AREVA

P130C

Directional Overcurrent and Frequency Protection

Version -301 -401 -601

Technical Manual

⚠ 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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Konformitätserklärung
Declaration of Conformity

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Schutz- und Schaltanlagenleittechnik
(Name des Anbieters / supplier`s name)

Lyoner Str. 44-48
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Diese Konformitätserklärung entspricht der Europäischen Norm EN 45014 "Allgemeine Kriterien für Konformitätserklärungen von Anbietern". Die Grundlage der Kriterien sind internationale Dokumente, insbesondere ISO bzw. IEC-Leitfaden 22, 1982, "Information on manufacturer's declaration of conformity with standards or technical specifications".

This Declaration of Conformity conforms to the European Standard EN 45014, "General criteria for supplier's declaration of conformity." The basis for the criteria has been found in international documentation, particularly in ISO/IEC Guide 22, 1982, "Information on manufacturer's declaration of conformity with standards or technical specifications".

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

Gerichtete Überstromzeit- und Frequenzschutzeinrichtung
Directional Time-Overcurrent and Frequency Protection Device

P130C

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 60255-6, November 1994
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, 10.7.2003
(Ort und Datum der Ausstellung / Place and date of issue)

Hauser Ferling

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

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QUALITY SYSTEM CERTIFICATE

Certificate Nr 0059-2002-FR-COFRAC-QUA

This is to certify that the Quality System of

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has been found to conform to the Quality System Standard

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This certificate is valid for the following product or service ranges

DESIGN, DEVELOPMENT, PRODUCTION, SALES AND SERVICING OF PROTECTION, CONTROL AND MEASUREMENT EQUIPMENTS AND SYSTEMS FOR GENERATION, TRANSMISSION AND DISTRIBUTION SYSTEMS.

Date and Place :
Marseille, 2002-01-10
This certificate is valid from : 2002-01-10
For Comité de la Marque of DET NORSKE VERITAS CERTIFICATION FRANCE

This certificate and Annexe are valid until : 2005-01-10
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General Manager

A lack of fulfilment of conditions as set out in the appendix may render this certificate invalid.

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1 Application and Scope

1 Application and Scope

The P130C time-overcurrent protection devices provide selective short-circuit protection, ground fault protection, and overload protection in high-voltage systems. The multitude of protection functions incorporated into the devices enable the user to cover a wide range of applications in the protection of cable and line sections, transformers and motors. The systems can be operated as impedance-grounded, resonant-grounded, or isolated-neutral systems.

General functions

The P130C time-overcurrent protection devices have the following general functions:

- ❑ Four-pole measurement (A, B, C, N)
- ❑ Definite-time overcurrent protection, three stages, phase-selective
- ❑ Inverse-time overcurrent protection, single-stage, phase-selective
- ❑ Short-circuit direction determination
- ❑ Switch on to fault protection
- ❑ Protective signaling
- ❑ Auto-reclosing control (three-pole)
- ❑ Ground Fault Direction Determination Using Steady-State Values
- ❑ Motor protection
- ❑ Thermal overload protection
- ❑ Unbalance protection
- ❑ Time-voltage protection
- ❑ Over-/underfrequency protection
- ❑ Power directional protection
- ❑ Circuit breaker failure protection
- ❑ Measuring-circuit monitoring
- ❑ Limit value monitoring
- ❑ Programmable Logic

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 P130C:

- Parameter subset selection
- Operating data acquisition (for support during commissioning, testing and operation)
- Operating data recording (time-tagged signal logging)
- Overload data acquisition
- Overload recording (time-tagged signal logging)
- Ground fault data acquisition
- Ground fault recording (time-tagged signal logging)
- Fault data acquisition
- 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)

Design

The P130C is compact in design. The printed circuit boards are housed in a robust aluminum case and electrically interconnected via ribbon cables. The P130C has a multifunctional case design that is equally well suited to either wall surface mounting or flush panel mounting due to its reversible terminal blocks and adjustable mounting bracket.

Inputs and outputs

The P130C has the following inputs and outputs:

- 4 current-measuring inputs
- 3 voltage-measuring inputs
- 2 binary signal inputs (optical couplers) with user-definable function assignment
- 8 output relays with user-definable function assignment

The nominal currents and nominal voltages of the measuring inputs in the P130C can be set.

The nominal voltage range of the optical coupler inputs is 24 to 250 V DC without internal switching. The auxiliary voltage for the power supply can be switched internally from 110 to 250 V DC, 100 to 230 V AC to the range 24 to 60 V DC.

All output relays are suitable for both signals and commands.

1 Application and Scope

(continued)

Interfaces

Local control and display:

- Local control panel
- 17 LED indicators, 12 of which allow freely configurable function assignment
- PC interface
- One or two communication interfaces for connection to a substation control system (optional)
- One InterMiCOM guidance interface designed for real-time signal transmission between two MiCOM devices

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

One channel of the communication interfaces is designed to conform either to international standard IEC 60870-5-103 or to IEC 870-5-101, MODBUS, DNP 3.0 or Courier. The second channel is designed to conform to international standard IEC 60870-5-103. The P130C can be integrated into a substation control system through the communication interfaces.

1 Application and Scope
(continued)

The P130C can be ordered as standard model (with current transformers) or as frequency protection model (without current transformers). These models differ in the number of function groups available to the user.

	Current Transformers	CT fitted	CT not fitted
ARC:	Auto-reclosing control	X	
CBF:	Circuit breaker failure protection	X	
COMM1:	"Logical" communication interface 1	X	X
COMM2:	"Logical" communication interface 2	X	X
COMM3:	"Logical" communication interface 3	X	X
DTOC:	Definite-time overcurrent protection	X	
DVICE:	Device	X	X
FT_DA:	Fault data acquisition	X	X
FT_RC:	Fault recording	X	X
f<>:	Frequency protection	X	X
F_KEY	Function Keys	X	X
GF_DA:	Ground fault data acquisition	X	
GF_RC:	Ground fault recording	X	
GFDSS:	Ground fault direction determination using steady-state values	X	
I2>:	Unbalance protection	X	
IDMT:	Inverse-time overcurrent protection	X	
INP:	Binary input	X	X
LED:	LED indicators	X	X
LIMIT:	Limit monitoring	X	
LOC:	Local control panel	X	X
LOGIC:	Logic	X	X
MAIN:	Main function	X	X
MCMON:	Measuring-circuit monitoring	X	X
MP:	Motor protection	X	
MT_RC:	Monitoring signal recording	X	X
OL_DA:	Overload data acquisition	X	
OL_RC:	Overload recording	X	
OP_RC:	Operating data recording	X	X
OUTP:	Binary and analog output	X	X
P<>:	Power directional protection	X	
PC:	PC link	X	X
PSIG:	Protective signaling	X	
PSS:	Parameter subset selection	X	X
SCDD:	Short-circuit direction determination	X	
SFMON:	Self-monitoring	X	X
SOTF:	Switch on to fault protection	X	
THERM:	Thermal overload protection	X	
V<>:	Time-voltage protection	X	X

2 Technical Data

2 Technical Data

2.1 Conformity

Notice

Applicable to P130C Version - 301 - 401 - 601

Declaration of conformity

(Per Article 10 of EC Directive 72/73/EC.)
The product designated 'P130C Directional Overcurrent Protection and Frequency Protection Device' has been designed and manufactured in conformance with the European standards EN 60255-6 and EN 60010-1 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

Design
Multifunctional case design suitable for either wall surface mounting or flush panel mounting

Installation Position
Vertical ± 30°.

Degree of Protection
Per DIN VDE 0470 and EN 60529 or IEC 529.
IP 51.

Weight
Approx. 4 kg

Dimensions and Connections
See dimensional drawings (Chapter 4) and terminal connection diagrams (Chapter 5 and Appendix C).

Terminals

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

Communication Interface:

Optical fibers (X7, X8 and X31, X32):	F-SMA fiber-optic connection per IEC 874-2 orDIN 47258 or ST® fiber-optic connection (ST® is a registered trademark of AT&T Lightguide Cable Connectors)
or Leads (X9, X10 and X33):	M2 threaded terminal ends for wire cross-sections up to 1.5 mm^2.
IRIG-B Interface (X11):	BNC plug

Other Inputs and Outputs:
M4 threaded terminal ends, self-centering with wire protection for conductor cross sections from 0.5 to 6 mm^2 or 2×2.5 mm^2.

<u>Creepage Distances and Clearances</u>
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 Tests

Type tests

Electromagnetic compatibility (EMC)

All tests per EN 60255-6§ or IEC 255-6.

<u>Interference Suppression</u>
Per EN 55022§ or IEC CISPR 22, Class A.

<u>1 MHz Burst Disturbance Test</u>
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

<u>Immunity to Electrostatic Discharge</u>
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

<u>Immunity to Radiated Electromagnetic Energy</u>
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 %

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

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

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 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.
Test voltage: 10 V

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

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

Insulation

Voltage Test
Per DIN EN 61010 or 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

2.1.2 Routine Tests

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

Voltage Test
Per IEC 255-5.
2.5 kV AC, 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 (23°F to 131°F)
Limit temperature range: -25°C to +70°C (-13°F to 158°F)

Humidity
≤ 75 % relative humidity (annual mean),
56 days at ≤ 95 % relative humidity and 40°C (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: 1 and 5 A AC (adjustable).
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}.
Frequency protection: 40 to 70 Hz

Binary signal inputs

Nominal auxiliary voltage $V_{in,nom}$: 24 to 250 V DC.
Operating range: 0.8 to 1.1 $V_{in,nom}$ with a residual ripple of up to 12 % $V_{in,nom}$

Operate value / Release Value (as per order)
Standard variant 18V:
$V_{op} \geq$ 19 V DC
$V_{rel} \leq$ 14 V DC

Special variant 90 V:
(60% to 70% of voltages in the range $V_{in,nom}$: 125 to 150 V DC)
$V_{op} \geq$ 100 V DC
$V_{rel} \leq$ 80 V DC

Special variant 155 V:
(60% to 70% of voltages in the range $V_{in,nom}$: 220 to 250 V DC)
$V_{op} \geq$ 180 V DC
$V_{rel} \leq$ 130 V DC

Power Consumption per Input:
Standard variant 18V:
V_{in} = 19 to 110 V DC: 0.5 W ± 30 %,
V_{in} > 110 V DC: $V_{in,nom} \cdot$ 5 mA ± 30 %.

Special variants 90 V and 155 V:
$V_{in,nom} \cdot$ 5 mA ± 30 %.

Output relays

Rated voltage: 250 V DC, 250 V AC
Continuous current: 5 A
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:
Via 7 keys and an LCD display consisting of 4 x 20 characters and 4 freely configurable function keys

State and fault signals:
17 LED indicators (5 permanently assigned, 12 freely configurable)

PC interface

Transmission rate: 300 to 115,200 baud (adjustable)

Communication interfaces

The communication unit can have three communication channels – depending on the version. Channels 1 and 3 are designed for wire connection or fiber-optic connection, whereas Channel 2 is intended for wire connection only.
For "logical" communication interface 1, interface protocols based on IEC 60870-5-103, IEC 870-5-101, MODBUS, or DNP 3.0 can be set. "Logical" communication interface 2 can only be operated using the interface protocol based on IEC 60870-5-103.
"Logical" communication interface 3 is intended for real-time signal transmission between two MiCOM devices (peer-to-peer link, "InterMiCOM" interface).

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

	Transmission Rate	Transmission Protocol
Order ext. No. -910 (one channel available)	300 to 19 200 baud (adjustable)	IEC 60870-5-103
Order ext. No. -921 (two channels available)	300 to 64 000 baud (adjustable)	Can be set by user for one channel
Order ext. No. -951 (InterMiCOM)	600 to 19 200 baud (adjustable)	

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

Plastic Fiber Connection
Optical wave length: 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

	Transmission Rate	Transmission Protocol
Order ext. No. -910 (one channel available)	300 to 38 400 baud (adjustable)	IEC 60870-5-103
Order ext. No. -922 (two channels available)	300 to 64 000 baud (adjustable)	Can be set by user for one channel
Order ext. No. -952 (InterMiCOM)	600 to 19 200 baud (adjustable)	

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

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. 1400 m

Glass Fiber Connection G 50/125 or G 62.5/125

	Transmission Rate	Transmission Protocol
Order ext. No. -910 (one channel available)	300 to 38 400 baud (adjustable)	IEC 60870-5-103
Order ext. No. -924 (two channels available)	300 to 64 000 baud (adjustable)	Can be set by user for one channel
Order ext. No. -955 (InterMiCOM)	600 to 19 200 baud (adjustable)	

IRIG-B interface

B122 format
Amplitude-modulated signal
Carrier frequency: 1 kHz
BCD-coded dating information

[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, 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

Short-Circuit Direction Determination
Nominal acceptance angle for forward decision: ± 90°
Resetting ratio forward/backward recognition: ≤ 7
Base point release for phase currents: 0.1 I_{nom}
Base point release for phase-to-phase voltages: 0.002 V_{nom} at V_{nom} = 100 V
Base point release for residual current: 0.01 I_{nom}
Base point release for neutral displacement voltage: 0.015 to 0.6 $V_{nom}/\sqrt{3}$ (adjustable)

Time-Voltage Protection
Operate time including output relay (measured variable from nominal value to 1.2-fold operate value or measured variable from nominal value to 0.8-fold operate value): ≤ 40 ms, approx. 30 ms
Reset time (measured variable from 1.2-fold operate value to nominal value or measured variable from 0.8-fold operate value to nominal value): ≤ 45 ms, ca. 30 ms
Resetting ratio of the starting:
Approx. 0.95 for operate values > 0.6 V_{nom} or $V_{nom}/\sqrt{3}$
Approx. 1.05 for operate values < 0.6 V_{nom} or $V_{nom}/\sqrt{3}$

2.9 Deviations

2.1.1 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.

Measuring-circuit monitoring

Operate values I_{neg}, V_{neg}
Deviation: ± 3°

Definite-time and inverse-time overcurrent protection

Phase and Residual Current Stages
Deviation: ± 5 %

Negative-Sequence System Stages
Deviation: ± 5 %

Short-circuit direction determination

Deviation: ± 10°

Motor protection and thermal overload protection (reaction time)

Deviation ± 7.5 % when I/Iref = 6

Unbalance protection

Deviation: ± 5 %

Time-voltage protection

Operate Values
Deviation: ± 5 % (or ± 1 % referred to the nominal value)

Over-/underfrequency protection

Operate Values
Deviation: ± 3 % (or ± 1 % referred to the nominal value)

Power directional protection

Operate Values P<>, Q<>
Deviation: ± 5 %

Ground fault direction determination using steady-state values

Operate Values $V_{NG}>$, $I_{N,act}$, $I_{N,reac}$, $I_N>$
Deviation: ± 3 %

Sector Angle
Deviation: 1°

2.1.2 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% + 10 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

2.1.3 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.

2 Technical Data

(continued)

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: ± 2 %

Active and Reactive Power / Active and Reactive Energy
Deviation: approx. ± 2 % of the measured value for cos φ = ± 0.7
Deviation: approx. ± 5 % of the measured value for cos φ = ± 0.3

Load angle
Deviation: ± 1°

Frequency
Deviation: ± 10 mHz

Fault data acquisition

Short-Circuit Current and Voltage
Deviation: ± 3 %

Short-Circuit Impedance, Reactance, and Fault Location
Deviation: ± 5 %

Internal clock

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

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

With synchronization via IRIG-B interface: ± 1 ms

2.10 Recording Functions

Organization of the Recording Memories

Operating data memory

Scope: All signals relating to normal operation; from a total of 1024 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 1024 different logic state signals (see "Monitoring Signal Memory" in the Address List)
Depth: Up to 30 signals

Overload memory

Number: The 8 most recent overload events
Scope: All signals relating to an overload event; from a total of 1024 different logic state signals (see "Overload Memory" in the Address List)
Depth: 200 entries per overload event

Ground fault memory

Number: The 8 most recent ground fault events
Scope: All signals relating to a ground fault event; from a total of 1024 different logic state signals (see "Ground Fault Memory" in the Address List)
Depth: 200 entries per ground fault event

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;
820 periods in total for all faults, that is
16.4 s (for f_{nom} = 50 Hz) or 13.7 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

Residual current

Dynamic range:	16 I_{nom}
Amplitude resolution:	0.98 mA r.m.s. at I_{nom} = 1 A 4.9 mA r.m.s. at I_{nom} = 5 A

Voltages

Dynamic range:	150 V AC
Amplitude resolution:	9.2 mV r.m.s

2.11 Power Supply

Power supply

Nominal auxiliary voltage $V_{A,nom}$:
100 to 250 V DC /100 to 230 V AC and 24 to 60 V DC (internal switching)

Operating range for direct voltage:
0.8 to 1.1 $V_{A,nom}$ with a residual ripple of up to 12 % $V_{A,nom}$
Operating range for alternating voltage: 0.9 to 1.1 $V_{A,nom}$

Nominal consumption:	
Initial position, approx.:	8 W
Active position, approx.:	10 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:

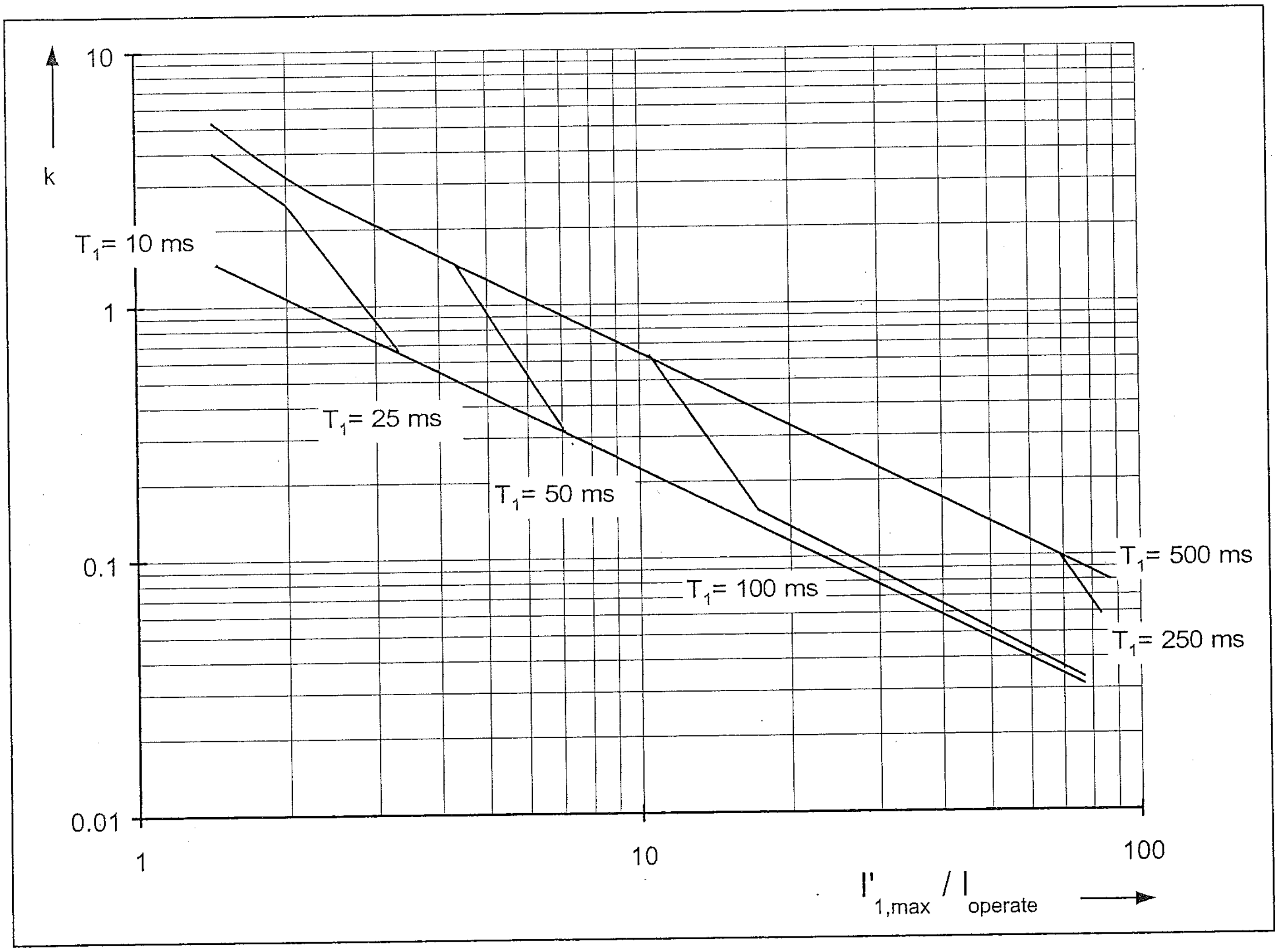
$$k_{max} \approx 1 + \omega T_1$$

where:

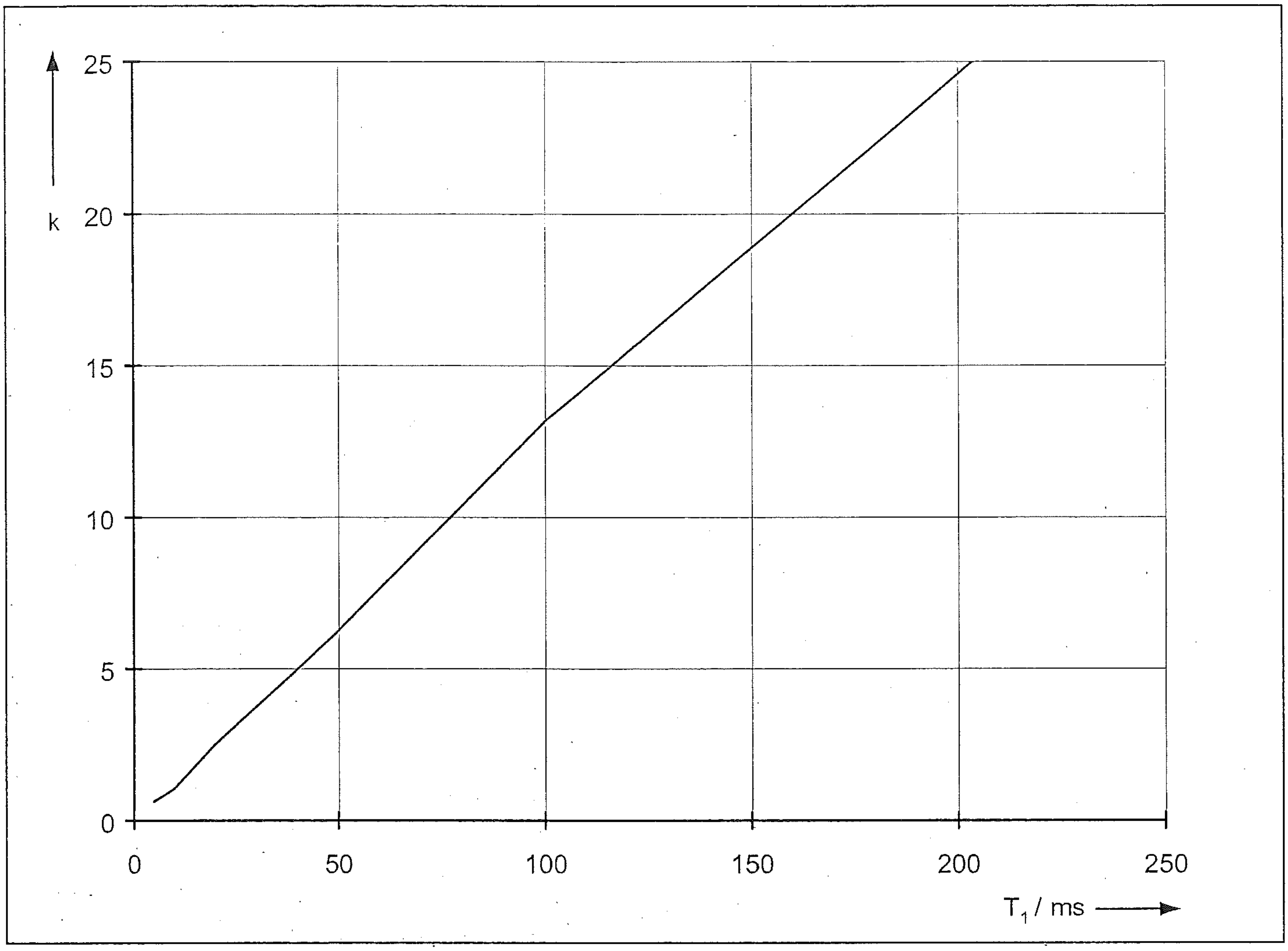
ω :	system angular frequency
T_1:	system time constant

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 P130C 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*

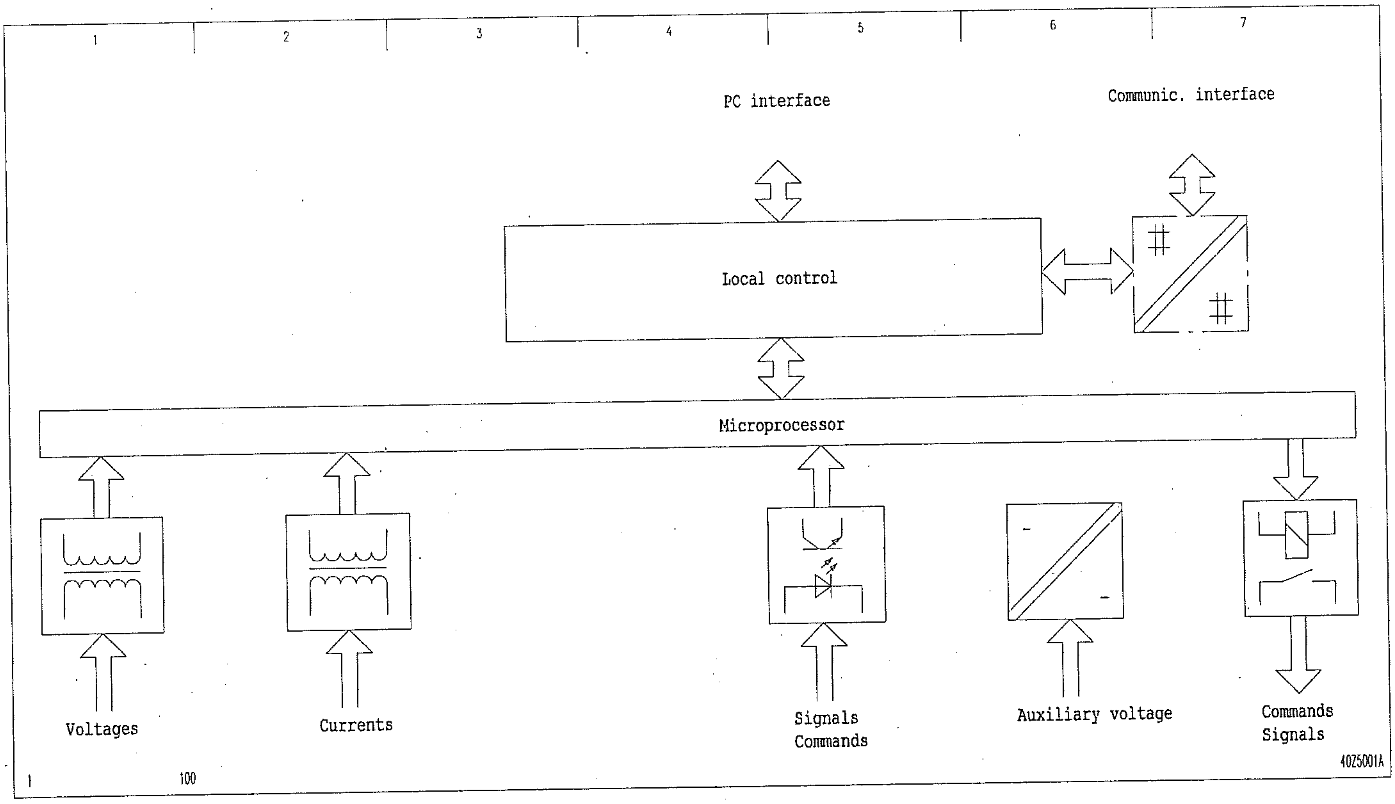


2-2 Required overdimensioning factor for inverse-time maximum current protection where fnom= 50 Hz

3 Operation

3.1 Modular Structure

The P130C, a numeric device, is part of the MiCOM P 30 family of devices. Figure 3-1 shows the basic hardware structure of the P130C.



3-1 *Basic hardware structure*

The external analog and binary quantities – electrically isolated – are converted to the internal processing levels by 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 connected to the power supply unit which provides the auxiliary voltages that are required internally.

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 settings, 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, and the 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 P130C in the form of an 'address list'. This address list is complete and thus contains all settings, signals and measured variables used with the P130C.

The configuration of the local control panel also permits the installation of Measured Value 'Panels' on the LCD display. Different Measured Value Panels are automatically displayed for specific system operating conditions. Priority increases from normal operation to operation under overload conditions, operation during a ground fault, and finally to operation following a short circuit in the system. Thus the P130C provides the measured data relevant for the prevailing conditions.

3.3 Configuring the Measured Value Panels (Function Group LOC)

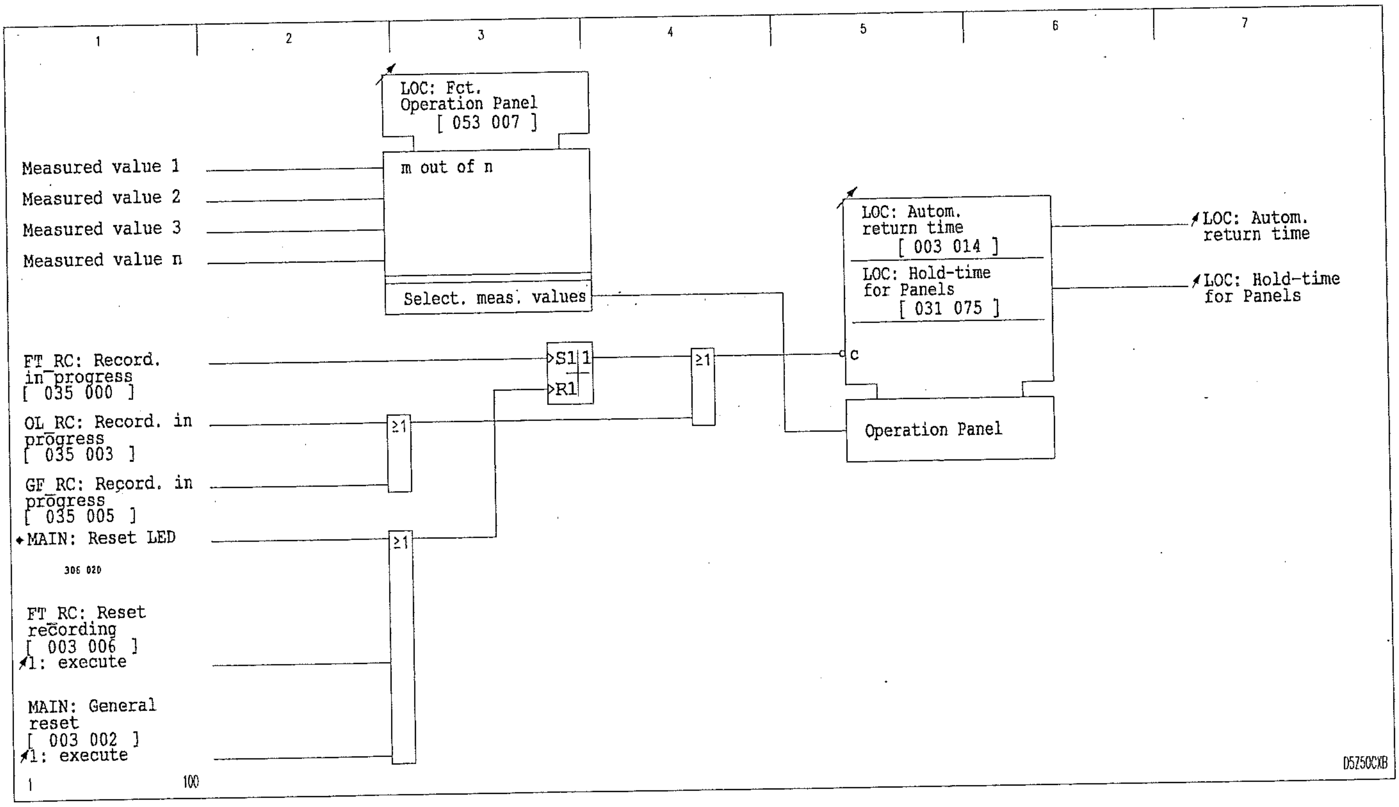
The P130C provides Measured Value Panels that display the measured values relevant at a given time.

During normal power system operation, the Operation Panel is displayed. When 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 an overload event or a ground fault, the display will automatically switch back 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.

Operation Panel

The Operation Panel is displayed after the set return time has elapsed, provided that 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 LCD display can accommodate, 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 keys on the local control panel are pressed.

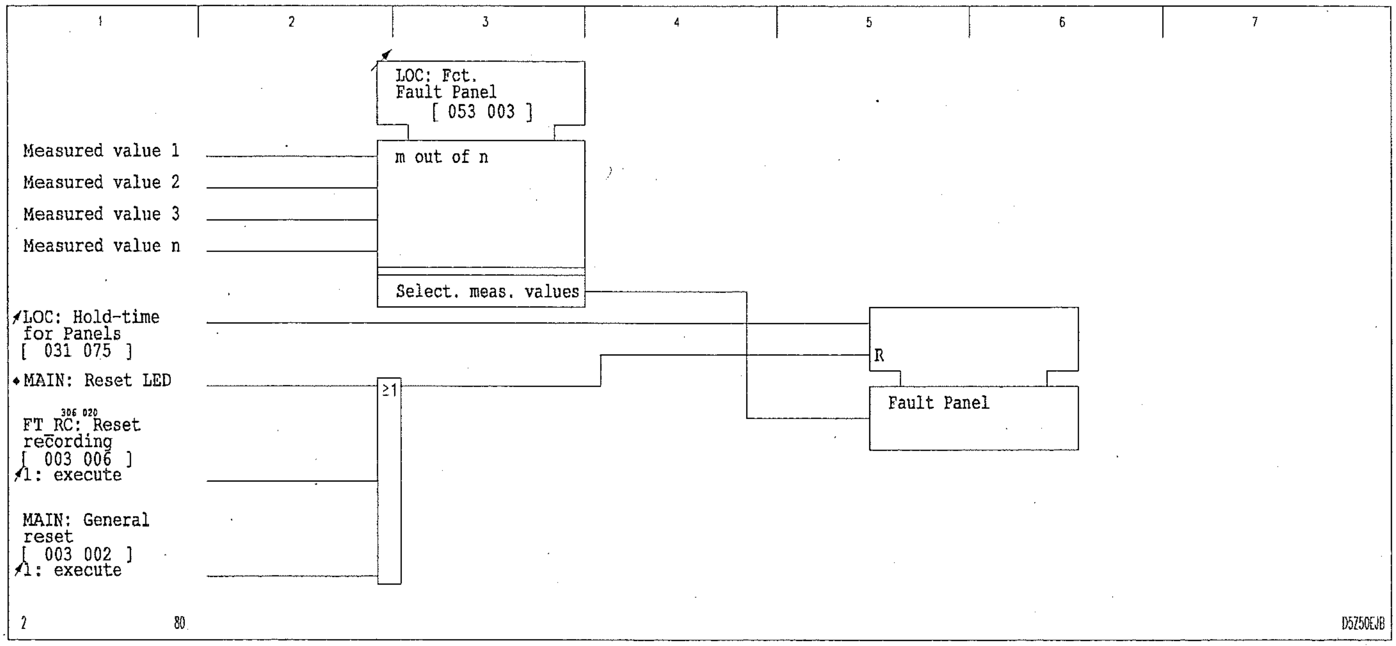


3-2 *Operation Panel*

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 LCD display can accommodate, 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 keys on the local control panel are pressed.

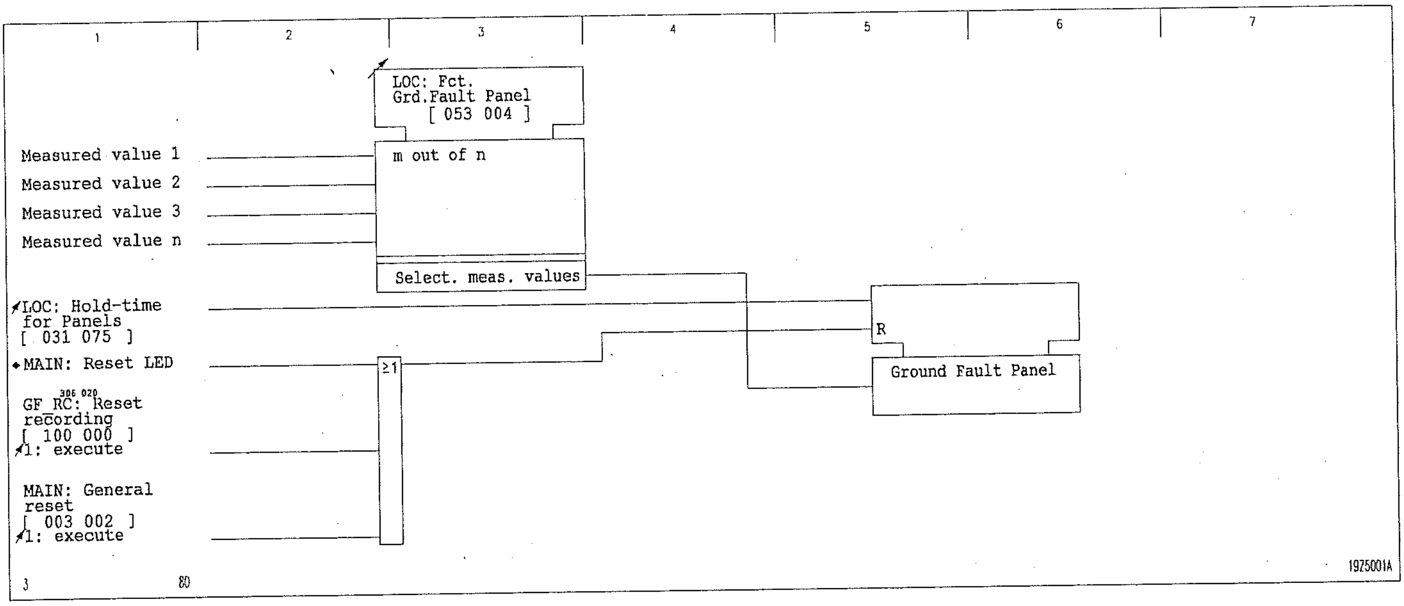


3-3 *Fault Panel*

Ground Fault Panel

The Ground Fault Panel is automatically displayed in place of another data panel when there is a ground fault, provided that at least one measured value has been configured. The Ground Fault Panel remains on display until the ground fault ends, unless a fault occurs. In this case, the display switches to the Fault Panel.

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

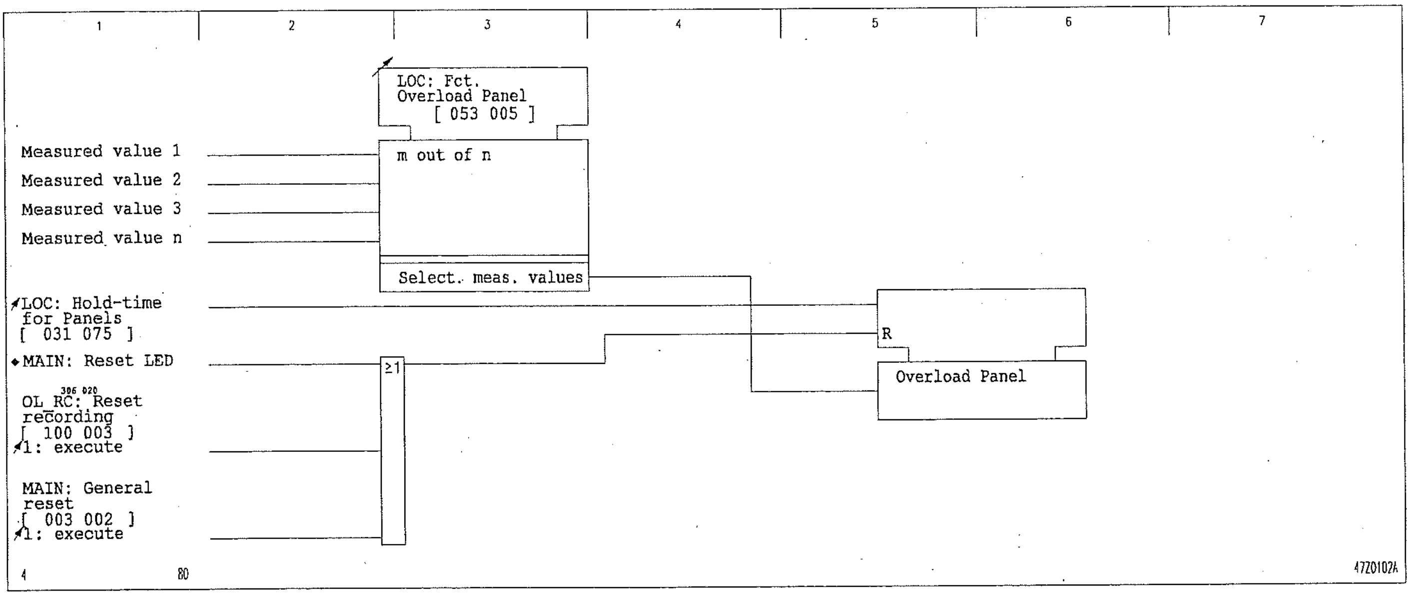


3-4 *Ground Fault Panel*

Overload Panel

The Overload Panel is automatically displayed in place of another data panel when there is an overload, provided that at least one measured value has been configured. The Overload Panel remains on display until the overload ends, unless a fault occurs. In this case, the display switches to the Fault Panel.

The user can select the measured values that will be displayed on the Overload Panel by setting an 'm out of n' parameter. If more measured values are selected for display than the LCD display can accommodate, 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 keys on the local control panel are pressed.



3-5 *Overload Panel*

3.4 Serial Interfaces

The P130C has a PC interface as a standard component. The communication unit is optional and can have one or two communication channels – depending on the design version. Communication between the P130C and the control station's computer is through the communication unit. Setting and readout are possible through all P130C interfaces.

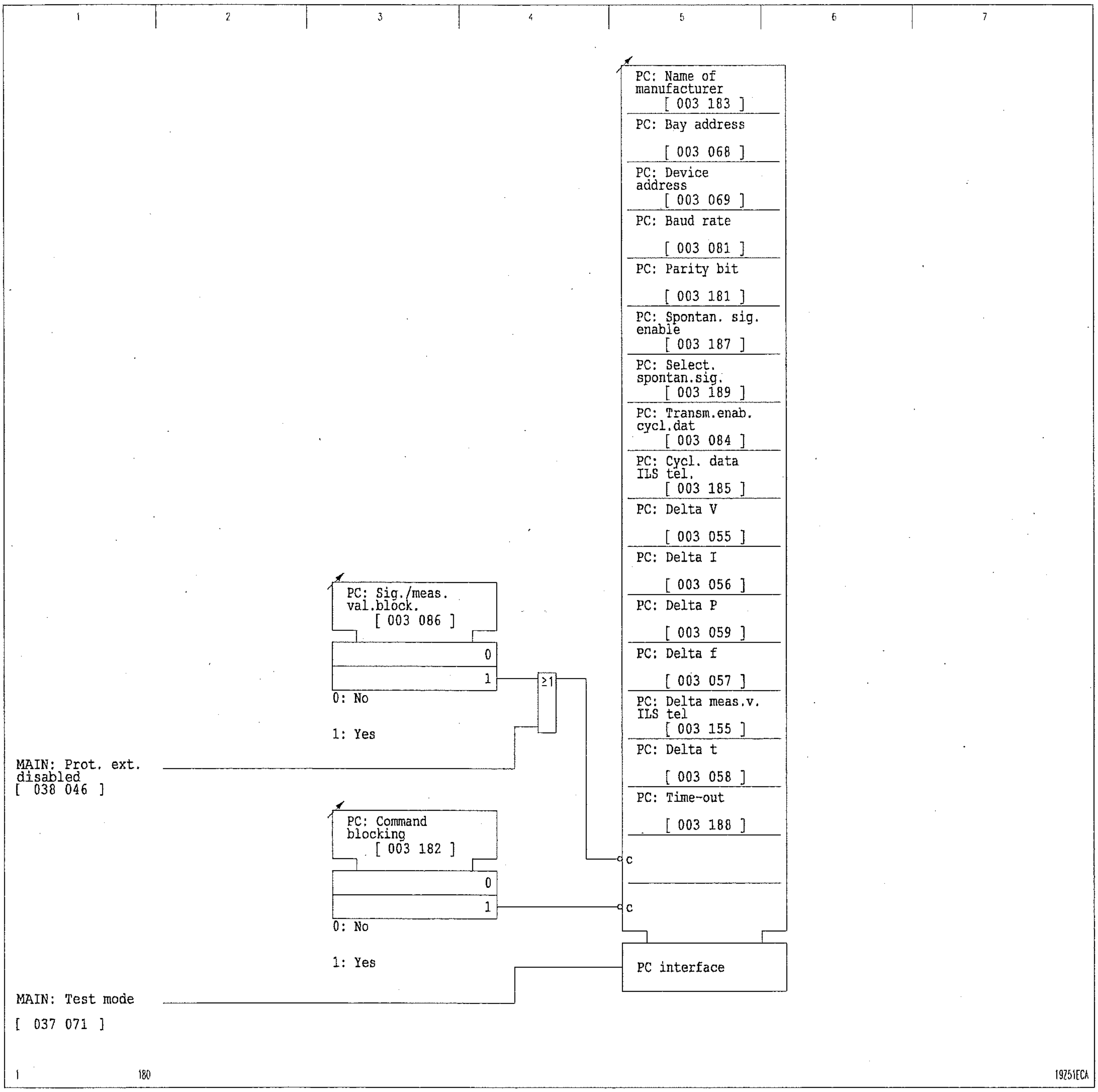
If the communication unit with two communication channels is installed, settings for two "logical" communication interfaces will be available. The settings for "logical" communication interface 1 (COMM1) can be assigned to physical communication channels 1 or 2 (see section entitled 'Main Functions'). 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 P130C 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 P130C, 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 'General 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 P130C and the PC to function, several settings must be made in the P130C.

An operating program is available as an accessory for P130C control (see Chapter 13).



3-6 PC interface settings

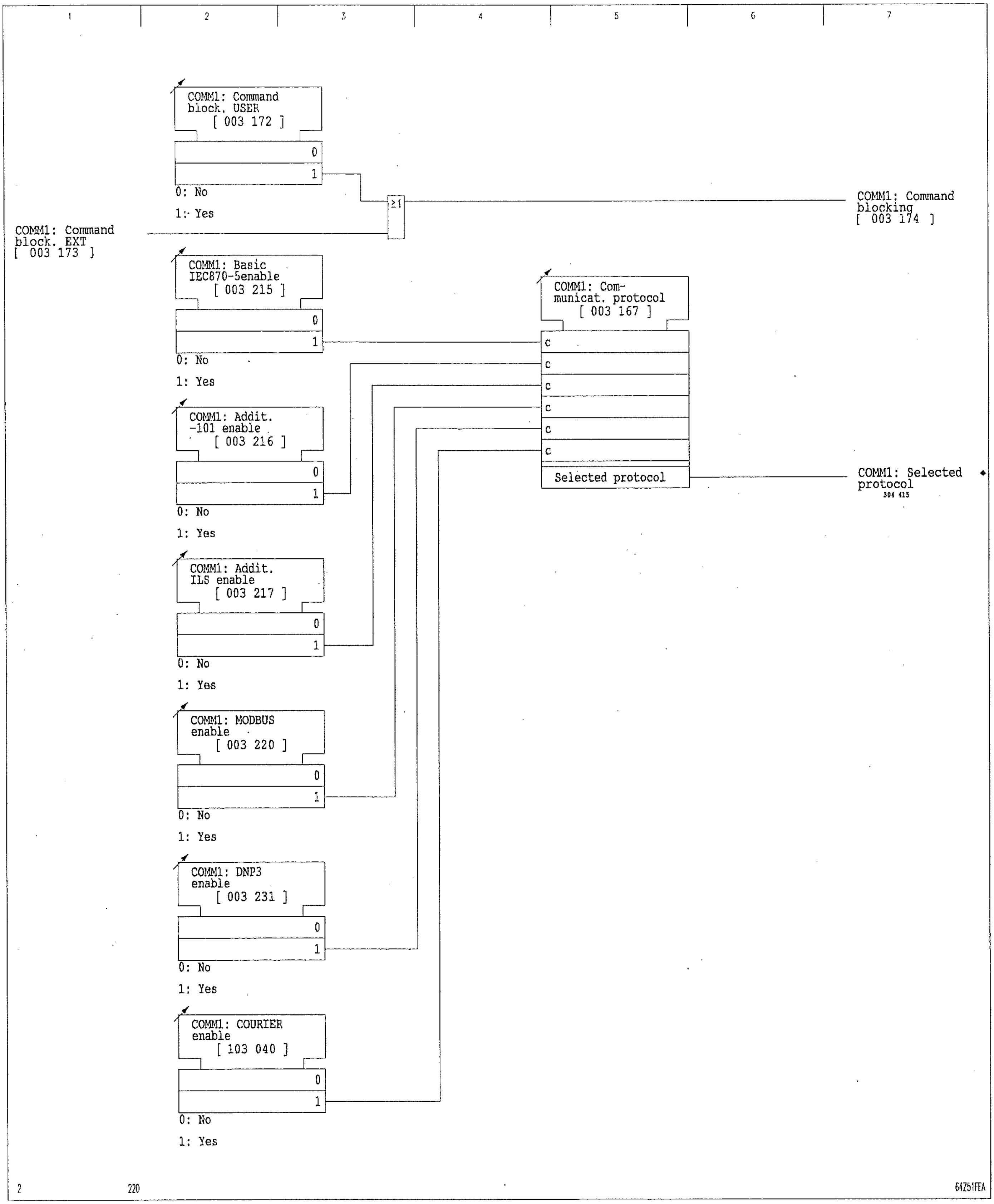
3.4.2 "Logical" Communication Interface 1 (Function Group COMM1)

Depending on the design version of the communication unit (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 P130C:

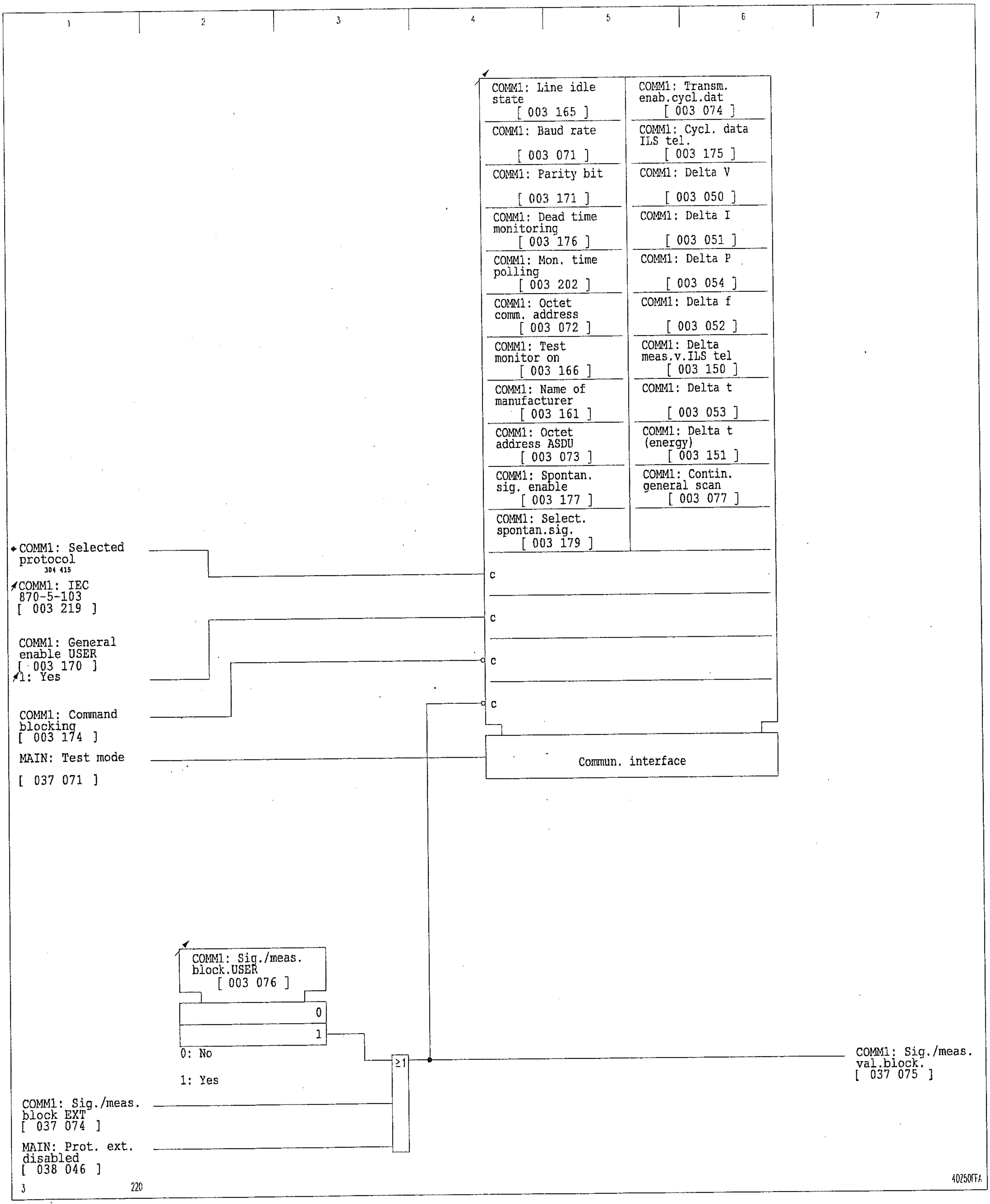
- IEC 60870-5-103, "Transmission protocols - Companion standard for the informative interface of protection equipment,' first edition, 1997-12 (corresponds to VDEW / ZVEI Recommendation, "Protection communication companion standard 1, compatibility level 2," February 1995 edition) with additions covering 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 ALSTOM Energietechnik GmbH
- MODBUS
- DNP 3.0
- COURIER

In order for data transfer to function properly, several settings must be made in the P130C.

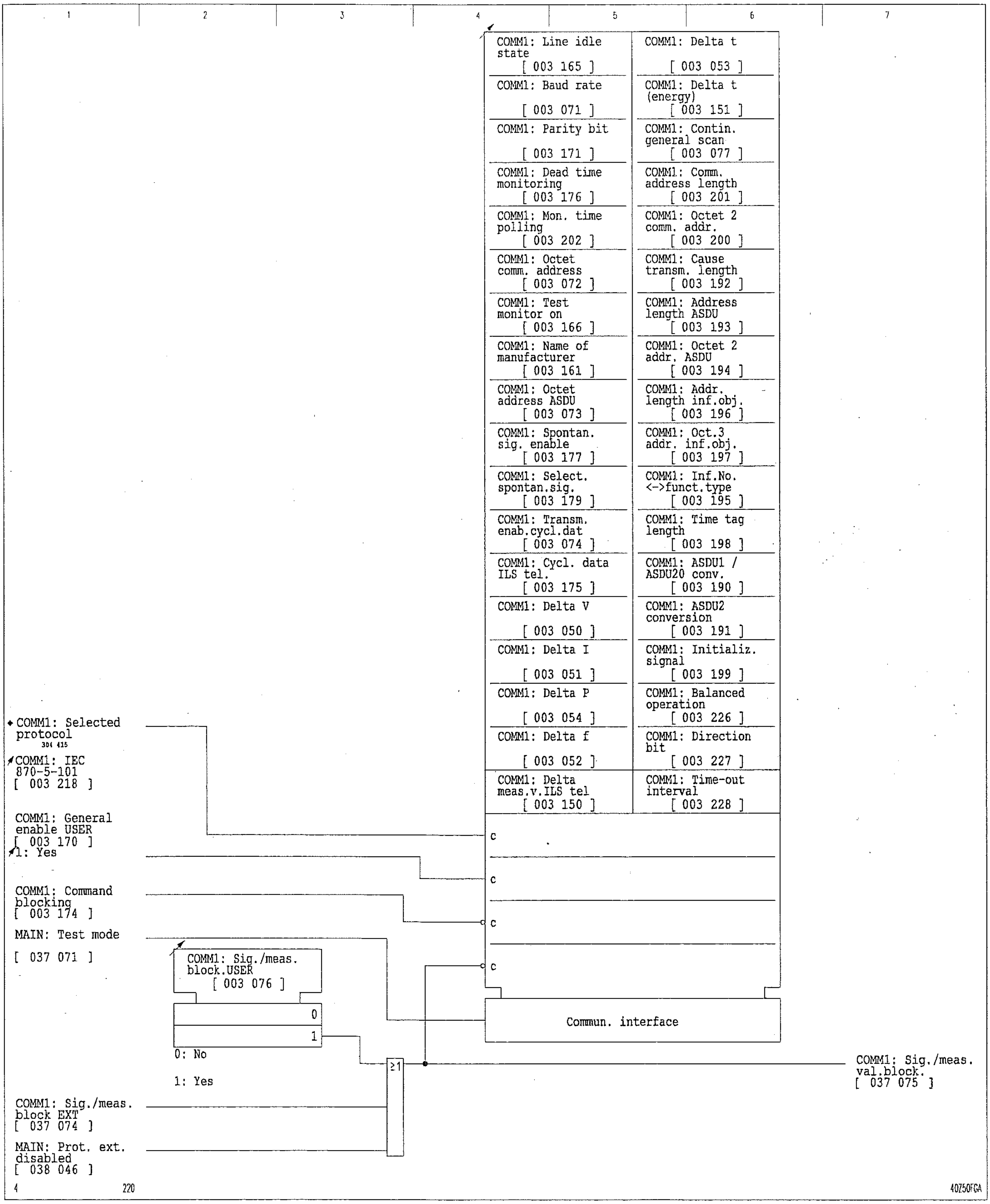
The communication interface can be blocked through a binary signal input. In addition, a signal or measured-data block can also be imposed through a binary signal input.



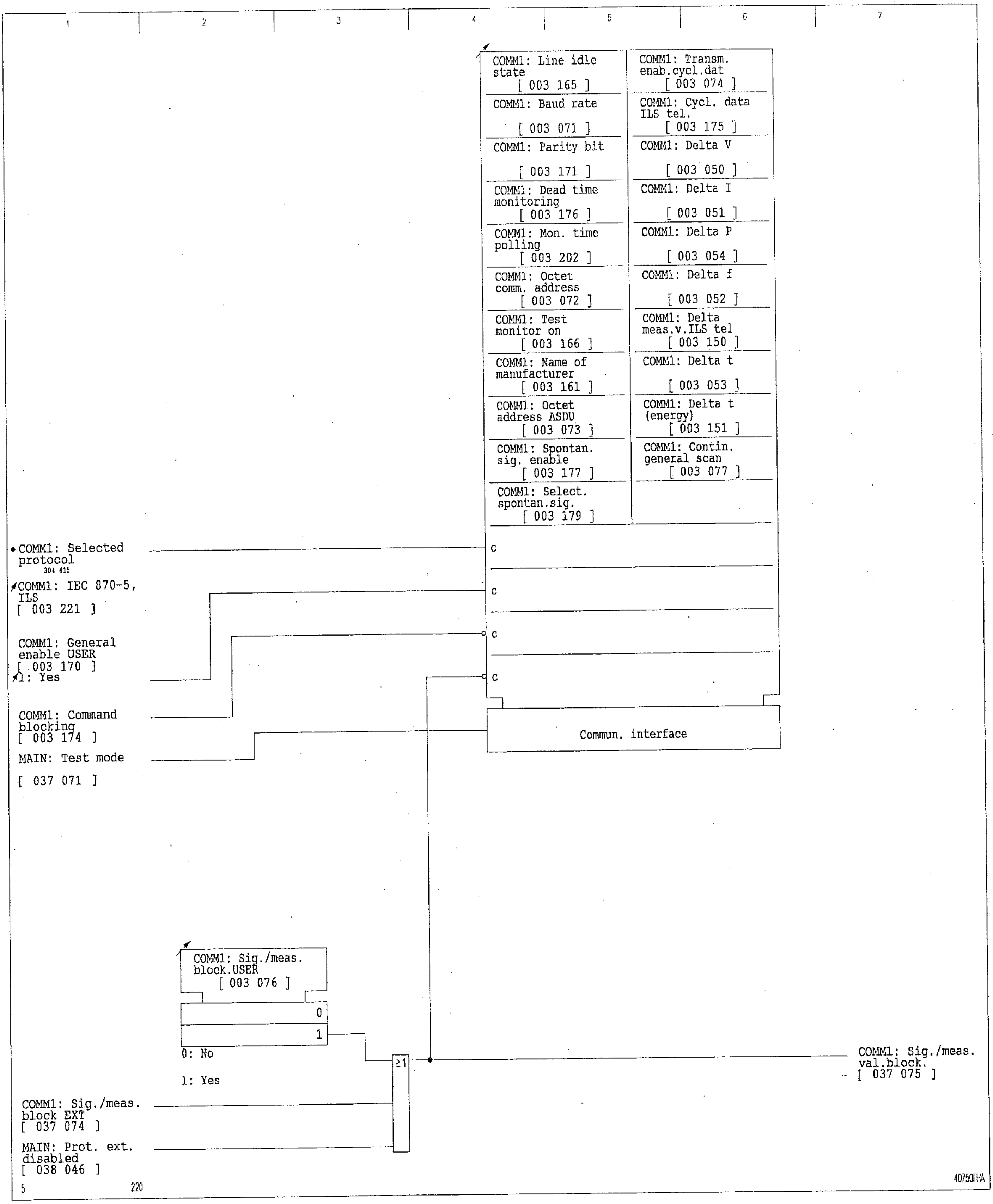
3-7 *"Logical" communication interface 1: selecting the interface protocol*



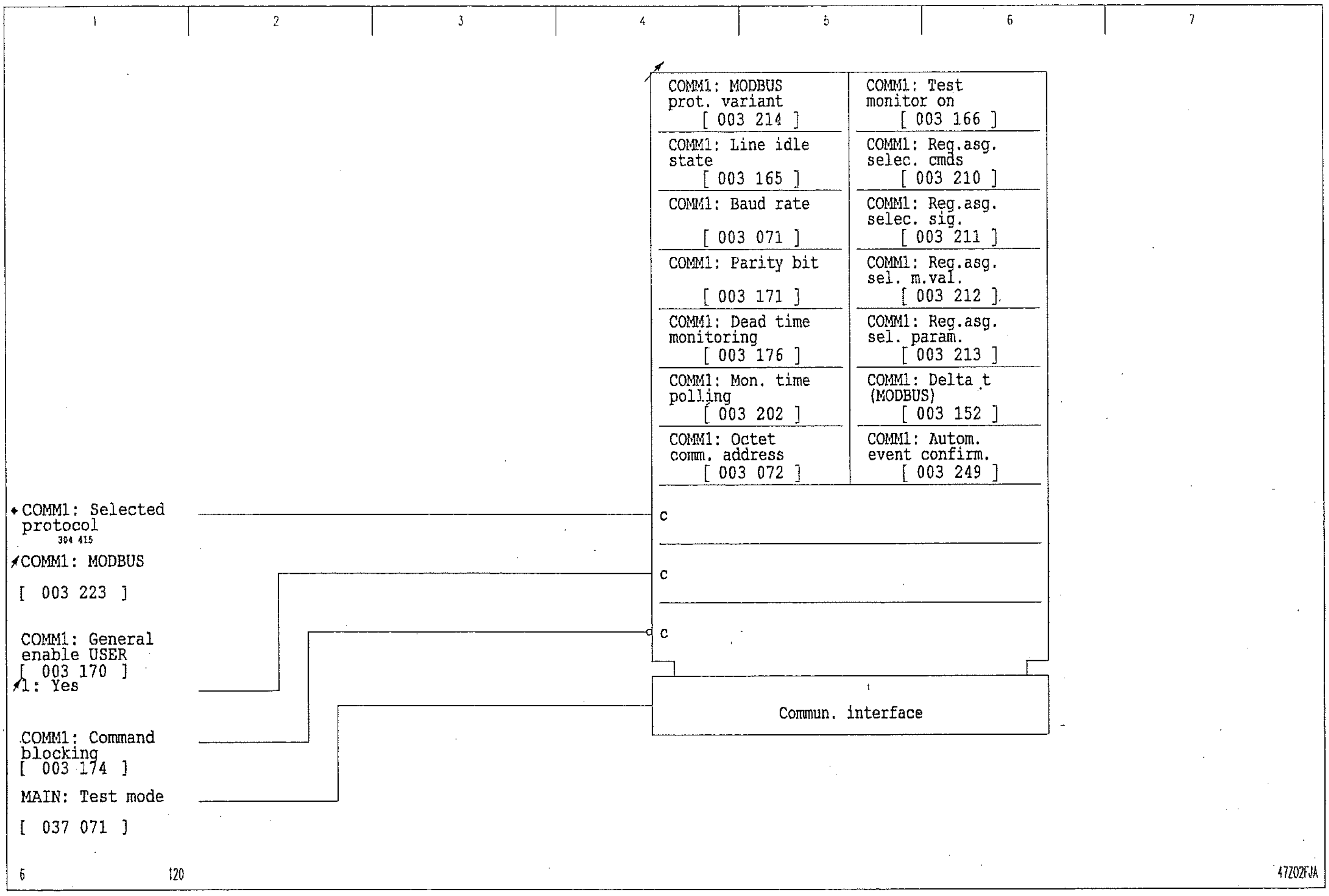
3-8 *"Logical" communication interface 1: settings for the IEC 60870-5-103 interface protocol*



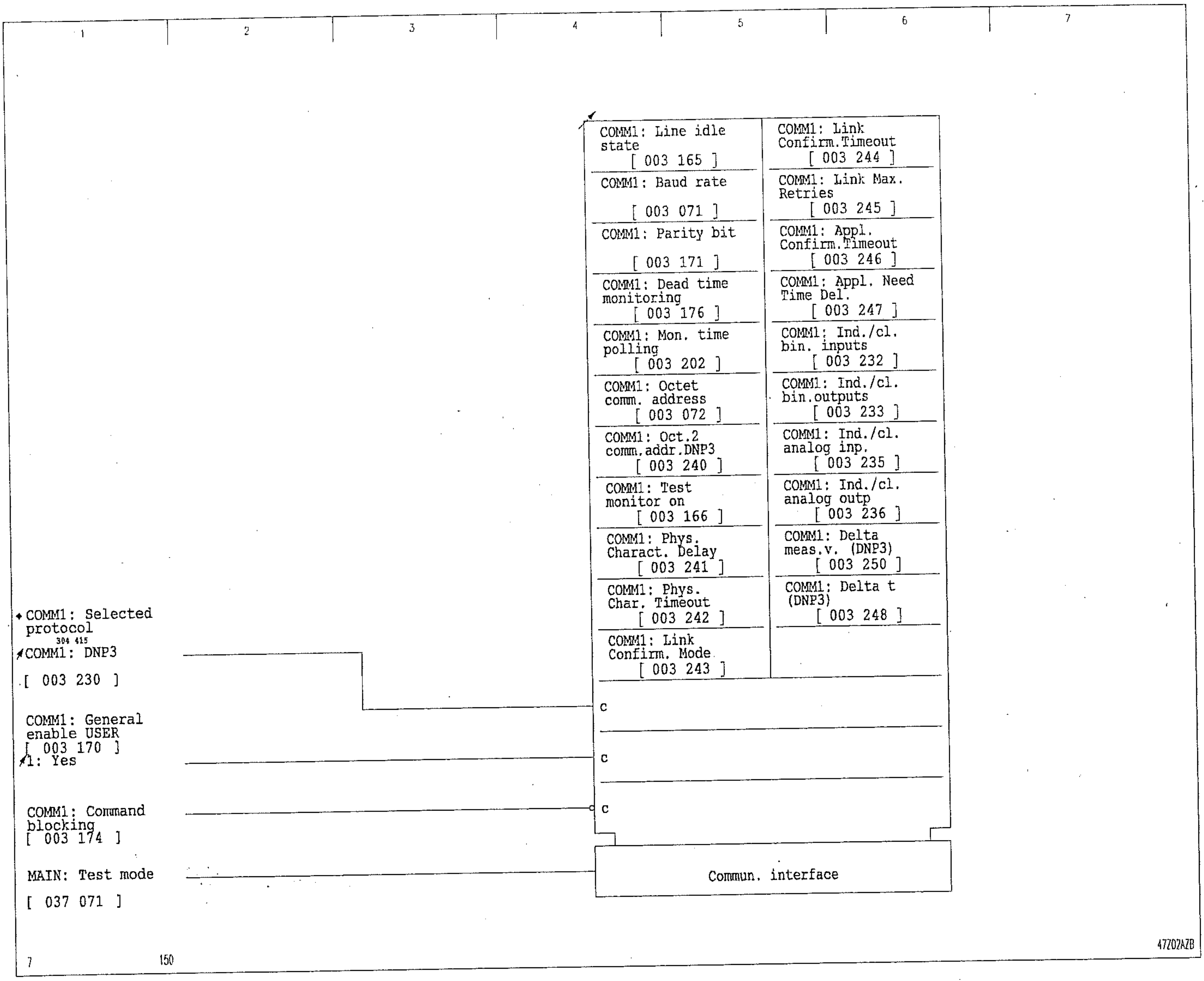
3-9 *"Logical" communication interface 1: settings for the IEC 870-5-101 interface protocol*



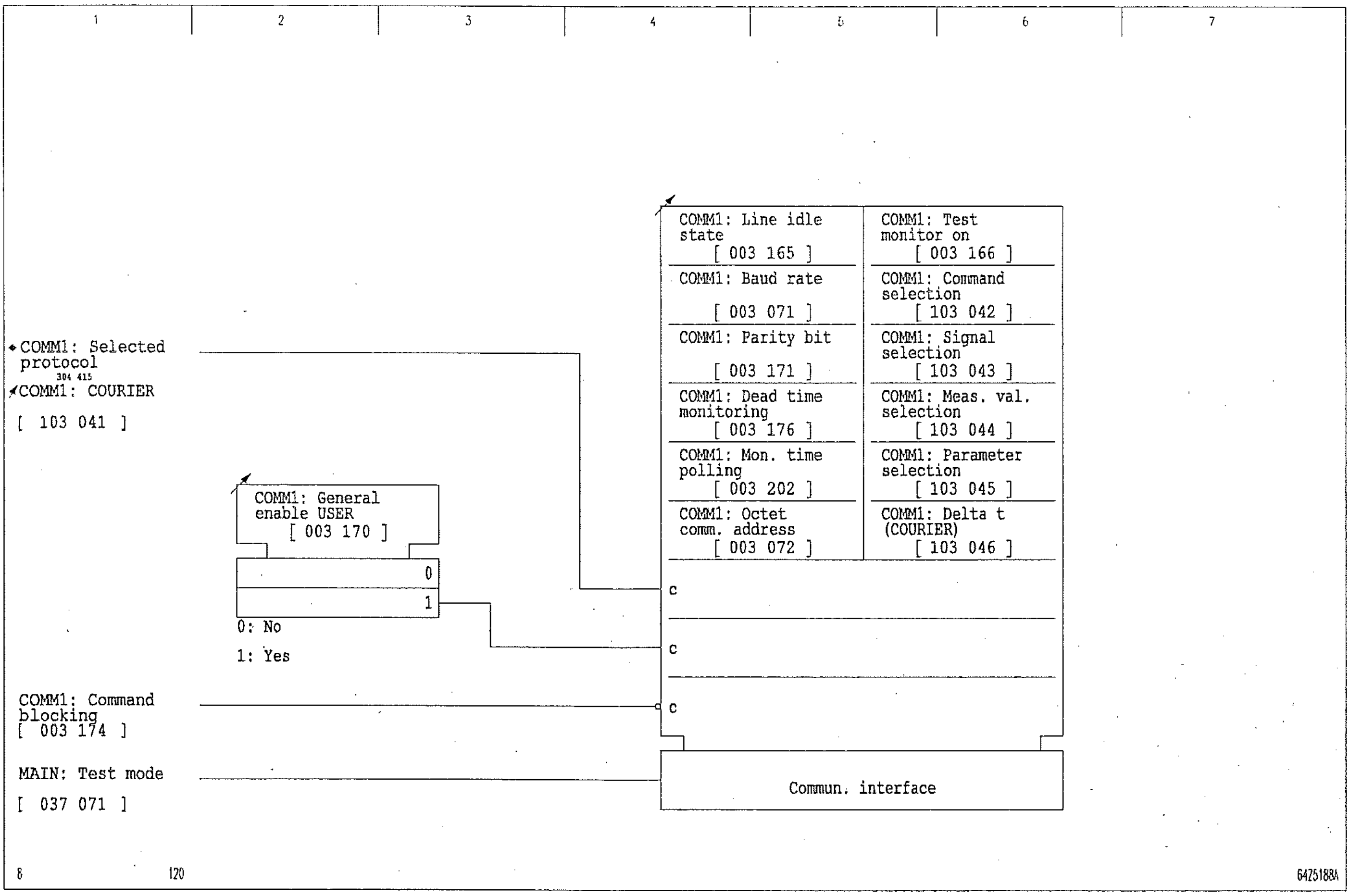
3-10 *"Logical" communication interface 1: settings for the ILS_C interface protocol*



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



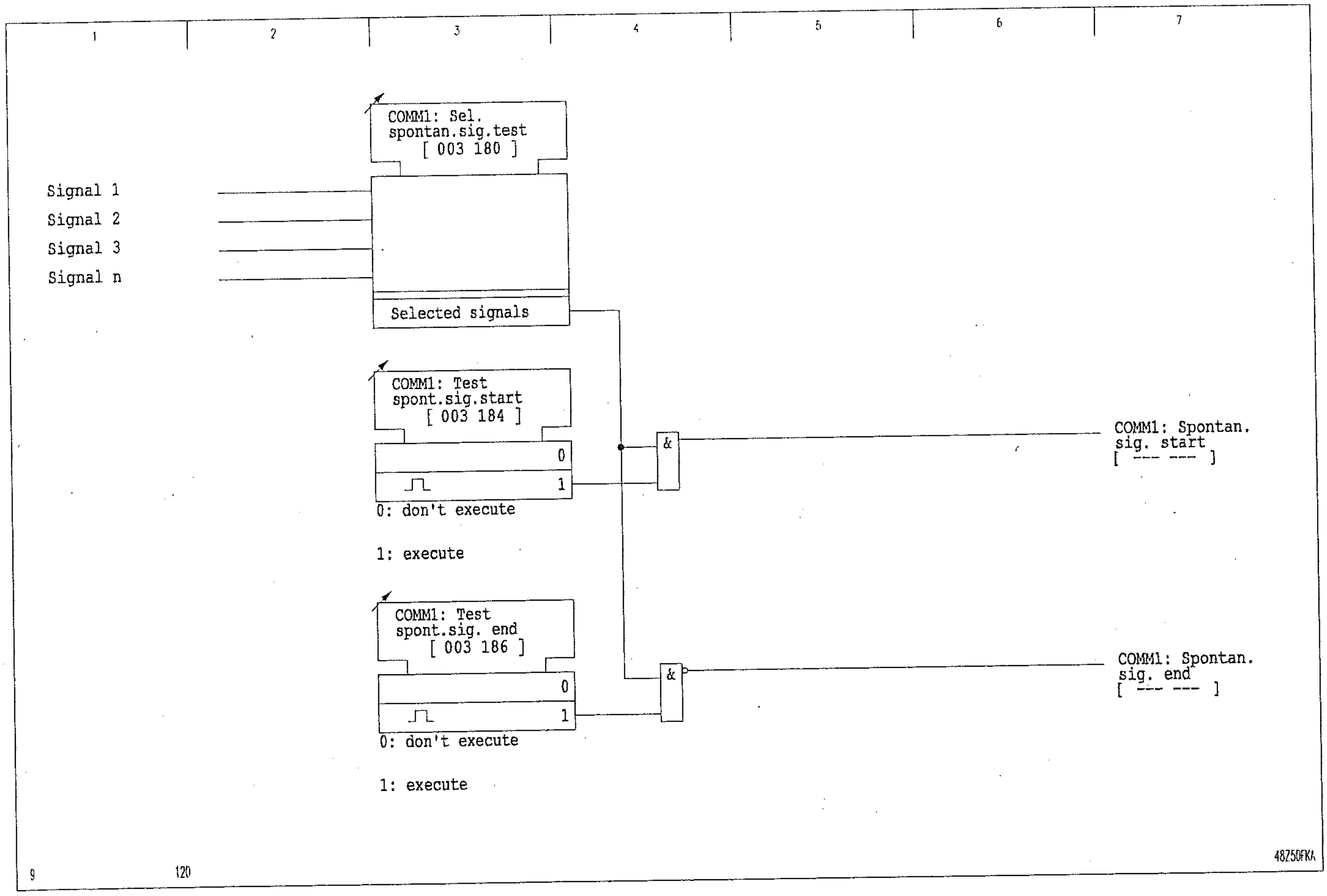
3-12 *"Logical" communication interface 1: settings for DNP 3.0*



3-13 *"Logical" communication interface 1: settings for the COURIER interface protocol*

Checking spontaneous signaling

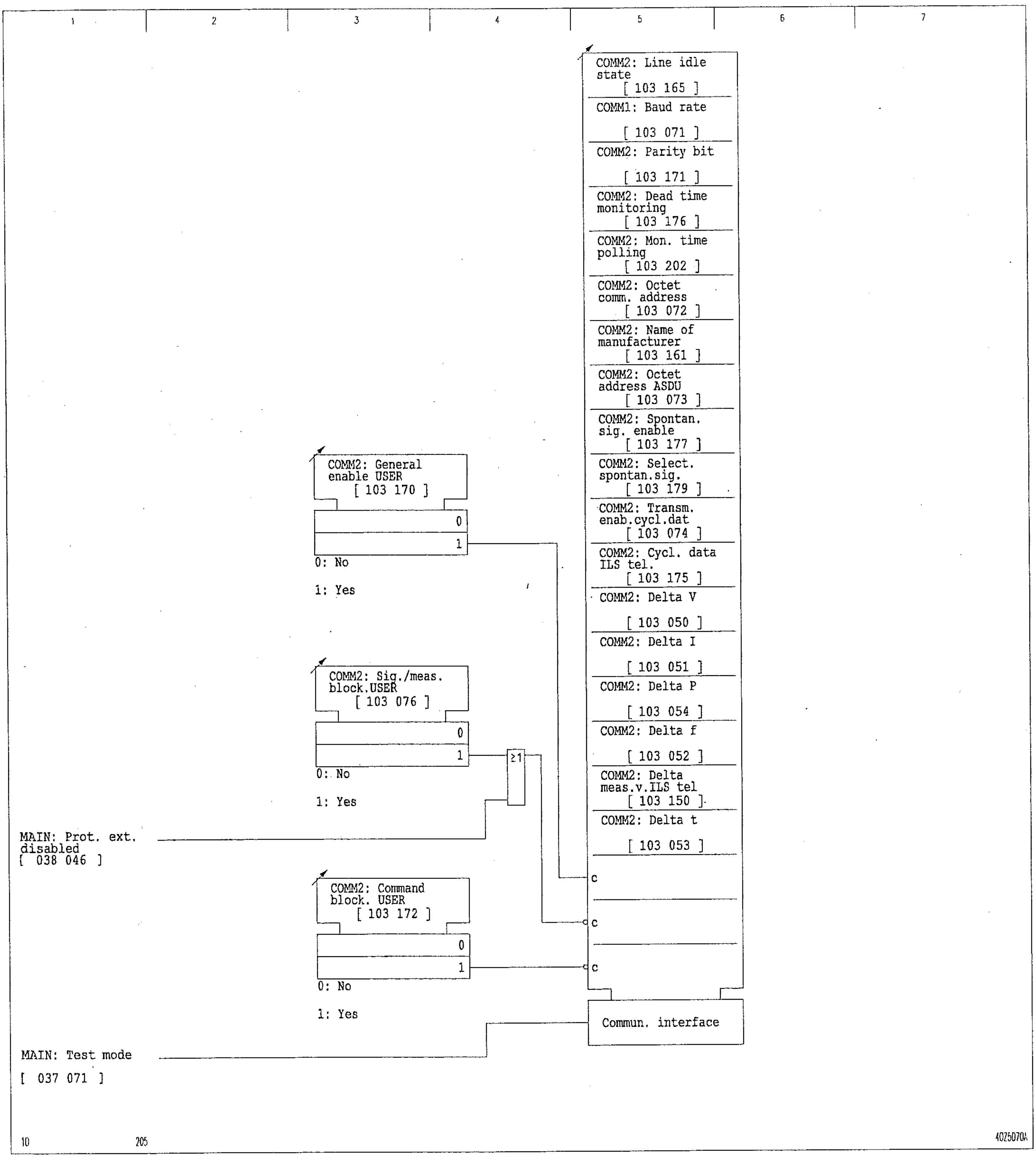
For interface protocols per IEC 60870-5-103, IEC 870-5-101 or ILS-C, there is the option of selecting a signal for testing purposes. This transmission of this signal to the control station as 'sig. start' or 'sig. end' can then be triggered via the local control panel.



3-14 Checking spontaneous signaling

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

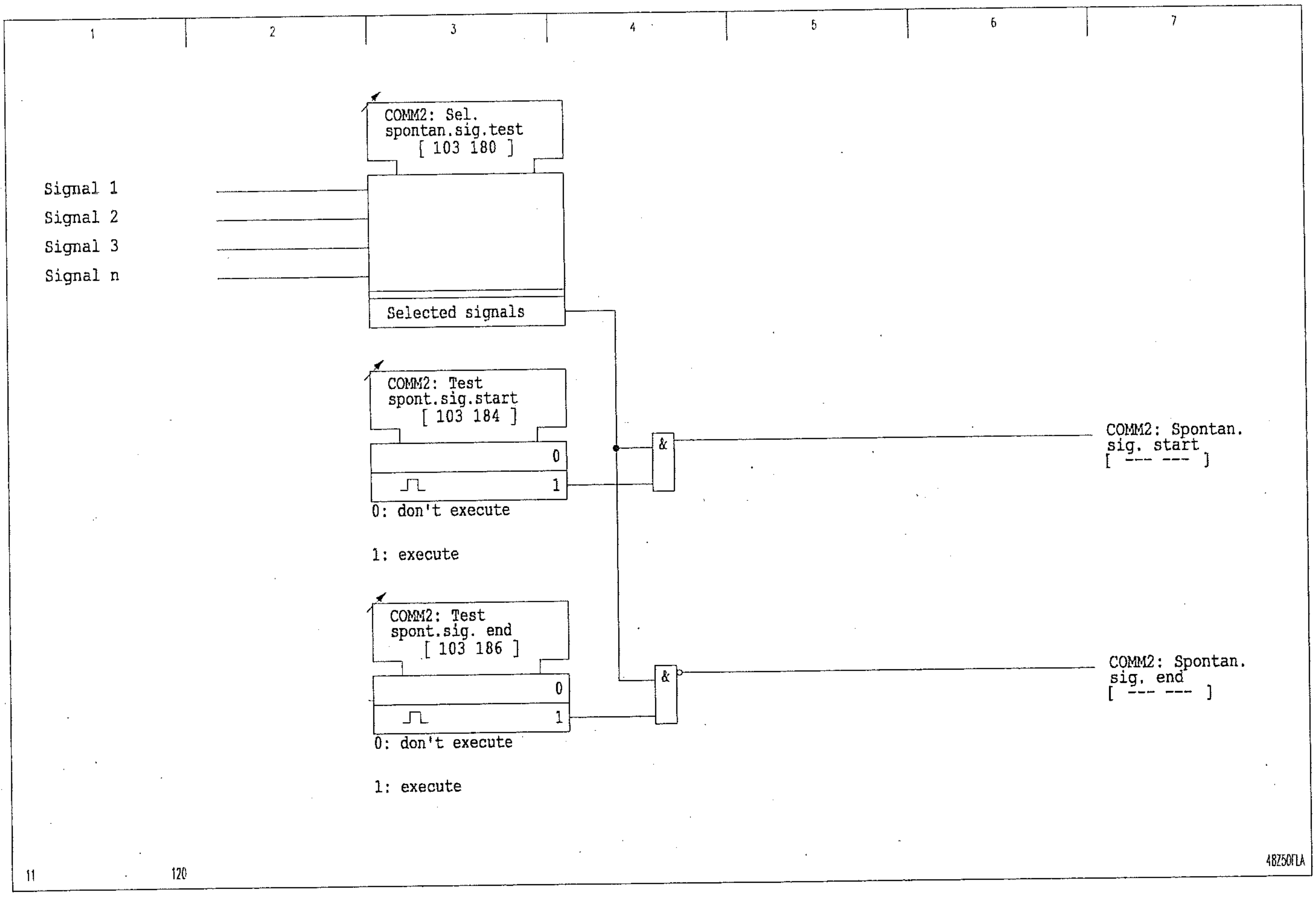
"Logical" communication interface 2 supports the IEC 60870-5-103 interface protocol. In order for data transfer to function properly, several settings must be made.



3-15 Settings for "logical" communication interface 2

Checking spontaneous signaling

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.



3-16 Checking spontaneous signaling

3.4.4 "Logical" Communication Interface 3 (Function Group COMM3)

Application and Scope

"Logical" communication interface 3 provides a digital communication link between two MiCOM devices for the exchange of up to 8 binary protection signals. While "logical" communication interfaces 1 and 2 are intended for data acquisition and remote access, "logical" communication interface 3 is a "guidance interface" designed for real-time signal transmission (the "InterMiCOM" interface). The primary application resides in the exchange of signals associated with the PSIG (protective signaling) function. However, the InterMiCOM interface can also be employed for the transmission of any other binary signals internal or external to the device.

Hardware options

COMM3 is designed as asynchronous, full-duplex communication interface for the following transmission options.

Direct link without any ancillary equipment:

- □ Glass fiber (e.g. via 2 x G62.5/125 up to max. 1.4 km)
- □ Twisted pair (RS 422 up to max. 1.2 km)

Use of ancillary transmission equipment:

- □ Fiber-optic module (e.g. OZD 485 BFOC-1300 / Hirschmann up to max. 8/14/20 km)
- □ Universal modem (e.g. PZ 511 via twisted pair 2x2x0.5 mm up to max. 10 km)
- □ Voice frequency modem (e.g. TD-32 DC / Westermo up to max. 20 km)

Digital network:

- □ Asynchronous data interface of a primary multiplexing equipment

Enabling

In order to use InterMiCOM, communication interface COMM3 has to be included in the device configuration by way of the setting COMM3: Function group COMM3. This setting parameter is only visible if the relevant optional communication module is fitted. After configuration of COMM3, all addresses associated with this function group (setting parameters, binary state signals etc.) become visible.
The function group can then be enabled or disabled at COMM3: General enable USER.

Telegram configuration

The communication baud rate can be set (at COMM3: Baud rate) so as to meet the transmission channel requirements. Source address (COMM3: Source address) and receiving address (COMM3: Receiving address) can be set to differing values to prevent InterMiCOM communication internal to the device.

Using the InterMiCOM interface, eight independent binary signals can be transmitted in each direction. For the assignment of functions to the send signals (COMM3: Fct. assignm. send 1, ...), any signal from the "Binary Outputs" selection table can be selected. For the receive signals (COMM3: Fct. assignm. rec. 1, ...), any signal from the "Binary Inputs" selection table can be chosen.

For each receive signal, an individual operating mode can be set (COMM3: Oper. mode receive 1, ...) thus defining the required checks for accepting the received binary signal. The 8 signals are divided into two groups with differing choices for the operating mode. The operating mode selected for the telegram check defines the relative weighting of the conflicting target characteristics "Speed", Security" and Dependability" as required for specific protection schemes.

- Binary signals 1 to 4:
  Choice of *Blocking* or *Direct intertrip* for the operating mode.

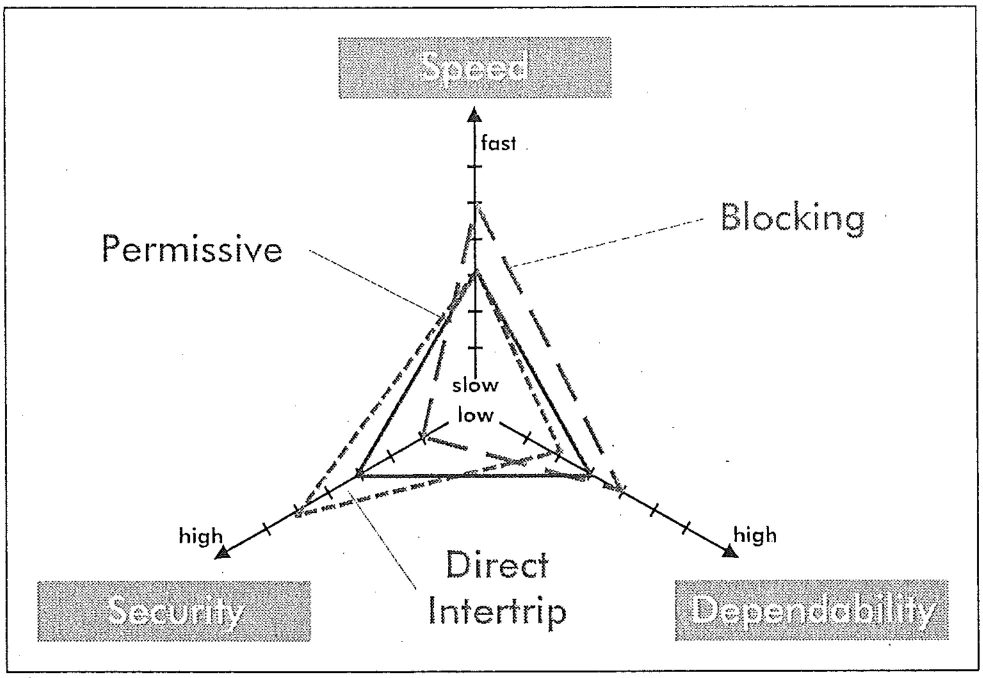
- Binary signals 5 to 8:
  Choice of *Permissive* or *Direct intertrip* for the operating mode.

EN 60834-1 classifies command based teleprotection schemes into 3 categories according to their specific requirements. The following settings for the operating modes are recommended for compliance with the requirements for the individual teleprotection schemes:

- Direct transfer trip or intertripping:
  - Preference: Security.
  - Implication: No spurious pickup in the presence of channel noise.
  - Recommended setting: Operating mode *Direct intertrip* (groups 1 to 4 or 5 to 8).

- Permissive teleprotection scheme:
  - Preference: Dependability.
  - Implication: Maximum probability of signal transmission in the presence of channel noise.
  - Recommended setting: Operating mode *Permissive* (groups 5 to 8).

- Blocking teleprotection scheme:
  - Preference: Speed.
  - Implication: Fast peer-to-peer signal transfer.
  - Recommended setting: Operating mode *Blocking* (groups 1 to 4).

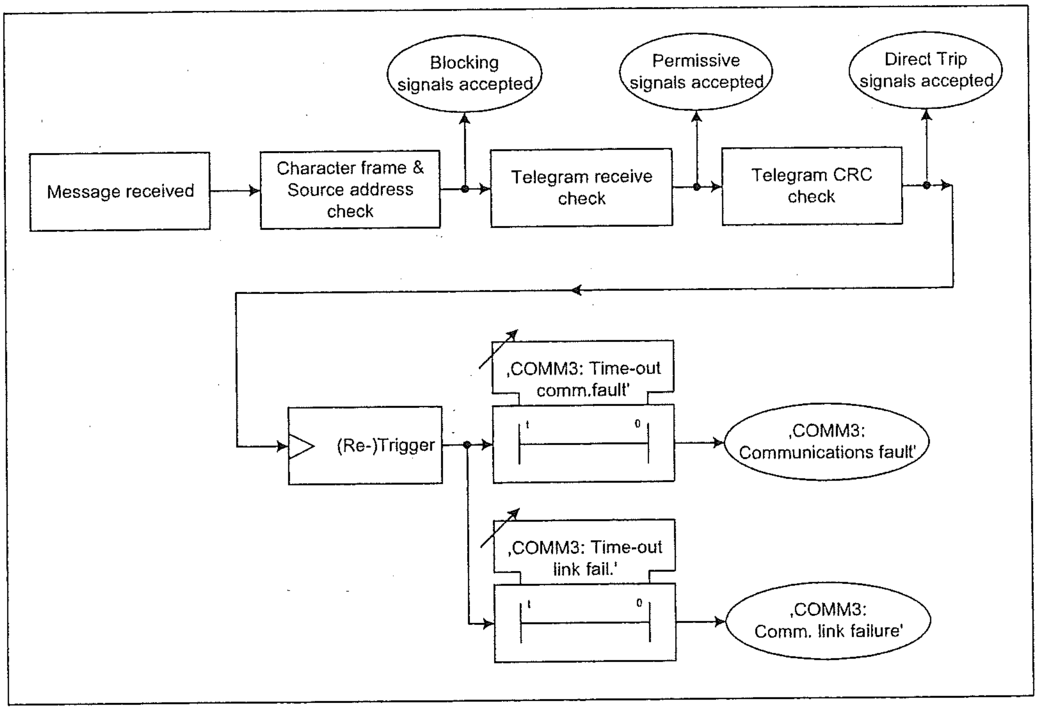


3-17 *Comparison of the operating modes*

Communication monitoring

Timer stage COMM3: Time-out comm.fault is used for monitoring the transmission channel. This timer is retriggered whenever a 100% valid telegram is received. The wide setting range allows adaptation to the actual channel transmission times. This is particularly important for time-critical schemes such as the blocking scheme. After this timer stage has elapsed, alarm signals COMM3: Communications fault and SFMON: Communic.fault COMM3 are issued and the received signals are set to their user-defined default values (COMM3: Default value rec. 1, ...), thus ensuring that the relay protection logic will continue to operate in a pre-determined failsafe way. When the InterMiCOM interface is used in connection with the PSIG (protective signaling) function, the alarm signals can be configured to the corresponding PSIG input signals using the COMM3: Sig.asg. comm.fault setting.

COMM3: Time-out link fail. is used to determine a persistent failure of the channel. After this timer stage has elapsed, alarm signals COMM3: Comm. link failure and SFMON: Comm.link fail.COMM3 are raised. These can be mapped to give the operator a warning LED or contact, to indicate that maintenance attention is required.



3-18 *Message processing and communication monitoring*

Supervision of communication link quality

For each received message, InterMiCOM carries out a syntax check and updates the proportion of corrupted messages within the last 1000 received messages. These ratio results are provided as continuously updated values (COMM3: No. tel. errors p.u.) and as maximum value (COMM3: No.t.err.,max,stored). The user may declare the percentage of corrupted messages that can be allowed compared to total messages transmitted (COMM3: Limit telegr. errors), before an alarm is raised (COMM3: Lim.exceed.,tel.err. and SFMON: Lim.exceed.,tel.err.). All corrupted messages are counted (COMM3: No. telegram errors). This counter as well as the stored maximum ratio of corrupted messages can be reset via COMM3: Reset No. tel.errors.

Commissioning tools

The actual values of send and receive signals can be read from the device as physical state signals (COMM3: State send 1, ... and COMM3: State receive 1, ...).
In addition, InterMiCOM provides two test facilities for commissioning of the protection interface.

For the loop back test, the send output is directly linked back to the receive input of the same device. The test can be triggered via COMM3: Loop back test. The device then sends the bit pattern (set as equivalent decimal number at COMM3: Loop back send) for the preset time COMM3: Hold time for test. Only for this test, the source address is set to "0", a value that is not used for regular peer-to-peer communication.

While the hold time is running, the test result can be checked by reading out the measured operating data values COMM3: Loop back result and COMM3: Loop back receive. Once the hold time has expired, the loop back test is terminated and InterMiCOM reverts to the normal sending mode (i.e. sending the updated values of the configured send signals, using the set source address).

Thus in case of communication problems, the loop back test can be used to verify or to exclude a device malfunction. The transmission channel including the receiving device can be checked manually by setting individual signals (COMM3: Send signal for test) to user-defined test values (COMM3: Log. state for test). After triggering the test via COMM3: Send signal, test, the preset signal is sent with the preset value for the set hold time COMM3: Hold time for test. The 7 remaining signals are not affected by this test procedure and are sent with their updated values. During this time, the received signal can be checked from the receiving device, e.g. by reading the physical state signal. Once the hold time has expired, the test mode is reset automatically and the updated values of all 8 signals are transmitted again.

3.5 Time Synchronization via the IRIG-B Interface (Function Group IRIGB)

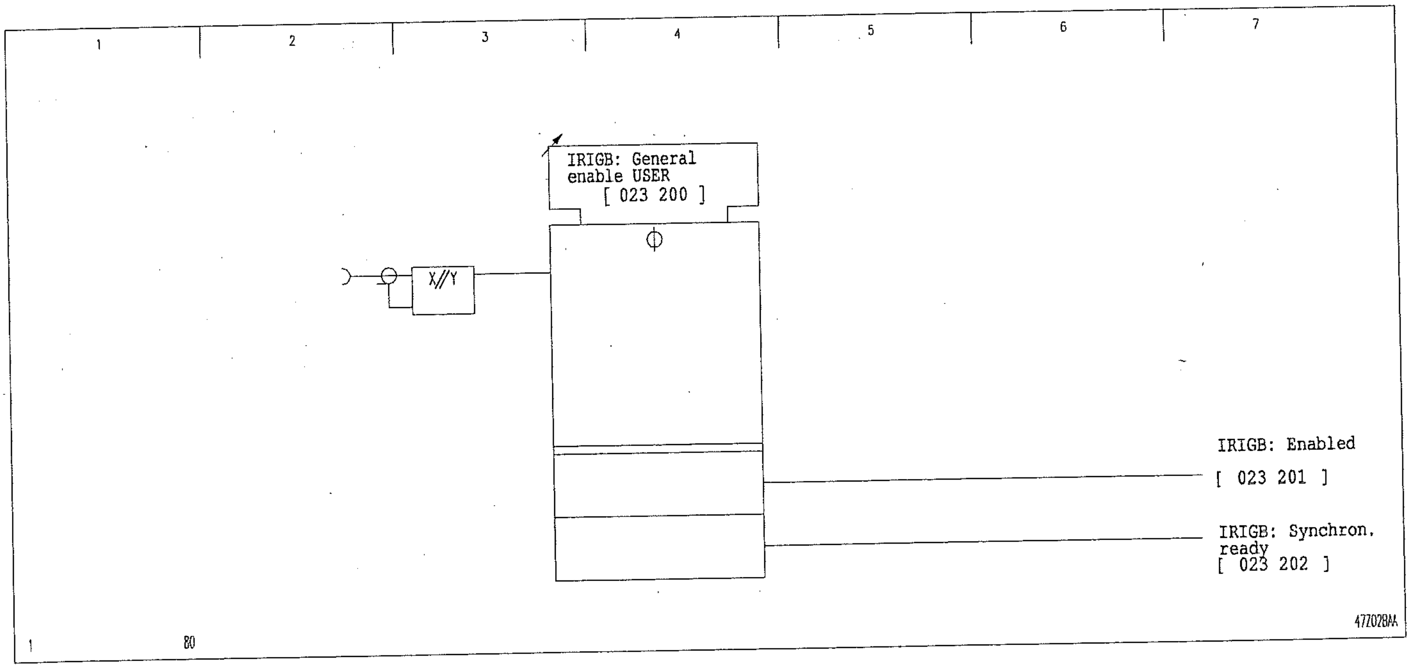
If a GPS receiver with an IRIG-B connection is available, for example, then the internal clock in the P130C can be synchronized to GPS time through the optional IRIG-B interface. The user must keep in mind that the IRIG-B signal contains only one piece of information about the date (the day as numbered since the beginning of the year). On the basis of this piece of information about the date, the P130C calculates the current date (DD.MM.YY) based on the year set in the P130C.

Disabling and enabling the IRIG-B interface

The IRIG-B interface can be disabled or enabled from the local control panel.

Ready to synchronize

Once the IRIG-B interface has been enabled and is receiving a signal, the P130C checks the received signal for plausibility. Non-plausible signals are rejected by the P130C. If a correct signal is not received by the P130C continuously, then the synchronization function is no longer ready.



3-19 *IRIG-B interface*

3.6 Configurable Function Keys (Function Group F_KEY)

The P130C has four freely configurable function keys. Figure 3-20 illustrates their operation using function key F1 as an example. This function key is not enabled unless the associated password F_KEY: Password funct. key1 has been entered first. Once the password has been entered, the function key remains active for no longer than the set time F_KEY: Return time fct.keys. Thereafter, the function key is disabled until the password is entered again. The same rules apply to function keys F2, F3 and F4.

Configuring the function keys with a single function

A single function can be assigned to each function key by selecting a logic state signal (except LOC: Trig. menu jmp x EXT) via F_KEY: Fct. assignm. Fx (Fx: F1, F2, F3 or F4). The selected signal will then be triggered in the P130C whenever the relevant function key is pressed.

Configuring the function keys using menu jump lists

Instead of a single function, a menu jump list can be assigned to each function key by selecting the entry LOC: Trig. menu jmp x EXT (x: 1 or 2) at F_KEY: Fct. assignm. Fx (Fx: F1, F2, F3 or F4). Repeated pressing of the relevant function key will then sequentially trigger the functions of the selected menu jump list.

The two menu jump lists are composed via LOC: Fct. menu jmp list x (x: 1 or 2). Up to 16 functions can be selected, including setting parameters, event counters and /or event recordings.

Configuring the read key

At LOC: Fct. read key up to 16 functions can be selected from the same list as for LOC: Fct. menu jmp list x. Repeated pressing of the read key will then sequentially trigger the selected functions.

Operating mode of the function keys

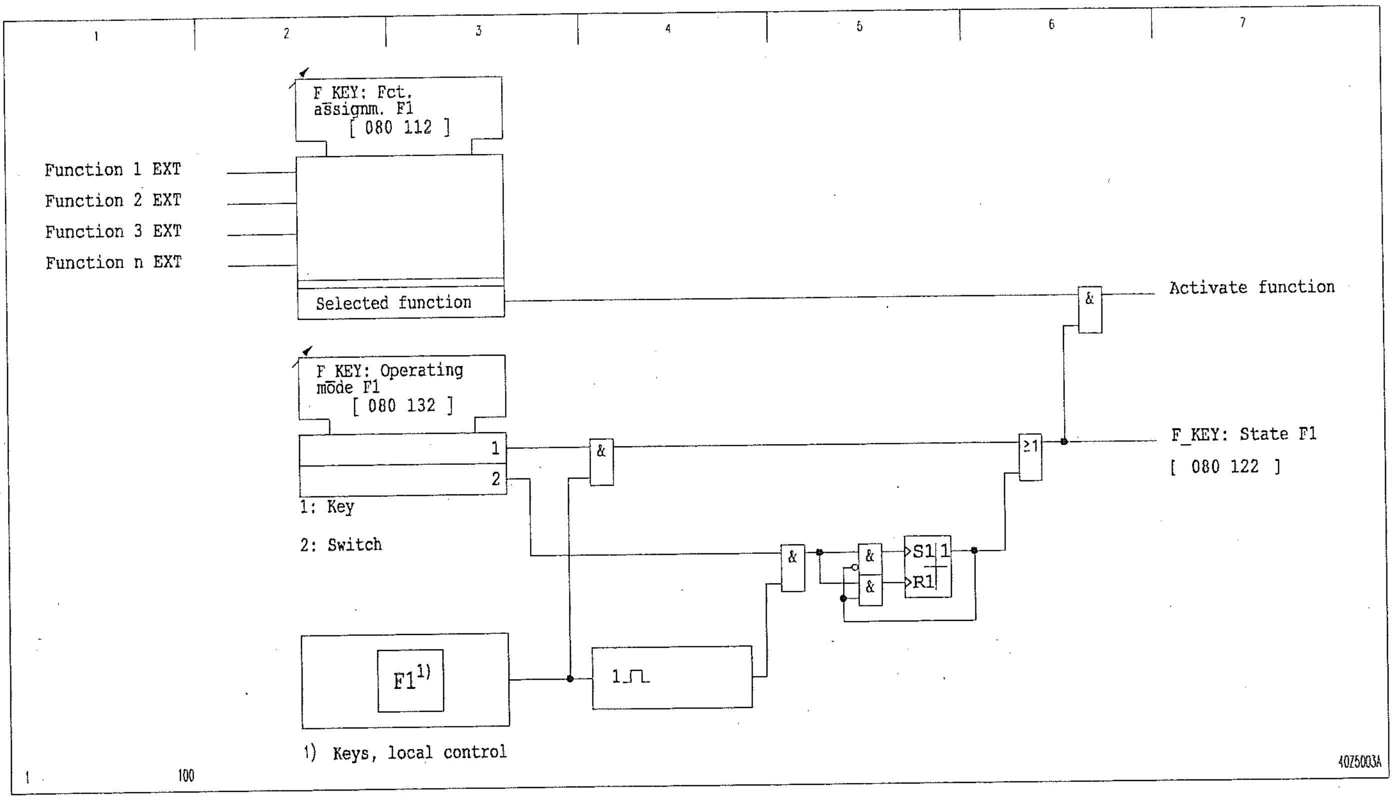
For each function key, the user can define an operating mode.

- *Key* mode: The selected function is active while the function key is being pressed.
- *Switch* mode: The status of the selected function will change between 'enabled' *(On)* and 'disabled' *(Off)* whenever the function key is pressed.

The switching state of the function key can be displayed.

Key response

If the backlighting of the LCD display is switched off, pressing a function key or the read key will initially result in switching on the backlighting. Pressing the key a second time will then trigger the selected function (as for the other keys).



3-20 *Configuration and operating mode of the function keys. The associated function can be a single function or a menu jump list.*

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

The P130C has optical coupler inputs for processing binary signals from the system. The functions that will be activated in the P130C 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 P130C.

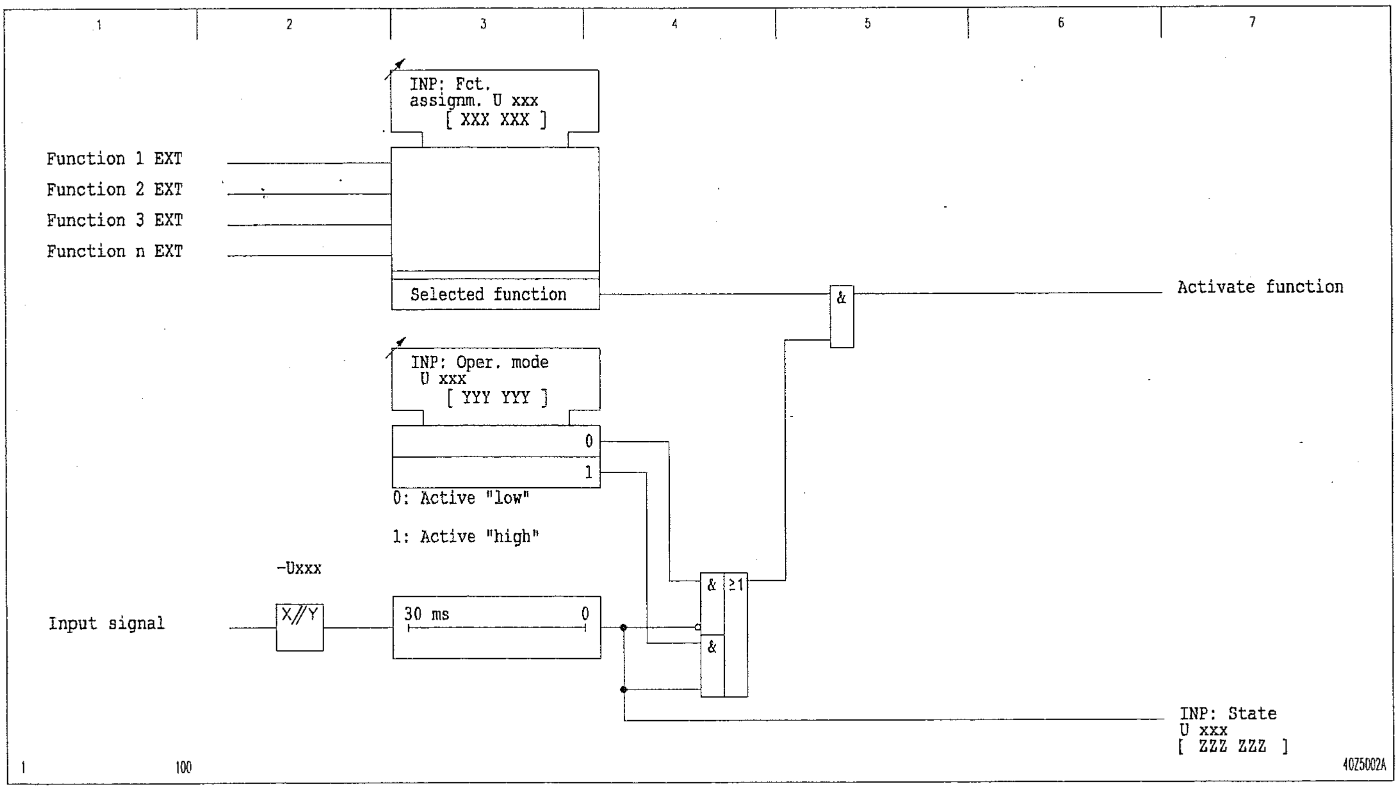
Configuring the binary inputs

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.



3-21 *Configuration and operating mode of the binary signal inputs*

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

The P130C 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 (ES) mode or normally-energized (NE) mode and whether it will operate in latching mode.

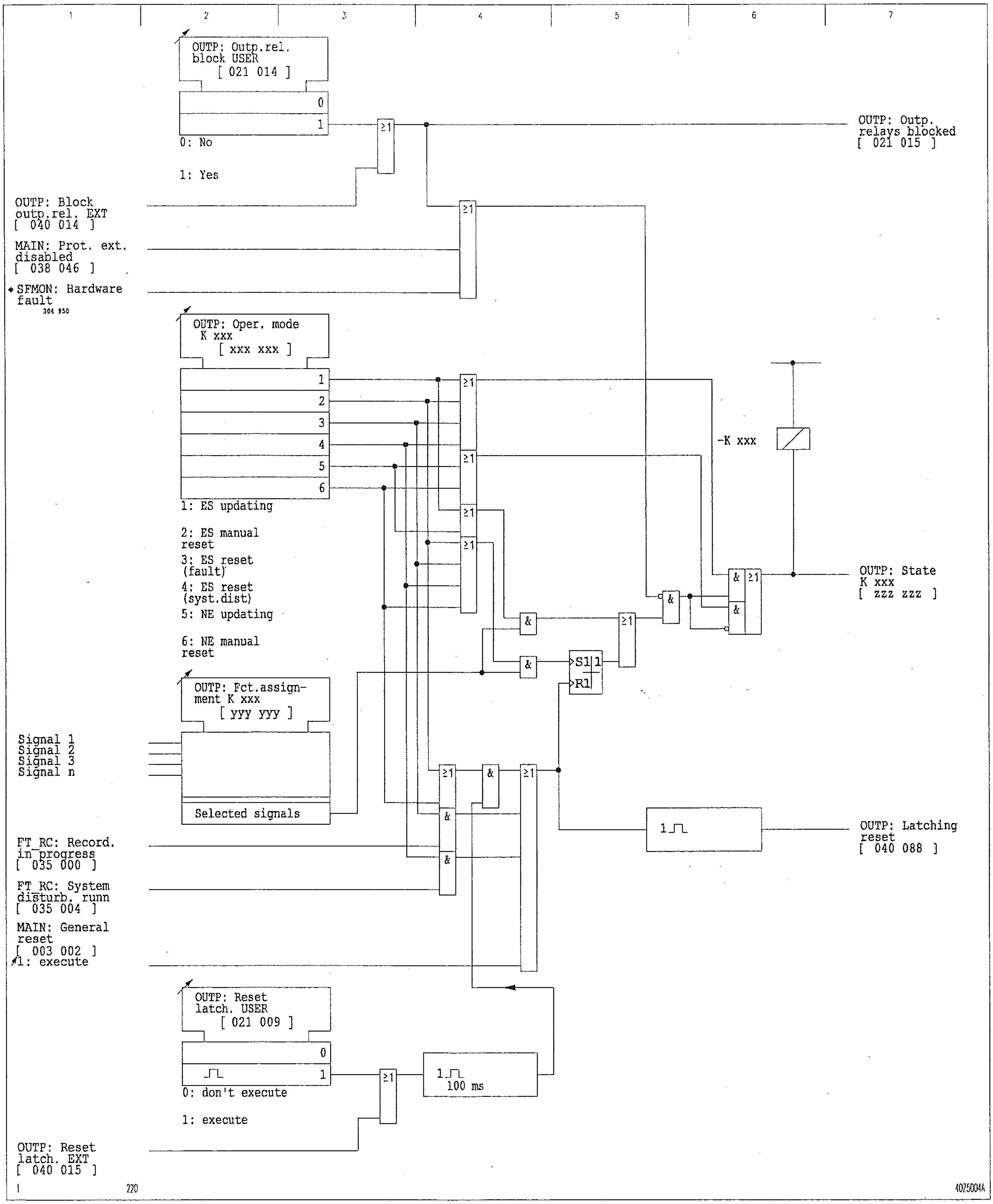
Depending on the I/O module under consideration, the output relays have either make contacts, changeover contacts or both (see the Terminal Connection Diagrams in the Appendix). For relays with make contacts, the energize-on-signal (ES) mode corresponds to normally-open operation. The normally-energized (NE) mode means that the polarity of the driving signal is inverted, such that a logic "0" maintains the relay normally-closed. For relays with changeover contacts, these more common descriptions are not applicable.

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 P130C 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. In such cases, the relays are treated according to their operating mode. They are not triggered if they are in energize-on-signal (ES) mode; only relays in normally-energized (NE) mode are triggered.
An exception is made for those relays that have the signals SFMON: Warning (relay) or MAIN: Blocked/faulty assigned to them. Thereby the blocking is indicated correctly.
(The signal MAIN: Blocked/faulty is coupled to the activation of the LED labeled 'OUT OF SERVICE'.)

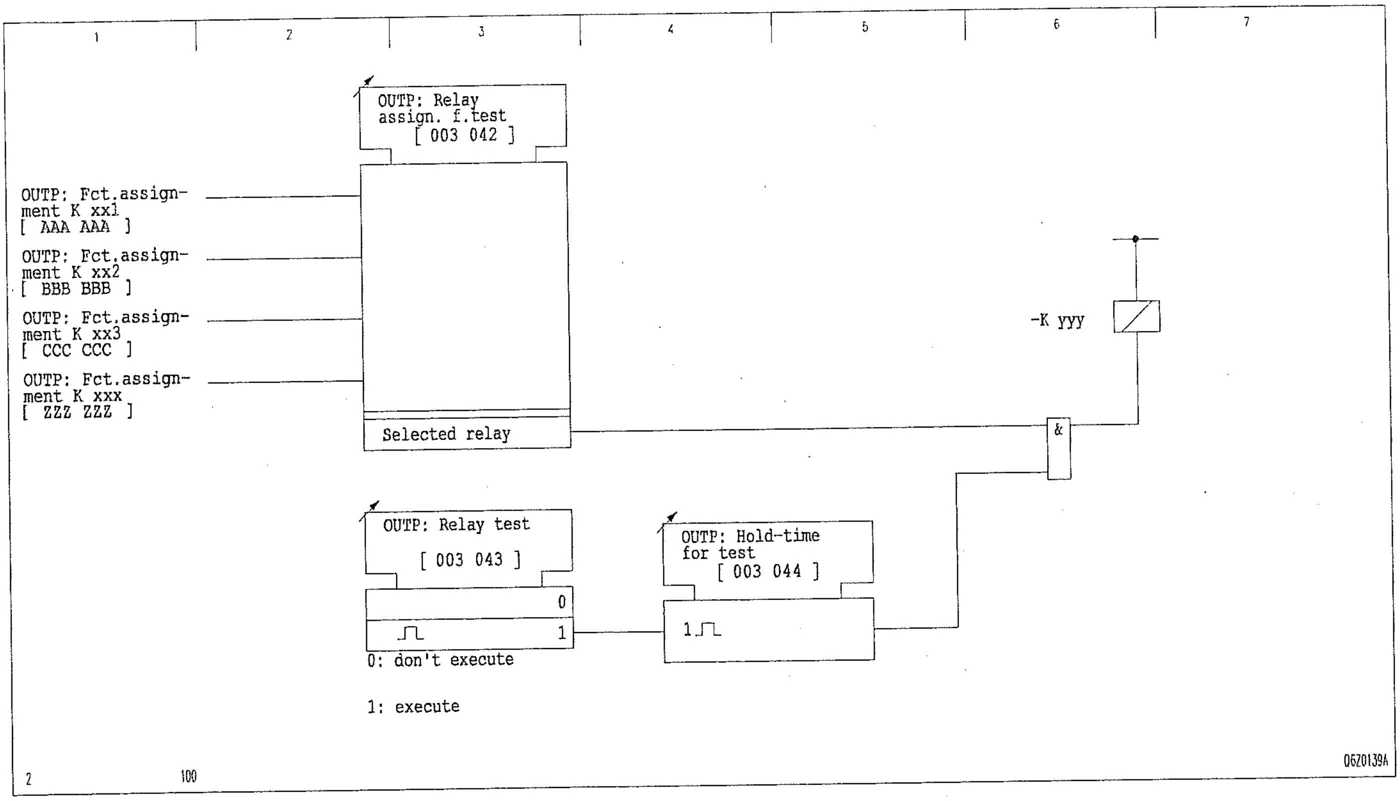
If, on the other hand, a serious hardware error has been detected by the self-monitoring function (see the error messages leading to blocking according to Chapter 10) then all output relays are reset whatever the set operating mode or signal configuration.



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*

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

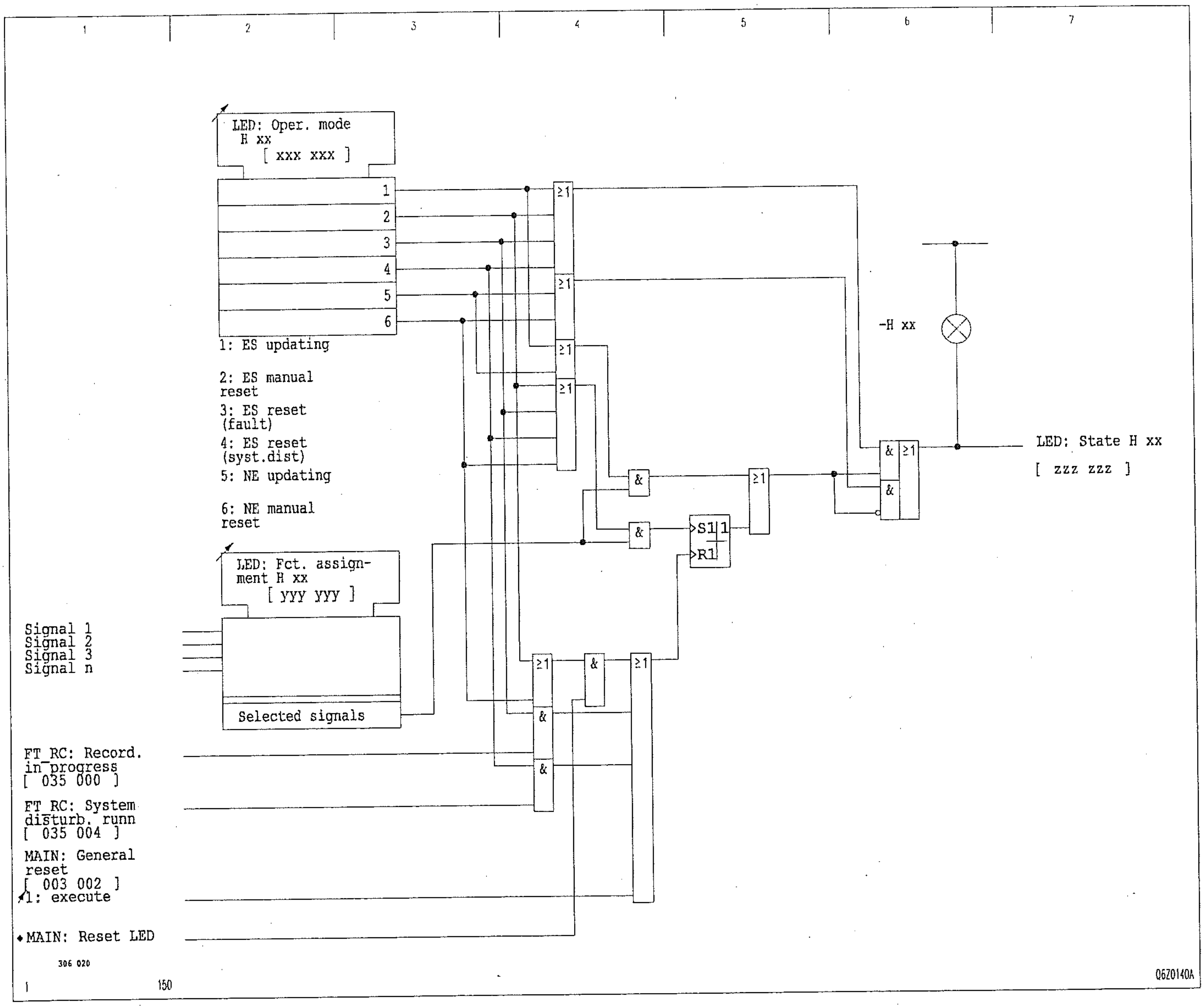
The P130C has 17 LED indicators for the indication of binary signals. Five of the LED indicators are permanently assigned to functions. The other LED indicators are freely configurable.

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 P130C') 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*

3.10 Main Functions of the P130C (Function Group MAIN)

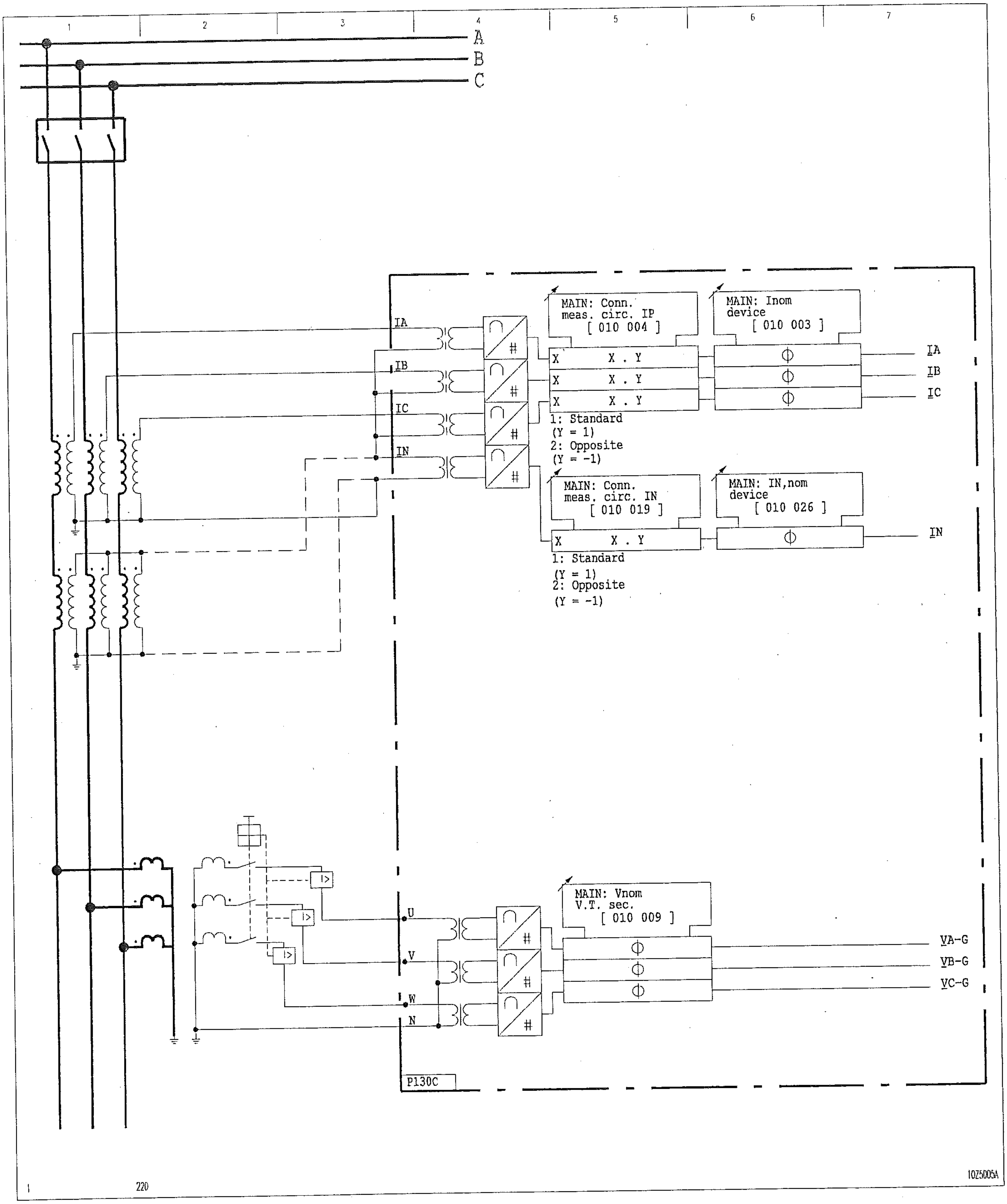
3.10.1 Conditioning the Measured Variables

The secondary phase currents of the system transformers are fed to the P130C. The measured variables are – electrically isolated – converted to normalized electronics levels. Air-gap transformers are used in the phase current path to suppress aperiodic signal components. The analog quantities are digitized and are thus available for further processing.

Settings that do not refer to nominal quantities are converted by the P130C 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 P130C. Figure 3-25 shows the standard connection. The phase of the digitized currents is rotated 180° by this setting.

If the P130C is to operate with the GFDSS function (ground fault direction determination using steady-state values), current transformer T4 needs to be connected to a current transformer in Holmgreen connection (dashed lines in Figure 3-25) or to a window-type current transformer.



3-25 *Connecting the P130C measuring circuits. For the frequency protection model, the current transformers are not included. (When using P1-P2 and S1-S2 identifications for the terminal polarity of CT's, the dot shown identifies the P1 and S1 terminals.)*

3.10.2 Operating Data Measurement

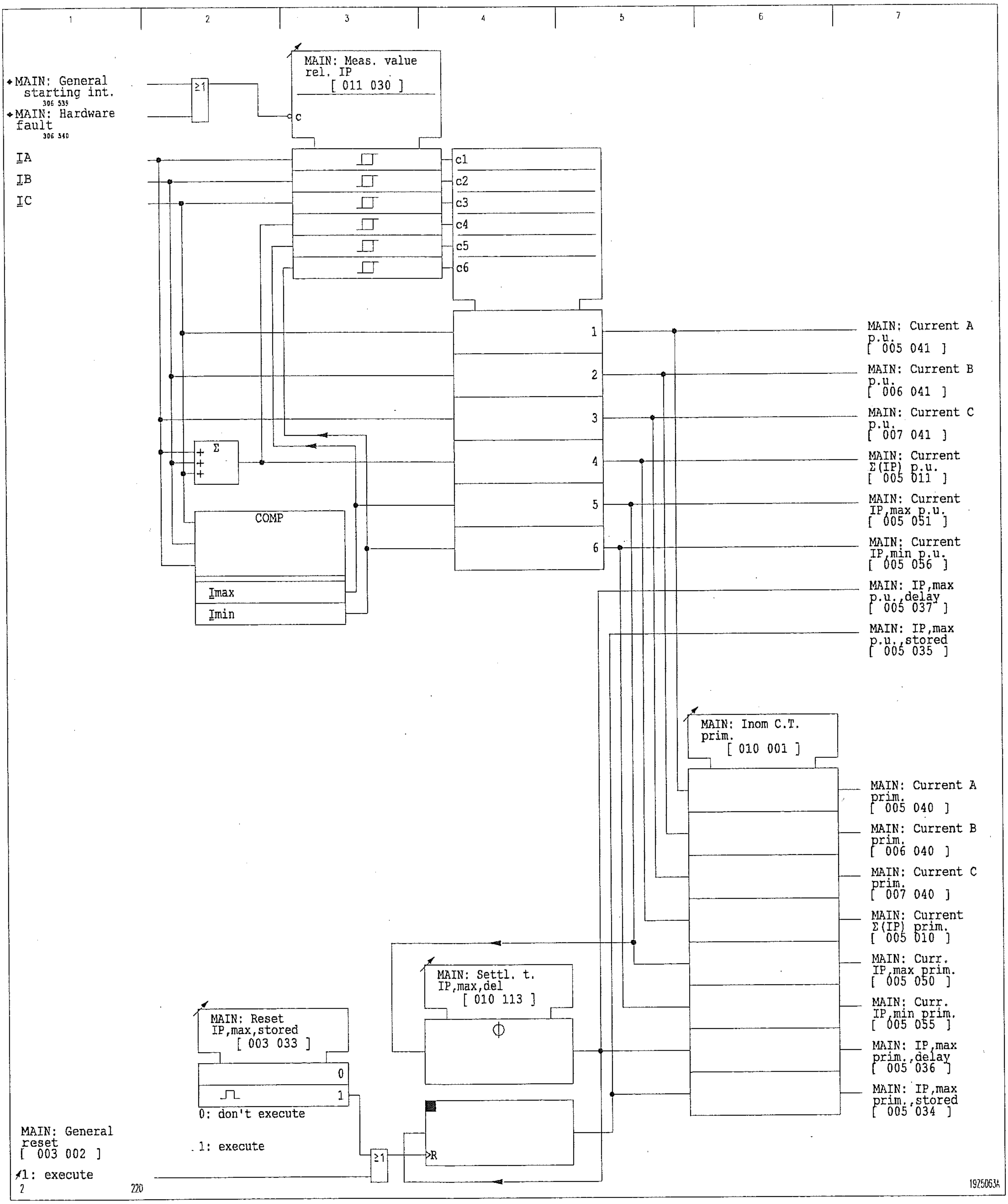
The P130C has an operating data measurement function for the display of currents and voltages measured by the P130C; quantities derived from these measured values are also displayed. Set minimum thresholds must be exceeded in order for measured values to be displayed. If these minimum thresholds are not exceeded, '*not measured*' is displayed in place of a value. The following measured variables are displayed:

- Phase currents for all three phases
- Maximum phase current
- Minimum phase current
- Delayed and stored maximum phase current
- Residual current measured by the P130C at the T 4 transformer
- 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
- Active and reactive power
- Active power factor
- Load angle φ in all three phases
- Phase relation between calculated and measured residual current
- Frequency
- Active and reactive energy output and input

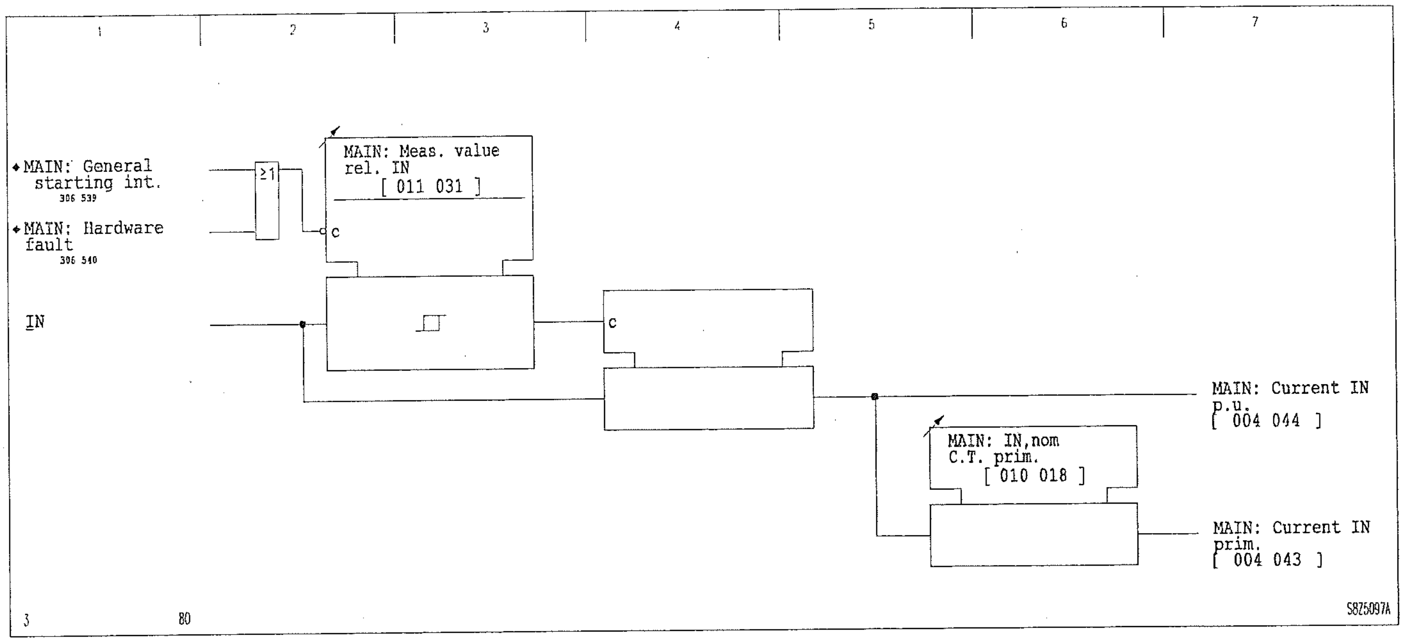
The measured data are updated at 1 s intervals. Updating is interrupted if a general starting state is present or if the self-monitoring function detects a hardware fault.

Measured current values

The measured current values are displayed both as per-unit quantities referred to the nominal quantities of the P130C 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 P130C.



3-26 *Measured operating data - phase current*



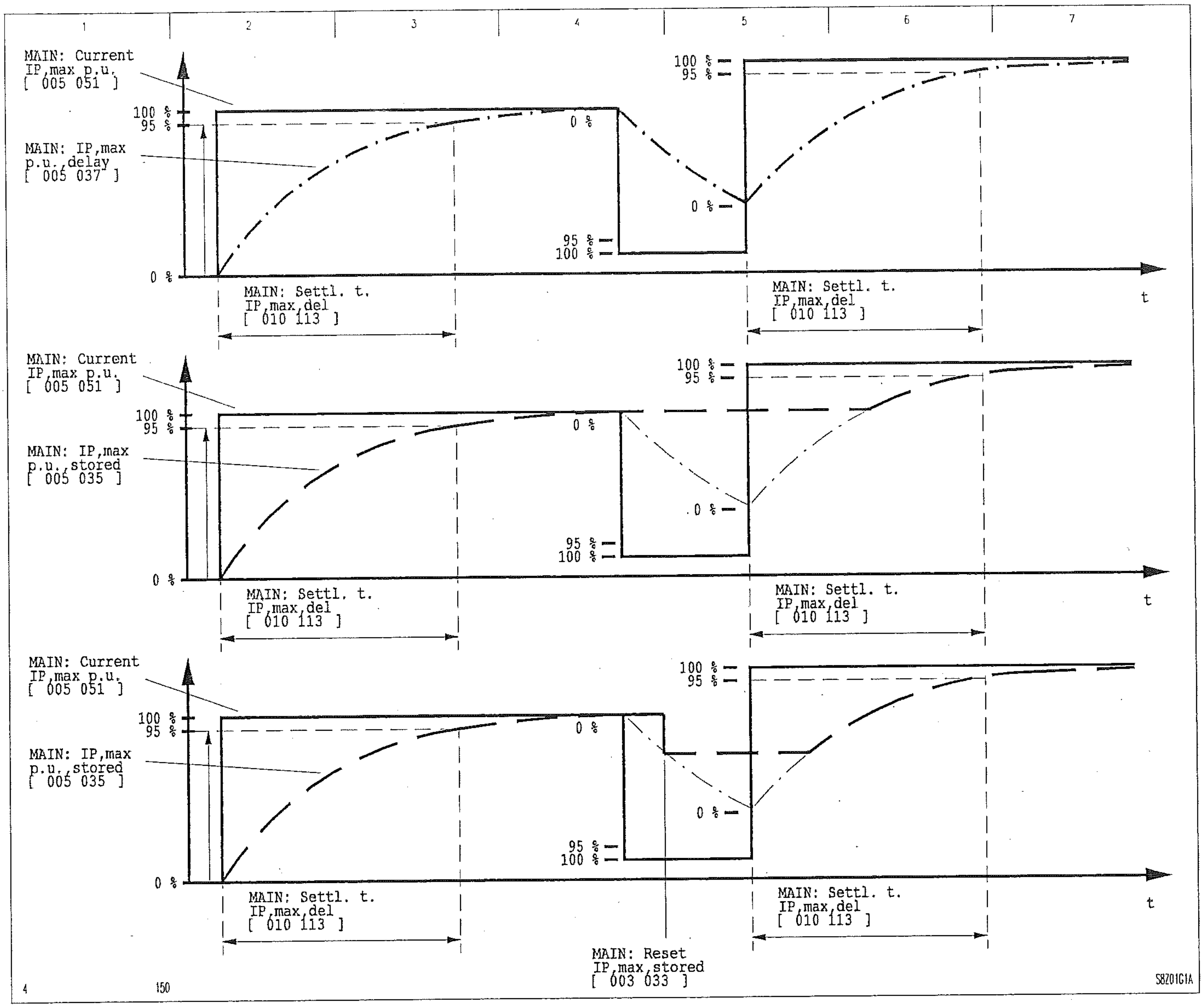
3-27 *Measured operating data - residual current*

Delayed maximum phase current display

The P130C 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 3-28). 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

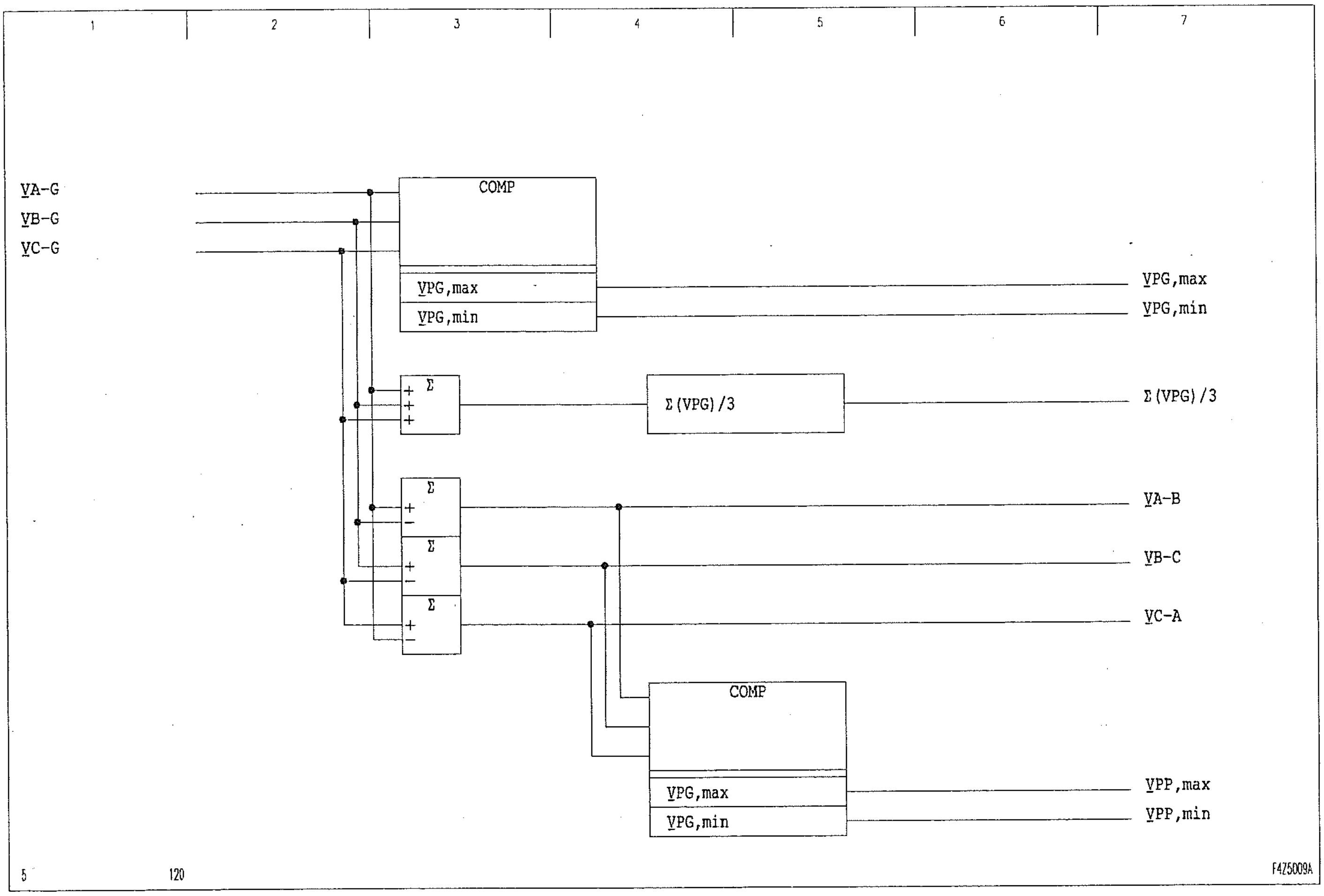
The stored maximum phase current follows the delayed maximum phase current. If the value of the delayed maximum phase current is declining, then the highest value of the delayed maximum phase current remains stored. The display remains constant until the actual delayed maximum phase current exceeds the value of the stored maximum phase current (see middle curve in Figure 3-28). 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 3-28).



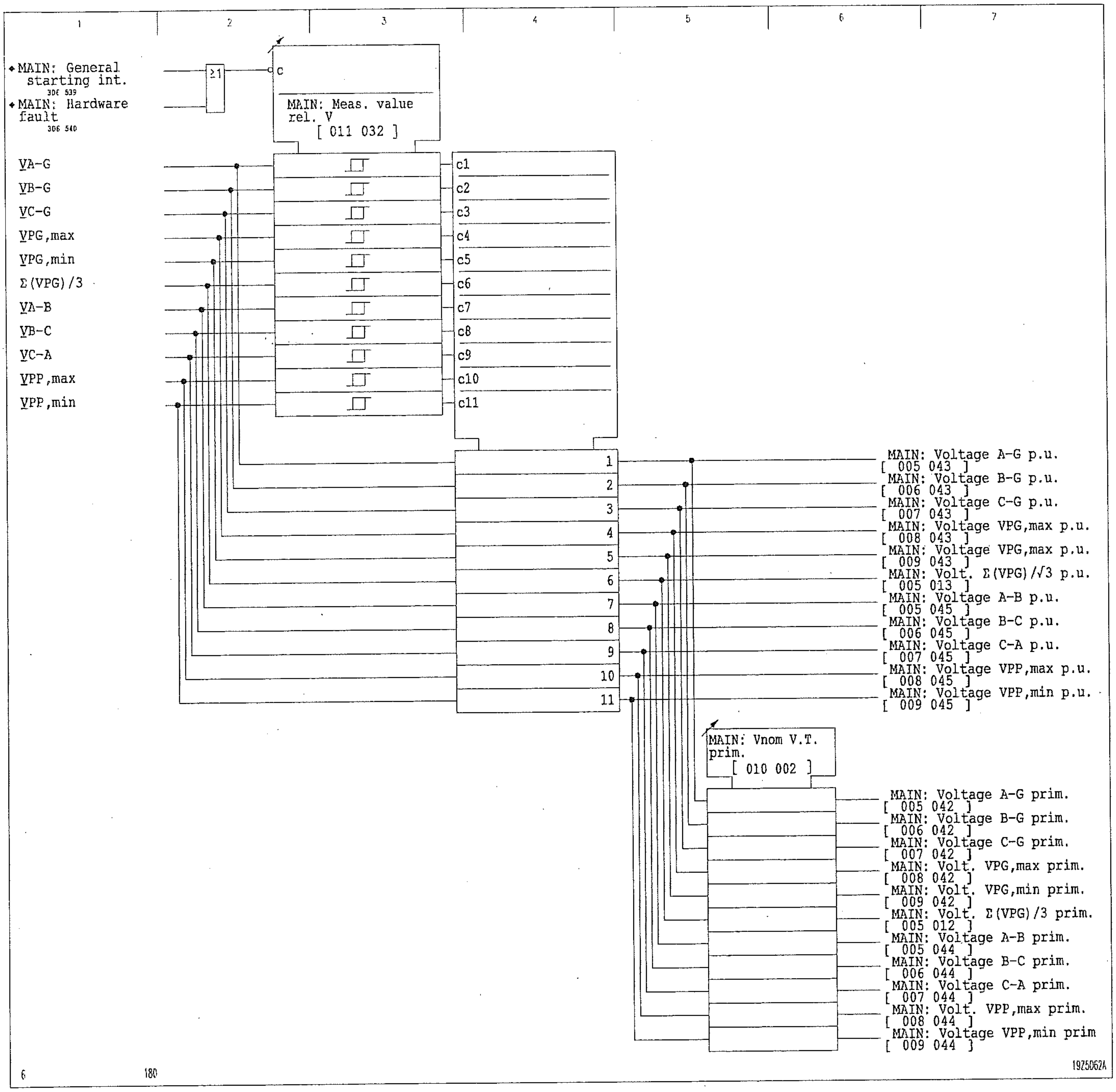
3-28 *Operation of delayed and stored maximum phase current display*

Measured voltage values

The measured voltage values are displayed both as per-unit quantities referred to the nominal quantities of the P130C 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 P130C.



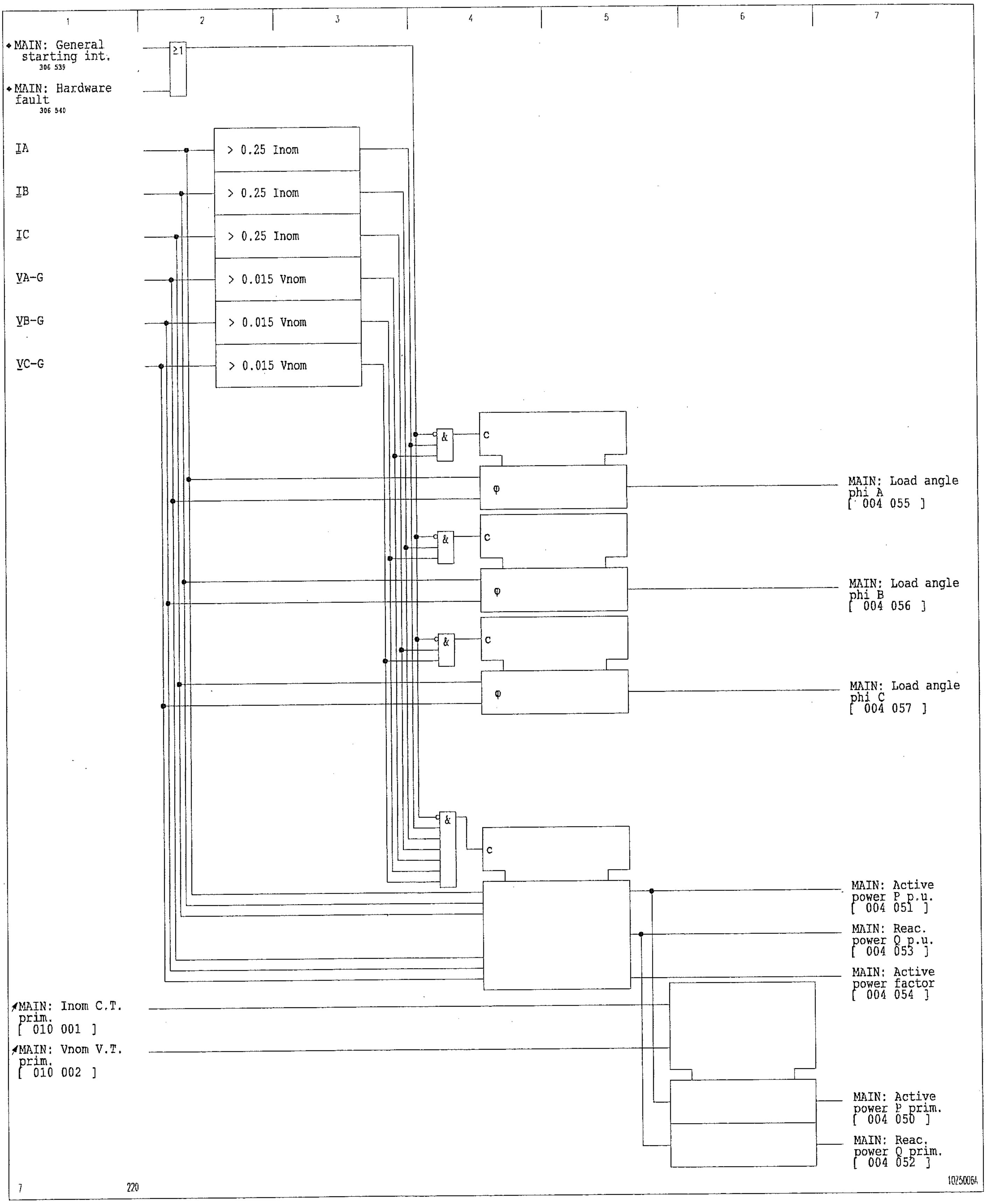
3-29 *Determining the minimum and maximum phase-to-ground and phase-to-phase voltages*



3-30 Measured operating data - phase-to-ground and phase-to-phase voltages

Measured values for power, active power factor, and angle

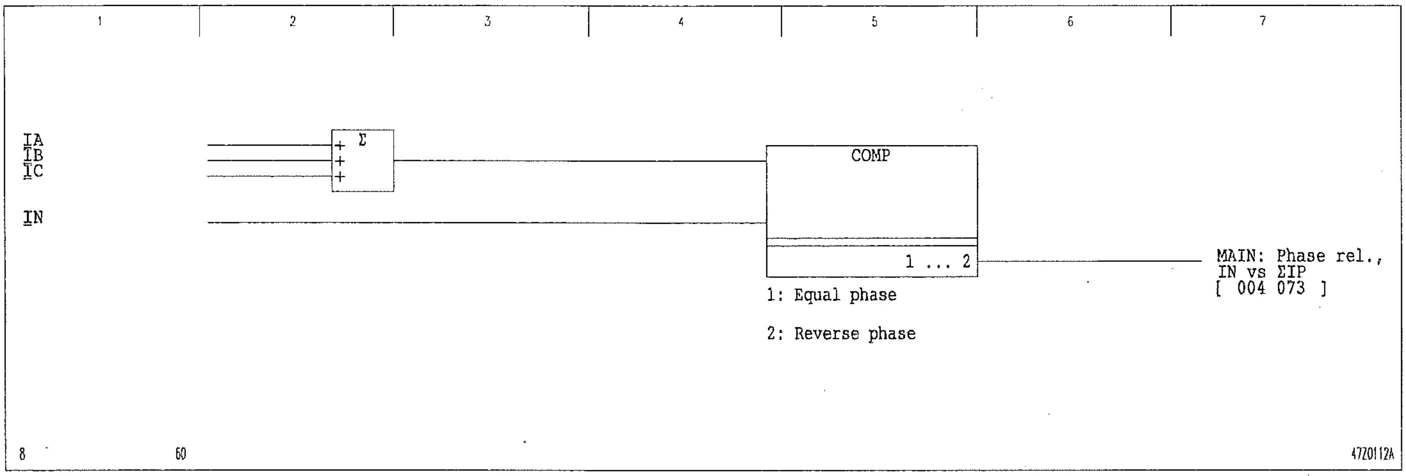
The active and reactive power and the active power factor are determined when currents and voltages in all three phases exceed minimum thresholds.



3-31 *Measured operating data - power, active power factor, and angle*

Phase relation I_N

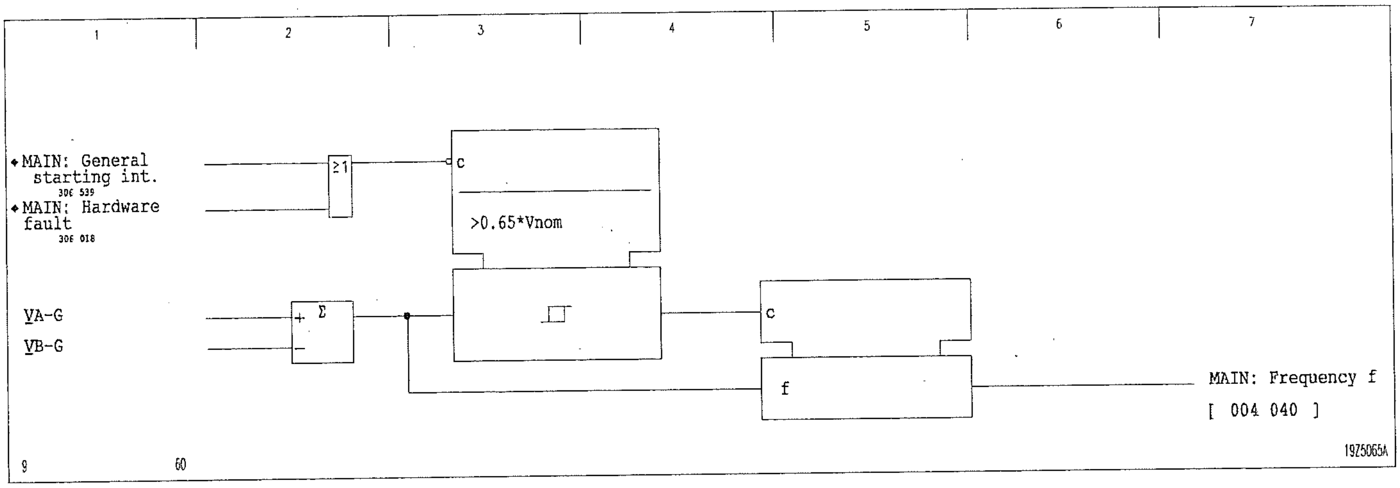
The P130C checks to determine whether the phase relations of calculated residual current and measured residual current agree. If the phase displacement between the two currents is ≤ 45°, then the indication '*Equal phase*' is displayed.



3-32 *Phase relation between calculated and measured residual current*

Frequency

The P130C determines the frequency from voltage $V_{A\text{-}B}$. The voltage needs to exceed a minimum threshold of 0.65 V_{nom} in order for frequency to be determined.



3-33 *Frequency measurement*

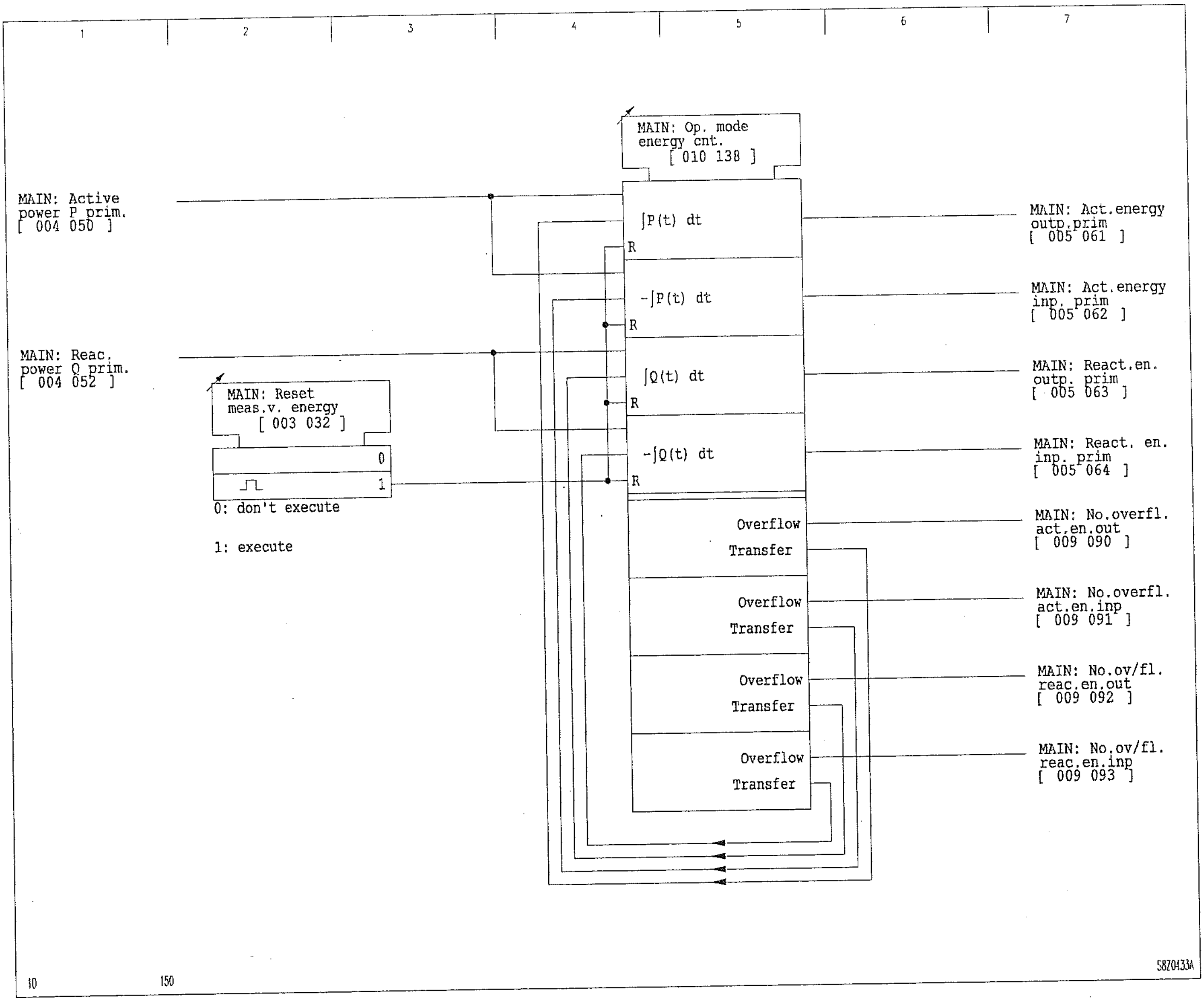
Active and reactive energy output and input

The P130C determines the active and reactive energy output and input based on the primary active or reactive power.

The user can choose between two procedures for the determination of the active and reactive energy. If procedure 1 is selected, active and reactive energy are determined every 2 s (approximately). If procedure 2 is selected, active and reactive energy are determined every 100 ms (approximately) thus achieving higher accuracy. Whenever the maximum value of 655.35 MWh or 655.35 Mvar h is exceeded, a counter is incremented and the determination of the energy output recommences. The value that exceeded the range is transferred to the new cycle.

^The total energy is calculated as follows:

Total energy = number of overflows * 655.35 + current count

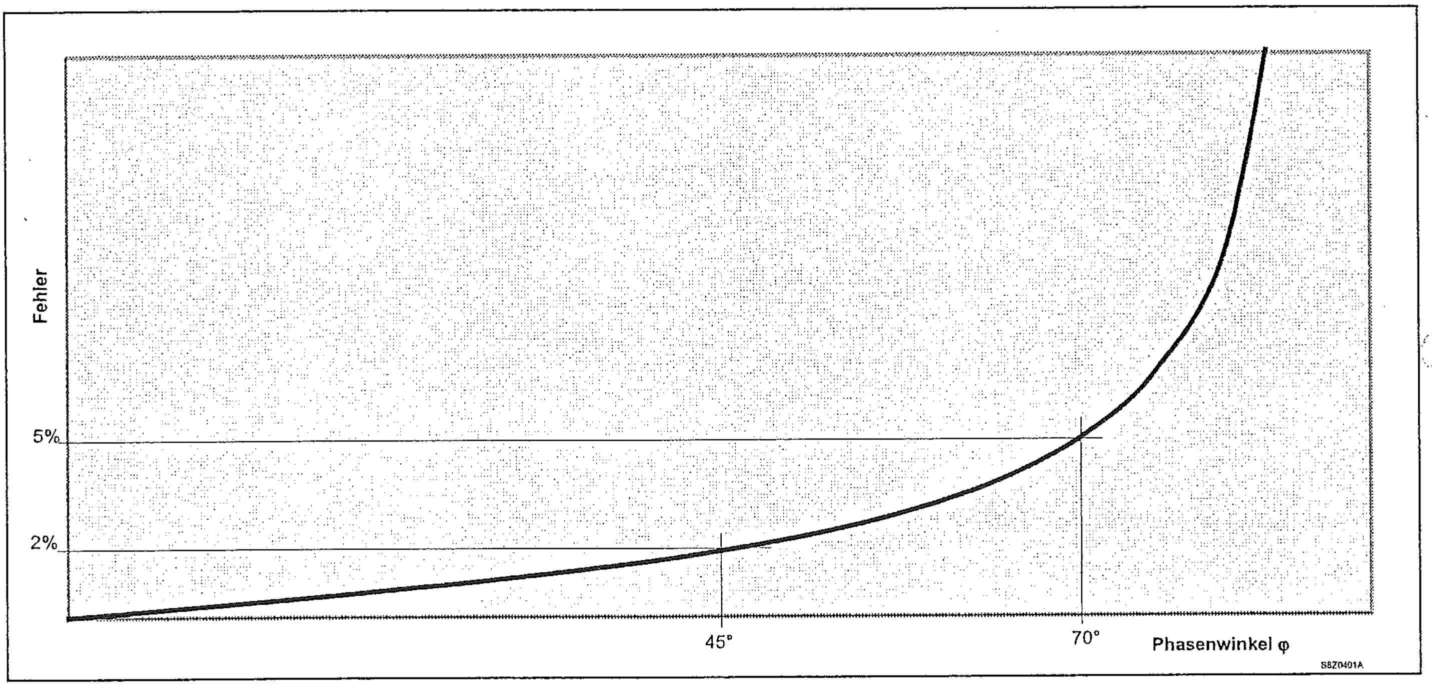


3-34 *Determining the active and reactive energy output and input*

Selection of the procedure for the determination of the energy output

Procedure	Characteristics	Applications
1	□ Determination of the active and reactive energy every 2 s (approximately) □ Reduced system loading	□ Constant load and slow load variations (no significant load variations within 1 second) □ Phase angles below 70° (cos φ > 0.3).
2	□ Determination of the active and reactive energy every 100 s (approximately) □ Higher system loading	□ Fast load variations □ Phase angles below 70° (cos φ > 0.3).

The maximum phase-angle error of the P139 is 1°. For high phase angles, an error of measurement needs to be taken into account. This error increases with the phase angle as shown in the following diagram.



3-35 *Error of measurement in the determination of energy output resulting from the phase-angle error of the P130C*

Error of measurement:

Approx. ± 2 % of the measured value for cos φ = ± 0.7

Approx. ± 5 % of the measured value for cos φ = ± 0.3

For phase angles in excess of 70° or when the error of measurement resulting from the maximum phase-angle error is not acceptable, external counters should be used to determine the energy output.

3.10.3 Configuring and Enabling the Protection 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.
- □ None of the functions of the device function to be canceled may be selected in a list parameter setting.

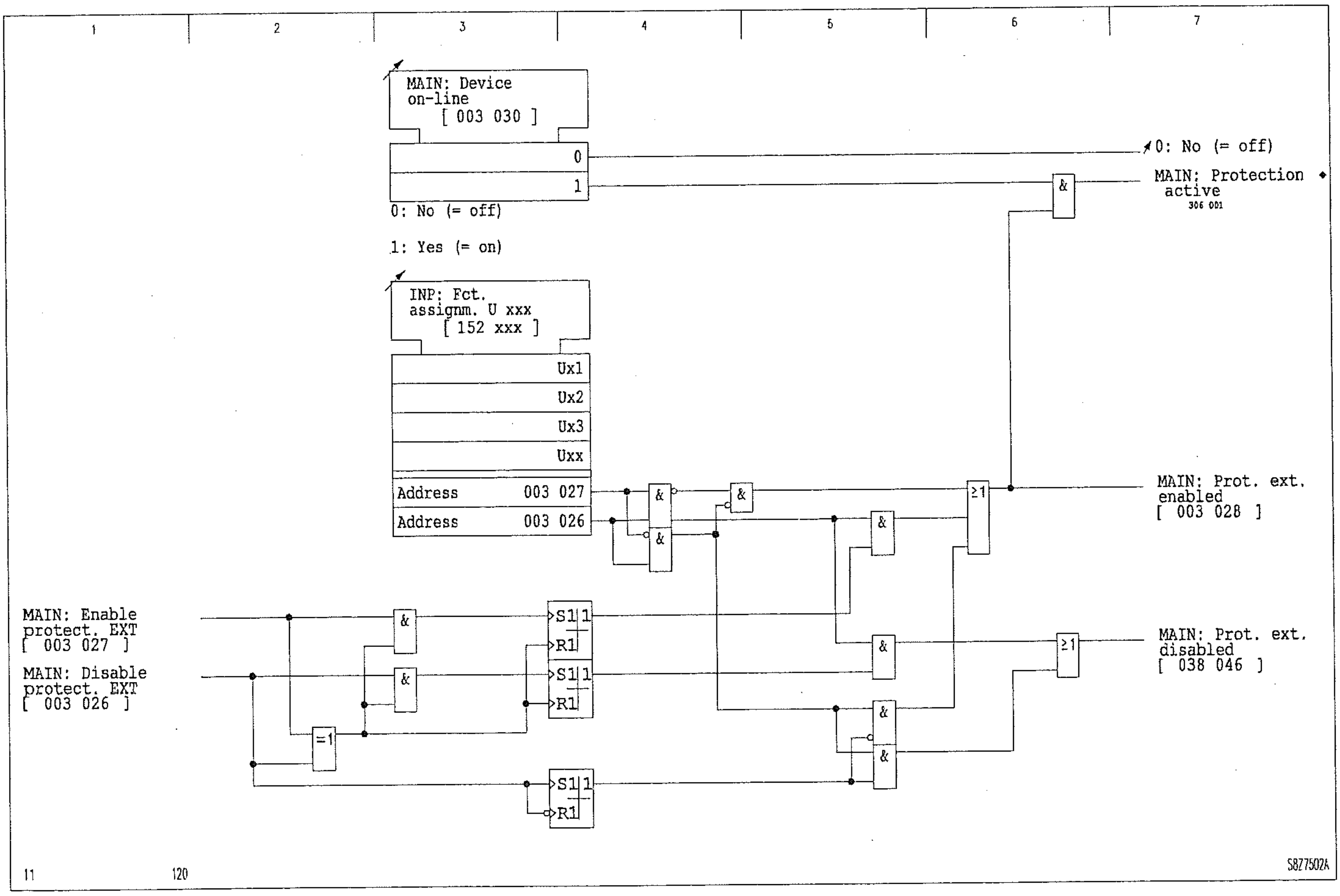
If the above conditions are met, proceed through the Configuration Parameters branch of the menu tree to access the setting parameters relevant for canceling device functions. If you wish to cancel the LIMIT function group, for example, access the setting parameter `LIMIT: Function group LIMIT` and set 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. Provided that the binary signal inputs MAIN: Disable protect. EXT and MAIN: Enable protect. EXT functions are both configured, the protection functions can be disabled or enabled through these. 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. If only MAIN: Disable protect. EXT is assigned to a binary signal input, the protection functions will be disabled by a positive edge of the input signal; they will be enabled by a negative edge. When only one or neither of the two functions is configured, this is interpreted as 'Protection externally enabled'.

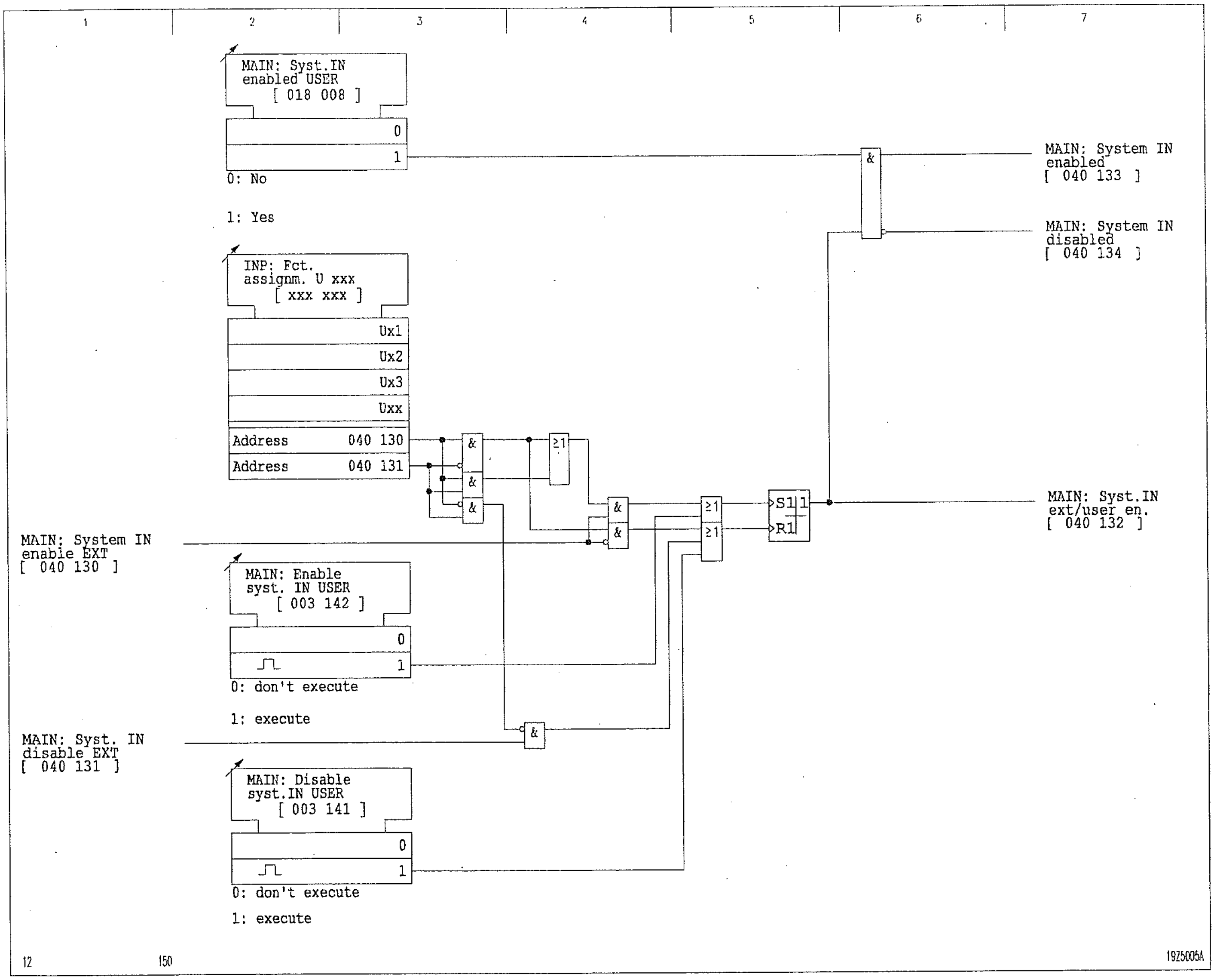
Note: If the protection function is disabled via the binary signal input that is configured for MAIN: Disable protect. EXT, then there is no MAIN: Blocked/faulty signal.
(The signal MAIN: Blocked/faulty is coupled to the activation of the LED labeled 'OUT OF SERVICE').



3-36 *Enabling or disabling a device function*

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

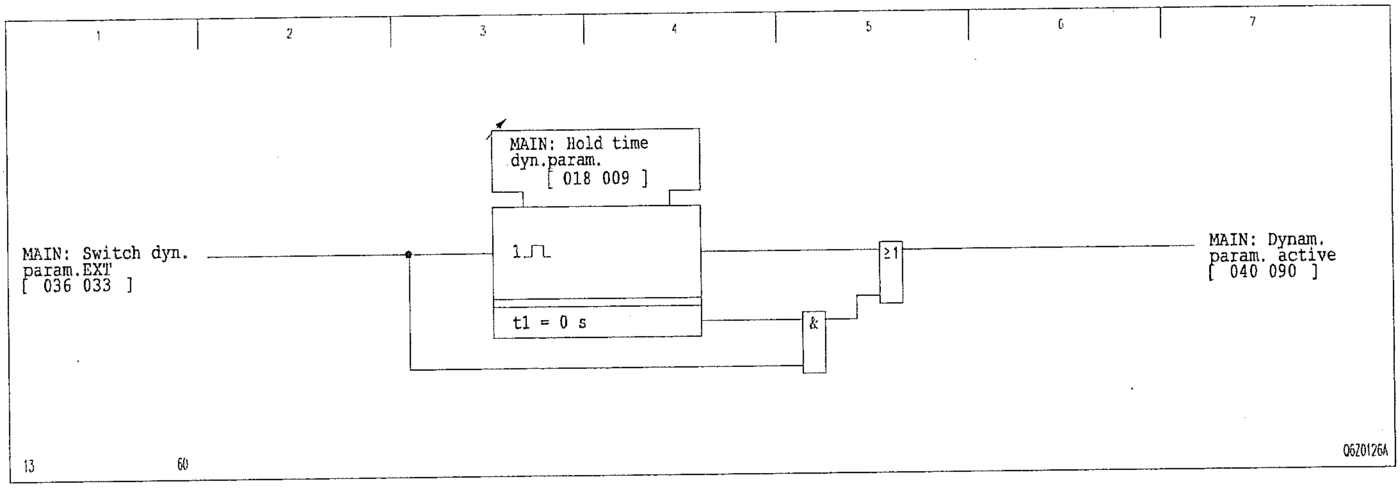
The function can be disabled or enabled from the integrated local control panel or through appropriately configured binary signal inputs. Whether the enabling of the residual current systems of the DTOC/IDMT protection by one of these two means is effective depends on the setting at MAIN: Syst.IN enabled 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.



3-37 *Enabling or disabling the residual current systems of the DTOC/IDMT protection*

3.10.4 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.



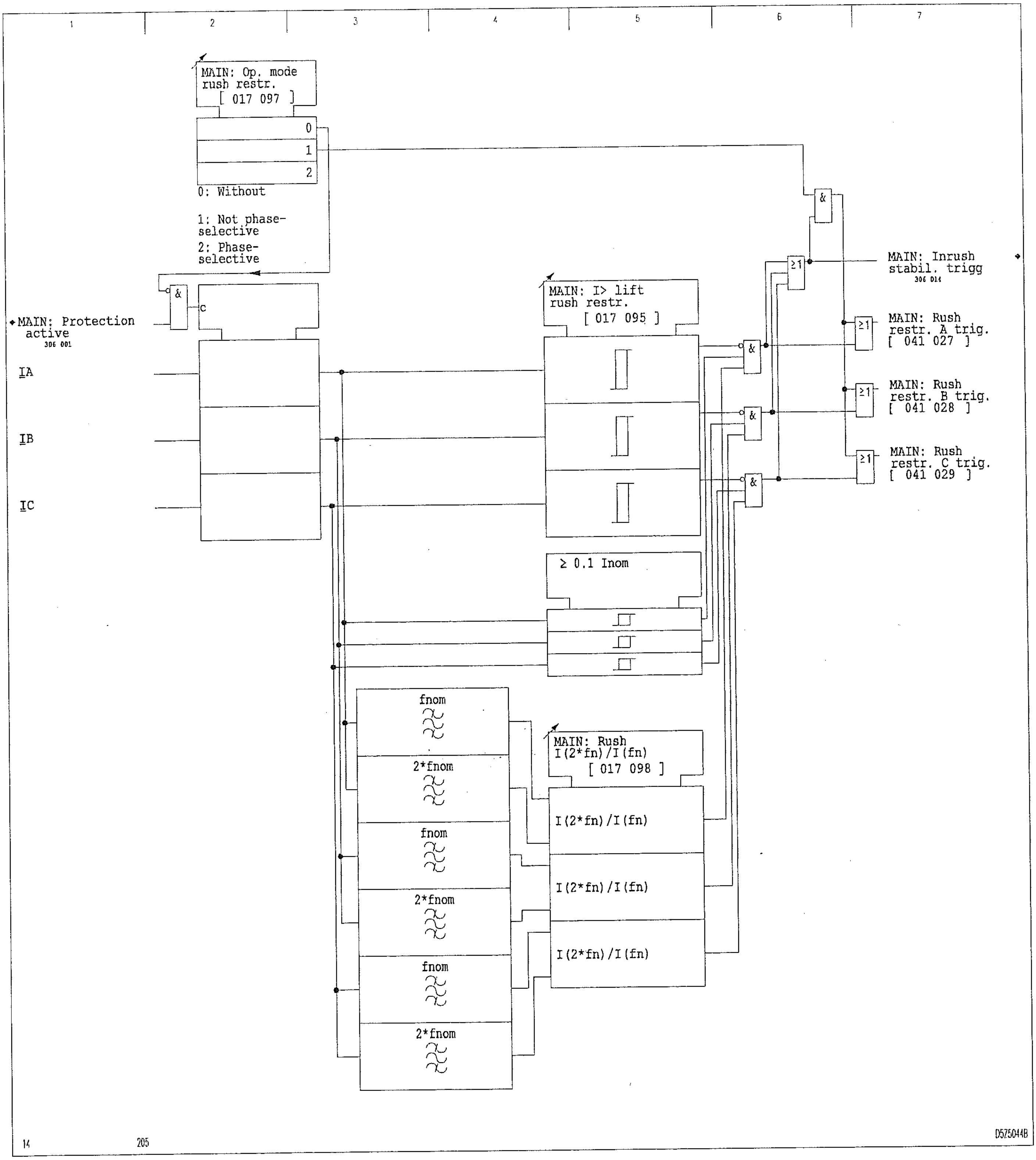
3-38 *Activation of dynamic parameters*

3.10.5 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)

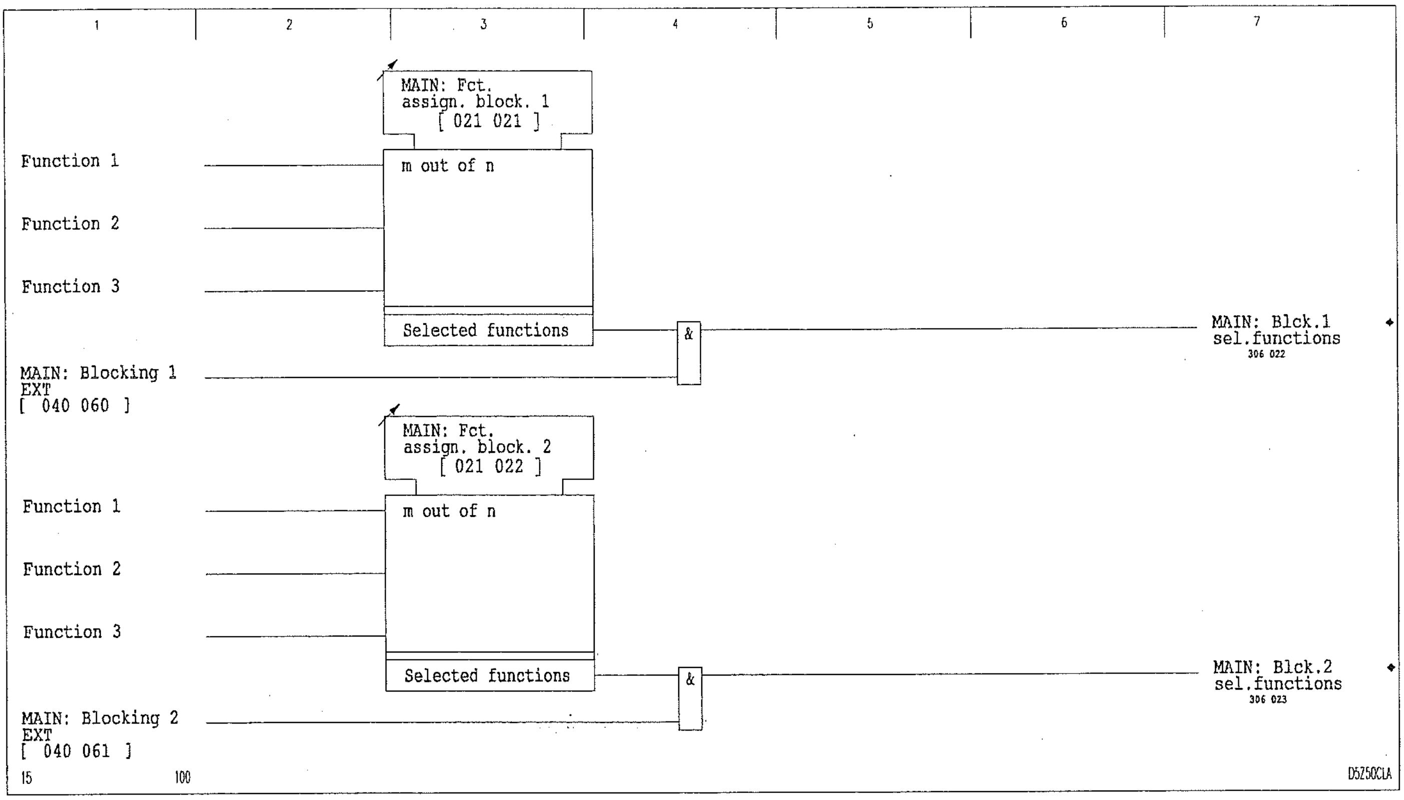
The inrush stabilization function identifies an inrush current by evaluating the ratio of the second harmonic current components to the fundamental wave. If this ratio exceeds the set threshold, then the inrush stabilization function operates. Another settable current trigger blocks inrush stabilization 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.



3-39 *Inrush stabilization (harmonic restraint)*

3.10.6 Multiple Blocking

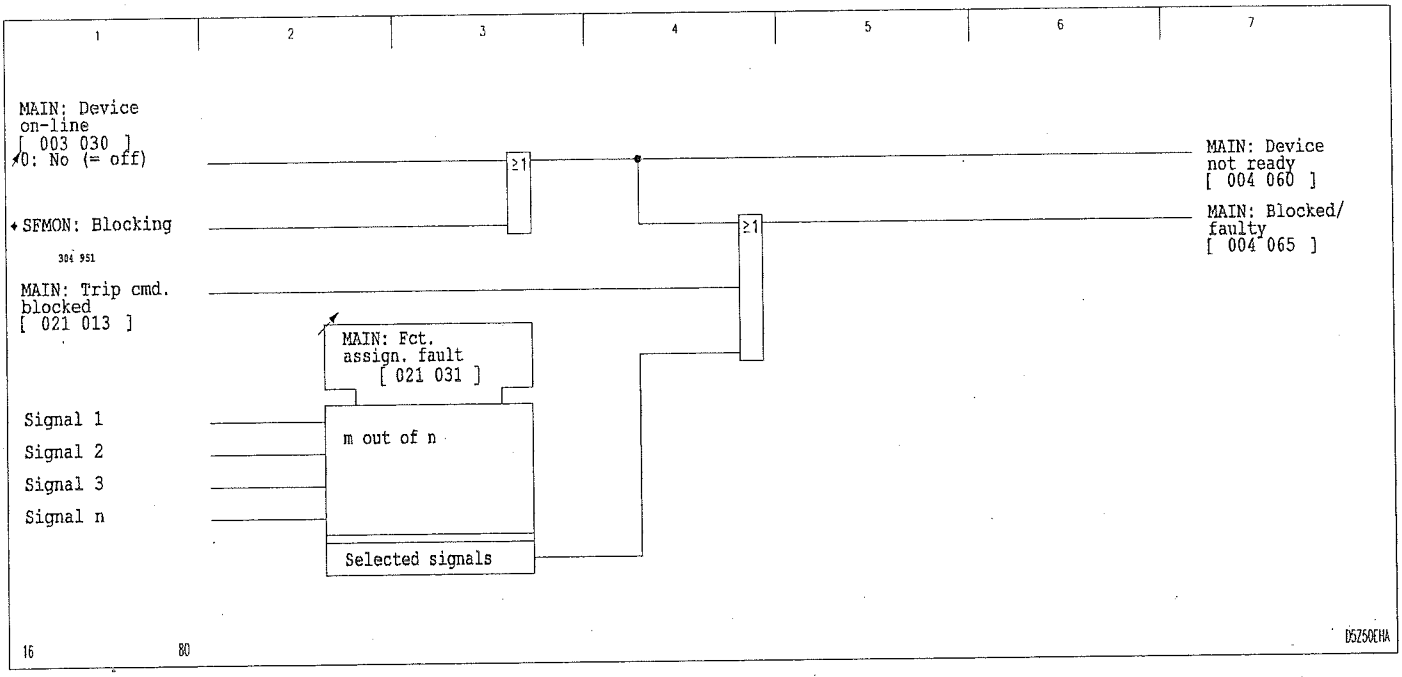
Two multiple blocking conditions may be defined by selecting 'm out of n' parameters. The items available for selection are found in the Address List. In this way the functions defined by the selection can be blocked by way of an appropriately configured binary signal input.



3-40 *Multiple blocking*

3.10.7 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').



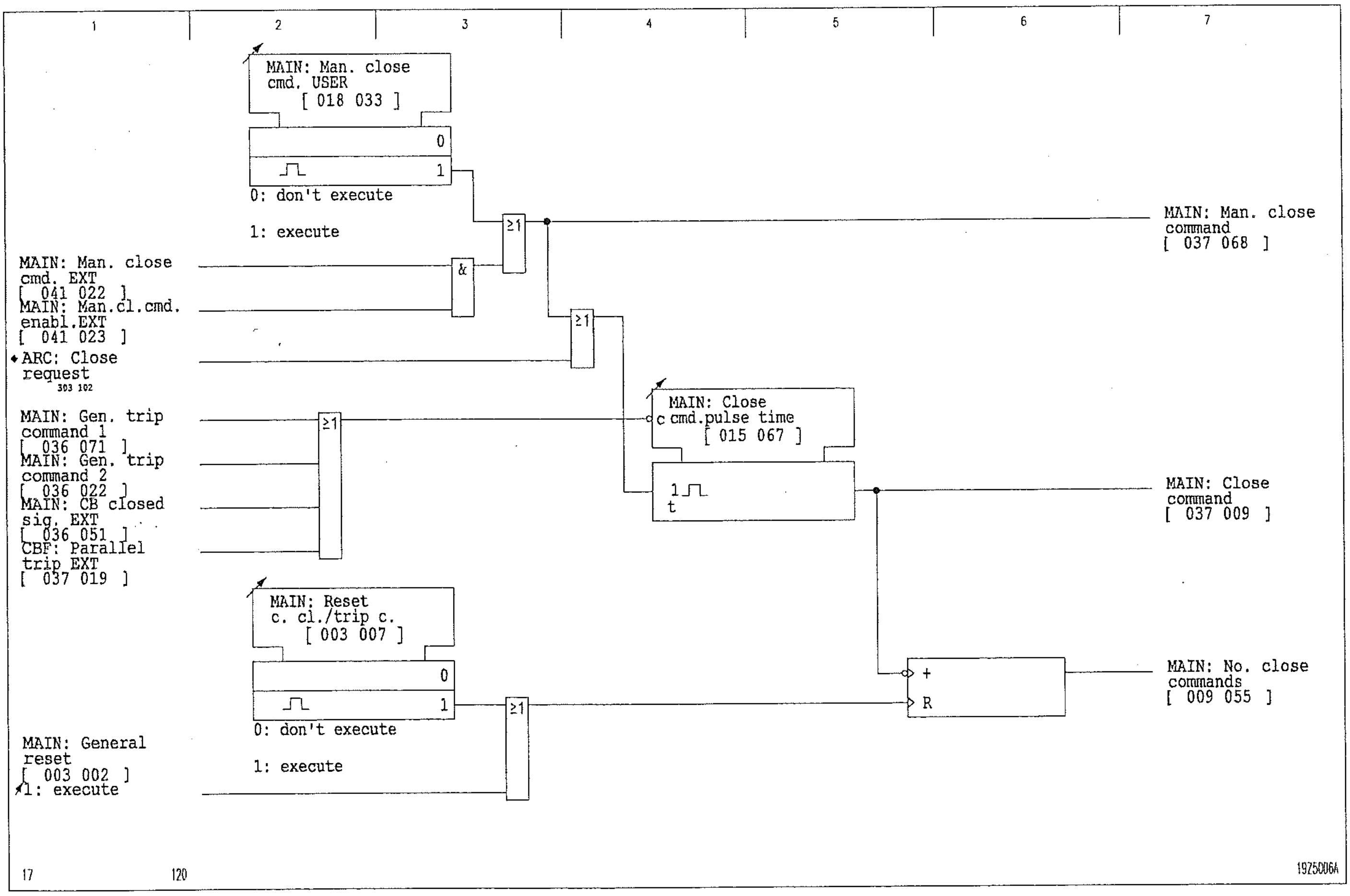
3-41 *'Blocked/faulty' signal*

3.10.8 Close Command

The circuit breaker can be closed by the auto-reclosing control function (ARC) integrated into the P130C, 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.

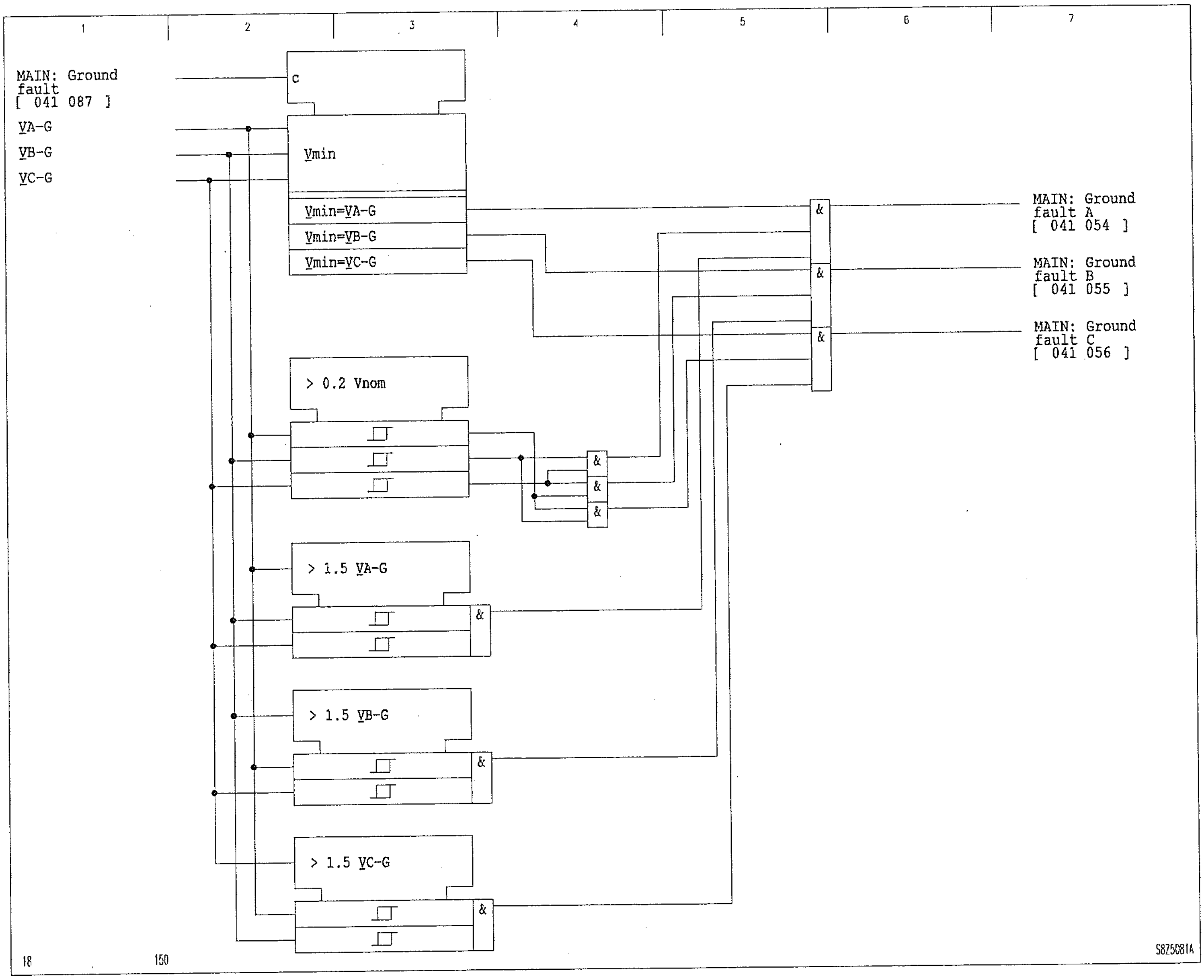


3-42 Close command

3.10.9 Ground Fault Signaling

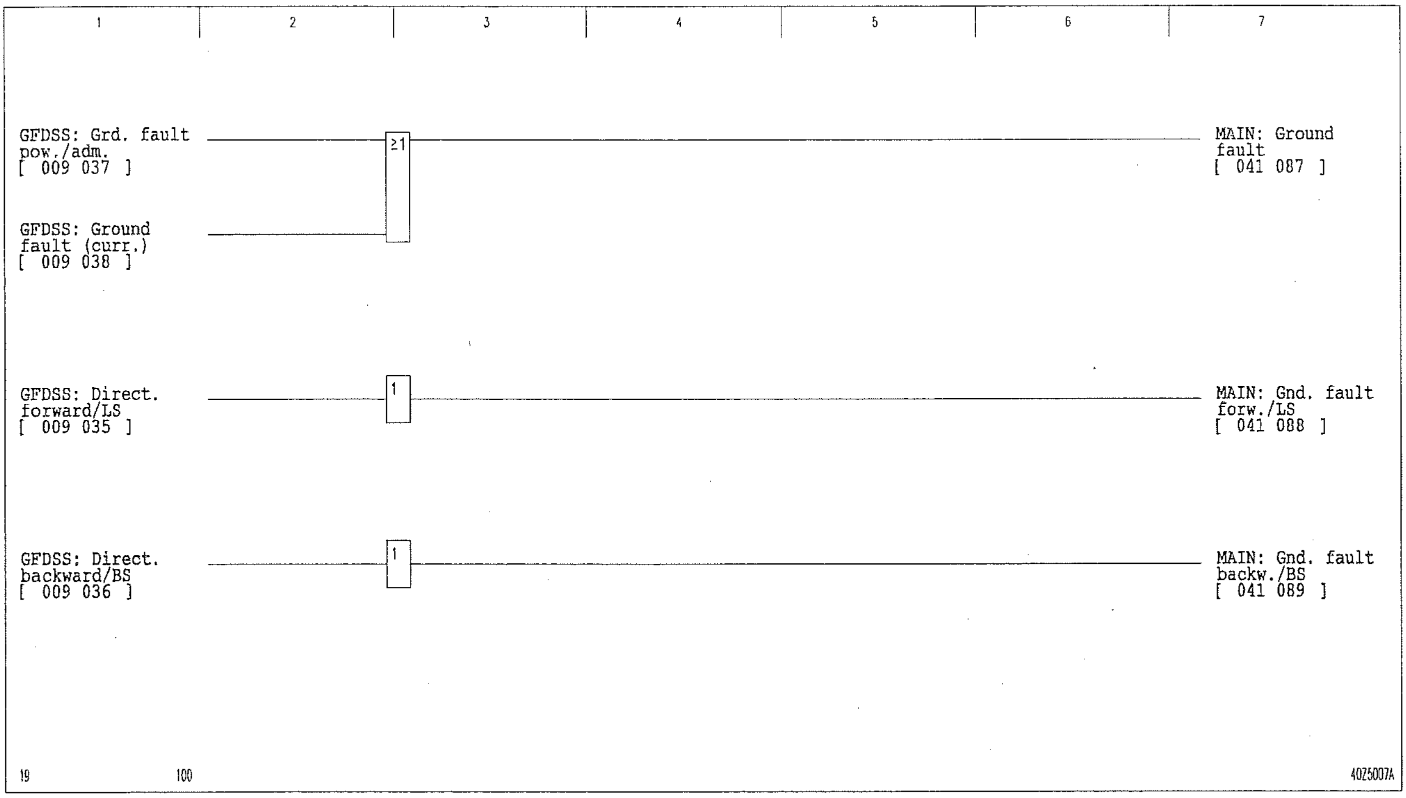
If a ground fault has been detected by either the GFDSS function (ground fault direction determination by steady-state values), the P130C analyzes the phase-to-ground voltages and identifies the phase where the ground fault is located.

During a ground fault, the P130C determines the lowest phase-to-ground voltage and checks to determine if the two other phase-to-ground voltages exceed the threshold of 0.2 V_{nom}. In addition, the two higher phase-to-ground voltages must exceed the lowest phase-to-ground voltage by a factor of 1.5. If these conditions are met, a ground fault signal is issued for the phase with the lowest phase-to-ground voltage.



3-43 *Phase-selective ground fault signaling*

Ground fault signals generated either by ground fault direction determination using steady-state values (GFDSS) are grouped together to form multiple signals.



3-44 Multiple ground fault signals

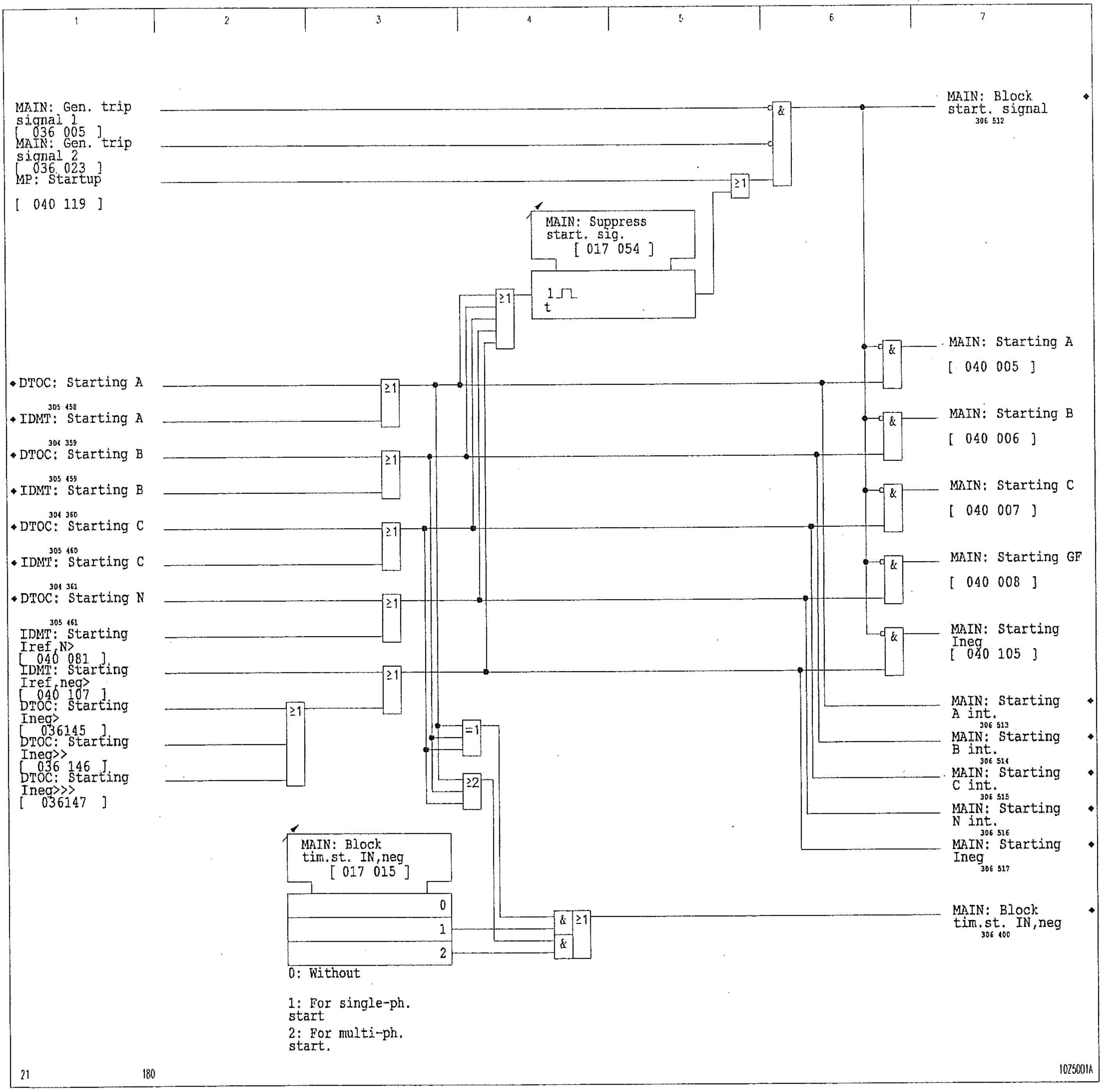
3.10.10 Starting Signals and Tripping Logic

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.

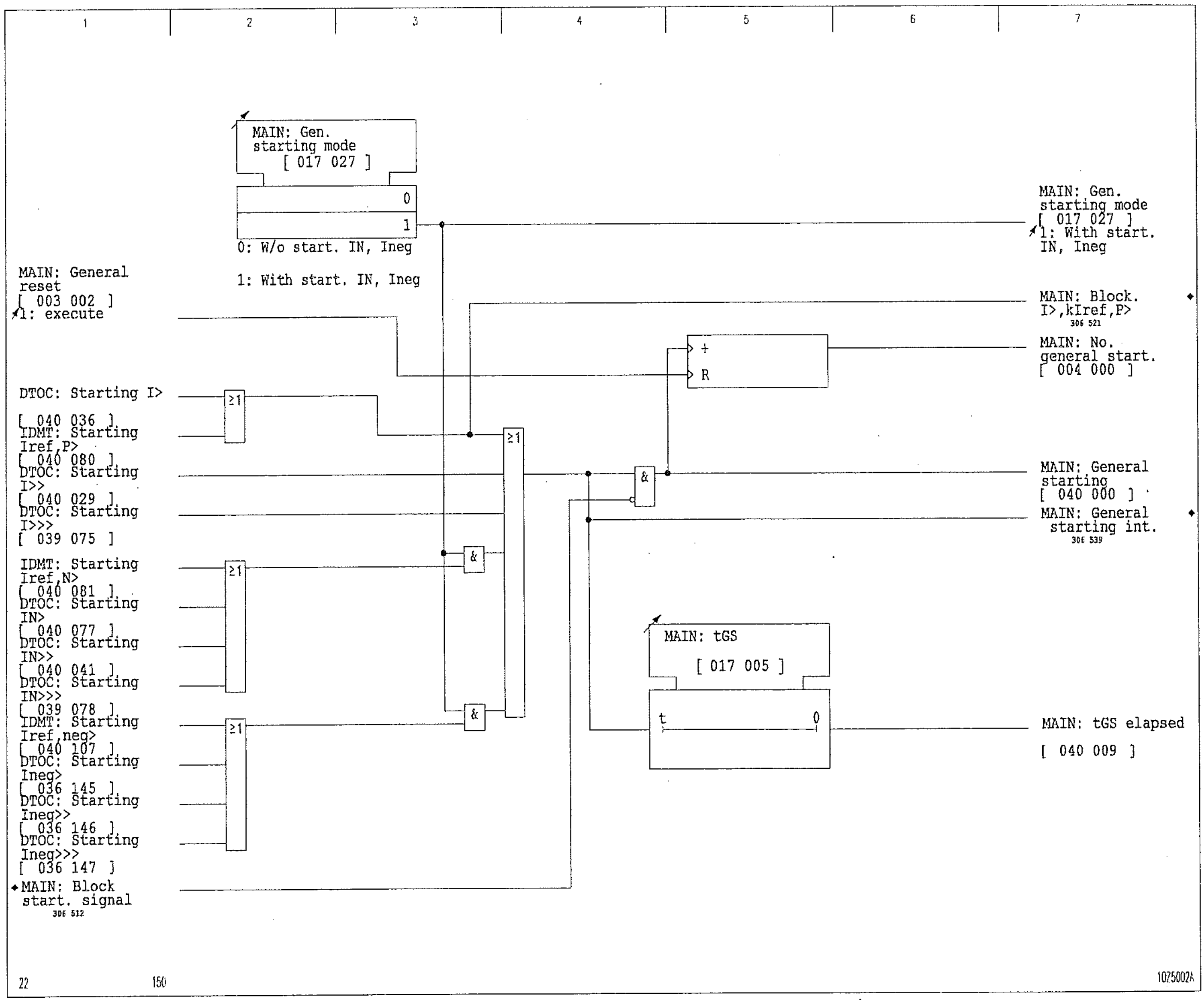
The operate delays of the residual current and negative-sequence current stages of the DTOC and IDMT protection functions can be blocked for a single-pole or multipole starting (depending on the setting).



3-45 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.



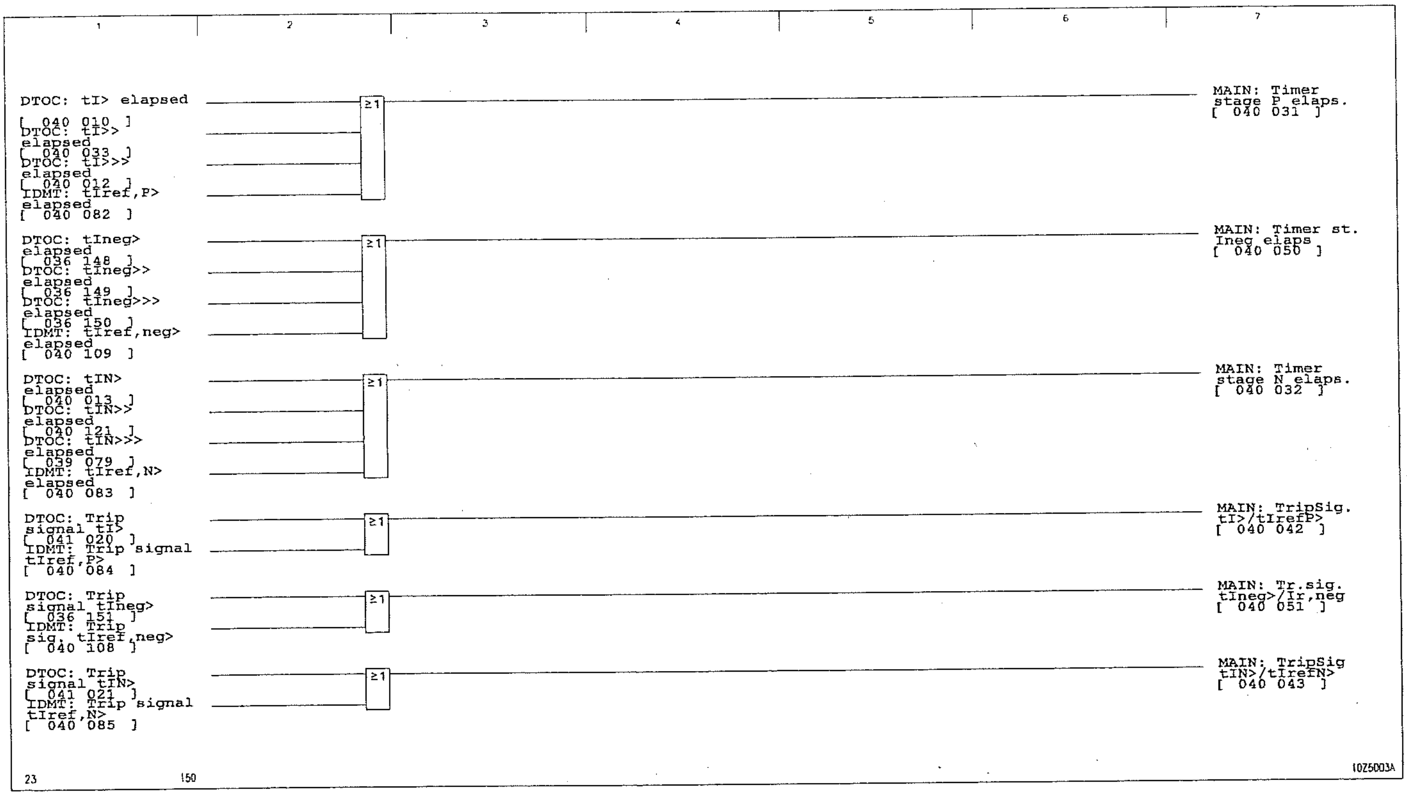
3-46 *General starting*

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.



3-47 *Multiple signaling of the DTOC and IDMT protection functions*

Trip command

The P130C 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

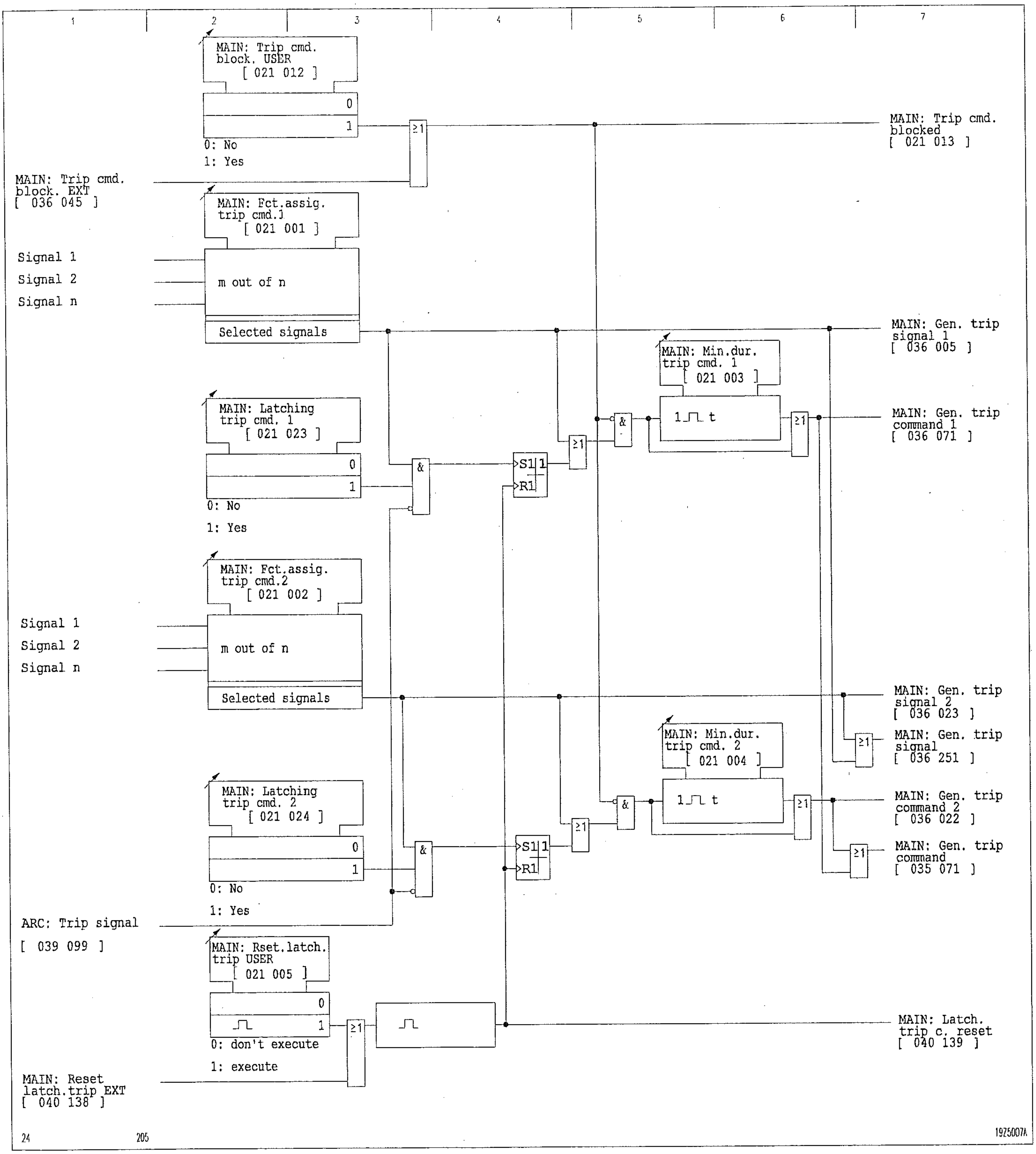
For each of the two trip commands, the user can specify by way of the appropriate setting whether it will operate in latching mode. If the latching mode is selected, the trip command persists until it is reset from the local control panel or via an appropriately configured binary signal. Latching is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

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

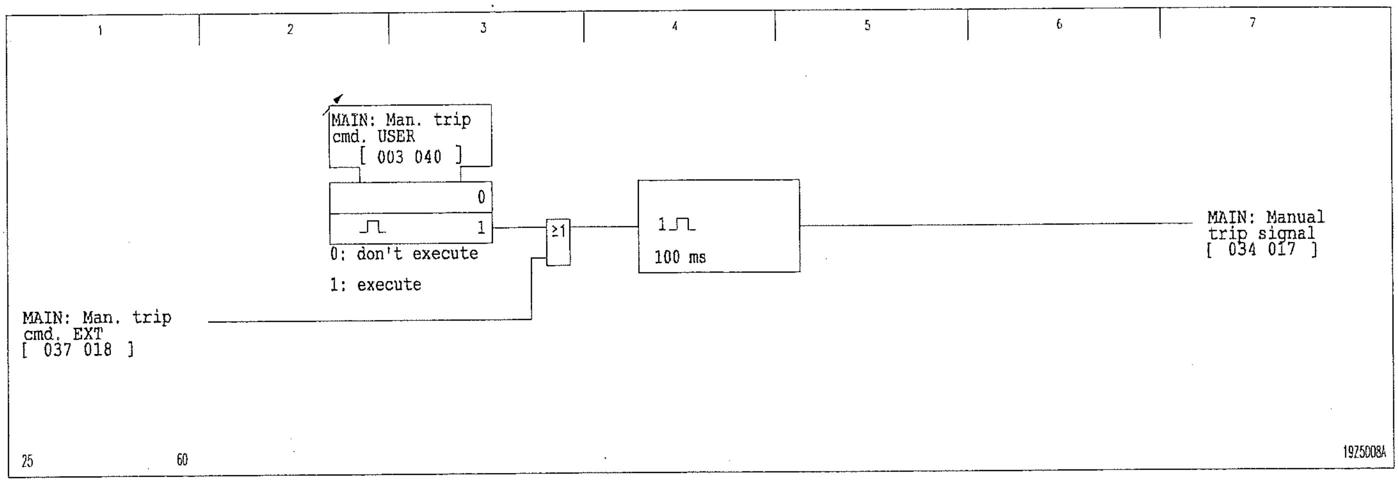
The trip commands are counted. The counters can be reset either individually or as a group.



3-48 *Forming the trip commands*

Manual trip command

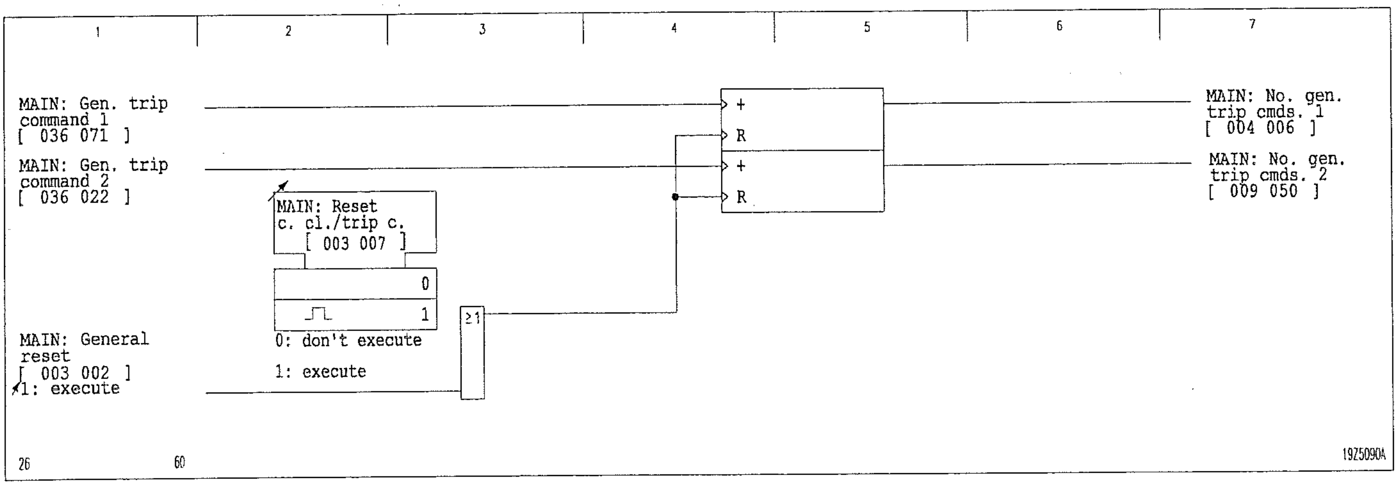
A manual trip command may be issued via the local control panel or a signal input configured accordingly. It is not executed, however, unless the manual trip is included in the selection of possible functions to effect a trip.



3-49 *Manual trip command*

Trip command counter

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

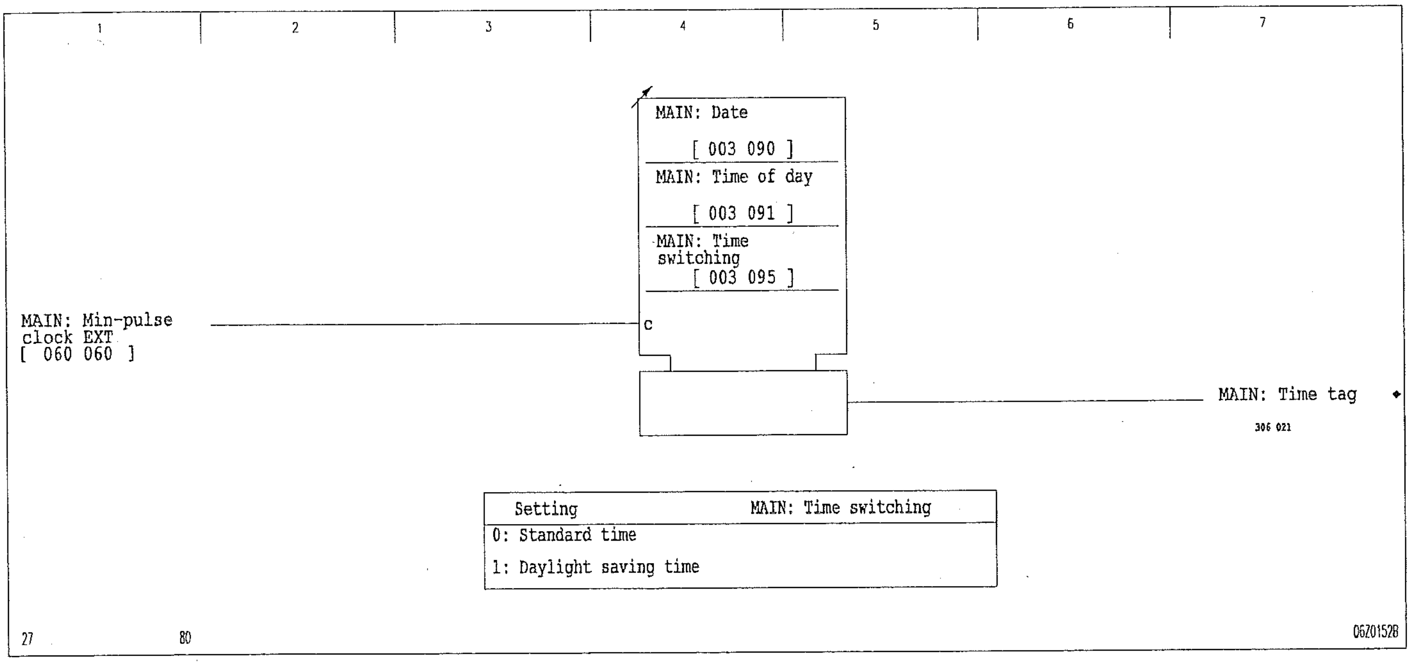


3-50 *Trip command counter*

3.10.11 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 P130C.

The time of different devices may be synchronized by a pulse through an appropriately configured binary signal input. The P130C 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.



3-51 *Date and time setting and clock synchronization*

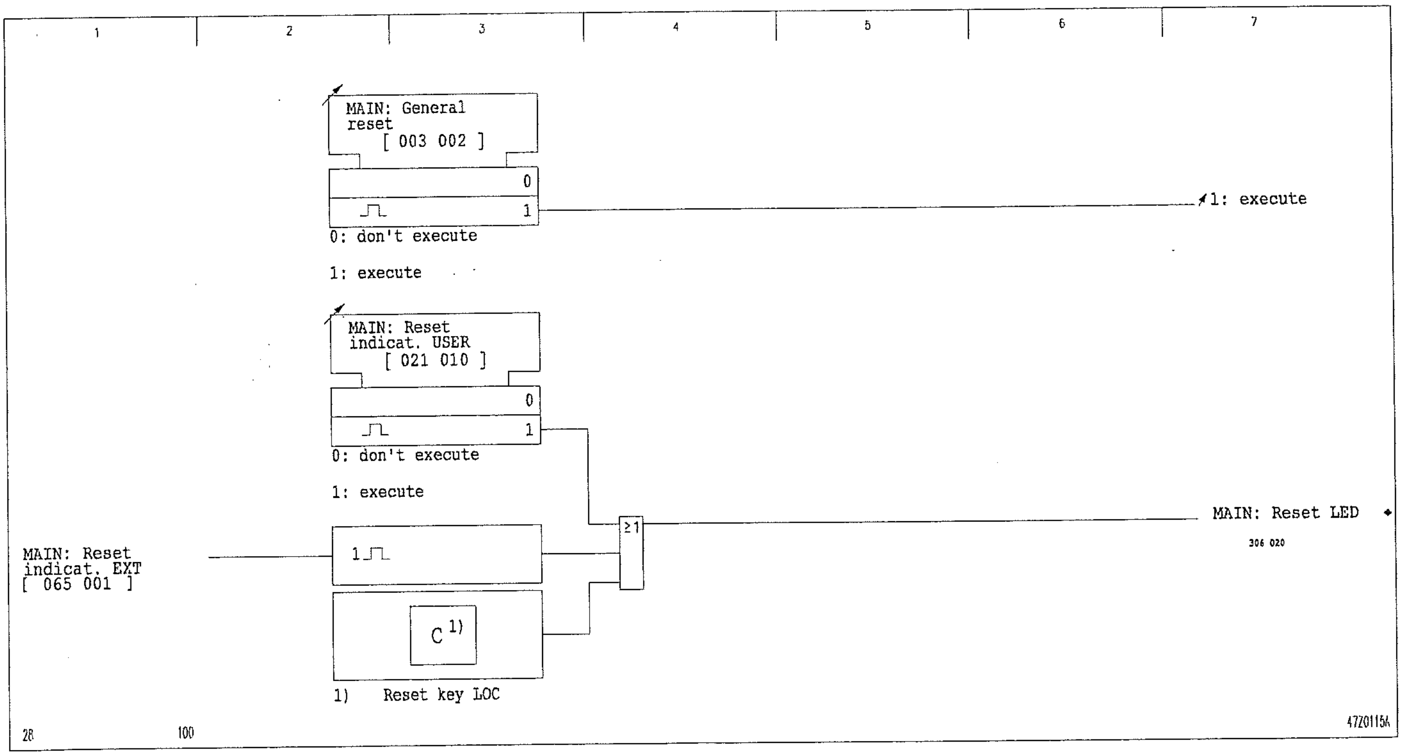
3.10.12 Resetting Mechanisms

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.

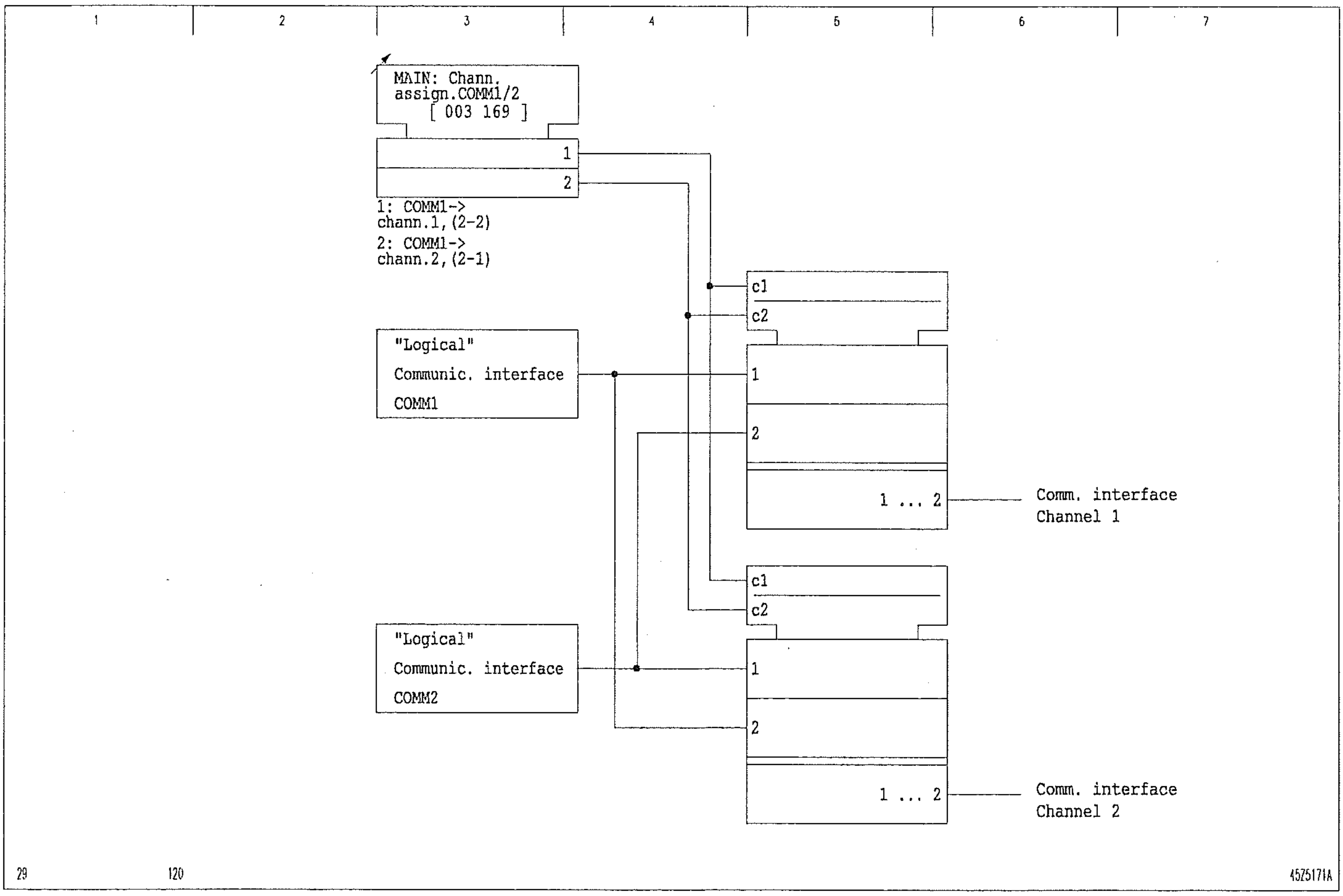


3-52 *General reset, LED reset, and measured fault data reset from the local control panel*

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

Depending on the design version of communication module A, 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.

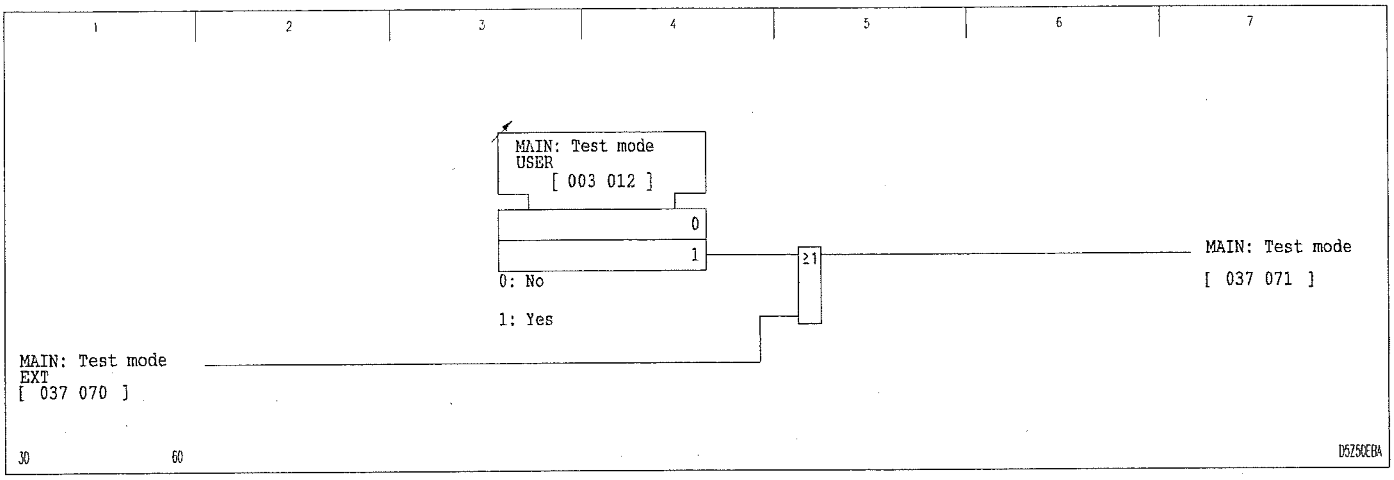
If the COMM1 "logical" communication interface has been assigned to communication channel 2, then this means that the settings for "logical" communication interface 2 (COMM2) will automatically be active for communication channel 1. Communication with the P130C via communication channel 2 is only possible when the PC interface is inactive. As soon as communication occurs through the PC interface, communication channel 2 is "dead".



3-64-a *Assignment of the “logical” communication interfaces to the physical communication channels*

3.10.14 Test Mode

If tests are run on the P130C, the user is advised to activate the test mode so that all incoming signals via the serial interfaces will be identified accordingly.



3-65 *Setting the test mode*

3.11 Parameter Subset Selection (Function Group PSS)

The P130C 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.

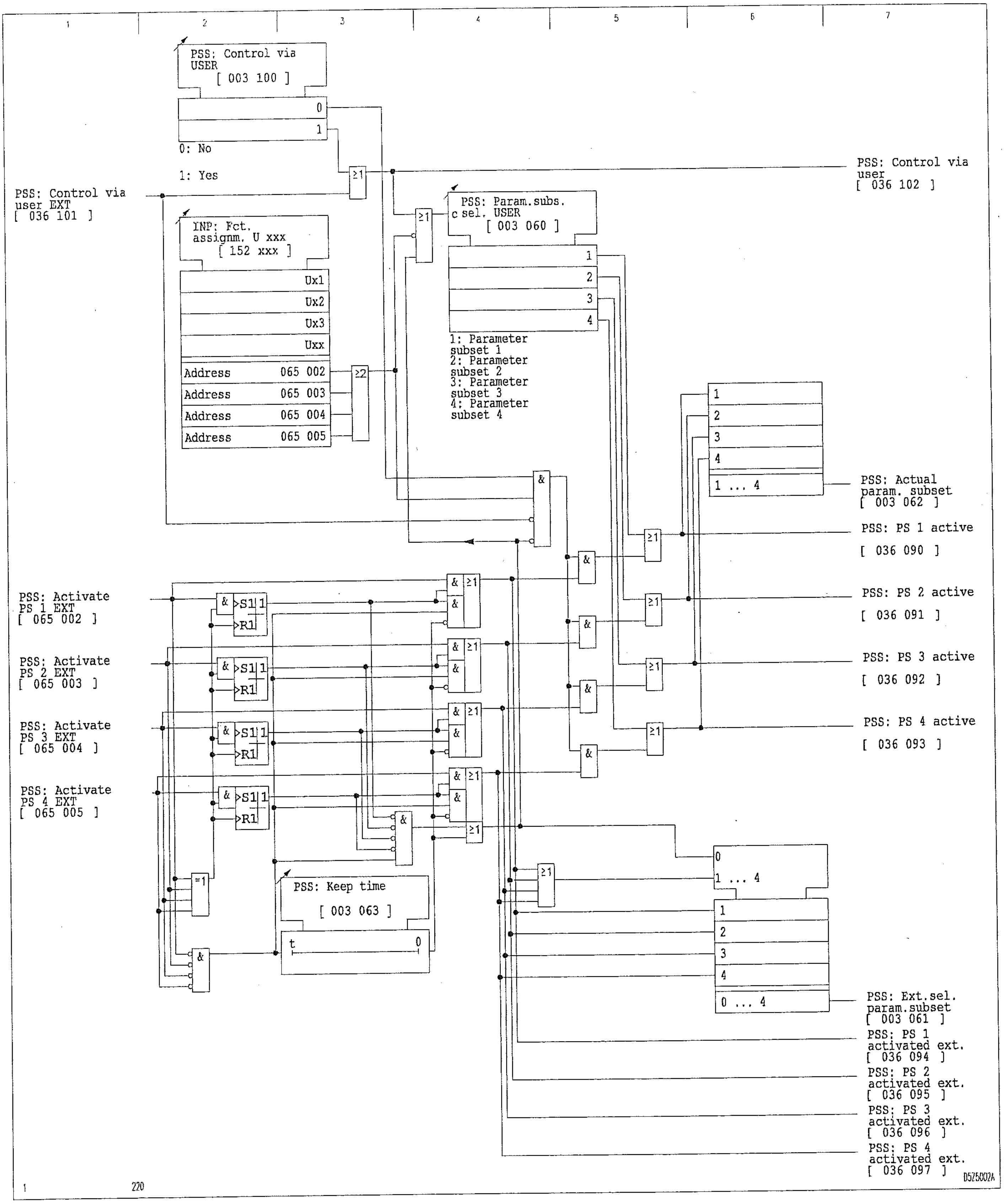
Selecting the parameter subset via binary inputs

If the binary signal inputs are to be used for parameter subset selection, then the P130C 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 P130C 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.



3-55 *Activating the parameter subsets*

3.12 Self-Monitoring (Function Group SFMON)

Comprehensive monitoring routines in the P130C 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 P130C. If the P130C 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 P130C can only be initiated by turning the supply voltage off and then on again.

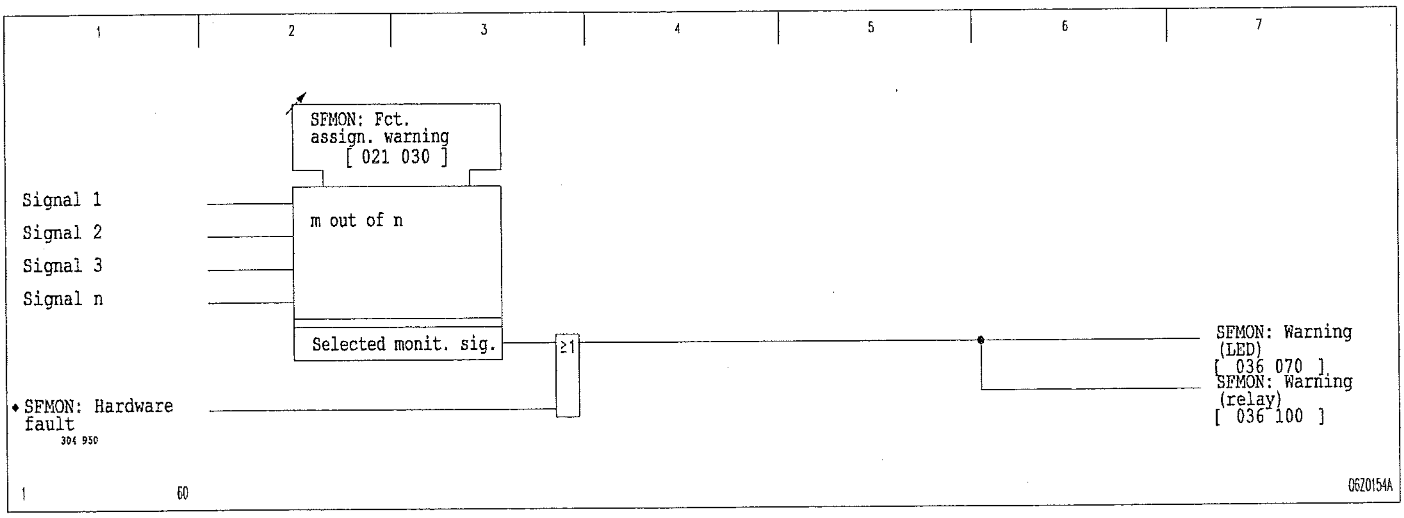
Cyclic tests

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).

The self-monitoring function monitors the built-in battery for any drop below the minimum acceptable voltage level. If the associated monitoring signal is displayed, then the battery should be replaced within a month, since otherwise there is the danger of data loss if the supply voltage should fail. Chapter 11 gives further instructions on battery replacement.

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.



3-56 *Monitoring signals*

Device response

The response of the P130C is a function of the type of monitoring signal. The following responses are possible:

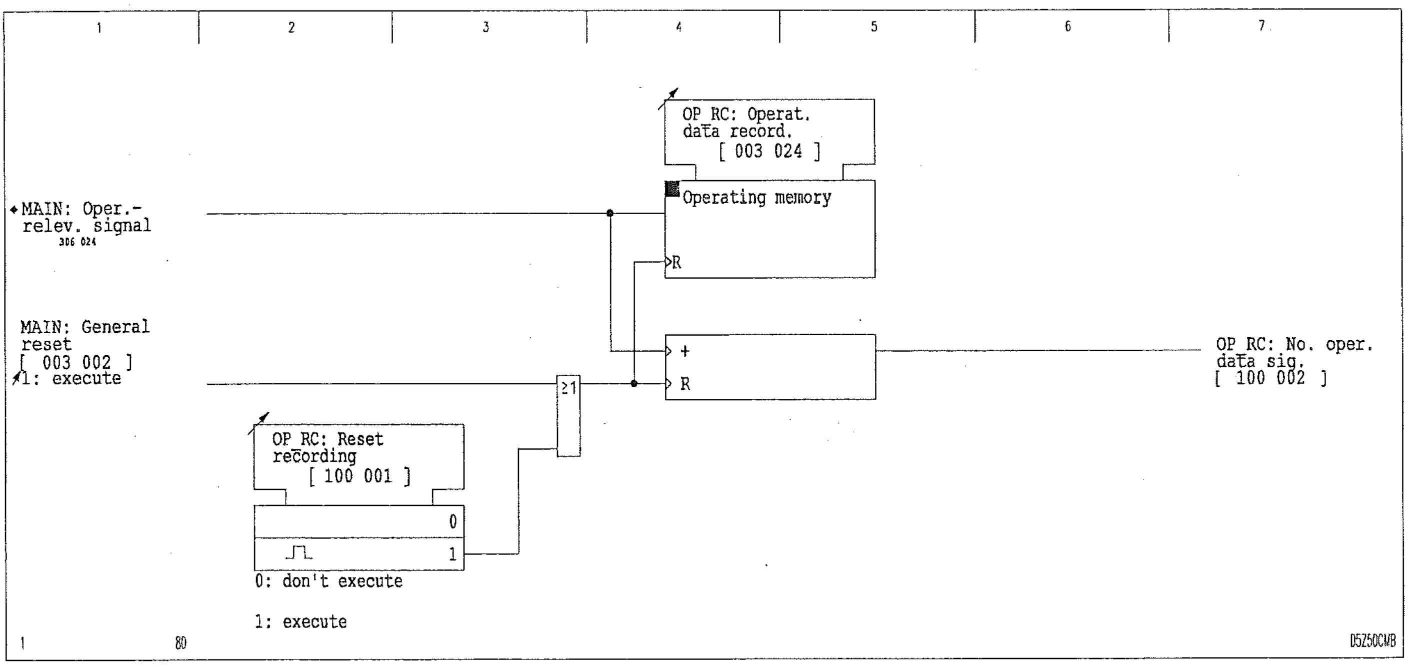
- ☐ Signaling Only
  If there is no malfunction associated with the monitoring signal, then only a signal is issued, and there are no further consequences. This situation exists, for example, when internal data acquisition memories overflow.
- ☐ Selective Blocking
  If a fault is diagnosed solely in 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.

3.13 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.



3-57 Operating data recording and counter for signals relevant to system operation

3.14 Monitoring Signal Recording (Function Group MT_RC)

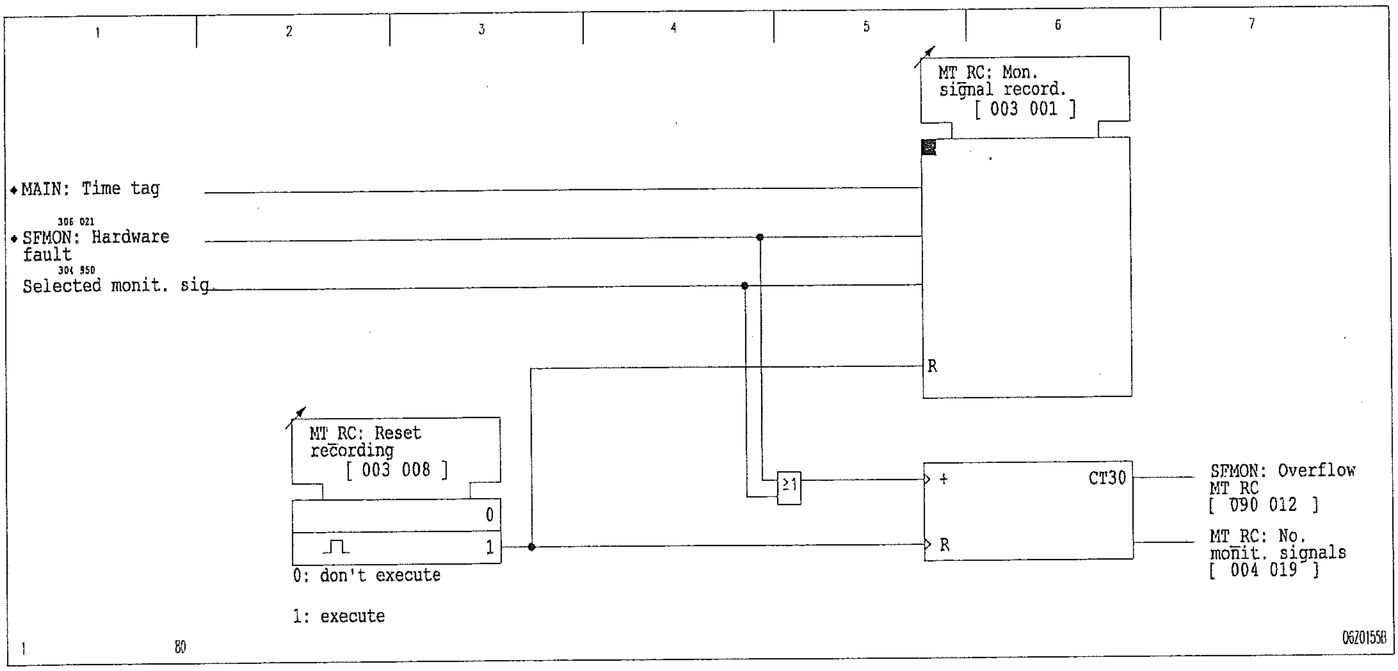
The monitoring signals generated by the self-monitoring function are recorded in the monitoring signal memory. A listing of all possible entries in this monitoring signal memory is given in the address list (see Appendix). The memory depth allows for a maximum of 30 entries. If more than 29 monitoring 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).

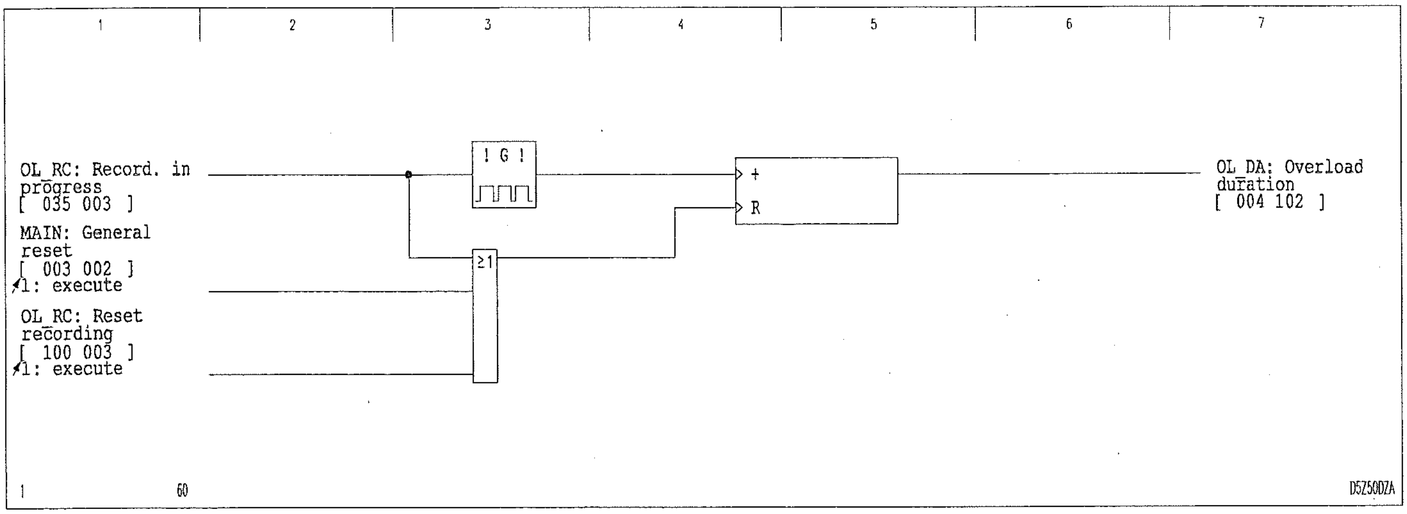


3-58 *Monitoring signal recording and the monitoring signal counter*

3.15 Overload Data Acquisition (Function Group OL_DA)

Overload duration

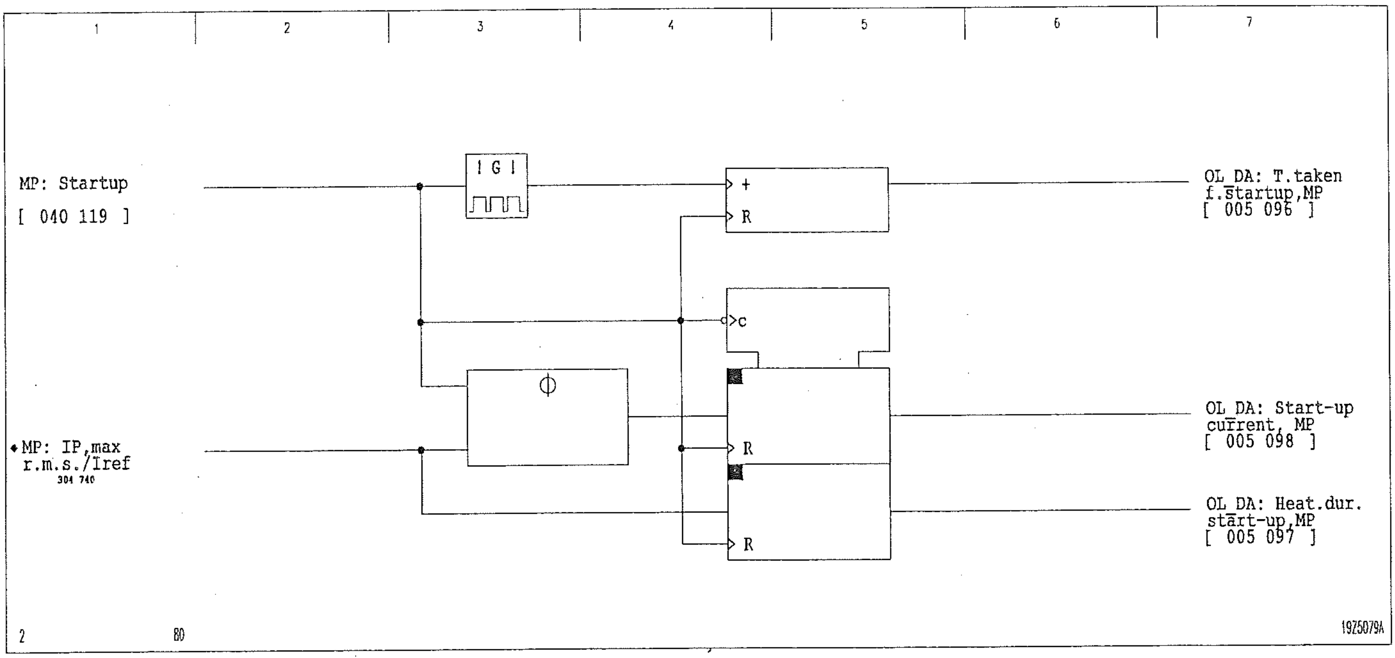
In the event of an overload, the P130C determines the overload duration. The overload duration is defined as the time between the start and end of the OL_RC: Record. in progress signal.



3-59 *Overload duration*

Acquisition of measured overload data by the motor protection function

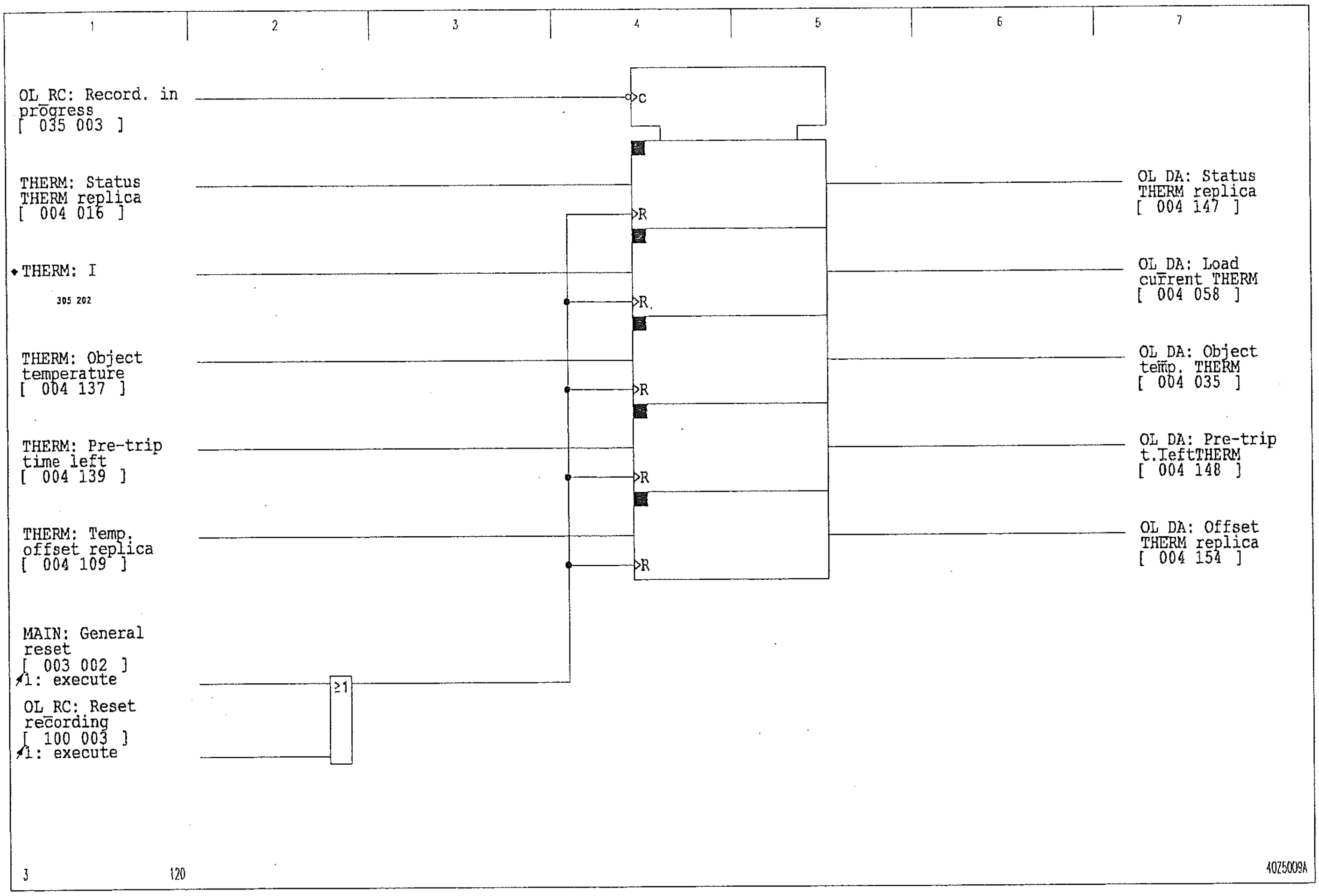
During motor startup, the measured data for the startup time, the maximum startup current and the startup heating are determined and stored at the end of the startup process.



3-60 *Measured overload data of the motor protection function*

Acquisition of the measured overload data of thermal overload protection

The measured overload data are derived from the measured operating data of the thermal overload protection function. They are stored at the end of the overload event.



3-61 *Measured overload data of thermal overload protection*

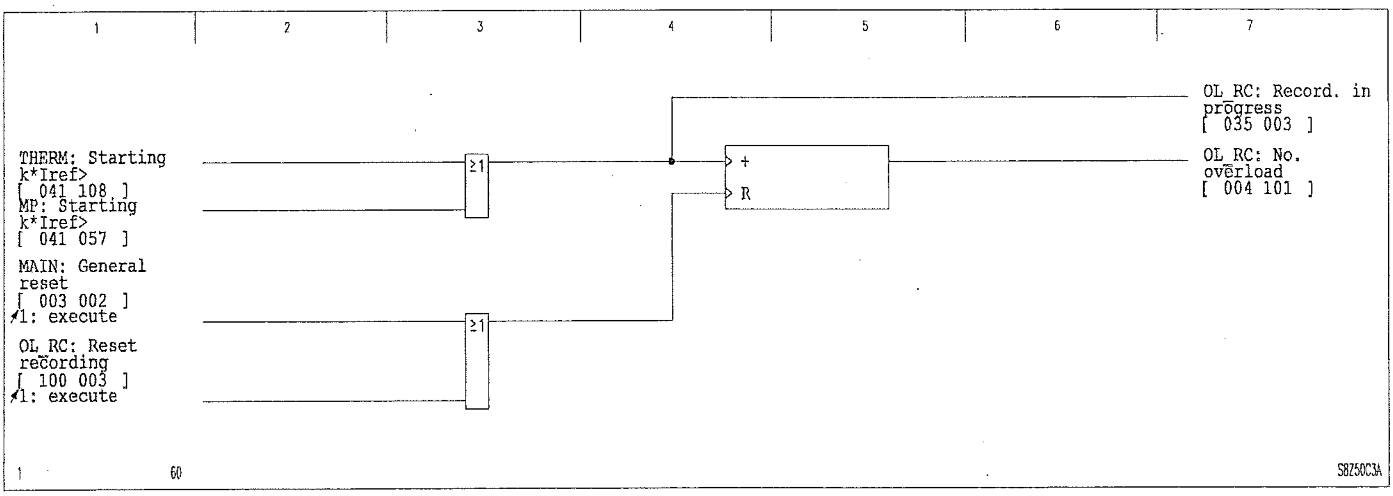
3.16 Overload Recording (Function Group OL_RC)

Start of overload recording

An overload exists and therefore overload recording begins if a starting signal is issued by either the motor protection function (MP: Starting k*Iref>) or the thermal overload protection function (THERM: Starting k*Iref>).

Counting overload events

Overload events are counted and identified by sequential number.



3-62 *Counting overload events*

Time tagging

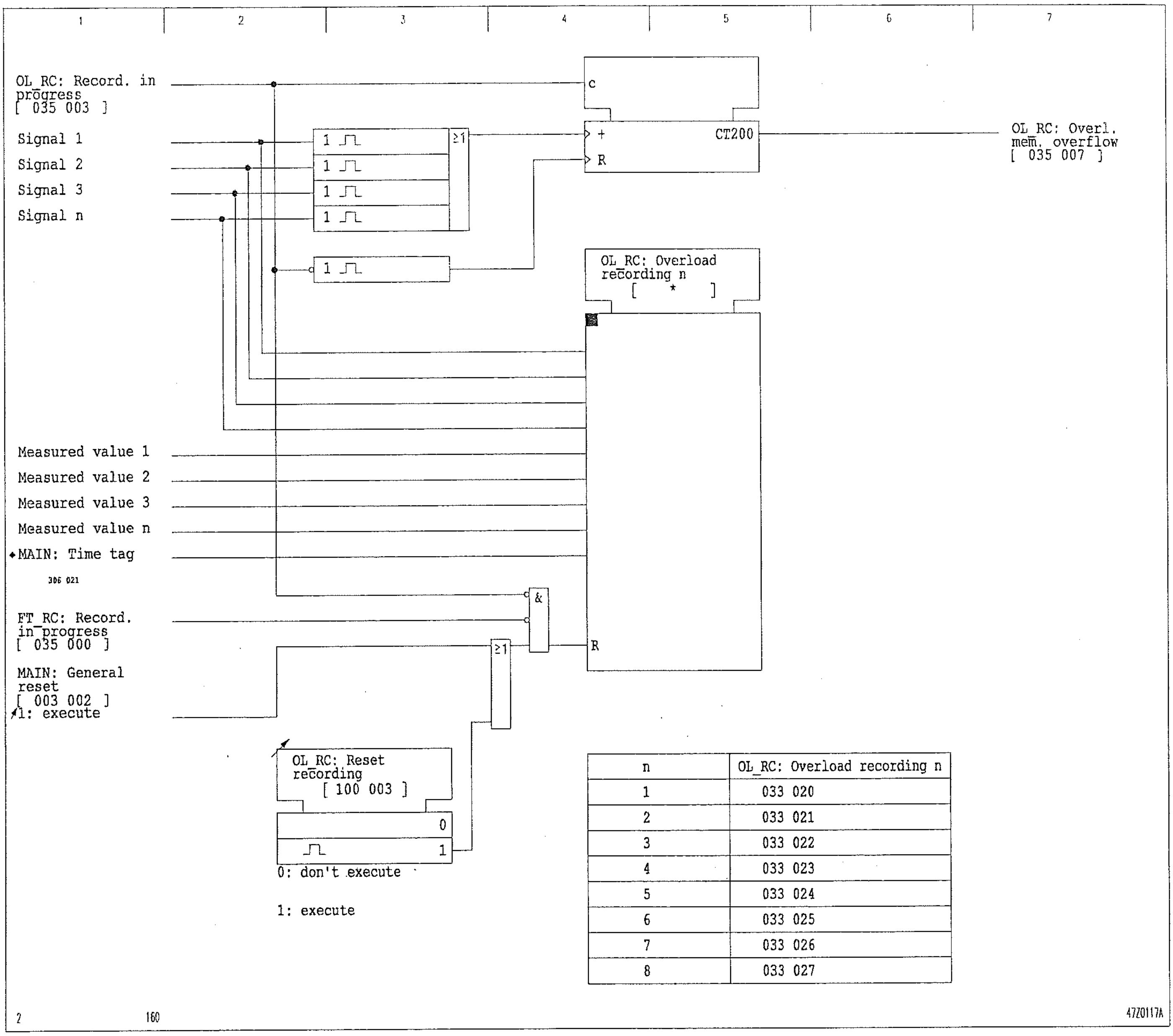
The date that is assigned to each overload event by the internal clock is stored. An overload event's individual start or end signals are likewise time-tagged by the internal clock. The date and time assigned to an overload event when the event begins can be read out from the overload memory on the local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

Overload logging

Protection signals during an overload event are logged in chronological order with reference to the specific event. A total of eight overload events, each involving a maximum of 200 start or end signals, can be stored in the non-volatile overload memories. After eight overload events have been logged, the oldest overload log will be overwritten, unless memories have been cleared in the interim. If more than 199 start or end signals have occurred during a single overload event, then `OL_RC: Overl. mem. overflow` will be entered as the last signal.

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

The overload logs can be read from the local control panel or through the PC or communication interfaces.



n	OL_RC: Overload recording n
1	033 020
2	033 021
3	033 022
4	033 023
5	033 024
6	033 025
7	033 026
8	033 027

3-63 Overload memory

3.17 Ground Fault Data Acquisition (Function Group GF_DA)

In the event of a ground fault, the P130C acquires the following measured ground fault data:

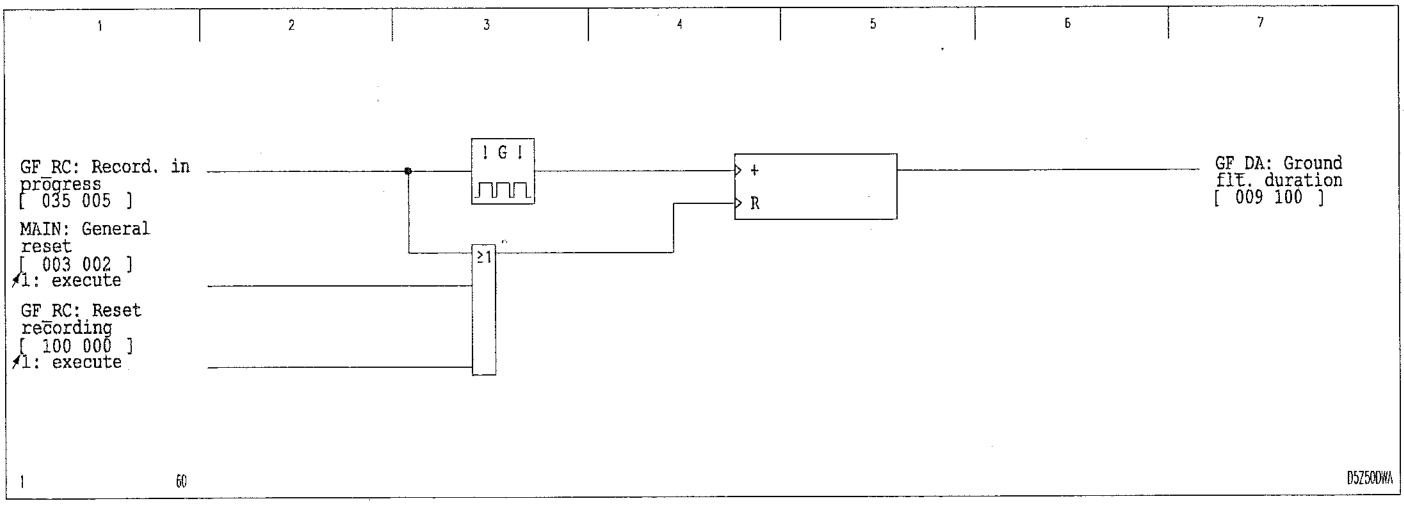
- Duration of the ground fault recording
- When the GFDSS function (ground fault direction determination using steady-state values) is enabled:
  - Ground fault duration determined by steady-state power, steady-state current or admittance evaluation
  - Neutral-point displacement voltage V_{NG} determined by steady-state power or admittance evaluation
  - Residual current I_N
  - Active component of residual current determined by steady-state power evaluation
  - Reactive component of the residual current determined by steady-state power evaluation
  - Filtered residual current determined by steady-state current evaluation
  - Admittance, conductance and susceptance if the admittance evaluation mode is enabled

Resetting the measured ground fault data

After the reset key 'C' on the local control panel is pressed, the ground 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.

Duration of the ground fault recording

The ground fault duration is defined as the time between the start and end of the OL_RC: Record. in progress signal.

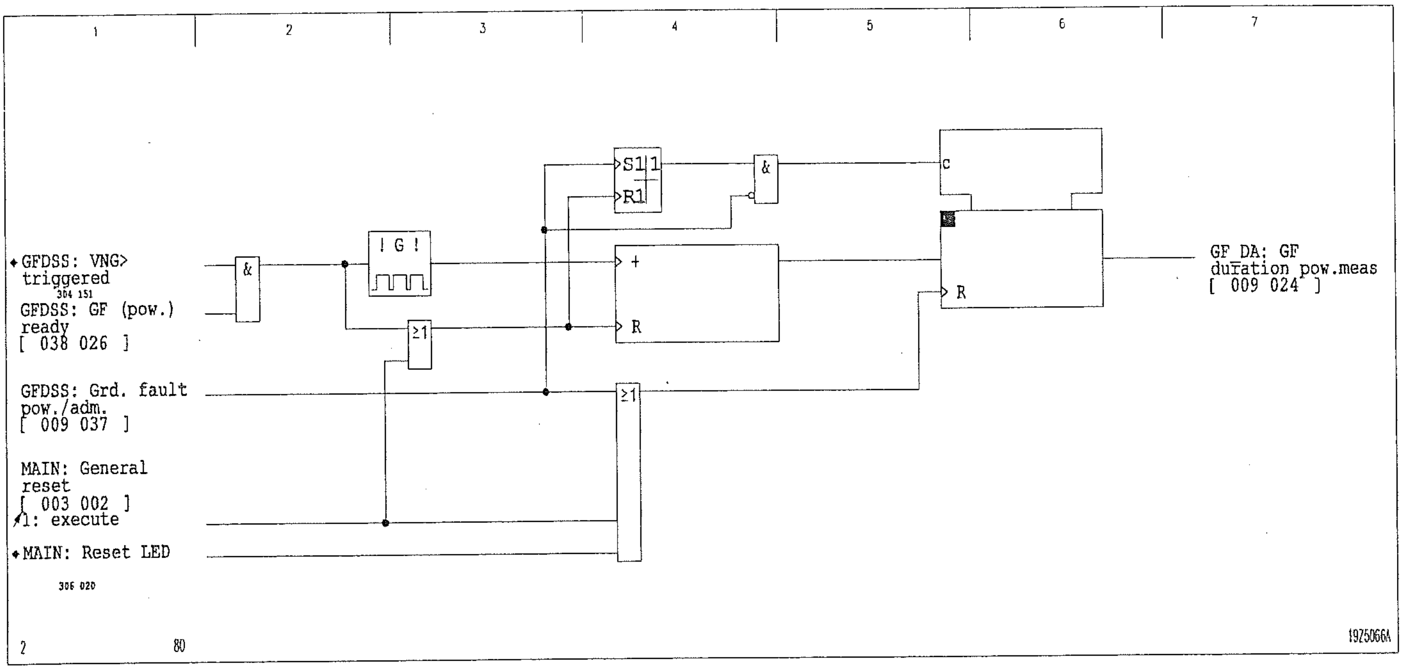


3-64 *Duration of the ground fault recording*

3.17.1 Measured Ground Fault Data from Steady-State Power Evaluation

Ground fault duration

Ground fault duration is defined as the time between operation and dropout of the trigger GFDSS: VNG>. However, there is only a time output after the end of a ground fault if the trigger GFDSS: VNG> has operated at least for the set time GFDSS: tVNG>. After GFDSS: tVNG> has elapsed, the display of the ground fault duration of the last ground fault is automatically cleared.



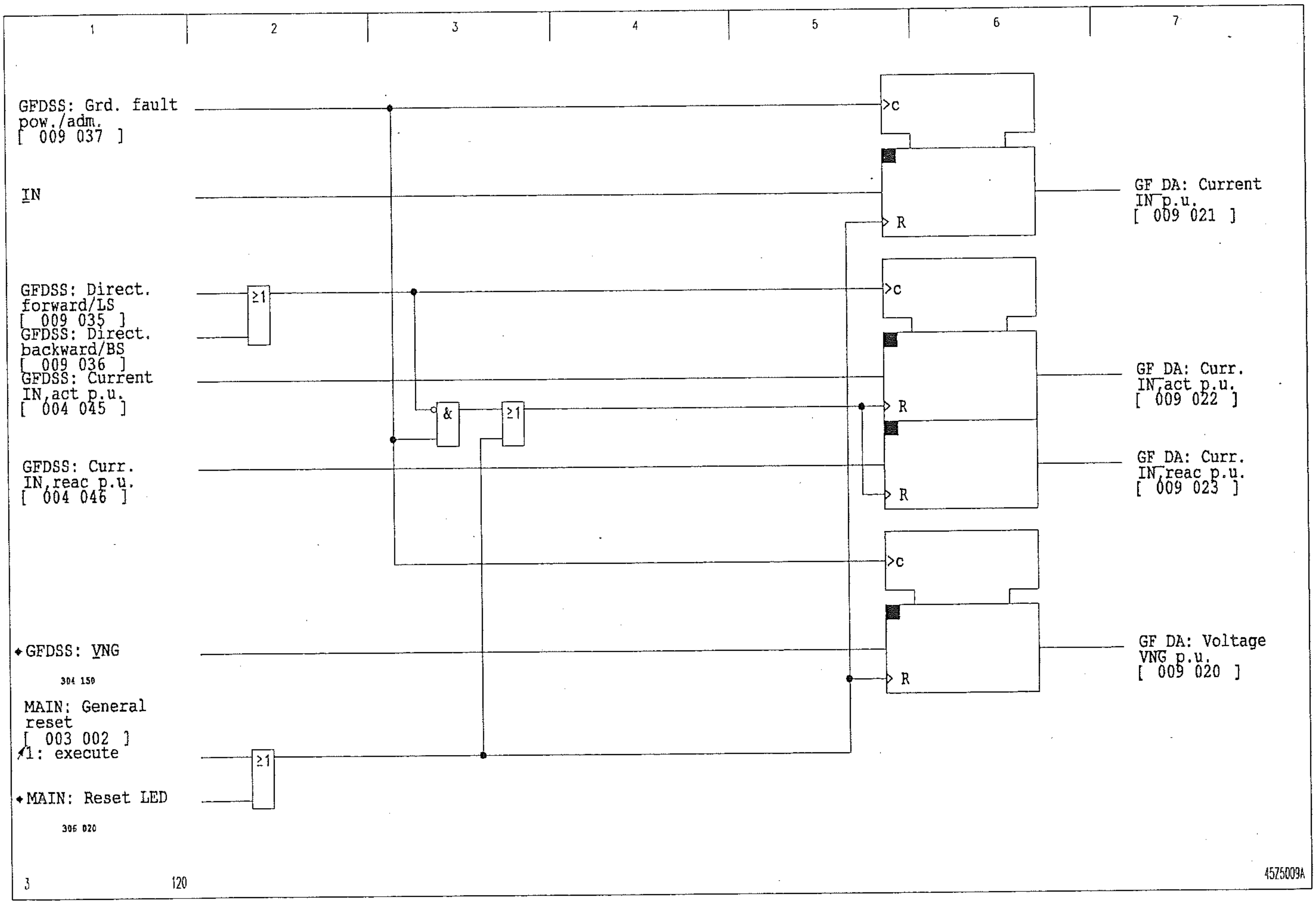
3-65 *Measurement and storage of ground fault duration, steady-state power evaluation*

Residual current

The residual current that is present at the time the timer stage GFDSS: tVNG> elapses is stored in memory. In addition, the active or reactive component of the residual current at the time of the direction decision output is also stored. All measured data are output as per-unit quantities referred to the nominal current I_{nom} of the device.

Neutral displacement voltage

The neutral displacement voltage that is present at the time the timer stage GFDSS: tVNG> elapses is stored in memory.

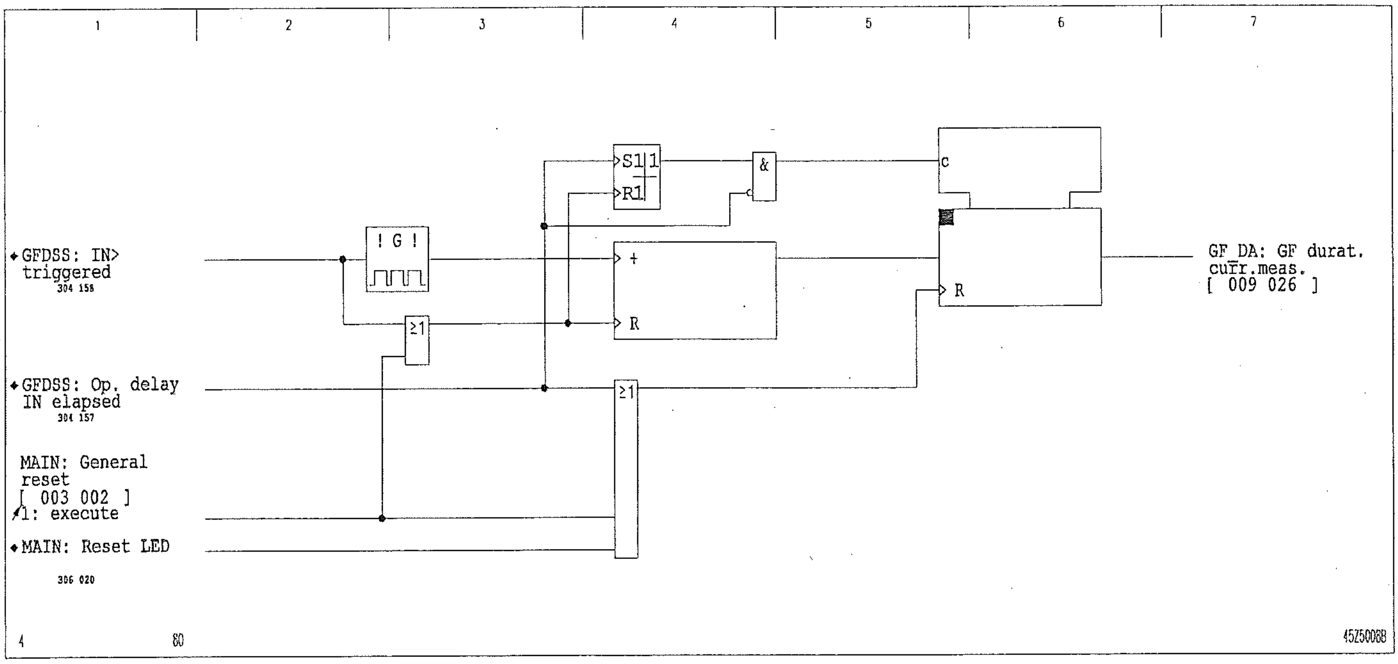


3-66 *Residual current and neutral-displacement voltage for steady-state power evaluation*

3.17.2 Measured Ground Fault Data from Steady-State Current Evaluation

Ground fault duration

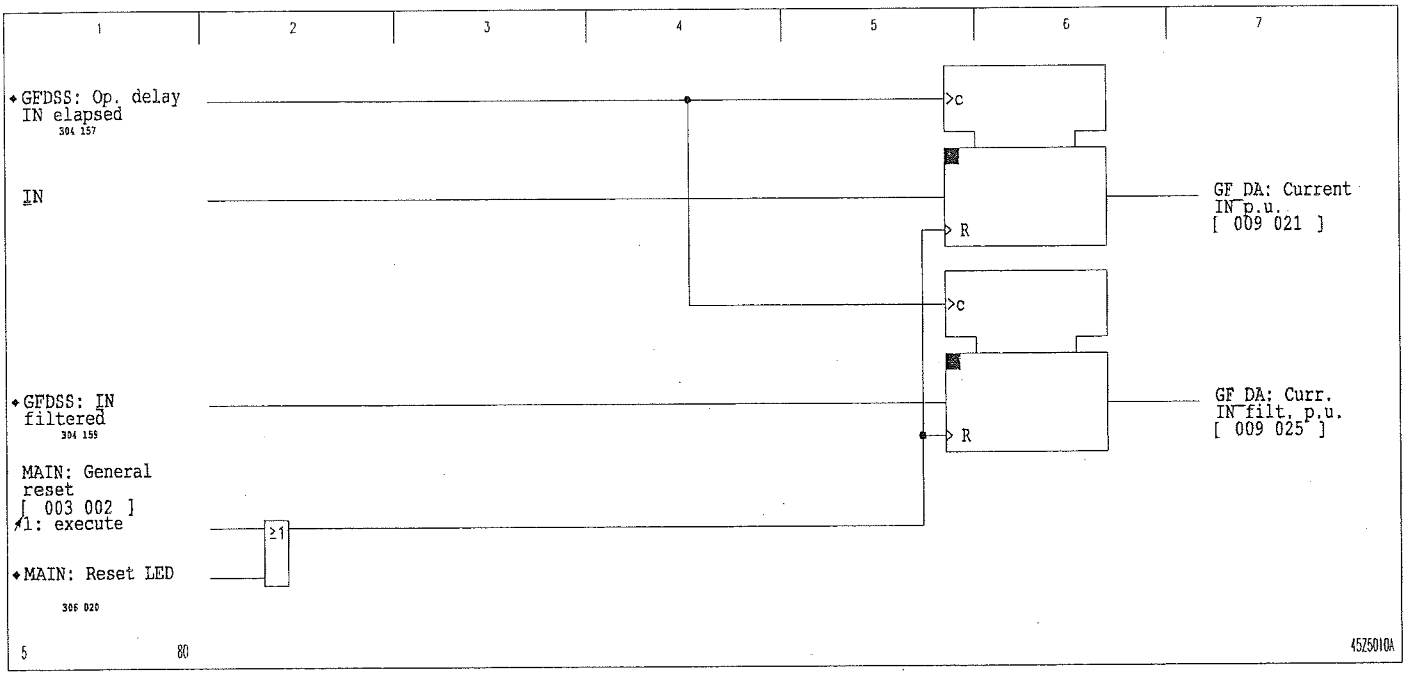
Ground fault duration is defined as the time between operation and dropout of the trigger GFDSS: IN>. However, there is only a time output after the end of a ground fault if the trigger GFDSS: IN> has operated at least for the duration of the set operate delay (GFDSS: Operate delay IN). After the operate delay has elapsed, the display of the ground fault duration of the last ground fault is automatically cleared.



3-67 *Measurement and storage of ground fault duration, steady-state current evaluation*

Residual current

Both the unfiltered and the filtered residual current at the time when the operate delay GFDSS: Operate delay IN elapses are stored.

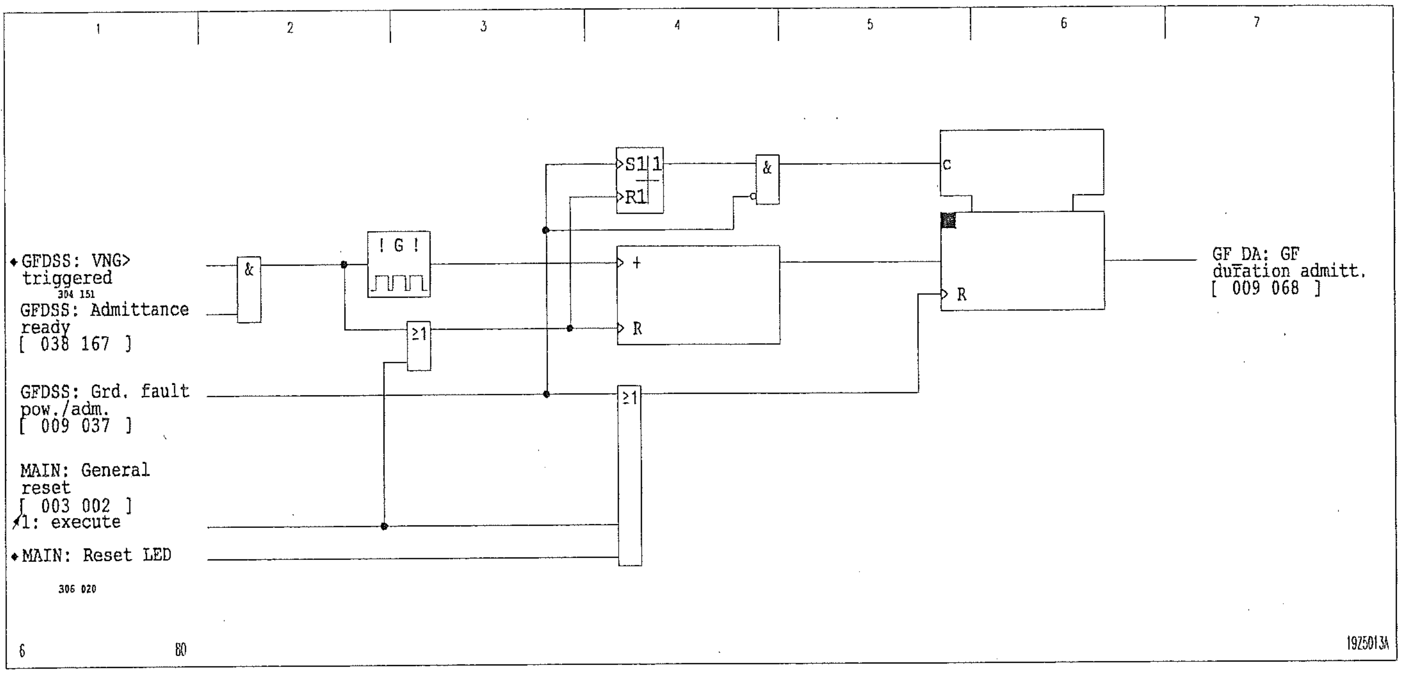


3-68 *Filtered residual current determined by steady-state current evaluation*

3.17.3 Measured Ground Fault Data from Admittance Evaluation

Ground fault duration

Ground fault duration is defined as the time between operation and dropout of the trigger GFDSS: VNG>. However, there is only a time output after the end of a ground fault if the trigger GFDSS: VNG> has operated at least for the set time GFDSS: tVNG>. After GFDSS: tVNG> has elapsed, the display of the ground fault duration of the last ground fault is automatically cleared.



3-69 *Measurement and storage of ground fault duration, admittance evaluation mode*

Acquisition of admittance, conductance and susceptance

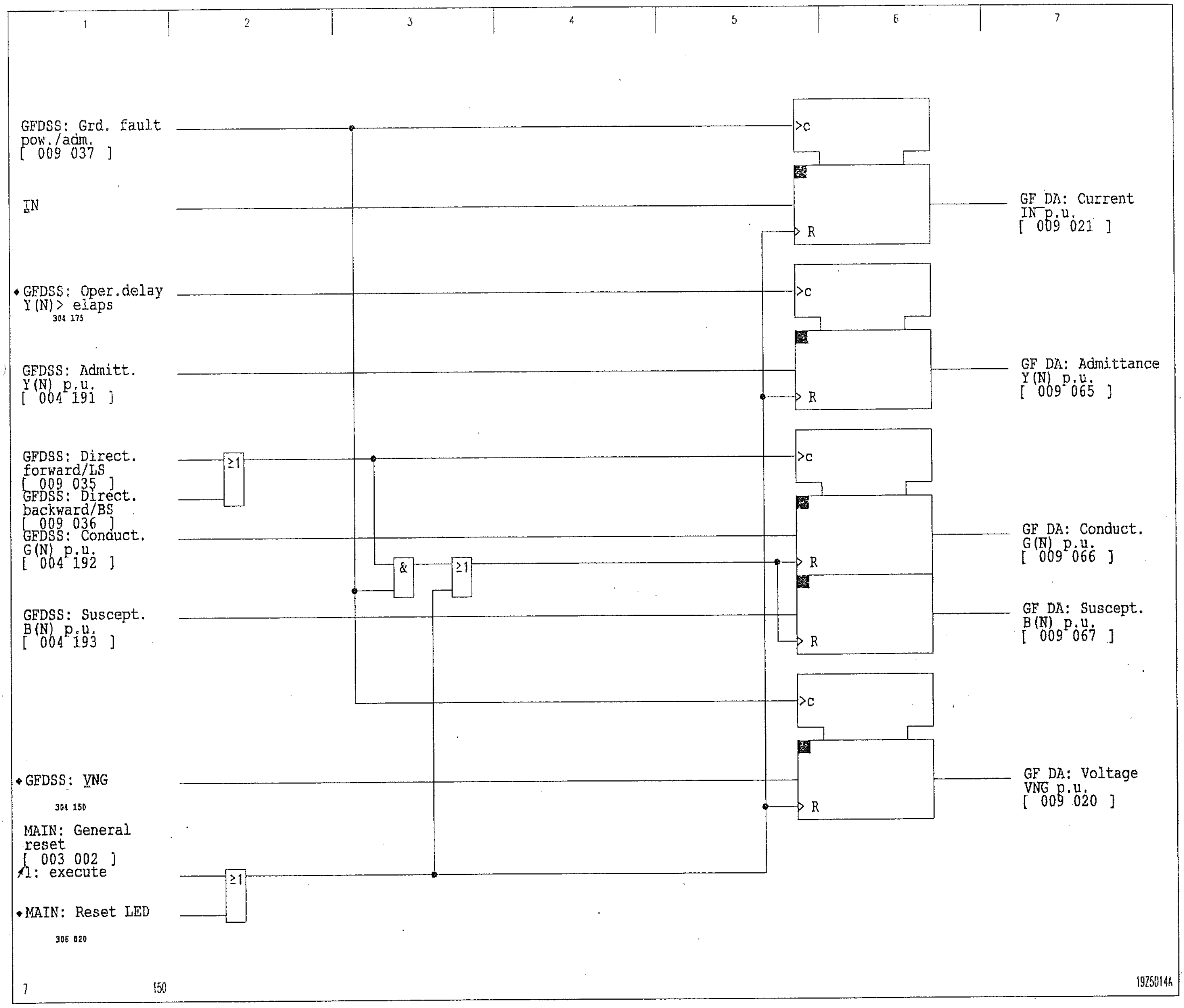
Conductance and susceptance are stored at the time when the direction decision is issued. The acquisition of the admittance data value is carried out at the time when timer stage GFDSS: Operate delay Y(N)> elapses.

Residual current

The residual current that is present at the time the timer stage GFDSS: tVNG> elapses is stored in memory. The measured data value is output as per-unit quantity referred to the nominal current I_{nom} of the device.

Neutral displacement voltage

The neutral displacement voltage that is present at the time the timer stage GFDSS: tVNG> elapses is stored in memory.



3-70 *Measured ground fault data for the admittance evaluation mode*

3.18 Ground Fault Recording (Function Group GF_RC)

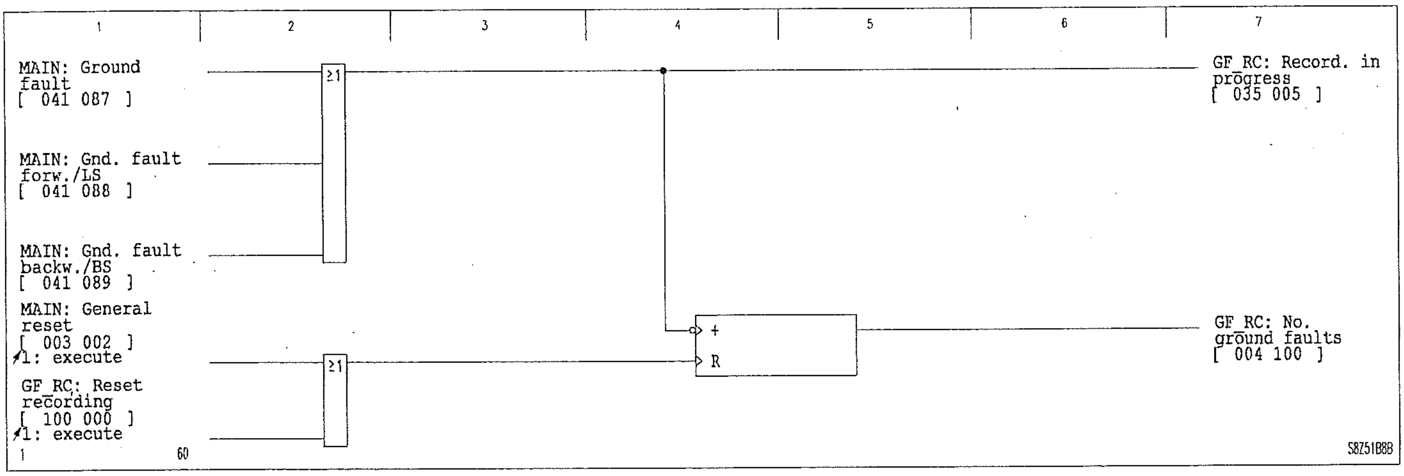
Start of ground fault recording

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

- A ground fault has been detected by the GFDSS function (ground fault direction determination using steady-state values).
- A ground fault has been detected by transient ground fault direction determination.

Ground fault counting

The ground faults are counted and identified by sequential number.



3-71 *Ground fault counting*

Time tagging

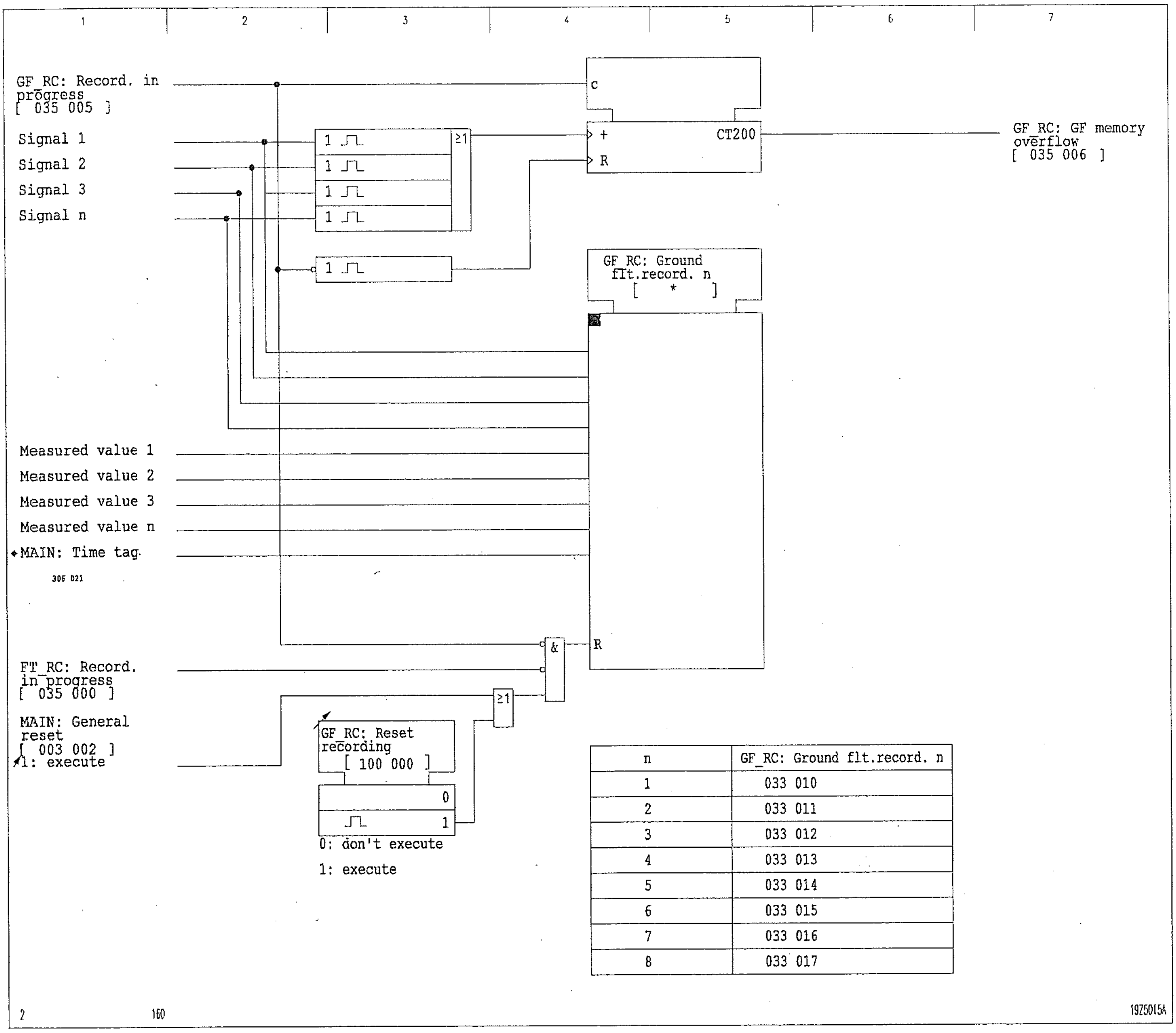
The date that is assigned to each ground fault by the internal clock is stored. A ground fault's individual start or end signals are likewise time-tagged by the internal clock. The date and time assigned to a ground fault event when the event begins can be read out from the ground fault memory on the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

Ground fault logging

Protection signals issued during a ground fault are logged in chronological order with reference to the specific ground fault. A total of eight ground fault logs, each involving a maximum of 200 start or end signals, can be stored in the non-volatile ground fault memories. After eight ground faults have been logged, the oldest ground fault log will be overwritten, unless memories have been cleared in the interim. If more than 199 start or end signals have occurred during a single ground fault, then GF_RC: GF memory overflow will be entered as the last signal.

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

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



n	GF_RC: Ground flt.record. n
1	033 010
2	033 011
3	033 012
4	033 013
5	033 014
6	033 015
7	033 016
8	033 017

3-72 Ground fault memory

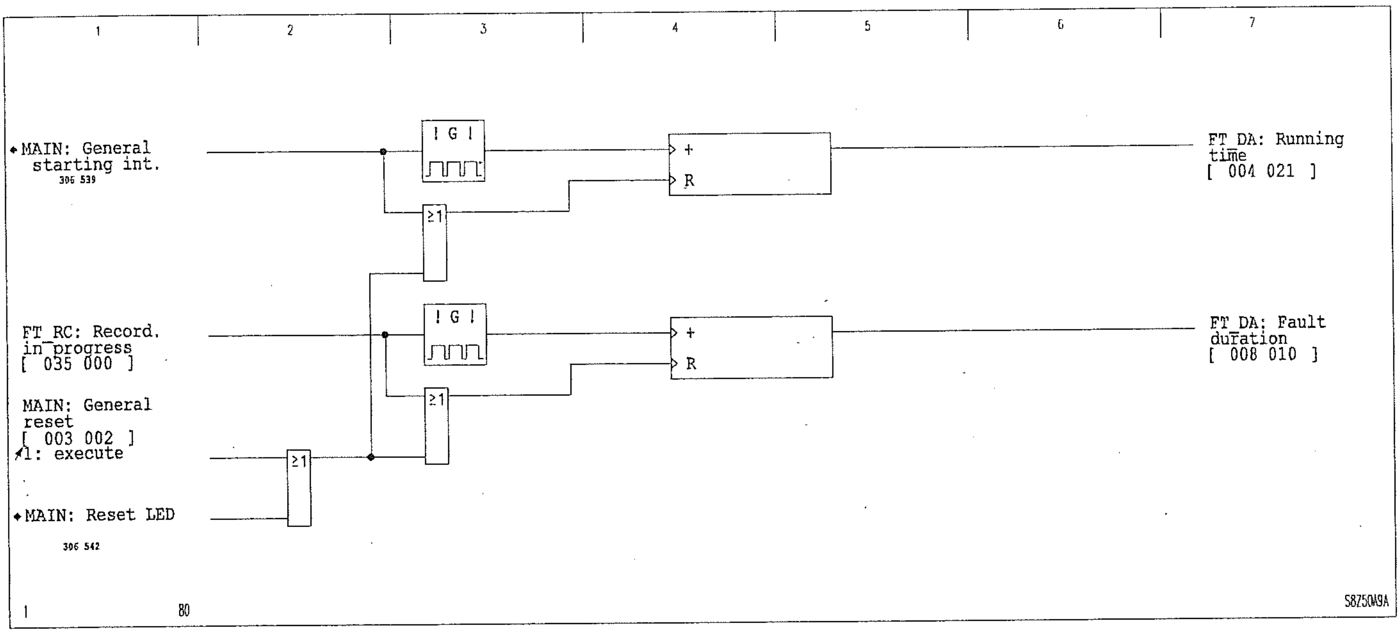
3.19 Fault Data Acquisition (Function Group FT_DA)

When there is a fault in the system, the P130C collects the following measured fault data:

- Running time
- Fault duration
- Fault current (short-circuit current)
- Fault voltage (short-circuit voltage)
- Short-Circuit Impedance
- Fault reactance (short-circuit reactance) in percent of line reactance and in Ω
- Fault angle
- Fault distance
- Ground fault current
- Ground fault angle
- Fault location in %
- Fault location in km

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 P130C, and the fault duration is defined as the time between the start and end of the FT_RC: Record. in progress signal.



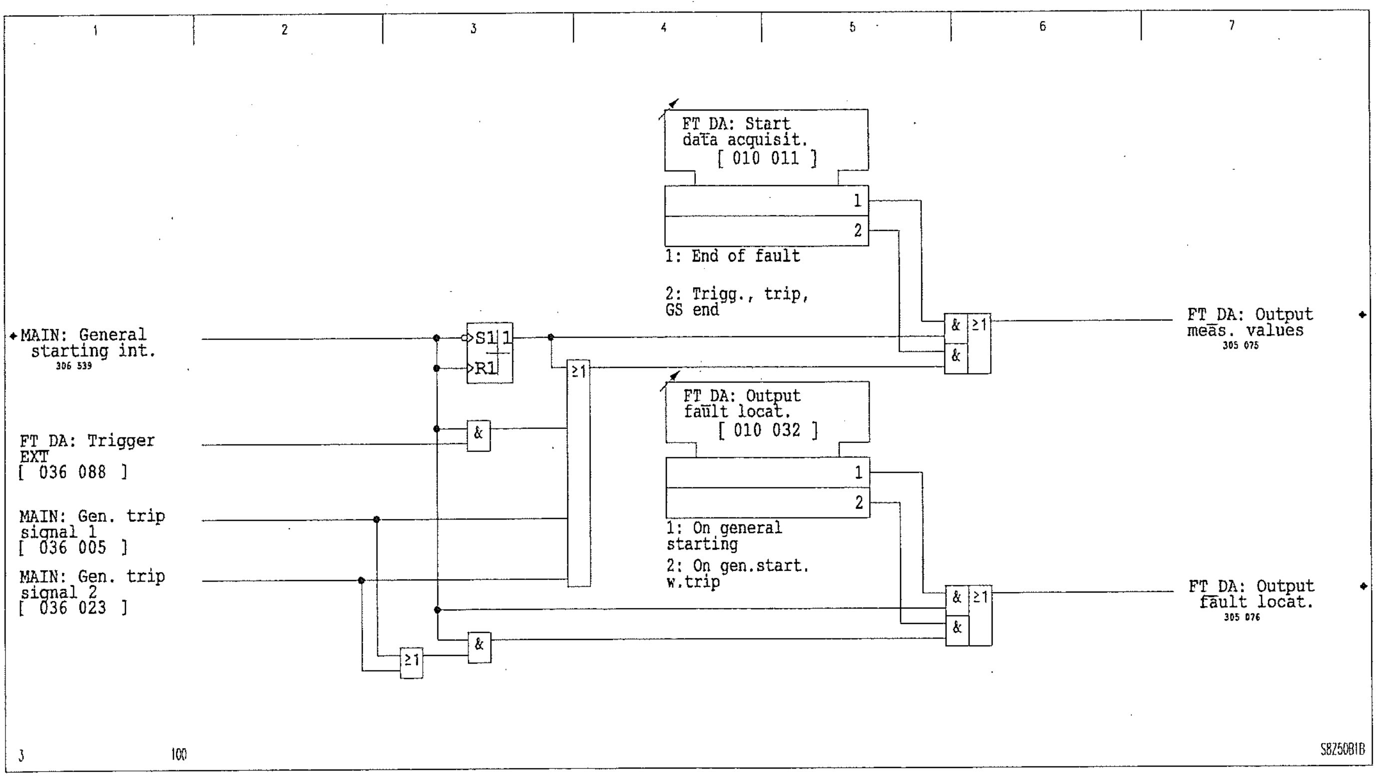
3-73 *Running time and fault duration*

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

Output of fault location occurs – depending on the setting – either when there is a general starting signal or when there is both a general starting signal and a simultaneous general trip signal.

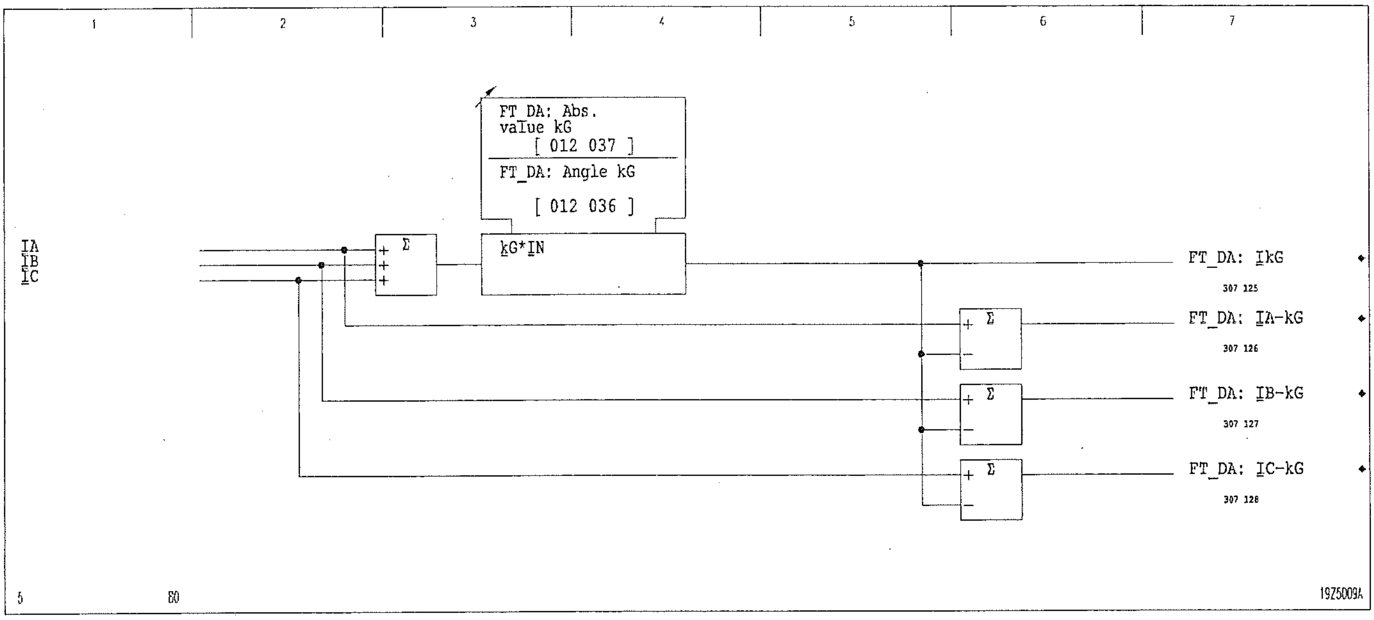


3-74 *Enabling of measured fault data acquisition and fault location output*

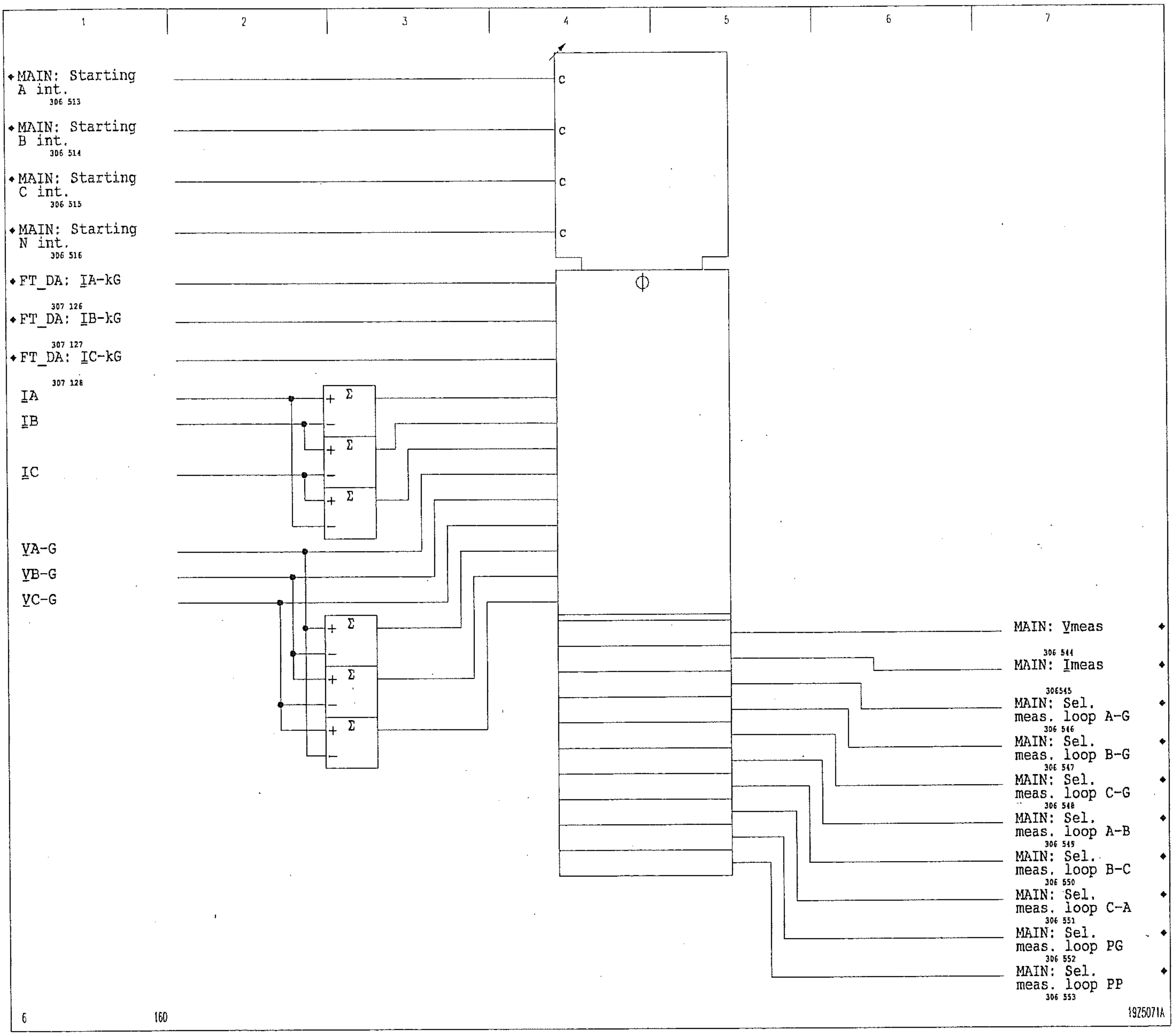
Fault data acquisition

The P130C selects a measuring loop based on the phase-selective starting decision. The short-circuit impedance (fault impedance) and fault direction are determined from this measuring loop's voltage and current. In the case of single-pole starting with ground fault detection, the currents corrected by the ground factor are selected as measured variables. In the case of three-phase starting, either grounded or ungrounded, the minimum voltage of the phase-to-phase voltages and the associated phase-to-phase current are selected as measured variables.

Fault Detection	Variables Selected for Measurement
IA	IA-kG / VA-G
IB	IB-kG / VB-G
IC	IC-kG / VC-G
IA-G	IA-kG / VA-G
IB-G	IB-kG / VB-G
IC-G	IC-kG / VC-G
IA-B	IA-B / VA-B
IB-C	IB-C / VB-C
IC-A	IC-A / VC-A
IA-B-G	IA-B / VA-B
IB-C-G	IB-C / VB-C
IC-A-G	IC-A / VC-A
IA-B-C	IP-P(min) / VP-P (min)
IA-B-C-G	IP-P(min) / VP-P (min)



3-75 Formation of currents corrected by ground factor



3-76 Selection of measured variables for fault data acquisition

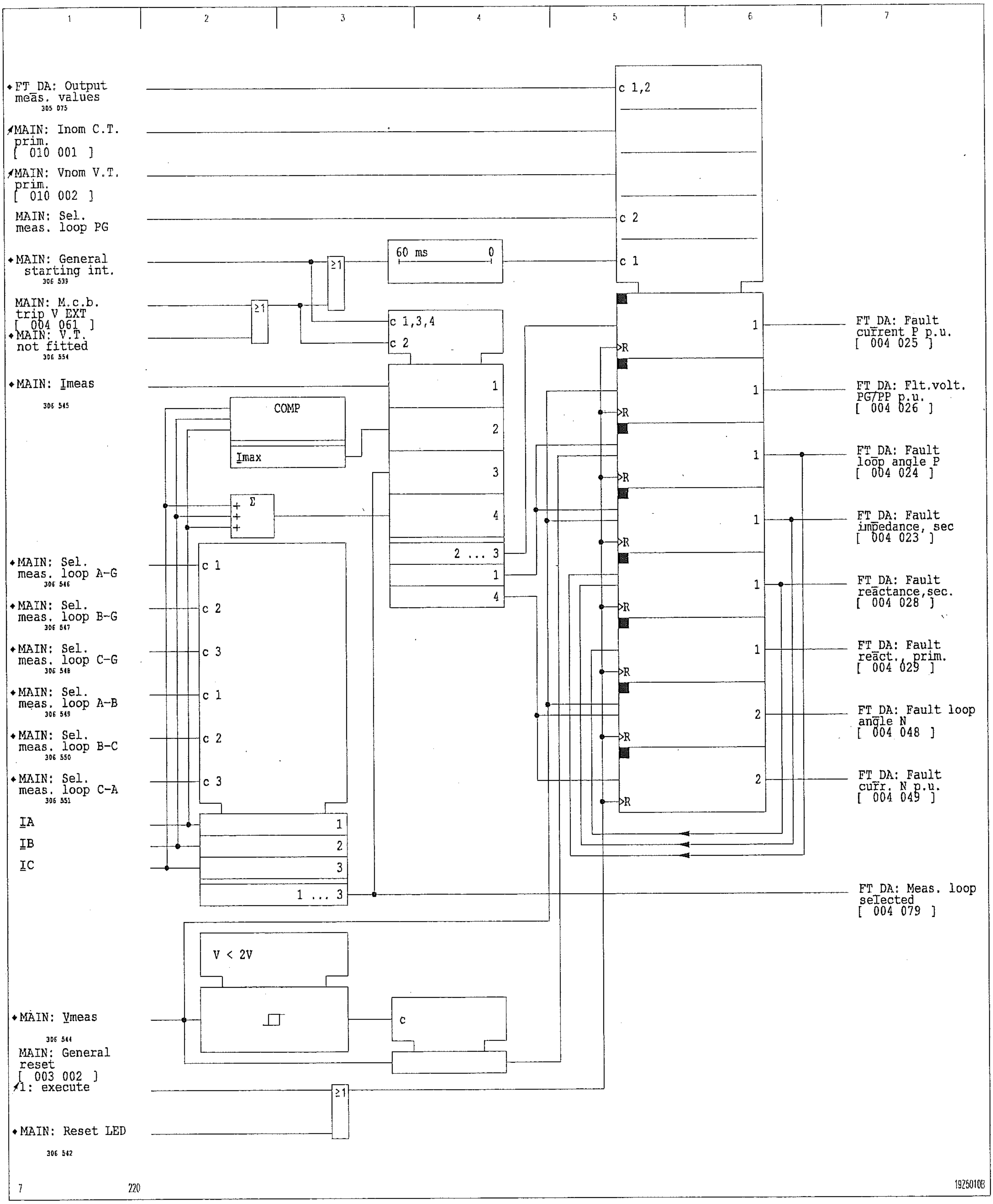
The fault must last for at least 60 ms so that the fault data can be determined.

The fault data are determined using the measured variables $\underline{I}_{meas}$ and $\underline{V}_{meas}$ selected by measured variable selection, if the fault is detected by fault data acquisition. One phase current is selected as the fault current in accordance with the measuring loop selected. In the case of multi-phase starting this is the current of the leading phase in the cycle. The primary fault reactance is calculated from the per-unit fault reactance using the nominal data for the set primary current and voltage transformers.

The ground fault data are only determined if a phase-to-ground loop has been selected for measurement in conjunction with the fault data acquisition function. The geometric sum of the three phase currents is displayed as the ground fault current. The ground fault angle is the phase displacement between ground fault current and selected measuring voltage.

If there is an m.c.b. trip signal or the transformer module is not fitted with a voltage transformer, then only fault current is determined. The maximum phase current is displayed.

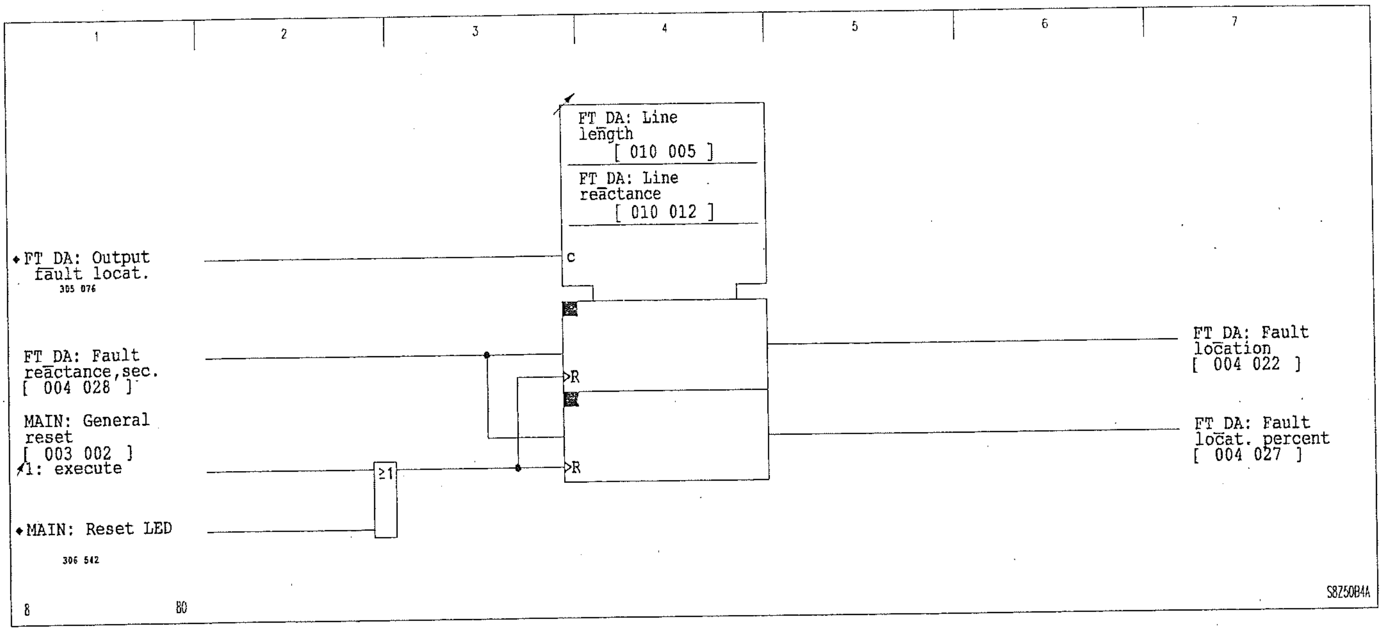
Fault current and voltage are displayed as per-unit quantities referred to I_{nom} and V_{nom}. If the measured or calculated values are outside the acceptable measuring range, the '*Overflow*' indication is displayed.



3-77 *Acquisition of fault data (short-circuit data)*

Acquisition of fault location

In order for the fault location to be determined in percent of line length and in km, the user must enter two settings in the P130C the value of the line reactance that corresponds to 100% of the line section being monitored and the value of the corresponding line length in km.



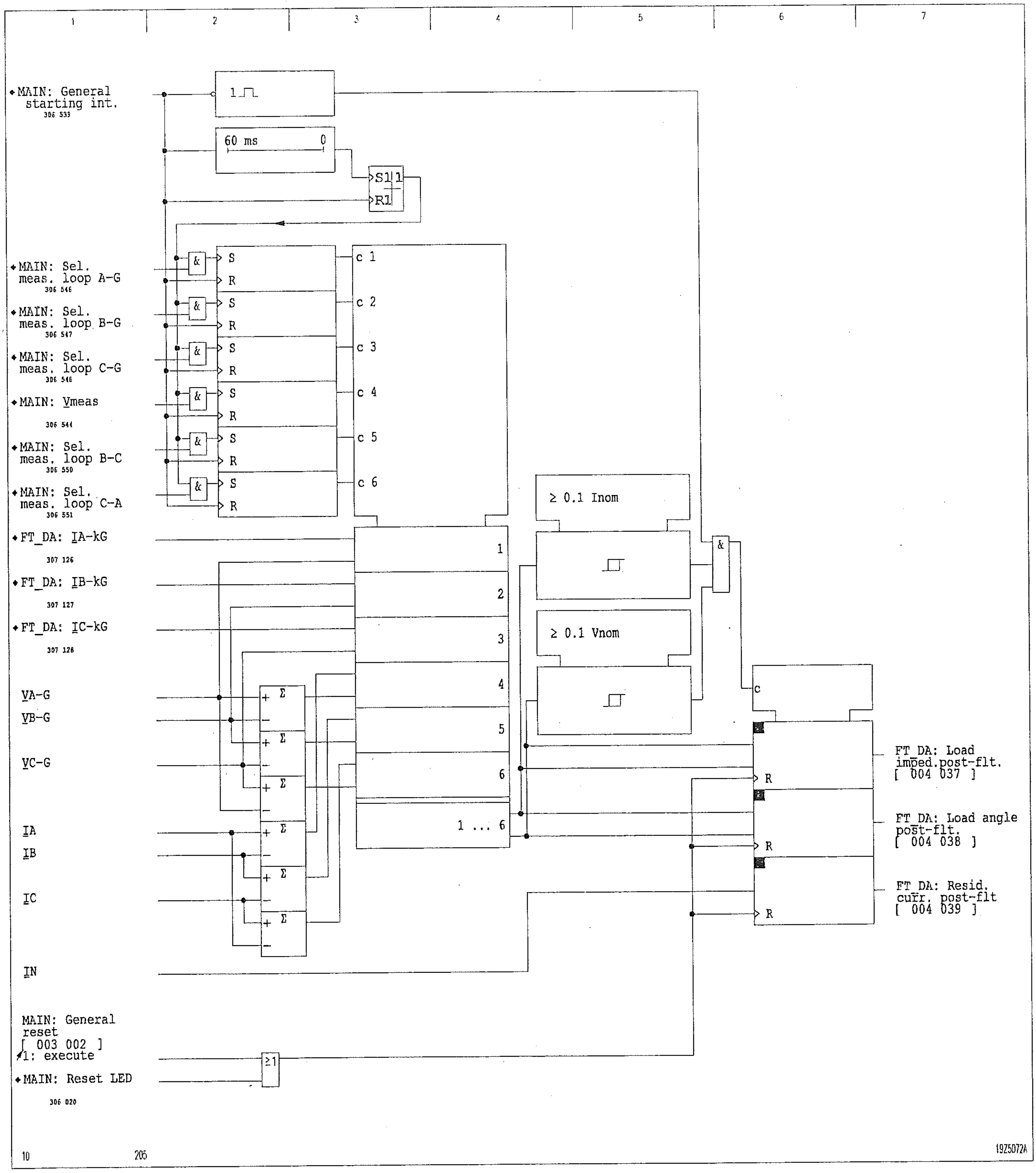
3-78. *Acquisition of fault location*

Acquisition of load data

In addition to fault data and fault location, the following load data are determined when the general starting signal drops out:

- Load impedance
- Load angle
- Residual current

The same measuring loop used to determine fault impedance is used to determine load impedance and load angle. The load current and the voltage must exceed the thresholds 0.1 I_{nom} and 0.1 V_{nom}, respectively, in order for the load data to be determined. If the thresholds are not reached or if the general starting signal does not last as long as 60 ms, the display '*Not measured*' appears.



3-79 *Acquisition of load 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.

3.20 Fault Recording (Function Group FT_RC)

Start of fault recording

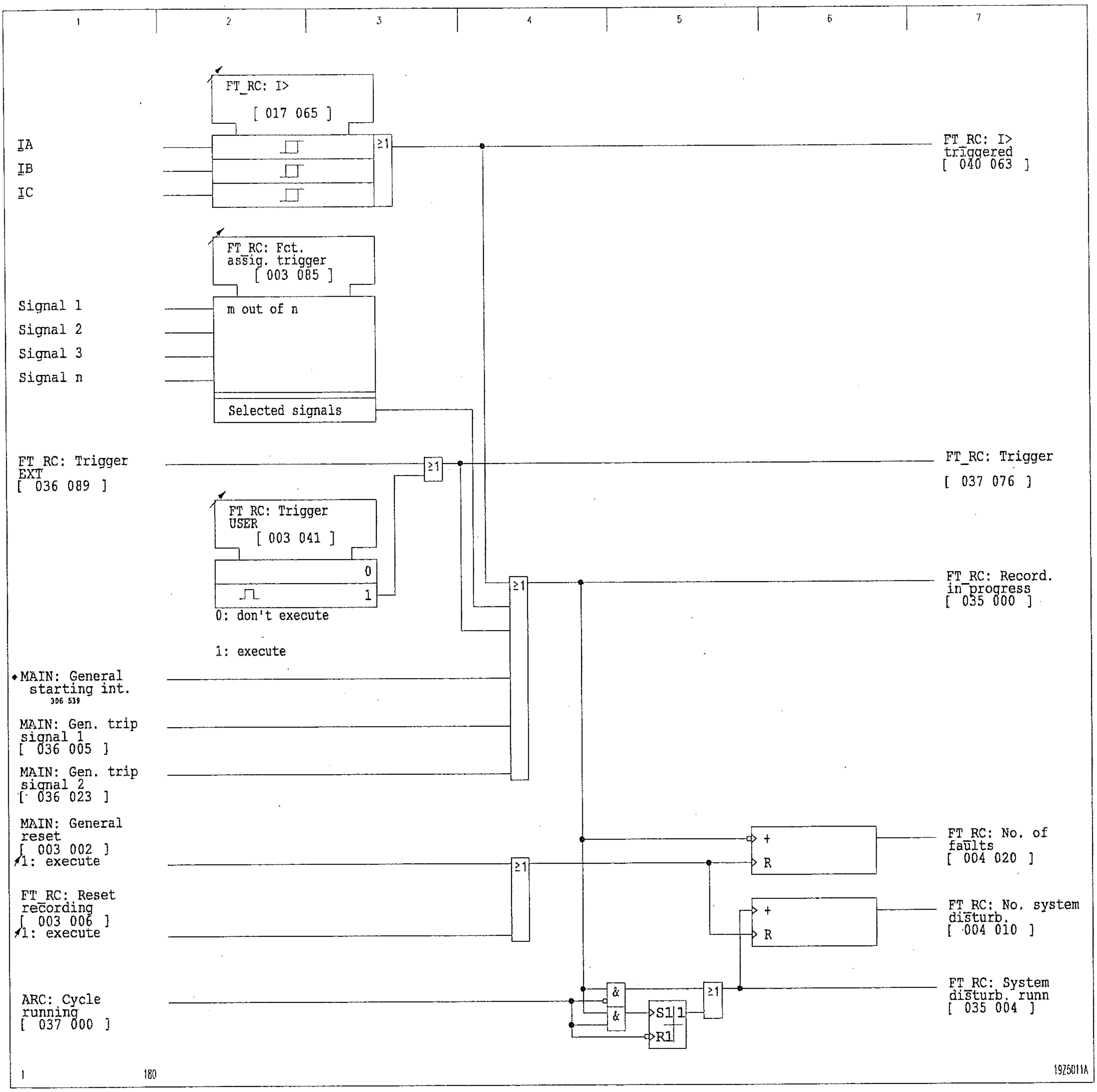
A fault exists, and therefore fault recording begins, if at least one of the following signals is present:

- 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.



3-80 *Start of fault recording and fault counter*

Time tagging

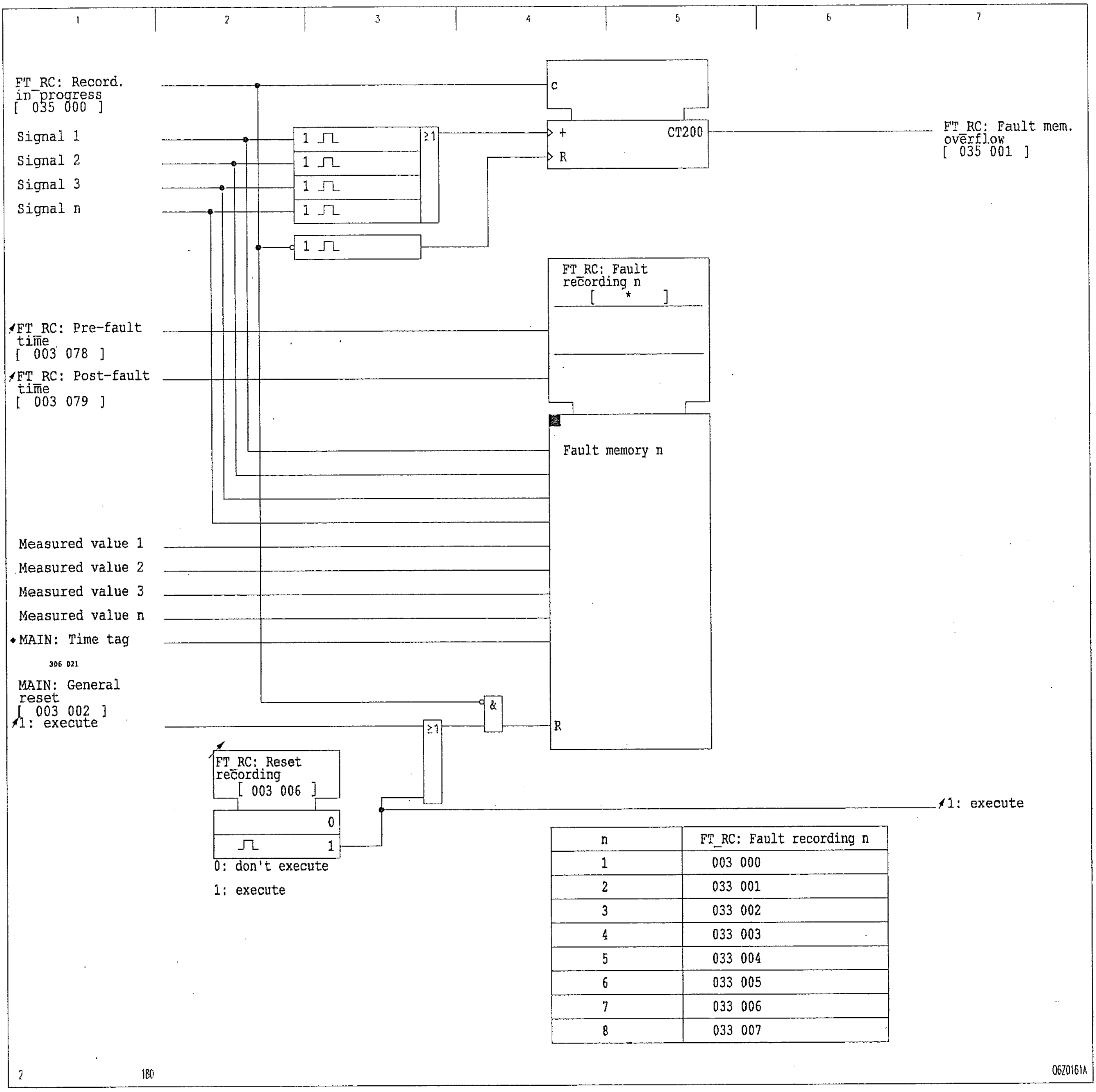
The date that is assigned to each fault by the internal clock is stored. A fault's individual start or end signals are likewise time-tagged by the internal clock. The date and time assigned to a fault when the fault begins can be read out from the fault memory on the local control panel or through the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

3-81 Fault memory

Fault value recording

The following analog signals are recorded:

- Phase currents
- Phase-to-ground voltages
- Residual current, measured by the P130C at the T 4 transformer

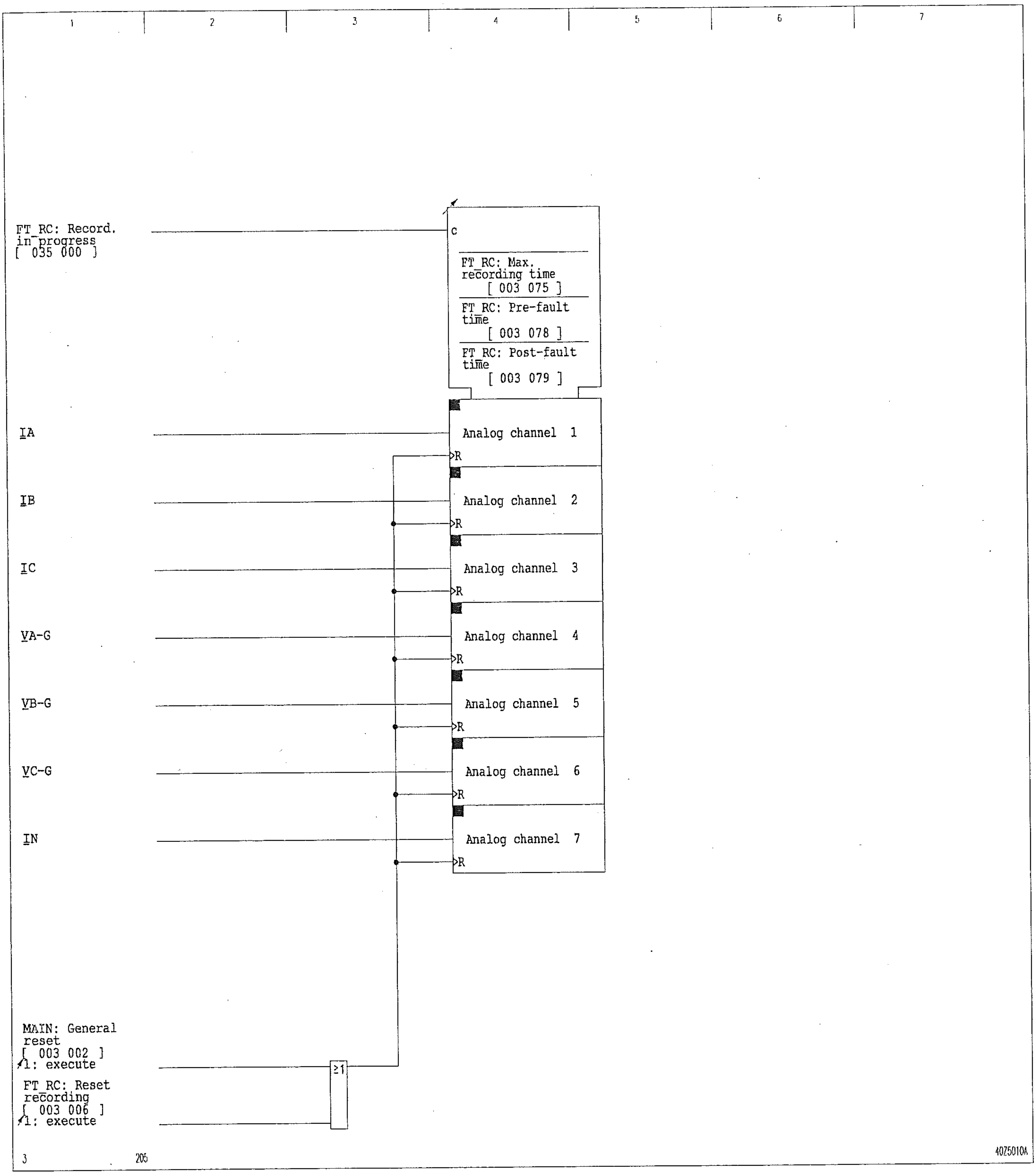
The signals are recorded before, during and after a fault. The times for recording before and after the fault can be set. A maximum time period of 16.4 s is available for recording. This period can be divided among a maximum of eight faults. The maximum recording time per fault can be set. If a fault, 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 16.4 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.

When the supply voltage is interrupted or after a warm restart, the values of all faults remain stored.



3-82 *Fault value recording*

3.21 Definite-Time Overcurrent Protection (Function Group DTOC)

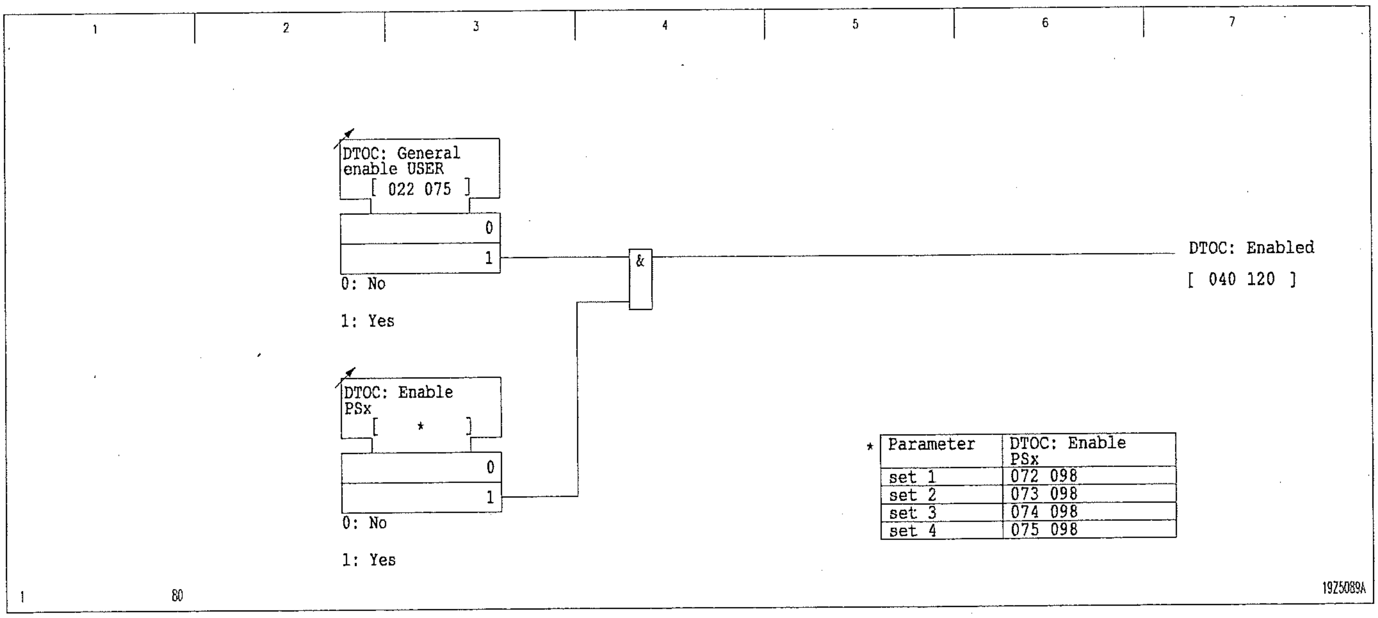
A three-stage definite-time overcurrent protection function (DTOC protection) is implemented in the P130C. Two separate measuring systems are available for this purpose:

- Phase currents system
- Residual currents system

Either the short-circuit direction determination function or the auto-reclosing control may intervene in the functional sequence of the DTOC function.

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.



3-83 *Disabling or enabling DTOC protection*

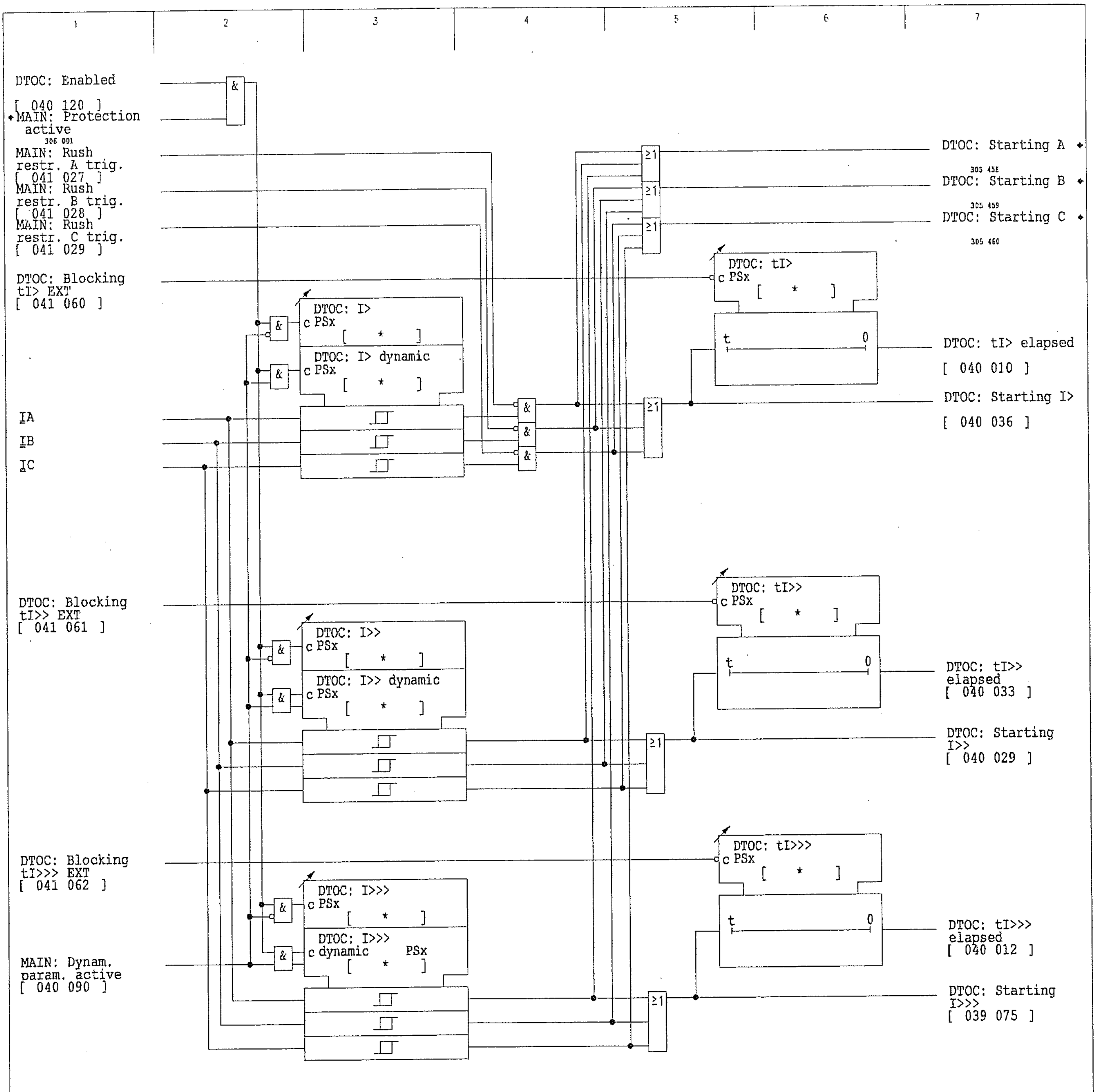
Phase current stages

The three phase currents are monitored by the P130C 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 of the PS 462, PS 482') is triggered, the 1st stage of the DTOC function is blocked.

The trip signals of all phase current stages are blocked by the auto-reclosing control function (ARC) if the ARC is able to form a trip command.

The trip signals of the DTOC function can be blocked by the short-circuit direction determination function (stages I> and I>> only). Depending on the settings for the short-circuit direction determination function, the trip signal of stages I> or I>> may be enabled.

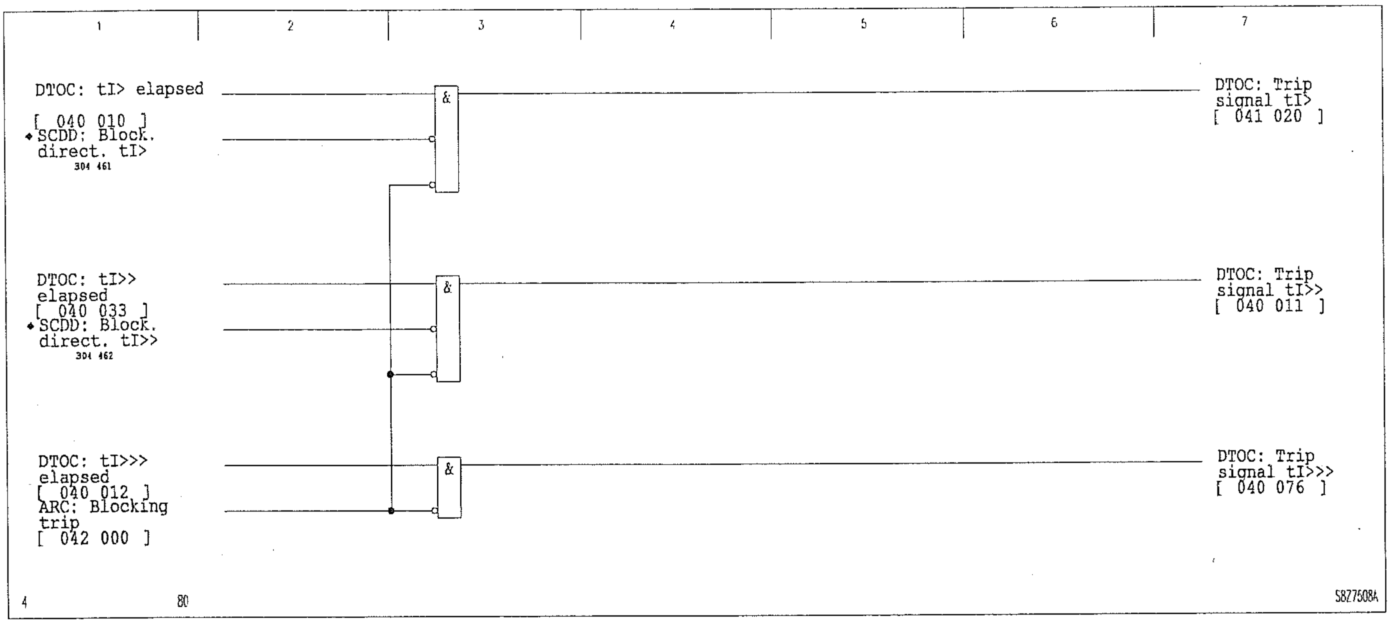


* Parameter	DTOC: I> PSx	DTOC: I> dynamic PSx	DTOC: I>> PSx	DTOC: I>> dynamic PSx
set 1	017 000	017 080	017 001	017 084
set 2	073 007	073 032	073 008	073 033
set 3	074 007	074 032	074 008	074 033
set 4	075 007	075 032	075 008	075 033

* 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

3-84 *Phase current stages*



3-85 *Trip signals of the DTOC phase current stages*

Negative-sequence current stages

The P130C calculates the negative-sequence current from the three phase currents according to one of the following formulas. The rotary field direction setting is taken into account.

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:

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

$$\underline{a} = e^{j120°}$$

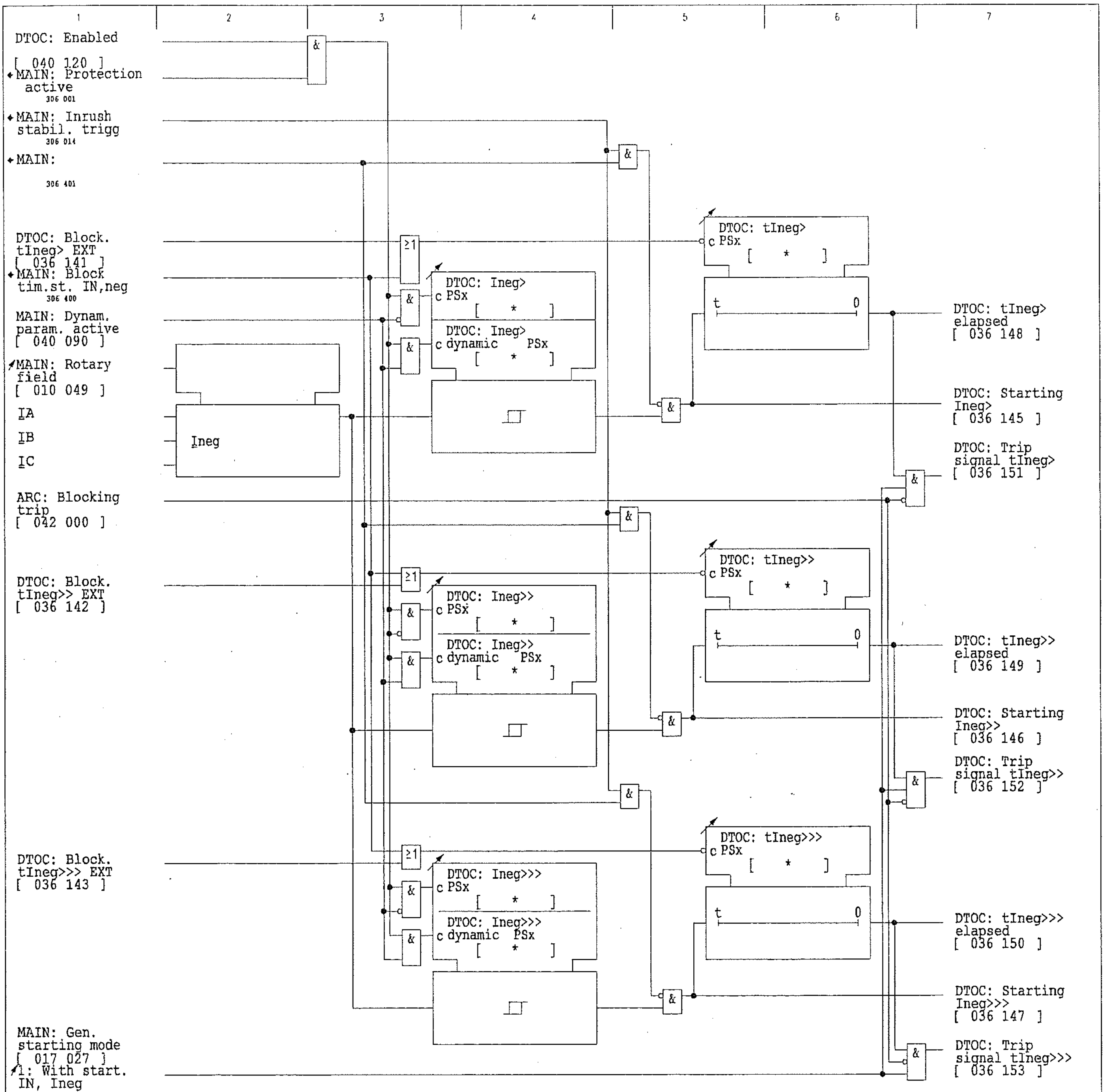
$$\underline{a}^2 = e^{j240°}$$

The negative-sequence current is monitored by the P130C 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 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.

When the inrush stabilization function (see: 'Main Functions of the P130C') is triggered, the negative-sequence current stage is blocked.

If short-circuit direction determination is enabled, then the trip signal issued by the DTOC negative-sequence current stage is always non-directional.

The trip signal of the negative-sequence current stage is blocked by the auto-reclosing control function (ARC) if the ARC is able to form a trip command.

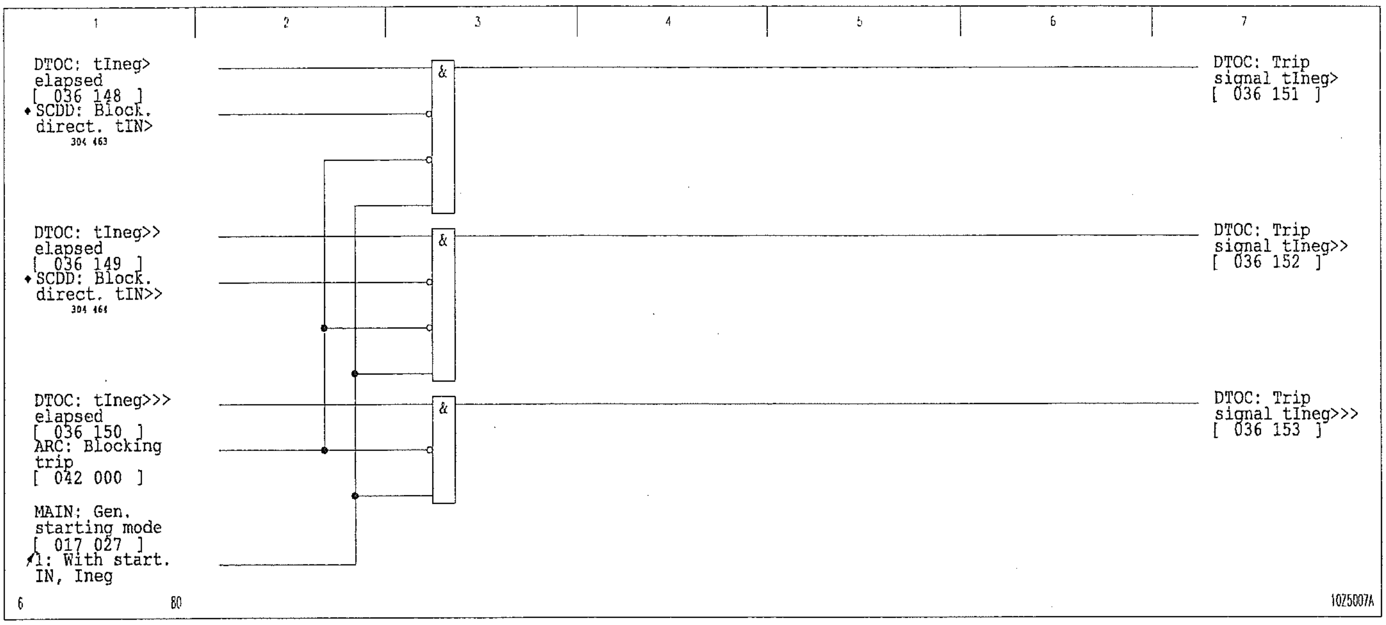


* Parameter	DTOC: Ineg> PSx	DTOC: Ineg> dynamic PSx	DTOC: Ineg>> PSx	DTOC: Ineg>> dynamic PSx
set 1	072 011	076 200	072 012	076 201
set 2	073 011	077 200	073 012	077 201
set 3	074 011	078 200	074 012	078 201
set 4	075 011	079 200	075 012	079 201

* Parameter	DTOC: Ineg>>> PSx	DTOC: Ineg>>> dynamic PSx	DTOC: tIneg> PSx	DTOC: tIneg>> PSx	DTOC: tIneg>>> PSx
set 1	072 013	076 202	072 023	072 024	072 025
set 2	073 013	077 202	073 023	073 024	073 025
set 3	074 013	078 202	074 023	074 024	074 025
set 4	075 013	079 202	075 023	075 024	075 025

5 220 1Z5004A

3-86 Negative-sequence current stages



3-87 *Trip signals of the DTOC negative-sequence 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.

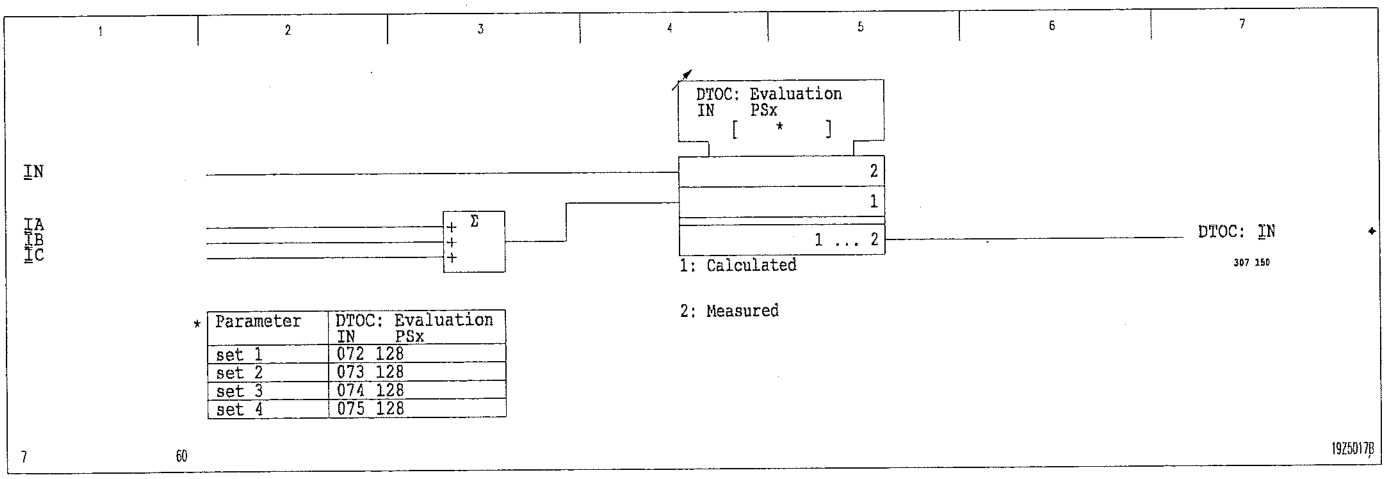
The trip signals of the residual current stages are not enabled unless the operating mode of the general starting is set to *With start. IN, Ineg.*

The trip signals of all residual current stages are be blocked by the auto-reclosing control function (ARC) if the ARC is able to form a trip command.

The trip signals of the DTOC function can be blocked by the short-circuit direction determination function (stages IN> and IN>> only). Depending on the settings for the short-circuit direction determination function, the trip signal of stages IN> or IN>> may be enabled.

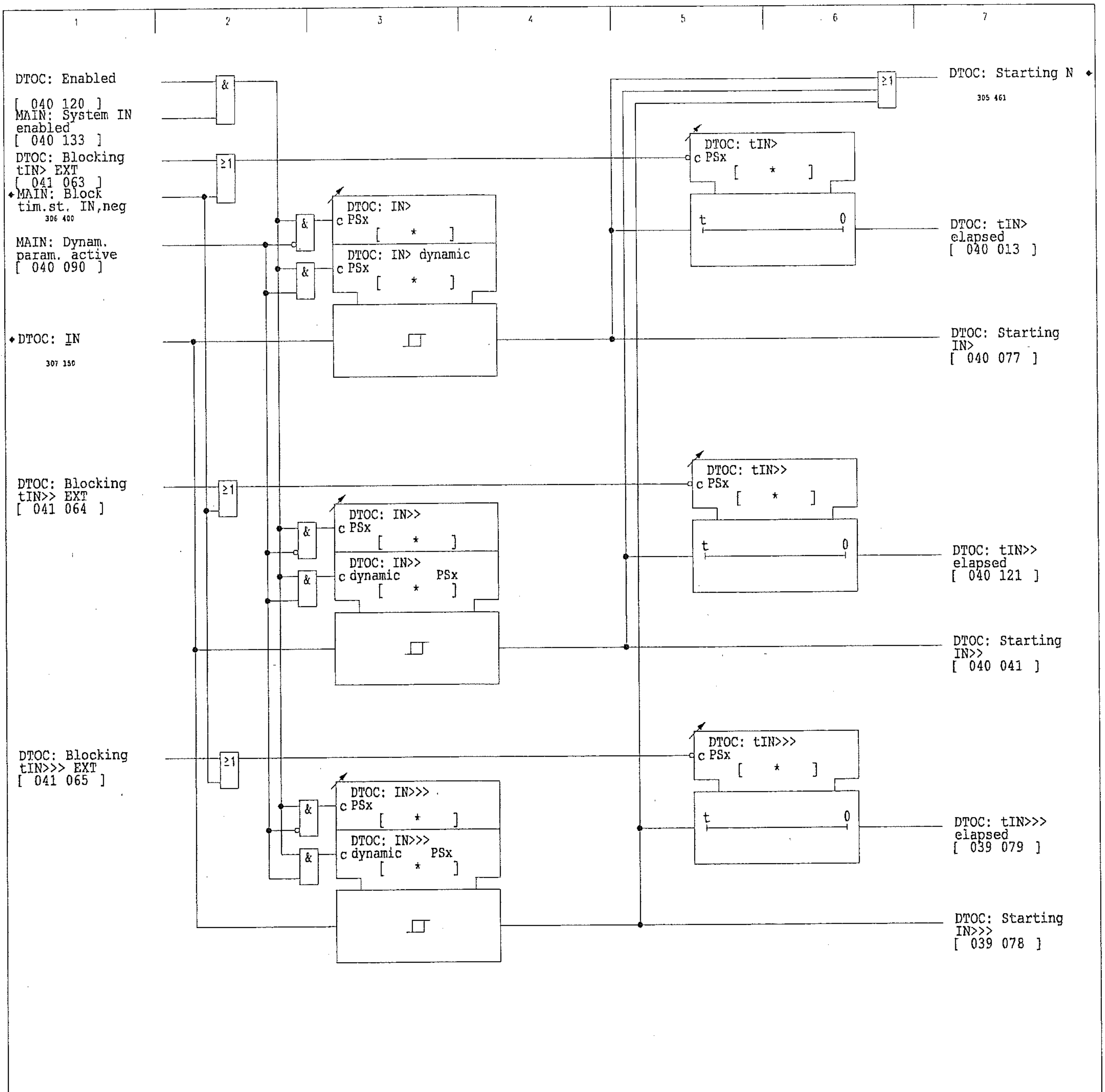
Selecting the measured variable

A setting specifies which current will be used by the P130C as the residual current: either the residual current calculated from the three phase currents or the residual current measured at the fourth transformer.



Parameter	DTOC: Evaluation IN PSx
set 1	072 128
set 2	073 128
set 3	074 128
set 4	075 128

3-88 *Selecting the measured variable*

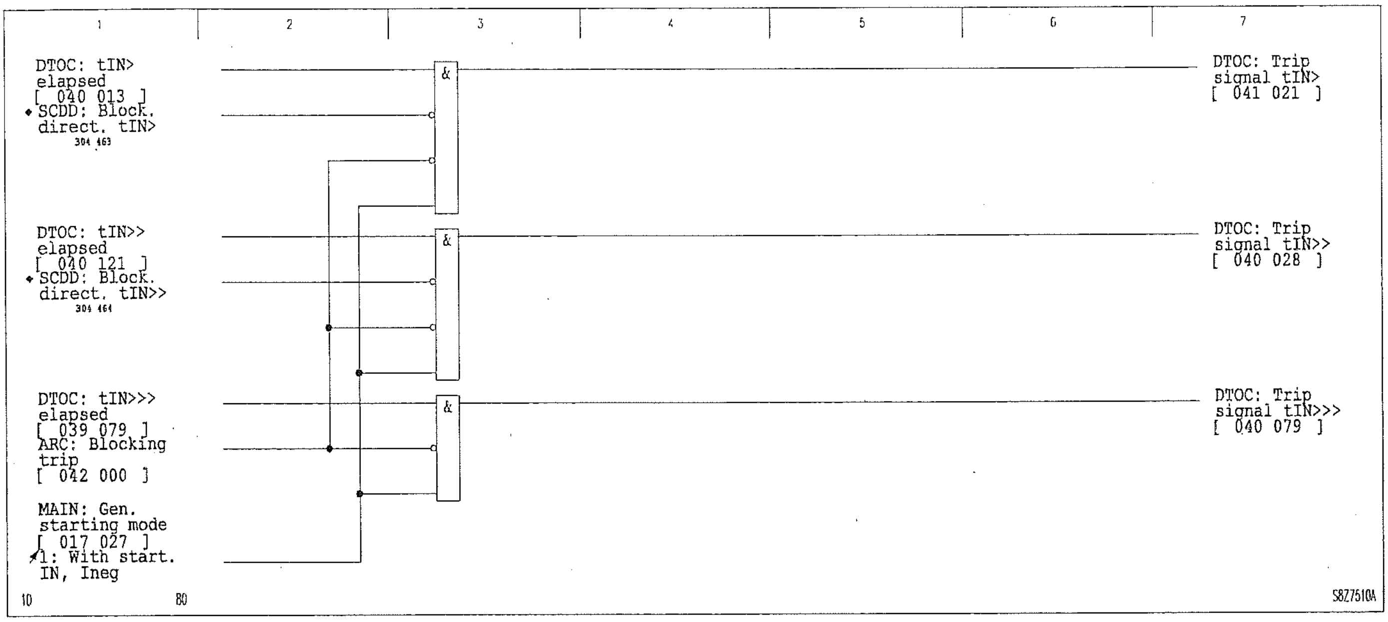


* Parameter	DTOC: IN> PSx	DTOC: IN> dynamic PSx	DTOC: IN>> PSx	DTOC: IN>> dynamic PSx
set 1	017 003	017 081	017 009	017 086
set 2	073 015	073 035	073 016	073 036
set 3	074 015	074 035	074 016	074 036
set 4	075 015	075 035	075 016	075 036

* 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

8 220 S877509A

3-89 *Residual current stages*

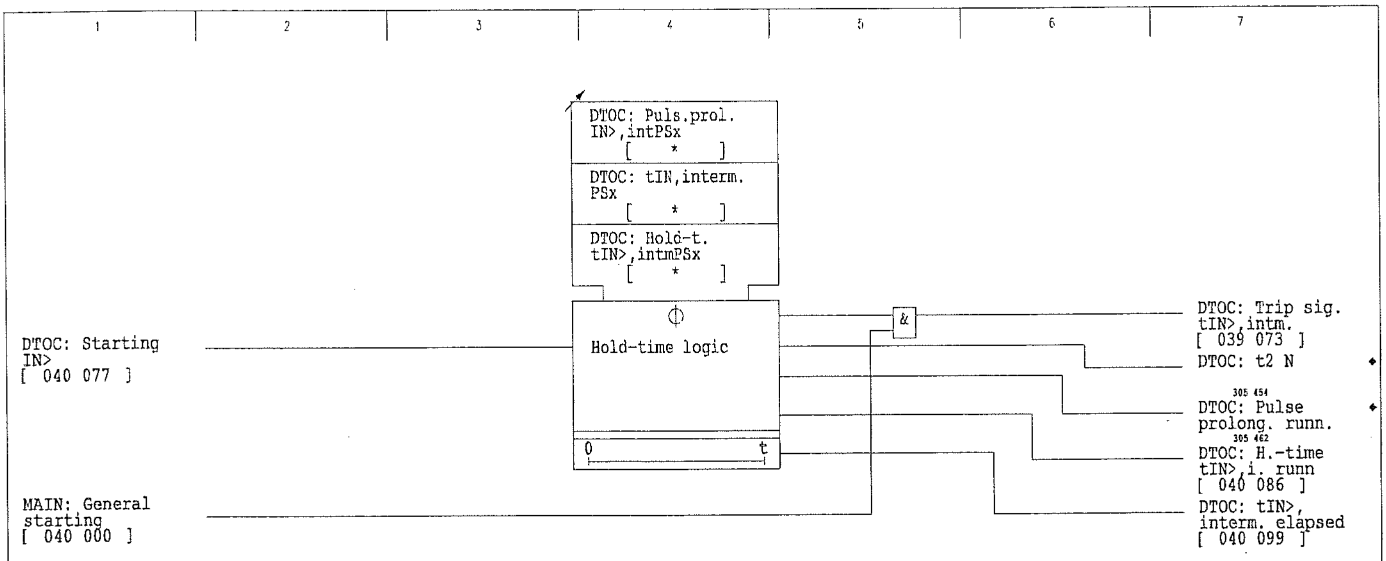


3-90 *Trip signals of the DTOC residual current stages*

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 P130C.

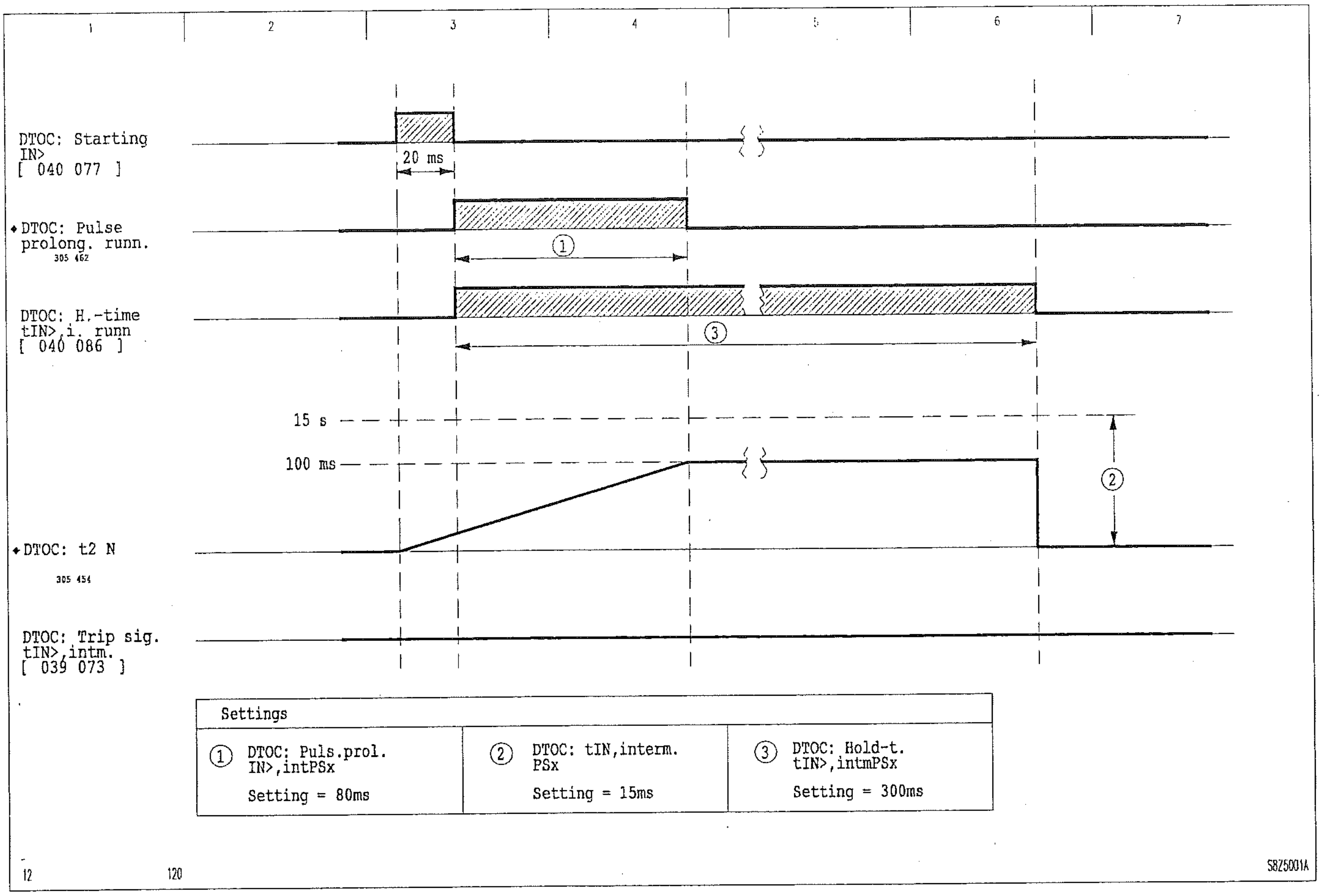
- □ As the I_N> starting in the residual current stage starts, the hold time is reset. At the same time, the starting time is accumulated at the onset of I_N> starting.
- □ As I_E> starting ends, the timer stage DTOC: Puls.prol.IN>,intPSx is started and the charging of the accumulation buffer is thereby 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.



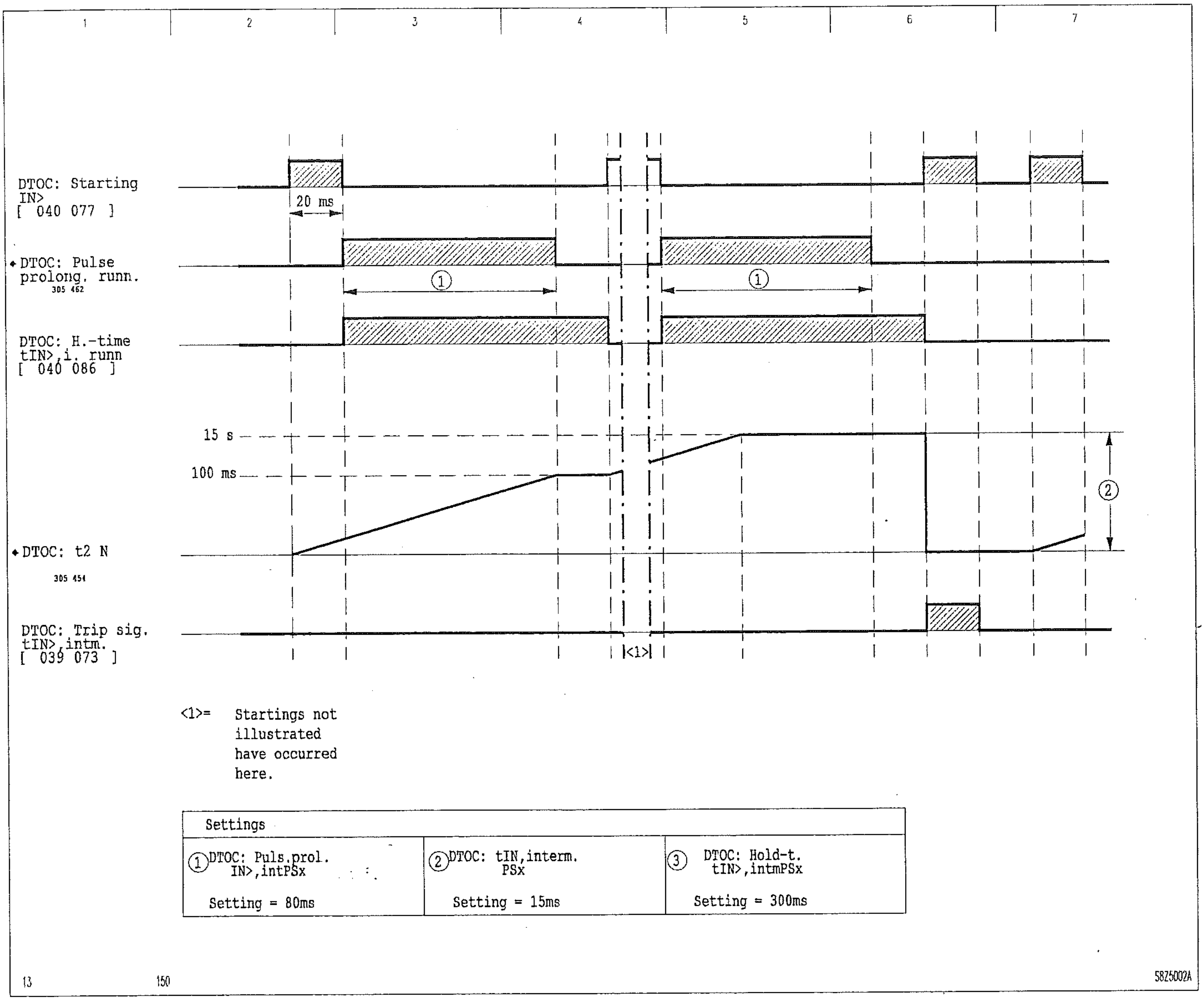
* Parameter	DTOC: Puls.prol. IN>,intPSx	DTOC: tIN,interm. PSx	DTOC: Hold-t. tIN>,intmPSx
set 1	017 055	017 056	017 057
set 2	073 042	073 038	073 039
set 3	074 042	074 038	074 039
set 4	075 042	075 038	075 039

11 100 19Z5019A

3-91 *Hold-time logic for definite-time characteristics*



3-92 *Signal flow for values below the accumulation limit value*



3-93 *Signal flow for values at the accumulation limit value*

3.22 Inverse-Time Overcurrent Protection (Function Group IDMT)

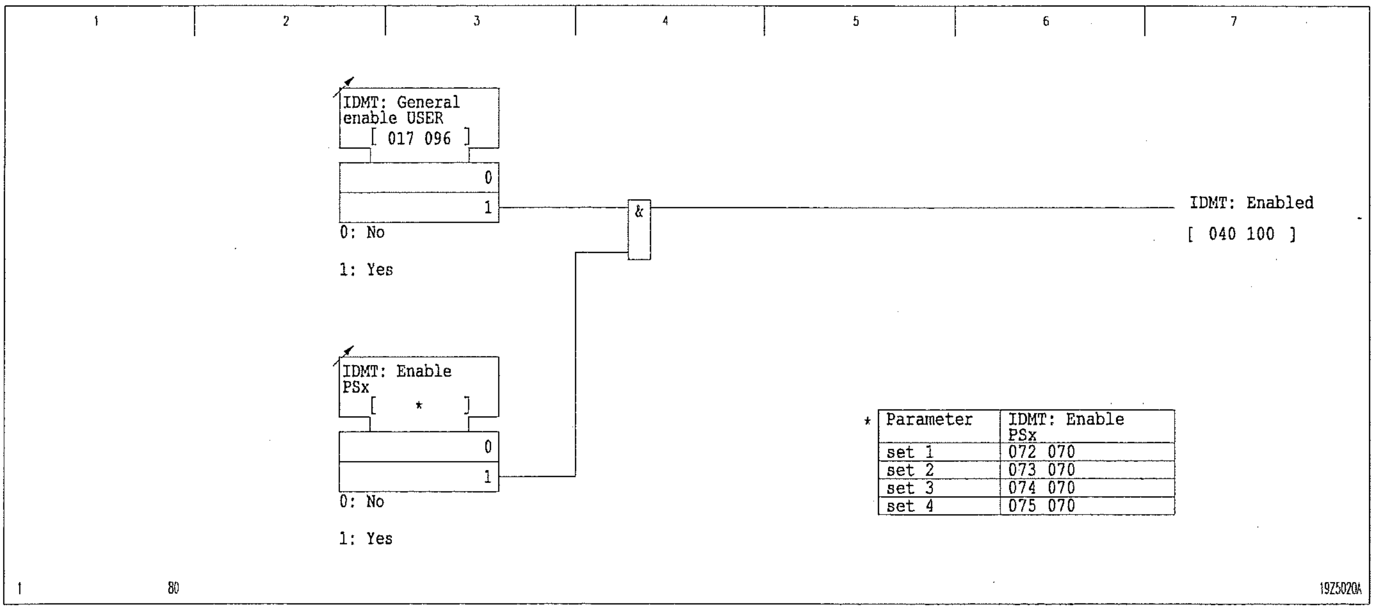
The inverse-time overcurrent protection (IDMT) function operates with three separate measuring systems:

- Phase currents
- Negative-sequence current
- Residual current

Either the short-circuit direction determination function or the auto-reclosing control may intervene in the functional sequence of the IDMT function.

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.

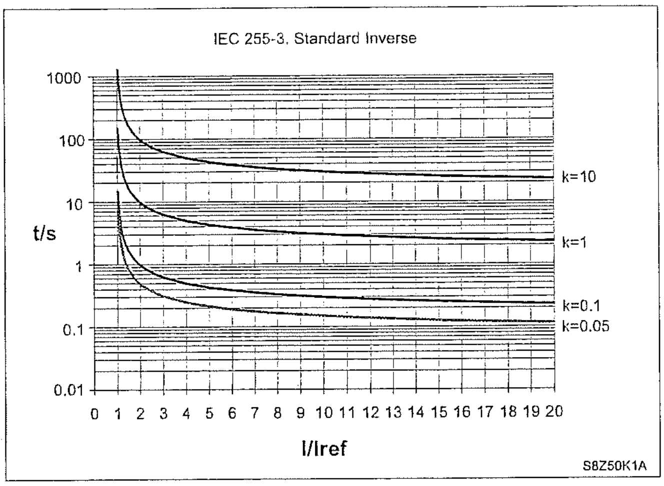


3-94 *Disabling or enabling IDMT protection*

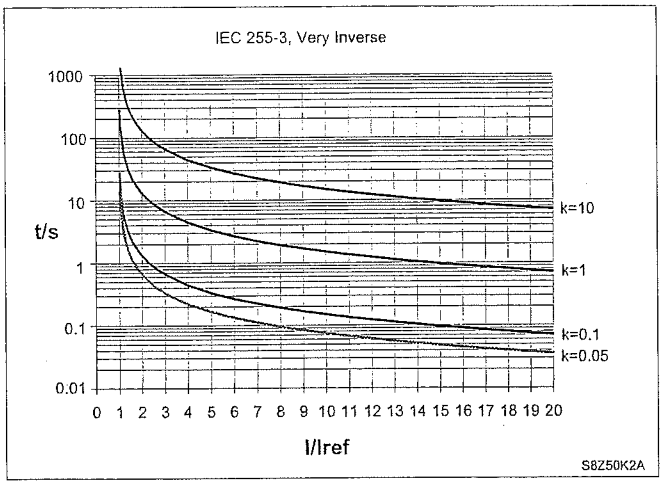
Time-dependent characteristics

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 3-95 to 3-98 .

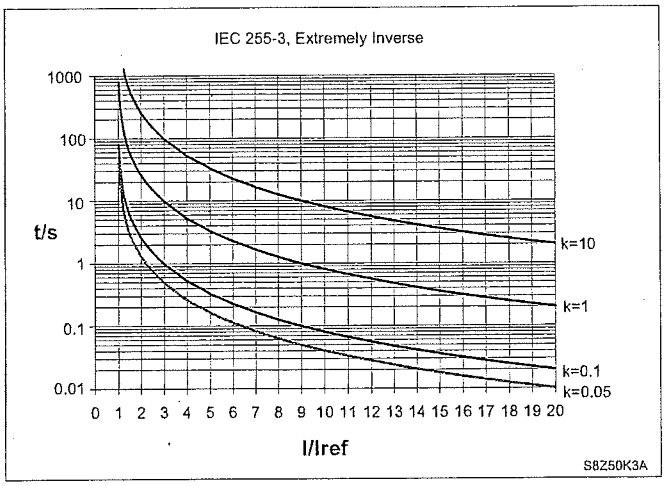
No.	Tripping Characteristic k = 0.01 to 10.00	Formula for the Tripping Characteristic	Constants a	 b	 c	Formula for the Release Characteristic	 R
0	Definite Time	$t = k$					
	Per IEC 255-3	$t = k \cdot \frac{a}{\left(\frac{I}{I_{ref}}\right)^{b} - 1}$					
1	Standard Inverse		0.14	0.02			
2	Very Inverse		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	$t = k \cdot \left(5.8 - 1.35 \cdot \ln \frac{I}{I_{ref}} \right)$					



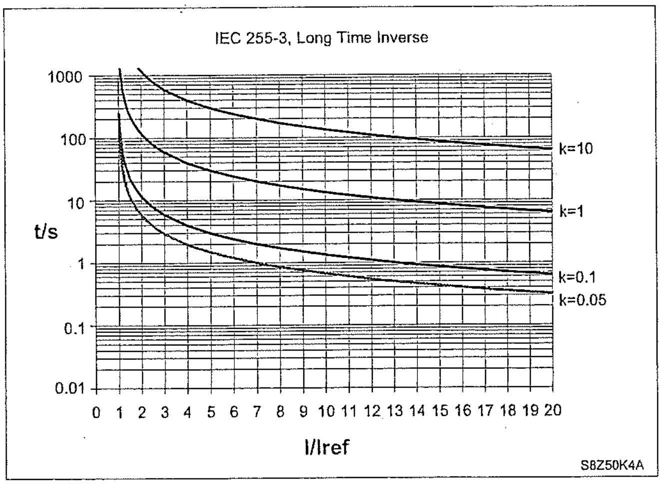
Characteristic No. 1



Characteristic No. 2

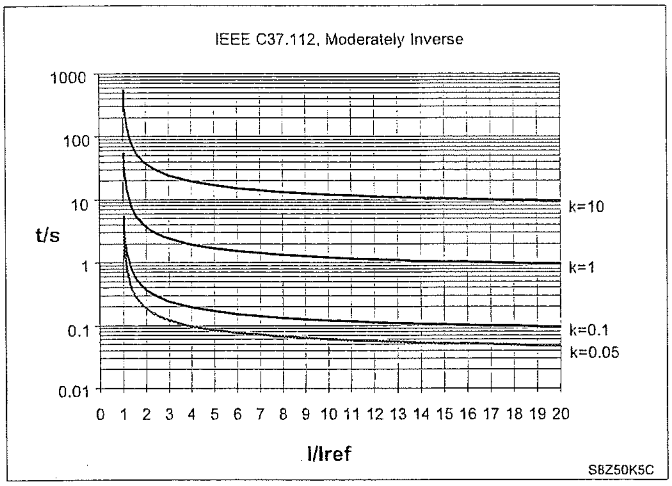


Characteristic No. 3

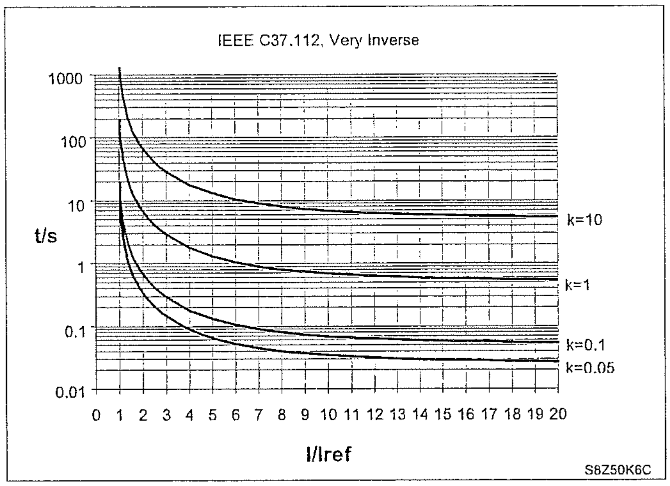


Characteristic No. 4

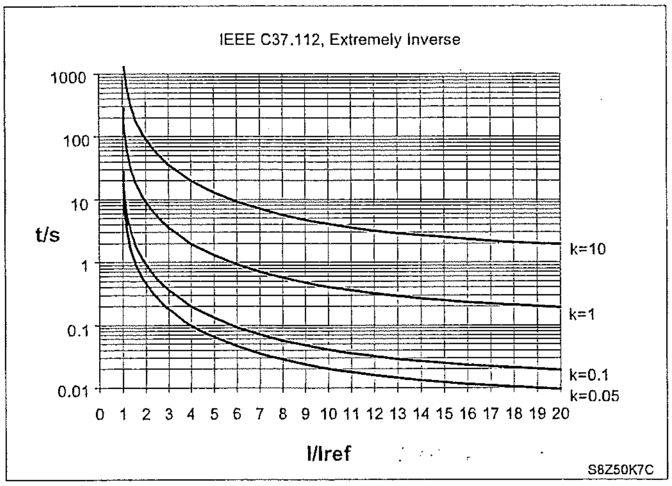
3-95 *Tripping characteristics per IEC 255-3*



Characteristic No. 5

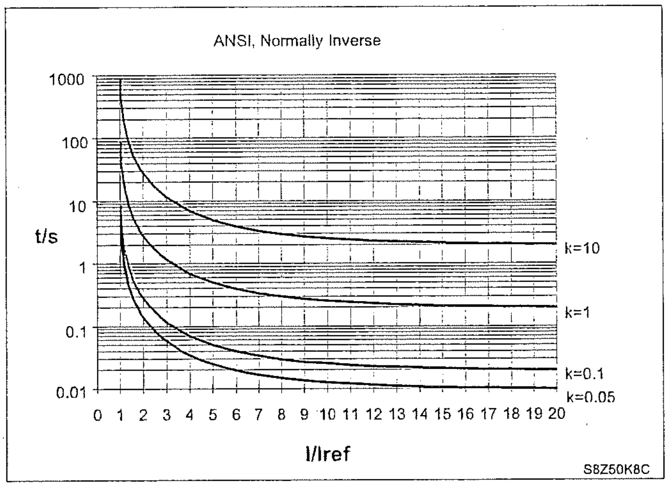


Characteristic No. 6

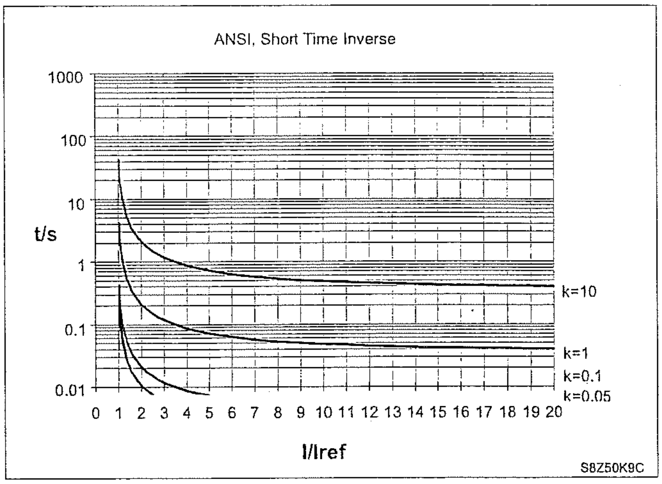


Characteristic No. 7

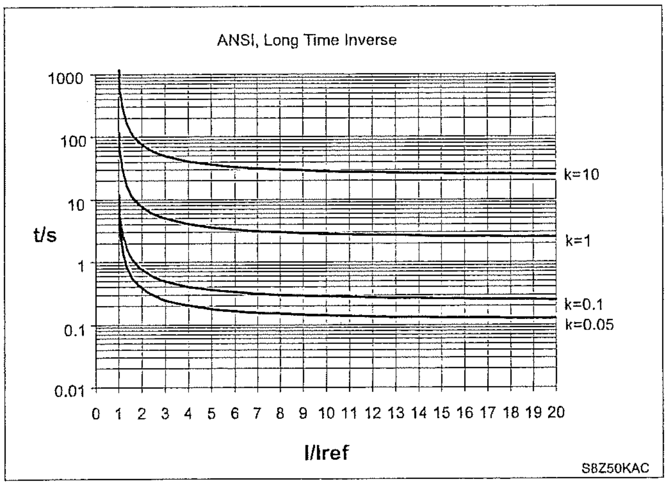
3-96 Tripping characteristics per IEEE C37.112



Characteristic No. 8

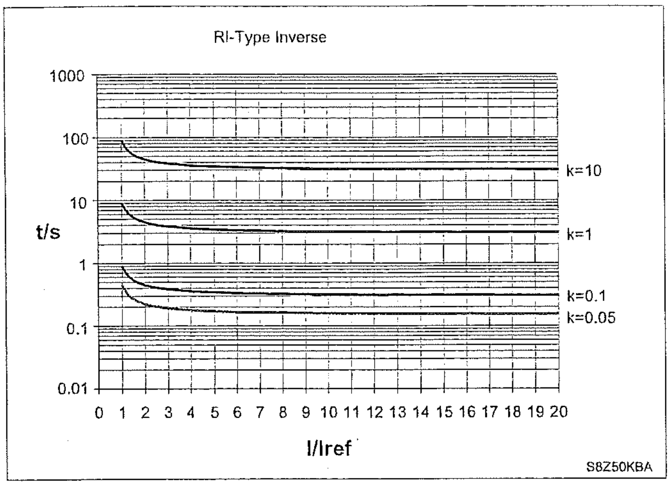


Characteristic No. 9

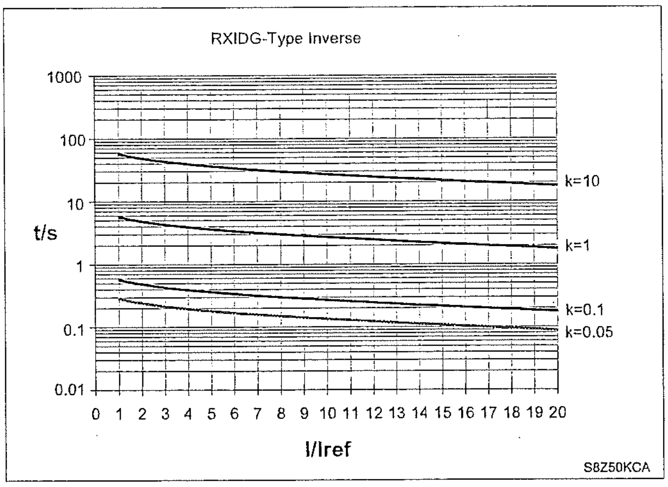


Characteristic No. 10

3-97 *Tripping characteristics per ANSI*



Characteristic No. 11



Characteristic No. 12

3-98 *RI-type inverse and RXIDG-type inverse tripping characteristics*

Phase current stage

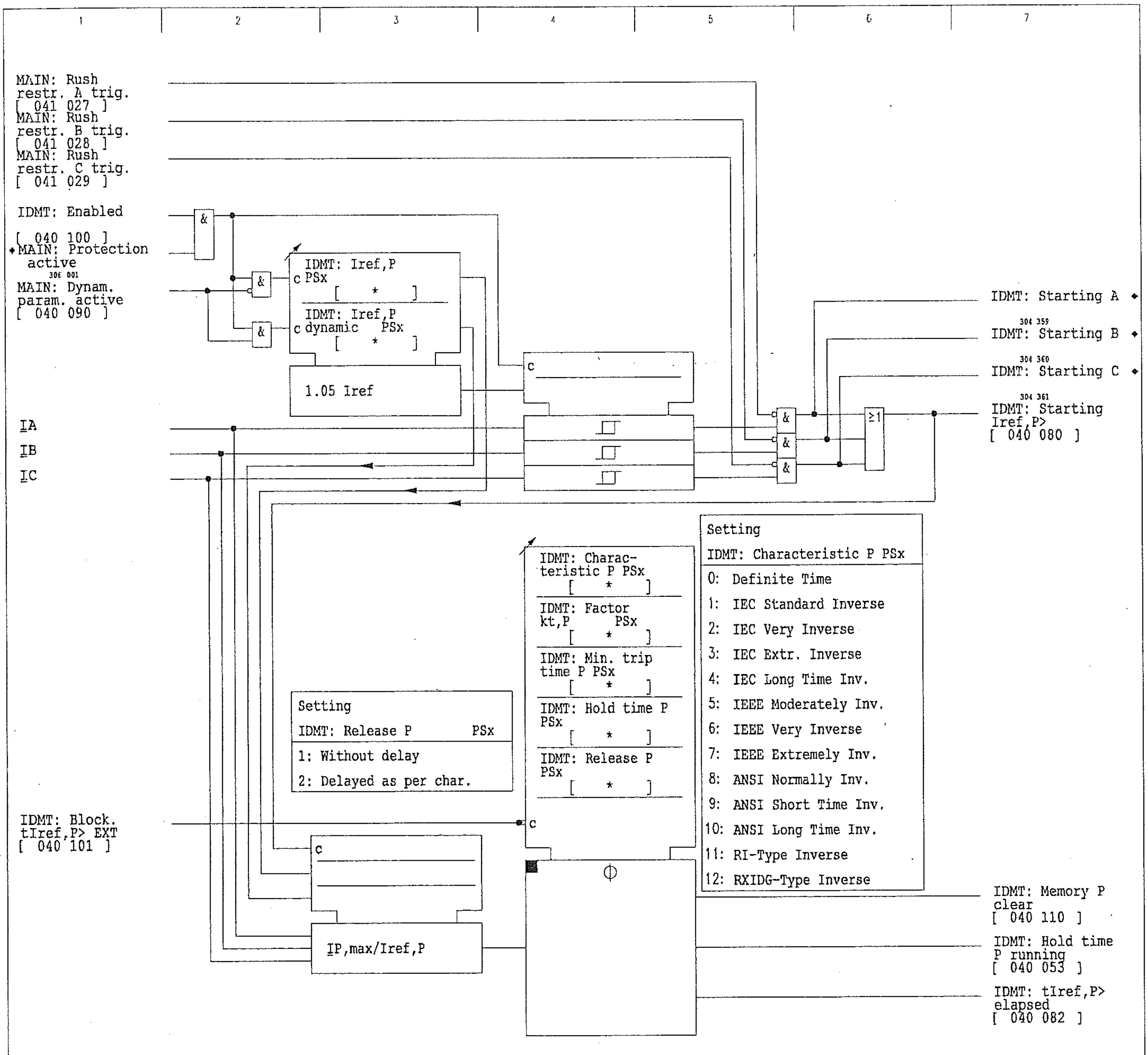
The three phase currents are monitored by the P130C to detect when they exceed the set thresholds. Alternatively, two different threshold types can be active. The “dynamic” threshold is active for the set hold time of the “dynamic parameters” (see “Activation of Dynamic Parameters”); the “normal” threshold 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 P130C determines the highest of the three phase currents for further processing. As a function of this current and of the set characteristic, the P130C 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 P130C’) is triggered, the phase current stage is blocked.

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

The trip signal of the IDMT protection function is blocked by the auto-reclosing control function (ARC) if the ARC is able to form a trip command.

The trip signal of the IDMT function can be blocked by the short-circuit direction determination function. Depending on the settings for the short-circuit direction determination function, the trip signal may be enabled.

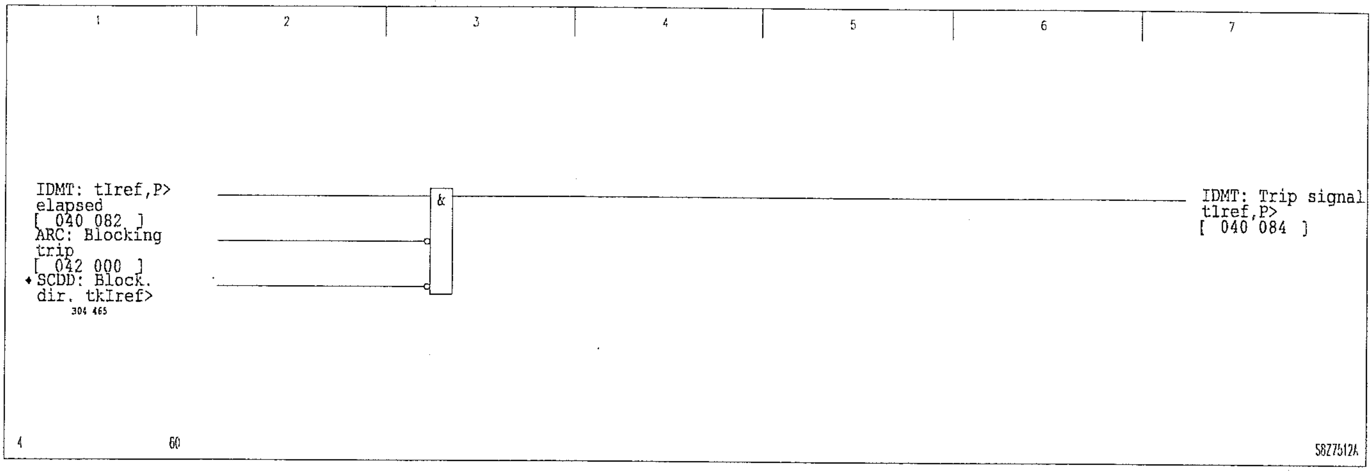


* Parameter	IDMT: Iref,P PSx	IDMT: Iref,P dynamic PSx	IDMT: Charac- teristic P PSx	IDMT: Factor kt,P PSx
set 1	072 050	072 003	072 056	072 053
set 2	073 050	073 003	073 056	073 053
set 3	074 050	074 003	074 056	074 053
set 4	075 050	075 003	075 056	075 053

* Parameter	IDMT: Min. trip time P PSx	IDMT: Hold time P PSx	IDMT: Release 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 1025008A

3-99 *Phase current stage*



3-100 *Trip signal of the phase current stage*

Negative-sequence current stage

The P130C 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:

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

$$\underline{a} = e^{j120°}$$

$$\underline{a}^2 = e^{j240°}$$

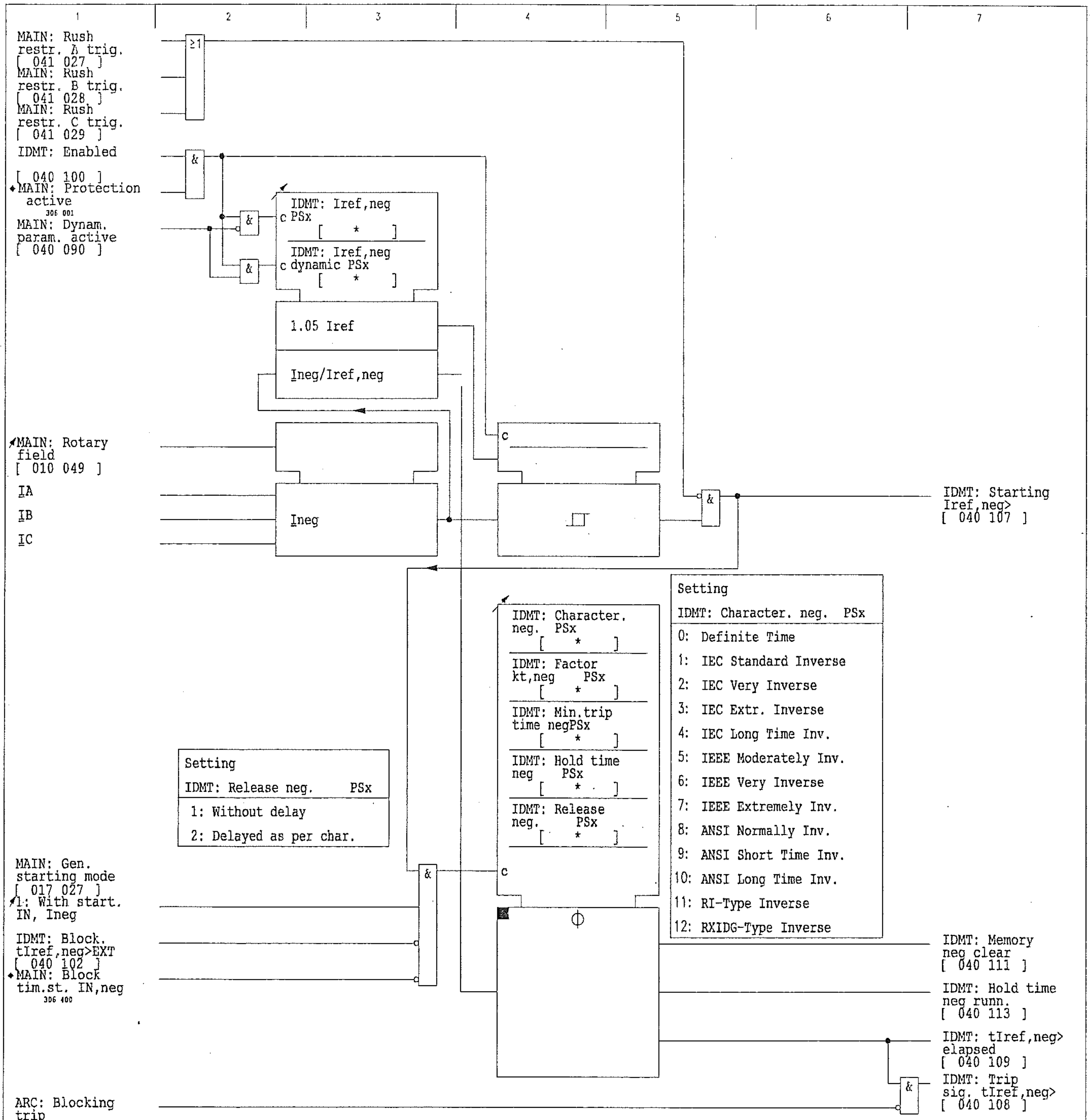
The negative-sequence current is monitored by the P130C to detect when it exceeds the set thresholds. Alternatively, two different threshold types can be active. The "dynamic" threshold is active for the set hold time of the "dynamic parameters" (see "Activation of Dynamic Parameters"); the "normal" 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 P130C 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 P130C') 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.

If short-circuit direction determination is enabled, then the trip signal issued by the IDMT negative-sequence current stage is always non-directional.

The trip signals of the negative-sequence current stage are blocked by the auto-reclosing control function (ARC) if the ARC is able to form a trip command.



*

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

*

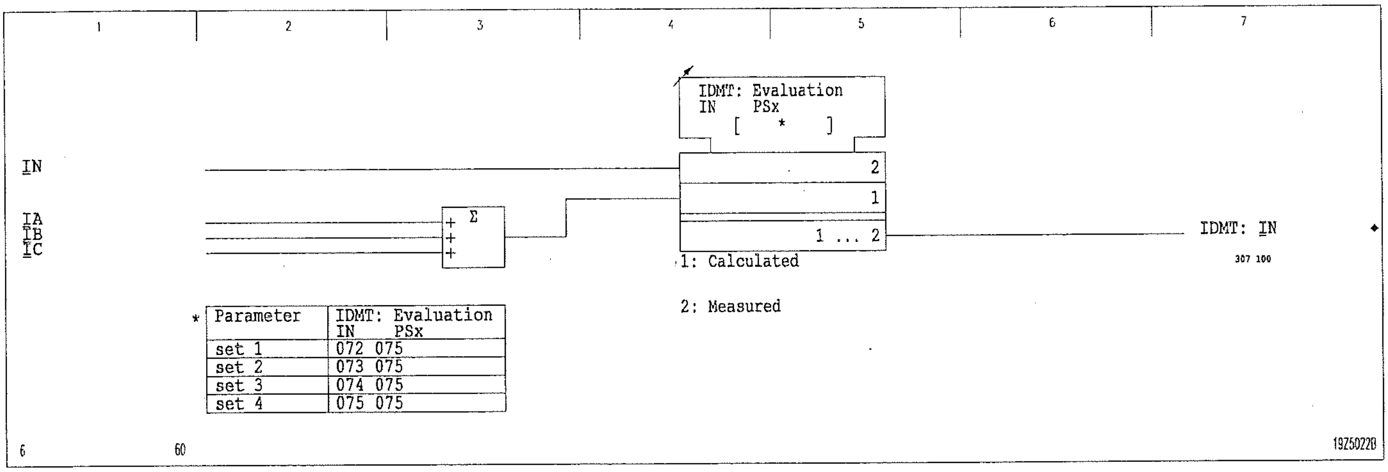
Parameter	IDMT: Min.trip time negPSx	IDMT: Hold time neg PSx	IDMT: Release neg. PSx
set 1	072 078	072 072	072 060
set 2	073 078	073 072	073 060
set 3	074 078	074 072	074 060
set 4	075 078	075 072	075 060

5 220 10Z5009A

3-101 *Negative-sequence current stage*

Selection of measured variables for the residual current stage

A setting specifies which current will be used by the P130C as the residual current: either the residual current calculated from the three phase currents or the residual current measured at the fourth transformer.



3-102 Selecting the measured variable

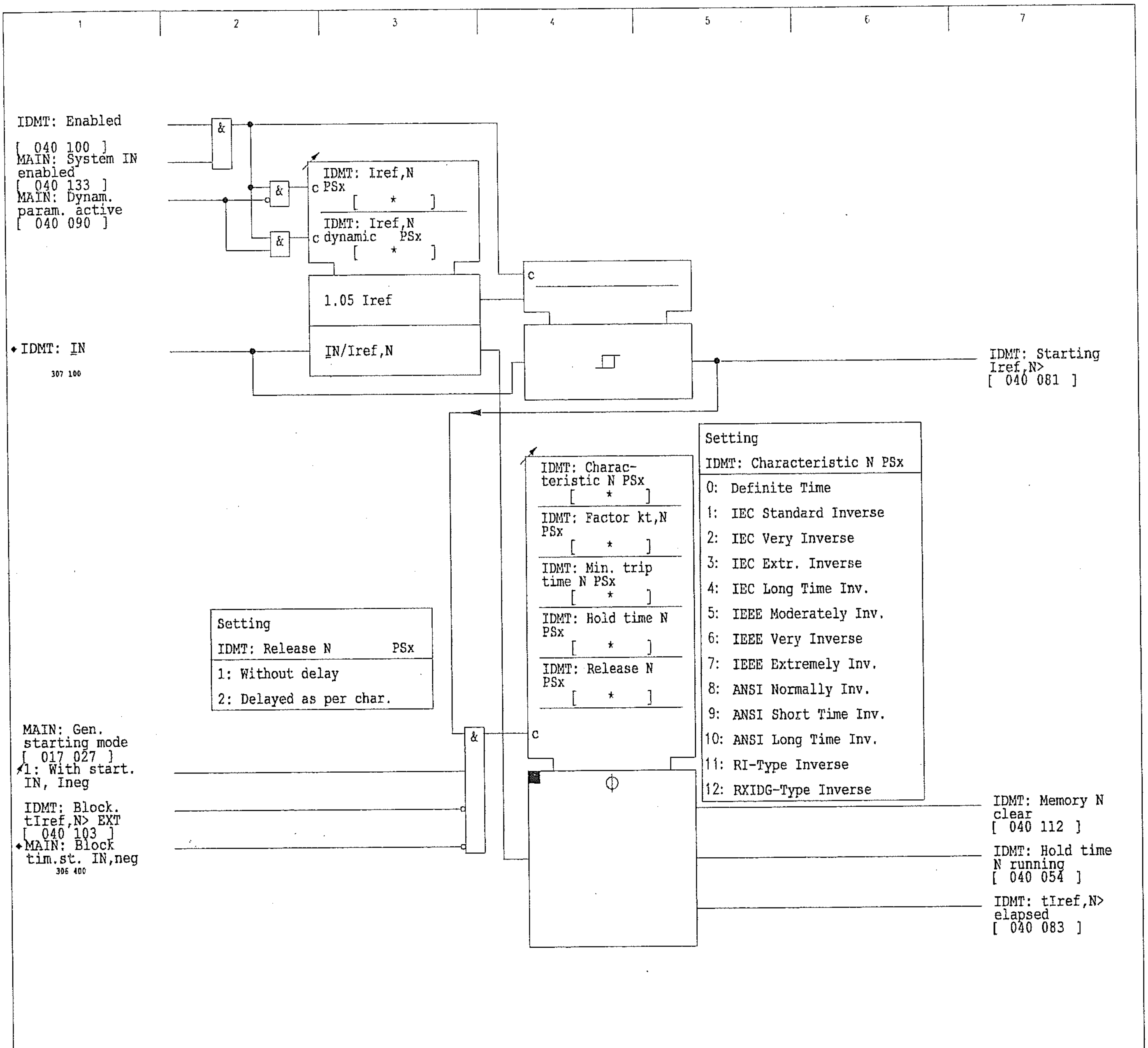
Residual current stage

The residual current is monitored by the P130C 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 P130C 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.

The trip signal of the IDMT protection function is blocked by the auto-reclosing control function (ARC) if the ARC is able to form a trip command.

The trip signal of the IDMT function can be blocked by the short-circuit direction determination function. Depending on the settings for the short-circuit direction determination function, the trip signal may be enabled.



*

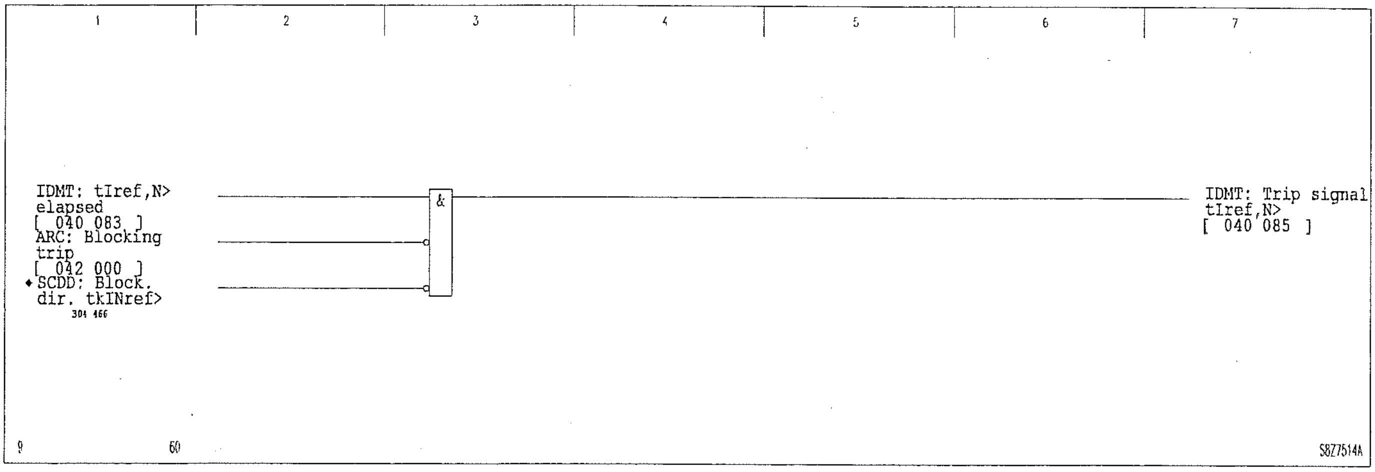
Parameter	IDMT: Iref,N PSx	IDMT: Iref,N dynamic PSx	IDMT: Characteristic N PSx	IDMT: Factor kt,N PSx
set 1	072 052	072 005	072 058	072 055
set 2	073 052	073 005	073 058	073 055
set 3	074 052	074 005	074 058	074 055
set 4	075 052	075 005	075 058	075 055

*

Parameter	IDMT: Min. trip time N PSx	IDMT: Hold time N PSx	IDMT: Release 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

7 205 12Z5010A

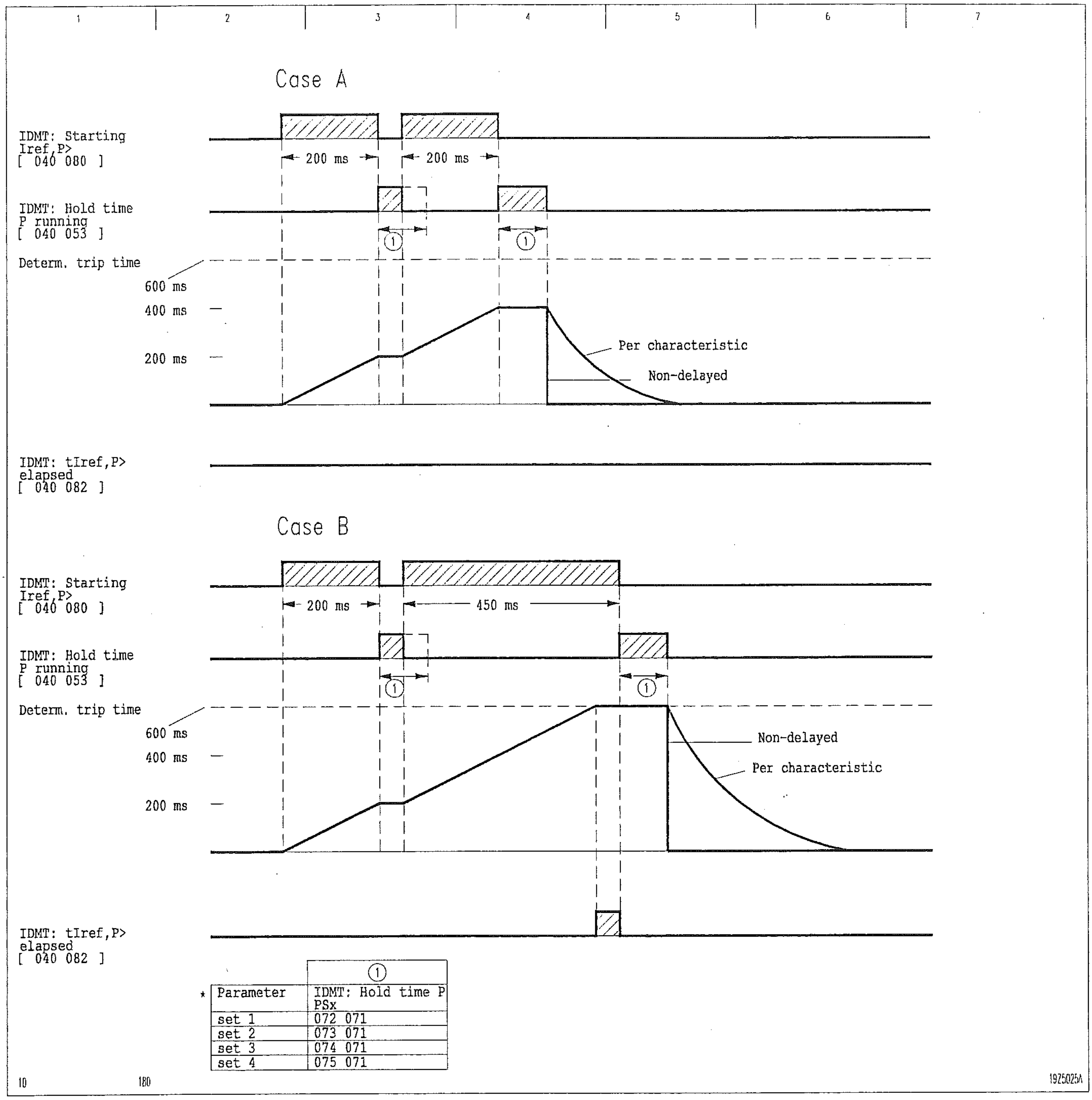
3-103 Residual current stage



3-104 *Trip signal of the residual current stage*

Holding time

As a function of the current, the P130C 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 P130C 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 3-105.



*	①
Parameter	IDMT: Hold time P PSx
set 1	072 071
set 2	073 071
set 3	074 071
set 4	075 071

3-105. 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

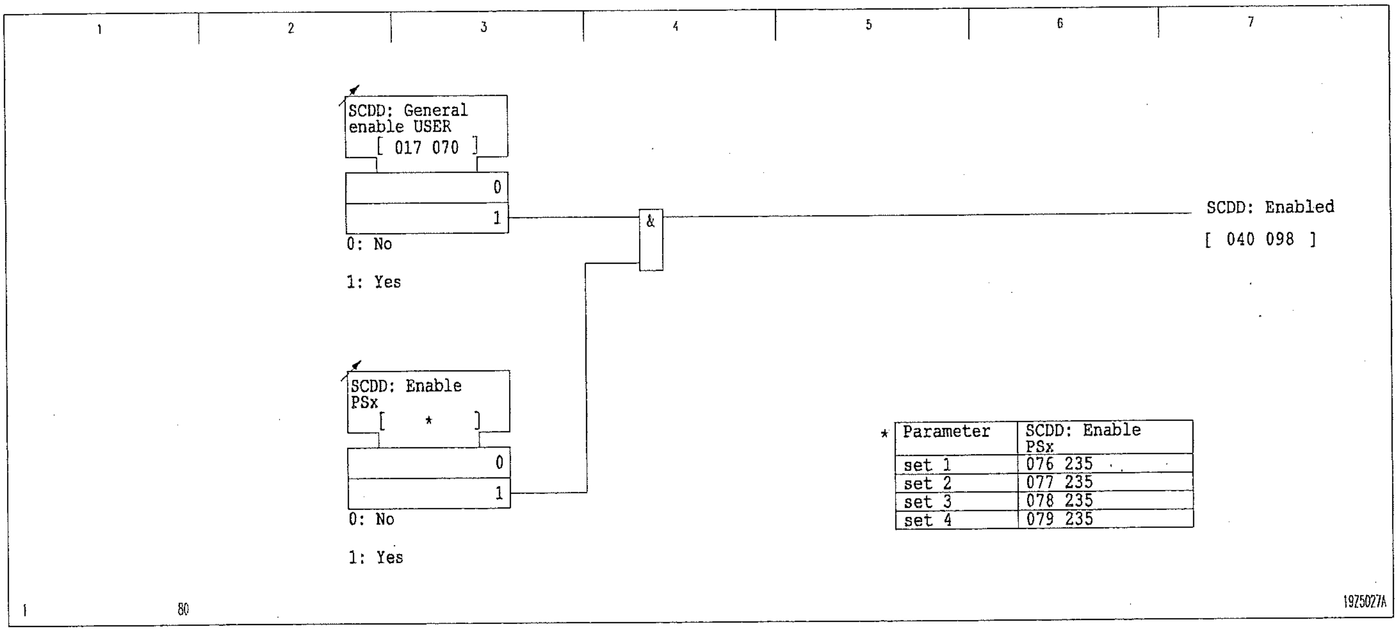
3.23 Short-Circuit Direction Determination (Function Group SCDD)

A short-circuit direction determination function (SCDD) has been implemented in the P130C. Thus the P130C can be used as a directional definite-time overcurrent protection device and also as a directional inverse-time overcurrent protection device. Two separate measuring systems are available for this purpose:

- Phase currents system
- Residual currents system

Disabling and enabling short-circuit direction determination

Short-circuit direction determination can be disabled or enabled from the local control panel. Moreover, enabling can be carried out separately for each parameter set.



* Parameter	SCDD: Enable PSx
set 1	076 235
set 2	077 235
set 3	078 235
set 4	079 235

3-106 *Disabling and enabling short-circuit direction determination*

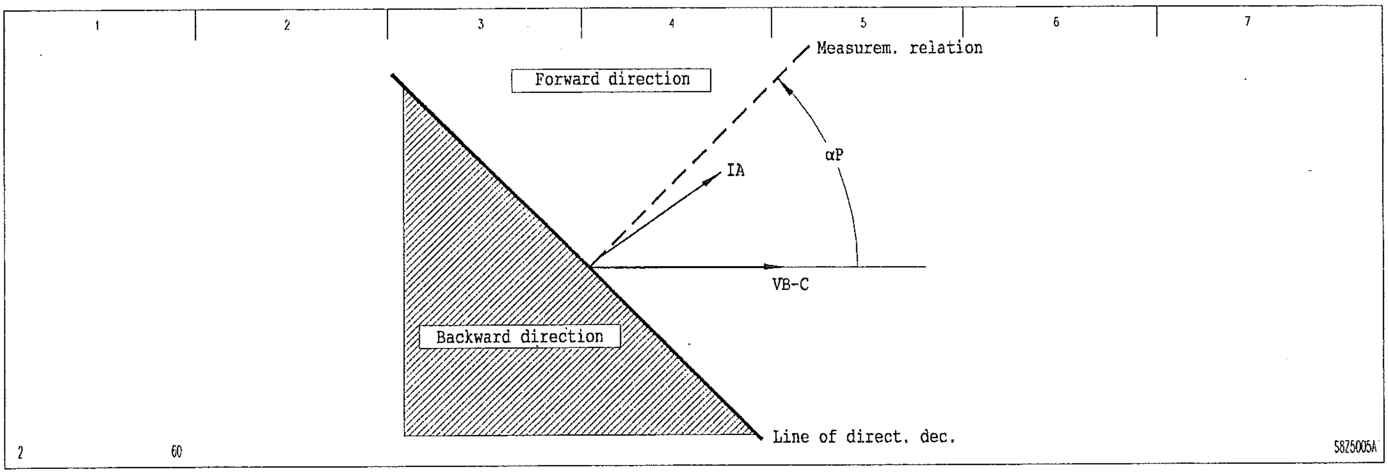
Phase current stages

For direction determination of phase current stages, a phase current and the phase-to-phase voltage opposite this current are selected as a function of fault type, and an optimum characteristic angle is used.

For a single-pole fault in A-G, for example, the current A and the voltage V_{B-C} are selected as measured variables, and a characteristic angle α_P of +45° is used (see Figure 3-107).

The reference quantity is the vector of the selected phase-to-phase voltage. The characteristic angle α_P specifies the measurement relation to the reference quantity. Different characteristic angles corresponding to fault type are specified by the P130C. The measuring position is defined as the bisector of the 'forward' direction zone. The forward direction applies if the vector of the selected phase current is in the range ≤ ± 90° of the measurement relation.

The backward direction applies if the vector of the selected phase current is in the range > ± 90° of the measurement relation.



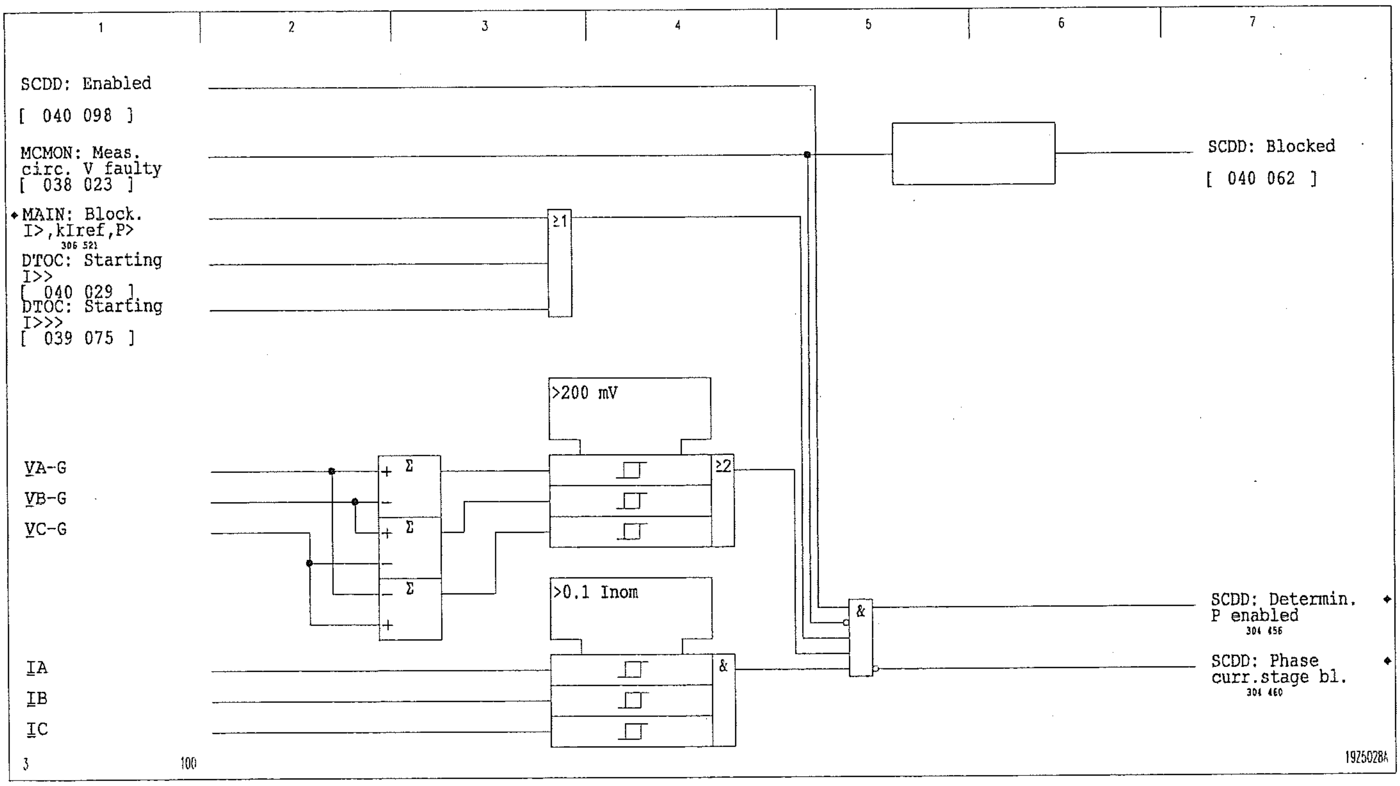
3-107 *Example of formation of phase current stage direction decision with a single-pole fault in A-G, an inductive system, and a clockwise rotary field*

Enabling the phase current stages

The direction determination function of the phase current stages is enabled if the following conditions are satisfied simultaneously:

- ☐ The short-circuit direction determination function is enabled.
- ☐ The measuring-circuit monitoring function has not identified any errors in the voltage measuring circuit (see Measuring-Circuit Monitoring).
- ☐ A phase starting signal is present.
- ☐ At least two phase-to-phase voltages are greater than 200 mV.
- ☐ All three phase currents are greater than 0.1 I_{nom}.
- ☐ There is no external signal MAIN: M.c.b. trip V EXT.

If there is no enable for direction determination, then the following internal signal is generated: SCDD: Phase curr. stage bl.

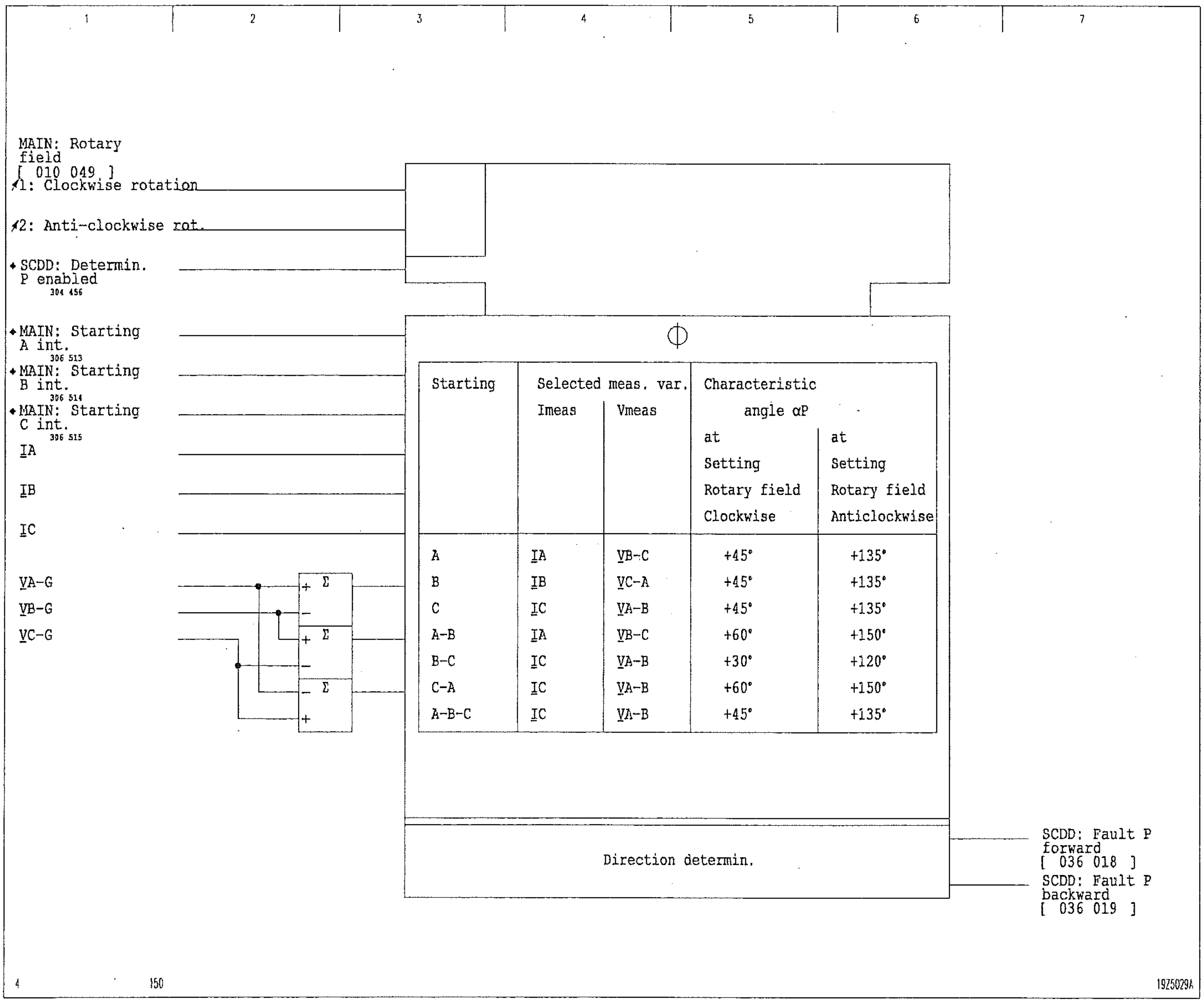


3-108 *Enable for the direction determination function of the phase current stages*

After direction determination is enabled, one of the following two signals is generated, depending on the measurement decision:

- ☐ In the case of a fault in the forward direction,
  `SCDD: Fault P forward.`
- ☐ In the case of a fault in the backward direction,
  `SCDD: Fault P backward.`

To control transient competition problems, the release of a direction decision in both directions is delayed by 30 ms.



Starting	Selected meas. var. Imeas	Vmeas	Characteristic angle αP at Setting Rotary field Clockwise	at Setting Rotary field Anticlockwise
A	IA	VB-C	+45°	+135°
B	IB	VC-A	+45°	+135°
C	IC	VA-B	+45°	+135°
A-B	IA	VB-C	+60°	+150°
B-C	IC	VA-B	+30°	+120°
C-A	IC	VA-B	+60°	+150°
A-B-C	IC	VA-B	+45°	+135°

3-109 Direction determination of the phase current stages

Formation of the blocking signal for the phase current stages

For the formation of the blocking signal for the two DTOC phase current stages and the single IDMT phase current stage, the fault direction for evaluating the measurement decision can be separately set, once the user has selected *forward*, *backward* or *non-directional*.

A blocking signal for the first DTOC phase current stage is formed if one of the following conditions is met:

- ☐ The direction for $t_{I>}$ is set on forward, and the short-circuit direction determination function identifies a fault in the backward direction.
- ☐ The direction for $t_{I>}$ is set on backward, and the short-circuit direction determination function identifies a fault in the forward direction.

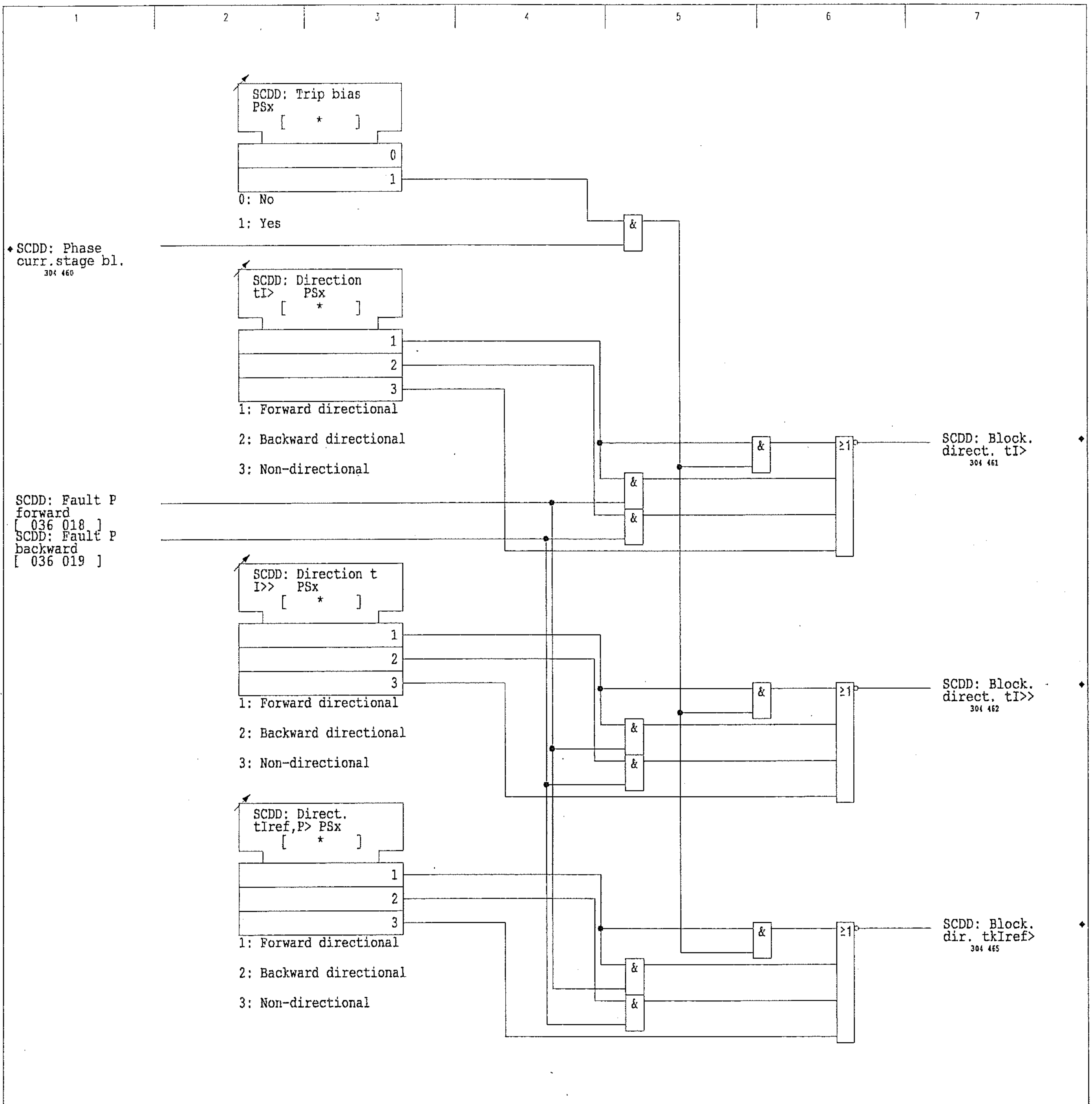
A blocking signal for the second DTOC phase current stage is formed if one of the following conditions is met:

- ☐ The direction for $t_{I>}$ is set on forward, and the short-circuit direction determination function identifies a fault in the backward direction.
- ☐ The direction for $t_{I>}$ is set on backward, and the short-circuit direction determination function identifies a fault in the forward direction.

A blocking signal for the IDMT phase current stage is formed if one of the following conditions is met:

- ☐ The direction for $t_{Iref,P>}$ is set on forward, and the short-circuit direction determination function identifies a fault in the backward direction.
- ☐ The direction for $t_{Iref,P>}$ is set on backward, and the short-circuit direction determination function identifies a fault in the forward direction.

If there is no enable for direction determination (in the case of m.c.b. trip, for example), the user may specify at `SCDD: Trip bias PSx` whether stages set to *forward* shall be operated with trip bias.



* Parameter	SCDD: Trip bias PSx	SCDD: Direction tI> PSx	SCDD: Direction t I>> PSx	SCDD: Direct. tIref,P> PSx
set 1	017 074	017 071	017 072	017 066
set 2	077 236	077 237	077 238	077 233
set 3	078 236	078 237	078 238	078 233
set 4	079 236	079 237	079 238	079 233

3-110 *Formation of the blocking signals for the phase current stage*

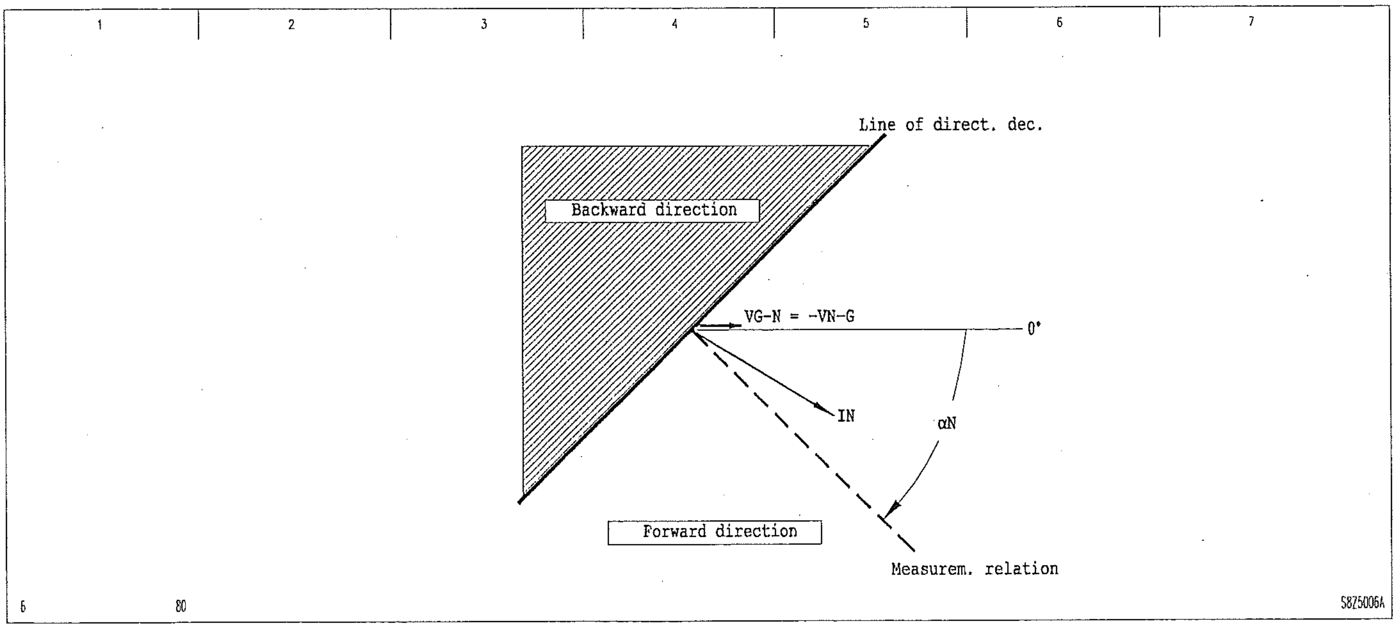
Residual current stages

The measured residual current $\underline{I}_N$ and the neutral displacement voltage $\underline{V}_{G-N} = -\underline{V}_{N-G}$ are used for the direction determination function of the residual current stages. The user must specify a favorable characteristic angle in accordance with the neutral-point treatment of the power system. The characteristic angle α_N can be set within the range of - 90° to + 90°.

The reference quantity is the vector of the neutral displacement voltage. The characteristic angle specifies the measuring position relative to the reference quantity. The measuring position is defined as the bisector of the 'forward' direction zone. The forward direction applies if the vector of the residual current is in the range of ≤ ± 90° of the measuring position.

The backward direction applies if the vector of the residual current is in the range > ± 90° of the measuring position.

In the following example the system neutral has been grounded with a relatively low resistance. When there is a single-pole fault in A-G and a fault in the forward direction, the residual current will then assume a position approximately like the one shown in Figure 3-111. With a set characteristic angle of α_N = - 45°, a direction decision in the forward direction is issued.

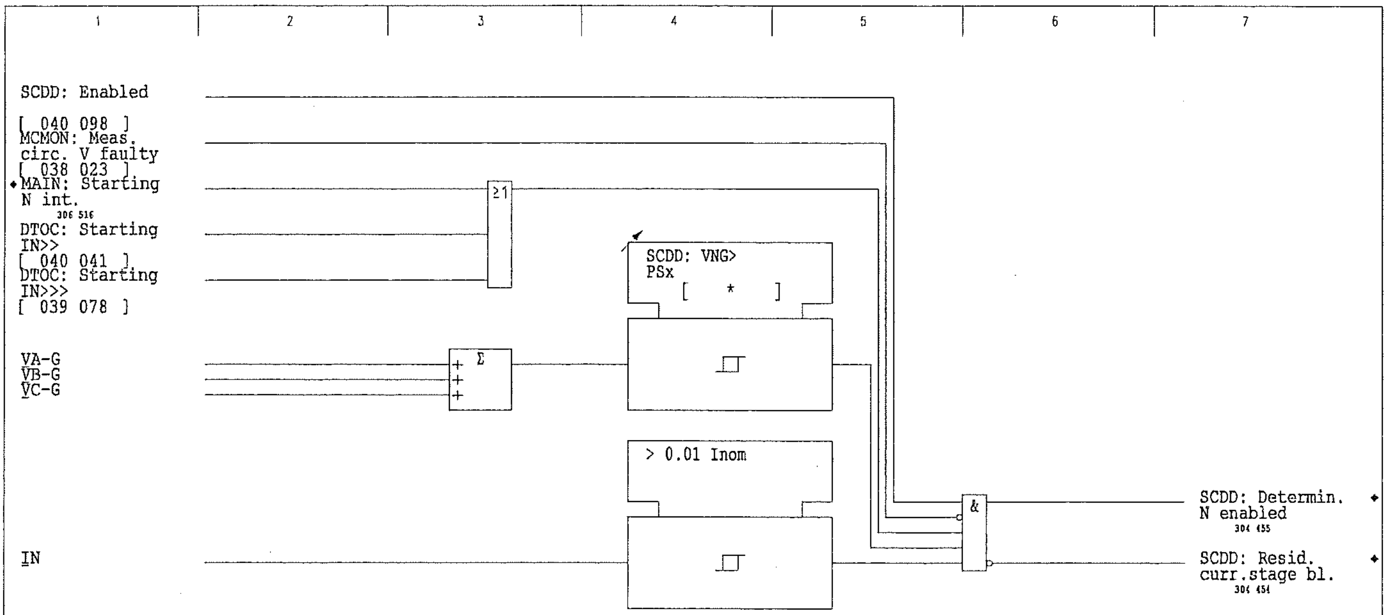


3-111 *Example of direction decision formation for residual current stage*

Enabling the residual current stages

The enable for the direction determination function of the residual current stages is issued if the following conditions are satisfied simultaneously:

- ☐ The short-circuit direction determination function is enabled.
- ☐ The short-circuit direction determination function is not blocked by measuring circuit monitoring (see 'Measuring Circuit Monitoring').
- ☐ A zero-sequence starting signal is present.
- ☐ The residual current is greater than $0.01 \cdot I_{nom}$.
- ☐ There is no external signal MAIN: M.c.b. trip V EXT.
- ☐ The neutral displacement voltage is greater than the set triggering value of the function SCDD: VNG>.



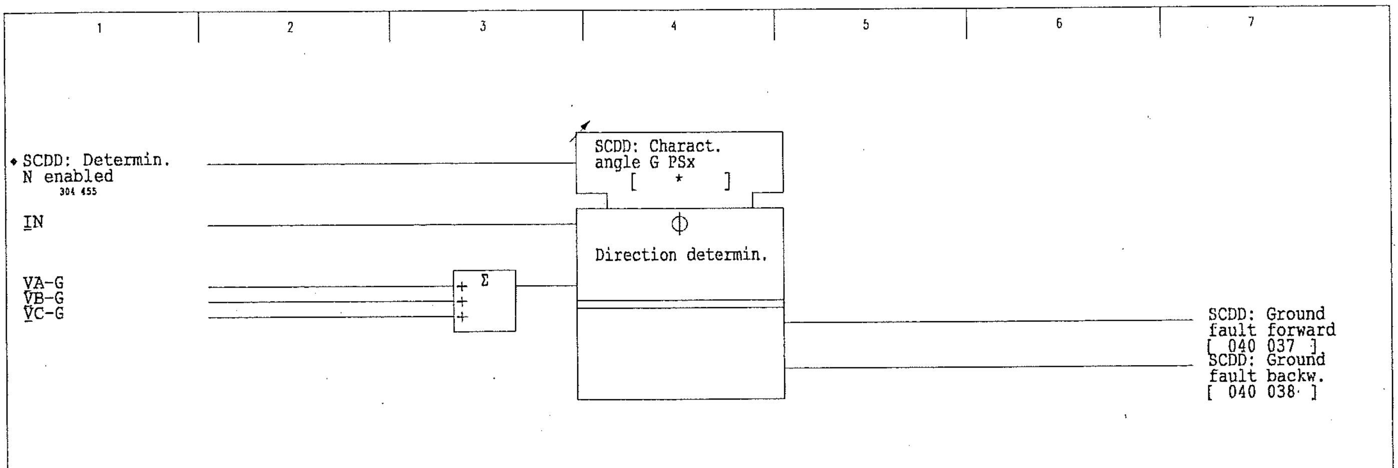
* Parameter	SCDD: VNG> PSx
set 1	017 077
set 2	077 244
set 3	078 244
set 4	079 244

3-112 *Enable for the direction determination function of the residual current stages*

After direction determination is enabled, one of the following two signals is generated, depending on the measurement decision:

- ☐ If there is a fault in the forward direction, SCDD: Ground fault forward.
- ☐ If there is a fault in the backward direction, SCDD: Ground fault backw.

To control transient competition problems, the release of a direction decision in both directions is delayed by 30 ms.



* Parameter	SCDD: Charact. angle G PSx
set 1	017 076
set 2	077 243
set 3	078 243
set 4	079 243

3-113 *Direction determination of the residual current stages*

Formation of the blocking signal for the residual current stages

For the formation of the blocking signal for the two DTOC residual current stages and the IDMT residual current stage, the fault direction for evaluating the measurement decision can be separately set. once the user has selected *forward*, *backward* or *non-directional*.

A blocking signal for the first DTOC residual current stage is formed if one of the following conditions is met:

- ☐ The direction for $t_{IN>}$ is set on forward, and the short-circuit direction determination function identifies a fault in the backward direction.
- ☐ The direction for $t_{IN>}$ is set on backward, and the short-circuit direction determination function identifies a fault in the forward direction.

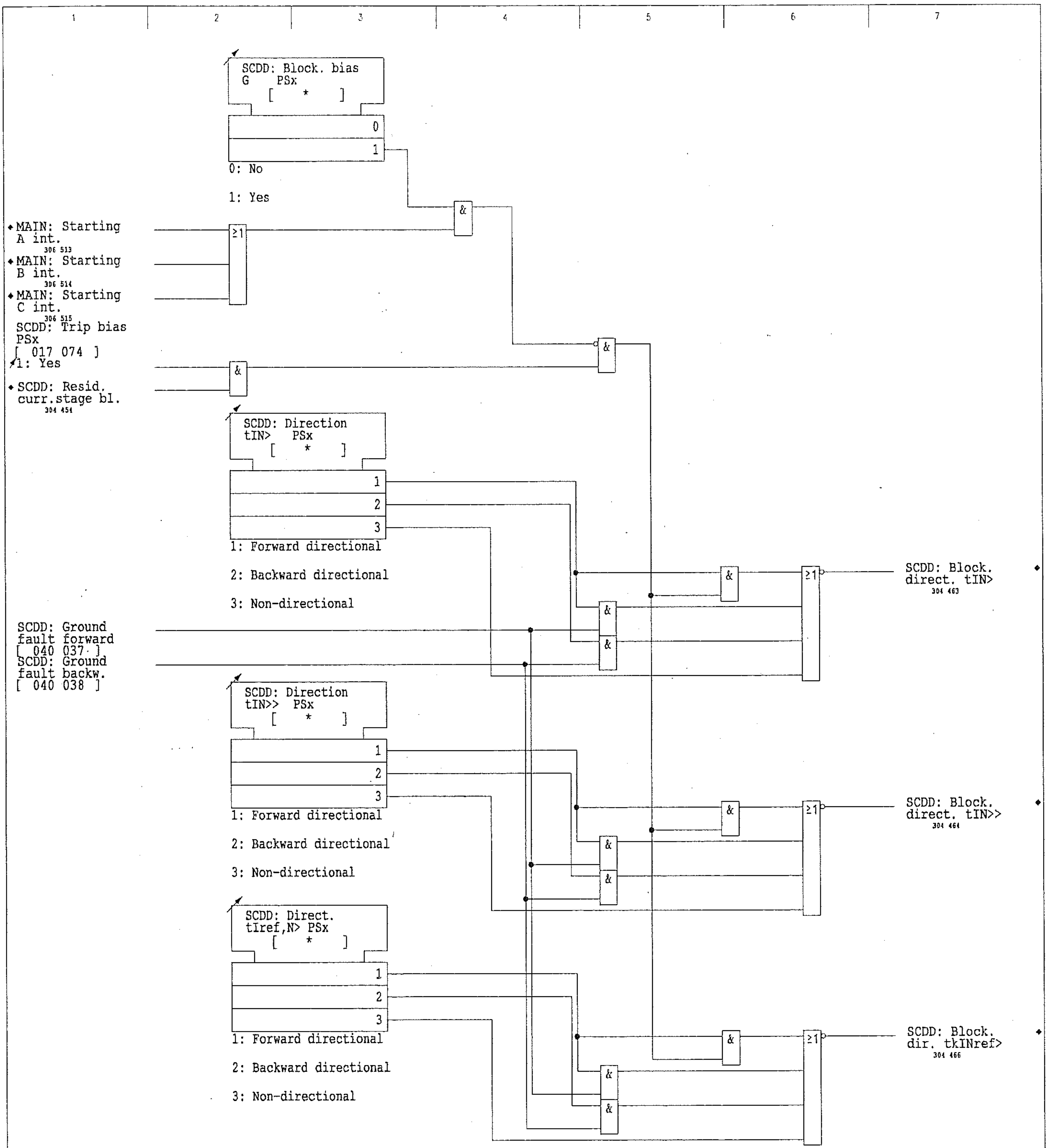
A blocking signal for the IDMT residual current stage is formed if one of the following conditions is met:

- ☐ The direction for $t_{IN>>}$ is set on forward, and the short-circuit direction determination function identifies a fault in the backward direction.
- ☐ The direction for $t_{IN>>}$ is set on backward, and the short-circuit direction determination function identifies a fault in the forward direction.

A blocking signal for the IDMT residual current stage is formed if one of the following conditions is met:

- ☐ The direction for $t_{Iref,P>}$ is set on forward, and the short-circuit direction determination function detects a fault in the backward direction.
- ☐ The direction for $t_{Iref,N>}$ is set on backward, and the short-circuit direction determination function identifies a fault in the forward direction.

If there is no enable for direction determination (in the case of m.c.b. trip, for example), the user may specify at `SCDD: Trip bias PSx)` whether stages set to *forward* shall be operated with trip bias. In the event of phase current starting, the trip bias can be suppressed in the residual current stage by making the appropriate setting at `SCDD: Block. bias G PSx`.



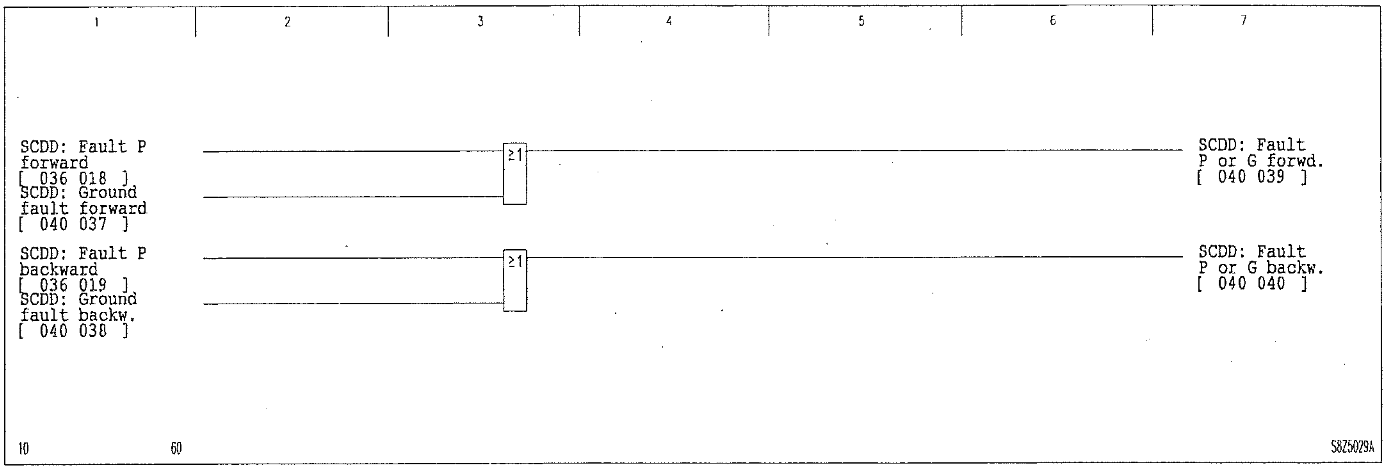
* Parameter	SCDD: Block. bias G PSx	SCDD: Direction tIN> PSx	SCDD: Direction tIN>> PSx	SCDD: Direct. tIref,N> PSx
set 1	017 078	017 073	017 075	017 067
set 2	077 245	077 240	077 241	077 242
set 3	078 245	078 240	078 241	078 242
set 4	079 245	079 240	079 241	079 242

9 220 1975033A

3-114 *Formation of the blocking signals for the residual current stage*

Signaling logic

The signals for fault direction that are generated by the direction determination functions of the phase current and residual current stages are combined into one common function.



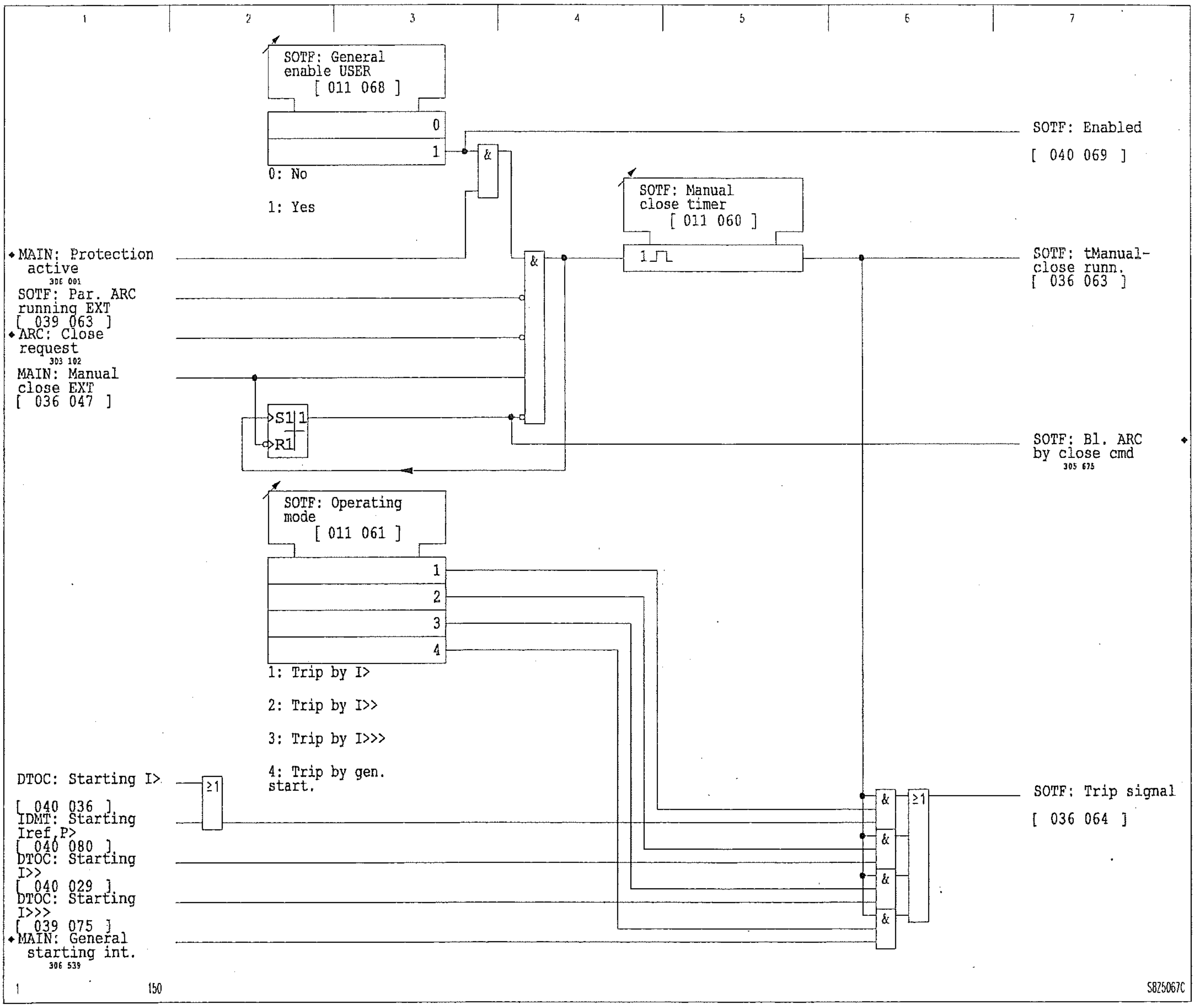
3-115 *Fault signals of phase current stage or residual current stages, forward or backward*

3.24 Switch on to Fault Protection (Function Group SOTF)

When the circuit breaker is closed manually, it is possible to switch on to an existing fault. This is particularly critical since the time-overcurrent protection would not clear the fault until after the set operate delay had elapsed. In this situation, however, the fastest possible clearance is desired.

To ensure rapid clearing with manual closing, the manual close signal must be issued not only to the circuit breaker but also to the P130C at the same time. If there is no close request from the ARC and if no HSR cycle of an external auto-reclosure control is running, an adjustable timer stage is started with the manual close command. By setting a parameter, the user can choose which of the time-overcurrent protection starting decisions will generate a trip signal while the timer stage is elapsing:

An internal blocking signal is generated with the starting signal for the timer stage. This signal prevents the ARC from being activated when a manual close causes switching on to a fault.



3-116 *Switch on to fault protection*

3.25 Protective Signaling (Function Group PSIG)

Protective signaling

Protective signaling is used together with short-circuit direction determination in power systems with single-side infeed and a subsequent parallel line configuration (line section). Selective instantaneous clearing of the line section affected by the fault is initiated by this function, while the IDMT or DTOC tripping times are bypassed.

Disabling or enabling protective signaling

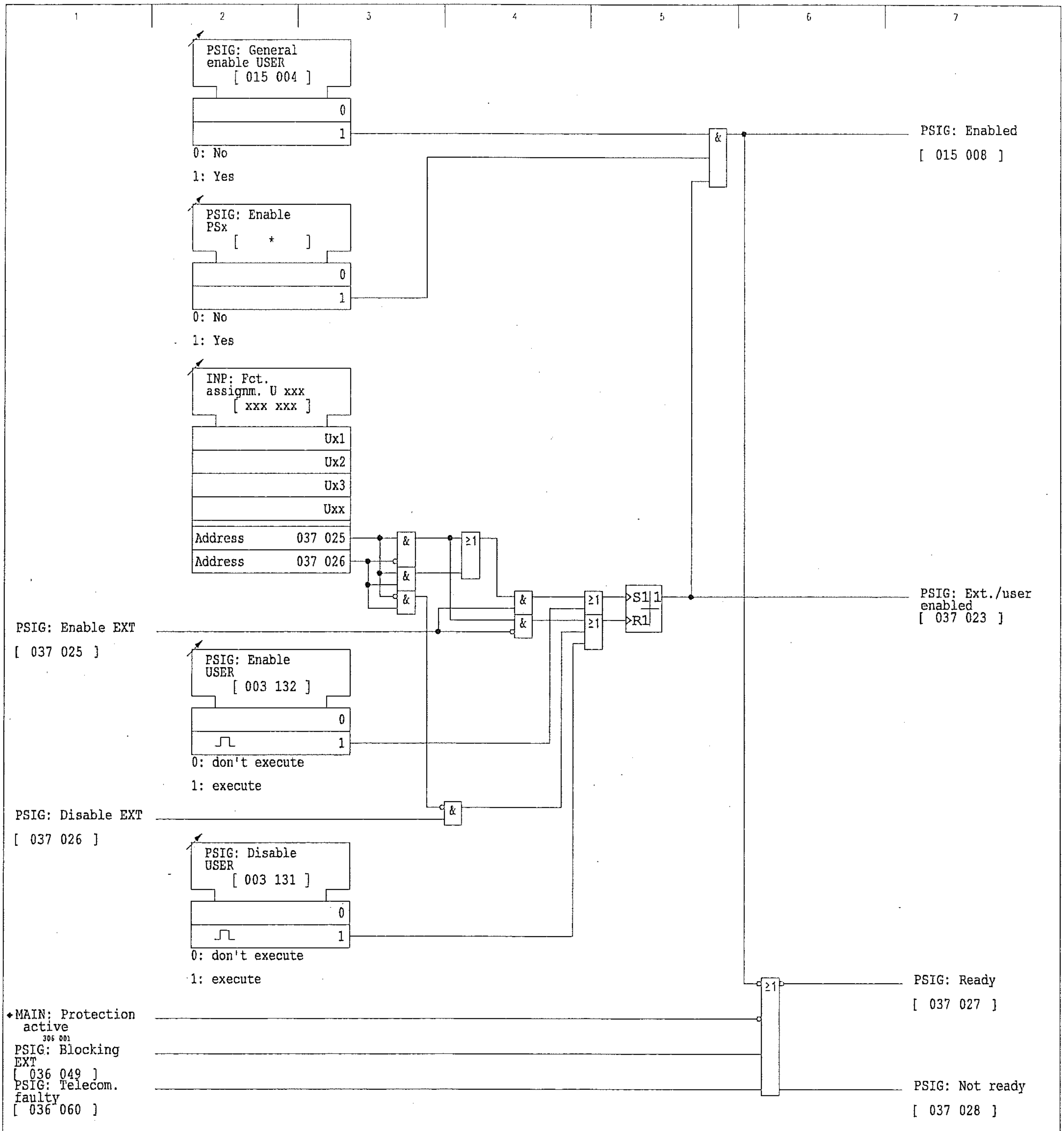
The function can be disabled or enabled from the integrated local control panel or through binary signal inputs.

Activation is enabled independent of parameter subset via PSIG: General enable USER. Activation is enabled for parameter subset PSx via PSIG: Enable PSx. Subsequently, protective signaling can be enabled via the local control panel or through appropriately configured binary signal inputs. Enabling from either the integrated local control panel or through binary signal inputs is equally effective. If only PSIG: Enable EXT is assigned to a binary signal input then protective signaling will be enabled by a positive edge of the input signal; it will be disabled by a negative edge. If only PSIG: Disable EXT is assigned to a binary signal input then a signal present at the input will have no effect.

Readiness of the protective signaling function

In order for protective signaling (PSIG) to function, the following requirements must be satisfied:

- It must be activated.
- There is no external block
- There is no transmission fault.



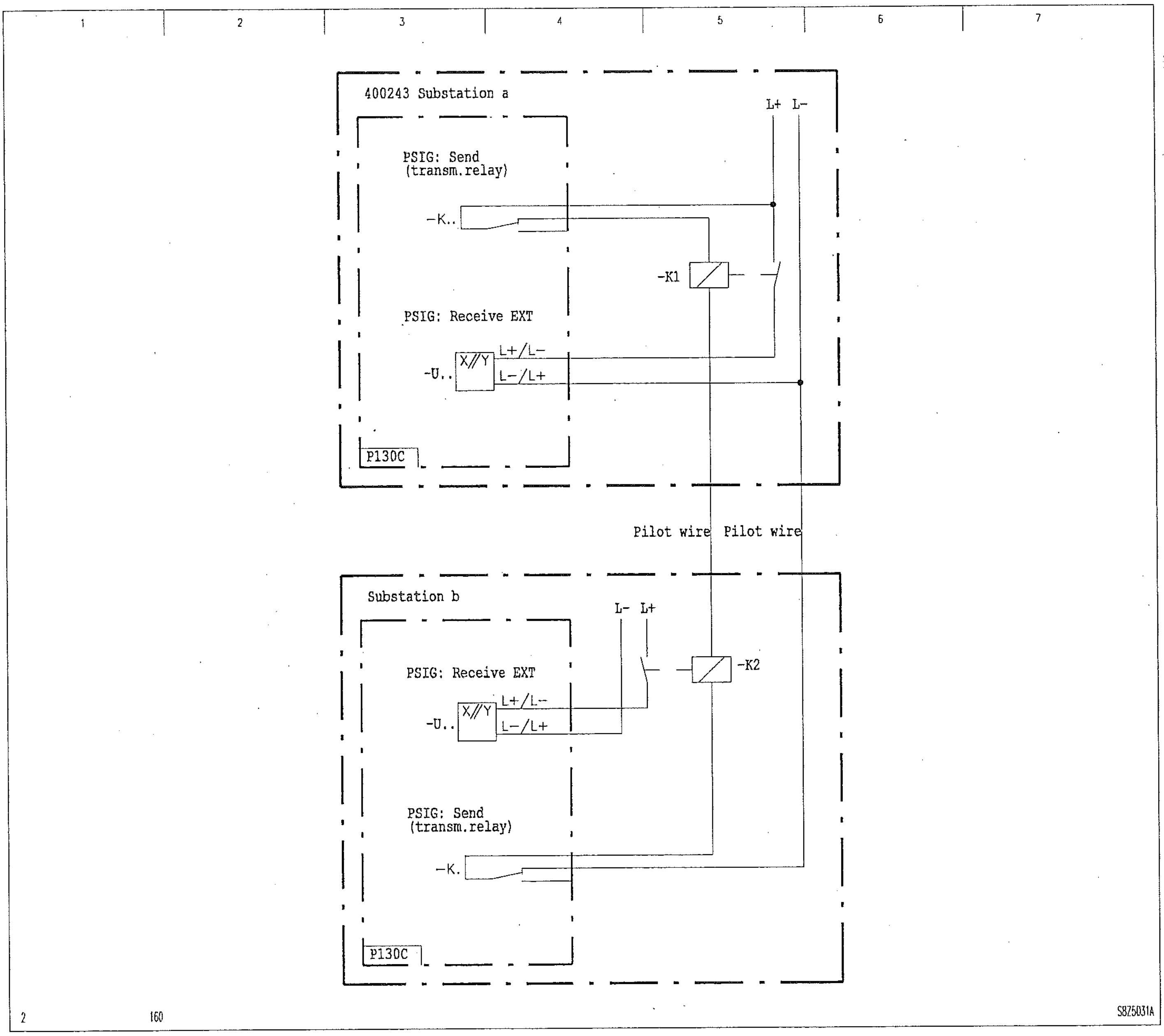
* Parameter	PSIG: Enable PSx
set 1	015 014
set 2	015 015
set 3	015 016
set 4	015 017

1 220 45Z5032A

3-117 *Protective signaling ready to operate*

Forming the communication link

To form the communication link it is necessary to connect either the break contact or the make contact of the transmitting relay, depending on the transmitting relay mode selected ('*Transm. relay make contact*' or '*Transm. relay break contact*'), to the P S I G : R e c e i v e E X T input of the remote station by means of pilot wires (see 'Installation and Connection' and Figure 3-118). With both operating modes, a receive signal (DC loop closed) is present in both protection devices in the idle state.



3-118 *Protective signaling using pilot wires, selected mode of operation: transmission relay break contact*

Operation of the protective signaling function

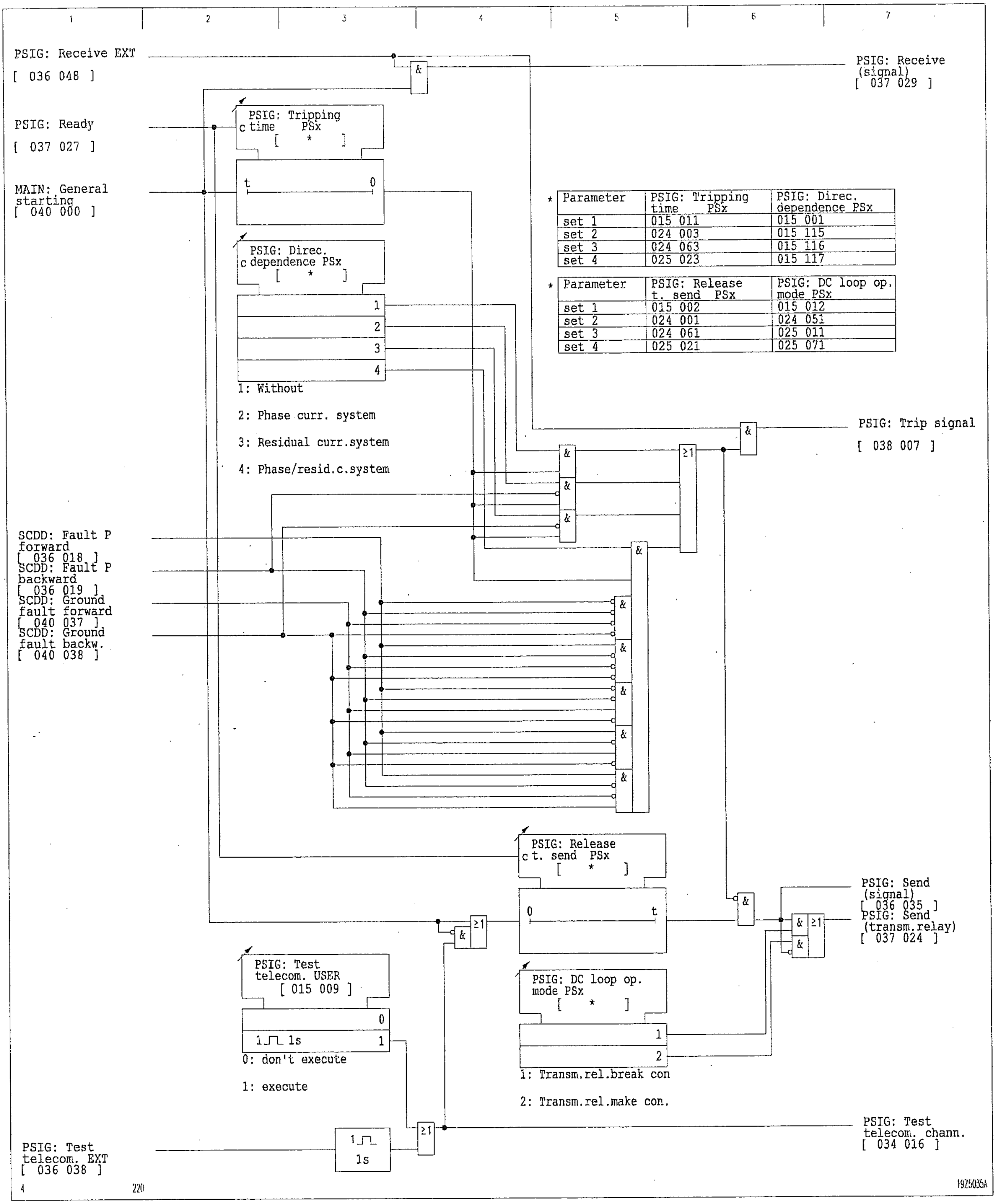
If a general starting condition begins, then the loop is opened without delay (transmitting). When a general starting signal is present and the set starting time has elapsed, loop reclosing takes place as follows in accordance with the mode selected at PSIG: Direct. depend. PSx and as a function of the direction decisions:

- ☐ Independently of any direction decision
- ☐ As a function of the condition that there not be any direction decision in the backward direction of the phase current stage
- ☐ As a function of the condition that there not be any direction decision in the backward direction of the residual current stage
- ☐ As a function of whether one of the following conditions in the table is satisfied (if one line of statements is true, then one condition is satisfied):

Fault Residual current stage Backwards	Fault Residual current stage Forwards	Fault Phase current stage Backwards	Fault Phase current stage Forwards
no	no	no	no
no	no	no	yes
no	yes	no	no
no	yes	no	yes
yes	no	no	yes

After the loop has reclosed and provided that both a general starting condition and a status signal through the PSIG: Receive EXT input of a closed loop are present, then the signal PSIG: Trip by PSIG is generated without delay. The loop recloses after dropout of the general starting condition and after a delay equal to the release time that can be set at PSIG: Release t. send. PSx.

If protective signaling is not ready, the DC loop will be open if *Transm. relay make contact* has been selected as operating mode for the transmitting relay or closed if *Transm. relay break contact* has been selected.



* Parameter	PSIG: Tripping time PSx	PSIG: Direc. dependence PSx
set 1	015 011	015 001
set 2	024 003	015 115
set 3	024 063	015 116
set 4	025 023	015 117

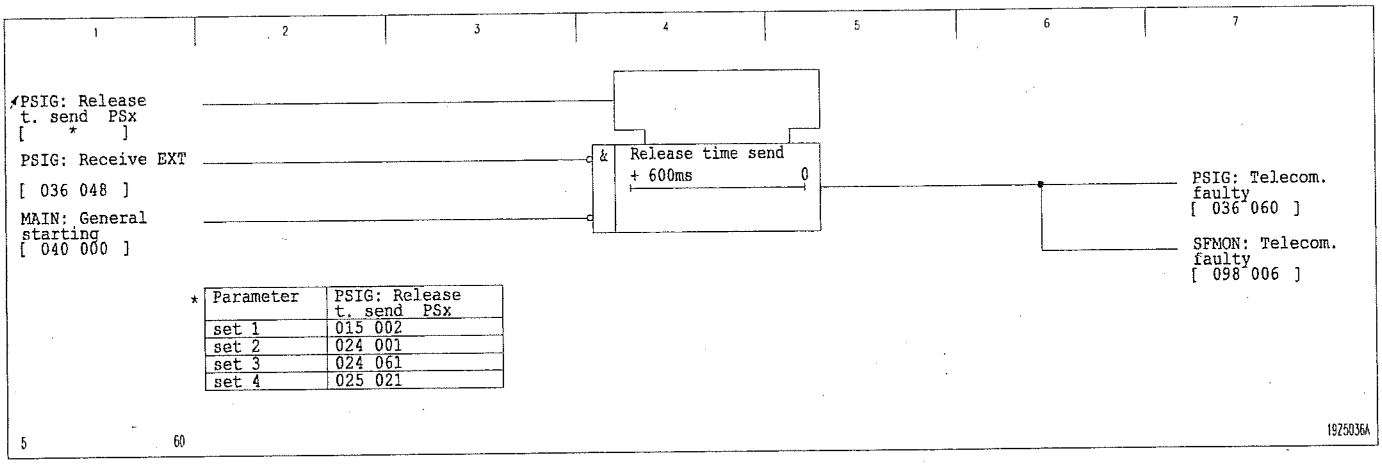
* Parameter	PSIG: Release t. send PSx	PSIG: DC loop op. mode PSx
set 1	015 002	015 012
set 2	024 001	024 051
set 3	024 061	025 011
set 4	025 021	025 071

3-119 *Protective signaling logic*

Protective signaling monitoring and loop check

The pilot wires are monitored for interruptions. If, in fault-free operation (i.e., in the absence of a general starting condition), no signal is received through the loop for a period longer than the set release time of the transmitting relay + 600 ms, then the signal PSIG: Telecom. faulty is issued (see Figure 3-120). A communication malfunction or failure leads to a protective signaling block.

To check the loop, the communications link can be opened from the local control panel by using the function PSIG: Test telecom. USER.



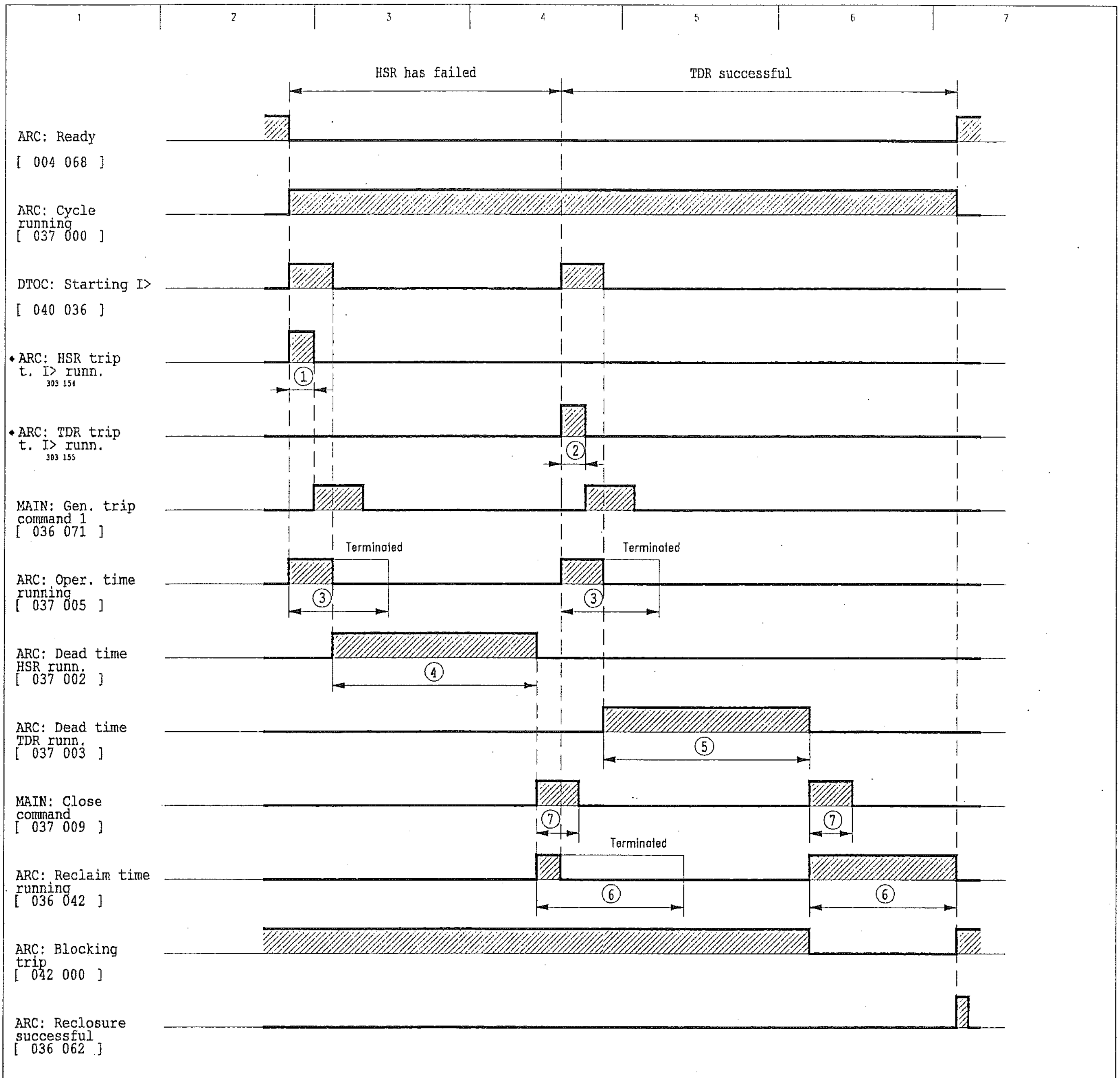
* Parameter	PSIG: Release t. send PSx
set 1	015 002
set 2	024 001
set 3	024 061
set 4	025 021

3-120 *Faulty transmission channel of protective signaling*

3.26 Auto-Reclosing Control (Function Group ARC)

Under certain conditions the automatic reclosing device (ARC) brings about clearing of a line section and, once the dead time has elapsed, automatic reclosing of the line section.

Figure 3-121 shows an example for the usual sequence of a failed high-speed reclosure followed by a subsequent successful time-delay reclosure.



	①	②	③	④	⑤	⑥
* Parameter	ARC: HSR trip. time I> PSx	ARC: TDR trip. time I> PSx	ARC: Operative time PSx	ARC: HSR dead time PSx	ARC: TDR dead time PSx	ARC: Reclaim time PSx
set 1	015 072	015 073	015 066	015 056	015 057	015 054
set 2	024 040	024 041	024 035	024 030	024 031	024 028
set 3	025 000	025 001	024 095	024 090	024 091	024 088
set 4	025 060	025 061	025 055	025 050	025 051	025 048

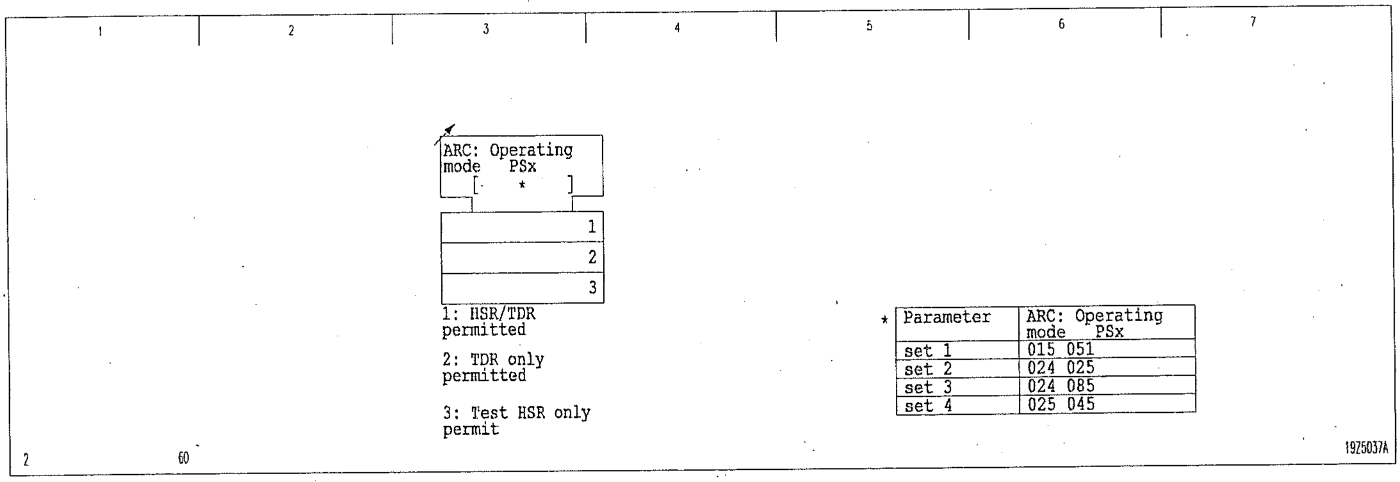
⑦ MAIN: Close cmd.pulse time [015 067]
ARC: No. permit. TDR PSx Setting: 1

1 205 S8Z7521A

3-121 Example for an ARC sequence

ARC operating modes

The ARC, which is integrated into the P130C, offers the possibility of triggering starting times by way of different starting signals. Once the starting times have elapsed, a trip signal is generated. With the ARC function that is implemented in the P130C, multiple reclosings are possible. If the ARC operating mode has been set accordingly, multiple reclosures begin with a high-speed reclosure (HSR). If the fault is not cleared after reclosing by HSR, then another attempt can be made to clear the fault by means of a time-delay reclosure (TDR). Multiple reclosures using only TDRs are also possible if the ARC operating mode is set accordingly.



* Parameter	ARC: Operating mode PSx
set 1	015 051
set 2	024 025
set 3	024 085
set 4	025 045

3-122 *Setting the ARC operating mode*