal Panel

Protection functions

- ❑ Optional Three-pole measurement (A, B, C) + voltage or current measurement
- ❑ Definite-time overcurrent protection, three stages, phase-selective (model 4 only)
- ❑ Inverse-time overcurrent protection, single-stage, phase-selective (model 4 only)
- ❑ Limit value monitoring
- ❑ Programmable Logic
- ❑ 0..20 mA interface (option)

The user can select all general functions individually for inclusion in the device configuration or cancel them as desired. By means of a straightforward configuration procedure, the user can adapt the device flexibly to the scope of protection required in each particular application. The unit’s powerful, freely configurable logic also makes it possible to accommodate special applications.

Global functions

In addition to the features listed above, as well as comprehensive self-monitoring, the following global functions are available in the C232:

- Parameter subset selection (model 4 only)
- Operating data recording (time-tagged signal logging)
- Fault data acquisition (model 4 only)
- Fault recording (time-tagged signal logging together with fault value recording of the three phase currents, the residual current as well as the three phase-to-ground voltages and the neutral-point displacement voltage)

Design

The C232 is housed in an aluminum case with threaded terminal ends in the form of plug-in blocks and with reversible mounting brackets. The case is equally suitable for surface mounting of flush panel mounting.

Inputs and outputs

The C232 has the following inputs and outputs:

- Up to 4 current-measuring inputs (option)
- Up to 14 output relays with freely configurable function assignment
- Up to 20 optical coupler inputs for binary signals with freely configurable function assignment for single signals
- 1 analog input, 0 to 20 mA (optional)

With the maximum number of binary inputs and outputs fitted, 6 switchgear units can be monitored and 6 of these can be electrically controllable.

The nominal voltage range of the optical coupler inputs is 24 to 250 V DC without internal switching. The auxiliary voltage input for the power supply is a wide-range design. The nominal voltage ranges are 48 to 250 V DC and 100 to 230 V AC.

All output relays are suitable for both signals and commands. Nominal voltages and currents of the measuring inputs has to be defined by using the appropriate order code.

The optional 0 to 20 mA input provides open-circuit and overload monitoring, zero suppression defined by a setting, plus the option of linearizing the input variable via 20 adjustable interpolation points.

Interfaces

Local control and display:

- Local control panel with LCD display (16 lines of 21 characters each with a resolution of 128 x 128 pixels)
- 13 LED indicators, 8 of which allow freely configurable function assignment
- PC interface
- Communication interface(s) for connection to a substation control system or for remote setting (optional)

Information is exchanged through the local control panel, the PC interface, or the optional communication interfaces.

The communication interface (COMM1) is designed to conform either to international standard IEC 60870-5-103 or to IEC 60870-5-101, MODBUS, or DNP 3.0. The C232 can be integrated into a substation control system through this communication interface.

2 Technical Data

2 Technical Data

2.1 Conformity

Notice

Applicable to C232, version -302 – 401 / 402 / 403 / 404 - 602.

Declaration of conformity

(Per Article 10 of EC Directive 72/73/EC.)
The product designated ‘C232 Compact Bay Unit’ has been designed and manufactured in conformance with the European standards EN 60255-6 and EN 61010-1 and with the ‘EMC Directive’ and the ‘Low Voltage Directive’ issued by the Council of the European Community.

2.2 General Data

General device data

<u>Design</u>
Extruded aluminum case with cover plate for wall installation or flush panel mounting

<u>Installation Position</u>
Vertical ±30°

<u>Degree of Protection</u>
Per DIN VDE 0470 and EN 60529 or IEC 529.
Case and Terminals: IP 20
Front panel, flush-mounted: IP 51

<u>Weight</u>
Up to 3,5 kg

<u>Dimensions and Connections</u>
See dimensional drawings (Chapter 4) and terminal connection diagrams (Appendix E).

<u>Terminals</u>

PC Interface (X6):
DIN 41652 connector, type D-Sub, 9-pin.

Communication Interface:

Optical fibers (X7 and X8):	F-SMA optical fiber connection per IEC 874-2 or DIN 47258 (plastic fiber) or BFOC (ST®) fiber-optic connection for glass fiber (ST® is a registered trademark of AT&T Lightguide Cable Connectors)
or	
Leads (X9, X10):	M2 threaded terminal ends for wire cross sections to 1.5 mm^2.

Current- and Voltage Measuring Inputs:
M5 threaded terminal ends, self-centering with wire protection for conductor cross sections 0.5 to 6 mm^2.

Other Inputs and Outputs:
M3 threaded terminal ends, self-centering with wire protection for conductor cross sections from 0.2 to 2.5 mm^2.

Creepage Distances and Clearances
Per EN 61010-1 § and IEC 664-1
Pollution degree 3, working voltage 250 V,
overvoltage category III, impulse test voltage 5 kV.

2.3 Tests

2.3.1 Type Test

Type tests

Tests per EN 60255-6 § or IEC 255-6.

EMC

Interference Suppression
Per EN 55022 § or IEC CISPR 22, Class A.

1 MHz Burst Disturbance Test
Per IEC 255 Part 22-1 § or IEC 60255-22-1, Class III.
Common-mode test voltage: 2.5 kV
Differential test voltage: 1.0 kV
Test duration: > 2 s
Source impedance: 200 Ω

Immunity to Electrostatic Discharge
Per EN 60255-22-2 § or IEC 60255-22-2, severity level 3.
Contact discharge,
single discharges: > 10
Holding time: > 5 s
Test voltage: 6 kV
Test generator: 50 to 100 MΩ, 150 pF / 330 Ω

Immunity to Radiated Electromagnetic Energy
Per EN 61000-4-3 § and ENV 50204 §, severity level 3.
Antenna distance to tested device: > 1 m on all sides
Test field strength, frequency band 80 to 1000 MHz: 10 V/m
Test using AM: 1 kHz / 80 %
Single test at 900 MHz: AM 200 Hz / 100%

Electrical Fast Transient or Burst Requirements
Per EN 61000-4-4 § or IEC 60255-22-4, severity levels 3 and 4.
Rise time of one pulse: 5 ns
Impulse duration (50% value): 50 ns
Amplitude: 2 kV / 1 kV or 4 kV / 2 kV
Burst duration: 15 ms
Burst period: 300 ms
Burst frequency: 5 kHz or 2.5 kHz
Source impedance: 50 Ω

§ For this EN, ENV, or IEC standard, the DIN EN, DIN ENV or DIN IEC edition respectively, was used in the test.

Surge Immunity Test
Per EN 61000-4-5 § or IEC 61000-4-5, insulation class 4.
Testing of circuits for power supply and unsymmetrical or symmetrical lines.
Open-circuit voltage, front time / time to half-value: 1.2 / 50 µs
Short-circuit current, front time / time to half-value: 8 / 20 µs
Amplitude: 4 / 2 kV
Pulse frequency: > 5 / min
Source impedance: 12 / 42 Ω

Immunity to Conducted Disturbances Induced by Radio Frequency Fields
Per EN 61000-4-6 § or IEC 61000-4-6, severity level 3.
Prüfspannung: 10 V.

Power Frequency Magnetic Field Immunity
Per EN 61000-4-8 § or IEC 61000-4-8, severity level 4.
Frequenz: 50 Hz,
Feldstärke: 30 A / m.

Alternating Component (Ripple) in DC Auxiliary Energizing Quantity
Per IEC 255-11.
12 %.

Insulation

Voltage Test
Per EN 61010-1 § and IEC 255-5.
2 kV AC, 60 s.
Direct voltage (2.8 kV DC) must be used for the voltage test of the power supply inputs.
The PC interface must not be subjected to the voltage test.

Impulse Voltage Withstand Test
Per IEC 255-5.
Front time: 1.2 µs,
Time to half-value: 50 µs
Peak value: 5 kV
Source impedance: 500 Ω

Mechanical robustness

Vibration Test
Per EN 60255-21-1 § or IEC 255-21-1, test severity class 1.
Frequency range in operation: 10 to 60 Hz, 0.035 mm, and 60 to 150 Hz, 0.5 g
Frequency range during transport: 10 to 150 Hz, 1 g

Shock Response and Withstand Test,
Bump Test
Per EN 60255-21-2 § or IEC 255-21-2, test severity class 1.
Acceleration: 5 g / 15 g
Pulse duration: 11 ms

Seismic Test
Per EN 60255-21-3,§ test procedure A, class 1
Frequency range:
5 to 8 Hz, 3.5 mm / 1.5 mm, 8 to 35 Hz, 10 / 5 m/s^2, 3 x 1 cycle

2.3.2 Routine Test

All tests per EN 60255-6§ or IEC 255-6
and DIN 57435 part 303.

Voltage Test
Per IEC 255-5.
2.2 kV AC or 2.8 kV DC, 1 s.
Direct voltage (2.8 kV DC) must be used for the voltage test of the power supply inputs.
The PC interface must not be subjected to the voltage test.

Additional Thermal Test
100% controlled thermal endurance test, inputs loaded

2.4 Environmental Conditions

Environment

Temperatures
Recommended temperature range: -5°C to +55°C or +23°F to +131°F.
Limit temperature range: -25°C to +70°C or -13°F to +158°F.

Ambient Humidity Range
≤ 75 % relative humidity (annual mean),
56 days at ≤ 95 % relative humidity and 40°C or 104°F, condensation not permissible.

Solar Radiation
Direct solar radiation on the front of the device must be avoided.

2.5 Inputs and Outputs

Measurement inputs

Current
Nominal current I_{nom}: 1 and 5 A AC (per order).
Nominal consumption per phase: < 0.1 VA at I_{nom}.
Load rating:
continuous 4 I_{nom}
for 10 s: 30 I_{nom}
for 1 s: 100 I_{nom}
Nominal surge current: 250 I_{nom}

Voltage
Nominal voltage V_{nom}: 50 to 130 V AC (adjustable)
Nominal consumption per phase: < 0.3 VA at V_{nom} = 130 V AC
Load rating: continuous 150 V AC

Frequency
Nominal frequency f_{nom}: 50 Hz and 60 Hz (adjustable)
Operating range: 0.95 to 1.05 f_{nom}

Binary signal inputs

Nominal auxiliary voltage $V_{A,nom}$: = 24 to 250 V DC
Operating range: 0.8 to 1.1 $V_{in,nom}$ with a residual ripple of up to 12 % $V_{in,nom}$
Power consumption per input:
V_{in} = 19 to 110 V DC: 0.5 W ± 30 %
V_{in} > 110 V DC: 5 mA ± 30 %

Binary count input

Maximum frequency of 10 Hz with a pulse/interpulse period of 1:1

Direct current input

Input current: 0 to 20 mA
Value range: 0.00 to 1.20 $I_{DC,nom}$ ($I_{DC,nom}$ = 20 mA)
Maximum permissible continuous current: 50 mA
Maximum permissible input current: 17 V
Input load: 250 Ω
Open-circuit monitoring: 0 to 10 mA (adjustable)
Overload monitoring: > 24.8 mA
Zero suppression: 0.000 to 0.200 $I_{DC,nom}$ (adjustable)

Output relays

Rated voltage: 250 V DC, 250 V AC
Continuous current: 8A
Short-duration current: 30 A for 0.5 s
Making capacity: 1000 W (VA) at L/R = 40 ms
Breaking capacity: 0.2 A at 220 V DC and L/R = 40 ms
4 A at 230 V AC and cos φ = 0.4

2.6 Interfaces

Local control panel

Input or output:
More than 12 keys and an LCD display with 16 lines and 21 columns (128 x 128 pixels)

State and fault signals:
13 LED indicators (5 permanently assigned, 8 freely configurable)

PC interface

Transmission rate: 300 to 115 200 baud (adjustable)

Communication interface

The communication module can have two communication channels – depending on the version. Channel 1 is designed for wire connection or fiber optic connection, whereas Channel 2 is intended for wire connection only.
For one channel (COMM1), interface protocols based on IEC 60870-5-103, IEC 60870-5-101, MODBUS, or DNP 3.0 can be set. The second channel (COMM2) can only be operated using the interface protocol based on IEC 60870-5-103.

Wire Leads
Per RS 485 or RS 422, 2 kV isolation
Distance to be bridged:
Point-to-point connection: max. 1200 m
Multipoint connection: max. 100 m

Order Code	Transmission Rate	Interface
- 456 - 925 (one channel available)	300 to 64,000 baud (adjustable)	COMM1
- 456 - 921 (two channels available)	300 to 64,000 baud (adjustable) 300 to 57,600 baud (adjustable)	COMM1 COMM2

Plastic Fiber Connection
Optical wavelength: typically 660 nm
Optical output: min. -7,5 dBm
Optical sensitivity: min. -20 dBm
Optical input: max. -5 dBm
Distance to be bridged:[1)] max. 45 m

Order Code	Transmission Rate	Interface
- 456 - 926 (one channel available)	300 to 64,000 baud (adjustable)	COMM1
- 456 - 922 (two channels available)	300 to 64,000 baud (adjustable) 300 to 57,600 baud (adjustable)	COMM1 COMM2

Glass Fiber Connection G 50/125
Optical wavelength: typically 820 nm
Optical output: min. -19.8 dBm
Optical sensitivity: min. -24 dBm
Optical input: max. -10 dBm
Distance to be bridged:[1)] max. 400 m

Order Code	Transmission Rate	Interface
- 456 - 927 (one channel available)	300 to 64,000 baud (adjustable)	COMM1
- 456 - 924 (two channels available)	300 to 64,000 baud (adjustable) 300 to 57,600 baud (adjustable)	COMM1 COMM2

[1)] Distance to be bridged given identical optical outputs and inputs at both ends, a system reserve of 3 dB, and typical fiber attenuation.

2 Technical Data

(continued)

Glass Fiber Connection G 62,5/125
Optical wavelength: typically 820 nm
Optical output: min. -16 dBm
Optical sensitivity: min. -24 dBm
Optical input: max. -10 dBm
Distance to be bridged:[1)] max. 1.400 m

Order Code	Transmission Rate	Interface
- 456 - 927 (one channel available)	300 to 64,000 baud (adjustable)	COMM1
- 456 - 924 (two channels available)	300 to 64,000 baud (adjustable) 300 to 57,600 baud (adjustable)	COMM1 COMM2

[1)] Distance to be bridged given identical optical outputs and inputs at both ends, a system reserve of 3 dB, and typical fiber attenuation.

2.7 Information Output

Counters, measured data, signals, and indications: see "Address List."

2.8 Settings

Typical characteristic data

Main Function
Minimum output pulse for trip command: 0.1 to 10 s (adjustable)
Output pulse for close command: 0.1 to 10 s (adjustable)

Definite-Time and Inverse-Time Overcurrent Protection
Operate time inclusive of output relay (measured variable from 0 to 2-fold operate value): ≤ 40 ms, approx. 30 ms
Reset time (measured variable from 2-fold operate value to 0): ≤ 40 ms, approx. 30 ms
Starting resetting ratio: approx. 0.95

2.9 Deviations

2.9.1 Deviations of the Operate Values

Definitions

'Reference Conditions'
Sinusoidal signals at nominal frequency f_{nom}, total harmonic distortion ≤ 2 %, ambient temperature 20°C (68°F), and nominal auxiliary voltage $V_{A,nom}$.

'Deviation'
Deviation relative to the setting under reference conditions.

Definite-time and inverse-time overcurrent protection

Phase and Residual Current Stages
Deviation: ± 5 %

Negative-Sequence System Stages
Deviation: ± 5 %

Direct current input

Deviation: ± 1 %

2.9.2 Deviations of the Timer Stages

Definitions

'Reference Conditions'
Sinusoidal signals at nominal frequency f_{nom}, total harmonic distortion ≤ 2 %, ambient temperature 20°C or 68°F, and nominal auxiliary voltage $V_{A,nom}$.

'Deviation'
Deviation relative to the setting under reference conditions.

Definite-time stages

Deviation: ± 1% + 20...40 ms

Inverse-time stages

Deviation where $I \geq 2\ I_{ref}$: ± 5 % +10 to 25 ms
For IEC characteristic 'extremely inverse' and for thermal overload protection: ± 7.5 % + 10 to 20 ms

2.9.3 Deviations of Measured Data Acquisition

Definitions

'Reference Conditions'
Sinusoidal signals at nominal frequency f_{nom}, total harmonic distortion ≤ 2 %, ambient temperature 20°C (68°F), and nominal auxiliary voltage $V_{A,nom}$.

'Deviation'
Deviation relative to the corresponding nominal value under reference conditions.

Operating data measurement

Measuring Input Currents
Deviation: ± 1 %

Measuring Input Voltages
Deviation: ± 0.5 %

Internally Formed Resultant Current and Negative-Sequence System Current
Deviation: ± 2 %

Internally Formed Neutral Displacement Voltage and Voltages of Positive- and Negative-Sequence Systems
Deviation: ± 1 %

Active and reactive power
Deviation: ± 2 % (single pole measurement)

Load angle
Deviation: ± 1°

Frequency
Deviation: ± 10 mHz

Direct Current of Measured Data Input and Output
Deviation: ± 1 %

Fault data

Short-Circuit Current
Deviation: ± 3 %

Internal clock

With free running internal clock:
Deviation: < 1 min/month

With external synchronization (with a synchronization interval ≤ 1 min):
Deviation: < 10 ms

2.10 Recording Functions

Organization of the Recording Memories

Operating data memory

Scope: All signals relating to normal operation; from a total of 334 different logic state signals (see “Operating Data Memory“ in the Address List)
Depth: The 100 most recent signals

Monitoring signal memory

Scope: All signals relating to self-monitoring; from a total of 48 different logic state signals (see “Monitoring Signal Memory“ in the Address List)
Depth: Up to 30 signals

Fault memory

Number: The 8 most recent fault events

Scope for signals:
All signals relating to a fault event; from a total of 1024 different logic state signals (see “Fault Memory“ in the Address List)

Scope for fault values:
Sampled data for all measured currents and voltages

Depth for signals:
200 entries per fault event

Depth for fault values:
Max. number of periods per fault set by the user;
300 periods in total for all faults, that is
6 s (for f_{nom} = 50 Hz) or 5 s (for f_{nom} = 60 Hz)

Resolution of the Recorded Data

Signals

Time resolution: 1 ms

Fault values

Time resolution: 20 sampled values per period

Phase currents

Dynamic range: 100 I_{nom}
Amplitude resolution: 6.1 mA r.m.s. at I_{nom} = 1 A
30.5 mA r.m.s. at I_{nom} = 5 A

Voltages

Dynamic range: 150 V AC

2.11 Power Supply

Power supply

Nominal auxiliary voltage $V_{A,nom}$:
48 to 250 V DC and 100 to 230 V AC

Operating range for direct voltage:
0.8 to 1.15 VA,nom with a residual ripple of up to 12 % VA,nom
Operating range for alternating voltage: 0.8 to 1.15 VA,nom

Nennverbrauch bei U_H = 220 V– und maximaler Bestückung
(Ausgangsstellung/Wirkstellung): max. 20 W
Start-up peak current: < 3 A for duration of 0.25 ms
Stored energy time ≥ 50 ms for interruption of V_A ≥ 220 V DC

2.12 Dimensioning of Current Transformers

The following equation is used for dimensioning a current transformer for the offset maximum primary current:

$$V_{sat} = (R_{nom} + R_i) \cdot n \cdot I_{nom} \geq (R_{op} + R_i) \cdot k \cdot I'_{1,max}$$

where:

V_{sat}:	saturation voltage
$I'_{1,max}$:	non-offset maximum primary current, converted to the secondary side
I_{nom}:	rated secondary current
n:	rated overcurrent factor
k:	over-dimensioning factor
R_{nom}:	rated burden
R_{op}	actual connected operating burden
R_i:	internal burden

The current transformer can then be dimensioned for the minimum required saturation voltage V_{sat} as follows:

$$V_{sat} \geq (R_{op} + R_i) \cdot k \cdot I'_{1,max}$$

Alternatively, the current transformer can also be dimensioned for the minimum required rated overcurrent factor n by specifying a rated power P_{nom} as follows:

$$n \geq \frac{(R_{op} + R_i)}{(R_{nom} + R_i)} \cdot k \cdot \frac{I'_{1,max}}{I_{nom}} = \frac{(P_{op} + P_i)}{(P_{nom} + P_i)} \cdot k \cdot \frac{I'_{1,max}}{I_{nom}}$$

where

$$P_{nom} = R_{nom} \cdot I^2_{nom}$$
$$P_{op} = R_{op} \cdot I^2_{nom}$$
$$P_i = R_i \cdot I^2_{nom}$$

Theoretically, the current transformer could be dimensioned for lack of saturation by inserting in the place of the required overdimensioning factor k its maximum:

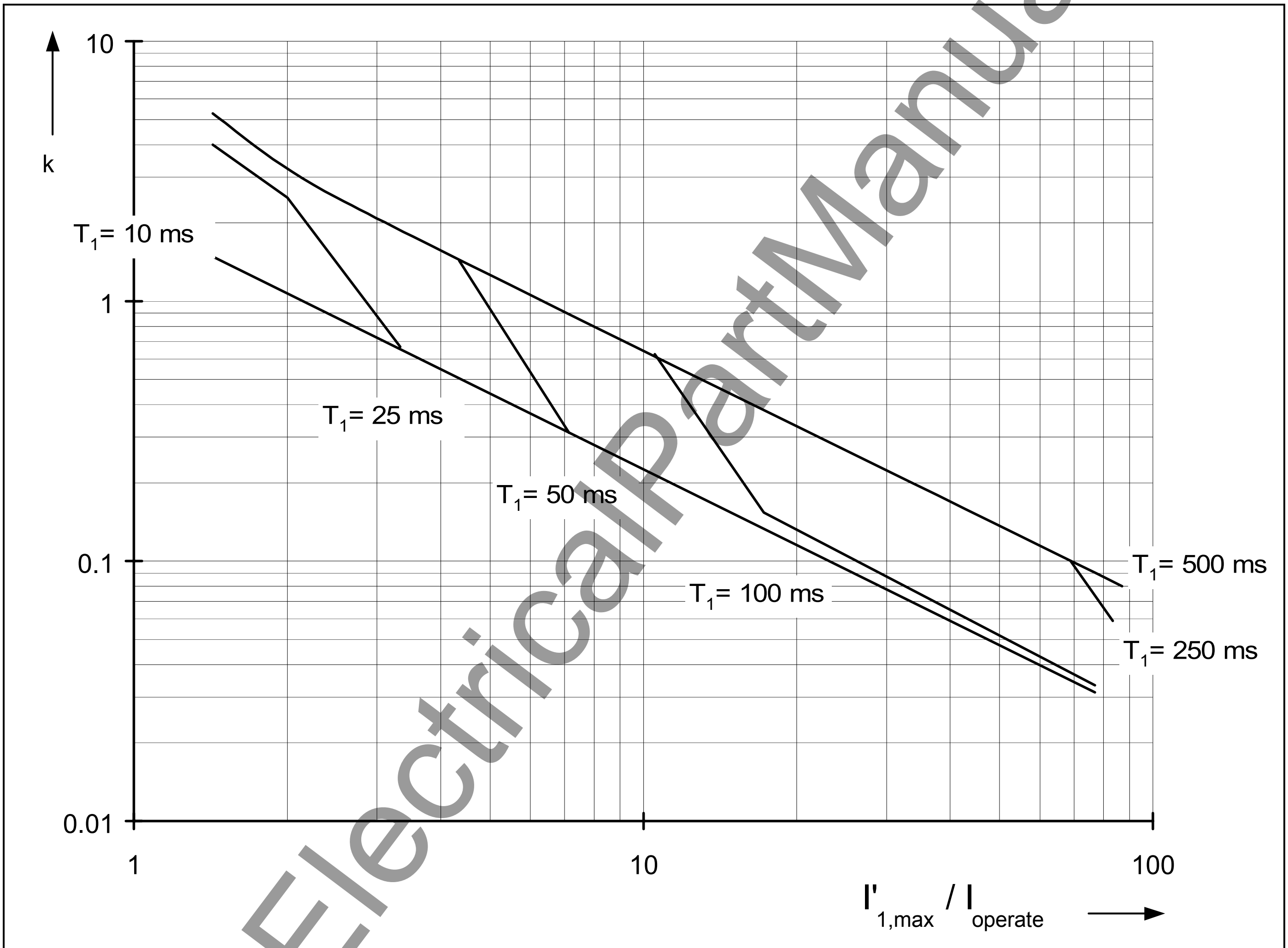
$$k_{max} \approx 1 + \omega T_1$$

where:

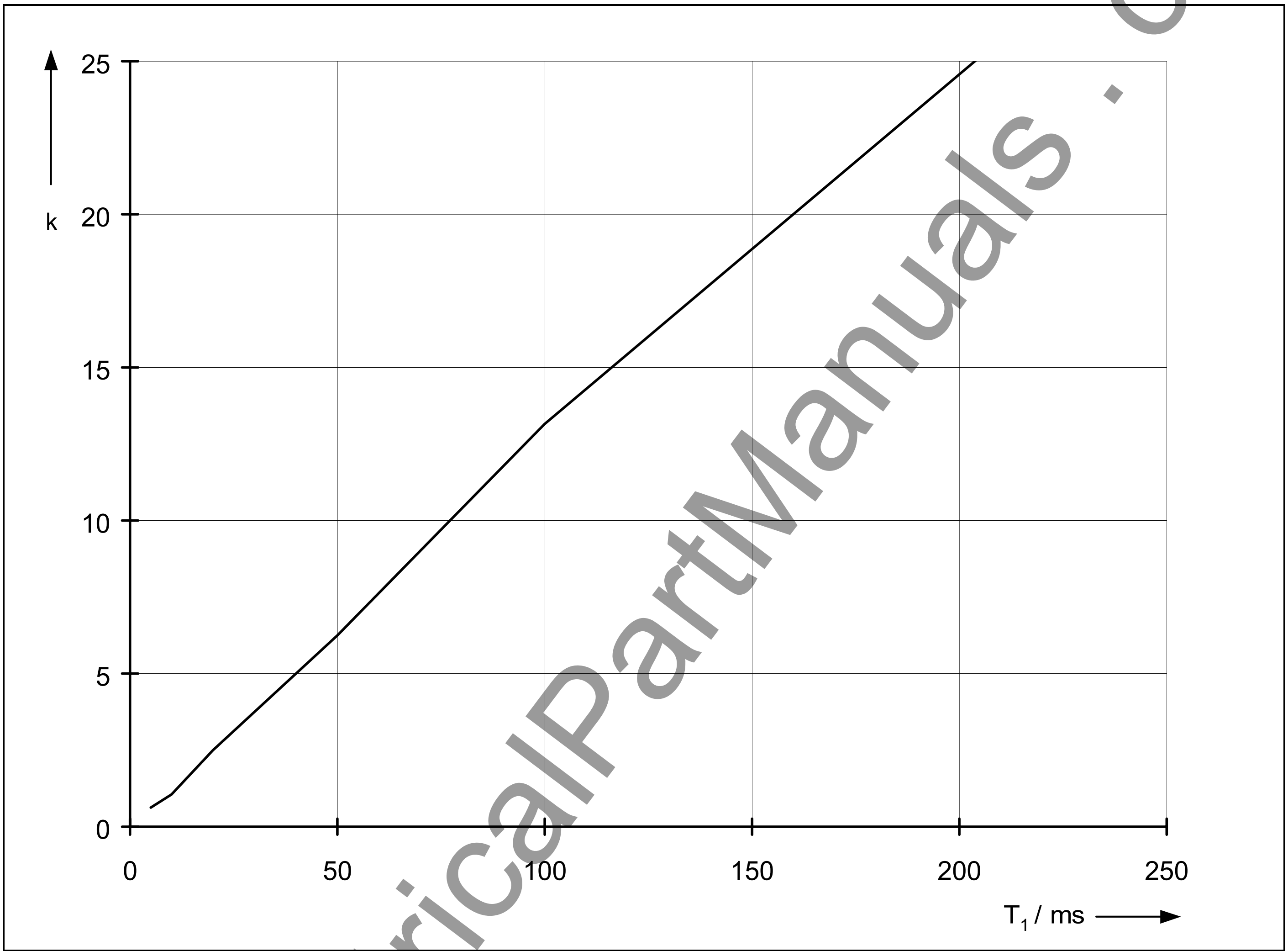
ω:	system angular frequency
T_1:	system time constant

However, this is not necessary. Instead, it is sufficient to dimension the overdimensioning factor k such that the normal behavior of the analyzed protective function is guaranteed under the given conditions.

If the C232 is to be used for definite-time overcurrent protection, then the overdimensioning factor k that must be selected is a function, first of all, of the ratio of the maximum short-circuit current to the set operate value and, secondly, of the system time constant T_1. The overdimensioning factor that is needed can be read from the empirically determined curves in Figure 2-1. When inverse-time maximum current protection is used, the overdimensioning factor can be taken from Figure 2-2.



2-1 Required overdimensioning factor for definite-time overcurrent protection where fnom= 50 Hz

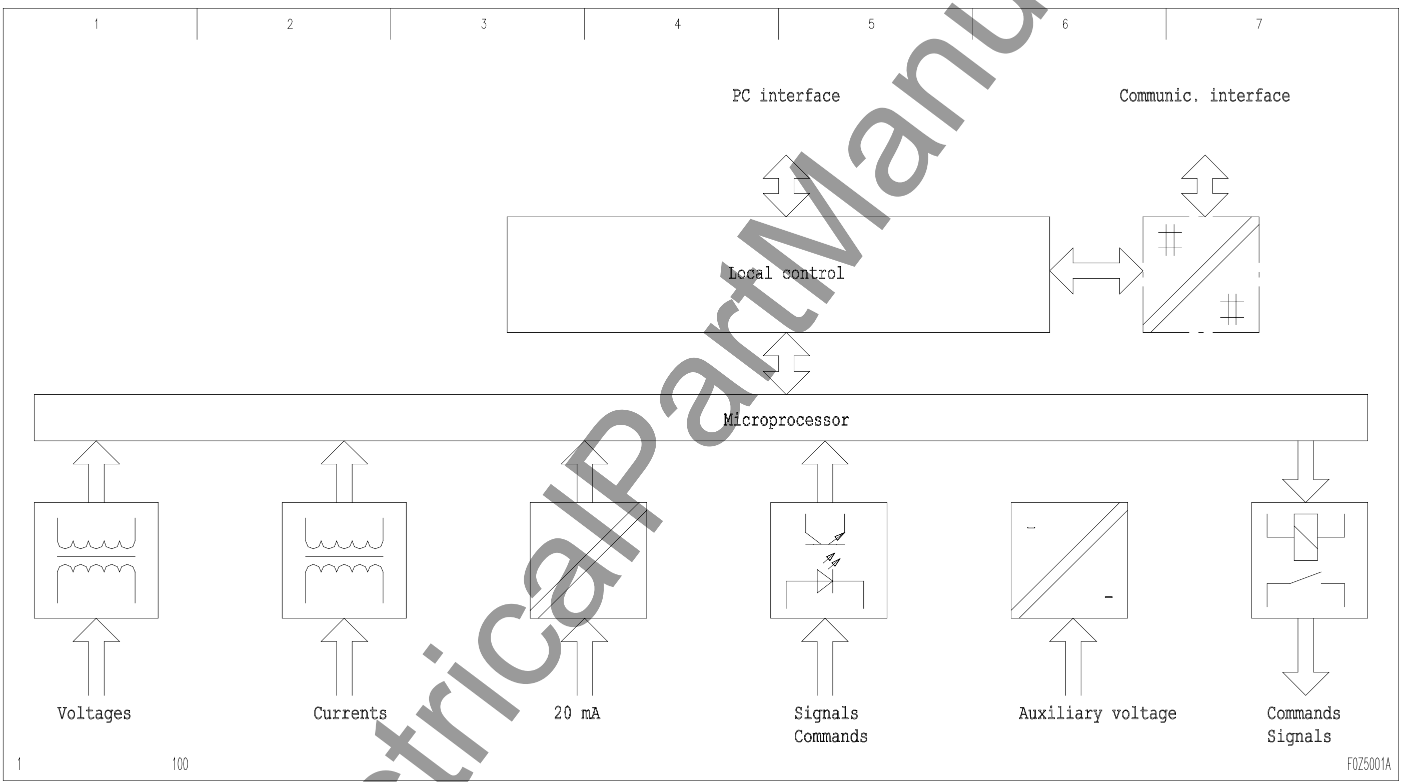


2-2 Required overdimensioning factor for inverse-time maximum current protection where fnom= 50 Hz

3 Operation

3.1 Modular Structure

The C232, a numeric device, is part of the MiCOM P 30 family of devices. The device types included in this family are built from identical uniform hardware modules. Figure 3-1 shows the basic hardware structure of the C232.



3-1 Basic hardware structure

The external analog and binary quantities – electrically isolated – are converted to the internal processing levels by the input transformers and optical couplers. Commands and signals generated by the device internally are transmitted to external destinations via floating contacts. The external auxiliary voltage is applied to the power supply, which supplies the auxiliary voltages that are required internally.

The analog data are always transferred from the transformer inputs to the processor by an internal bus system. The processor module contains all the elements necessary for the conversion of measured analog variables, including multiplexers and analog/digital converters. Binary signals are fed to the processor module by the binary I/O via the internal bus system. The processor handles the processing of digitized measured variables and of binary signals, generates the protective trip as well as the control commands and signals, and transfers them to the binary I/O via the internal bus system. The processor module also handles overall device communication. As an option, processor module provides up to two serial communication links with substation control systems or for remote setting.

The control and display elements of the integrated local control panel and the integrated PC interface are placed on processor module as well.

3.2 Operator-Machine Communication

The following interfaces are available for the exchange of information between operator and device:

- ◻ Integrated local control panel
- ◻ PC interface
- ◻ Communication interface

All setting parameters and signals as well as all measured variables and control functions are arranged within the branches of the menu tree following a scheme that is uniform throughout the device family. The main branches are:

'Parameters' branch

This branch carries all setting parameters, including the device identification data, the configuration parameters for adapting the device interfaces to the system, and the function parameters for adapting the device functions to the process. All values in this group are stored in non-volatile memory, which means that the values will be preserved even if the power supply fails.

'Operation' branch

This branch includes all information relevant for operation such as measured operating data and binary signal states. This information is updated periodically and consequently is not stored. In addition, various control parameters are grouped here, for example those for resetting counters, memories and displays.

'Events' branch

The third branch is reserved for the recording of events. Therefore all information contained in this group is stored. In particular the start/end signals during a fault, the measured fault data as well as sampled fault records are stored here and can be read out at a later time.

Settings and signals are displayed either in plain text or as addresses, in accordance with the user's choice. The appendix documents the settings and signals of the C232 in the form of an 'address list'. This address list is complete and thus contains all settings, signals and measured variables used with the C232.

Normally the local control panel will display the 'Bay Panel,' which represents a selected bay and shows the up-to-date switching status. The configuration of the local control panel also permits the installation of 'Measured Value Panels' on the LCD display. Different panels are automatically displayed for certain system operating conditions. Priority increases from normal operation to operation under overload conditions and finally to operation following a short circuit in the system. Thus the C232 provides the measured data relevant for the prevailing conditions.

3.3 Configuration of the Bay Panel and of the Measured Value Panels; Selection of the Control Point (Function Group LOC)

The topology of the switchbay with its switchgear units is displayed on the Bay Panel. Moreover, the C232 offers Measured Value Panels which display the measured values relevant at a given time.

During normal power system operation; the Bay Panel or – if activated – the Operation Panel is displayed. If the Operation Panel is activated as an event occurs, the display switches to the appropriate Event Panel - provided that measured values have been selected for the Event Panels. In the event of overload or ground fault events, the display will automatically switch to the Operation Panel at the end of the event. In the event of a fault, the Fault Panel remains active until the LED indicators or the fault memories are reset.

If the change-enabling command has been issued (LOC: Param. change enabl.,), it will be cancelled after the time defined by the setting LOC: Hold-time for Panels and the Bay Panel will be called up.

Bay Panel

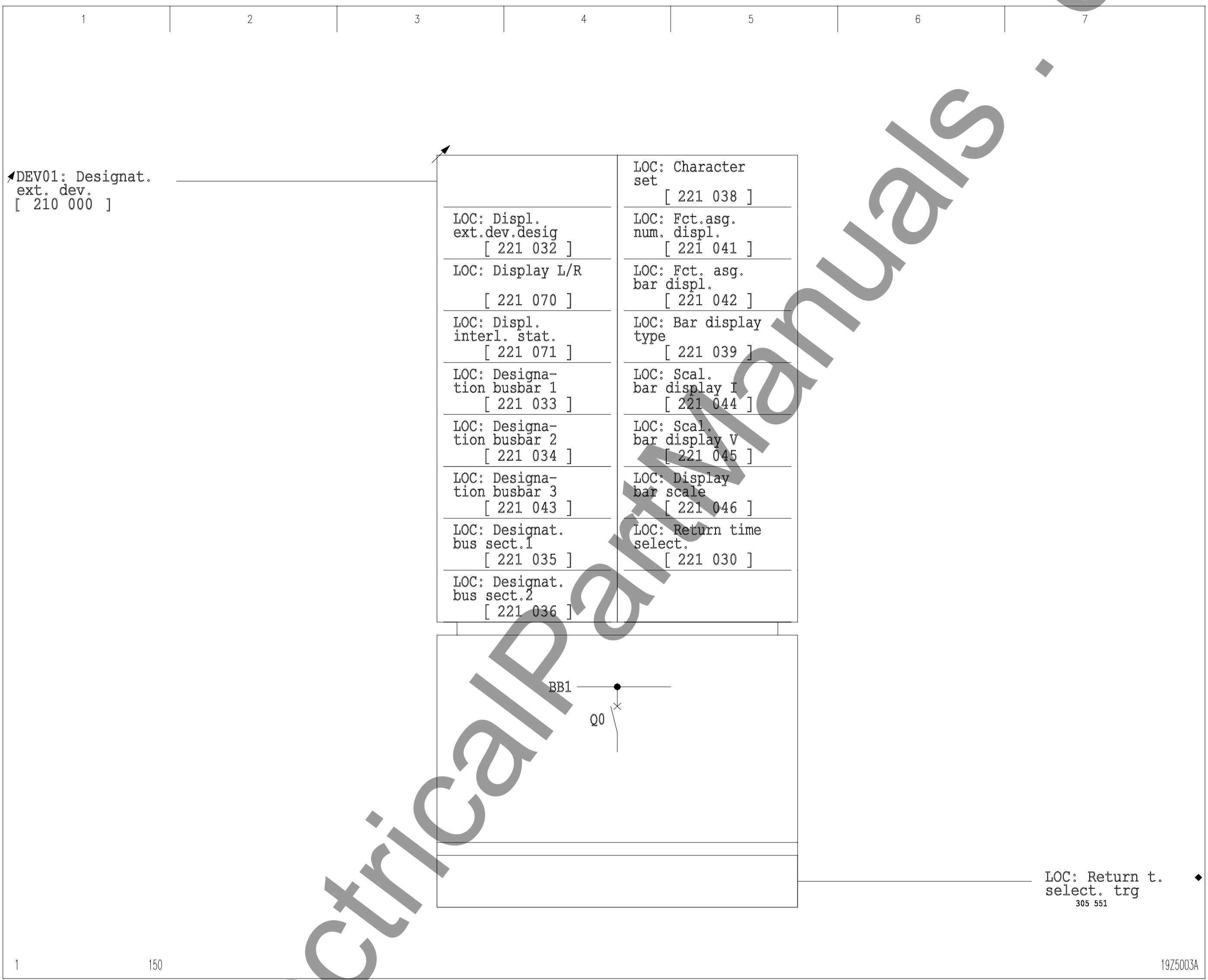
The C232 offers a selection from pre-defined bay types. Should the required bay type be missing from the standard selection then the user can contact the manufacturer to request the definition of a customized bay type for loading into the C232. The number of this additional bay type will then be displayed at MAIN: Customized bay type.

The selected bay is displayed on the Bay Panel in single-pole representation. The activation of the Bay Panel display is described in the Chapter entitled Local Control. The user can choose between several character sets for representing switchgear units on the Bay Panel. The character sets are illustrated in the Chapter entitled Local Control. Each device in the bay representation is identified by an external device name as set by the user. Designations for the busbars and busbar sections can also be selected by the user. The display of the external device names can be cancelled. The display of the control point – Local or Remote – and of the interlocking can also be cancelled.

The switchgear unit to be controlled needs to be selected first. The selection is valid for the set time LOC: Return time illumin.

The measured values that will be displayed on the Bay Panel can first be selected separately for the numerical and the bar display by way of an “m out of n” parameter. Measured values to be displayed in bar form must also be selected for display as numerical measured values. However, not all measured values that can be displayed in numerical form can also be displayed in bar form. In such cases, a dummy or placeholder must be included in the selection list for the bar display at the same point at which a measured value that cannot be displayed in bar form appears in the selection list for numerical measured values.

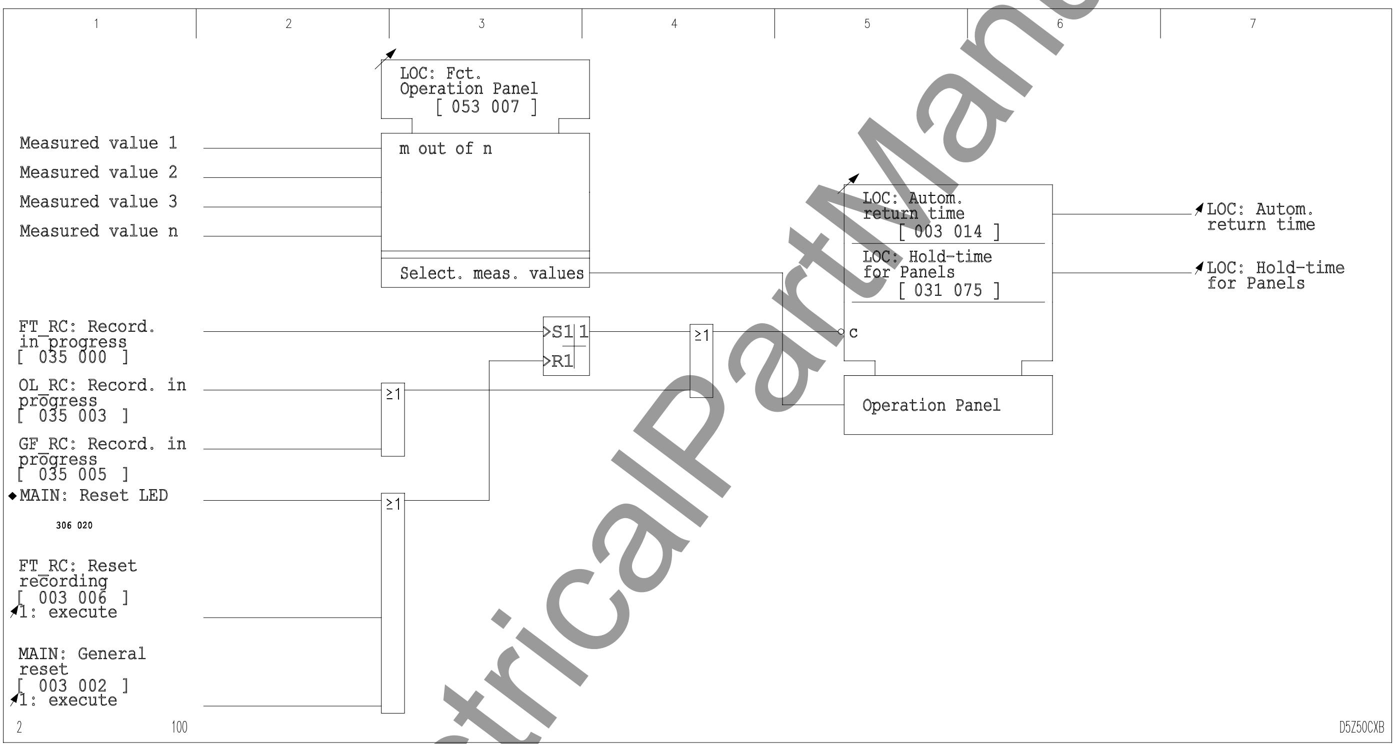
For the bar display, the orientation of the bar and the scaling can be selected (the latter separately for the current and voltage data). The display of the scaling can be cancelled.


1
2
3
4
5
6
7
DEV01: Designat. ext. dev. [210 000]
LOC: Character set [221 038]
LOC: Displ. ext.dev.desig [221 032]
LOC: Fct.asg. num. displ. [221 041]
LOC: Display L/R [221 070]
LOC: Fct. asg. bar displ. [221 042]
LOC: Displ. interl. stat. [221 071]
LOC: Bar display type [221 039]
LOC: Designa- tion busbar 1 [221 033]
LOC: Scal. bar display I [221 044]
LOC: Designa- tion busbar 2 [221 034]
LOC: Scal. bar display V [221 045]
LOC: Designa- tion busbar 3 [221 043]
LOC: Display bar scale [221 046]
LOC: Designat. bus sect.1 [221 035]
LOC: Return time select. [221 030]
LOC: Designat. bus sect.2 [221 036]
BB1
Q0
LOC: Return t. select. trg
305 551
1
150
19Z5003A

3-2 Bay Panel

Operation Panel

The Operation Panel is displayed if it is activated and at least one measured value has been configured. The user can select the measured operating values that will be displayed on the Operation Panel by setting an 'm out of n' parameter. If more measured values are selected for display than the LC display can accommodate, then the display will switch to the next set of values at intervals defined by the setting at L O C : H o l d - t i m e f o r P a n e l s or when the appropriate key on the local control panel is pressed.

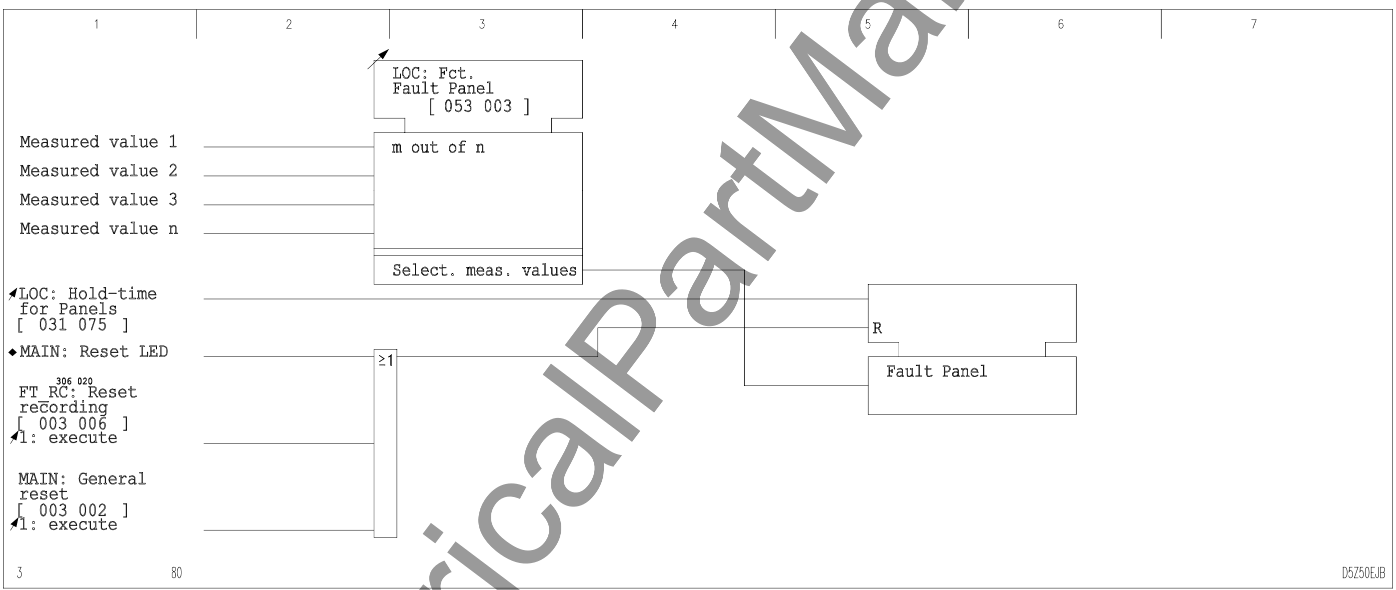


3-3 Operation Panel

Fault panel

The Fault Panel is displayed in place of another data panel when there is a fault, provided that at least one measured value has been configured. The Fault Panel remains on display until the LED indicators or the fault memories are reset.

The user can select the measured fault values that will be displayed on the Fault Panel by setting an 'm out of n' parameter. If more measured values are selected for display than the LC display can accommodate, then the display will switch to the next set of values at intervals defined by the setting at `LOC: Hold-time for Panels` or when the appropriate key on the local control panel is pressed.

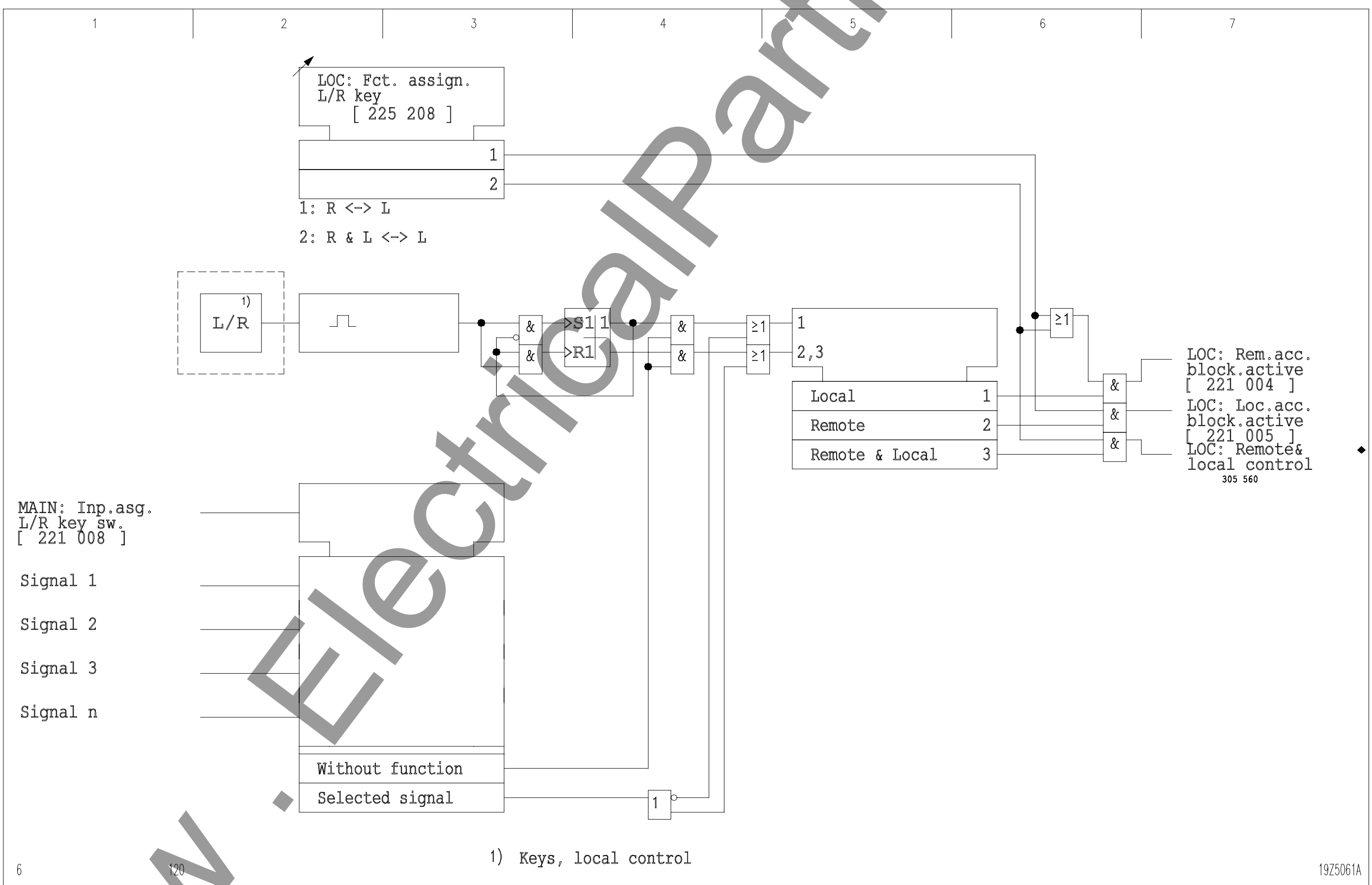


3-4 Fault panel

Selection of the control point

Switchgear units can be controlled remotely or locally. Switching between local and remote control is achieved using either the L/R key on the local control panel or an external key switch. The position of this switch is interrogated via an appropriately configured input (configuration at MAIN: Inp.asg. L/R key sw.) If the input is configured *to L/R key switch* then the L/R key on the local control panel is without function. The setting at LOC: Fct. assign. L/R key determines whether the switching (using either the local control panel key or the key switch) is between local and remote control (L↔R) or between local+remote and local control (R&L↔L).

If only remote control is enabled then there will be a local access blocking. If only local control is enabled then there will be a remote access blocking.



3-5 Selection of the control point

3.4 Serial Interfaces

The C232 has a PC interface as a standard component. Communication module A is optional and can have one or two communication channels – depending on the design version. Communication between the C232 and the control station's computer is through the communication module. Setting and readout are possible through all C232 interfaces.

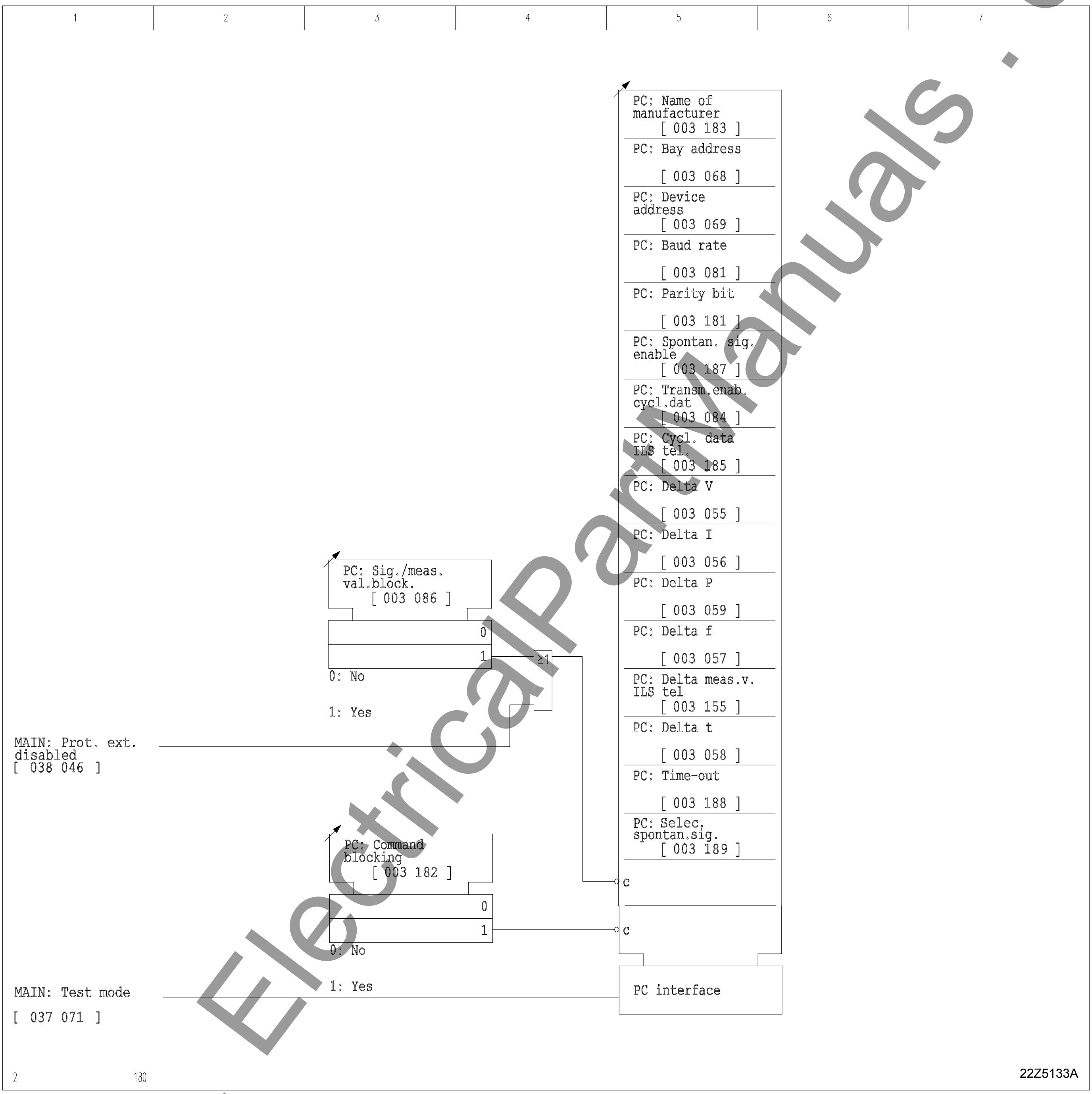
If the communication module with two communication channels is installed, settings for two "logical" communication interfaces will be available. The settings for "logical" communication interface 1 (COMM1) can be assigned to physical communication channels 1 or 2 (see section entitled 'Main Functions'). If the COMM1 settings have been assigned to communication channel 2, then this means that the settings for "logical" communication interface 2 (COMM2) will automatically be active for communication channel 1. Communication with the C232 via communication channel 2 is only possible when the PC interface is inactive. As soon as communication occurs through the PC interface, communication channel 2 is "dead".

If tests are run on the C232, the user is advised to activate the test mode so that the PC or the control system will evaluate all incoming signals accordingly (see section entitled 'Main Functions').

3.4.1 PC Interface (Function Group PC)

Communication between the device and a PC is through the PC interface. In order for data transfer between the C232 and the PC to function, several settings must be made in the C232.

An operating program is available as an accessory for C232 control (see Chapter 13).



3-6 PC interface settings

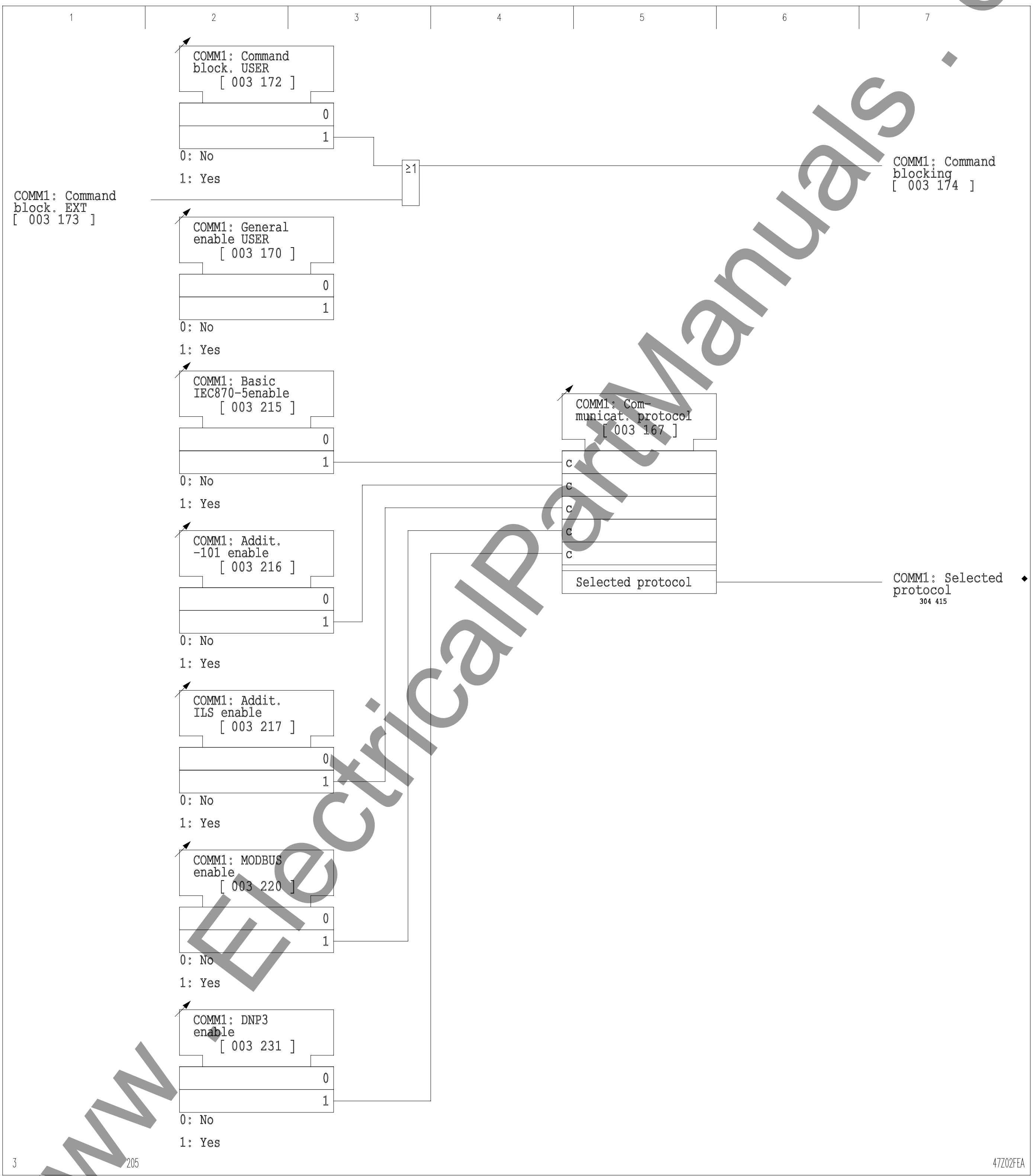
3.4.2 "Logical" Communication Interface 1 (Function Group COMM1)

Depending on the design version of communication module (see Technical Data), several interface protocols are available. The protocol as per IEC 60870-5-103 is supported for all versions. The following user-selected interface protocols are available for use with the C232:

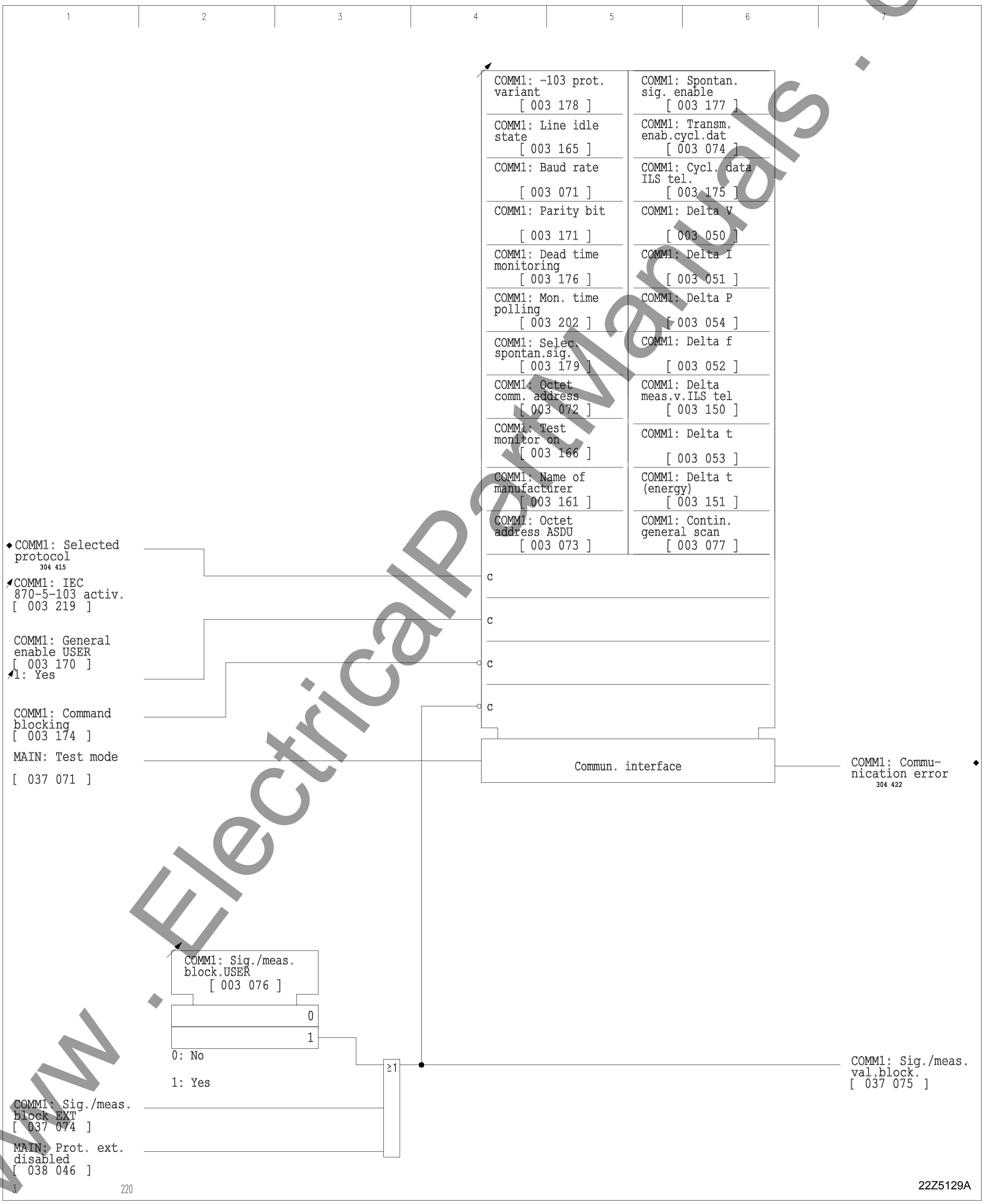
- ◻ IEC 60870-5-103, “Transmission protocols - Companion standard for the informative interface of protection equipment,’ first edition, 1997-12 (corresponds to VDEW / ZVEI Recommendation, “Protection communication companion standard 1, compatibility level 2,” February 1995 edition) with additions covering control and monitoring
- ◻ IEC 870-5-101, “Telecontrol equipment and systems - Part 5: Transmission protocols - Section 101 Companion standard for basic telecontrol tasks,” first edition 1995-11
- ◻ ILS-C, internal protocol of AREVA Energietechnik GmbH
- ◻ MODBUS
- ◻ DNP 3.0

In order for data transfer to function properly, several settings must be made in the C232.

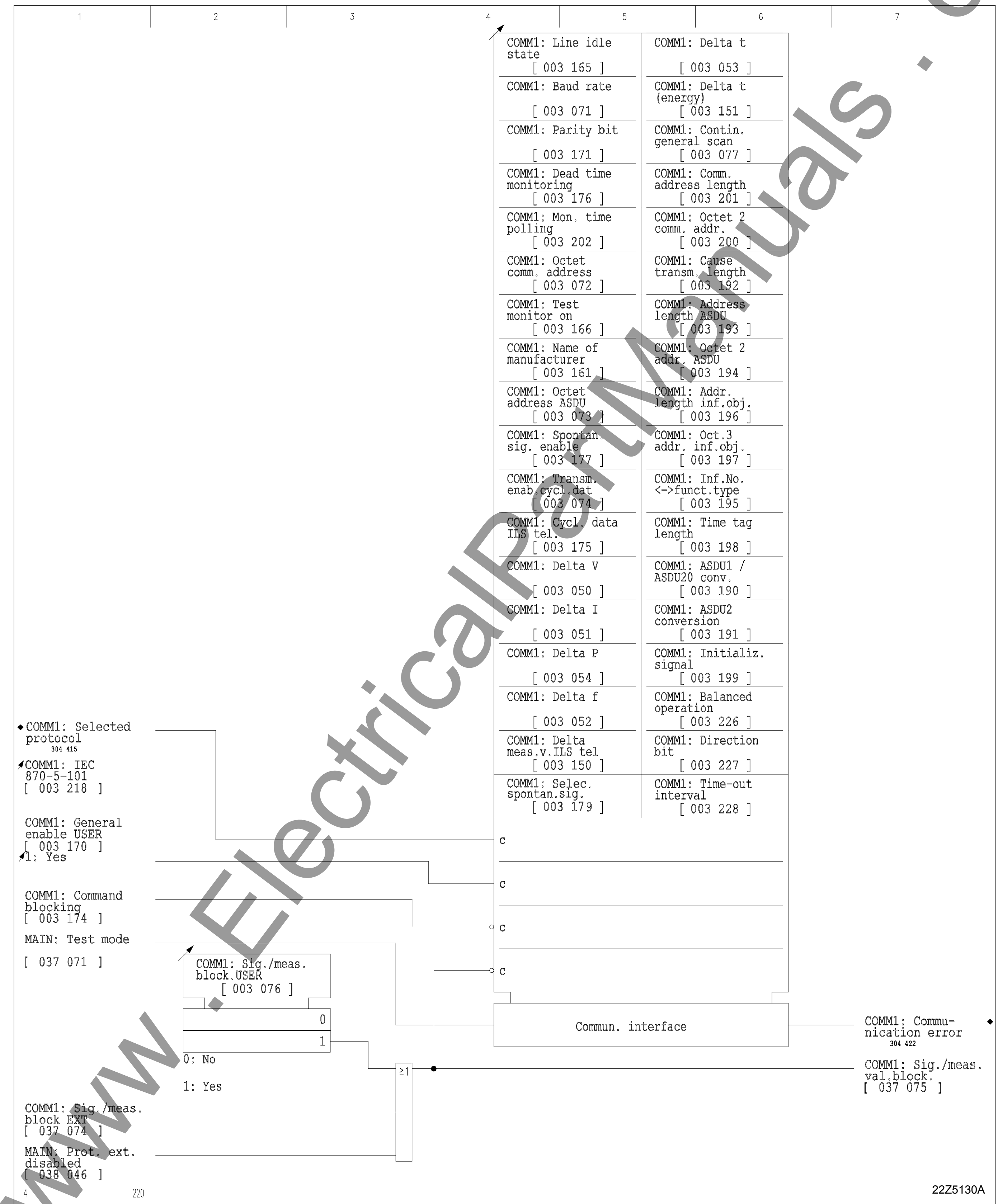
The communication interface can be blocked through a binary signal input. In addition, a signal or measured-data block can also be imposed through a binary signal input.



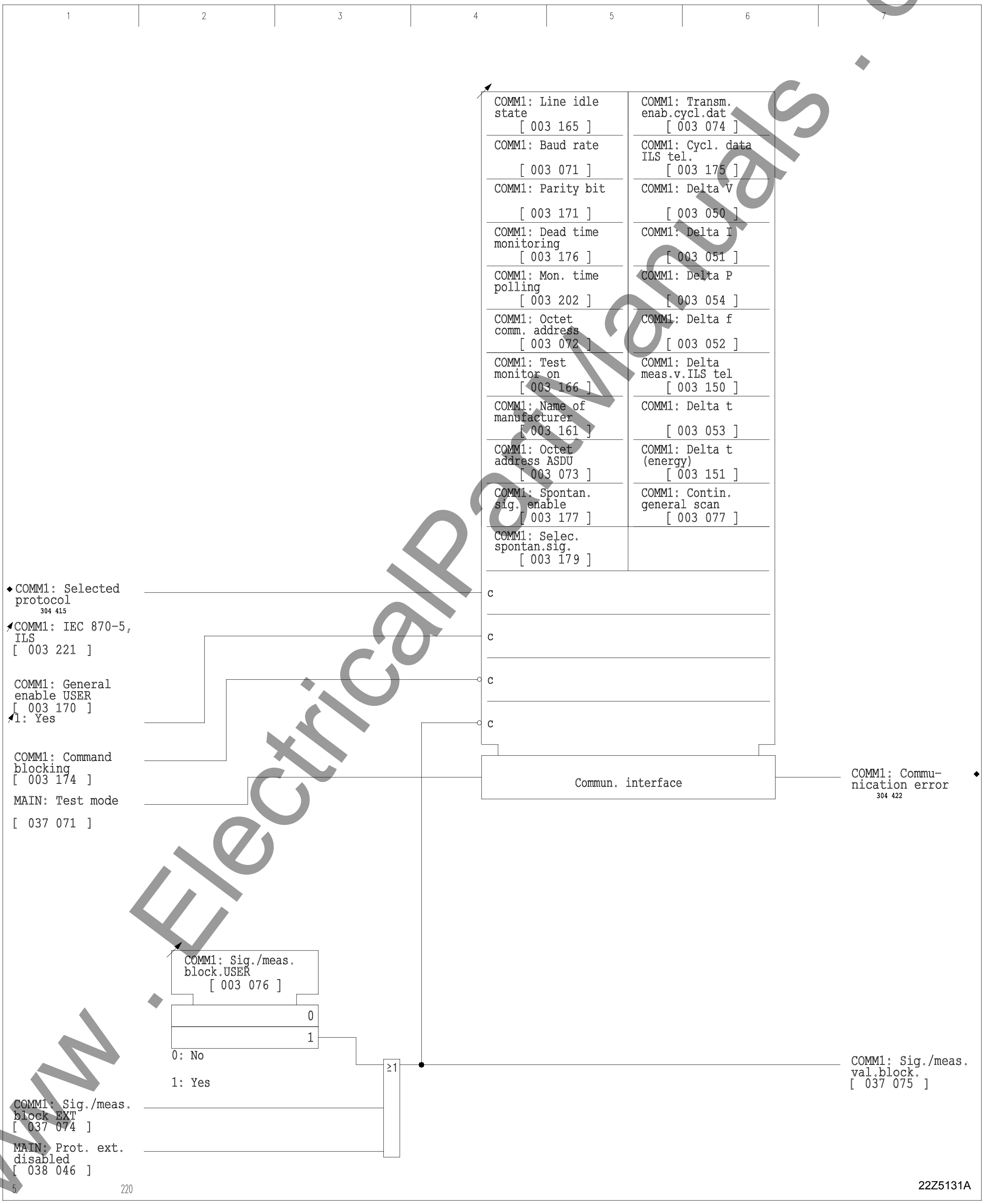
3-7 "Logical" communication interface 1: selecting the interface protocol



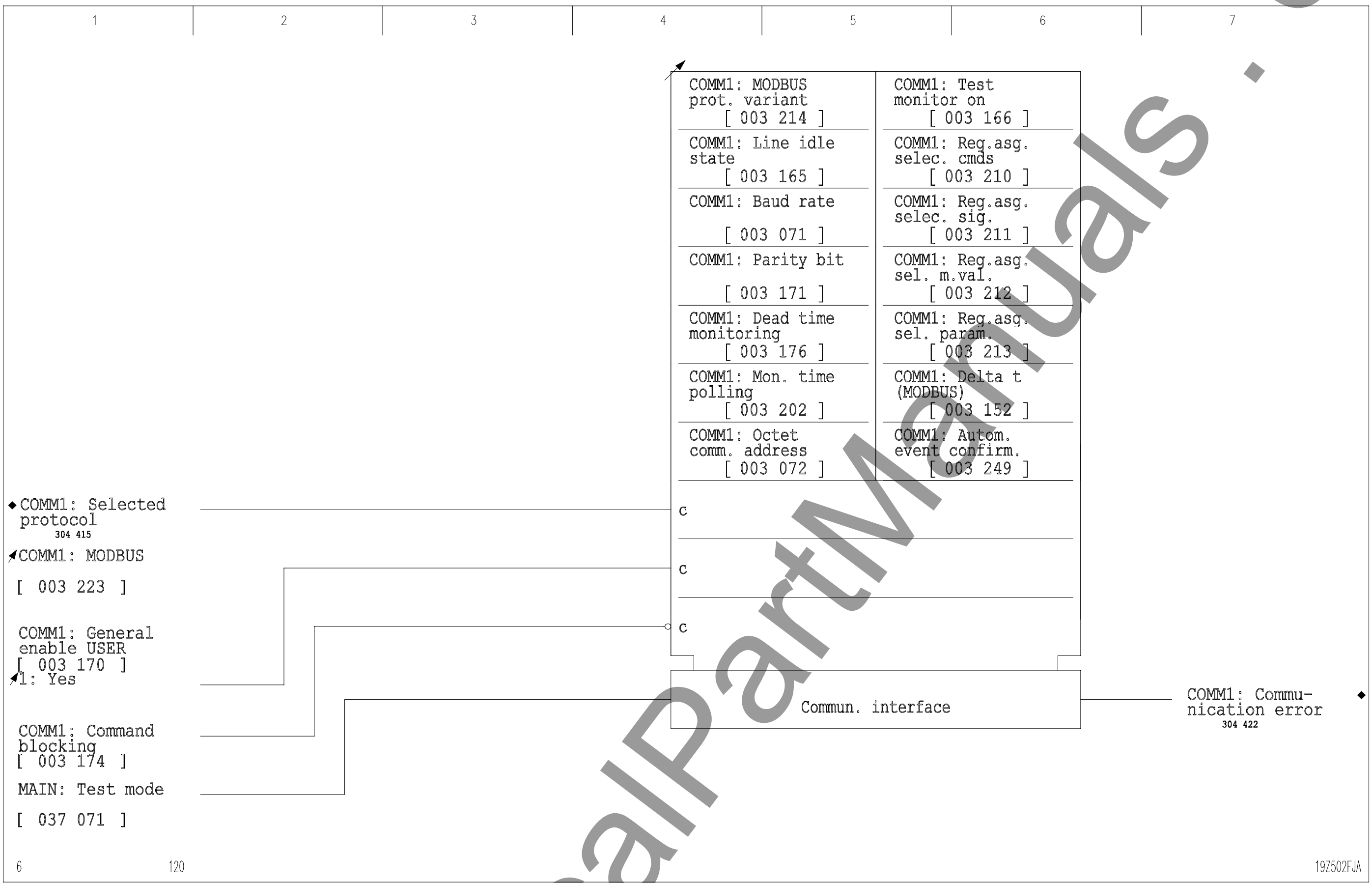
3-8 "Logical" communication interface 1: settings for the IEC 60870-5-103 interface protocol



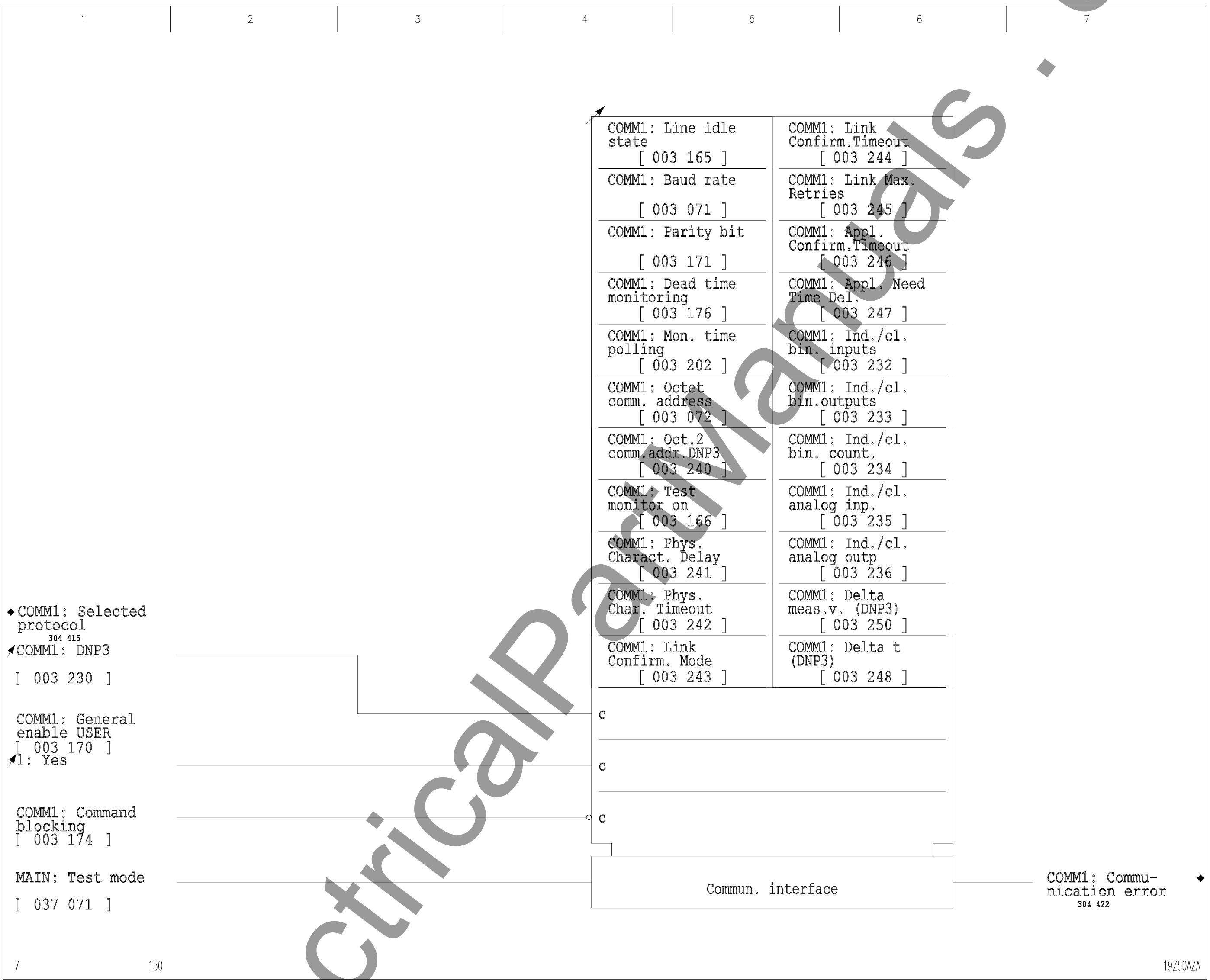
3-9 *"Logical" communication interface 1: settings for the IEC 60870-5-101 interface protocol*



3-10 "Logical" communication interface 1: settings for the ILS_C interface protocol



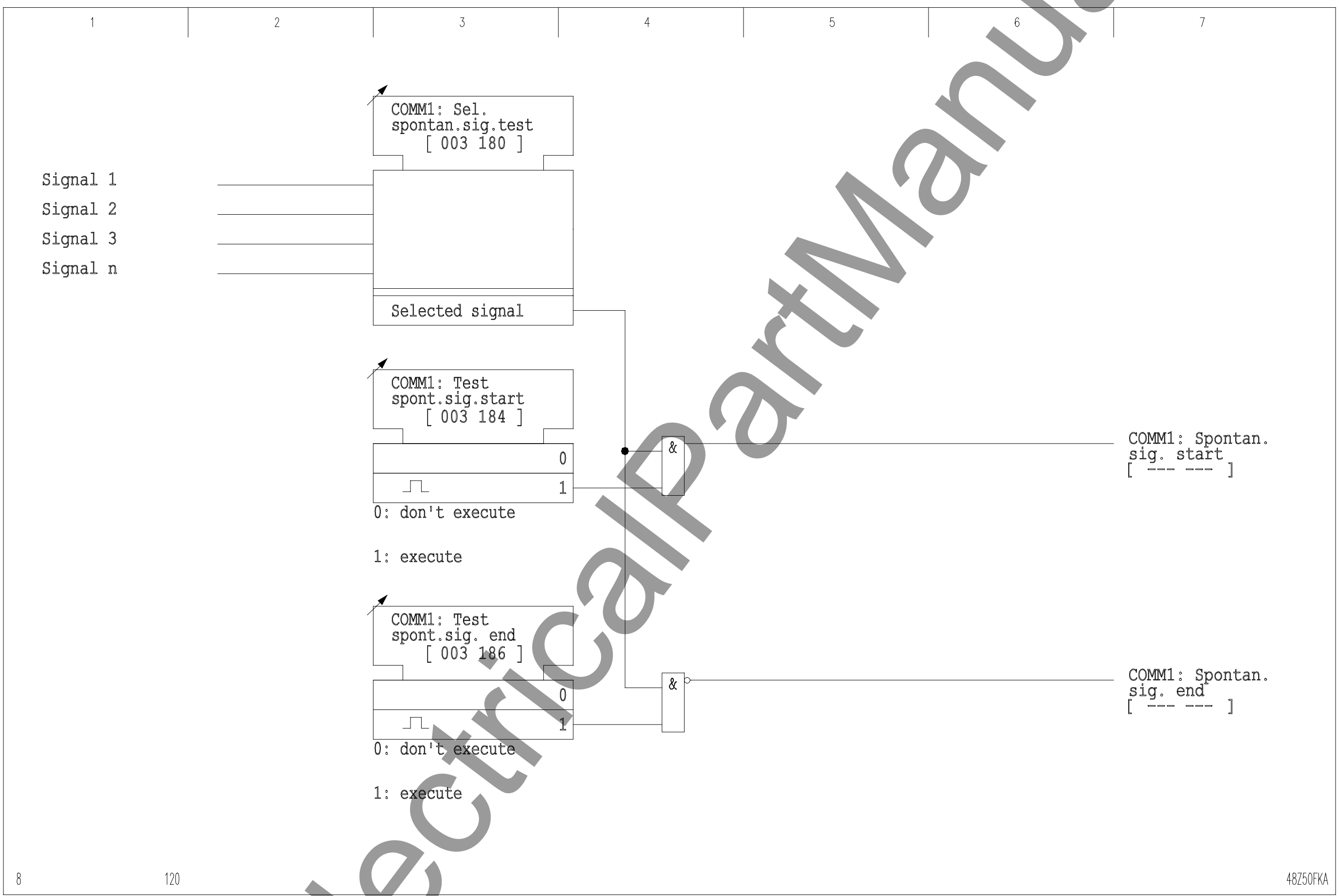
3-11 "Logical" communication interface 1: settings for the MODBUS protocol



3-12 "Logical" communication interface 1: settings for DNP 3.0

Checking spontaneous signaling

For interface protocols per IEC 60870-5-103, IEC 60870-5-101 or ILS-C, there is the option of selecting a signal for testing purposes. This transmission of this signal to the control station as 'sig. start' or 'sig. end' can then be triggered via the local control panel.

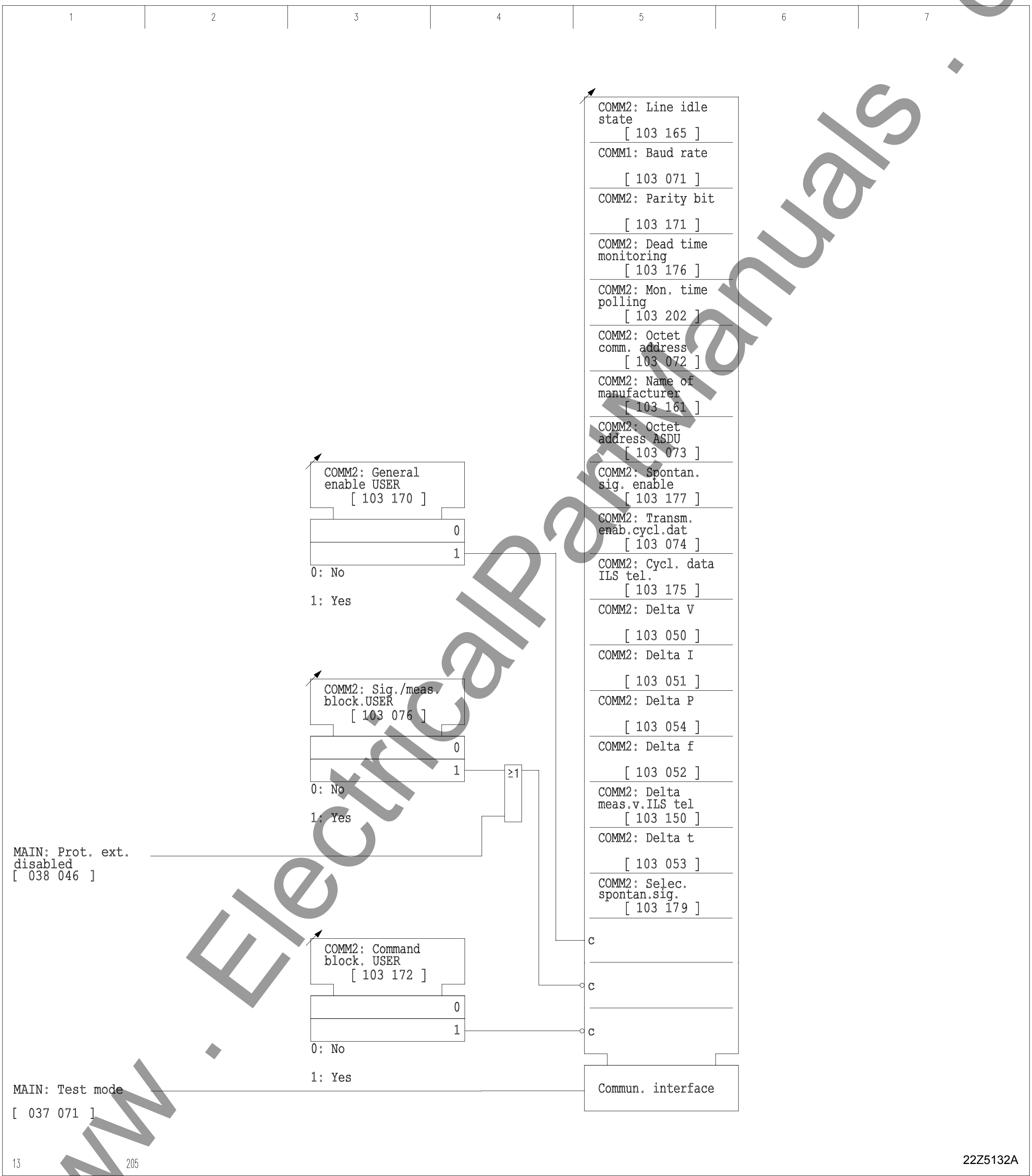


3-13 Checking spontaneous signaling

3.4.3 "Logical" Communication Interface 2 (Function Group COMM2)

"Logical" communication interface 2 supports the IEC 60870-5-103 interface protocol.

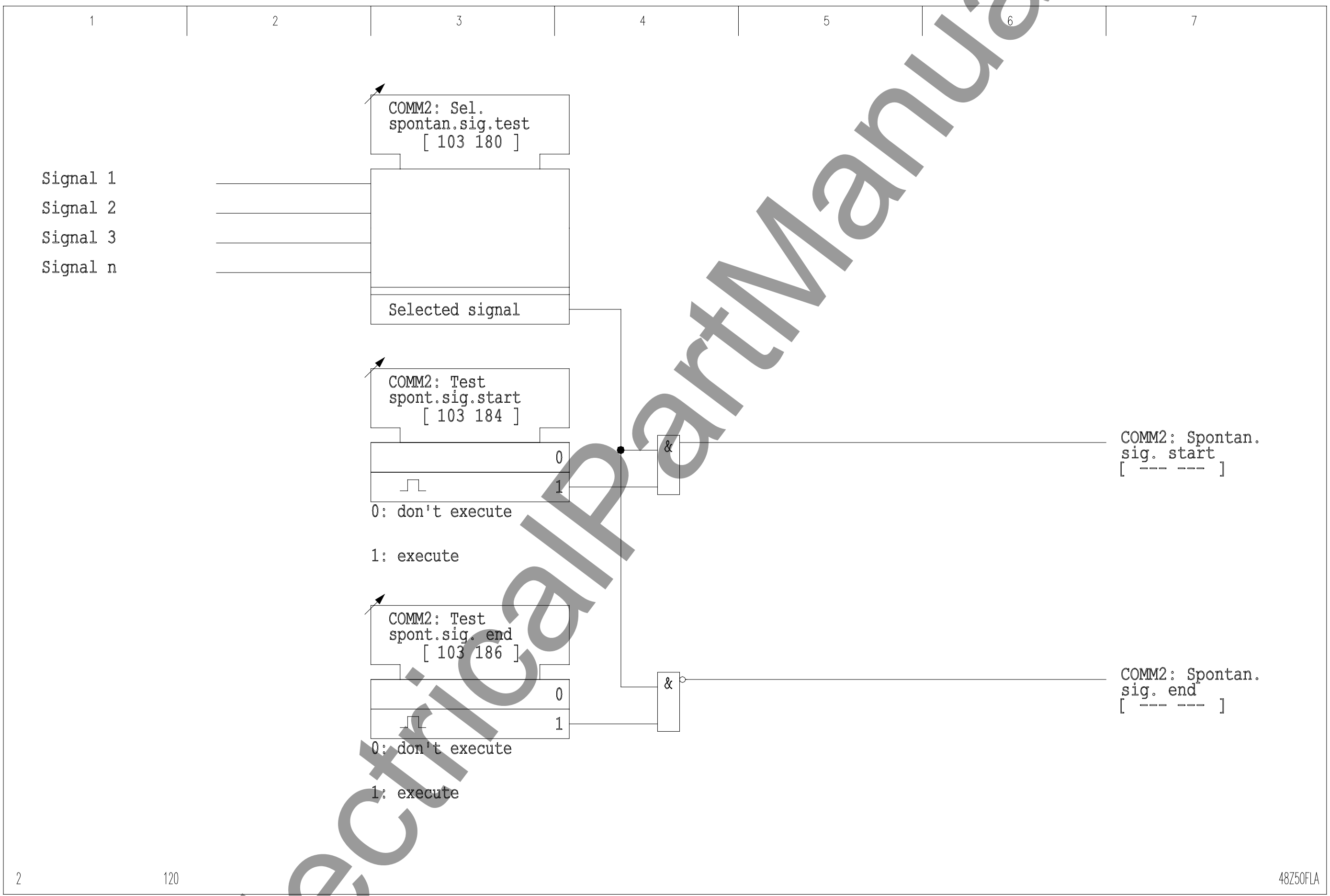
In order for data transfer to function properly, several settings must be made in the C232.



3-14 Settings for "logical" communication interface 2.

Checking spontaneous signaling

There is the option of selecting a signal for testing purposes. This transmssion of this signal to the control station as ‘sig. start‘ or ‘sig. end‘ can then be triggered via the local control panel.



3-15 Checking spontaneous signaling

3.5 Configuration and Operating Mode of the Binary Inputs (Function Group INP)

The C232 has optical coupler inputs for processing binary signals from the substation. The functions that will be activated by triggering these binary signal inputs are defined by the configuration of the binary signal inputs. The trigger signal must persist for at least 30 ms in order to be recognized by the C232.

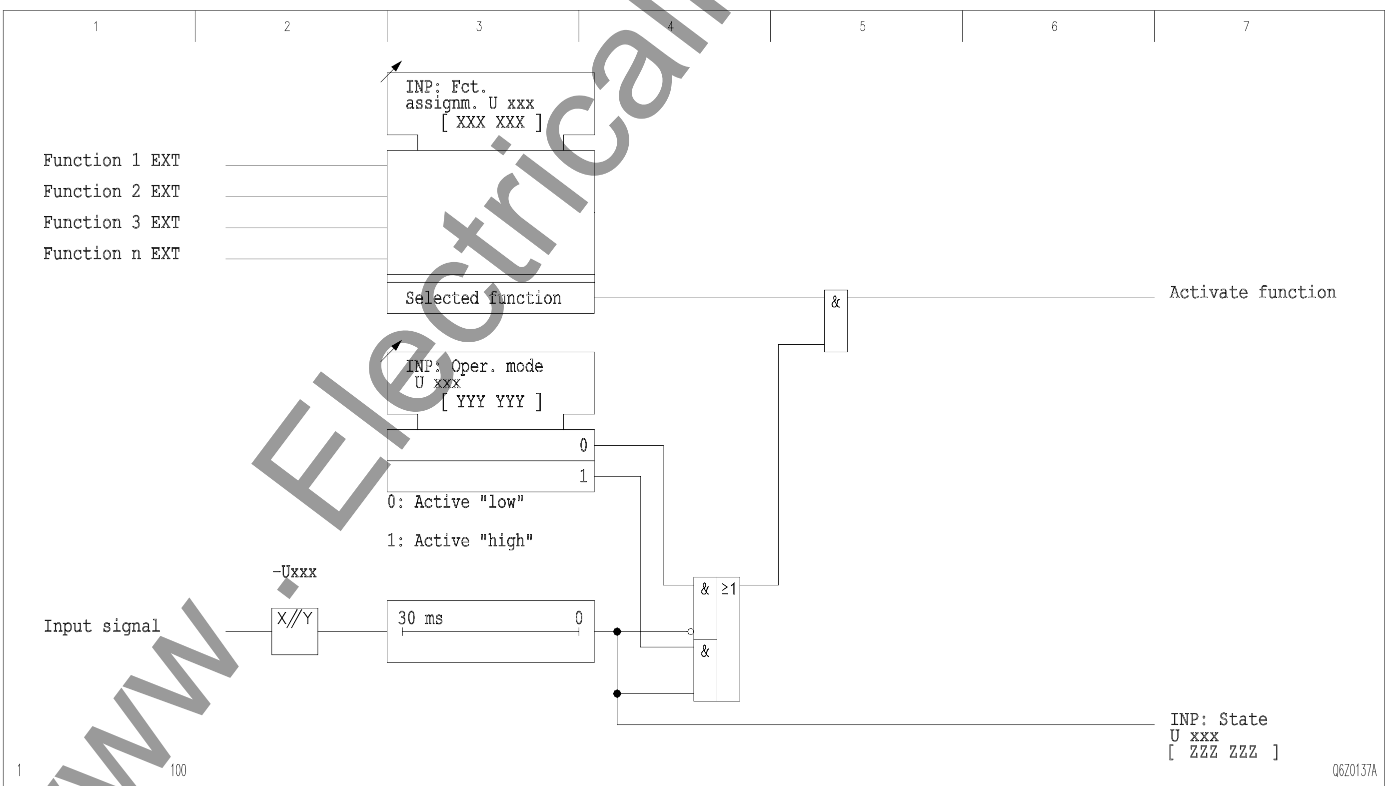
Configuring the binary inputs

One function can be assigned to each binary signal input by configuration. The same function can be assigned to several signal inputs. Thus one function can be activated from several control points having different signal voltages.

In this manual, we assume that the required functions (marked 'EXT' in the address description) have been assigned to binary signal inputs by configuration.

Operating mode of the binary inputs

The operating mode for each binary signal input can be defined. The user can specify whether the presence (active 'high' mode) or the absence (active 'low' mode) of a voltage should be interpreted as the logic '1' signal. The display of the state of a binary signal input – 'low' or 'high' – is independent of the setting for the operating mode of the signal input.



3-16 Configuration and operating mode of the binary signal inputs

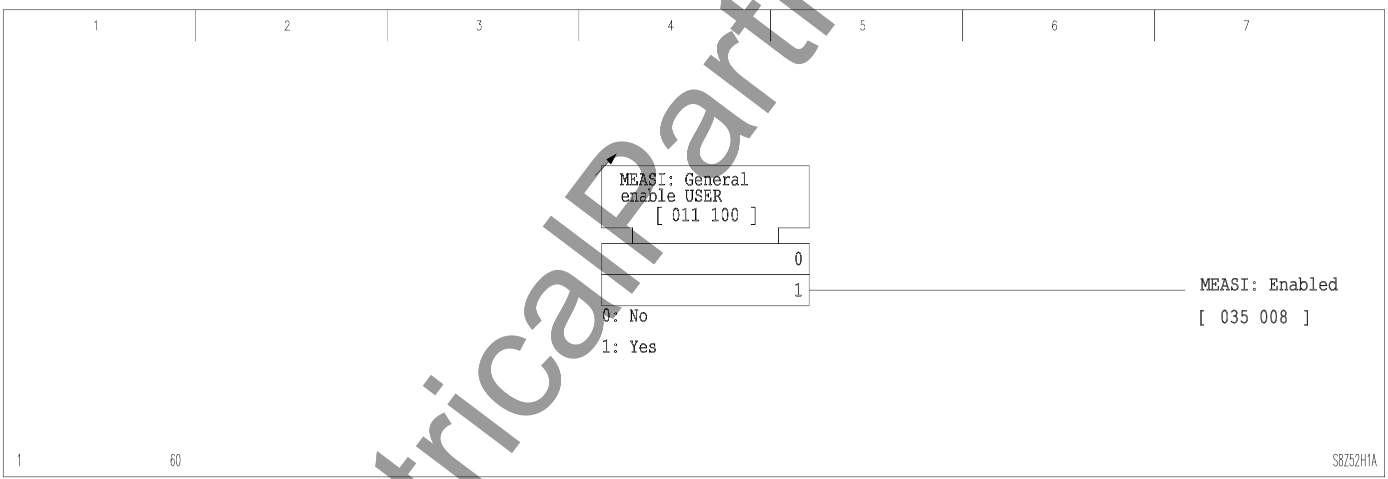
3.6 Measured Data Input (Function Group MEASI)

The C232 provides a measured data input function with one input. Direct current is fed to the C232 through this input.

The input current I_{DC} is displayed as a measured operating value. The current that is conditioned for monitoring purposes (I_{DClin}) is also displayed as a measured operating value. In addition, it is monitored by the limit value monitoring function to determine whether it exceeds or falls below set thresholds (see 'Limit Value Monitoring').

Disabling and enabling the measured data input function

The measured data input function can be disabled or enabled from the local control panel.

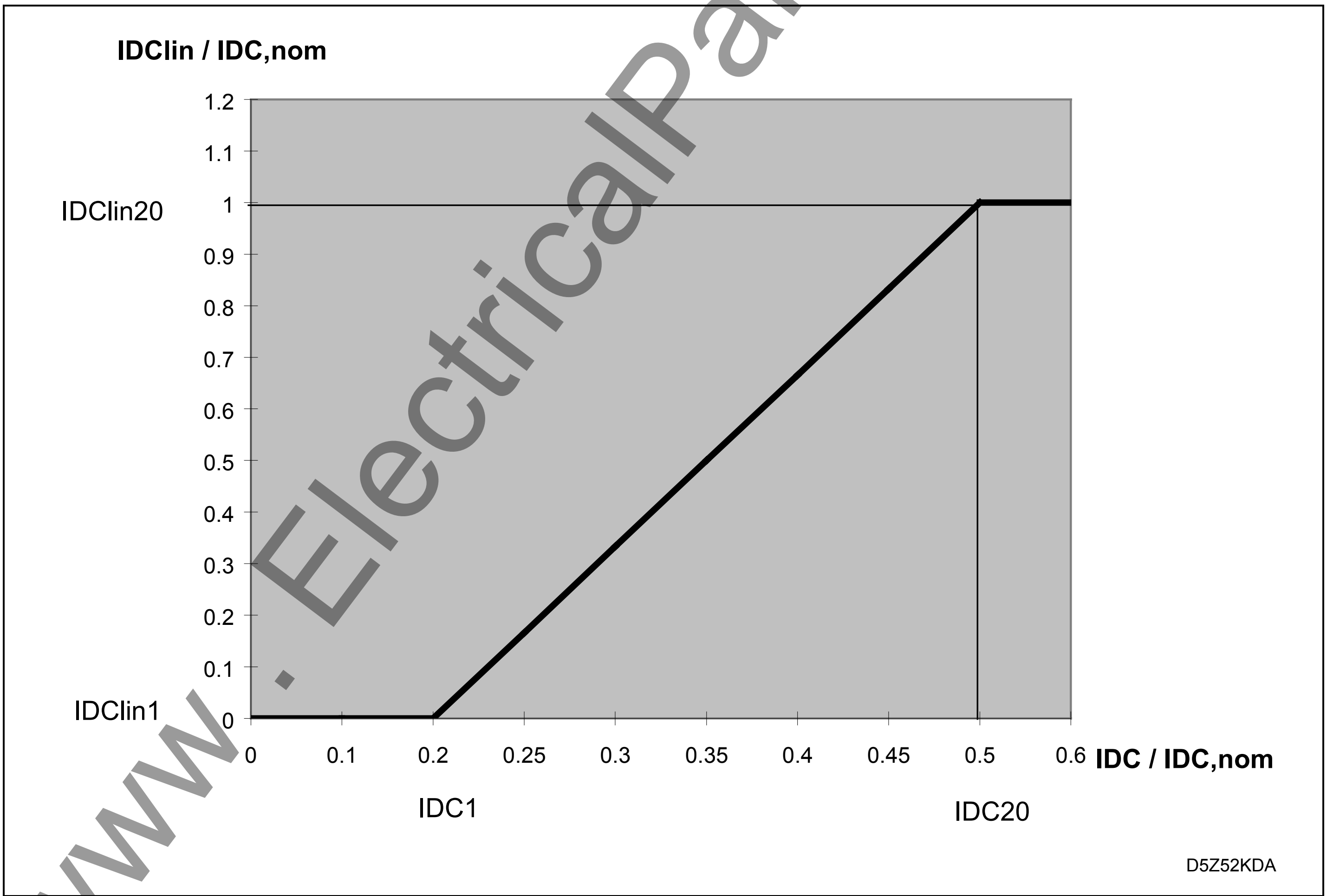


3-17 Disabling and enabling the measured data input function

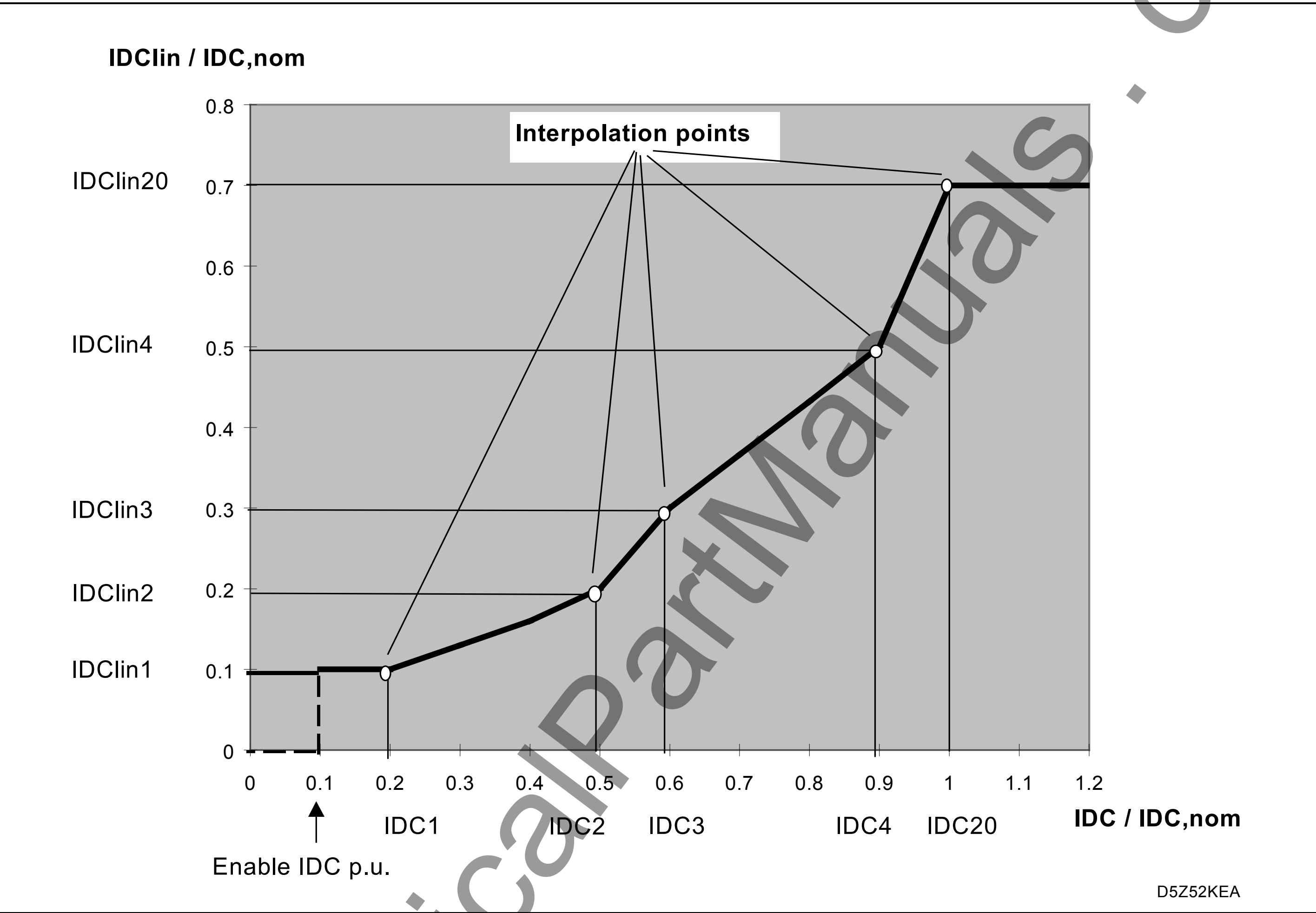
3.6.1 Direct Current Input

External measuring transducers normally supply an output current of 0 to 20 mA that is directly proportional to the physical quantity being measured – the temperature, for example. If the output current of the measuring transducer is directly proportional to the measured quantity only in certain ranges, linearization can be arranged – provided that the measured data input is set accordingly. Furthermore, it may be necessary for certain applications to limit the range being monitored or to monitor certain parts of the range that have a higher or lower sensitivity. By setting the value pair MEASI: IDC x and MEASI: IDClin x, the user specifies which input current (I_{DC}) will correspond to the current that is monitored by the limit value monitoring function ($I_{DC,lin}$). The resulting points, which are called 'interpolation points', are connected by straight lines in an I_{DC}-I_{DClin} diagram. In order to implement a simple characteristic, it is sufficient to specify two interpolation points, which are also used as limiting values (Figure 3-18). Up to 20 interpolation points are available for implementing a complex characteristic.

When setting the characteristic the user must remember that only a monotone ascending curve is allowed. If the setting differs, the signal SFMON: Invalid scaling IDC will be generated.



3-18 Example of the conversion of 4-10 mA input current to 0-20 mA monitored current, IDClin



3-19 Example of a characteristic having five interpolation points (characteristic with zero suppression setting of 0.1 $I_{DC,nom}$ is shown as a broken line)

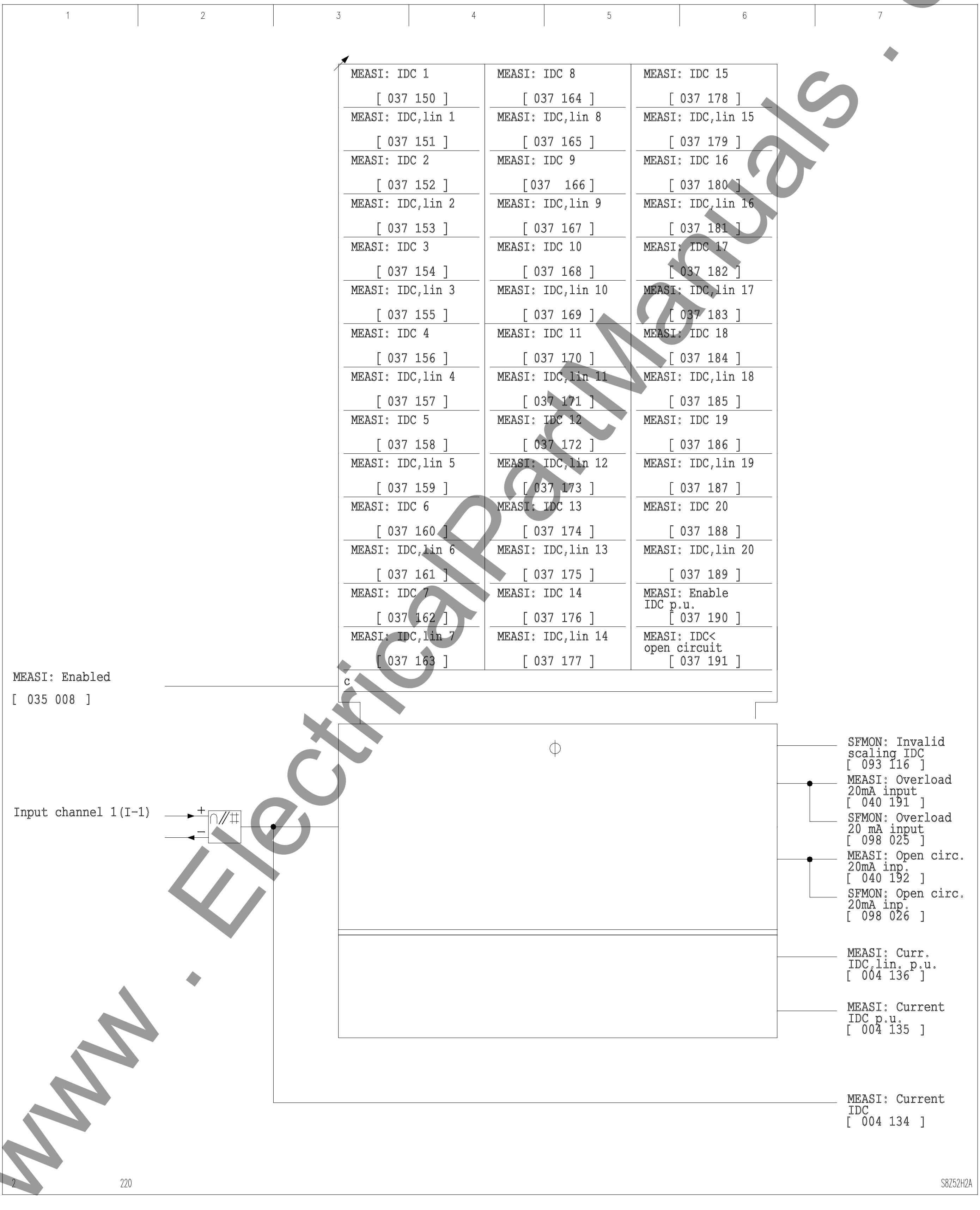
Zero suppression

Zero suppression is defined by setting M E A S I : E n a b l e I D C p . u . If the direct current does not exceed the set threshold, the per-unit input current $I_{DC\ p.u.}$ and the current I_{DClin} will be displayed as having a value of '*0*'.

Open-circuit and overload monitoring

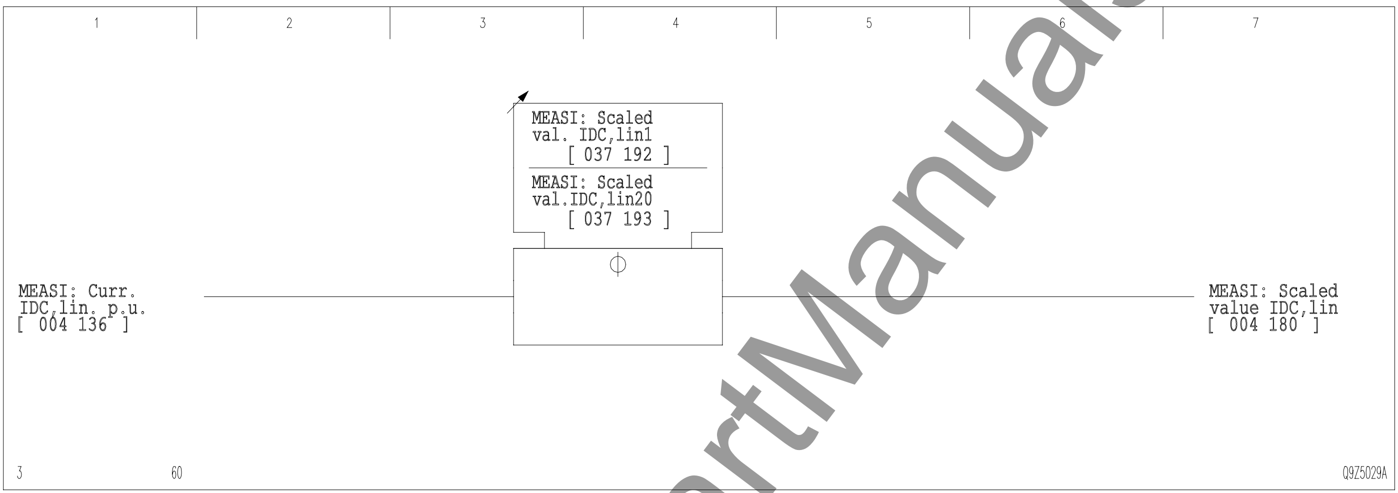
The device is equipped with an open-circuit monitoring function. If current I_{DC} falls below the set threshold, the signal M E A S I : O p e n c i r c . 2 0 m A i n p . is issued.

The input current is monitored in order to protect the 20 mA input against overloading. If it exceeds the fixed threshold of 24.8 mA, the signal M E A S I : O v e r l o a d 2 0 m A i n p u t is issued.



3-20 *Analog direct current input*

Beyond the linearization described above, the user has the option of scaling the linearized values. Thus even negative values, for example, can be displayed and are available for further processing by other functions.



3-21 Scaling the linearized measured value

3.7 Configuration, Operating Mode, and Blocking of the Output Relays (Function Group OUTP)

The C232 has output relays for the output of binary signals. The binary signals to be issued are defined by configuration.

Configuration of the output relays

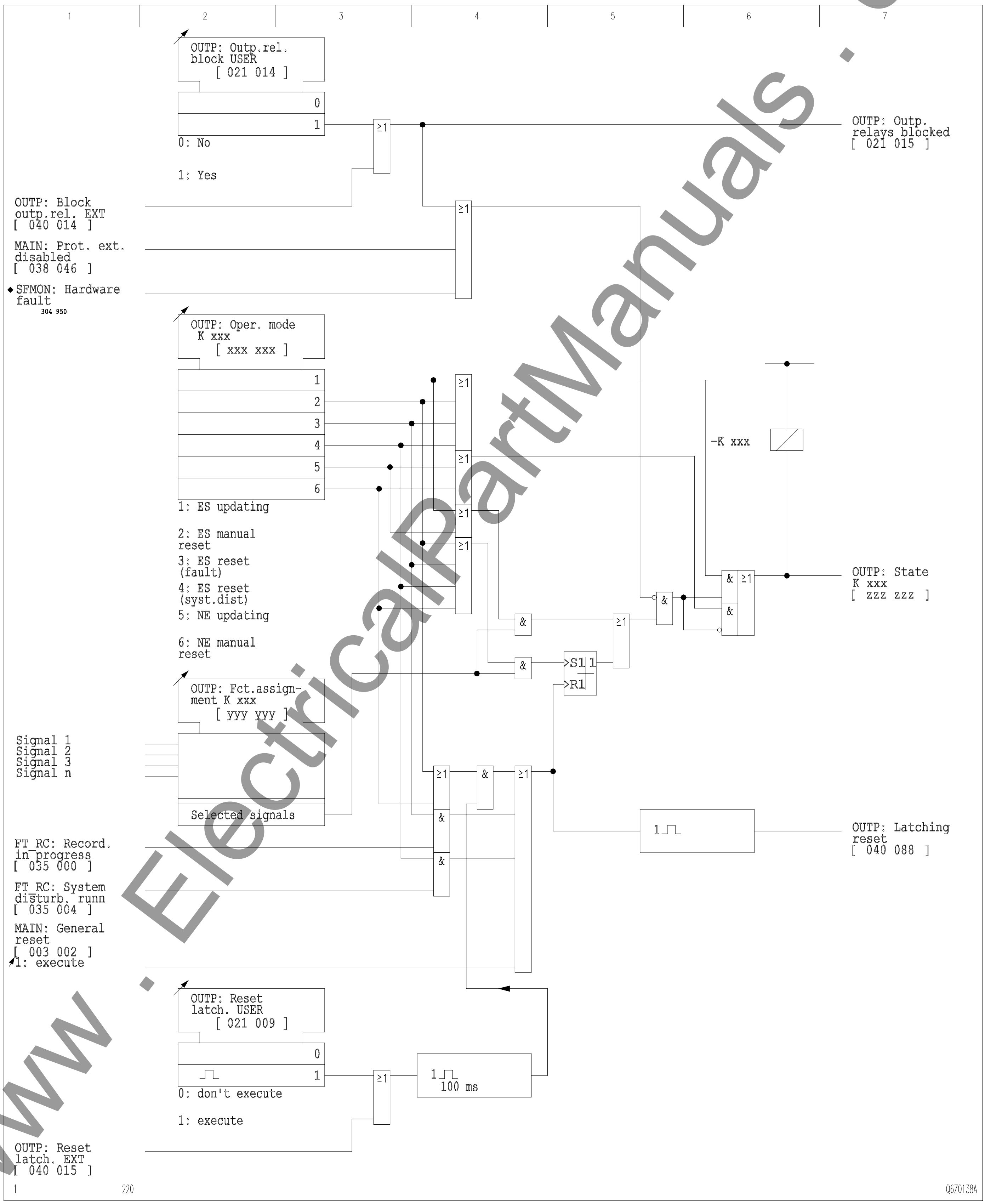
One binary signal can be assigned to each output relay. The same binary signal can be assigned to several output relays by configuration.

Operating mode of the output relays

The user can set an operating mode for each output relay. The operating mode determines whether the output relay will operate in an energize-on-signal arrangement (ES, 'open-circuit principle') or normally energized arrangement (NE, 'closed-circuit principle') and whether it will operate in latching mode. Latching is disabled manually from the local control panel or through an appropriately configured binary signal input either at the onset of a new fault or at the onset of a new system disturbance, depending on the operating mode selected.

Blocking the output relays

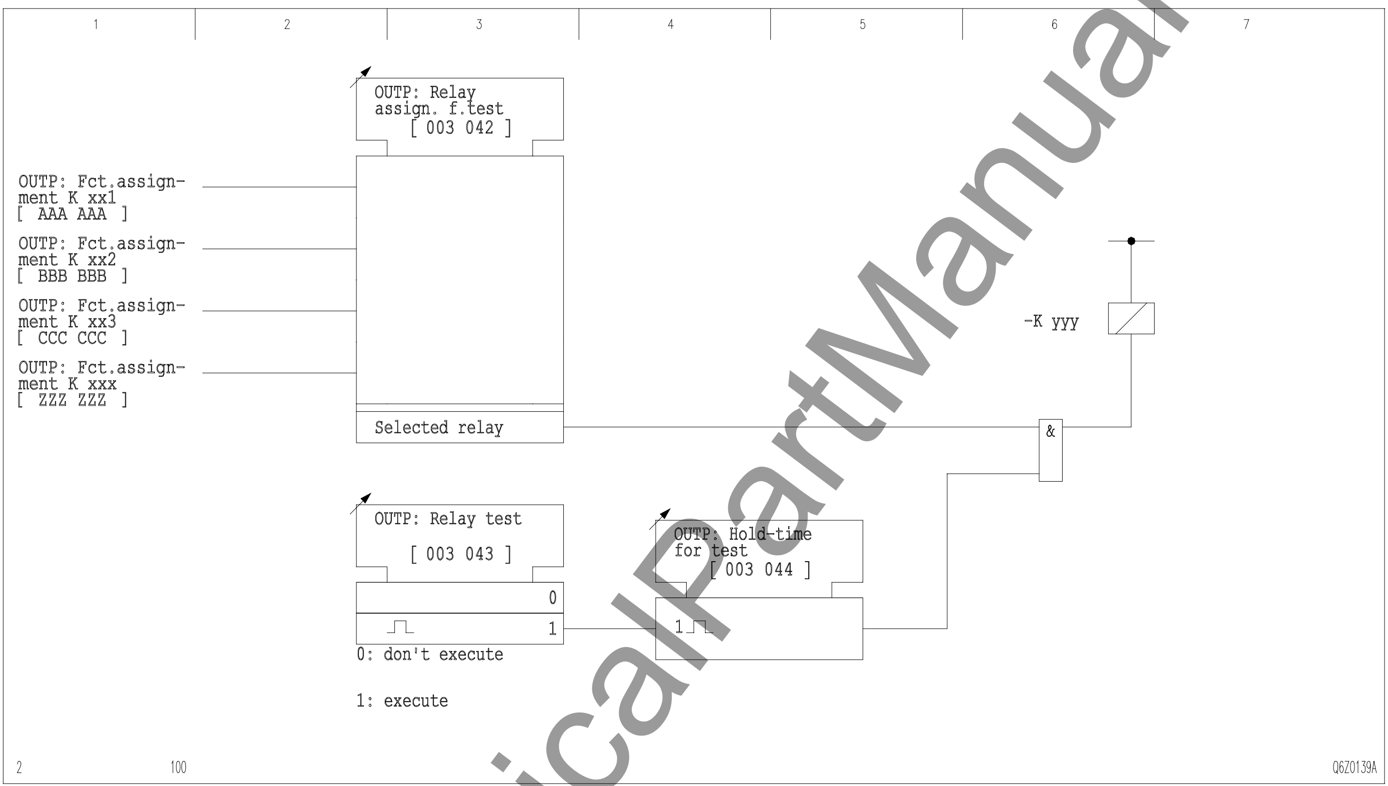
The C232 offers the option of blocking all output relays from the local control panel or by way of an appropriately configured binary signal input. The output relays are likewise blocked if the device is disabled via appropriately configured binary inputs or if the self-monitoring function detects a hardware fault. An output relay configured for the signal MAIN: Blocked/faulty is not included in blocking.



3-22 Configuration, setting the operating mode, and blocking the output relays

Testing the output relays

For testing purposes, the user can select an output relay and trigger it via the local control panel. Triggering persists for the duration of the set hold time.



3-23 Testing the output relays

3.8 Configuration and Operating Mode of the LED Indicators (Function Group LED)

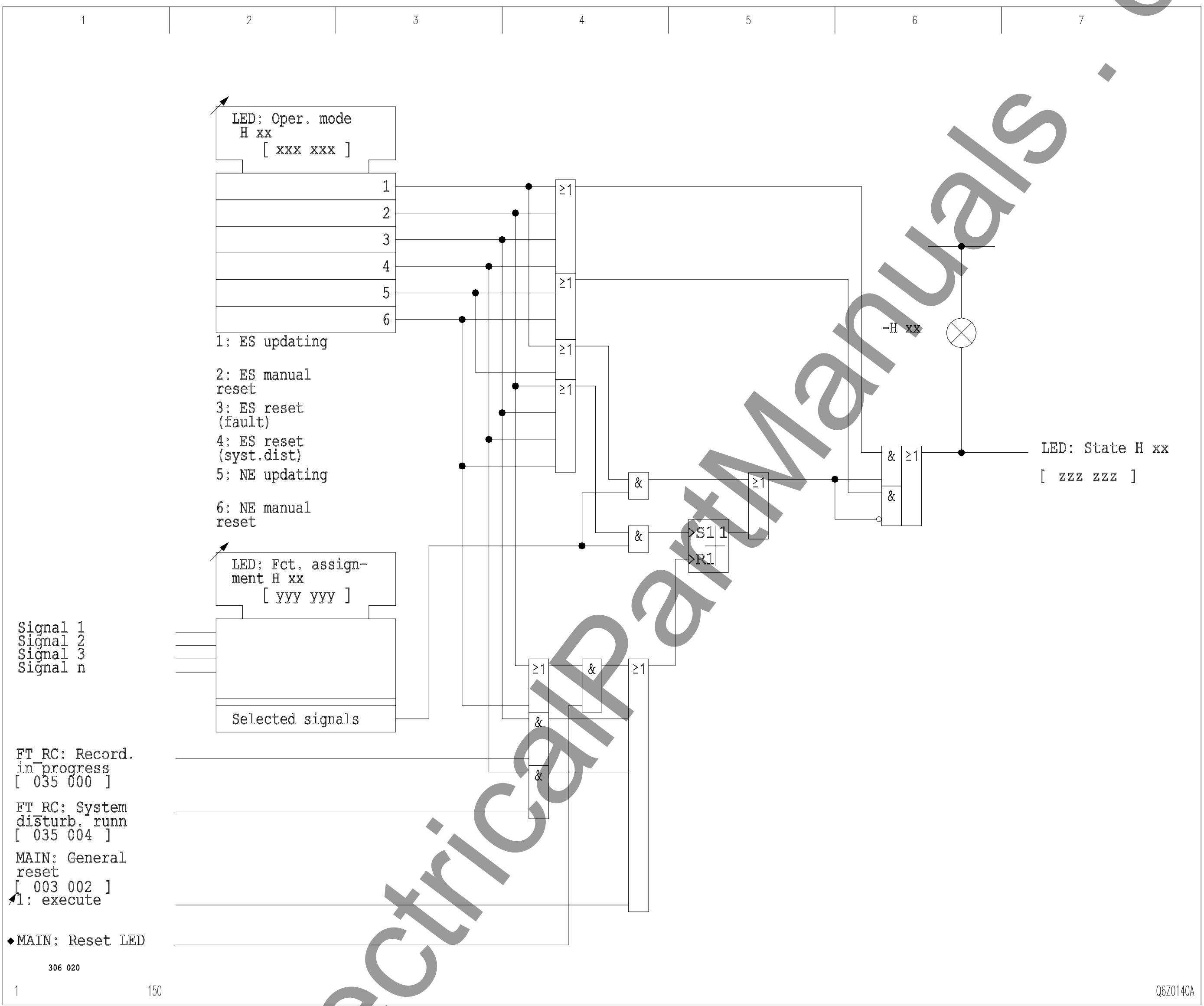
The C232 has 13 LED indicators for the indication of binary signals. Four of the LED indicators are permanently assigned to functions. A further LED has a default assignment but may be reconfigured if required. The other LED indicators are freely configurable.

Configuring the LED indicators

One binary signal can be assigned to each of the freely configurable LED indicators. The same binary signal can be assigned to several LED indicators by configuration.

Operating mode of the LED indicators

The user can set an operating mode for each LED indicator – with the exception of the first one. The operating mode determines whether the LED indicator will operate in an energize-on-signal arrangement (ES, 'open-circuit principle') or normally energized arrangement (NE, 'closed-circuit principle') and whether it will operate in latching mode. Latching is disabled manually from the local control panel or through an appropriately configured binary signal input (see section entitled 'Main Functions of the C232') either at the onset of a new fault or at the onset of a new system disturbance, depending on the operating mode selected.

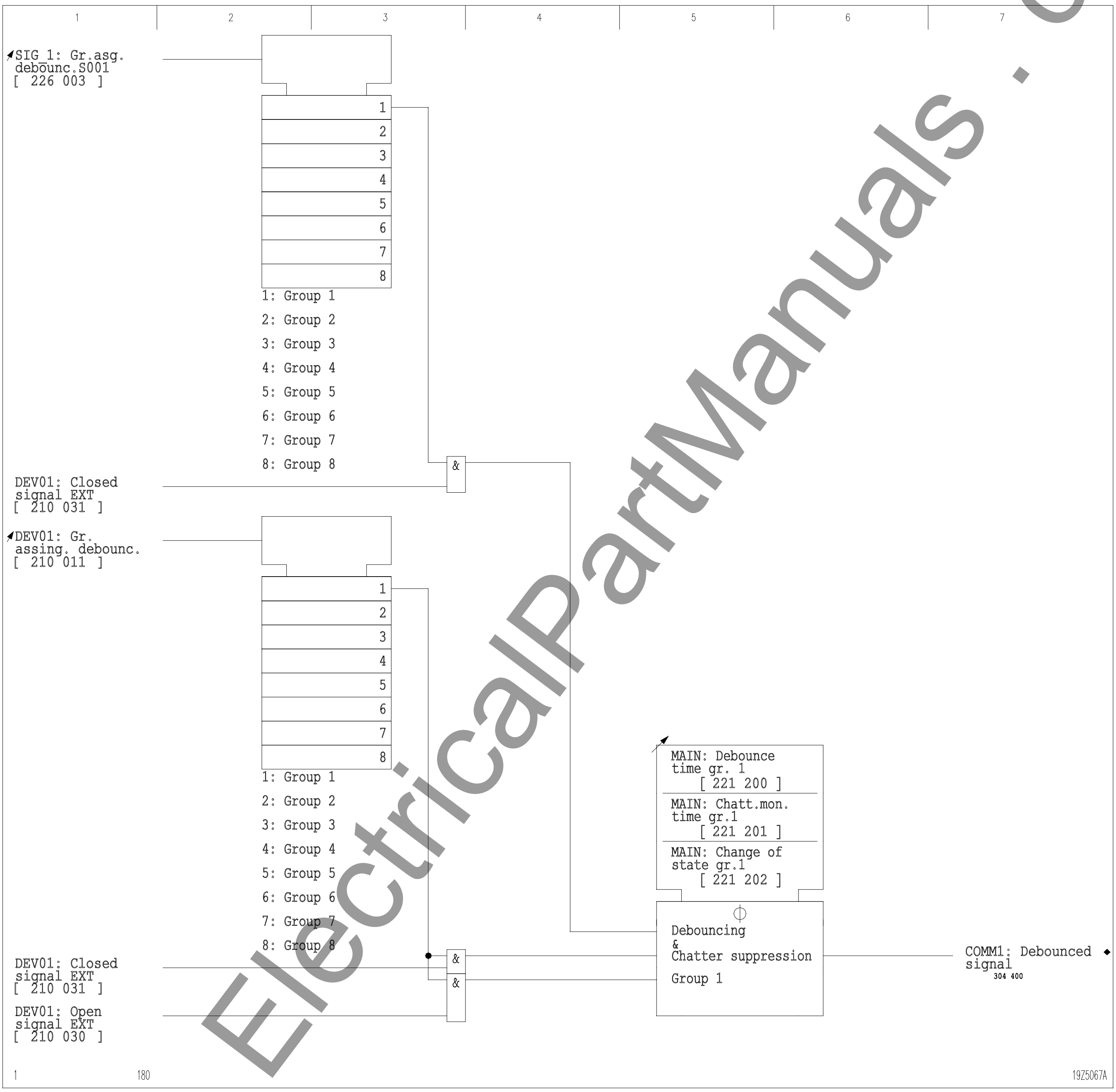


3-24 *Configuration and operating mode of the LED indicators*

3.9 Main Functions of the C232 (Function Group MAIN)

3.9.1 Acquisition of Binary Signals for Control

In the acquisition of signals for control purposes, the functions time tagging, debouncing and chatter suppression are included as a standard. Each of these signals can be assigned to one of eight groups. For each of these groups, the user can set the debouncing time and chatter suppression. Matching of these two parameters achieves the suppression of signal pulse edges as caused by a bouncing contact and of signals originating from transmitters near the trigger point.

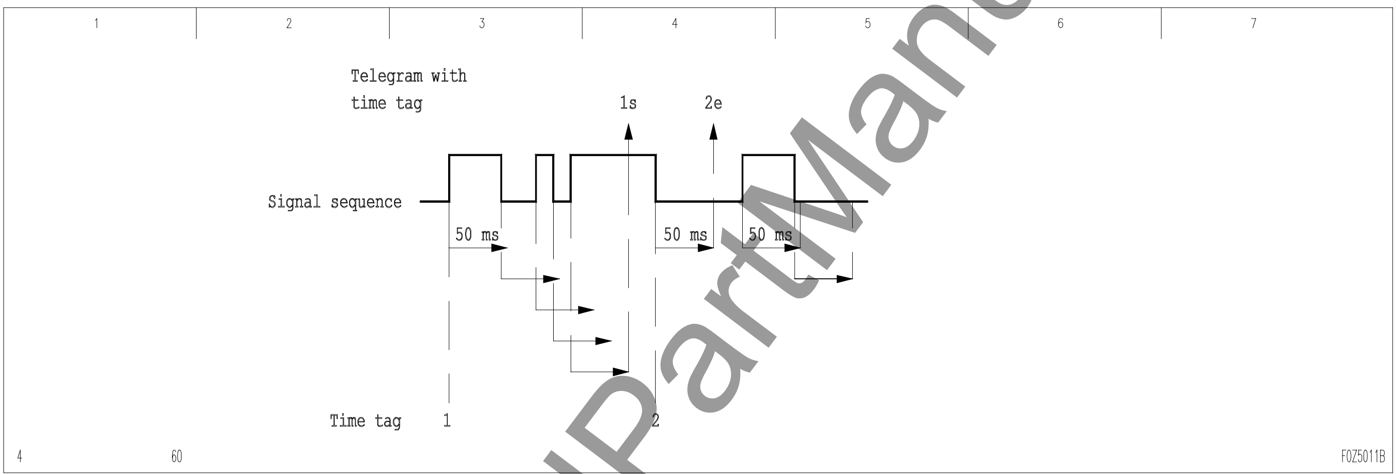


3-25 Group assignment and setting of debouncing and chatter suppression, illustrated for group 1

Debouncing

The first pulse edge of a signal starts a timer stage running for the duration of the set debouncing time. Each pulse edge during the debouncing time retriggers the timer stage. If the signal is stable until the set debouncing time elapses, a telegram containing the time tag of the first pulse edge is generated.

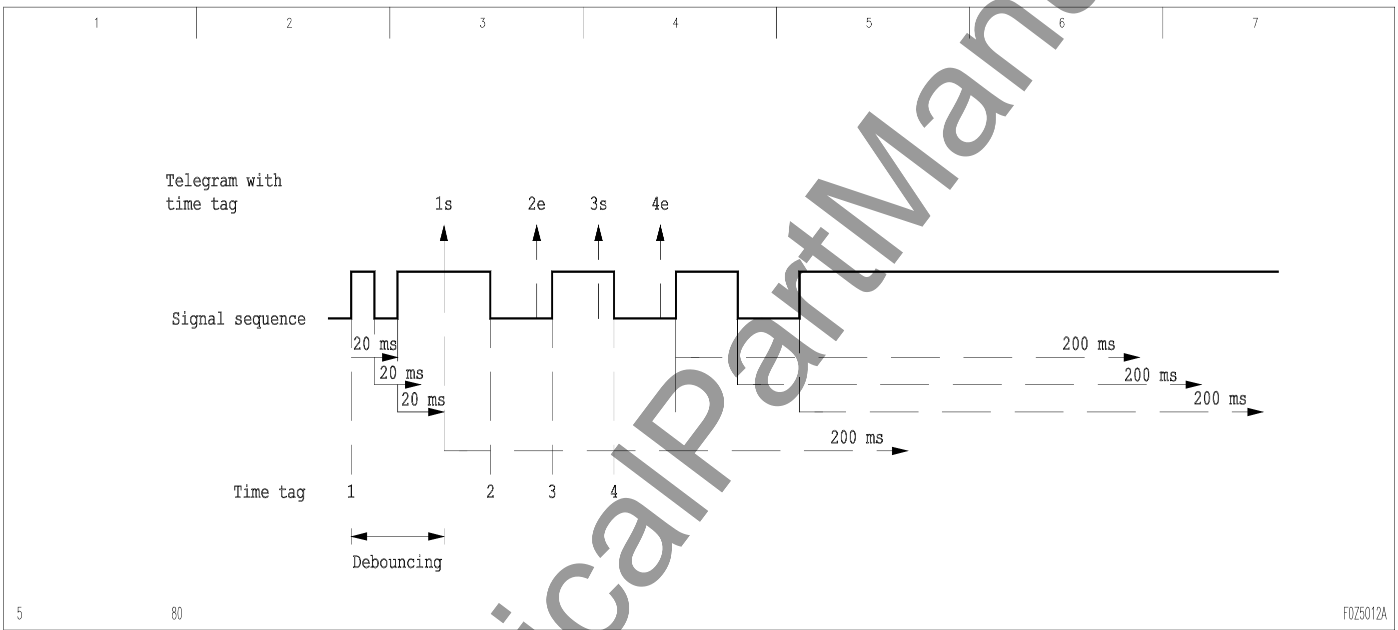
If the signal has not changed its state from the occurrence of the first pulse edge to the elapsing of the set debouncing time, no telegram is generated.



3-26 Signal flow for debouncing, example:
Set debouncing time: 50 ms
Key: s: start, e: end

Chatter suppression

Sending of the first telegram starts a timer stage running for the duration of the set monitoring time. While the timer stage is elapsing, telegrams are generated for the admissible signal changes. The user can set the number of admissible signal changes. After the first “inadmissible” signal change, no further telegrams are generated and the timer stage is retriggered. While the timer stage is elapsing, it is retriggered by each new signal change. Once the timer stage has elapsed, each signal change triggers a telegram.



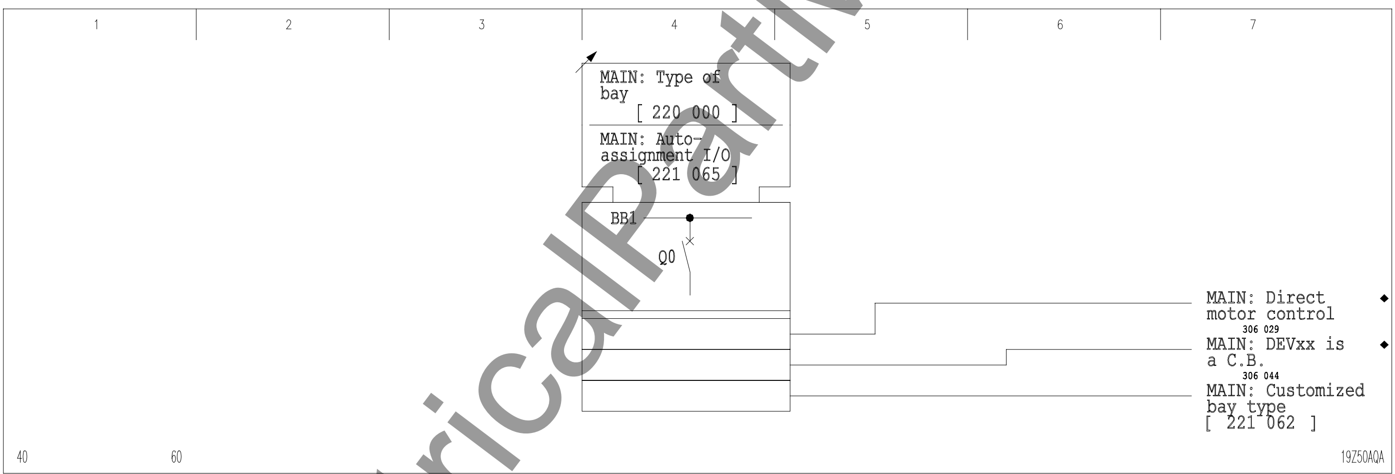
3-27 Signal flow for debouncing and chatter suppression, example:
Set debouncing time: 20 ms
Set chatter monitoring time: 200 ms
Number of admissible signal changes: 4
Key: s: start, e: end

3.9.2 Bay Type Selection

The C232 is designed for the control of up to 6 switchgear units. The topology of a switchbay with its switchgear units is defined by the bay type.

The C232 offers a selection from pre-defined bay types. Should the required bay type be missing from the standard selection then the user can contact the manufacturer of the C232 to request the definition of a customized bay type for loading into the C232. The number of this additional bay type will then be displayed at MAIN: Customized bay type.

Once the user has selected a bay type, the C232 can automatically configure the binary inputs and outputs with function assignments for the control of switchgear units. The assignment of inputs and outputs for an automatic configuration is shown in the List of Bay Types in the Appendix.



3-28 Bay type selection

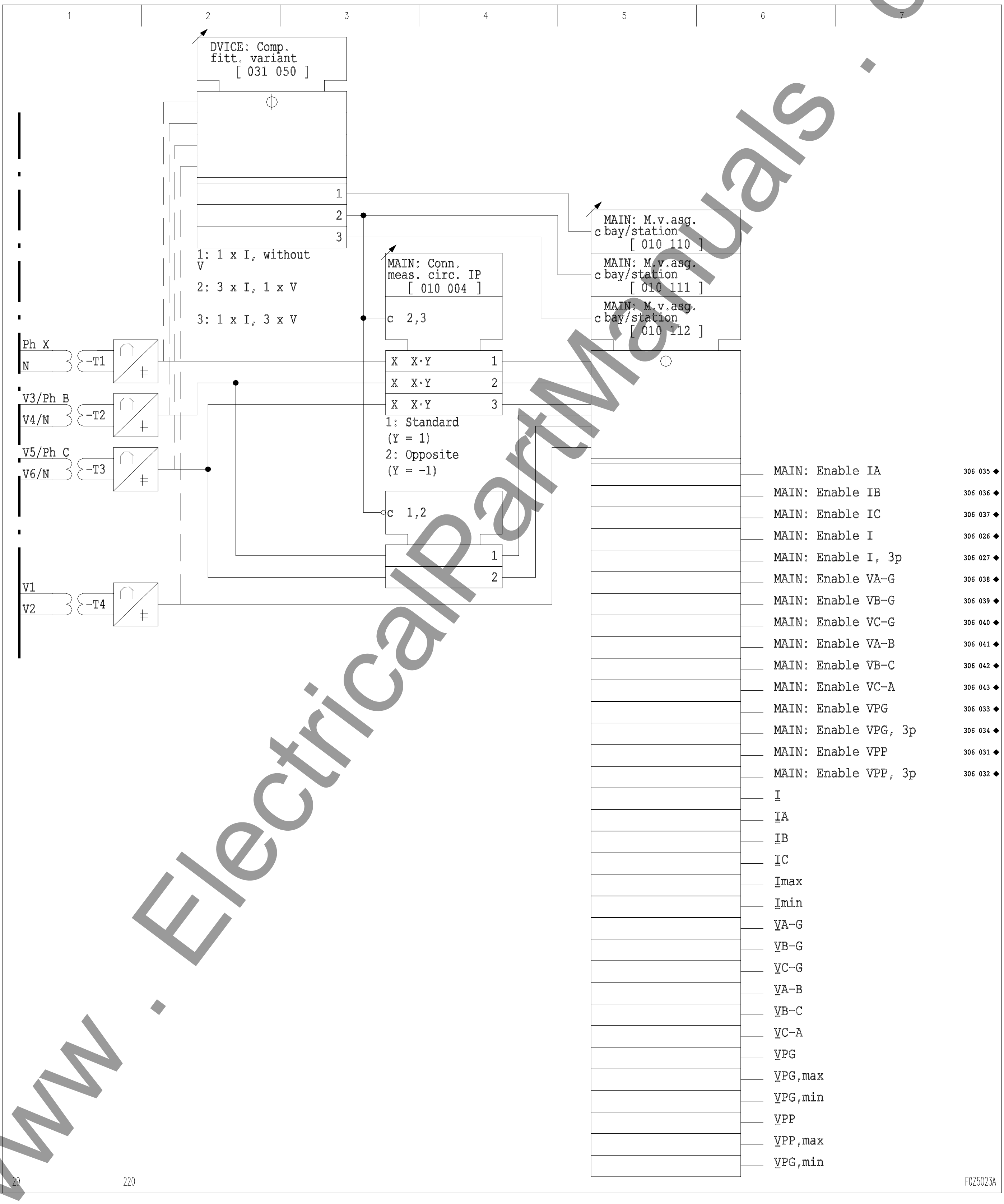
3.9.3 Conditioning the Measured Variables

Different combinations of fitted measuring transformers for the acquisition of current and voltage values are available depending on the selected model and the options specified in ordering. The C232 recognizes the fitted transformer combination during startup. Depending on this combination, measured value assignments can be performed. Only those setting parameters and measured values will be displayed that can be monitored or determined depending on the fitted transformers and the measured value assignments.

The measured variables are – electrically isolated – converted to normalized electronics levels. The analog quantities are digitized and are thus available for further processing.

Settings that do not refer to nominal quantities are converted by the C232 to nominal quantities. For this purpose, the user must set the secondary nominal currents and nominal voltages of the system transformers.

The connection arrangement of the measuring circuits must be set in the C232. Figure 3-29 shows the standard connection. The phase of the digitized currents is rotated 180° by this setting.



3-29 Connecting the C232 measuring circuits

3.9.4 Operating Data Measurement

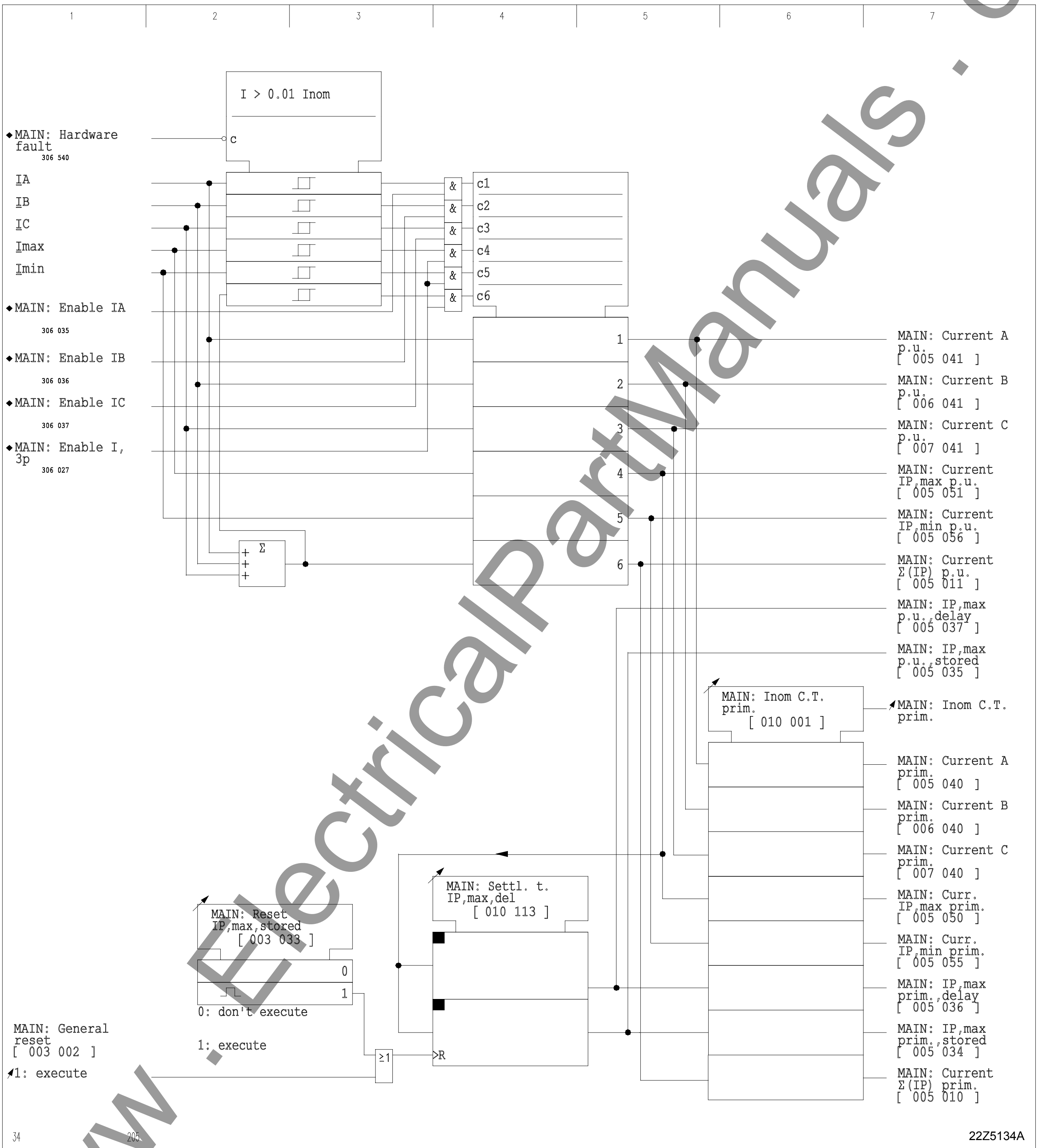
The C232 is provided with an operating data measurement function for the display of the measured currents and voltages and the variables derived from these measured values . The currents need to exceed 0.01 I_{nom} for measured values to be determined; for the voltages the threshold level is 0.1 V_{nom}. If these thresholds are not exceeded, the value *not measured* is displayed. The following measured operating data - depending on the fitted measuring transformers - are displayed:

- Phase currents for all three phases
- Maximum and maximum phase current
- Delayed and stored maximum phase current
- Residual current evaluated by the C232
- Phase-to-ground voltages
- Sum of the three phase-to-ground voltages
- Phase-to-phase voltages
- Maximum phase-to-phase voltage
- Minimum phase-to-phase voltage
- Maximum phase-to-ground voltage
- Minimum phase-to-ground voltage
- Active and reactive power
- Active power factor
- Load angle φ
- Frequency
- Active and reactive energy output and input

The measured data are updated at 1 s intervals. Updating is interrupted if a general starting state is present or if the self-monitoring function detects a hardware fault.

Measured current values

The measured current values are displayed both as per-unit quantities referred to the nominal quantities of the C232 and as primary quantities. In order for values to be displayed as primary values, the primary nominal current of the system transformer needs to be set in the C232.



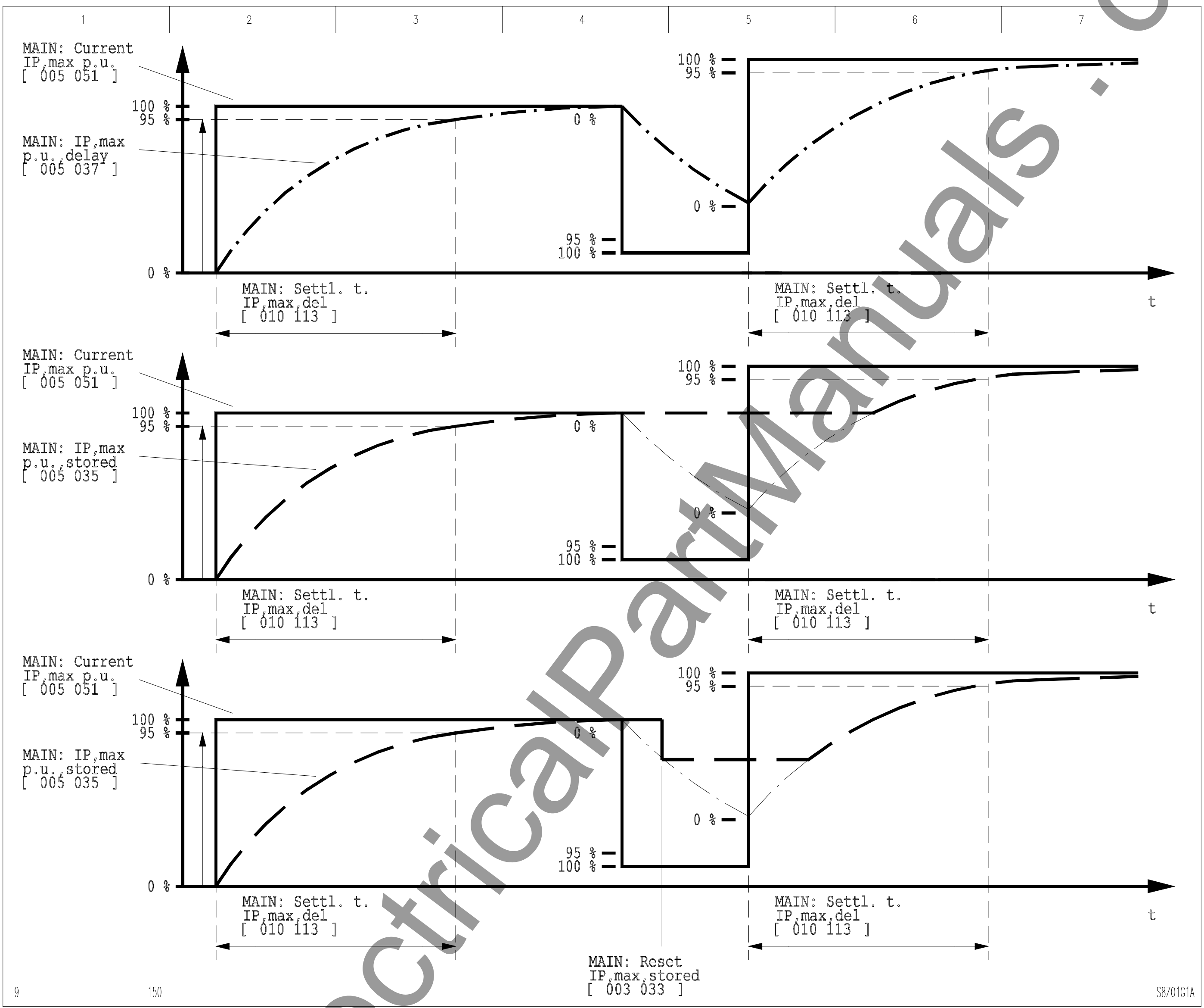
3-30 Measured operating data - phase current

Delayed maximum phase current display

The C232 offers the option of delayed display of the maximum value of the three phase currents. The delayed maximum phase current display is an exponential function of the maximum phase current $I_{P,max}$ (see upper curve in Figure 3-31). At MAIN: Settl. t. IP,max,del the user can set the time after which the delayed maximum phase current display will have reached 95 % of maximum phase current $I_{P,max}$.

Stored maximum phase current display

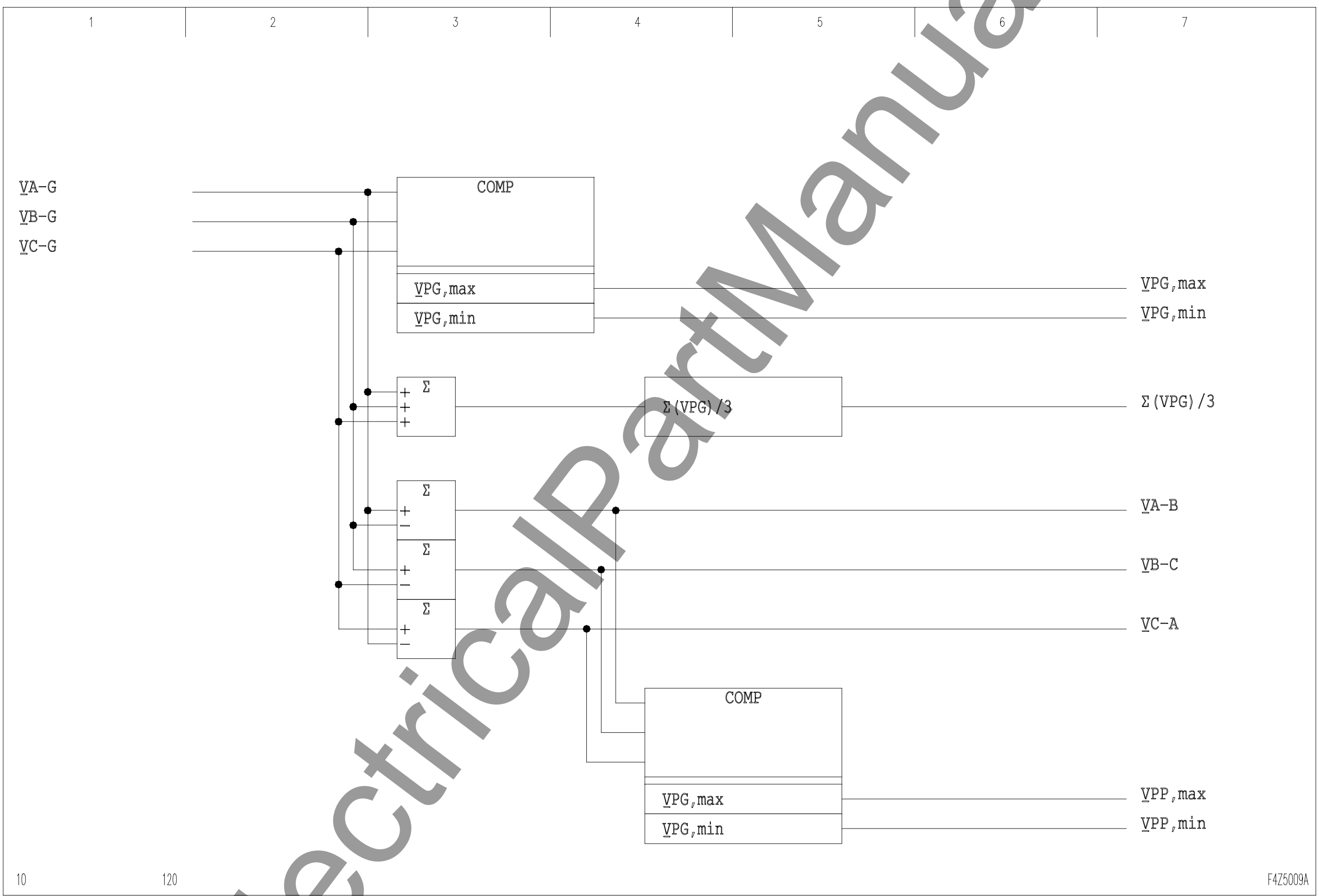
The stored maximum phase current follows the delayed maximum phase current. If the value of the delayed maximum phase current is declining, then the highest value of the delayed maximum phase current remains stored. The display remains constant until the actual delayed maximum phase current exceeds the value of the stored maximum phase current (see middle curve in Figure 3-31). At MAIN: Reset IP,max,stored the user can set the stored maximum phase current to the actual value of the delayed maximum phase current (see lower curve in Figure 3-31).



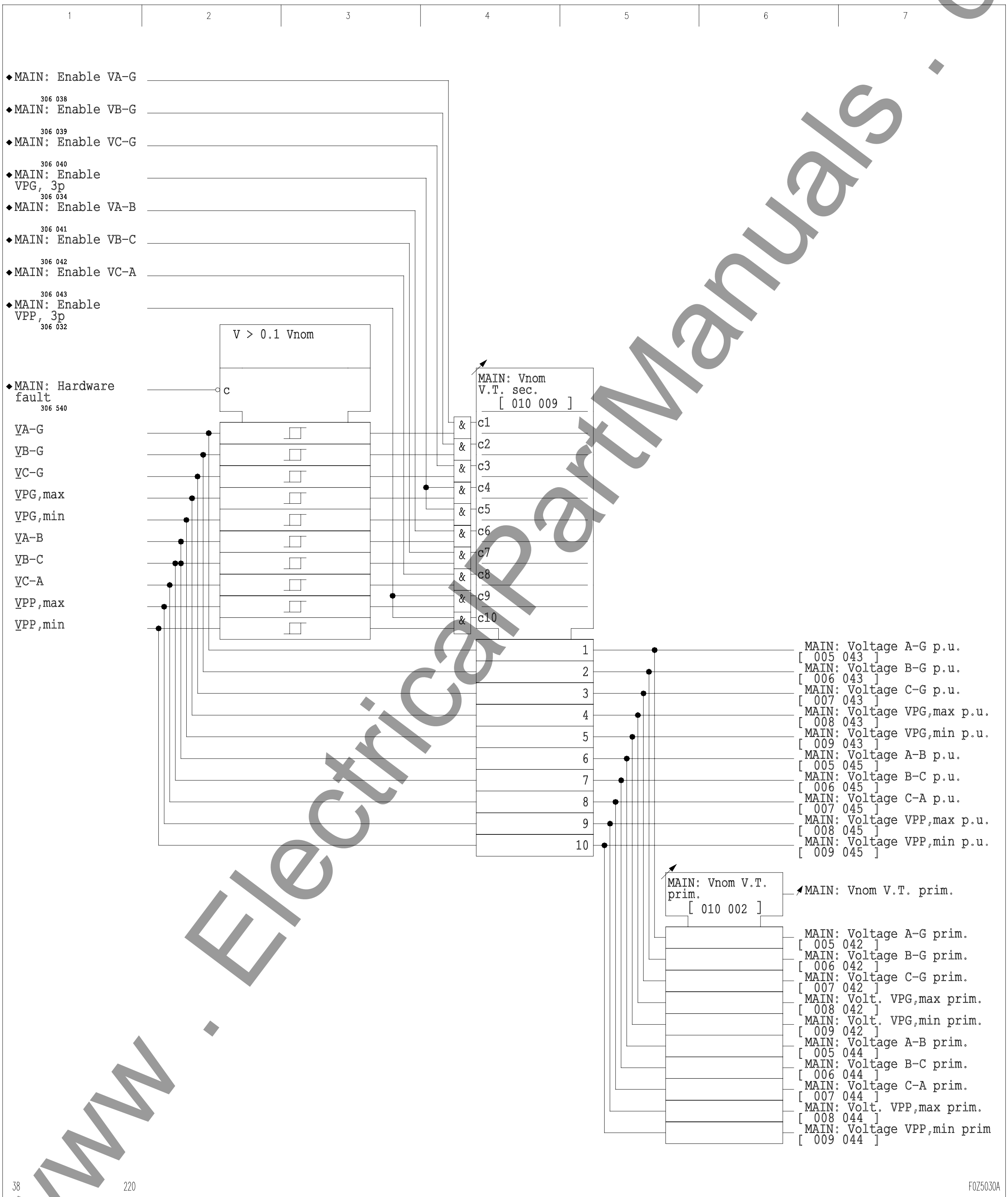
3-31 *Operation of delayed and stored maximum phase current display*

Measured voltage values

The measured voltage values are displayed both as per-unit quantities referred to the nominal quantities of the C232 and as primary quantities. In order for values to be displayed as primary values, the primary nominal voltage of the system transformer needs to be set in the C232.



3-32 *Determining the minimum and maximum phase-to-ground and phase-to-phase voltages*



3-33 Measured operating data - phase-to-ground and phase-to-phase voltages

Measured values for power, active power factor, and load angle

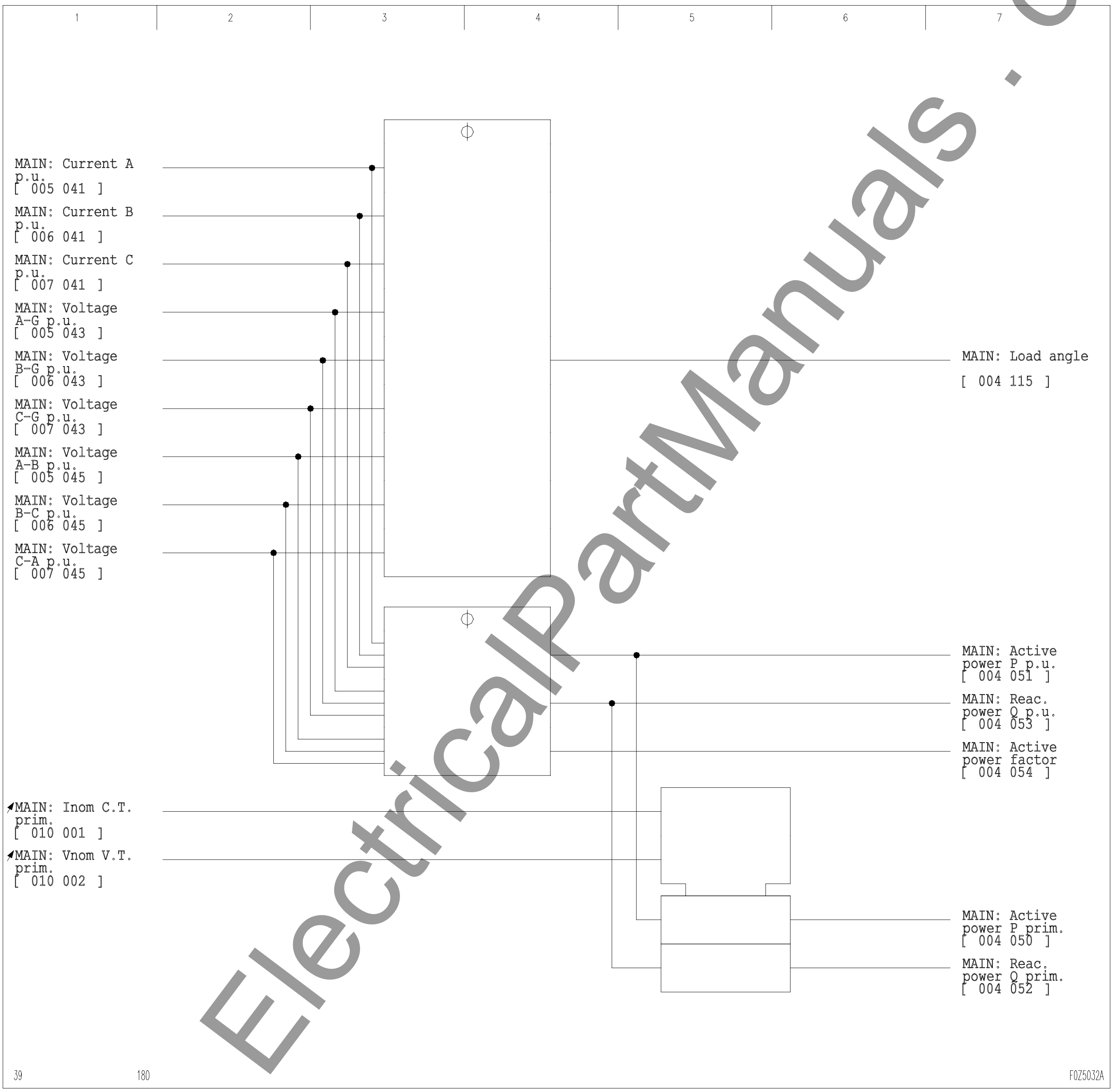
Where current and voltage are available as operating data, the C232 determines the active and reactive power plus the active power factor. Power is displayed with a plus or minus sign governed by the angle between current and voltage.

Due to the variation in the combination of measuring transformers fitted, the following combinations of measured variables are possible:

- One current and one voltage
- Three currents and one voltage
- One current and three voltages

If more than one current or one voltage is measured, the C232 selects the matching current/voltage pair and determines the load angle.

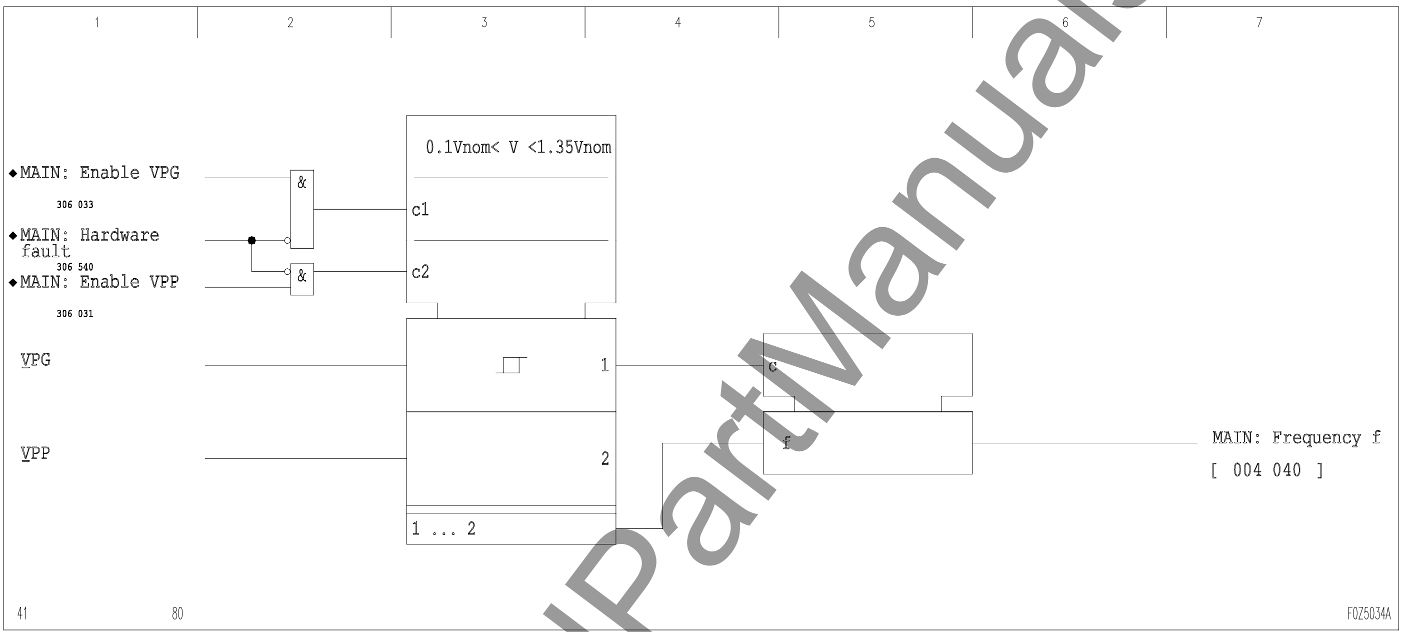
Active and reactive power are not intended to be used for billing purposes. High rate of changes of measurements may cause degradation of functionality of operating data measurement.



3-34 Measured operating data - power, active power factor, and angle

Frequency

If the C232 measures at least one voltage and if this voltage has an amplitude in the range 0.1 V_{nom} < V < 1.35 V_{nom}, the frequency is determined.

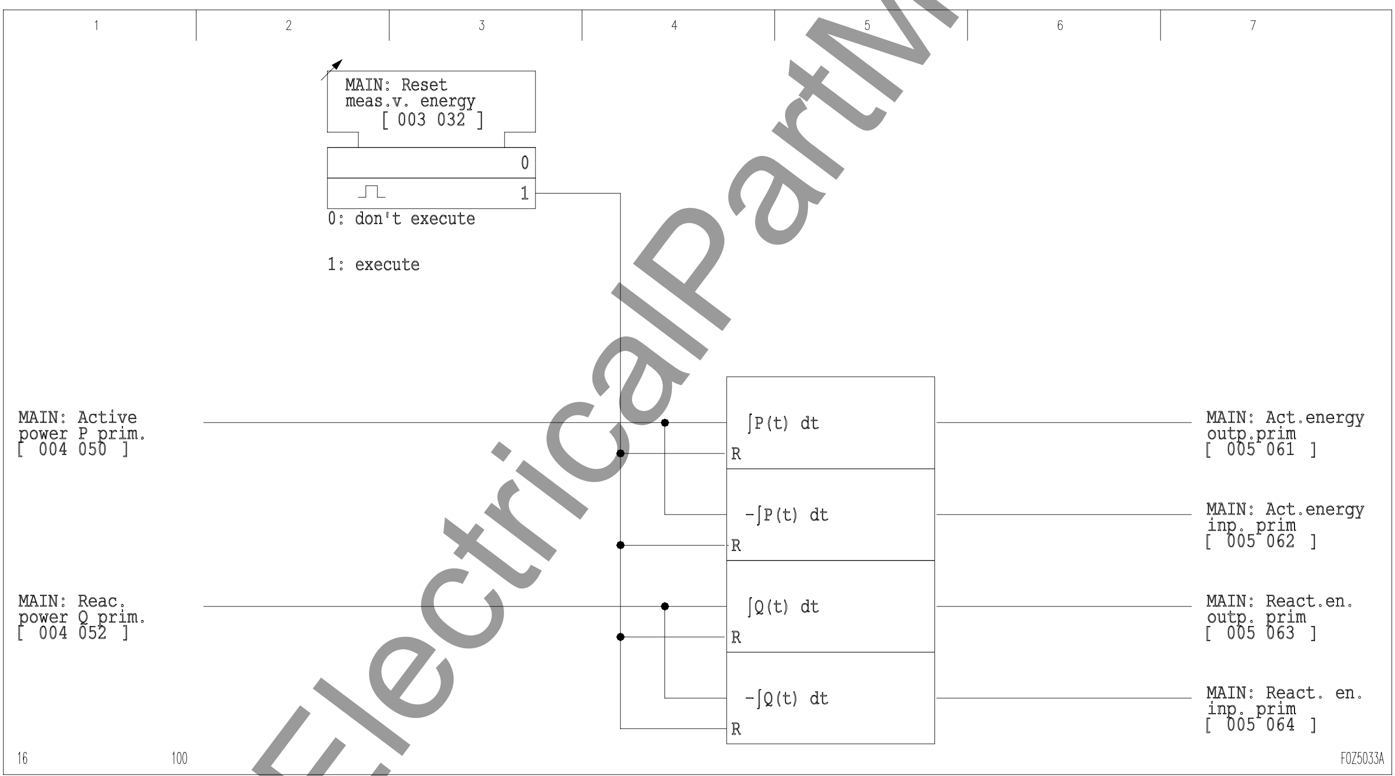


3-35 Frequency measurement

Active and reactive energy output and input

The C232 determines the active and reactive energy output and input based on the primary active or reactive power. Once the maximum value of energy output or input is reached, integration begins again from zero. Energy output and input can be reset jointly at MAIN: Reset meas.v. energy.

Active and reactive power are not intended to be used for billing purposes. High rate of changes of measurements may cause degradation of functionality of operating data measurement.



3-36 Determining the active and reactive energy output and input

3.9.5 Configuring and Enabling the Device Functions

The user can adapt the unit to the requirements of a specific high-voltage system by configuring the device functions. By including the desired device functions in the configuration and canceling all others, the user creates an individually configured unit appropriate for the specific application. Parameters, signals and measured values of canceled device functions are not displayed on the local control panel. Functions of general applicability such as operating data recording (OP_RC) or main functions (MAIN) cannot be canceled.

Canceling a device function

The following conditions must be met before a device function can be canceled or removed:

- The device function must be disabled.
- None of the functions of the device function to be canceled may be assigned to a binary input.
- None of the signals of the device function must be assigned to a binary output or an LED indicator.

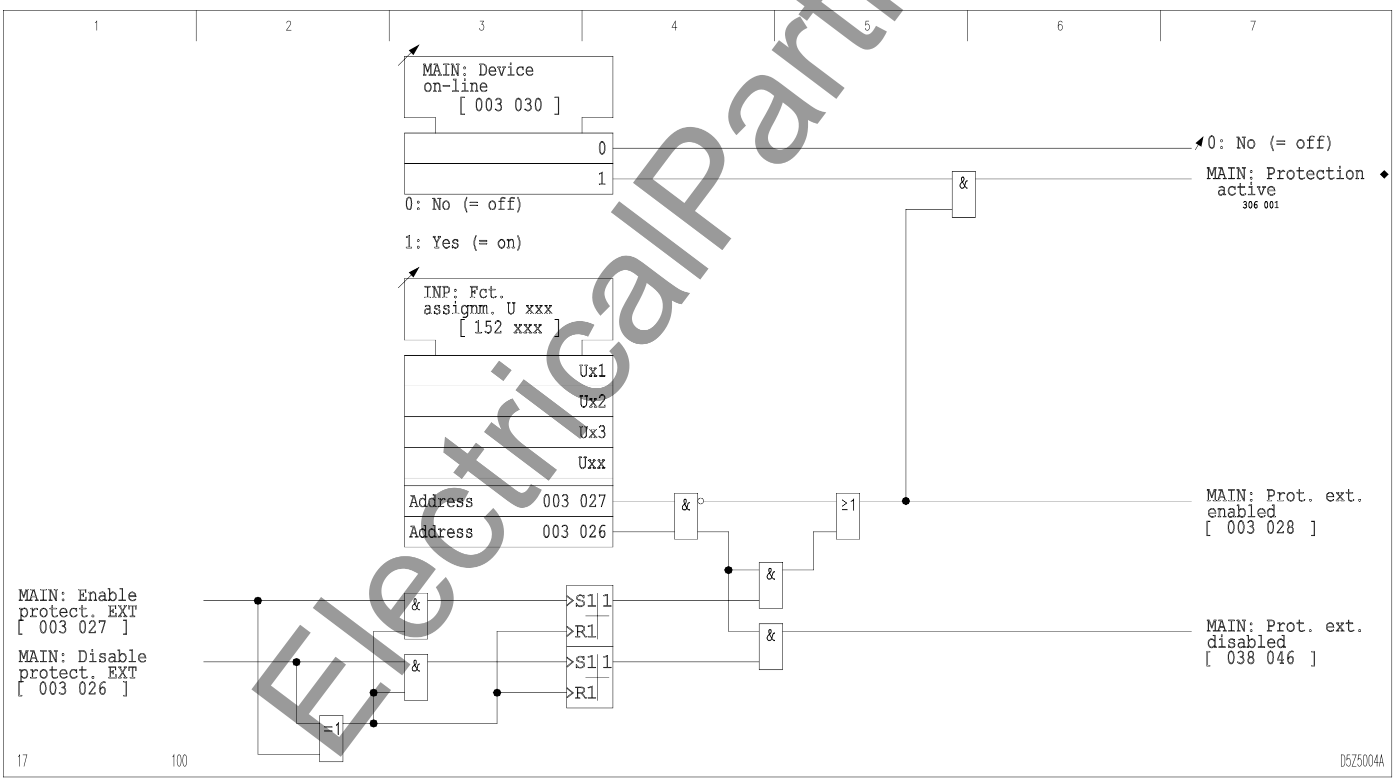
If the above conditions are met, proceed through the Configuration Parameters branch of the menu tree to access the setting parameters relevant for canceling device functions. If you wish to cancel the LIMIT function group, for example, access the setting parameter `LIMIT: Function group LIMIT` and set its value to *Without*. Should you wish to re-include the LIMIT function in the device configuration, access the same setting parameter and set the value to *With*.

The device function to which a parameter, a signal, or a measured value belongs is defined by the function group descriptor such as 'LIMIT'. In the descriptions of the device functions in the following sections of this manual, the device function being described is presumed to be included in the configuration.

Enabling or disabling a device function

Besides canceling device functions from the configuration, it is also possible to disable protection via a function parameter or binary signal inputs. Protection can only be disabled or enabled through binary signal inputs if the MAIN: Disable protect. EXT and MAIN: Enable protect. EXT functions are both configured. When only one or neither of the two functions is configured, this is interpreted as ‘Protection externally enabled’. If the triggering signals of the binary signal inputs are implausible – as for example when they both have a logic value of ‘1’, then the last plausible state remains stored in memory.

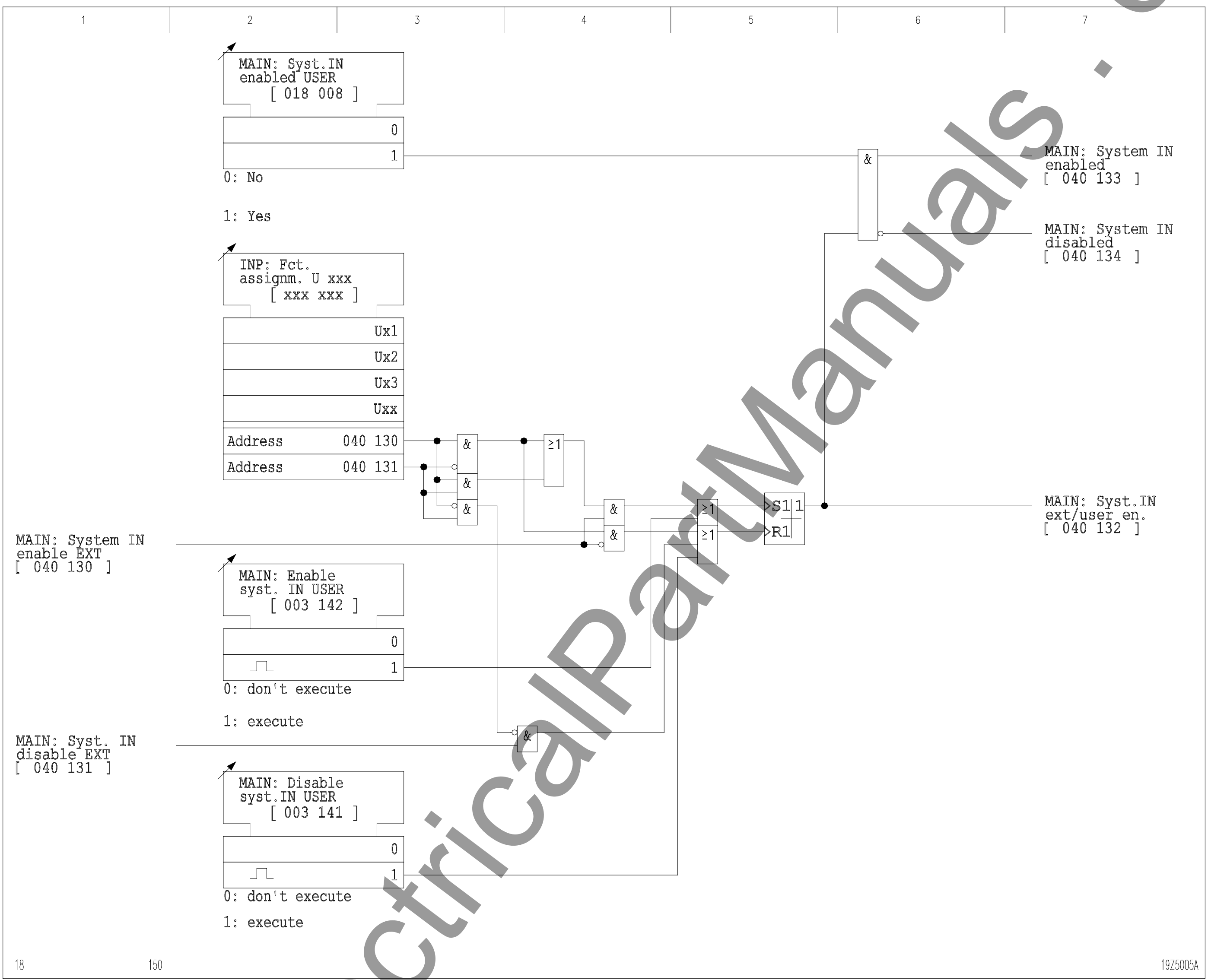
Note: If the protection function is disabled via the binary signal input that is configured for MAIN: Disable protect. EXT, then there is no MAIN: Blocked/faulty signal.
(The signal MAIN: Blocked/faulty is coupled to the activation of the LED labeled ‘OUT OF SERVICE’).



3-37 *Enabling or disabling a device function*

Enabling or disabling the residual current systems of the DTOC/IDMT protection

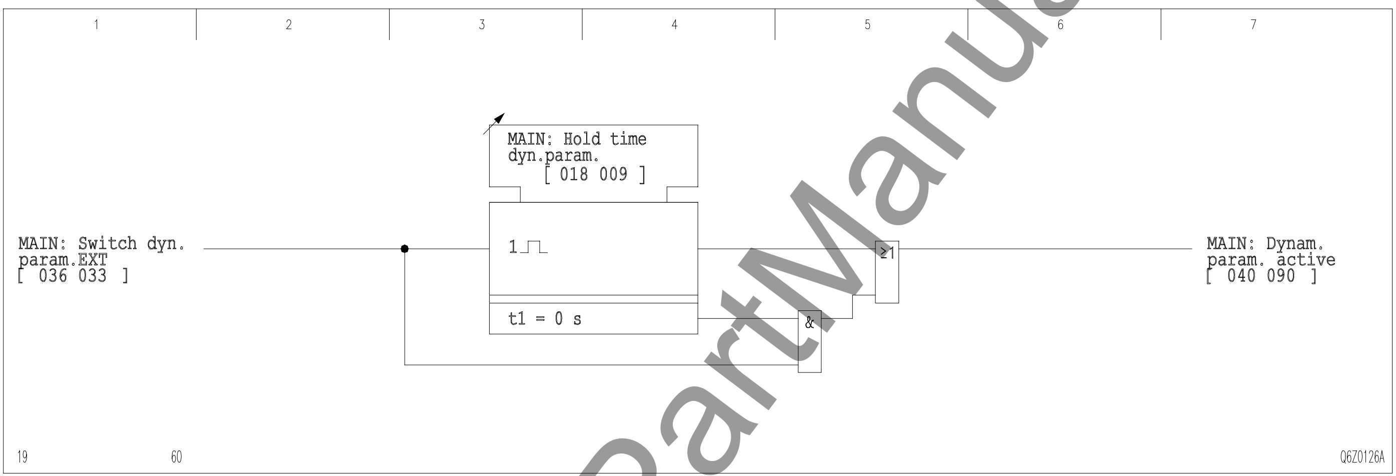
The function can be disabled or enabled from the integrated local control panel or through appropriately configured binary signal inputs. Whether the enabling of the residual current systems of the DTOC/IDMT protection by one of these two means is effective depends on the setting at MAIN: Syst.IN enabled USER. Enabling from either the integrated local control panel or through binary signal inputs is equally effective. If only MAIN: System IN enable EXT is assigned to a binary signal input, the residual current measuring systems of the DTOC/IDMT protection will be enabled by a positive edge of the input signal; they will be disabled by a negative edge. If only MAIN: System IN disable EXT is assigned to a binary signal input, a signal present at this input will have no effect.



3-38 Enabling or disabling the residual current systems of the DTOC/IDMT protection

3.9.6 Activation of Dynamic Parameters

For several of the protection functions, it is possible to switch for the duration of the set hold time to other settings - the "dynamic parameters" – through an appropriately configured binary signal input. If the hold time is set to 0 s, the switching is effective while the binary signal input is being triggered.



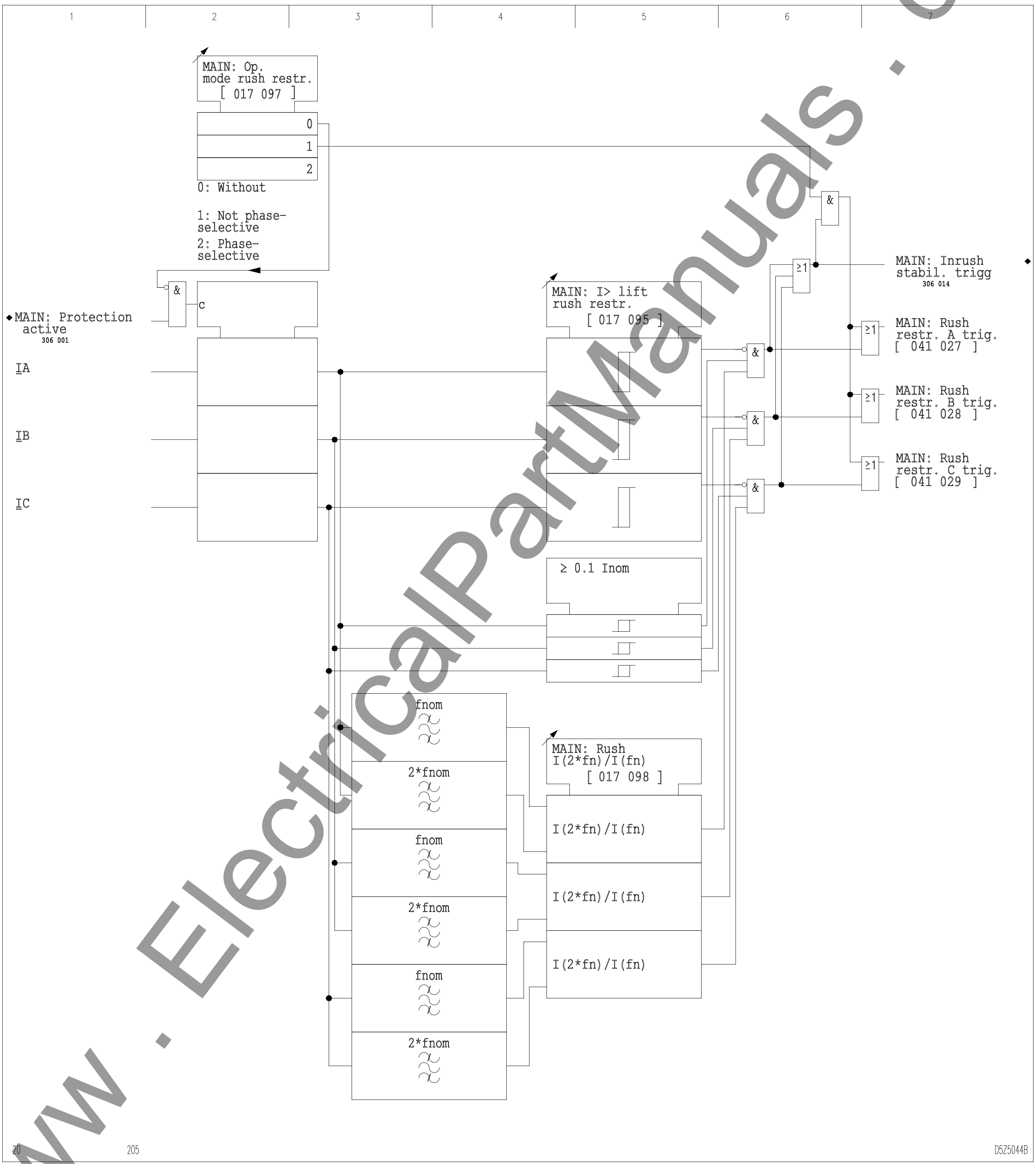
3-39 Activation of dynamic parameters

3.9.7 Inrush Stabilization (Harmonic Restraint)

The inrush stabilization function detects high inrush current flows that occur when transformers or machines are connected. The function will then block the following functions:

- The phase current starting of definite-time overcurrent protection (DTOC)
- The phase current starting and the negative-sequence current starting of inverse-time overcurrent protection (IDMT)

The inrush stabilization function identifies an inrush current by evaluating the ratio of the second harmonic current components to the fundamental wave. If this ratio exceeds the set threshold, then the inrush stabilization function operates. Another settable current trigger blocks inrush stabilization if the current exceeds this trigger. By setting the operating mode, the user determines whether inrush stabilization will operate phase-selectively or across all phases.

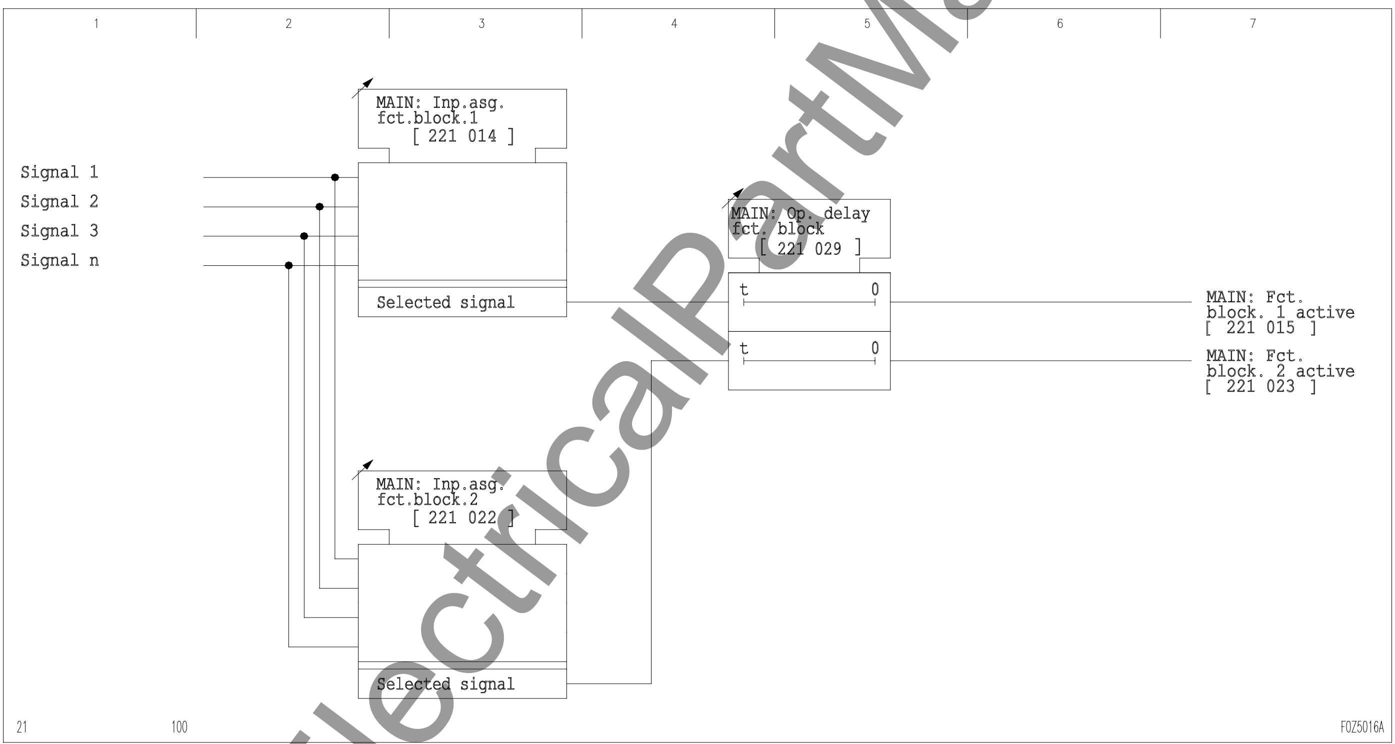


3-40 *Inrush stabilization (harmonic restraint)*

3.9.8 Function Blocks

By inclusion of the function blocks in the bay interlock conditions, switching operations can be prevented independently of the switching status at the time, for example, by an external signal ”CB drive not ready” or by the trip command of an external protection device.

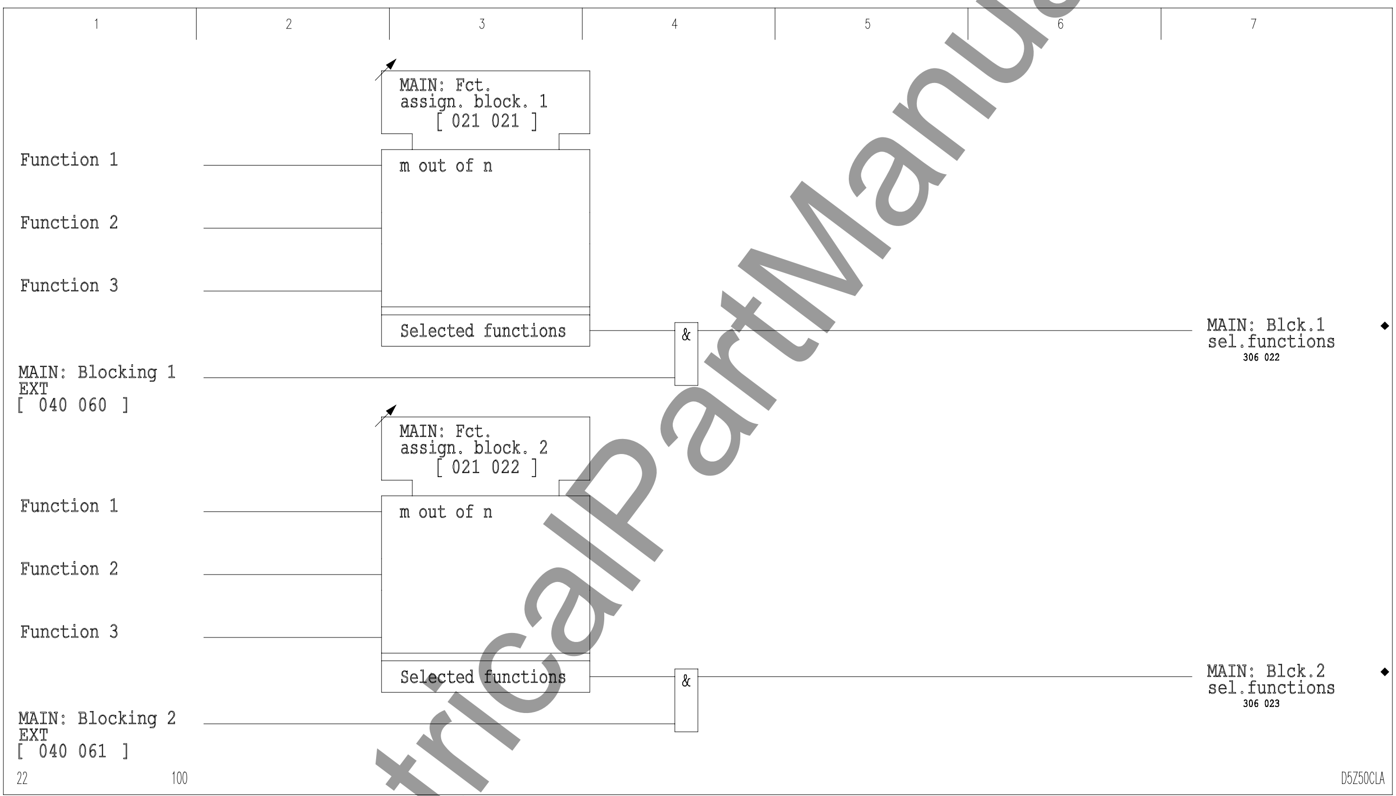
To the function blocks 1 and 2, the binary input signals conditioned by debouncing and chatter suppression or the output signals of the programmable logic function can be assigned by setting a '1 out of n' parameter. The input signal of the function blocks starts a timer stage. Once this has elapsed, the signal MAIN: Fct. block. 1 active is issued.



3-41 Function blocks

3.9.9 Multiple Blocking

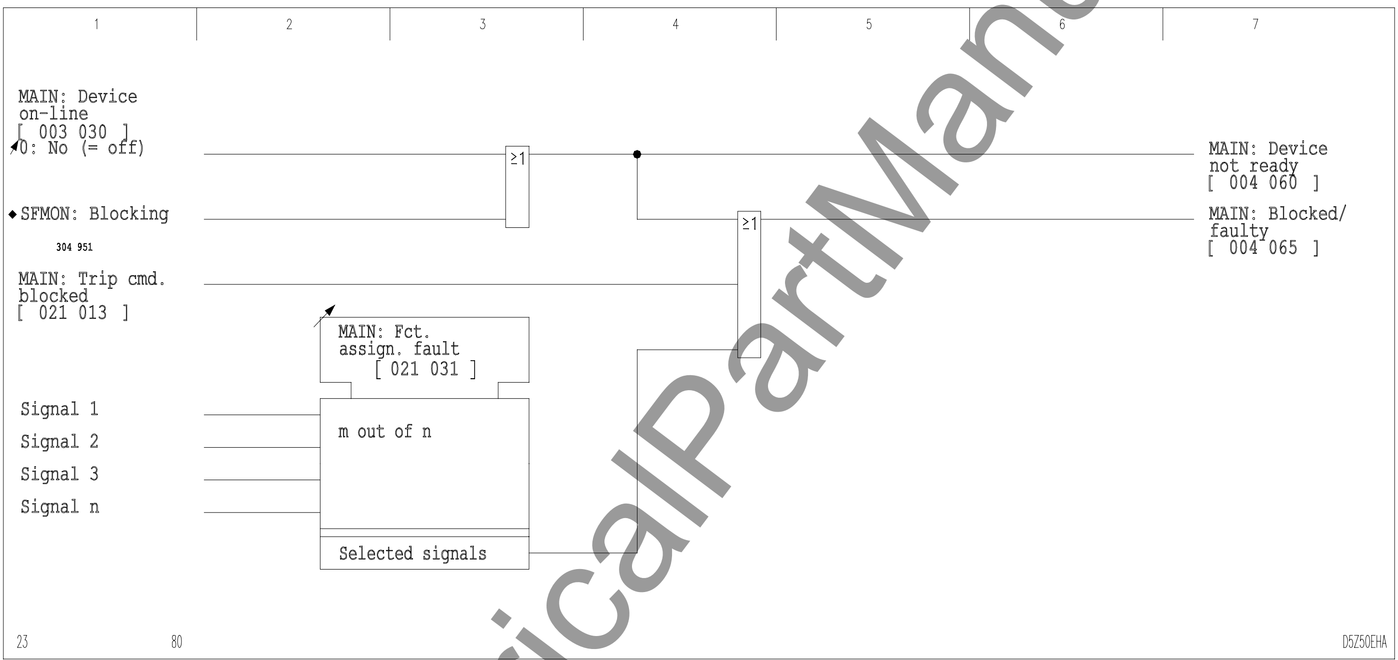
Two multiple blocking conditions may be defined by selecting 'm out of n' parameters. The items available for selection are found in the Address List. In this way the functions defined by the selection can be blocked by way of an appropriately configured binary signal input.



3-42 Multiple blocking

3.9.10 Blocked / Faulty (OUT OF SERVICE)

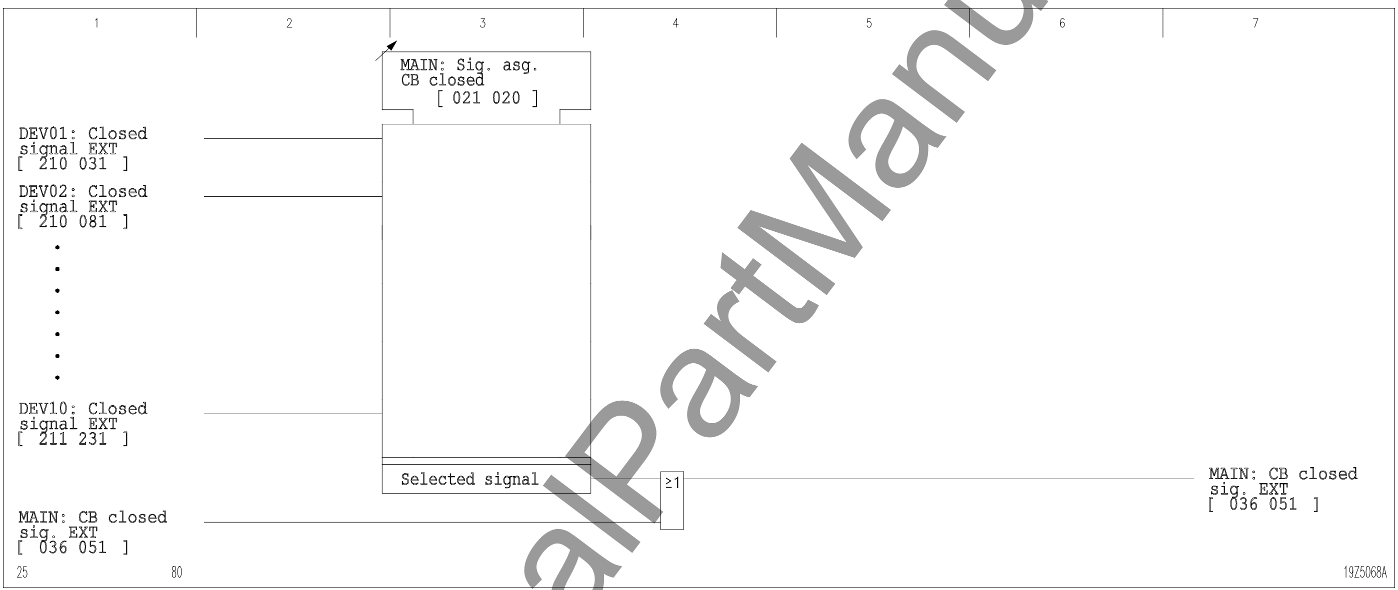
If the protection functions are blocked, this condition is signaled by a steady light from yellow LED indicator H 2 on the local control panel and also by a signal through the output relay configured for MAIN: Blocked/faulty. In addition, the user can select the functions that will produce the MAIN: Blocked/faulty signal by setting an 'm out of n' parameter. (The signal MAIN: Blocked/faulty is coupled to the activation of the LED labeled 'OUT OF SERVICE').



3-43 'Blocked/faulty' signal

3.9.11 Coupling between Control and Protection for the CB Closed Signal

Bay type selection defines the external device (DEV01 or DEV02 or ...) that represents the circuit breaker. Coupling between control and protection for the “Closed” position signal is achieved by the setting MAIN: Sig. asg. CB closed. As a result, the CB status signal needs to be assigned to one binary input only if this coupling is implemented.



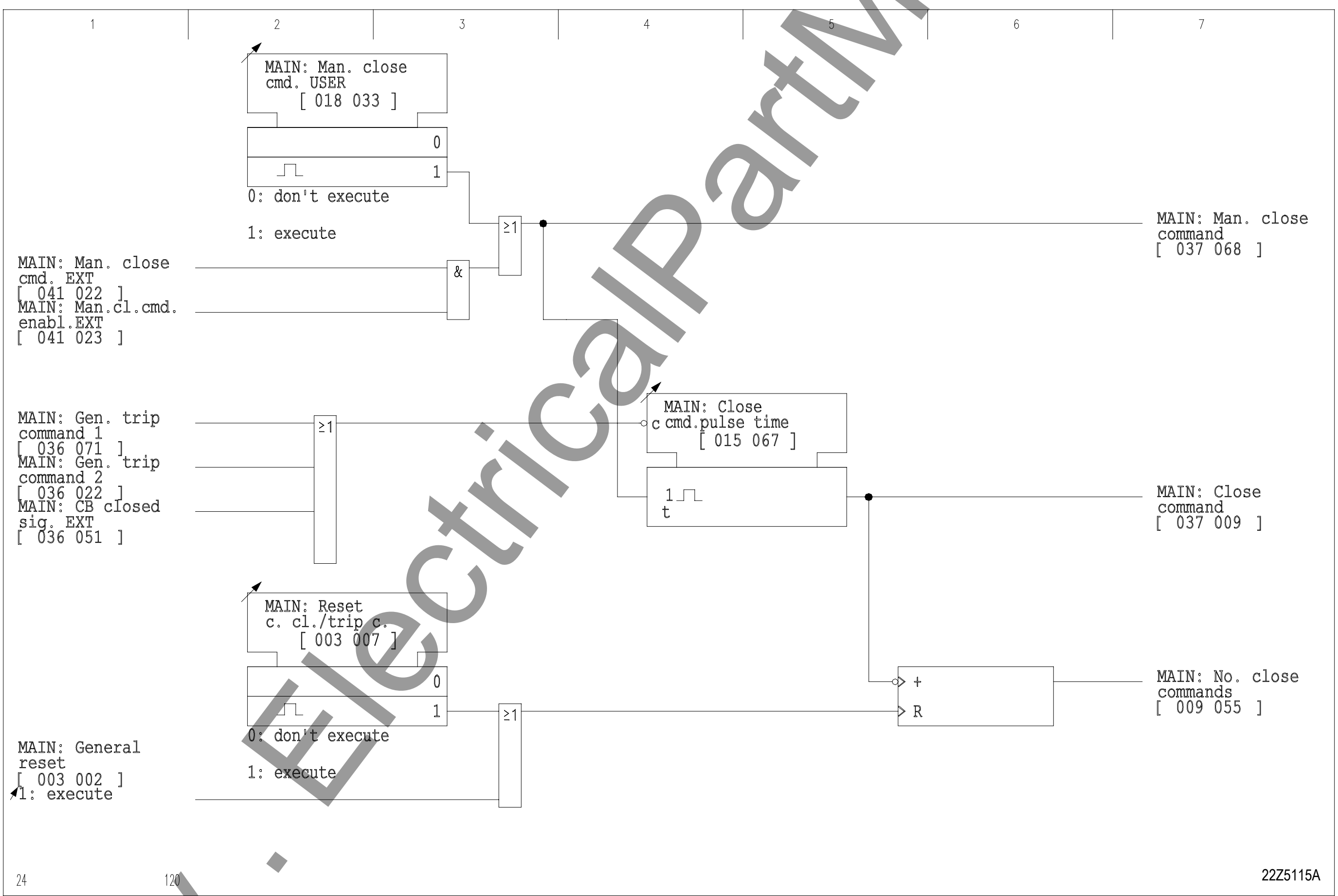
3-44 Coupling between control and protection for the CB closed signal

3.9.12 Close Command

The circuit breaker can be closed by the auto-reclosing control function (ARC) integrated into the C232, from the integrated local control panel, or via an appropriately configured binary signal input. The close command via local control panel or binary signal input is only executed if there is no trip command and no trip has been issued by a parallel protection device. Moreover, the close command is not executed if there is a “CB closed” position signal. The duration of the close command may be adjusted by a setting.

Close command counter

The close commands are counted. The counter may be reset either individually or together with the trip command counters.



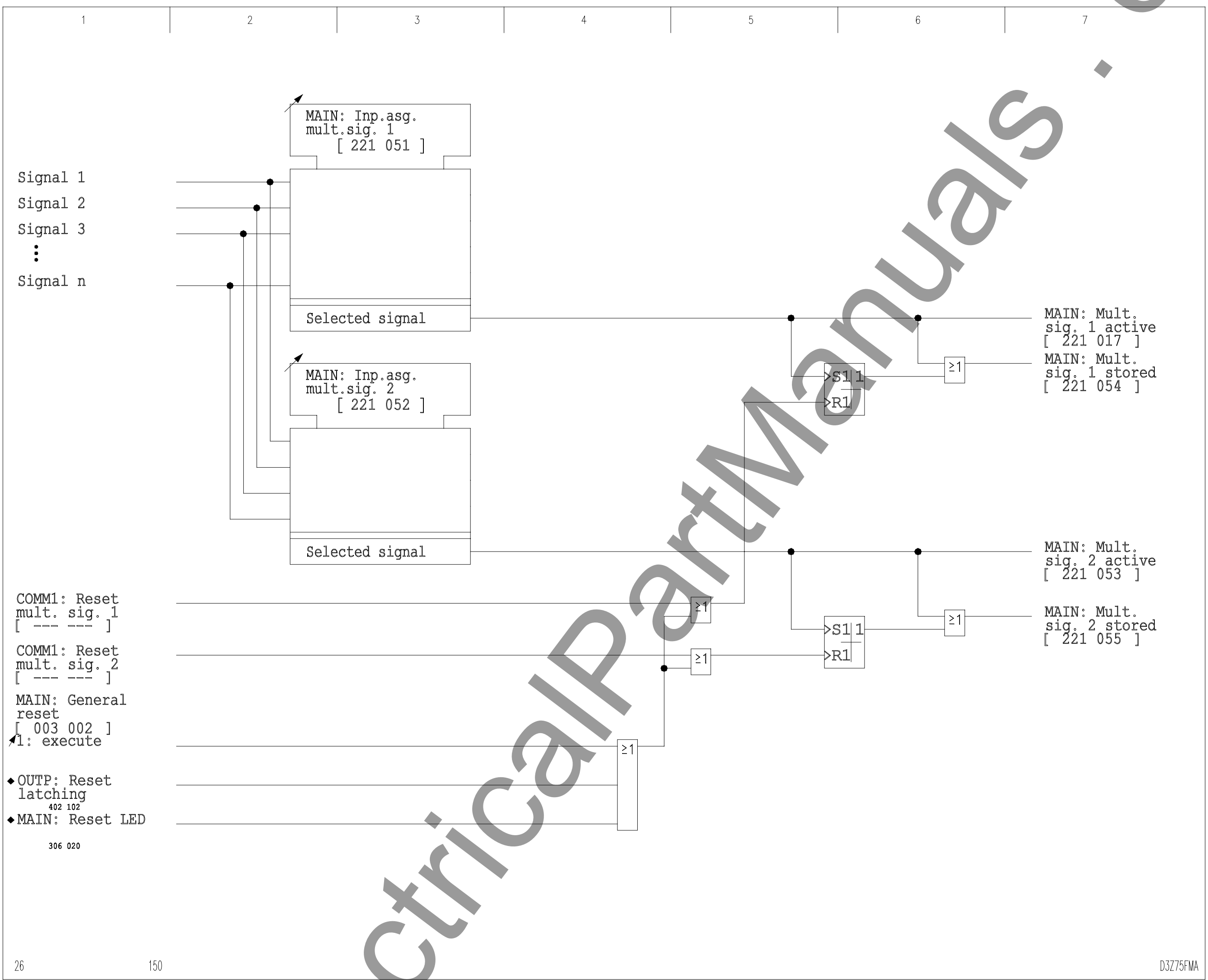
3-45 Close command

3.9.13 Multiple Signaling

The multiple signals 1 and 2 are formed by the programmable logic function using OR operators. The programmable logic output to be interpreted as multiple signaling is defined by the configuration of the input assignment of the relevant multiple signal. Both an updated and a stored signal are generated. The stored signal is reset by the following mechanisms:

- General reset
- Latching reset
- Reset of the LED indicators
- A command received through the communication interface

If the multiple signaling is still present at the time of the reset, the stored signal will follow the updated signal.



3-46 Multiple Signaling

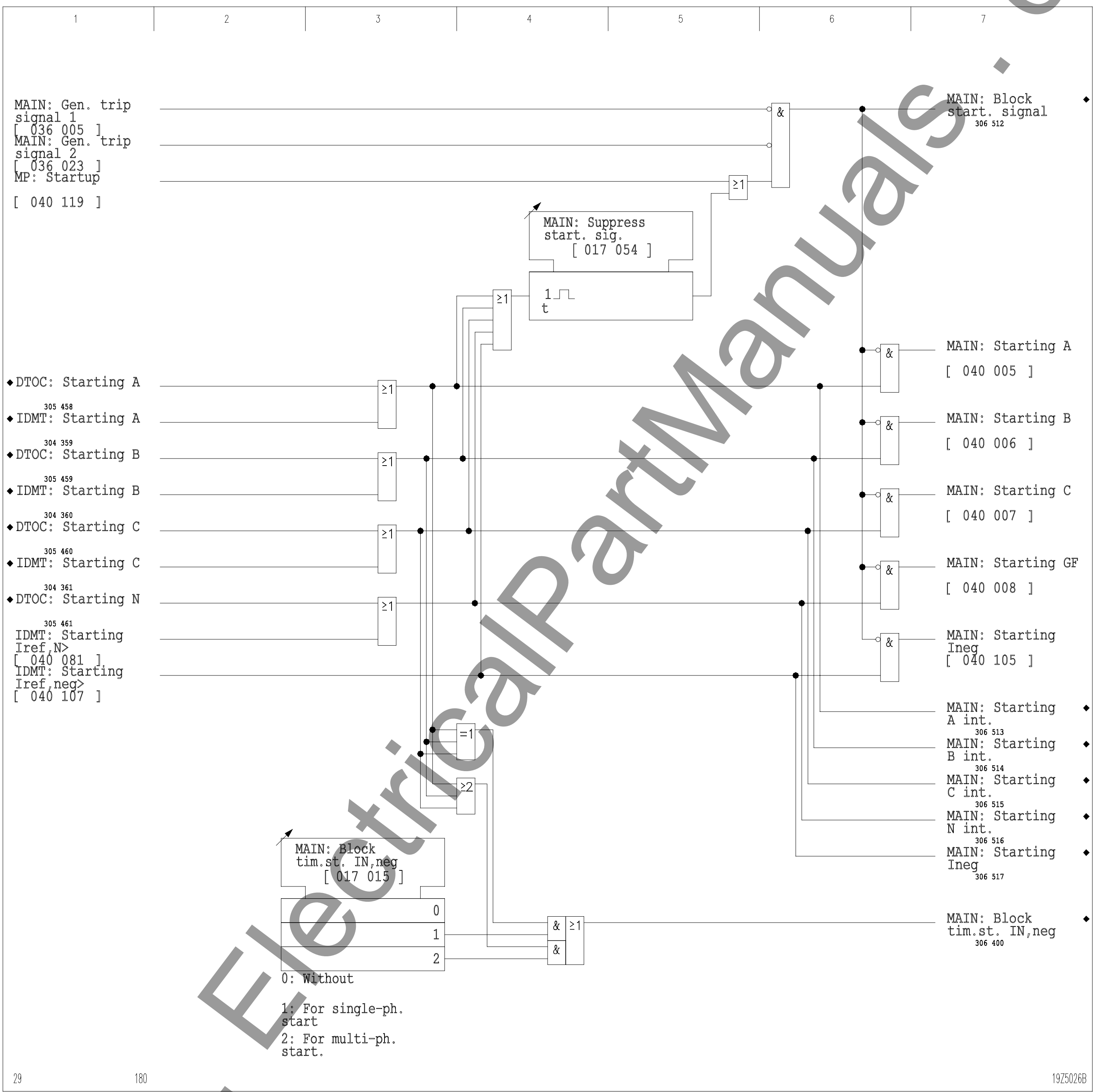
3.9.14 Starting Signals and Tripping Logic

Phase-selective starting signals

Common phase-selective starting signals are formed from the internal phase-selective starting signals of definite-time overcurrent protection and of inverse-time overcurrent protection.

An adjustable timer stage is started by the phase-selective starting signals and by the signals of residual current starting and negative-sequence system starting. While the timer stage is elapsing, the starting signals are blocked. The starting signals are blocked directly by motor protection if the startup of a motor has been detected. Blocking is ineffective if a trip signal is present.

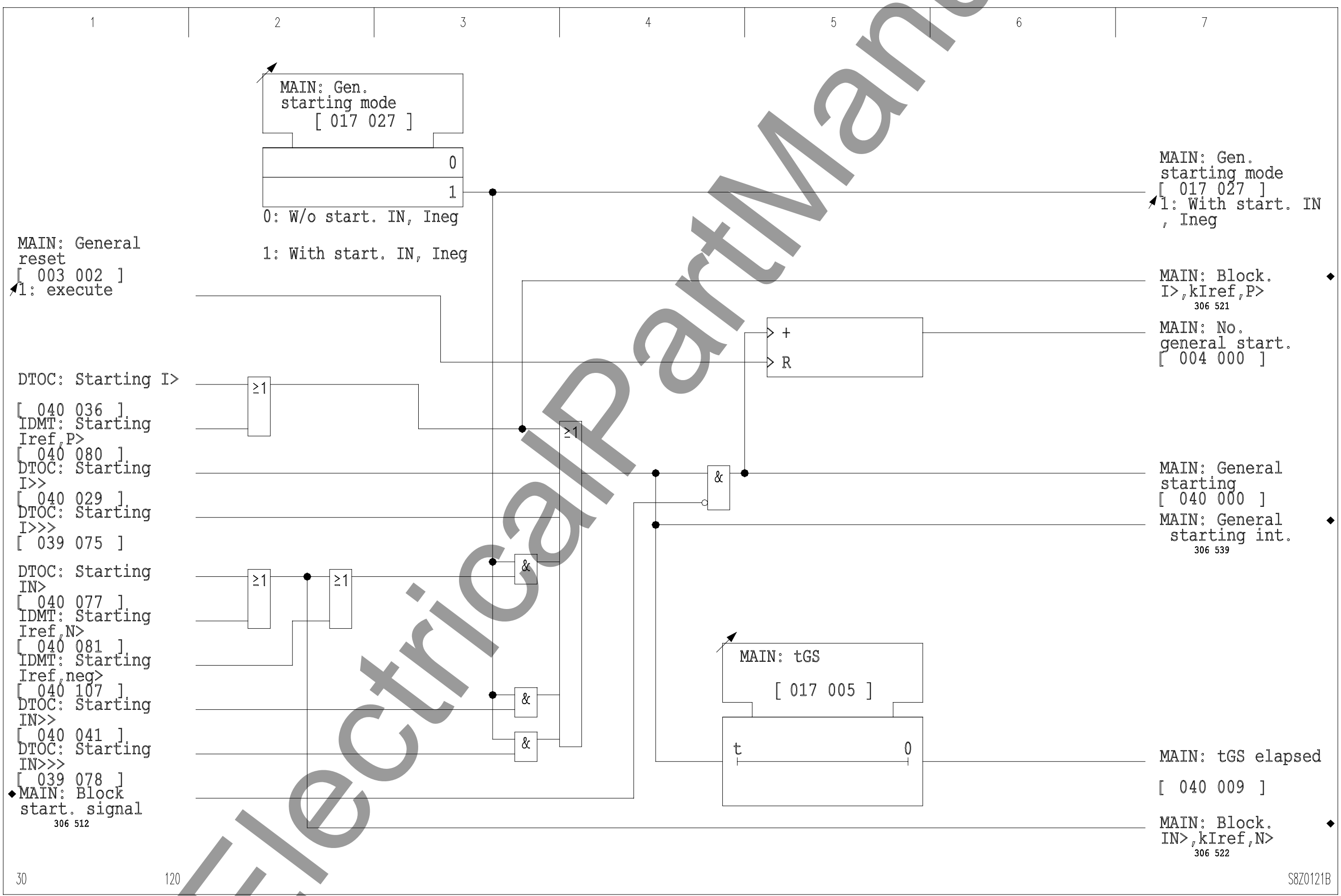
The operate delays of the residual current and negative-sequence current stages of the DTOC and IDMT protection functions can be blocked for a single-pole or multipole starting (depending on the setting).



3-47 Phase-selective starting signals

General starting

The general starting signal is formed from the starting signals of the DTOC and IDMT protection functions. A setting governs whether the residual current stages and the negative-sequence current stage will be involved in forming the general starting signal. If the operate signal of a residual current stage and the negative-sequence current stage does not cause a general starting (due to the setting) then the associated operate delays will be blocked. As a result, a trip command can not be issued by residual current and negative-sequence current stages.



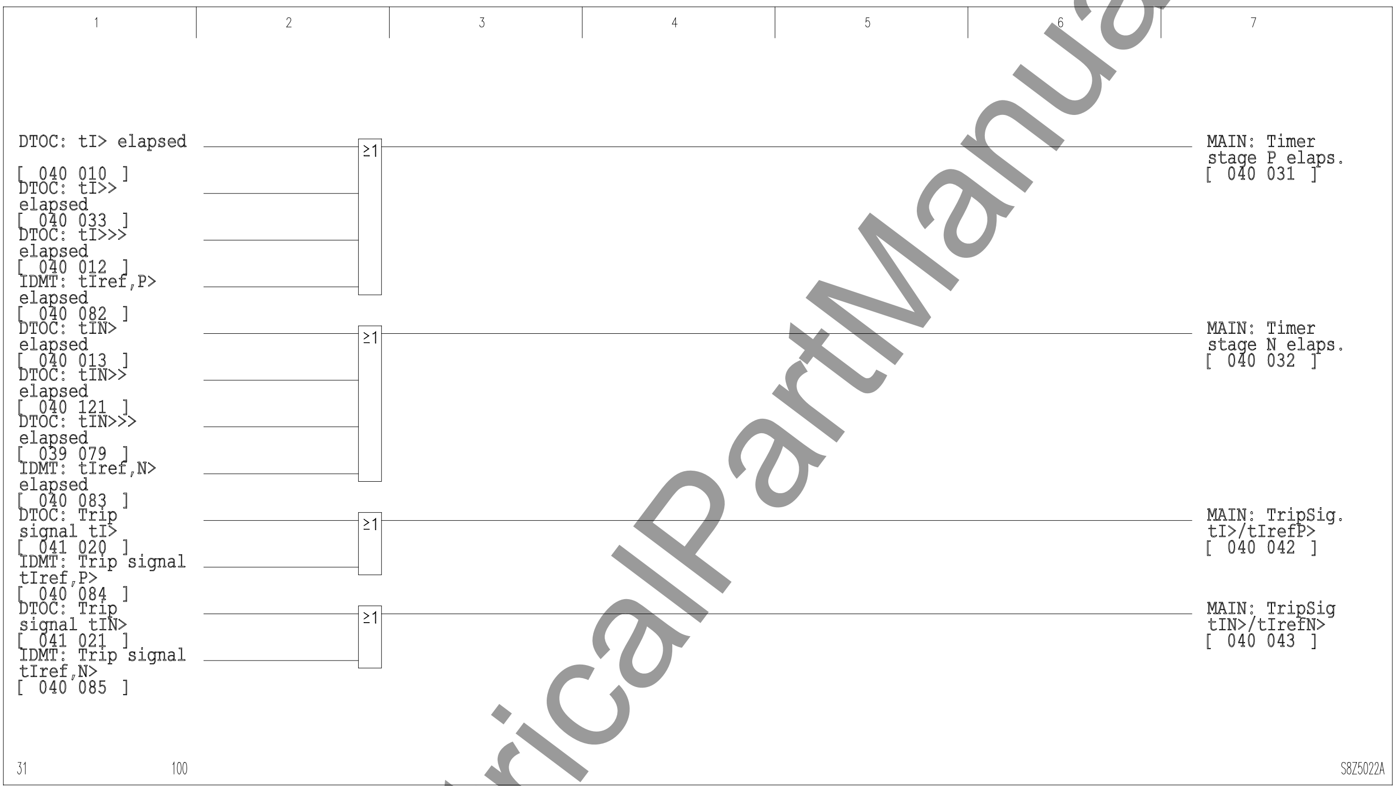
3-48 General starting

Counter of general starting signals

The number of general startings is counted.

Multiple signaling of the DTOC and IDMT protection functions

The trip signals generated by DTOC and IDMT protection are grouped together to form multiple signals.



3-49 Multiple signaling of the DTOC and IDMT protection functions

Trip command

The C232 has two trip commands. The functions to effect a trip can be selected by setting an 'm out of n' parameter independently for each of the two trip commands. The minimum trip command time may be set. The trip signals are present only as long as the conditions for the signal are satisfied.

Latching of the trip commands

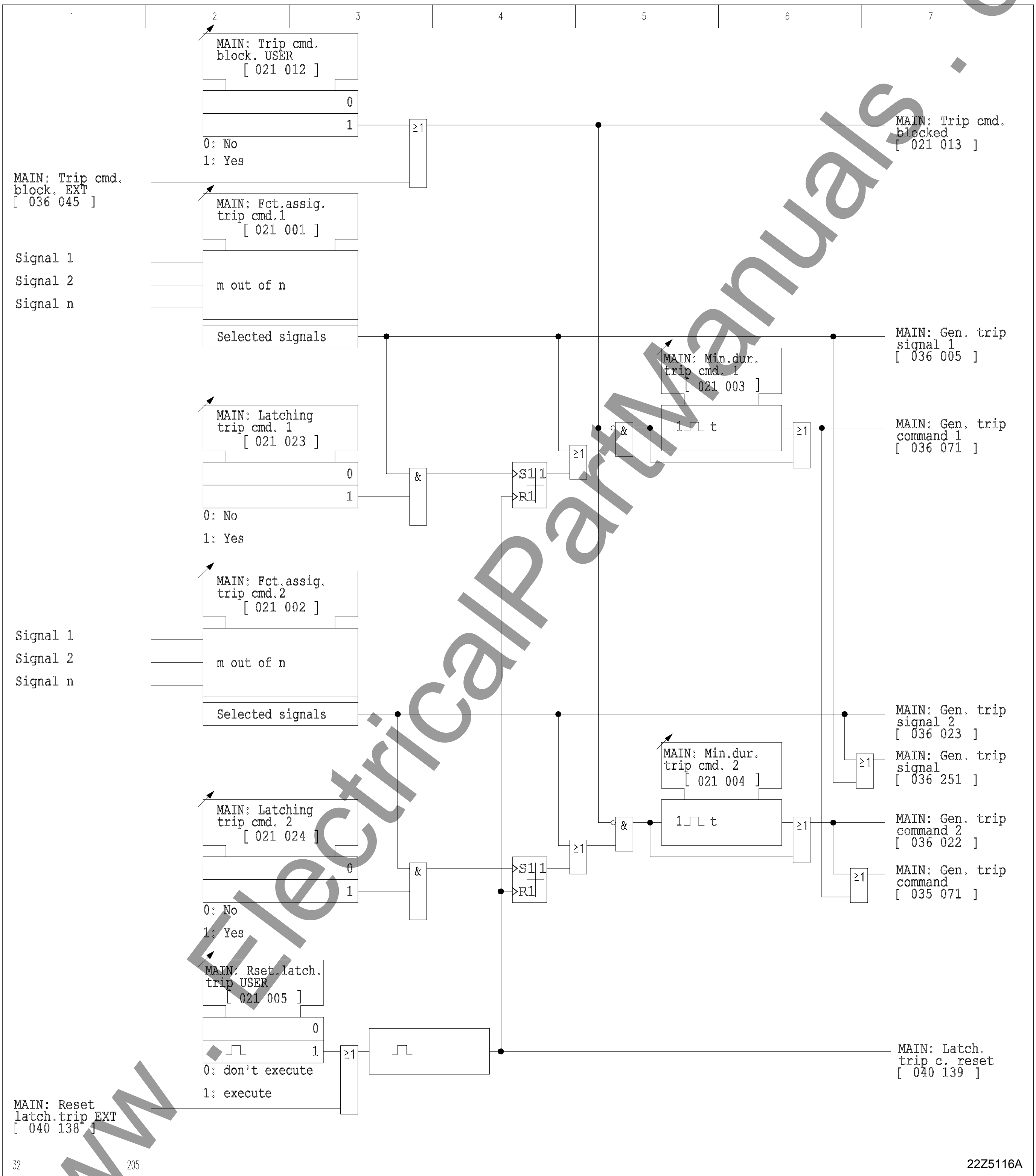
For each of the two trip commands, the user can specify by way of the appropriate setting whether it will operate in latching mode. If the latching mode is selected, the trip command persists until it is reset from the local control panel or via an appropriately configured binary signal.

Blocking the trip commands

The trip commands may be blocked from the integrated local control panel or through an appropriately configured binary signal input. Blocking is effective for both trip commands. The trip signals are not affected by blocking. If the trip commands are blocked, this will be indicated by a steady light at yellow LED indicator H 2 on the local control panel and by an output relay configured for ‘Blocked/faulty’.

Counter of trip commands

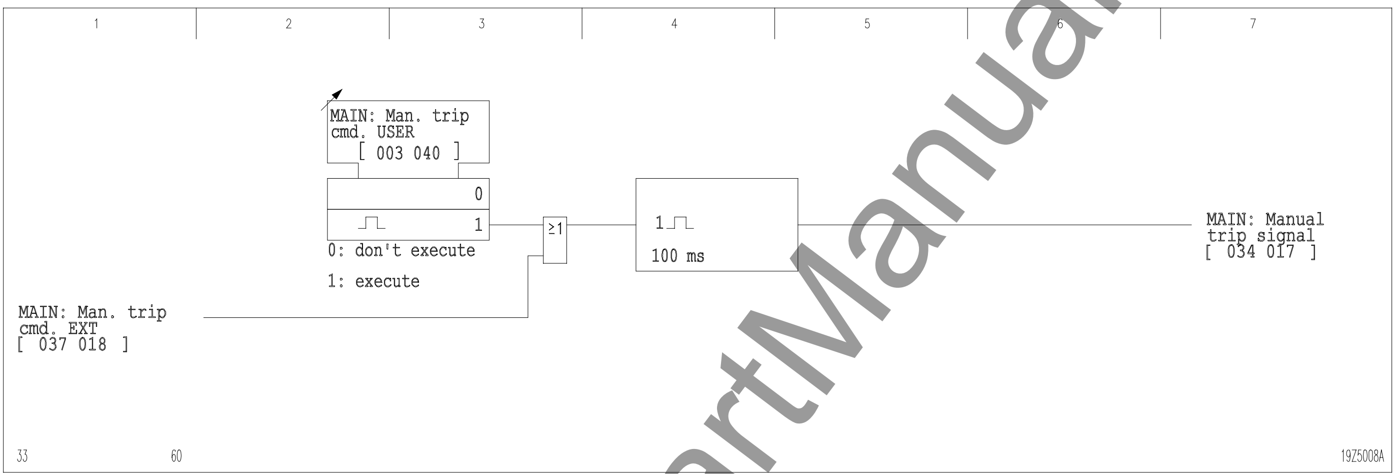
The trip commands are counted. The counters can be reset either individually or as a group.



3-50 *Forming the trip commands*

Manual trip command

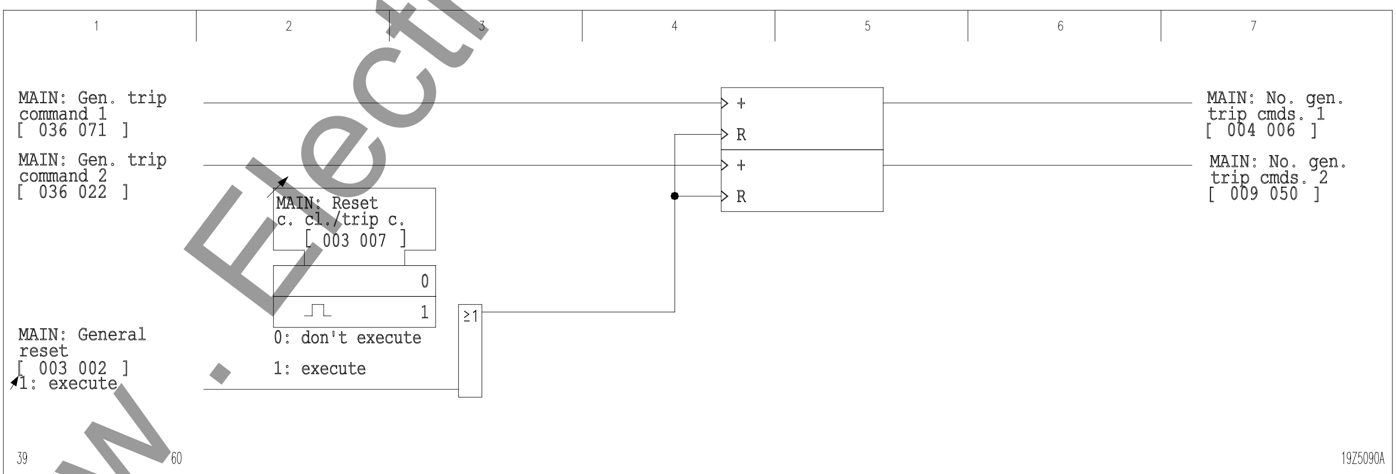
A manual trip command may be issued via the local control panel or a signal input configured accordingly. It is not executed, however, unless the manual trip is included in the selection of possible functions to effect a trip.



3-51 Manual trip command

Trip command counter

The trip commands are counted. The counters can be reset either individually or as a group.



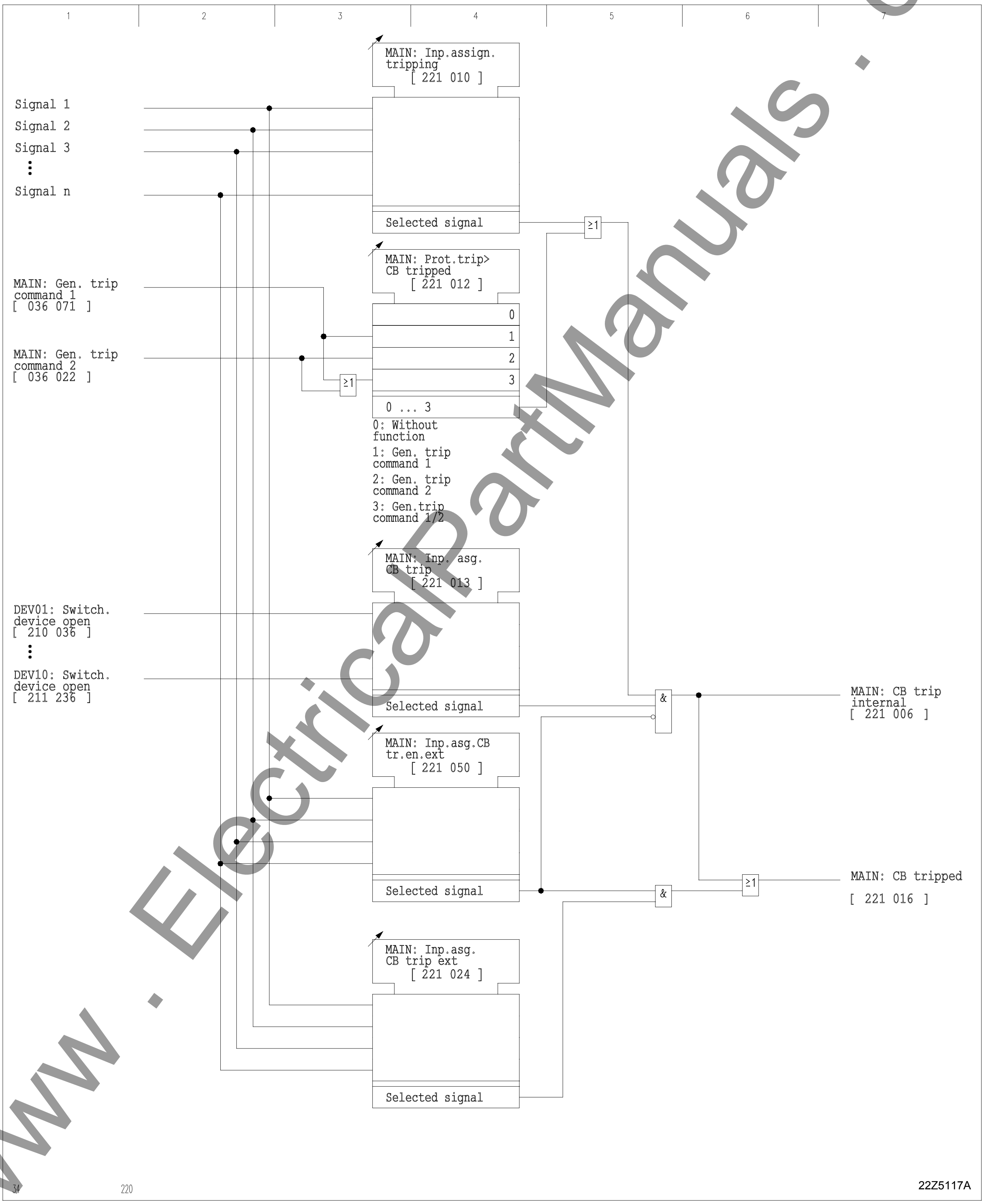
3-52 Trip command counter

3.9.15 CB Trip Signal

The signal MAIN: CB trip internal is issued if the following conditions are simultaneously met:

- The input configured for “tripping” is set to a logic value of '1' or the selected trip command of the C232 is present.
- At the input configured for “CB trip” a logic value of '1' is present.

The CB trip signal of an external device can also be signaled. For this task, one input needs to be configured for “CB trip enable ext.“, a further input for “CB trip ext.“.

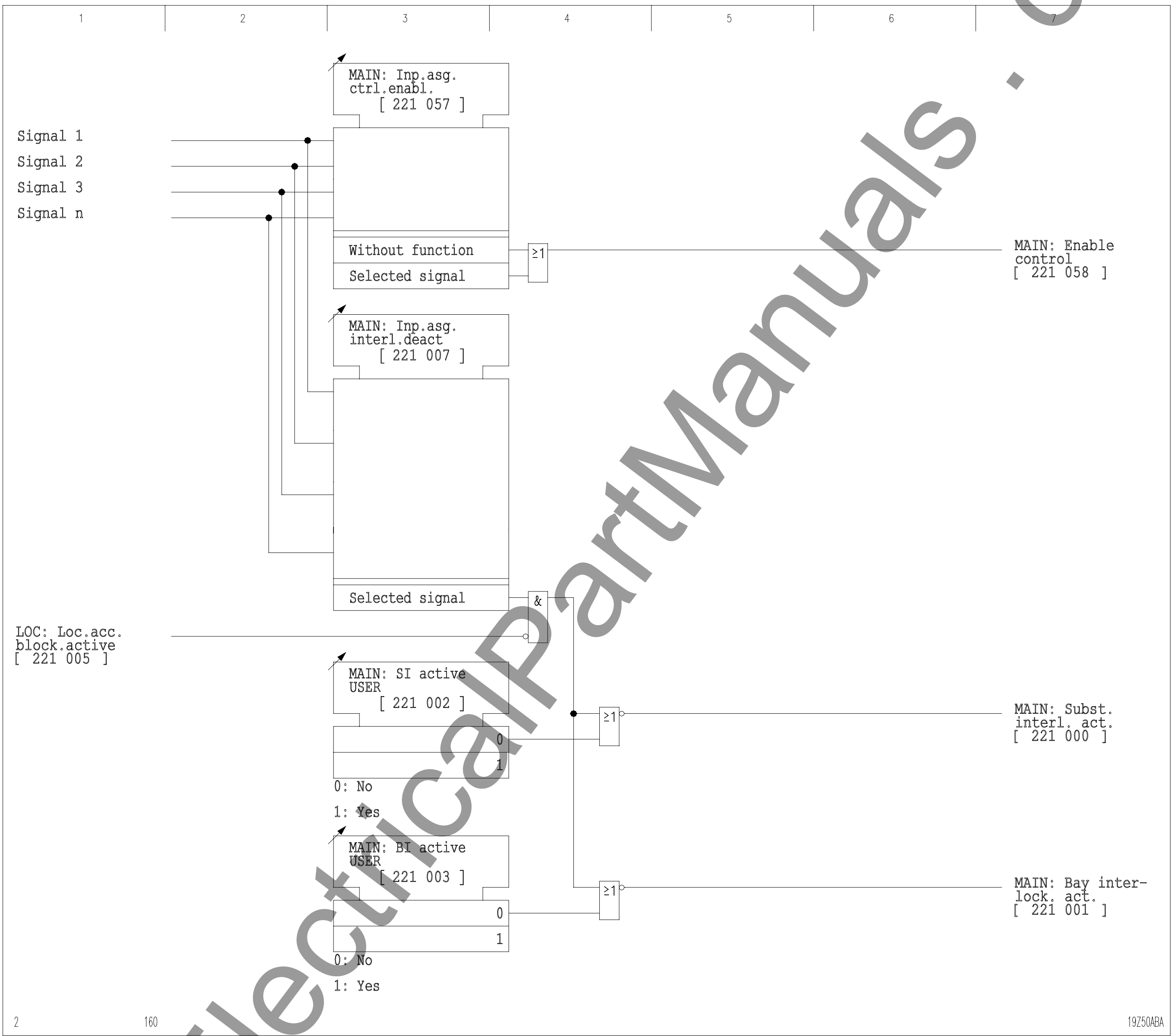


3-53 CB trip signal

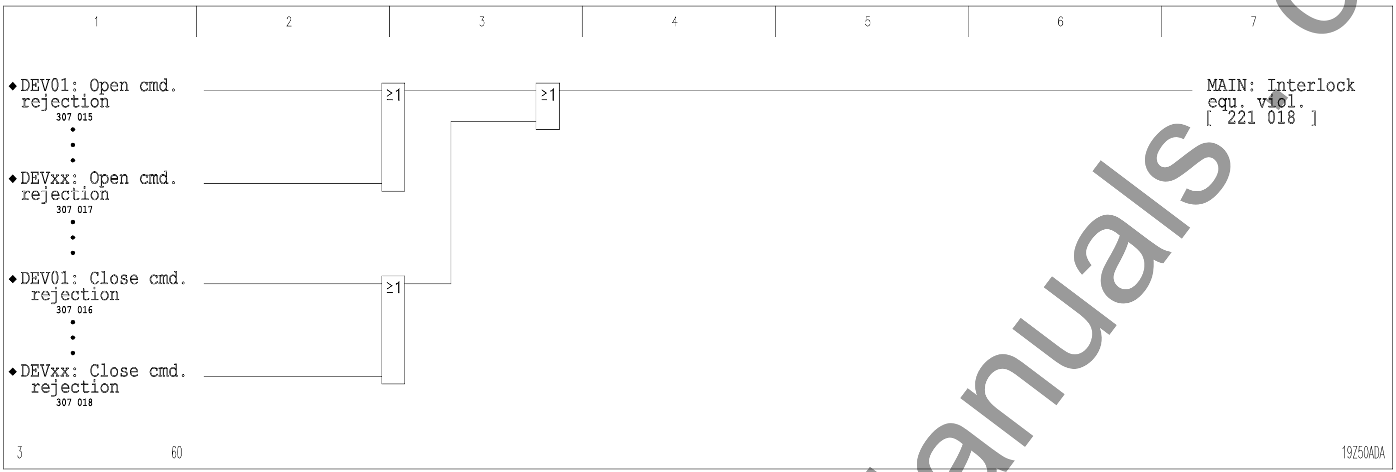
3.9.16 Enable for Switch Commands Issued by the Control Functions

Before a switching device within the bay is closed or opened by the control functions of the C232, the C232 first checks whether the switch command may be executed. A switch command will be executed if the optional control enable has been issued and the interlock conditions are met. The interlock conditions are defined in the interlocking logic for each switching device within the bay that is subject to control actions and for each control direction (Open/Close). Different conditions are defined for the bay interlock equations for operation with or without station interlock. The interrogation of the bay or station interlock equations can be canceled for all electrically controllable switchgear units within a bay. If the station interlock is active, it may be canceled selectively for each switching device and each control direction (see “Control and Monitoring of Switchgear Units”).

If “Local” has been selected as the control point, the bay and station interlocks may be canceled through an appropriately configured input.



3-54 General enable for switch commands issued by the control functions; activating or canceling the interlocks

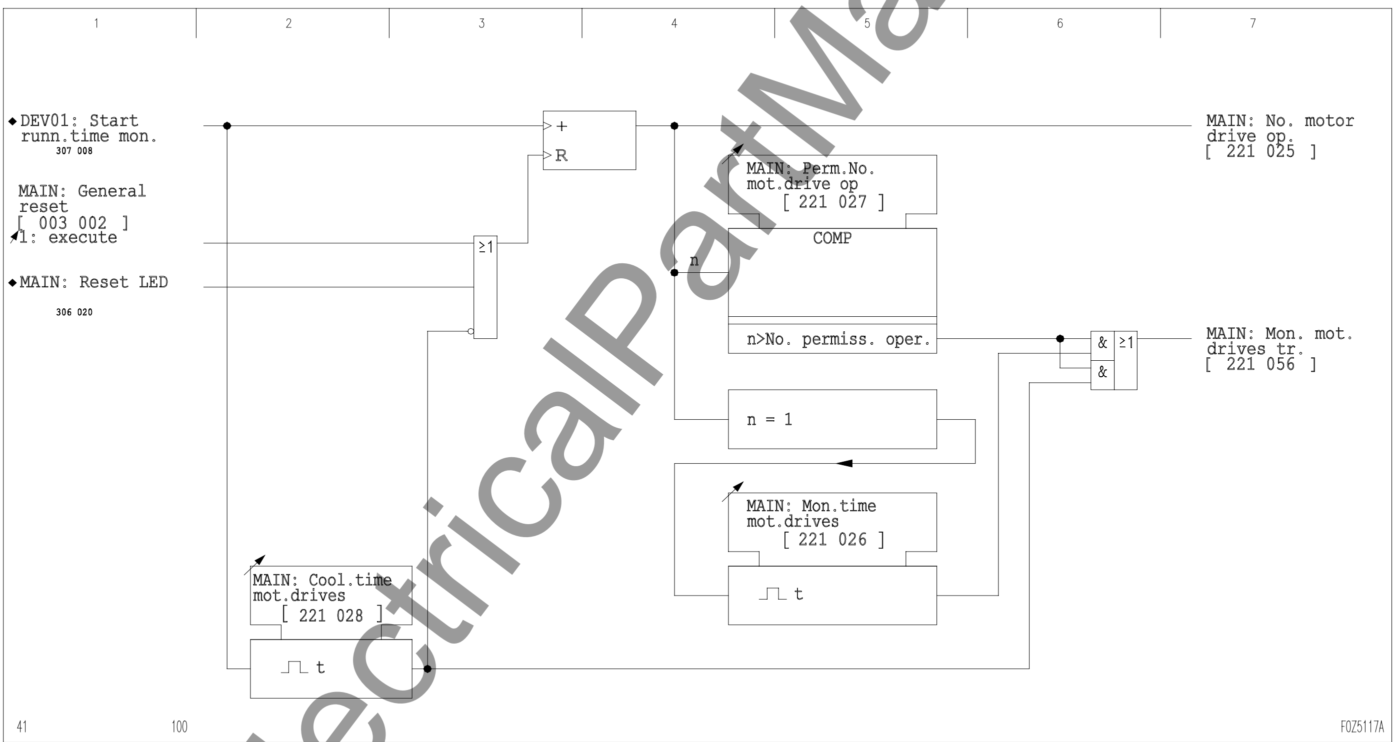


3-55 Rejection of the switching commands

3.9.17 Monitoring the Switchgear Unit Motors

For bays with direct motor drive control of switch disconnectors, disconnectors or grounding switches, a monitoring function is provided to protect the motors from overheating.

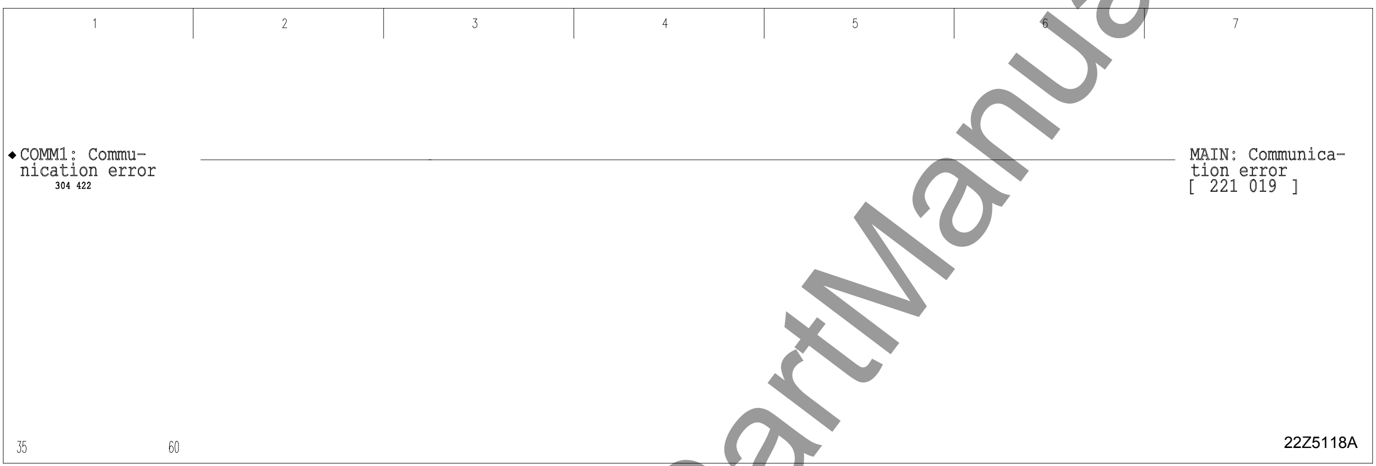
The number of switching operations within a set monitoring period is counted. If the number of control actions within the monitoring period exceeds the set limit, the signal MAIN: Mon. mot. drives tr. is issued. For the duration of the set cooling time, no control commands to motor-driven switchgear units will be executed. Once the set cooling time has elapsed, the control commands are enabled again.



3-56 Monitoring the switchgear unit motors

3.9.18 Communication Error

If a link to the control station can not be established or if the link is interrupted, the signal *Communication error* will be issued.



3-57 Communication error

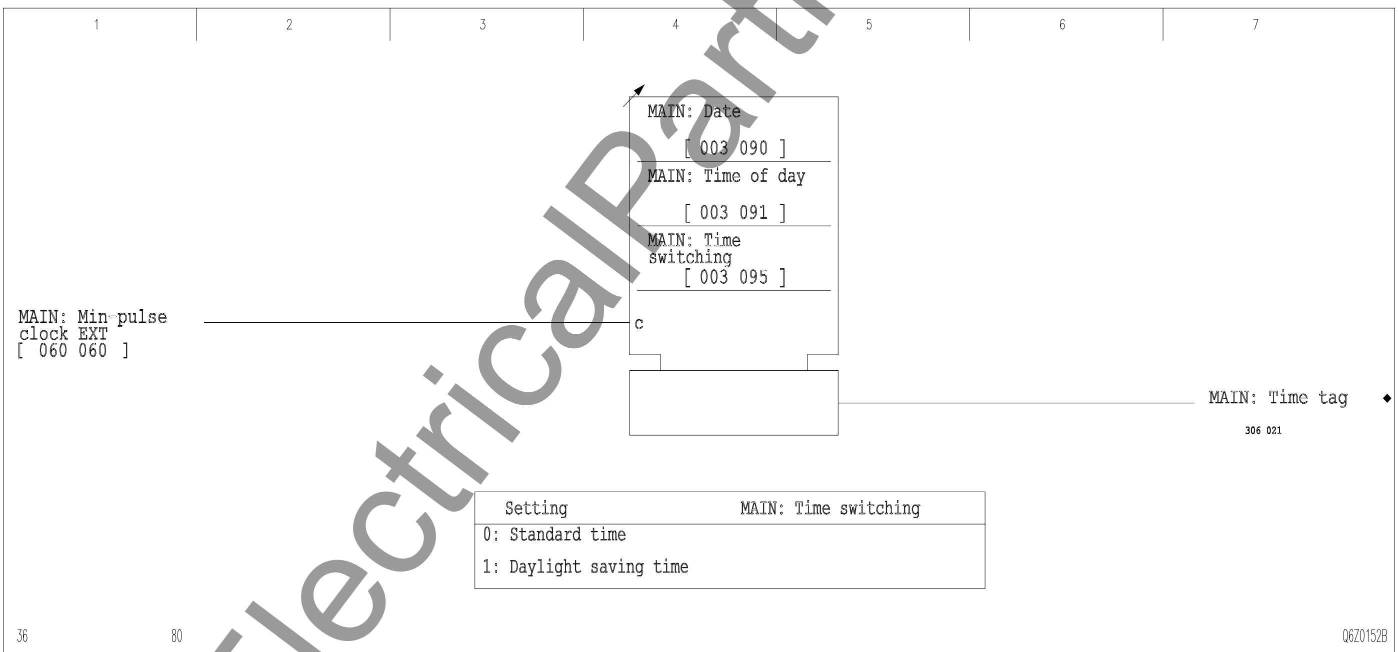
3.9.19 Time Tagging and Clock Synchronization

The data stored in the operating data memory, the monitoring signal memory, and the event memories are tagged with date and time of day. For correct time tagging, the date and time need to be set in the C232.

The time of different devices may be synchronized by a pulse through an appropriately configured binary signal input. The C232 evaluates the rising edge. In this way, the clock is set to the next full minute, rounding up or down. If several start/end signals occur (bouncing of a relay contact), the last edge is evaluated.

⚠

The C232 is not providing a battery backed-up real-time clock. After power-up time and date has to be set by user or serial link.



3-58 Date and time setting and clock synchronization

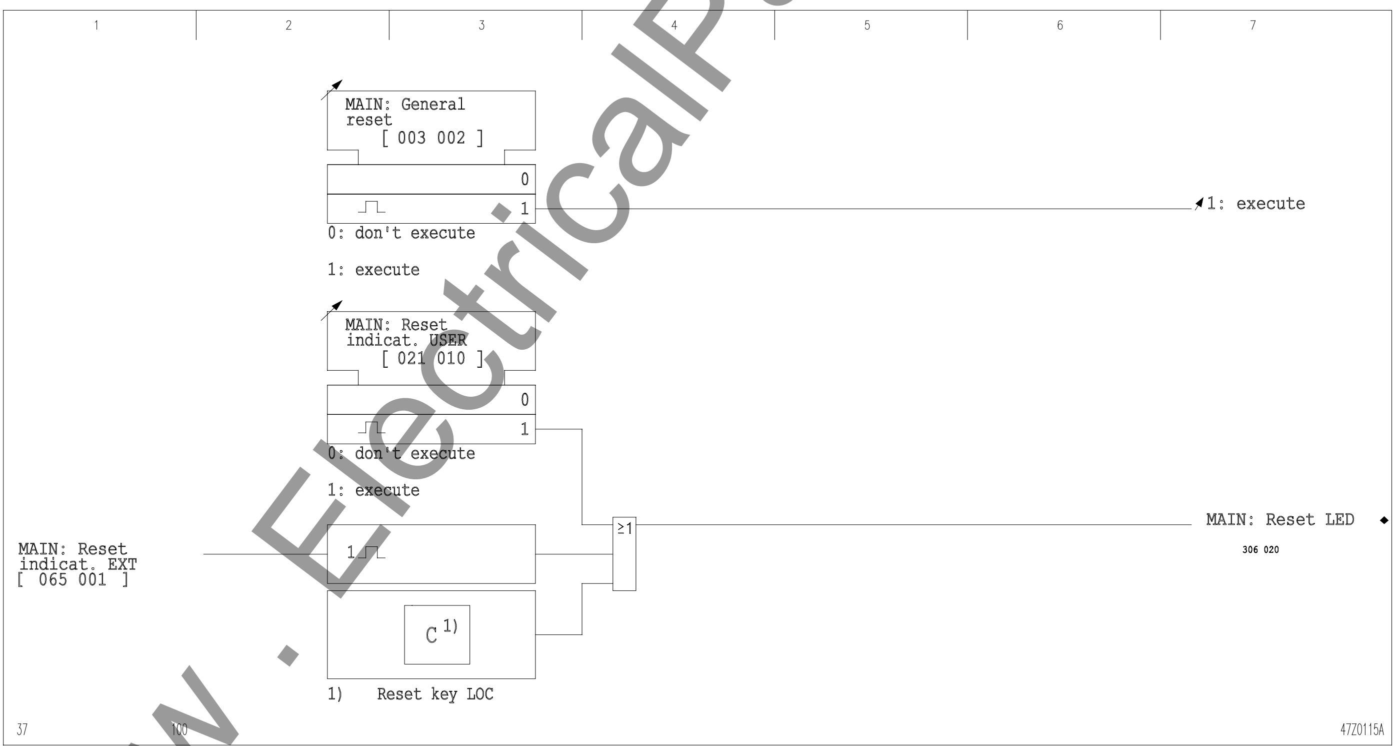
3.9.20 Resetting Mechanisms

Stored data such as event logs, measured fault data, etc., can be cleared in a number of different ways. The following mechanisms are available:

- Automatic resetting of the event signals indicated by LED indicators (provided that the LED operating mode has been set accordingly) and of the display of measured fault data on the local control panel whenever a new event occurs.
- Resetting of LED indicators and measured fault data on the local control panel by pressing the clear key (C) located on the panel.
- Selective resetting of a particular memory type (only the fault memory, for example) from the local control panel or through appropriately configured binary signal inputs
- General reset

In the first two cases listed above, only the displays on the local control panel are cleared but not the internal memories such as the fault memory.

In the event of a cold restart, namely simultaneous failure of both internal battery and power supply, all stored signals and values will be lost.

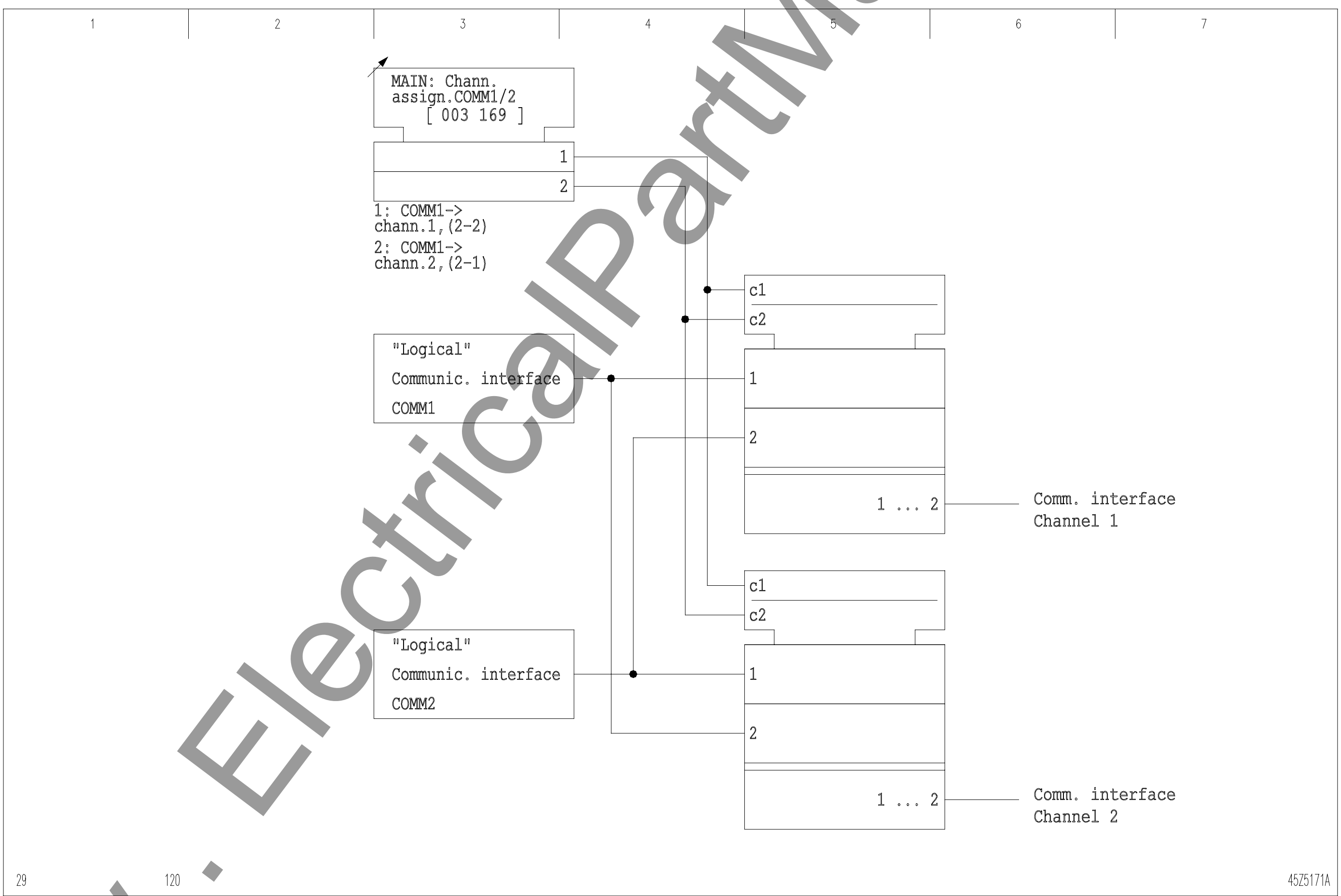


3-59 General reset, LED reset, and measured fault data reset from the local control panel

3.9.21 Assignment of the “Logical” Communication Interfaces to the Physical Communication Channels

Depending on the design, one or two communication channels are available (see “Technical Data”). The "logical" communication interfaces COMM1 and COMM2 can be assigned to these physical communication channels.

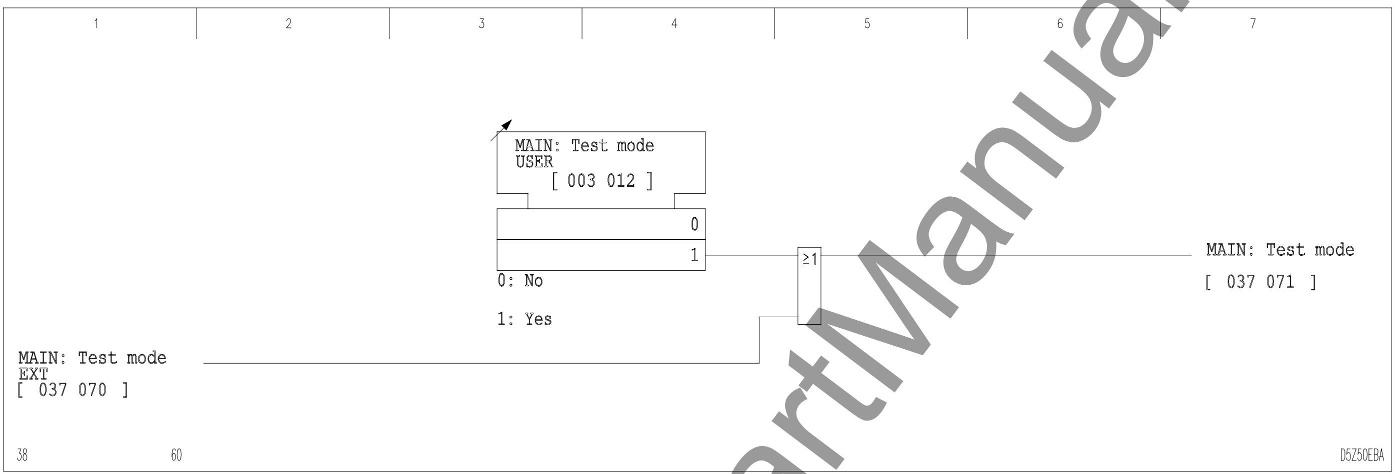
If the COMM1 "logical" communication interface has been assigned to communication channel 2, then this means that the settings for "logical" communication interface 2 (COMM2) will automatically be active for communication channel 1. Communication with the C232 via communication channel 2 is only possible when the PC interface is inactive. As soon as communication occurs through the PC interface, communication channel 2 is deactivated.



3-60 *Assignment of the “logical” communication interfaces to the physical communication channels*

3.9.22 Test Mode

If tests are run on the C232, the user is advised to activate the test mode so that all incoming signals via the serial interfaces will be identified accordingly.



3-61 Setting the test mode

3.10 Parameter Subset Selection (Function Group PSS)

The C232 allows the user to pre-set four independent parameter subsets. The user can switch between parameter subsets during operation without interrupting the protection function.

Selecting the parameter subset

The control path that will determine the active parameter subset (function parameter or binary signal input) can be selected via the function parameter PSS: Control via USER or the external signal PSS: Control via user EXT. Depending on the selection made, the parameter subset will be selected either in accordance with the pre-set function parameter PSS: Param. subs. sel. USER or as a function of external signals. The parameter subset that is active at any given time can be determined by scanning the logic state signals PSS: Actual param.subset or PSS: PSx active.

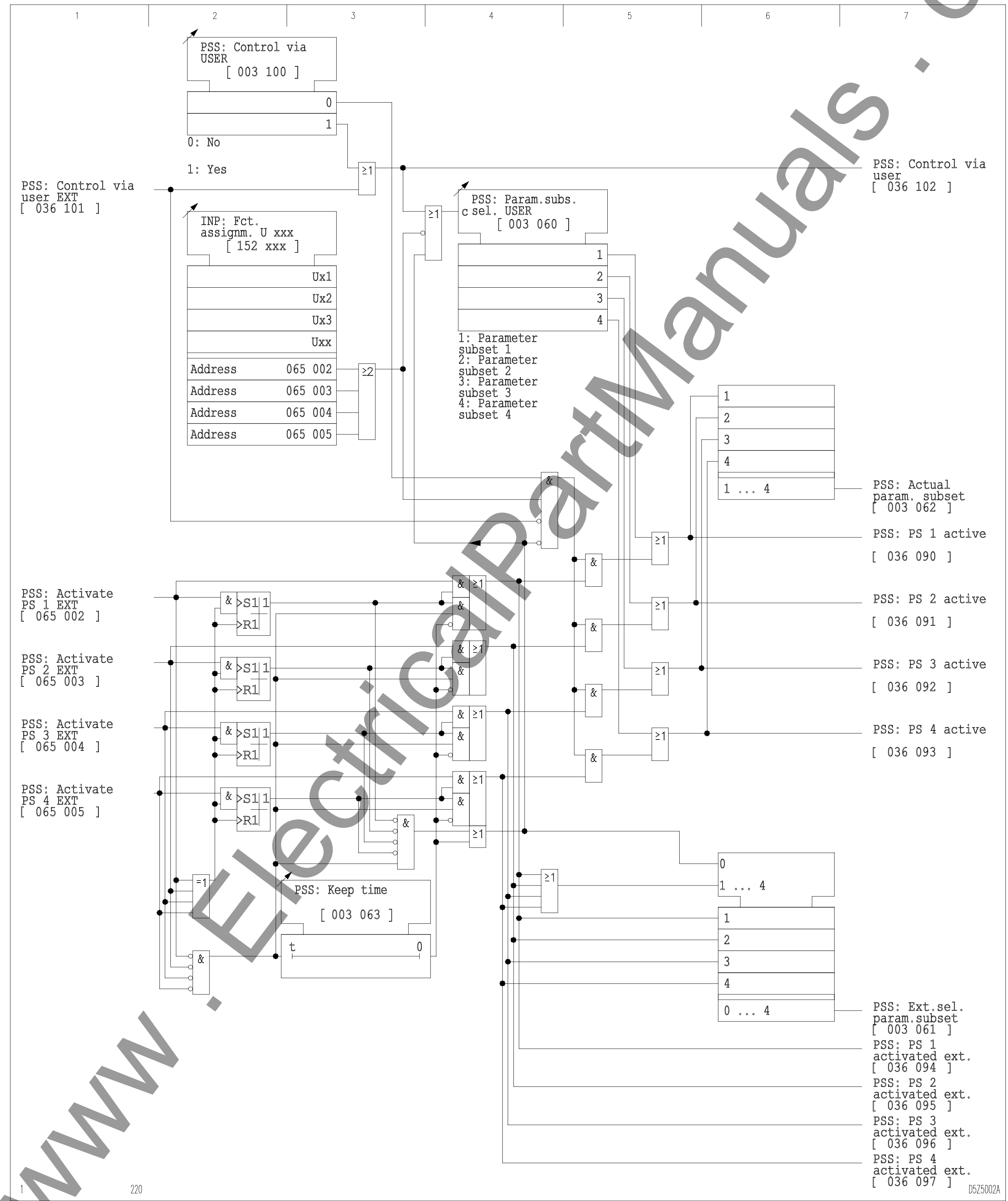
Selecting the parameter subset via binary inputs

If the binary signal inputs are to be used for parameter subset selection, then the C232 first checks to determine whether at least two binary inputs are configured for parameter subset selection. If this is not the case, then the parameter subset selected via the function parameter will be active. The C232 also checks to determine whether the signals present at the binary signal inputs allow an unambiguous parameter subset selection. This is true only when just one binary signal input is set to a logic value of ‘1’. If more than one signal input is set to a logic value of ‘1’, then the parameter subset previously selected remains active. Should a dead interval occur while switching between parameter subsets (this is the case if all binary signal inputs have a logic value of ‘0’), then the stored energy time is started. While this timer stage is running, the previously selected parameter subset remains active. As soon as a signal input has a logic value of ‘1’, the associated parameter subset becomes active. If, after the stored energy time has elapsed, there is still no signal input with a logic value of ‘1’, the parameter subset selected via a function parameter becomes active.

If, after the supply voltage is turned on, no logic value of ‘1’ is present at any of the binary signal inputs selected for the parameter subset selection, then the parameter subset selected via a function parameter will become active once the stored energy time has elapsed. The previous parameter subset remains active while the stored energy timer stage is running.

Parameter subset selection may also occur during a starting condition. When subset selection is handled via binary signal inputs, a maximum inherent delay of approximately 100 ms must be taken into account.

Settings for which only one address is given in the following sections are equally effective for all four parameter subsets.



3-62 Activating the parameter subsets

3.11 Self-Monitoring (Function Group SFMON)

Comprehensive monitoring routines in the C232 ensure that internal faults are detected and do not lead to malfunctions.

Tests during startup

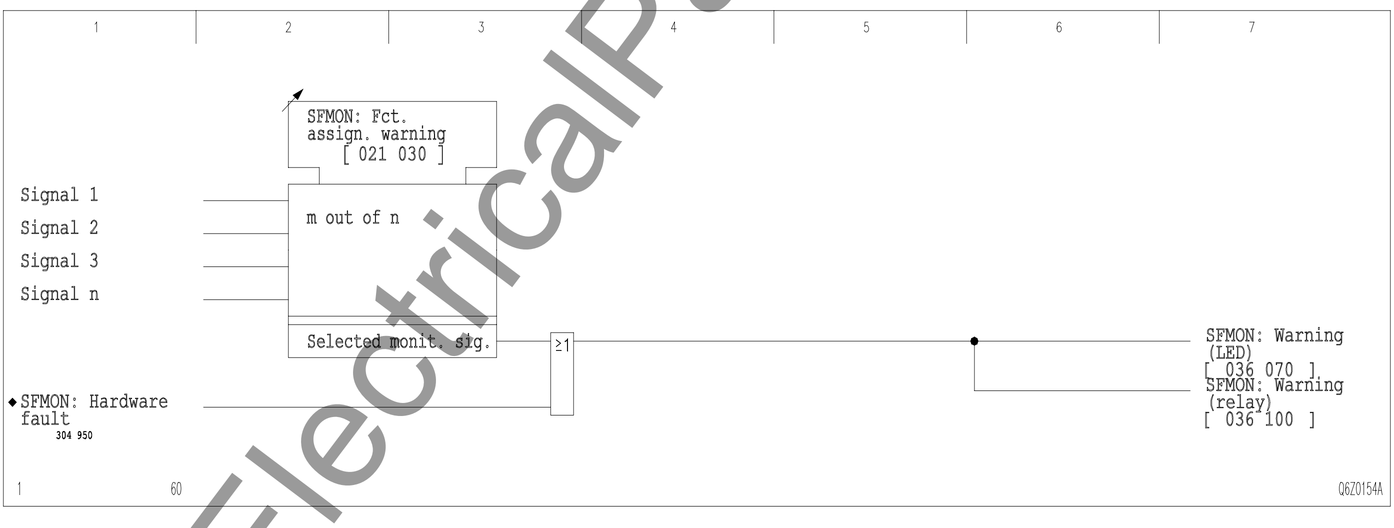
After the supply voltage has been turned on, various tests are carried out to verify full operability of the C232. If the C232 detects a fault in one of the tests, then startup is terminated. The display shows which test was running when termination occurred. No control actions can be carried out. A new attempt to start up the C232 can only be initiated by turning the supply voltage off and then on again.

Cyclic tests

After startup has been successfully completed, cyclic self-monitoring tests will be run during operation. In the event of a positive test result, a specified monitoring signal will be issued and stored in a non-volatile memory – the monitoring signal memory – along with the assigned date and time (see also Monitoring Signal Recording).

Signaling

The monitoring signals are also signaled via the output relay that is configured for SFMON: Warning. The output relay operates as long as an internal fault is detected.



3-63 Monitoring signals

Device response

The response of the C232 is a function of the type of monitoring signal. The following responses are possible:

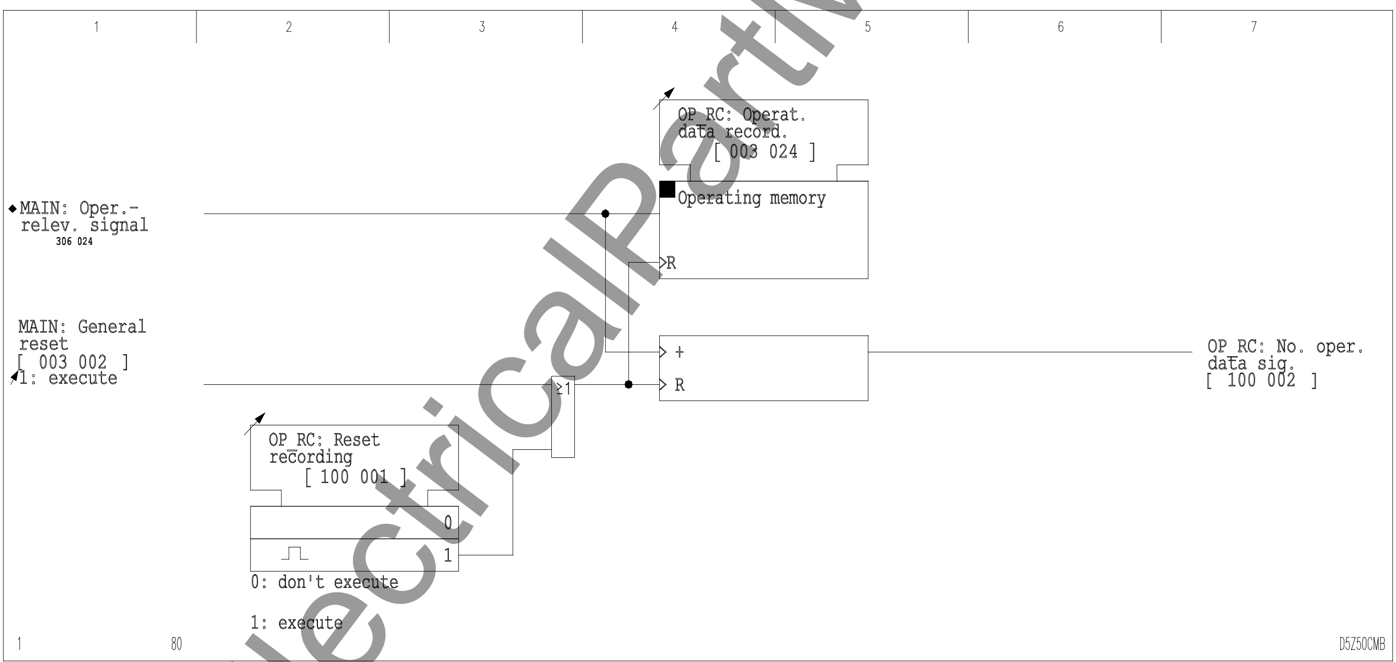
- Signaling Only
  If there is no malfunction associated with the monitoring signal, then only a signal is issued, and there are no further consequences. This situation exists, for example, when internal data acquisition memories overflow.
- Selective Blocking
  If a fault is diagnosed solely in an area that does not affect the protective functions, then only the affected area is blocked. This would apply, for example, to the detection of a fault on the communication module or in the area of the PC interface.
- Warm Restart
  If the self-monitoring function detects a fault that might be eliminated by a system restart – such as a fault in the hardware –, then a procedure called a warm restart is automatically initiated. During this procedure, as with any startup, the computer system is reset to a defined state. A warm restart is characterized by the fact that no stored data and, in particular, no setting parameters are affected by the procedure. A warm restart can also be triggered manually by a control action. During a warm restart sequence, both the protective functions and communication through serial interfaces will be blocked. If the same fault is detected after a warm restart has been triggered by the self-monitoring system, then the protective functions remain blocked, but communication through the serial interfaces will usually be possible again.
- Cold Restart
  If a corrupted parameter subset is diagnosed during the checksum test, which is part of the self-monitoring procedure, then a cold restart is carried out. This is necessary because the unit cannot identify which parameter in the subset is corrupt. A cold restart causes all internal memories to be reset to a defined state. This means that all device settings are also erased after a cold restart. The settings that then apply are the underlined values given in the column headed 'Range of Values' in the Address List (see Appendix). In order for a safe initial state to be established, the default values have been selected so that the protective functions are blocked. Both the monitoring signal that triggered the cold restart and the signal indicating parameter loss are entered in the monitoring signal memory.

3.12 Operating Data Recording (Function Group OP_RC)

For the continuous recording of processes in system operation as well as of events, a non-volatile ring memory is provided. The operationally relevant signals, each fully tagged with date and time at signal start and signal end, are entered in chronological order. The signals relevant for operation include control actions such as function disabling and enabling and triggers for testing and resetting. The onset and end of events in the system that represent a deviation from normal operation such as overloads, ground faults, or short-circuits are also recorded. The operating data memory can be cleared.

Counter for signals relevant to system operation

The signals stored in the operating data memory are counted.



3-64 Operating data recording and counter for signals relevant to system operation

3.13 Monitoring Signal Recording (Function Group MT_RC)

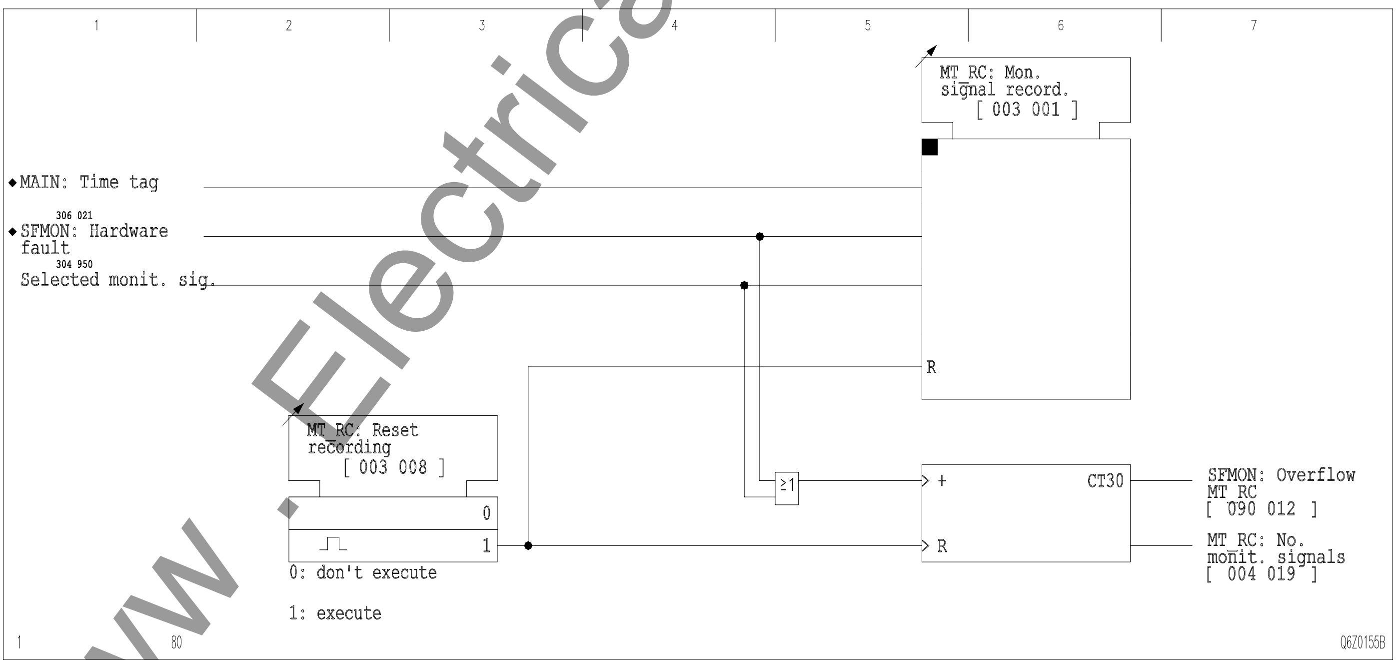
The monitoring signals generated by the self-monitoring function are recorded in the monitoring signal memory. A listing of all possible entries in this monitoring signal memory is given in the address list (see Appendix). The memory depth allows for a maximum of 30 entries. If more than 29 monitoring signals occur without interim memory clearance, the SFMON: Overflow MT_RC signal is entered as the last entry. Monitoring signals prompted by a hardware fault in the unit are always entered in the monitoring signal memory. Monitoring signals prompted by a peripheral fault can be entered into the monitoring signal memory, if desired. The user can select this option by setting an 'm out of n' parameter (see Self-Monitoring).

If at least one entry is stored in the monitoring signal memory, this fact is signaled by the red LED indicator H 3 on the local control panel. Each new entry is indicated by a flashing light.

The monitoring signal memory can only be cleared manually by a control action. Entries in the monitoring signal memory are not even cleared automatically if the corresponding test in a new test cycle has a negative result. The contents of the monitoring signal memory can be read from the local control panel or through the PC or communication interface. The time and date information assigned to the individual entries can be read out through the PC or communication interface or from the local control panel.

Monitoring signal counter

The number of entries stored in the monitoring signal memory is displayed on the monitoring signal counter (MT_RC: No. monit. signals).



3-65 Monitoring signal recording and the monitoring signal counter

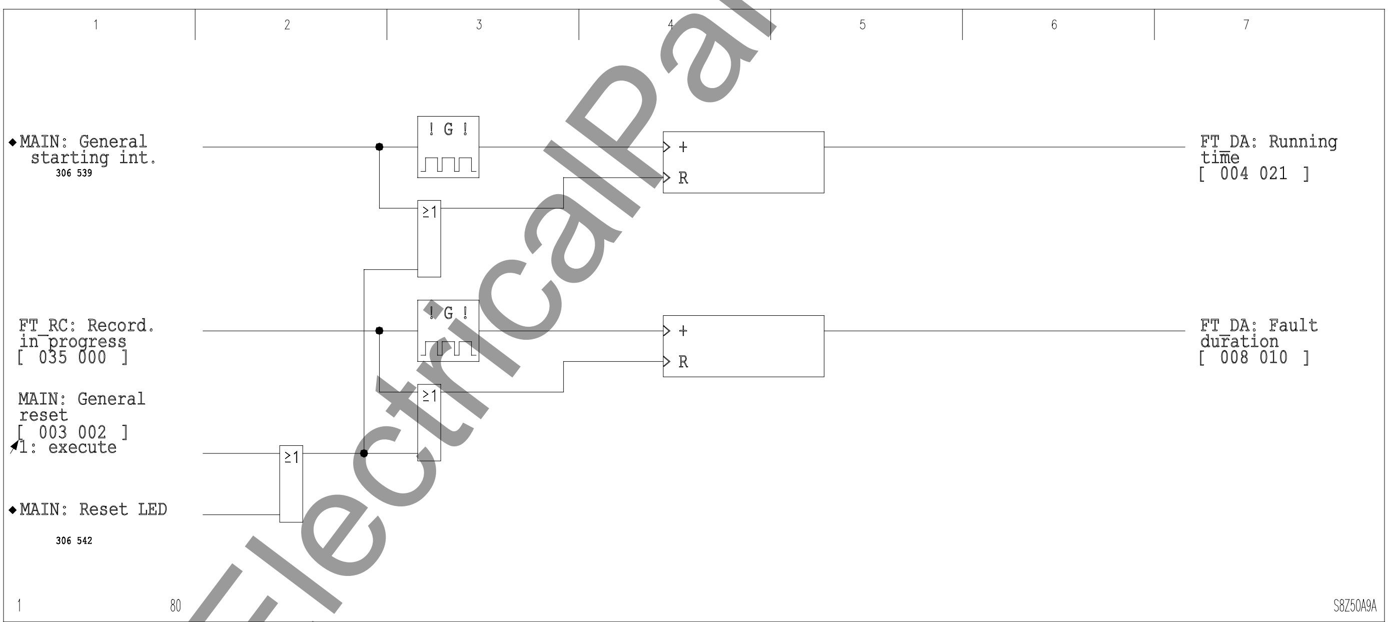
3.14 Fault Data Acquisition (Function Group FT_DA)

When there is a fault in the system, the C232 collects the following measured fault data:

- ◻ Running time
- ◻ Fault duration
- ◻ Fault current (short-circuit current)
- ◻ Ground fault current

Running time and fault duration

The running time is defined as the time between the start and end of the general starting signal that is generated within the C232, and the fault duration is defined as the time between the start and end of the FT_RC: Record. in progress signal.

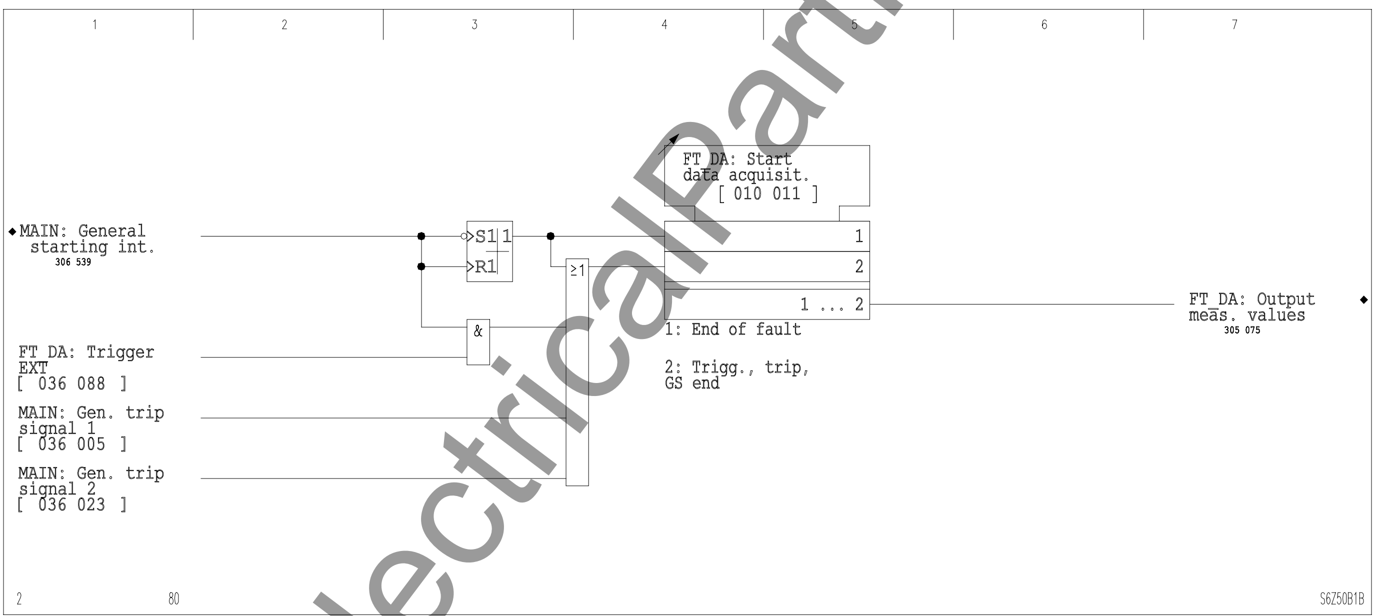


3-66 Running time and fault duration

Fault data acquisition time

The FT_DA: Start data acqu. setting governs the point during a fault at which the measured fault data are acquired. The following settings are possible:

- ☐ *End of fault*
  Acquisition at the end of the fault.
- ☐ *Trigg./Trip/GS end*
  Acquisition at one of the following points:
  - ■ Triggering of an appropriately configured binary signal input during a general starting state
  - ■ Issue of a general trip signal
  - ■ End of a general starting state



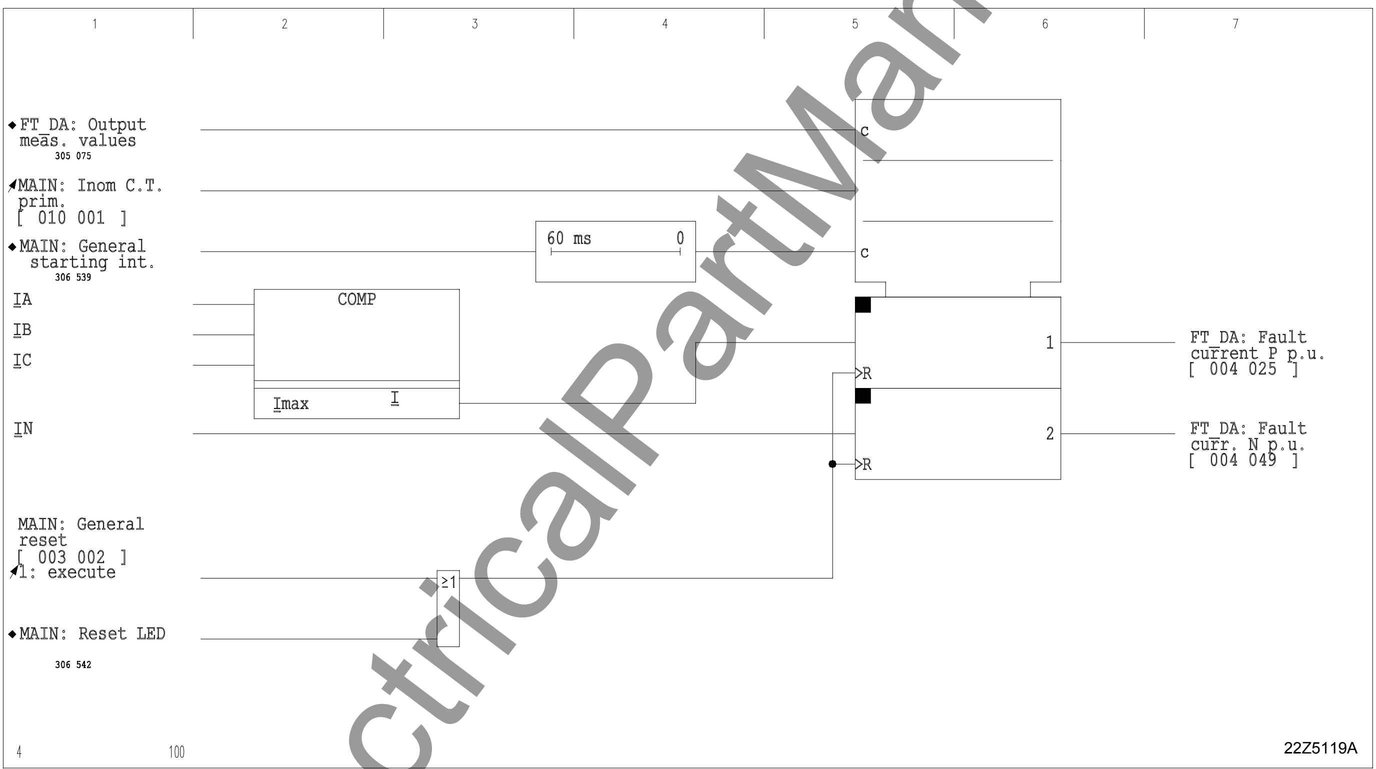
3-67 Enabling of measured fault data acquisition

Fault data acquisition

The fault must last for at least 60 ms so that the fault data can be determined.

The fault data are determined using the maximum phase current and the geometric sum of the three phase currents.

Fault current and ground fault current are displayed as per-unit quantities referred to I_{nom}. If the measured or calculated values are outside the acceptable measuring range, the '*Overflow*' indication is displayed.



3-68 Acquisition of fault data (short-circuit data)

Fault data reset

After the reset key ‘C’ on the local control panel is pressed, the fault data value is displayed as ‘*Not measured*’. However, the values are not erased and can continue to be read out through the PC and communication interfaces.

3.15 Fault Recording (Function Group FT_RC)

Start of fault recording

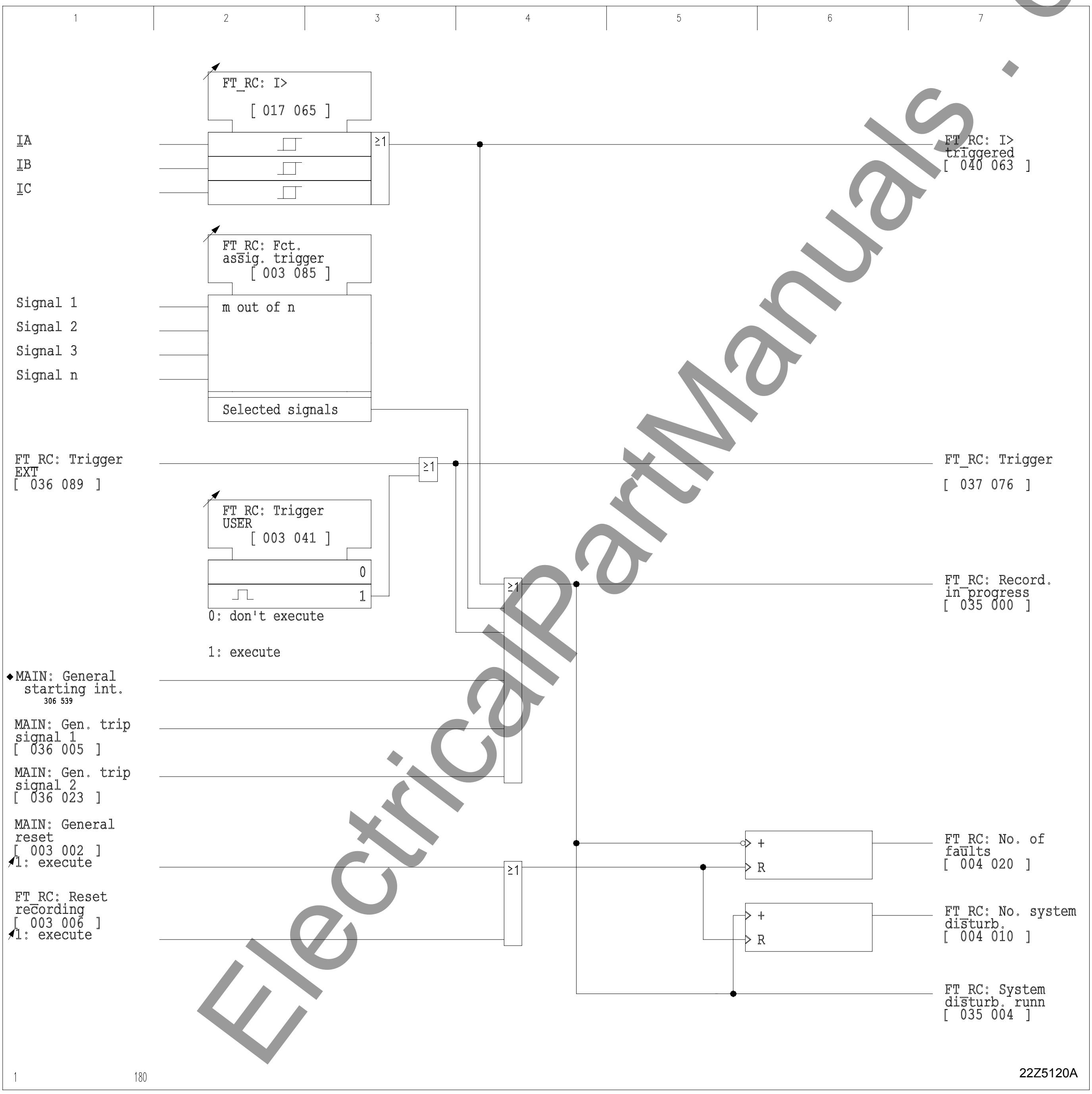
A fault exists, and therefore fault recording begins, if at least one of the following signals is present:

- ◻ MAIN: General starting
- ◻ MAIN: Gen. Trip signal 1
- ◻ MAIN: Gen. trip signal 2
- ◻ FT_RC: Trigger
- ◻ FT_RC: I>

In addition, the user can set an 'm out of n' parameter in order to configure signals whose appearance will trigger fault recording.

Fault counting

Faults are counted and identified by sequential number.



3-69 Start of fault recording and fault counter

Time tagging

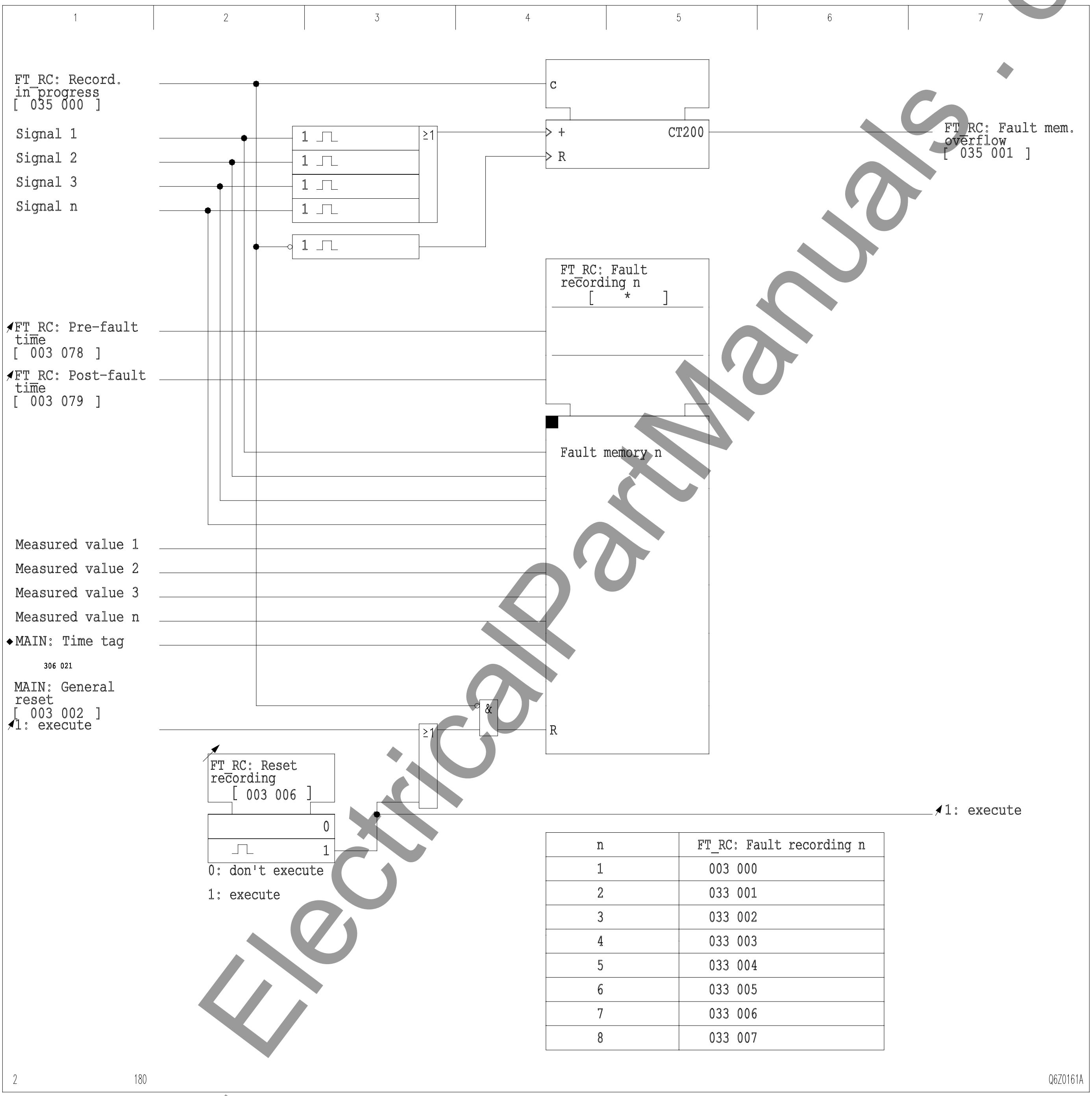
The date that is assigned to each fault by the internal clock is stored. A fault's individual start or end signals are likewise time-tagged by the internal clock. The date and time assigned to a fault when the fault begins can be read out from the fault memory on the local control panel or through the PC and communication interfaces. The time information (relative to the onset of the fault) that is assigned to the signals can be retrieved from the fault memory or through the PC or communication interfaces.

Fault recordings

Protection signals during a fault, including the signals during the settable pre-fault and post-fault times, are logged in chronological order with reference to the specific fault. A total of eight faults, each involving a maximum of 200 start or end signals, can be stored in the non-volatile fault memories. After eight faults have been recorded, the oldest fault recording will be overwritten, unless memories have been cleared in the interim. If more than 199 start or end signals have occurred during a single fault, then FT_RC: Fault mem. overflow will be entered as the last signal. If the time and date are changed during the pre-fault time, the signal FT_RC: Faulty time tag is generated.

In addition to the fault signals, the measured fault data are also entered in the fault memory.

The fault recordings can be read from the local control panel or through the PC or communication interfaces.



n	FT_RC: Fault recording n
1	003 000
2	033 001
3	033 002
4	033 003
5	033 004
6	033 005
7	033 006
8	033 007

3-70 Fault memory

Fault value recording

The following analog signals are recorded:

- Phase currents
- Phase-to-ground voltage V_{A-G}
- Residual current, evaluated by the C232

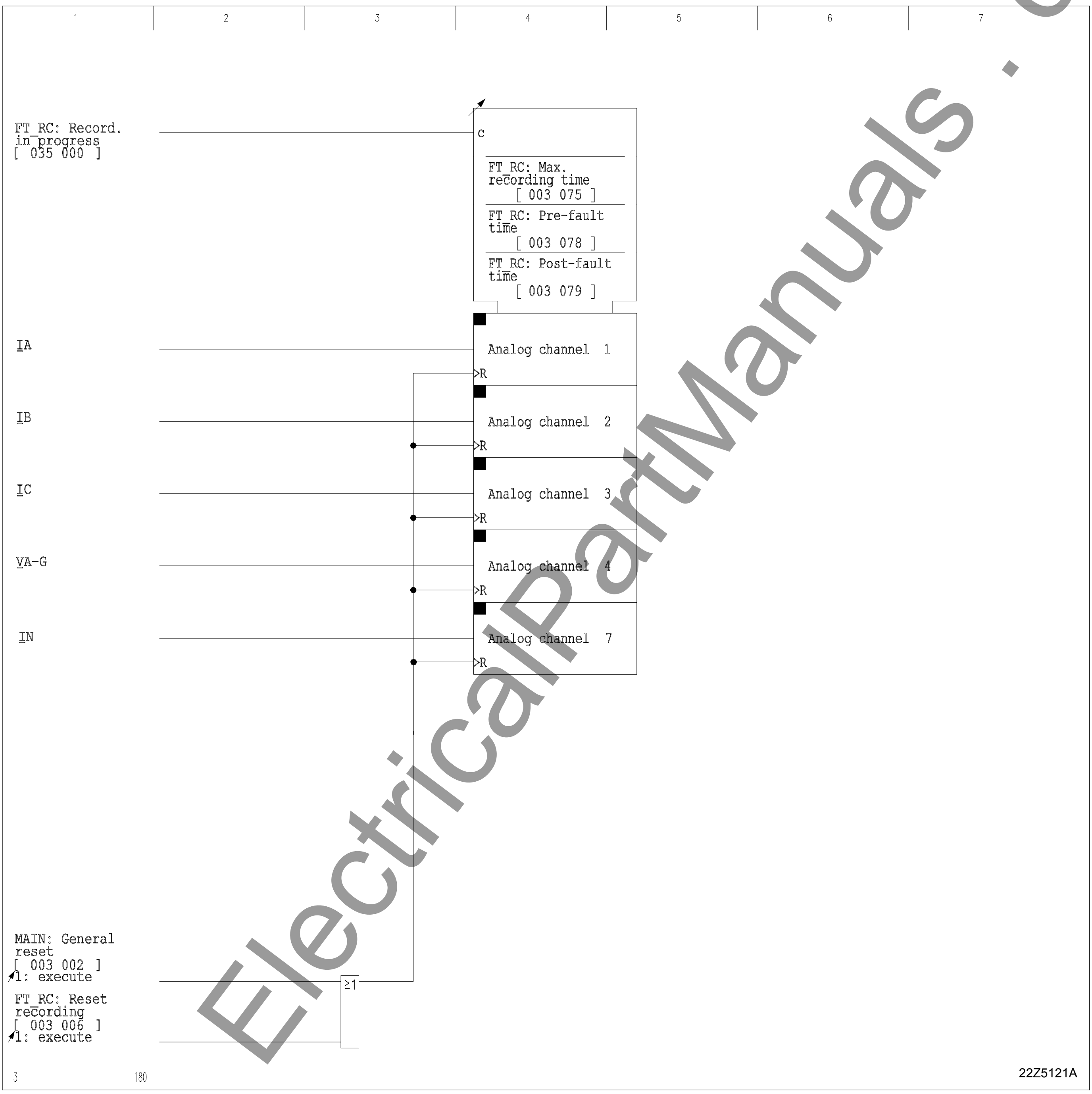
The signals are recorded before, during and after a fault. The times for recording before and after the fault can be set. A maximum time period of 6 s (50 Hz) is available for recording. This period can be divided among a maximum of eight faults. The maximum recording time per fault can be set. If a fault, including the set pre-fault and post-fault times, lasts longer than the set maximum recording time, then recording will terminate when the set maximum recording time is reached.

The pre-fault time is exactly adhered to if it is shorter than the set maximum recording time. Otherwise; the pre-fault time is set to the maximum recording time minus a sampling increment, and the post-fault time is set to zero.

If the maximum recording time of 6 s is exceeded, the analog values for the oldest fault are overwritten, but not the binary values. If more than eight faults have occurred since the last reset, then all data for the oldest fault are overwritten.

The analog data of the fault record can only be read out through the PC or communication interfaces.

After a warm restart, the values of all faults remain stored. When the supply voltage is interrupted all faults will be cleared.



3-71 Fault value recording

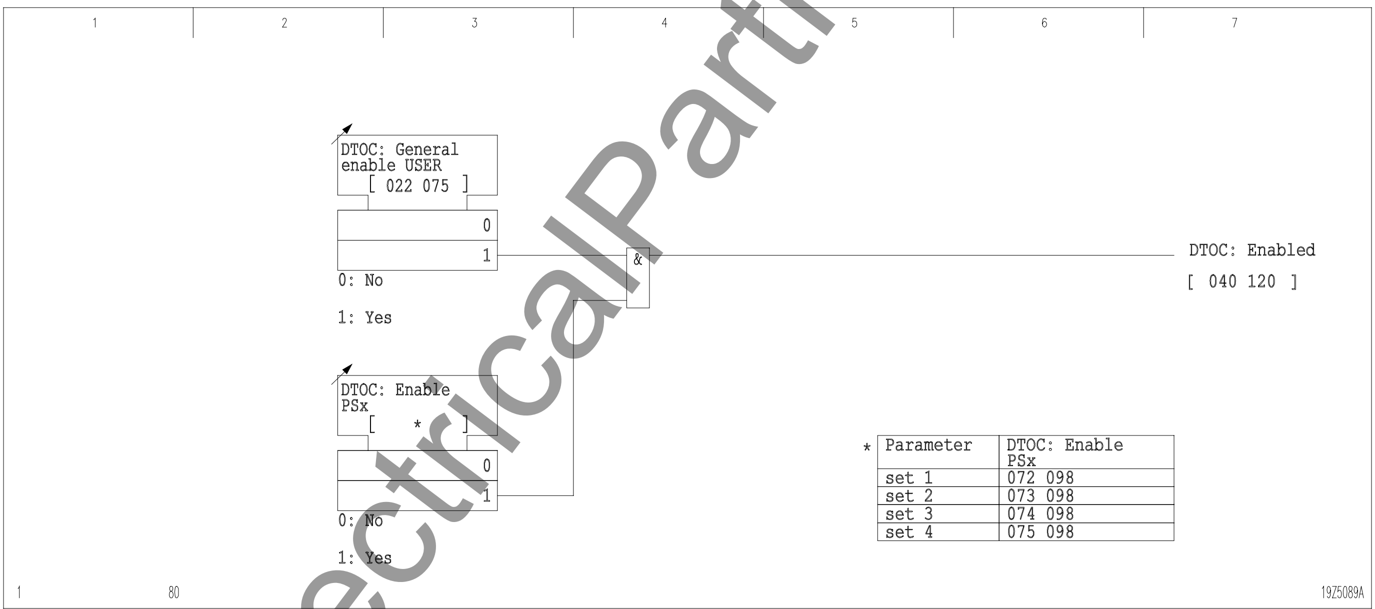
3.16 Definite-Time Overcurrent Protection (Function Group DTOC)

A three-stage definite-time overcurrent protection function (DTOC protection) is implemented in the C232. Two separate measuring systems are available for this purpose:

- Phase currents system
- Residual currents system

Disabling or enabling DTOC protection

DTOC protection can be disabled or enabled from the local control panel. Moreover, enabling can be carried out separately for each parameter set.

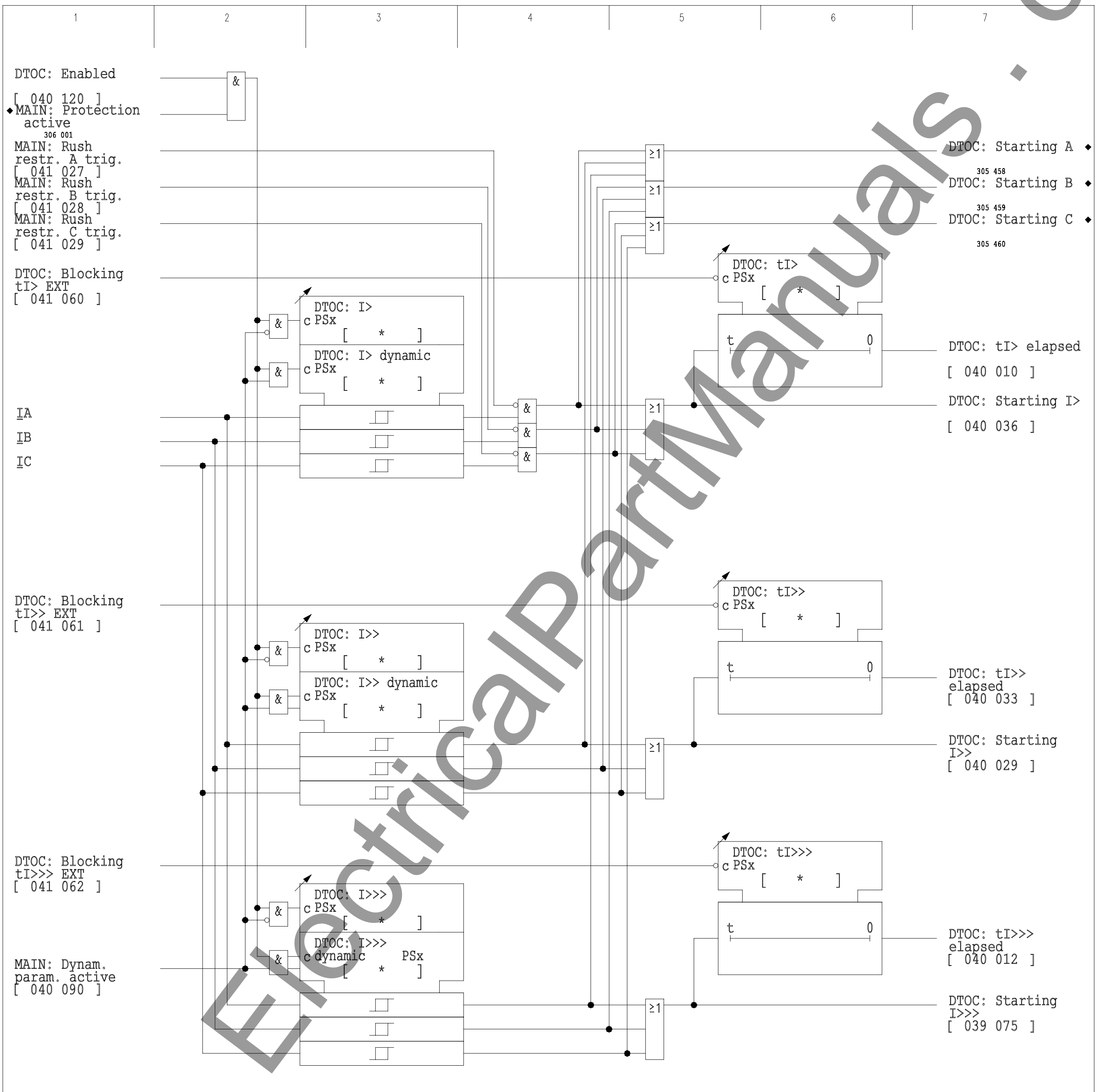


3-72 *Disabling or enabling DTOC protection*

Phase current stages

The three phase currents are monitored by the C232 with three-stage functions to detect when they exceed the set thresholds. Alternatively, two different threshold types can be active. The “dynamic” thresholds are active for the set hold time of the “dynamic parameters” (see “Activation of Dynamic Parameters”); the “normal” thresholds are active when no hold time is running. If the current exceeds the set thresholds in one phase, timer stages are started. Once these stages have elapsed, a signal is issued. The timer stages may be blocked via appropriately configured binary signal inputs.

When the inrush stabilization function (see: ‘Main Functions’) is triggered, the 1st stage of the DTOC function is blocked.

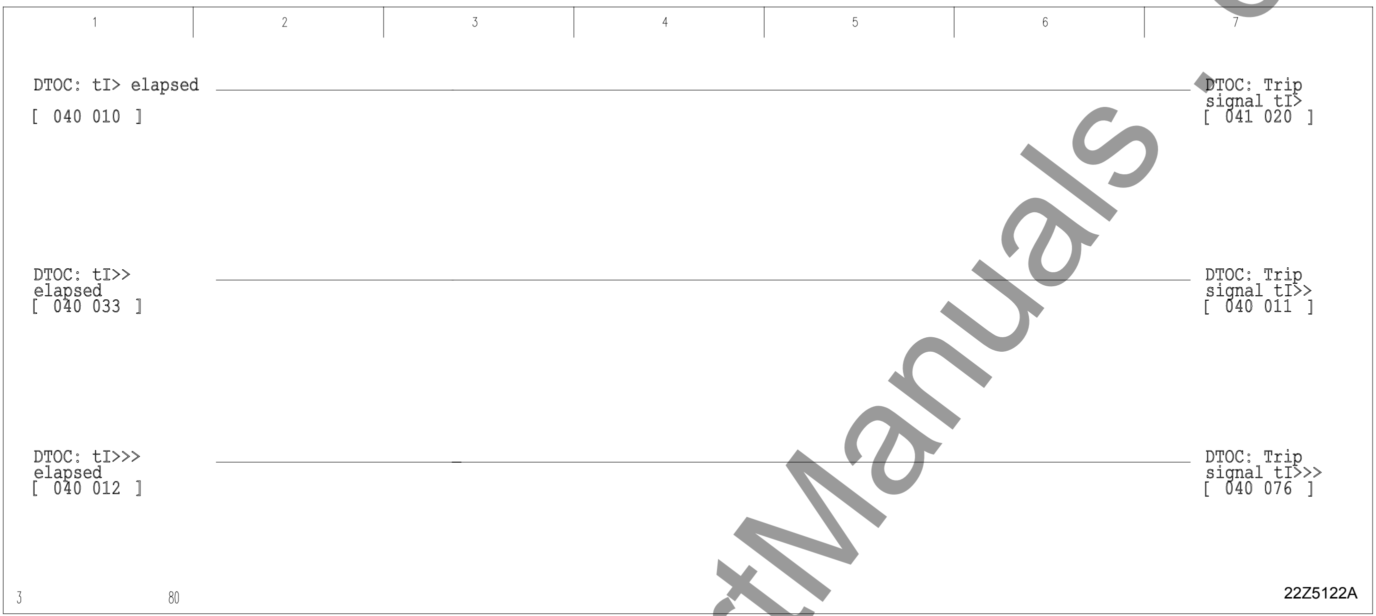


* Parameter	DTOC: I> PSx	DTOC: I> dynamic PSx	DTOC: I>> PSx	DTOC: I>> dynamic PSx
set 1	017 000	017 080	017 001	017 084
set 2	073 007	073 032	073 008	073 033
set 3	074 007	074 032	074 008	074 033
set 4	075 007	075 032	075 008	075 033

* Parameter	DTOC: I>>> PSx	DTOC: I>>> dynamic PSx	DTOC: tI> PSx	DTOC: tI>> PSx	DTOC: tI>>> PSx
set 1	017 002	017 085	017 004	017 006	170 007
set 2	073 009	073 034	073 019	073 020	073 021
set 3	074 009	074 034	074 019	074 020	074 021
set 4	075 009	075 034	075 019	075 020	075 021

2 220 S8Z7507A

3-73 Phase current stages



3-74 Trip signals of the DTOC phase current stages

Enabling or disabling the residual current systems of DTOC protection

The residual current systems of DTOC protection can be disabled or enabled from the local control panel or via binary signal inputs.

Residual current stages

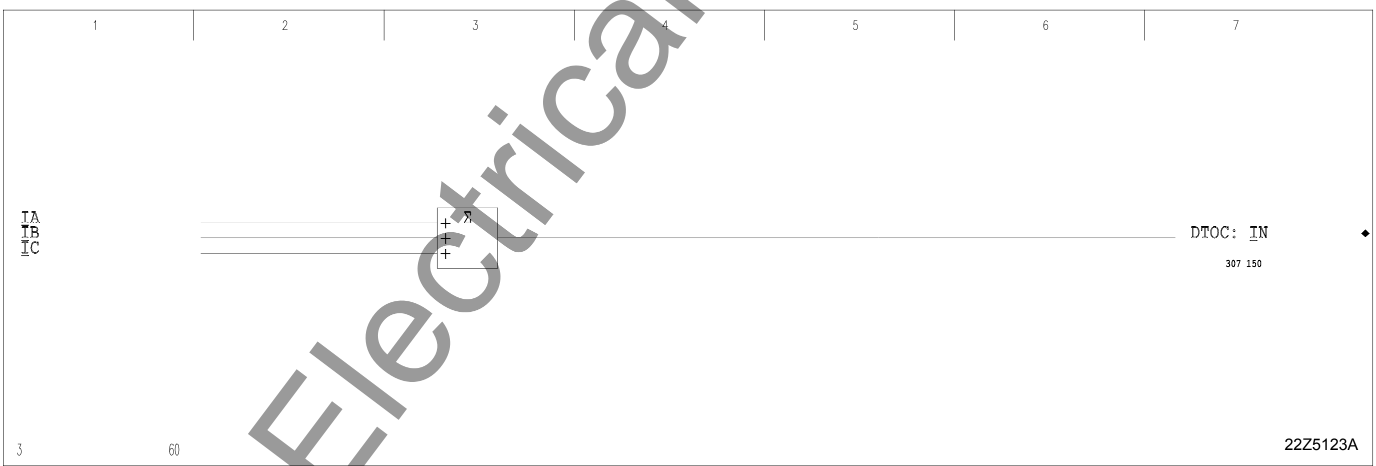
The residual current is monitored with three-stage functions to detect when it exceeds the set thresholds. Alternatively, two different threshold types can be active. The "dynamic" thresholds are active for the set hold time of the "dynamic parameters" (see "Activation of Dynamic Parameters"); the "normal" thresholds are active when no hold time is running. If the residual current exceeds the set thresholds, timer stages are started. Once these stages have elapsed, a signal is issued.

The timer stages may be blocked via appropriately configured binary signal inputs. Furthermore, the timer stages can – depending on the setting - be blocked automatically for single-pole or multi-pole startings.

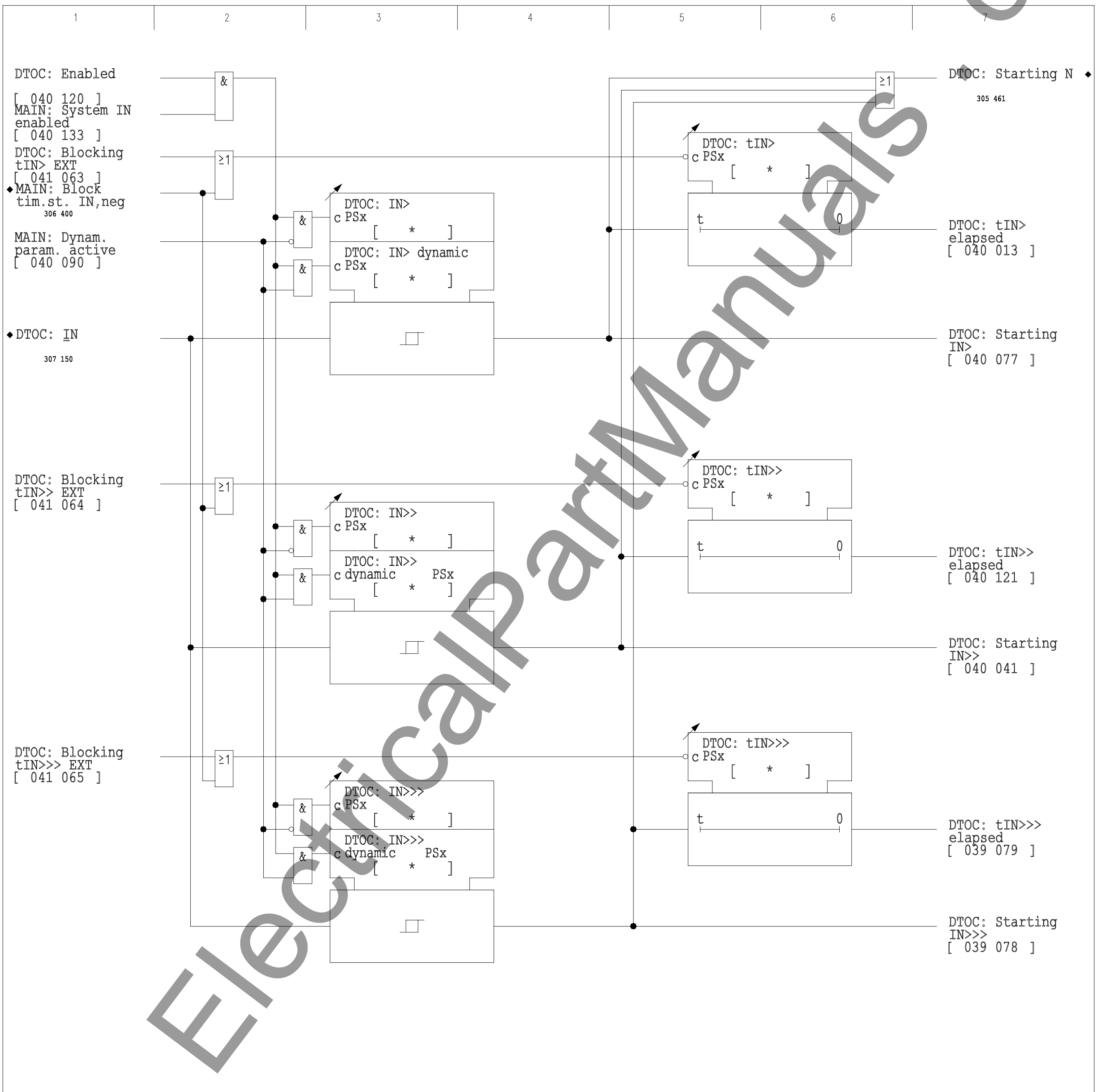
The trip signals of the residual current stages are not enabled unless the operating mode of the general starting is set to *With start. IN, Ineg*.

Residual current

The C232 will use the residual current calculated from the three phase currents as the residual current.



3-75 Selecting the measured variable



*

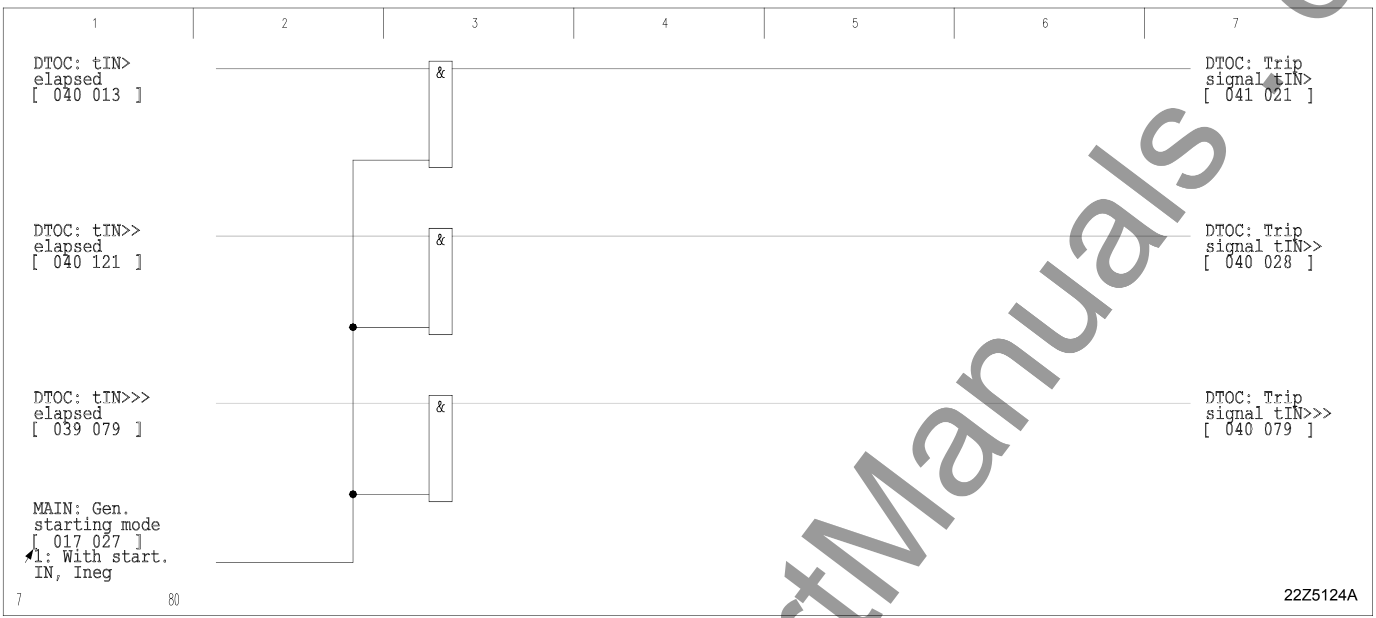
Parameter	DTOC: IN> PSx	DTOC: IN> dynamic PSx	DTOC: IN>> PSx	DTOC: IN>> dynamic PSx
set 1	017 003	017 081	017 009	017 086
set 2	073 015	073 035	073 016	073 036
set 3	074 015	074 035	074 016	074 036
set 4	075 015	075 035	075 016	075 036

*

Parameter	DTOC: IN>>> PSx	DTOC: IN>>> dynamic PSx	DTOC: tIN> PSx	DTOC: tIN>> PSx	DTOC: tIN>>> PSx
set 1	017 018	017 087	017 008	017 010	170 019
set 2	073 017	073 037	073 027	073 028	073 029
set 3	074 017	074 037	074 027	074 028	074 029
set 4	075 017	075 037	075 027	075 028	075 029

6 220 S8Z7509A

3-76 Residual current stages

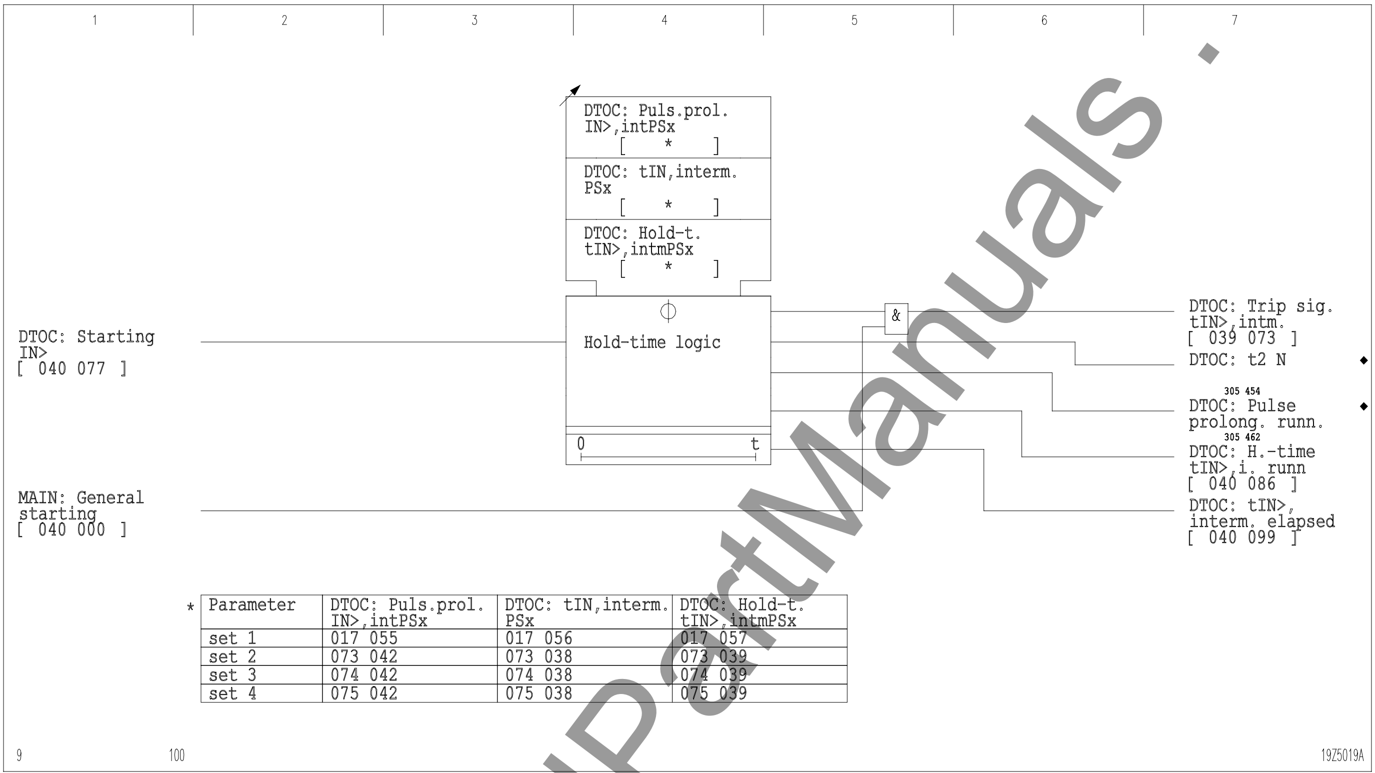


3-77 Trip signals of the DTOC residual current stages

Hold-time logic for the treatment of intermittent ground faults

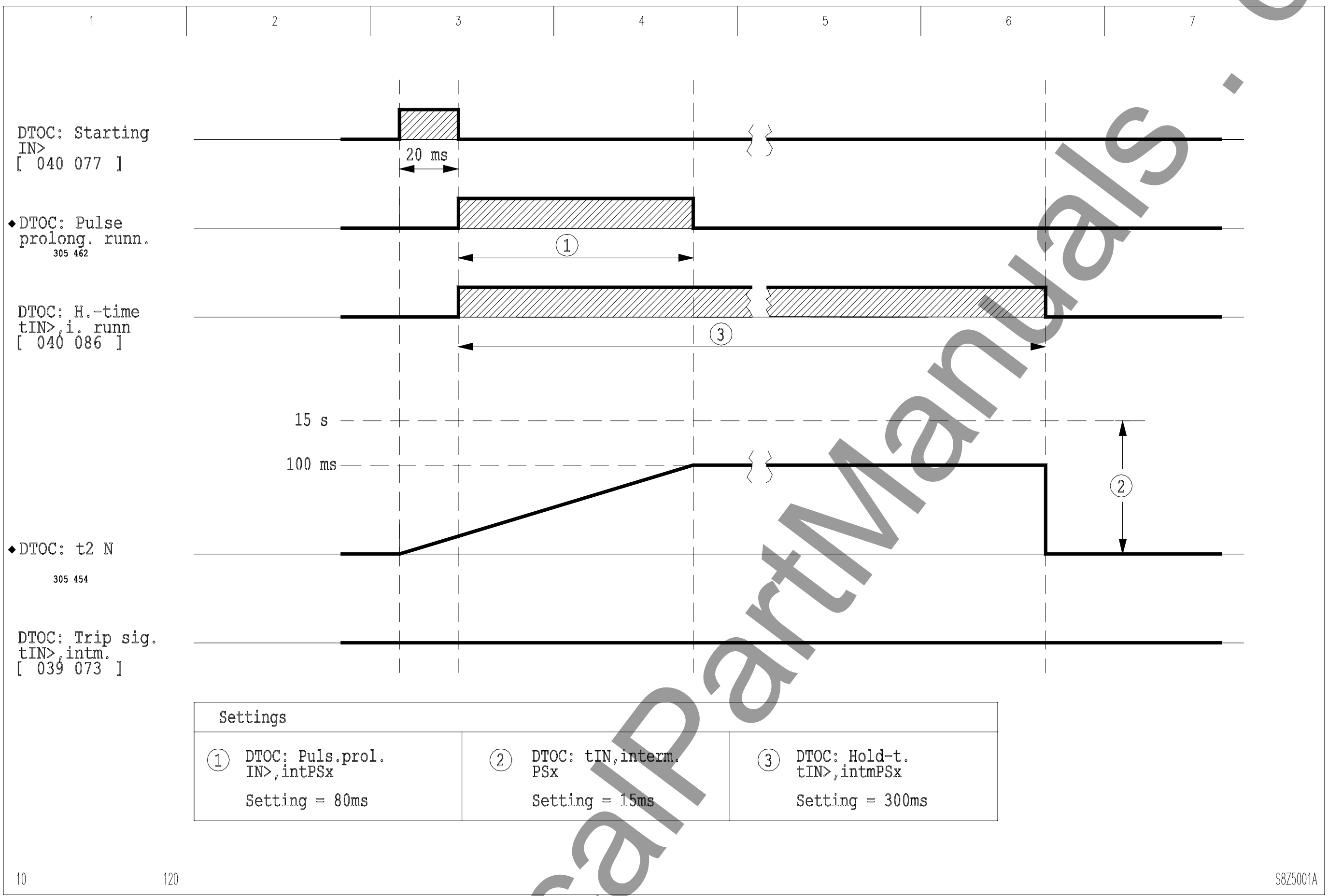
A hold-time logic for the treatment of intermittent ground faults is implemented in the C232.

- As the I_N> starting in the residual current stage starts, the hold time is reset. At the same time, the starting time is accumulated at the onset of I_N> starting.
- As I_E> starting ends, the timer stage DTOC: Puls.prol.IN>,intPSx is started and the charging of the accumulation buffer is thereby prolonged by the set value of the timer stage.
- The accumulation result is compared with the settable limit value DTOC: tIN>, interm. PSx.
- If the limit value is reached and a general starting is present, then a trip results, provided that it is permitted by the relevant global settings.
  - MAIN: Block tim.st. IN,neg (address 017 015)
  - MAIN: Gen. starting mode (address 017 027)
  - MAIN: Fct.assig.trip cmd.1 (address 021 001)
  - MAIN: Fct.assig.trip cmd.2 (address 021 002)
- If the limit value is reached while the timer stage DTOC: Puls.prol.IN>,intPSx is running, then a trip will occur at the onset of the next general starting phase.
- With each release of the trigger stage I_N>, the set hold-time DTOC: Hold-t. tIN>,intmPSx is restarted. When the hold time elapses or after the hold-time logic has issued a trip (DTOC: Trip sig. tIE>,intm.), accumulation is stopped and the accumulation buffer is cleared.

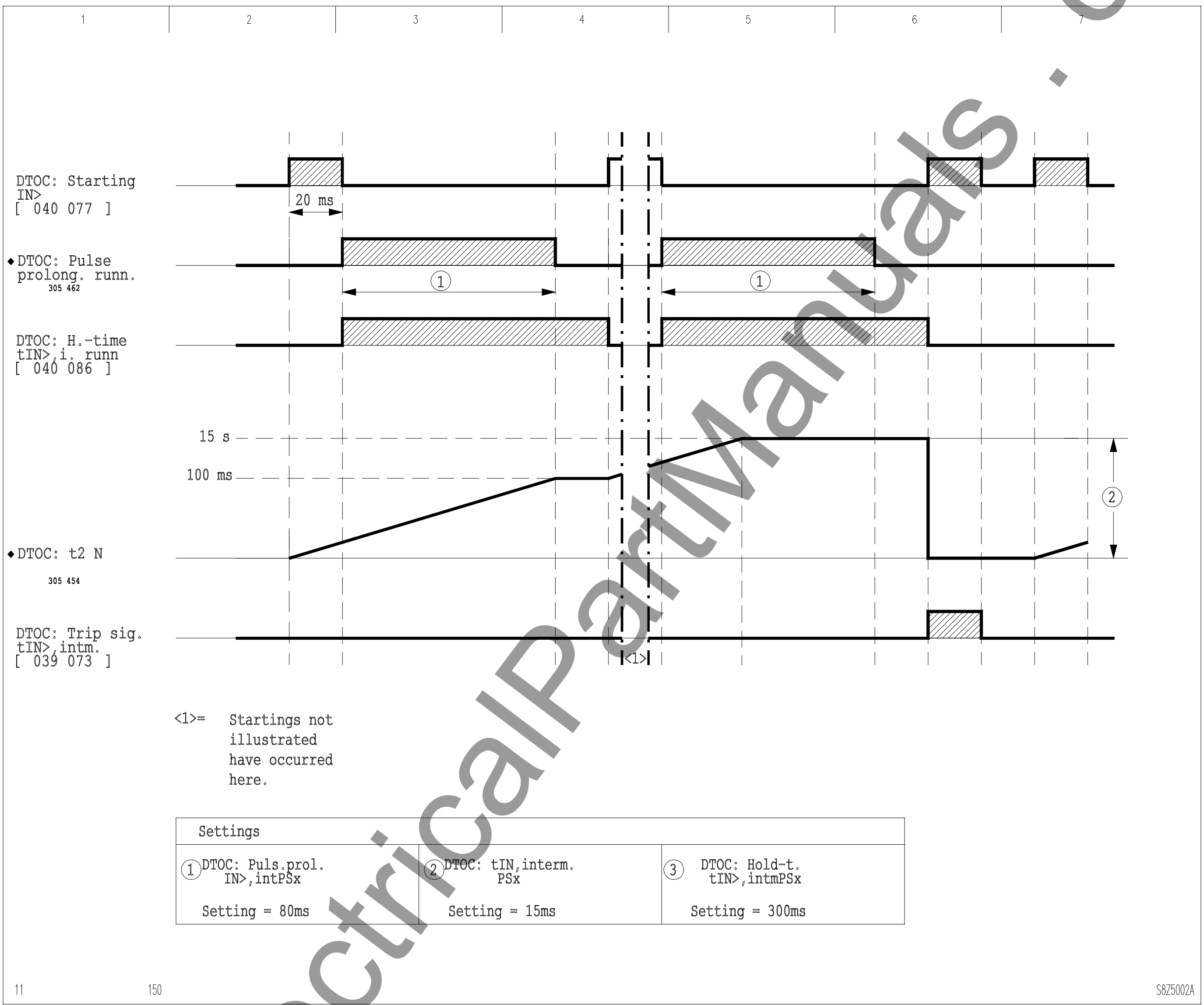


* Parameter	DTOC: Puls.prol. IN>,intPSx	DTOC: tIN,interm. PSx	DTOC: Hold-t. tIN>,intmPSx
set 1	017 055	017 056	017 057
set 2	073 042	073 038	073 039
set 3	074 042	074 038	074 039
set 4	075 042	075 038	075 039

3-78 Hold-time logic for definite-time characteristics



3-79 Signal flow for values below the accumulation limit value



3-80 Signal flow for values at the accumulation limit value

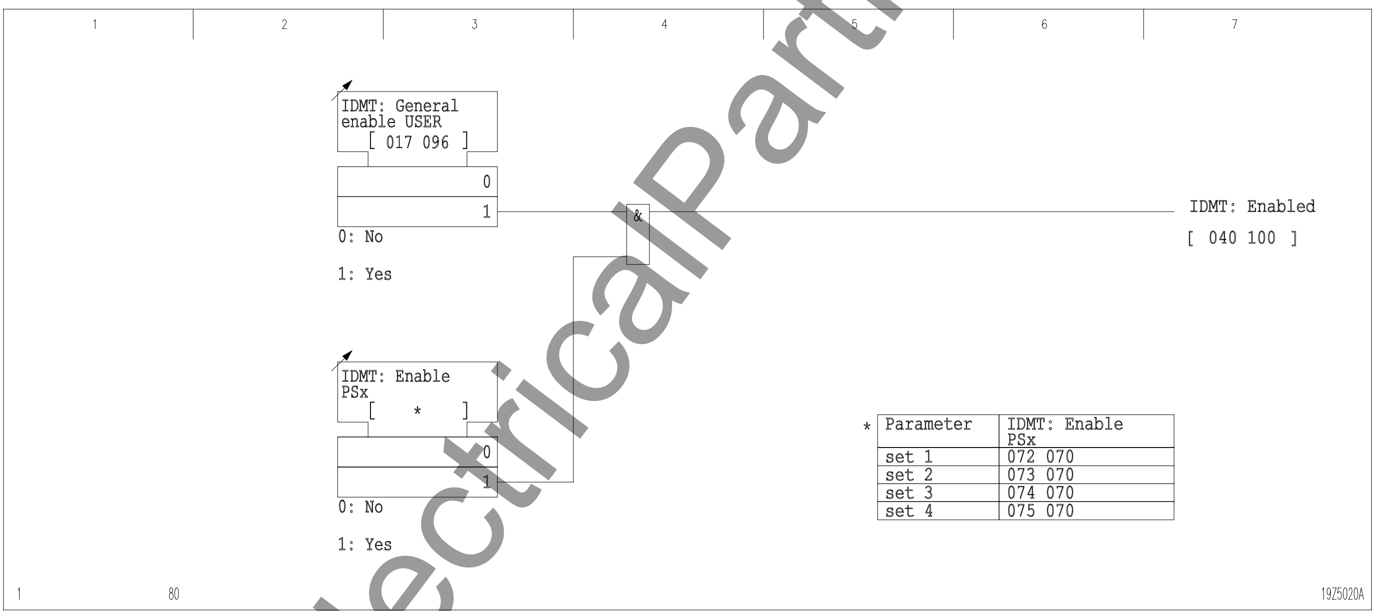
3.17 Inverse-Time Overcurrent Protection (Function Group IDMT)

The inverse-time overcurrent protection (IDMT) function operates with three separate measuring systems:

- Phase currents
- Negative-sequence current
- Residual current

Disabling or enabling IDMT protection

IDMT protection can be disabled or enabled from the integrated local control panel. Moreover, enabling can be carried out separately for each parameter set.

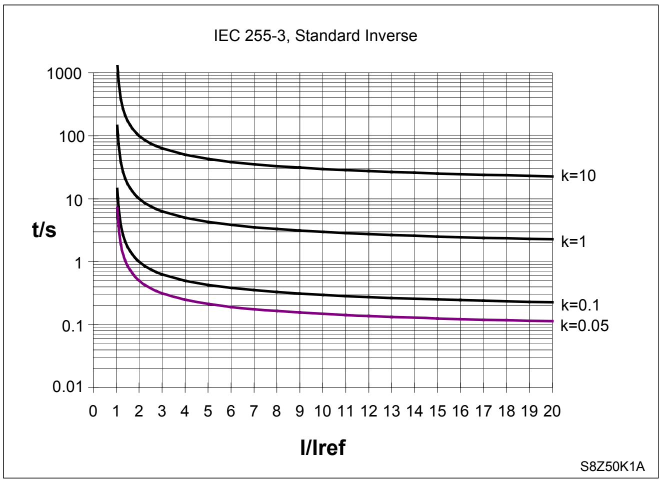


3-81 *Disabling or enabling IDMT protection*

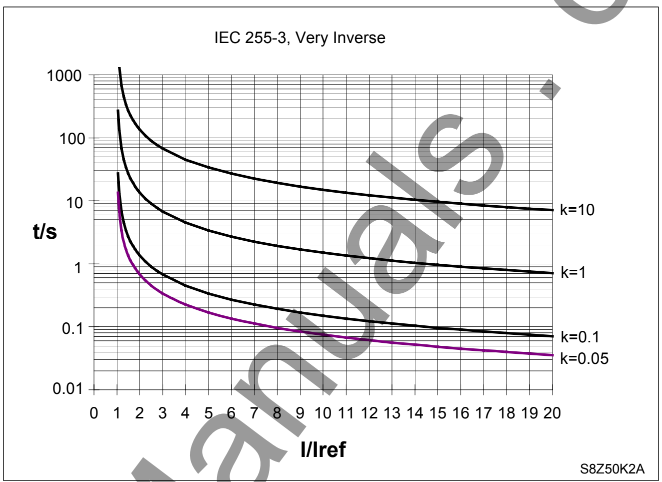
Time-dependent characteristics

The measuring systems for the evaluation of the three phase currents, the negative-sequence current system and the residual current operate independently and can be set separately. The user can select from a large number of characteristics (see table below). The measured variable is the maximum phase current, the negative-sequence current, or the residual current, depending on the measuring system. The tripping characteristics available for selection are shown in Figures 3-82 to 3-85 .

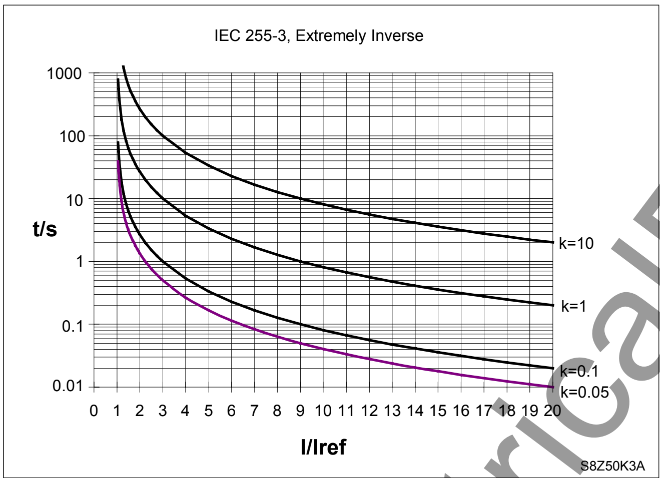
No.	Tripping Characteristic *k* = 0.01 to 10.00	Formula for the Tripping Characteristic	Constants a	b	c	Formula for the Release Characteristic	R
0	Definite Time	$t = k$					
	Per IEC 255-3	$t = k \cdot \frac{a}{\left(\frac{I}{I_{ref}}\right)^{b} - 1}$					
1	Standard Inverse		0.14	0.02			
2	Very Inverse		13.50	1.00			
3	Extremely Inverse		80.00	2.00			
4	Long Time Inverse		120.00	1.00			
	Per IEEE C37.112	$t = k \cdot \left(\frac{a}{\left(\frac{I}{I_{ref}}\right)^{b} - 1} + c \right)$				$t_r = k \cdot \frac{R}{\left(\frac{I}{I_{ref}}\right)^{2} - 1}$	
5	Moderately Inverse		0.0515	0.0200	0.1140		4.85
6	Very Inverse		19.6100	2.0000	0.4910		21.60
7	Extremely Inverse		28.2000	2.0000	0.1217		29.10
	Per ANSI	$t = k \cdot \left(\frac{a}{\left(\frac{I}{I_{ref}}\right)^{b} - 1} + c \right)$				$t_r = k \cdot \frac{R}{\left(\frac{I}{I_{ref}}\right)^{2} - 1}$	
8	Normally Inverse		8.9341	2.0938	0.17966		9.00
9	Short Time Inverse		0.2663	1.2969	0.03393		0.50
10	Long Time Inverse		5.6143	1.0000	2.18592		15.75
11	RI-Type Inverse	$t = k \cdot \frac{1}{0.339 - \frac{0.236}{\left(\frac{I}{I_{ref}}\right)}}$					
12	RXIDG-Type Inverse	$t = k \cdot \left(5.8 - 1.35 \cdot \ln \frac{I}{I_{ref}}\right)$					



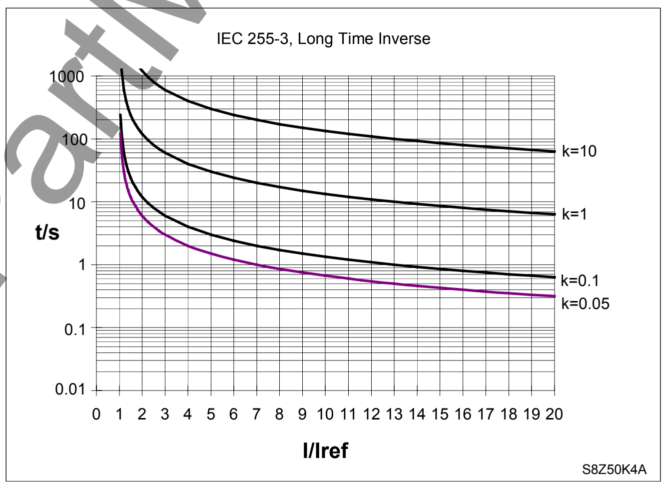
Characteristic No. 1



Characteristic No. 2

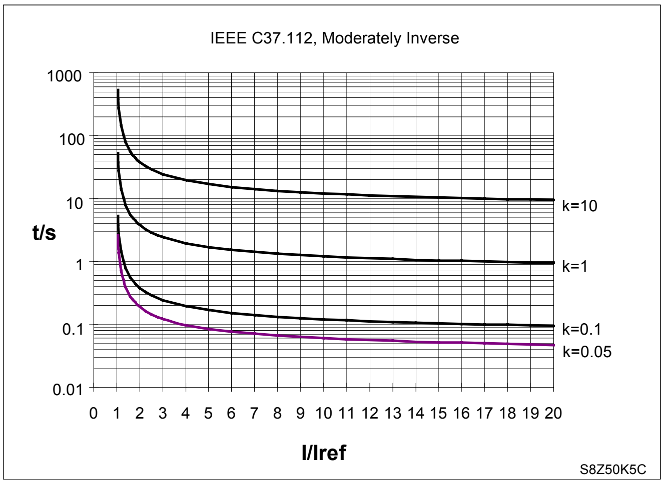


Characteristic No. 3

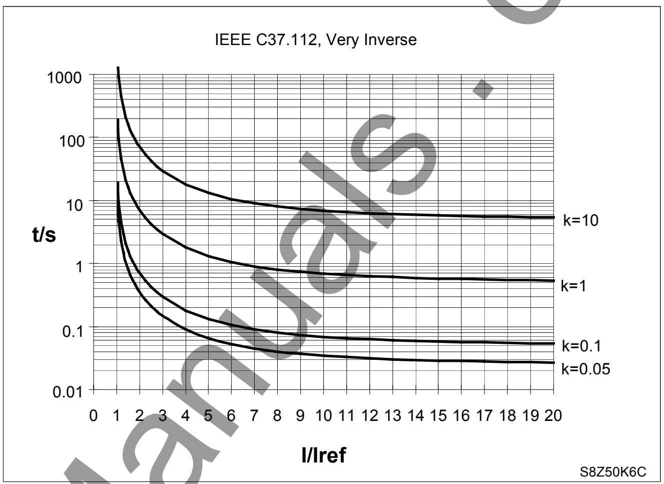


Characteristic No. 4

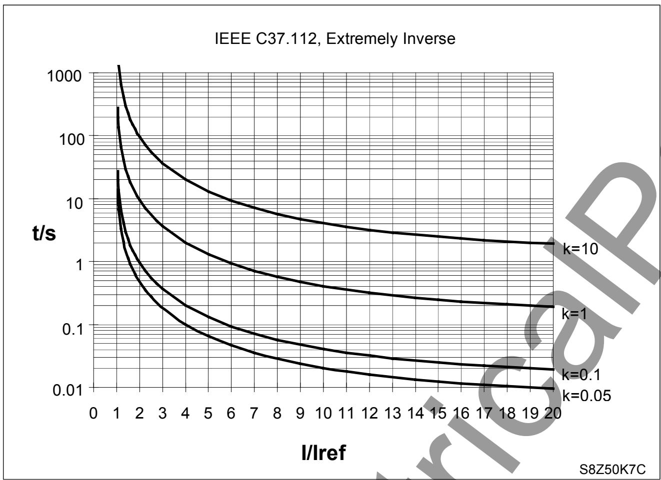
3-82 Tripping characteristics per IEC 255-3



Characteristic No. 5

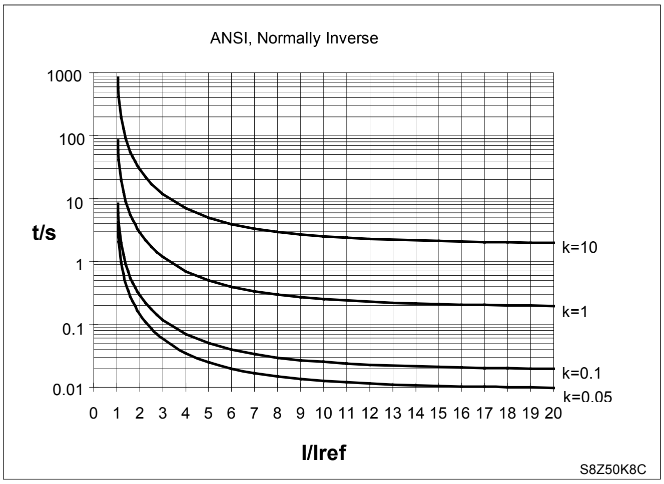


Characteristic No. 6

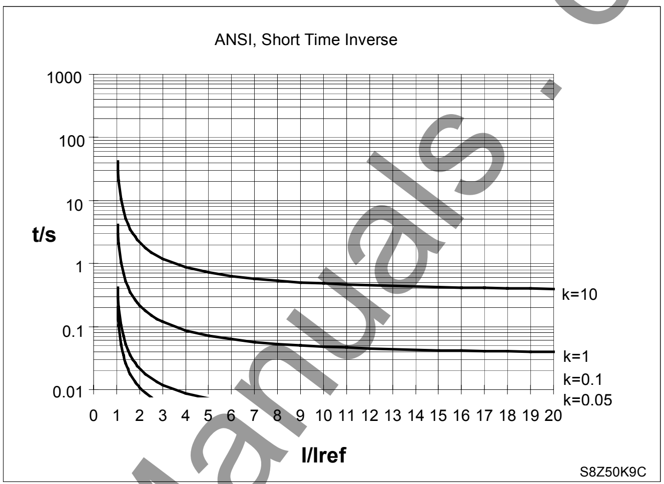


Characteristic No. 7

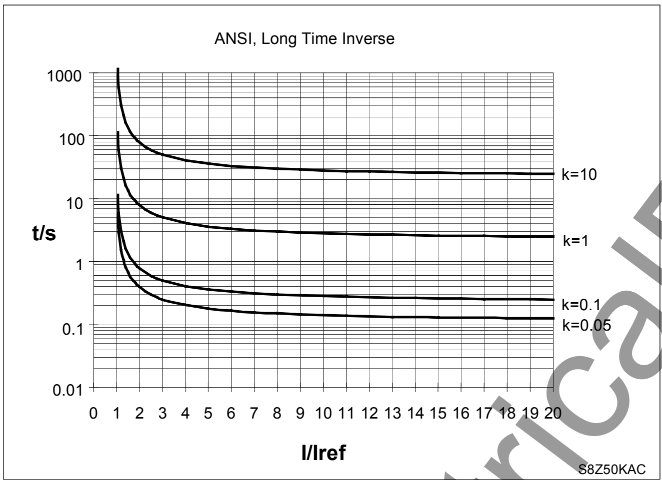
3-83 Tripping characteristics per IEEE C37.112



Characteristic No. 8

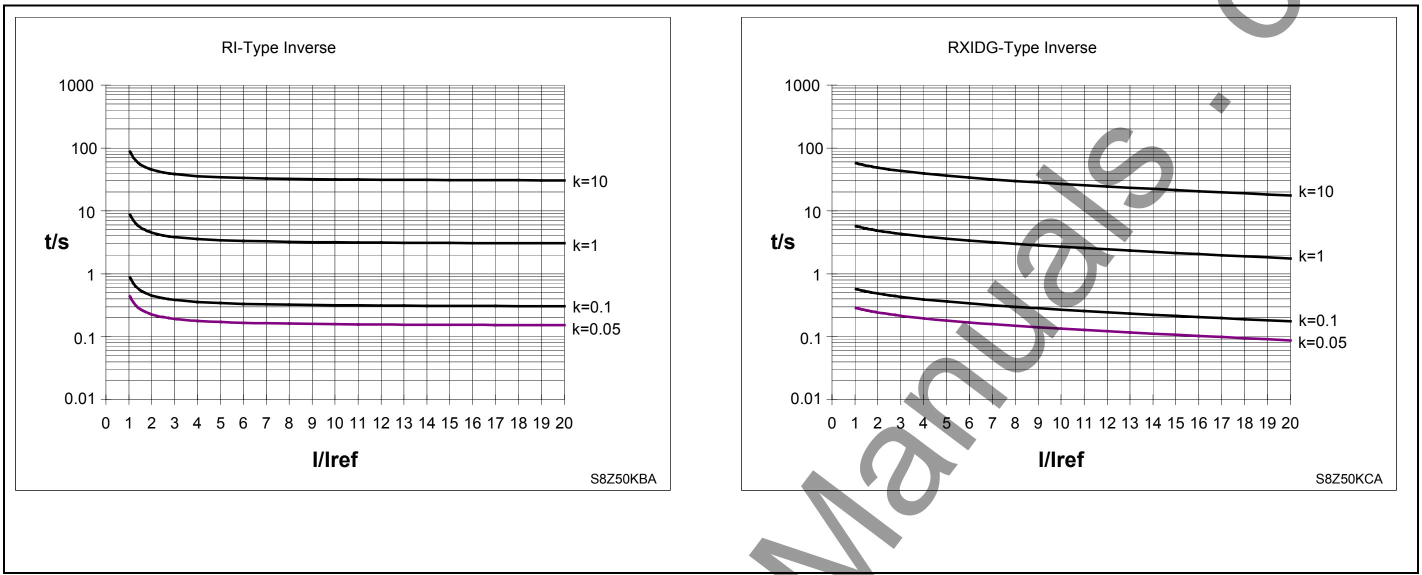


Characteristic No. 9



Characteristic No. 10

3-84 Tripping characteristics per ANSI



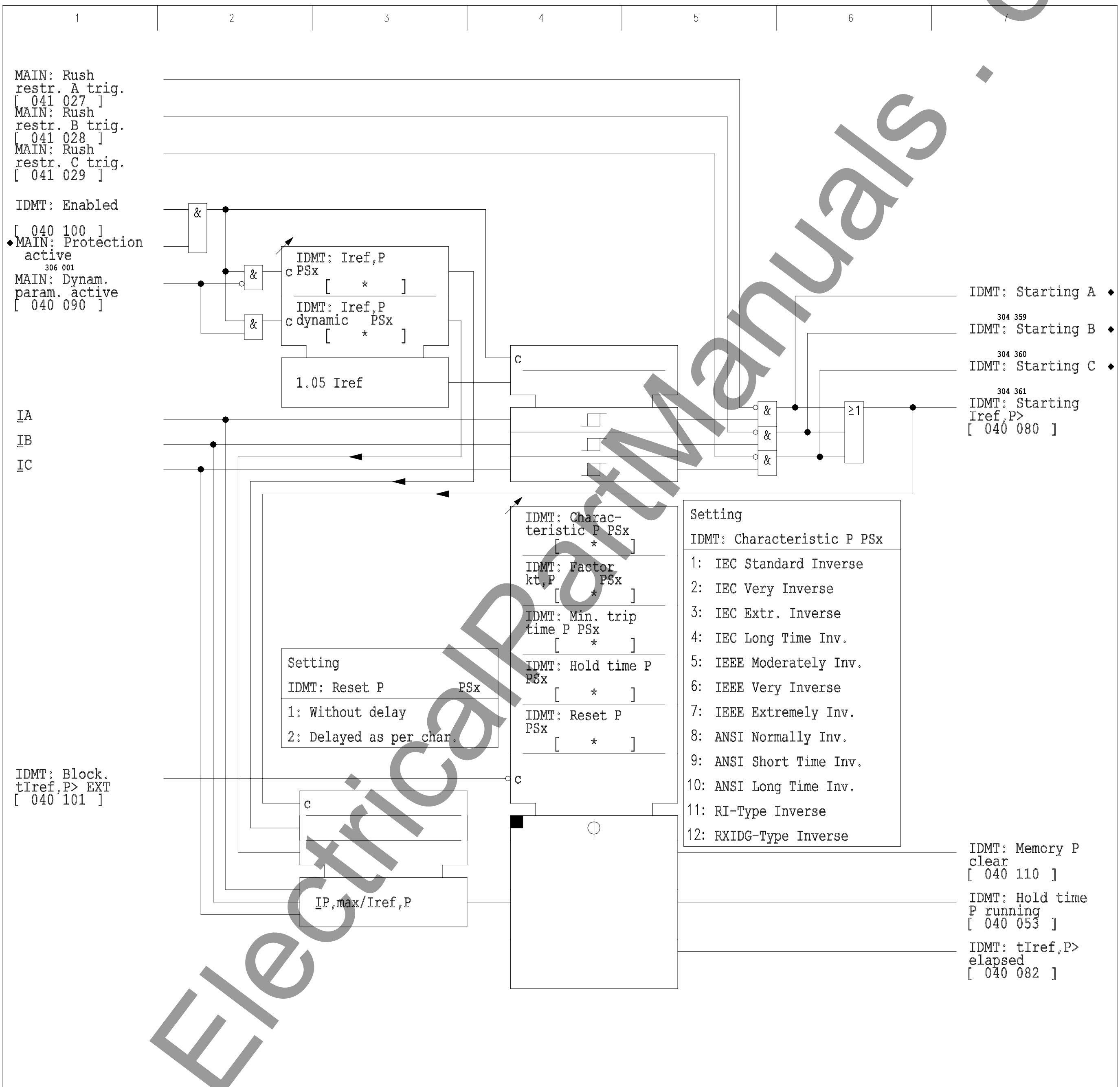
3-85 RI-type inverse and RXIDG-type inverse tripping characteristics

Phase current stage

The three phase currents are monitored by the C232 to detect when they exceed the set thresholds. Alternatively, two different threshold types can be active. The “dynamic” threshold is active for the set hold time of the “dynamic parameters” (see “Activation of Dynamic Parameters”); the “normal” threshold is active when no hold time is running. The IDMT protection function issues a starting signal if 1.05 times the set reference current is exceeded in one phase. The C232 determines the highest of the three phase currents for further processing. As a function of this current and of the set characteristic, the C232 will determine the tripping time. Furthermore, a minimum trip time can be set; the trip time will not fall below this minimum independent of the magnitude of the current.

When the inrush stabilization function (see: ‘Main Functions of the C232’) is triggered, the phase current stage is blocked.

The inverse-time stage can be blocked by way of an appropriately configured binary signal input.



*

Parameter	IDMT: Iref,P PSx	IDMT: Iref,P dynamic PSx	IDMT: Charac- teristic P PSx	IDMT: Factor kt,P PSx
set 1	072 050	072 003	072 056	072 053
set 2	073 050	073 003	073 056	073 053
set 3	074 050	074 003	074 056	074 053
set 4	075 050	075 003	075 056	075 053

*

Parameter	IDMT: Min. trip time P PSx	IDMT: Hold time P PSx	IDMT: Reset P PSx
set 1	072 077	072 071	072 059
set 2	073 077	073 071	073 059
set 3	074 077	074 071	074 059
set 4	075 077	075 071	075 059

2 220 S8Z7511A

3-86 Phase current stage

3-87 Trip signal of the phase current stage

Negative-sequence current stage

The C232 determines the negative-sequence current – based on the set rotary field – according to the following formulas:

Clockwise rotating field:

$$\underline{I}_{neg} = \frac{1}{3} \cdot \left| \left(\underline{I}_A + \underline{a}^2 \cdot \underline{I}_B + \underline{a} \cdot \underline{I}_C \right) \right|$$

Anticlockwise rotating field:

$$\underline{I}_{neg} = \frac{1}{3} \cdot \left| \left(\underline{I}_A + \underline{a} \cdot \underline{I}_B + \underline{a}^2 \cdot \underline{I}_C \right) \right|$$

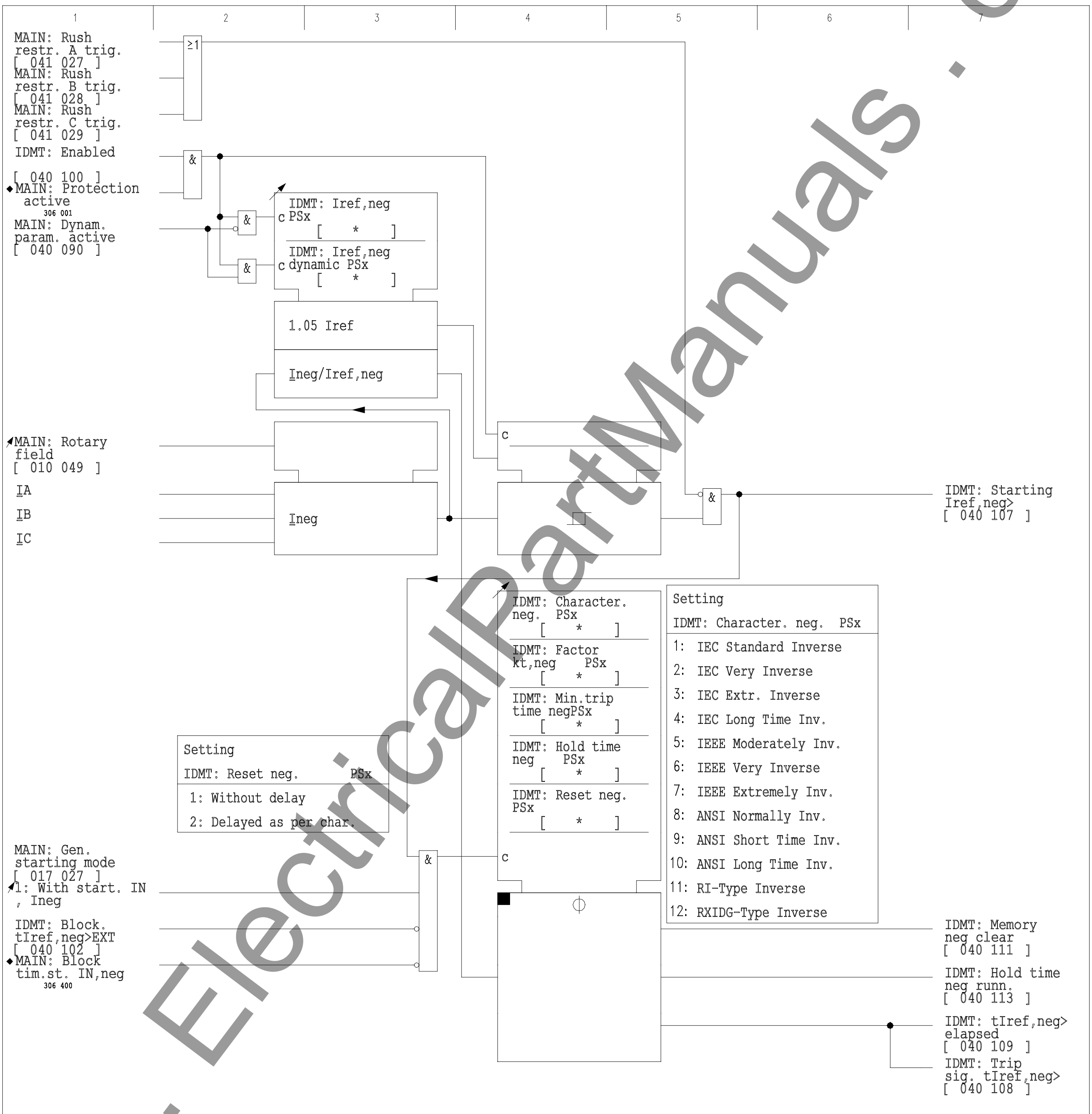
$$\underline{a} = e^{j120°}$$

$$\underline{a}^2 = e^{j240°}$$

The negative-sequence current is monitored by the C232 to detect when it exceeds the set thresholds. Alternatively, two different threshold types can be active. The “dynamic” threshold is active for the set hold time of the “dynamic parameters” (see “Activation of Dynamic Parameters”); the “normal” threshold is active when no hold time is running. The IDMT protection function issues a starting signal if the negative-sequence current exceeds a value of 1.05 times the set reference current. As a function of the set characteristic and of the residual current, the C232 will determine the tripping time. Furthermore, a minimum trip time can be set; the trip time will not fall below this minimum independent of the magnitude of the negative-sequence current.

When the inrush stabilization function (see: ‘Main Functions of the C232’) is triggered, the negative-sequence current stage is blocked.

The inverse-time stage can be blocked by way of an appropriately configured binary signal input. Furthermore, the inverse-time stage can – depending on the setting - be blocked automatically for single-pole or multi-pole startings.



*

Parameter	IDMT: Iref,neg PSx	IDMT: Iref,neg dynamic PSx	IDMT: Character. neg. PSx	IDMT: Factor kt,neg PSx
set 1	072 051	072 004	072 057	072 054
set 2	073 051	073 004	073 057	073 054
set 3	074 051	074 004	074 057	074 054
set 4	075 051	075 004	075 057	075 054

*

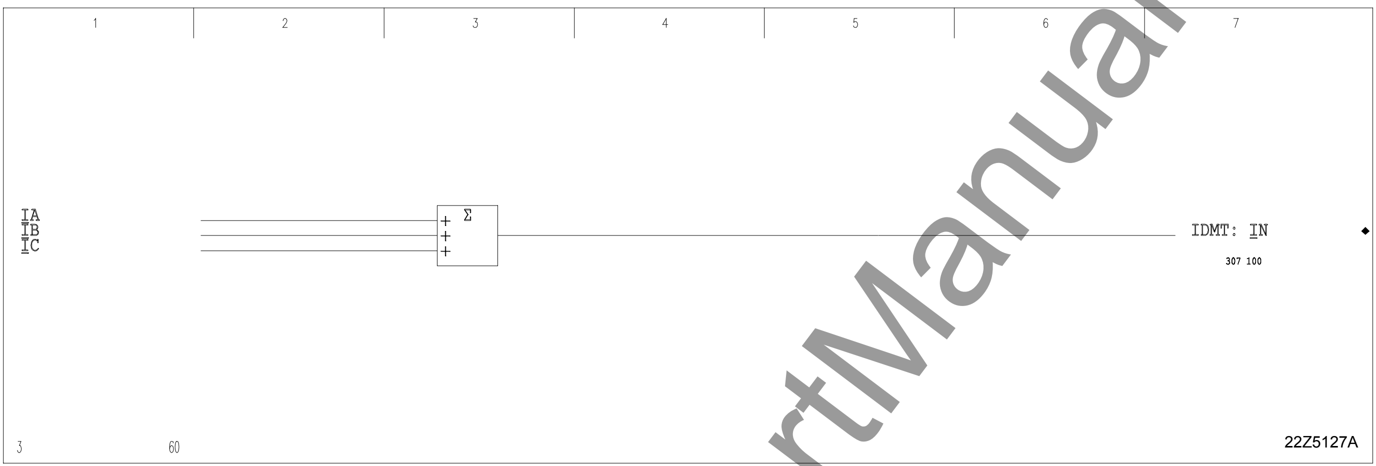
Parameter	IDMT: Min.trip time negPSx	IDMT: Hold time neg PSx	IDMT: Reset neg. PSx
set 1	072 078	072 072	072 060
set 2	073 078	073 072	073 060
set 3	074 078	074 072	074 060
set 4	075 078	075 072	075 060

22Z5126A

3-88 Negative-sequence current stage

Residual current

The C232 will use the residual current calculated from the three phase currents as the residual current.

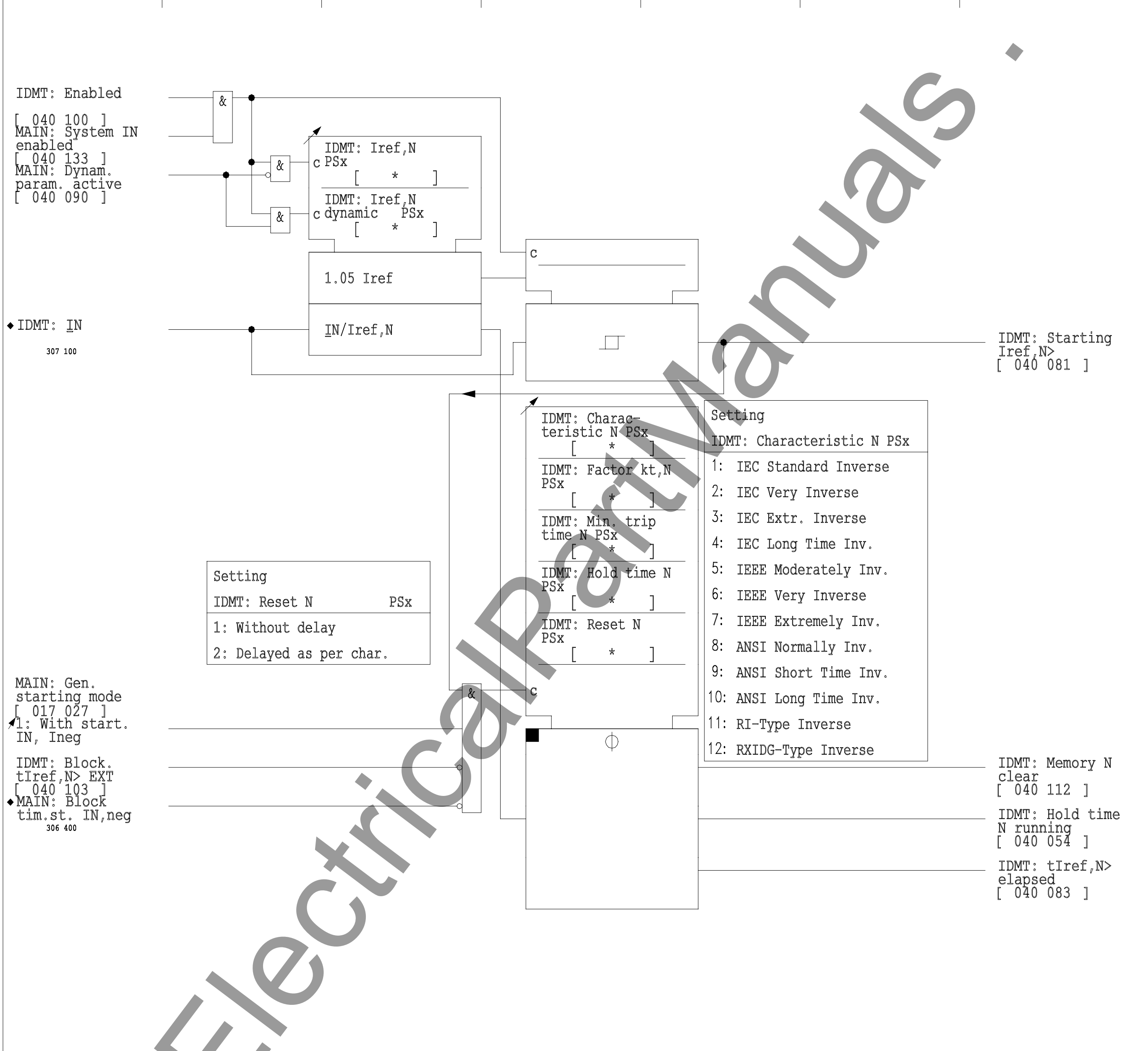


3-89 Selecting the measured variable

Residual current stage

The residual current is monitored by the C232 to detect when it exceeds the set thresholds. Alternatively, two different threshold types can be active. The “dynamic” threshold is active for the set hold time of the “dynamic parameters” (see “Activation of Dynamic Parameters”); the “normal” threshold is active when no hold time is running. The IDMT protection function issues a starting signal if the residual current exceeds a value of 1.05 times the set reference current. As a function of the set characteristic and of the residual current, the C232 will determine the tripping time. Furthermore, a minimum trip time can be set; the trip time will not fall below this minimum independent of the magnitude of the residual current.

The inverse-time stage can be blocked by way of an appropriately configured binary signal input. Furthermore, the inverse-time stage can – depending on the setting - be blocked automatically for single-pole or multi-pole startings.



* Parameter	IDMT: Iref,N PSx	IDMT: Iref,N dynamic PSx	IDMT: Charac-teristic N PSx	IDMT: Factor kt,N PSx
set 1	072 052	072 005	072 058	072 055
set 2	073 052	073 005	073 058	073 055
set 3	074 052	074 005	074 058	074 055
set 4	075 052	075 005	075 058	075 055

* Parameter	IDMT: Min. trip time N PSx	IDMT: Hold time N PSx	IDMT: Reset N PSx
set 1	072 079	072 073	072 061
set 2	073 079	073 073	073 061
set 3	074 079	074 073	074 061
set 4	075 079	075 073	075 061

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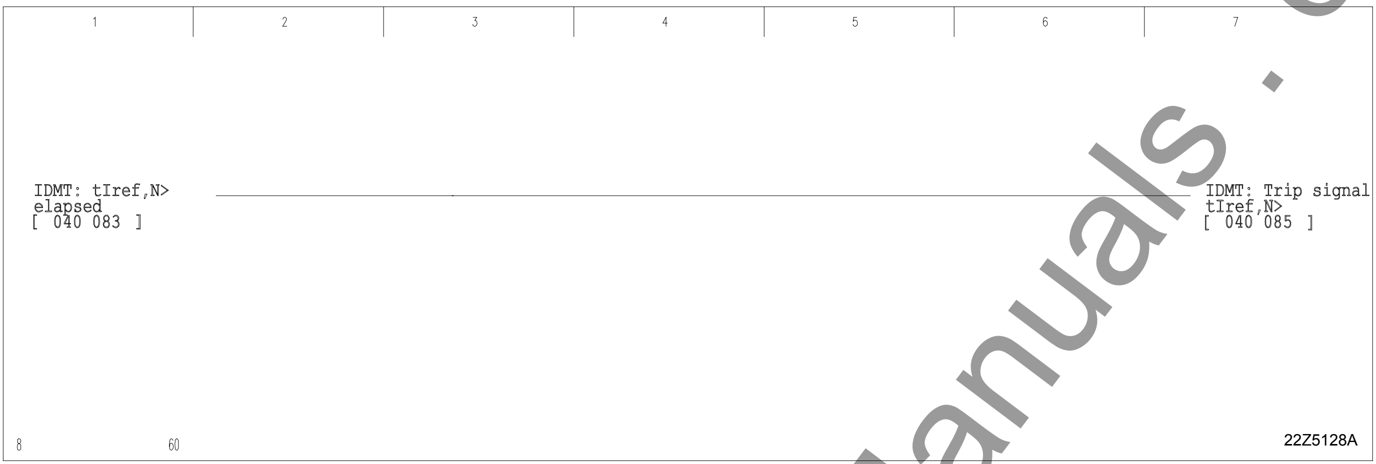
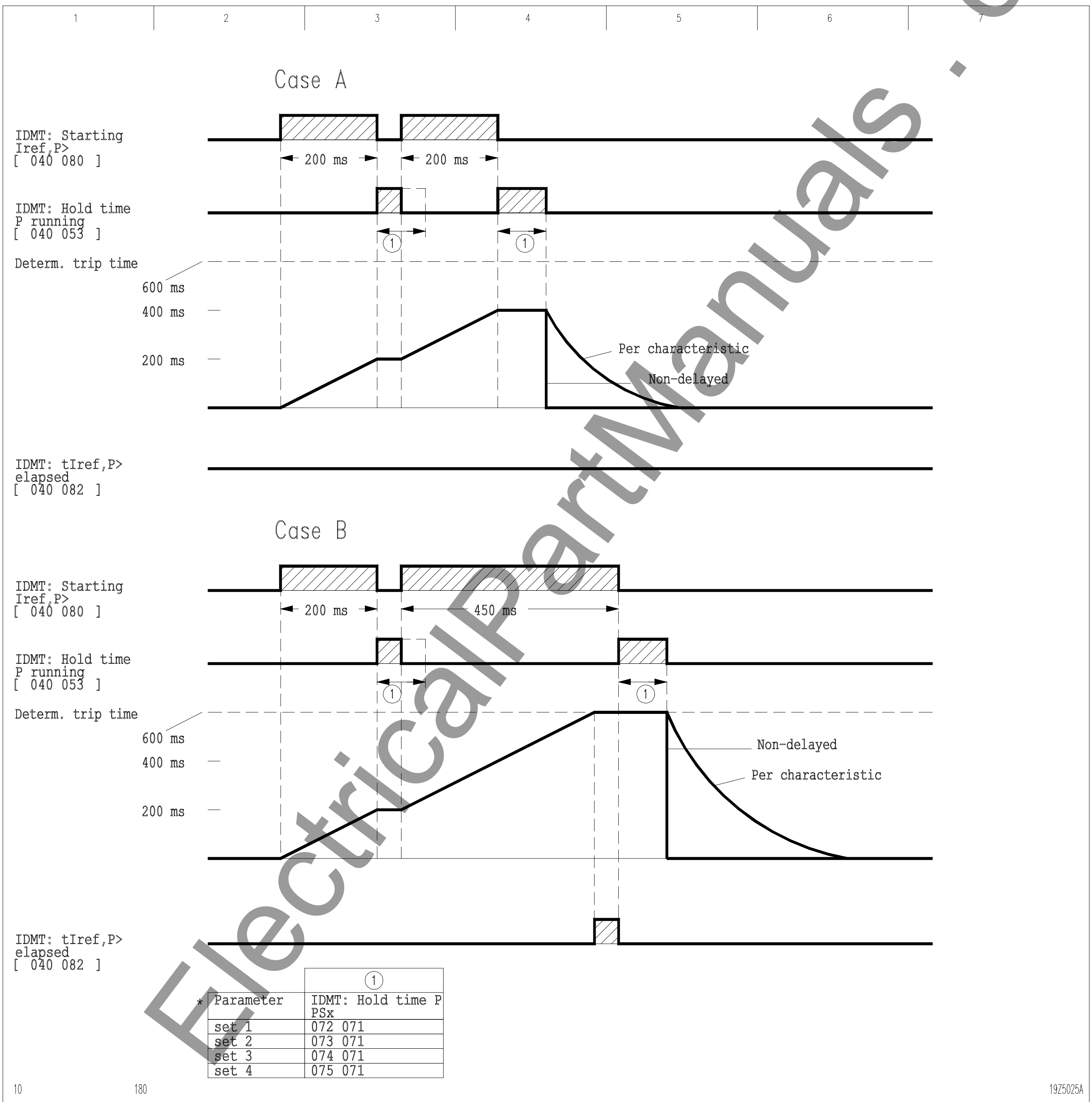
3-90 *Residual current stage*



3-91 Trip signal of the residual current stage

Holding time

As a function of the current, the C232 will determine the tripping time and start a timer stage. The setting for the holding time defines the period for the elapsed IDMT starting time to be stored after the starting has dropped out. If the starting time returns while the hold time elapses, the new starting time is added to the stored time. If the sum of the starting times reaches the tripping time determined by the C232 then the appropriate message is issued. If the starting time does not return while the hold time elapses then the memory storing the sum of the starting times will – in accordance with the setting - be cleared either without delay or according to the set characteristic. The phase current stage serves as an example to illustrate the effect of the holding time in Figure 3-92.



3-92. The effect of the holding time illustrated for the phase current stage as an example
Case A: The determined tripping time is not reached.
Case B: The determined tripping time is reached

3.18 Limit Value Monitoring (Function Group LIMIT)

Disabling or enabling limit value monitoring

Limit value monitoring can be disabled or enabled from the integrated local control panel.

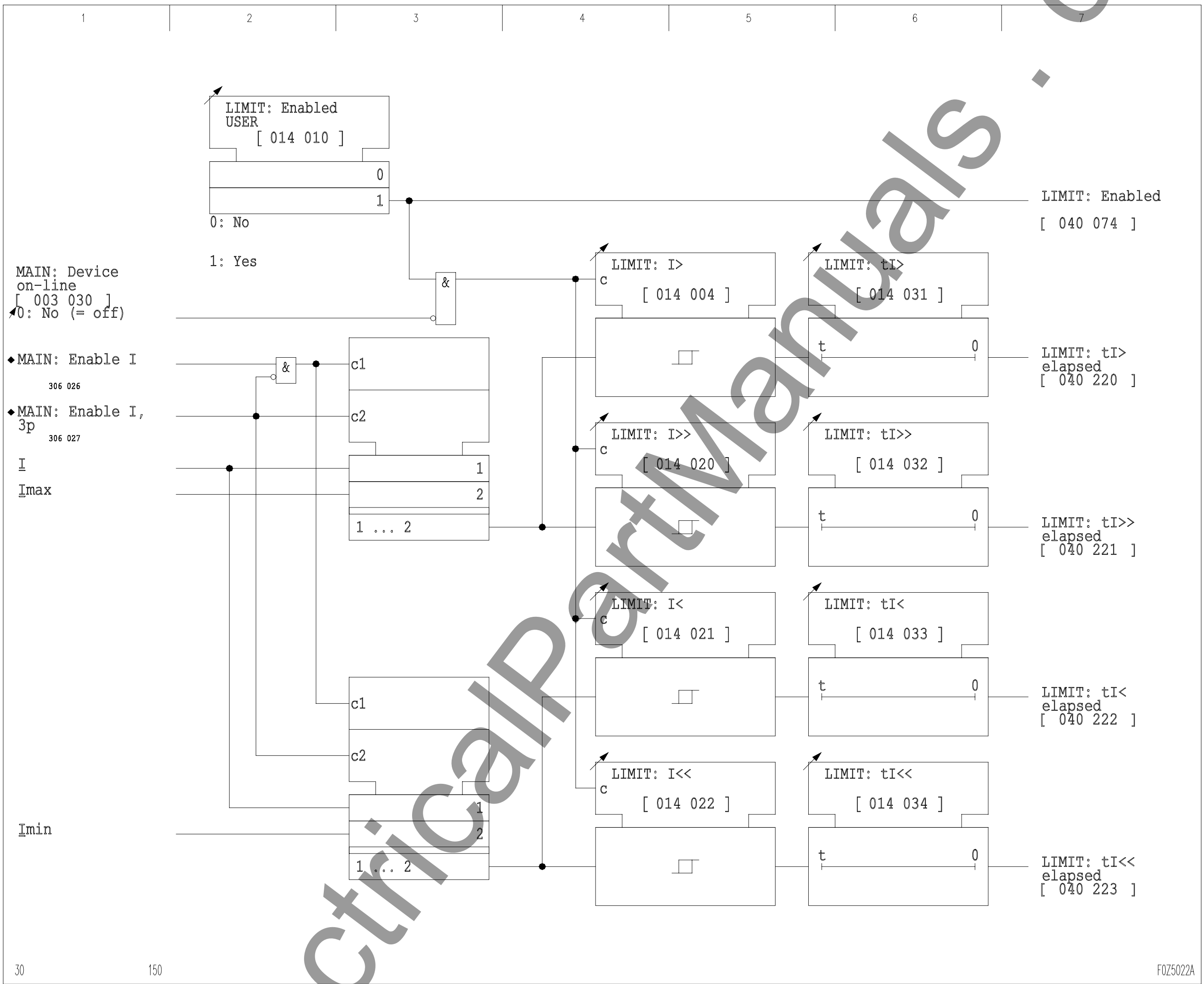
Monitoring phase currents and phase voltages

The C232 offers the possibility of monitoring the following measured values to determine if they exceed a set upper limit value or fall below a set lower limit value:

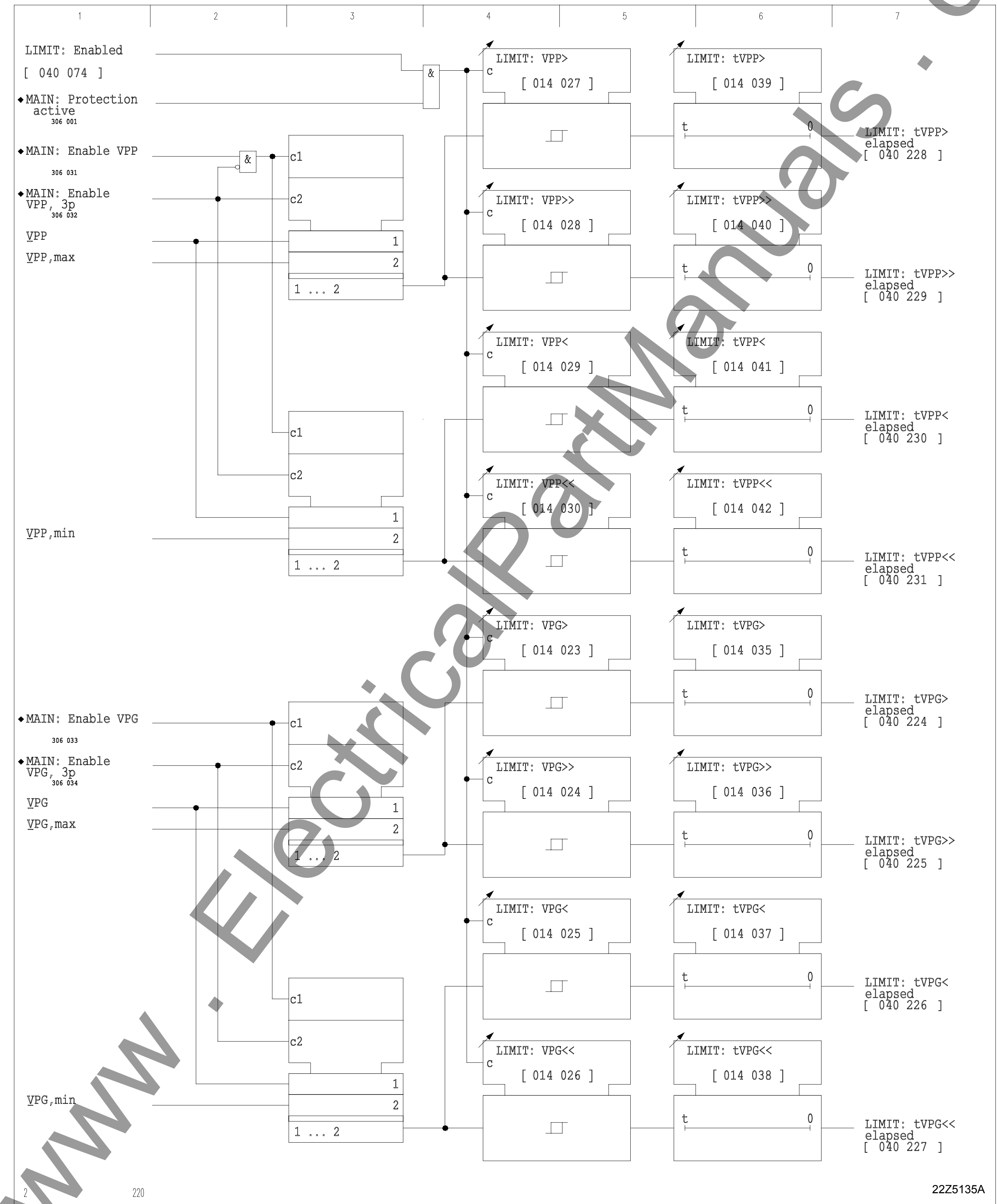
- Maximum phase current
- Minimum phase current
- Maximum phase-to-phase voltage
- Minimum phase-to-phase voltage
- Maximum phase-to-ground voltage
- Minimum phase-to-ground voltage

If one of the measured values exceeds or falls below one of the set upper or lower limit values, respectively, then a signal is issued once a set time period has elapsed.

If only one voltage transformer is fitted, the C232 needs to be informed via the setting `MAIN: M.v.asg. bay/station` which voltage (phase-to-ground or phase-to-phase voltage) is connected. Depending on this setting, the triggers for the monitoring of the phase-to-ground or phase-to-phase voltages are enabled. If three current or voltage transformers are fitted then either the variables of one three-phase system can be monitored or, alternatively, single-pole monitoring of the current or voltage of different transformers is possible.



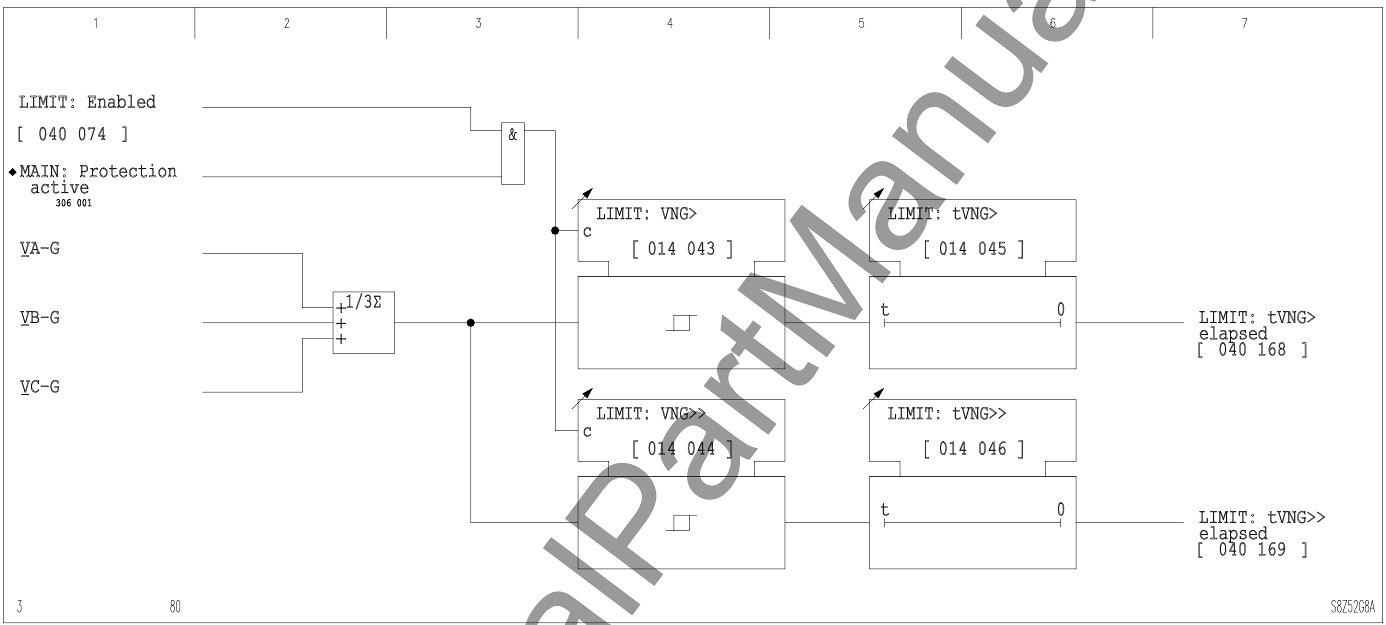
3-93 Limit value monitoring of minimum and maximum phase current



3-94 Limit value monitoring of maximum and minimum phase-to-phase voltage and maximum and minimum phase-to-ground voltage

Monitoring the neutral-displacement voltage

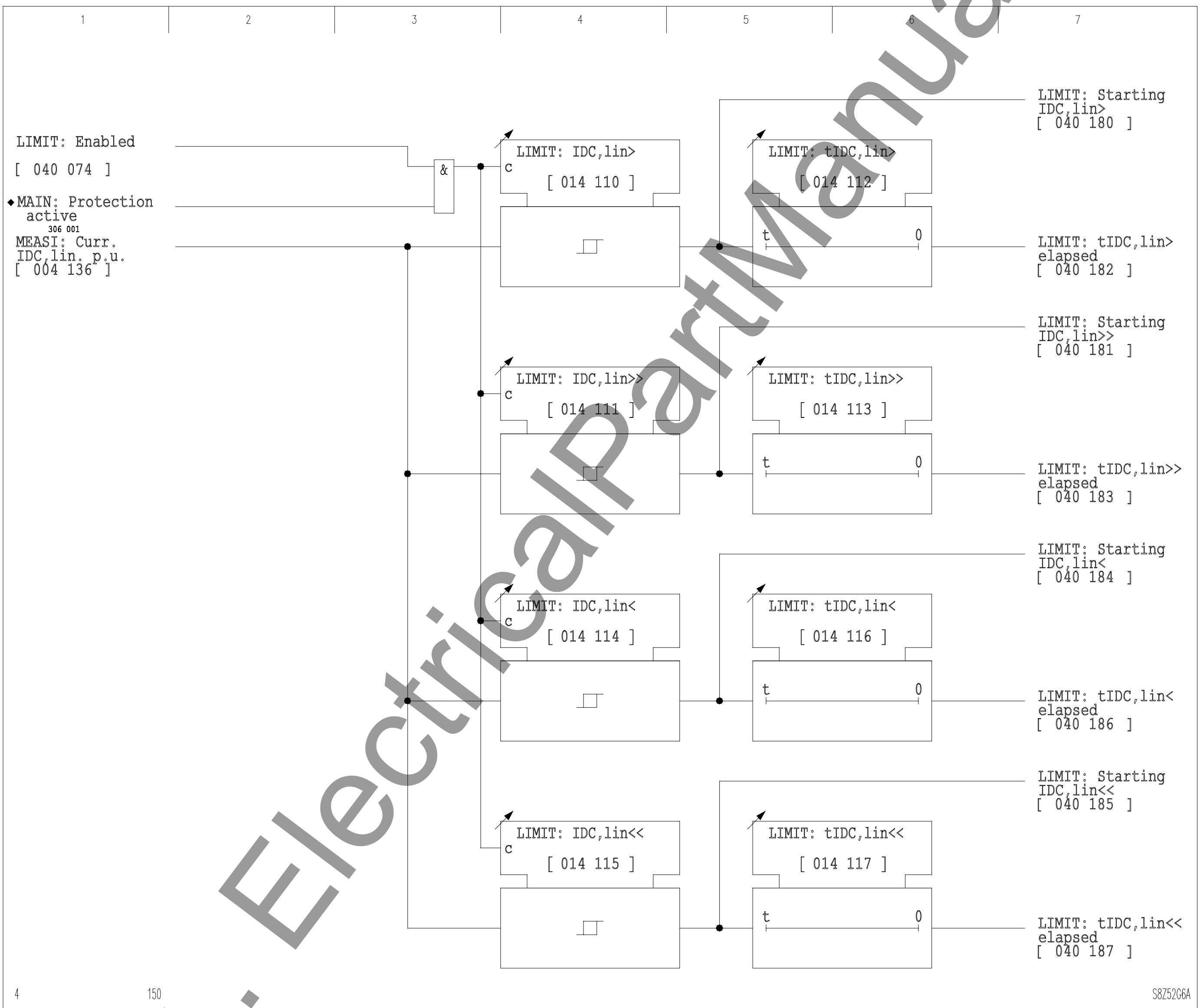
The neutral-displacement voltage calculated from the three phase-to-ground voltages is monitored by two stages to determine whether it exceeds set thresholds. If the thresholds are exceeded, a signal is issued after the set timer stage has elapsed.



3-95 Monitoring the neutral-displacement voltage

Monitoring the linearized measured DC values

The direct current that is linearized by analog measured data input is monitored by two stages to determine if it exceeds or falls below set thresholds. If it exceeds or falls below the thresholds, a signal is issued once a set time period has elapsed.



3-96 Monitoring the linearized direct current

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Publication: C232-302-401/402/403/404-603 / C232/EN M/A23

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