

# NEO 3000 SYSTEM



## FPC 680

# Multifunctional feeder terminal

THE FAMILY OF EQUIPMENT DEDICATED FOR POWER UTILITIES

Energy Sector



# FPC 680

## Multifunctional feeder terminal

### Description

FPC 680 is a comprehensive and cost effective feeder management IED for protection, control, measuring and supervision of utility and industrial distribution substations. FPC 680 is a member of NEO3000® Substation system and a part of FPC protection and control product series. FPC 680 also features necessary control functions constituting an ideal solution for feeder bay control. The FPC 680 support the IEC 61850 substation automation standard including horizontal GOOSE communication offering seamless connectivity to substation automation and SCADA systems.

FPC 680 can be used in applications of any MV networks and also as a back-up protection for HV power lines and transformers. Wide range of setting parameters enables FPC 680 to be used in solidly earthed, resistor earthed isolated and compensated networks. Control of feeder can be applied locally through local display unit LDU or remotely through substation control system.

Communication interface with IEC 61850 protocol enables integration of FPC 680 within substation control system and remote control centers.

FPC 680 is IEC 61850 certified by KEMA (Level A) independent laboratories.



KEMA



FPC 680i protection relay

### Main features

#### Total feeder protection functionality

Phase, earth-fault and negative sequence overcurrent with definite and inverse time directional/non-directional protection elements, including inrush restraint and cold load pickup.

Over/under voltage, over/under frequency, thermal overload protections and auto-recloser function.

#### Complete feeder control

Local and remote control of feeder switching elements applied through configurable interlocking.

#### Measurements and energy metering

Complete range of voltage, current, frequency, active and reactive power and power factor measurements with reactive and apparent double tariff forward/reverse energy metering.

#### Fault and event recording

Fault recording with 1ms resolution time tagging.

#### Disturbance recorder and power quality monitoring (PQM)

Disturbance recorder with capability of up to 50 recordings, up to 9 seconds each, COMTRADE format. Monitoring of parameters such as THD, sags and swells and harmonics up to 40th order.

#### Communication capabilities

Easy integration of the module within NEO3000 substation control and protection system through IEC 61850, DNP3, IEC 60870-5-104, IEC 60870-5-101, IEC 60870-5-103 and Modbus RTU protocols.

#### Intuitive user interface

Relay parameterizing, measurements and alarming, control with single line diagram presentation can be applied through graphical or textual Local Display Unit (LDU).

#### NEO3000 Power System Manager software tool

PC based software tool for device parameterizing, commissioning, testing, diagnostics and maintenance.

Protection configuration with NEO3000 Power System Manager is simple and intuitive, with graphic representation of connections between functions inside the relay. Yet it also provides depth by giving user the possibility of configuring every parameter.

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### Protection

FPC 680 provides complete range of protection functions for medium voltage switchgear, motors and transformers.

#### Phase and earth overcurrent protection (50, 50N, 51, 51N)

Overcurrent protection is based on measurements of phase and residual currents (or calculation zero sequence current from symmetrical components). Three stages can be set independently to definite time or inverse-time (IEC) characteristics. Inrush restraint or cold load pickup is applied for all overcurrent stages using set time or via binary input blocking.

#### Phase and earth directional overcurrent protection (67, 67N)

Phase and earth protections can be applied with directional elements. Fault current detection is determined using voltages of healthy phases. Direction determination in case of earth faults can be configured to respond to configurable value of corresponding residual voltage (or calculation zero sequence voltage from symmetrical components).

#### Sensitive earth directional/non-directional protection (50Ns, 51Ns, 67Ns)

Using sensitive current input the protection against high-resistance faults is achieved. Sensitive directional earth fault protection is in operation parallel to directional earth fault protection, resulting in secure operation when direction detection is disturbed.

#### Over-voltage, residual over-voltage and under-voltage protection (59, 59N, 27)

Two stages of over- and two stages of under-voltage protection can be applied for phase voltages and two stages of overvoltage protection can be applied for residual voltage (or calculation zero sequence voltage symmetrical component). Every stage is set separately.

#### Frequency protection (81L, 81H)

Frequency protection operation is based on periodical samples of system frequency and it is used for load shedding of system load. It operates using frequency hysteresis for under and over frequency settings that is defined by the user. When using frequency protection for load shedding, use of coordinated load shedding scheme for specified bus is essential. Two stages of over- and two stages of under-frequency protection can be applied.

#### Negative sequence overcurrent protection (46)

Negative sequence protection against unbalanced or reverse currents it is also used for protection of single or semi-pole faults of feeder, when the fault current is lower than nominal load current. For ensured tripping the minimal and maximal phase load currents condition is used. FPC 680 offers two stages of negative sequence protection.

#### Phase unbalance protection (46DP)

Provide protection against unbalanced phase currents by operating to trip the circuit breaker when a fixed percentage of unbalance exists between any two phases.

#### Thermal overload protection (49)

Power flow through the feeder causes the feeder to heat depending on heat constant and environment conditions. TOP uses conductor physical parameters and load current of the feeder to calculate the temperature of the feeder. Results are used for two stage protection (alarm and trip) to prevent feeder overheating and in that way optimize load of the feeder.

#### Busbar protection (50BB)

When the FPC 680 is applied for back-up protection of the secondary winding of power transformer it can also perform protection of MV busbars. Busbar protection is integrated in protection scheme of MV switchgear, where high stage overcurrent protection pickup signals of each feeder are received via GOOSE or are hardwired to the FPC 680. FPC 680 on MV side of transformer start the busbar protection algorithm for any fault on any MV feeder, but it trips only in cases when it is not blocked by tripping of any MV feeder protection relay. That means that the bus-bar scheme eliminates only faults on the busbars and skips the faults that occur on feeders.

#### Breaker failure protection (50BF)

When a trip signal is issued to the circuit breaker the current should drop after specified time. That time is usually defined by the circuit breaker brake time. In case that circuit breaker is still closed after set time, than FPC 680 sends a trip command to all feeders connected to the same busbars. This protection can also be used in combination with busbar protection.

#### External protection

In some applications new feeder terminals are added to existing protection relays that are kept in function. For these cases FPC 680 offers hardwired connection of the existing protection relay to the digital input for immediate or delayed tripping of existing protection relays. That is appropriate to achieve exact time tagging avoiding separate acquisition unit.

#### Auto-recloser (79)

All protection functions of FPC 680 can be equipped with auto-recloser. The function enables grouping trip signals in groups with same settings (up to 10 groups).

### Functional overview

#### Protection

- Three-phase overcurrent directional/non directional protection with definite/inverse time operation (50,51,67)
- Earth-fault directional/non directional protection with definite/inverse time operation, Var/Watt-metric metod (50N,51N,67N,32N)
- Sensitive earth-fault directional/non directional protection with definite time operation, Var/Watt-metric metod (50Ns,51Ns,67Ns,32Ns)
- REF 64
- Over/under voltage protection (59/27)
- Under/over frequency protection (81L/81H)
- Residual voltage protection (59N)
- Thermal overload protection (49M, 49T)
- Negative sequence overcurrent protection (46)
- Phase unbalance protection (46DP)
- Temperature monitoring (up to 8 sensors) (38/49T)
- Locked rotor, excessive starting time (48/51LR/14)
- Starts per hour (66)
- Thermostat/Buchholz switch (26/63)
- Auto-recloser (79)
- Circuit breaker failure protection (50BF)
- External protection
- Multiple protection setting groups

#### Control

- Internal data acquisition (protection operation, automatic reclosing and other internal signalization)
- external data acquisition (switching elements, alarm devices) - up to 44 DI
- power relay outputs - up to 16 DO
- synchro-check- V, deg & Hz (25)
- Time tagging (high resolution events)
- Local and remote setting

#### Monitoring and measurements

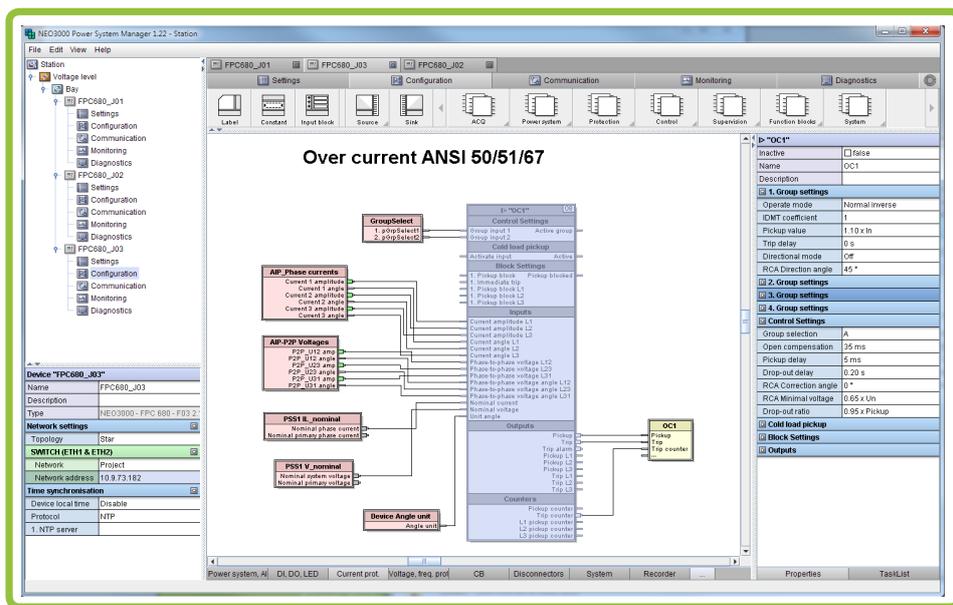
- Current, voltage, power, frequency and power factor measurements
- Energy metering
- Fault recording
- Event recording
- Transient disturbance recorder (DREC)
- Power Quality Monitoring
- Statistical data processing (operation counters of protection devices, automatic reclosing units and circuit breakers)
- Breaker I2t monitoring
- Trip circuit monitoring (TCM)
- Self-monitoring
- Fault location monitoring

#### Local Display Unit (LDU)

- Textual or graphical LCD display with single line diagram
- Web LDU interface
- Control for switching elements
- Showing measurements and alarms
- Event list
- Local/Remote switch with LED indication
- Easy to use navigation keys
- Open/Close control keys
- Ready LED + Alarm LED + 16 programmable LEDs
- 6 programmable function keys
- Front Ethernet RJ-45 communication port for local connection to device

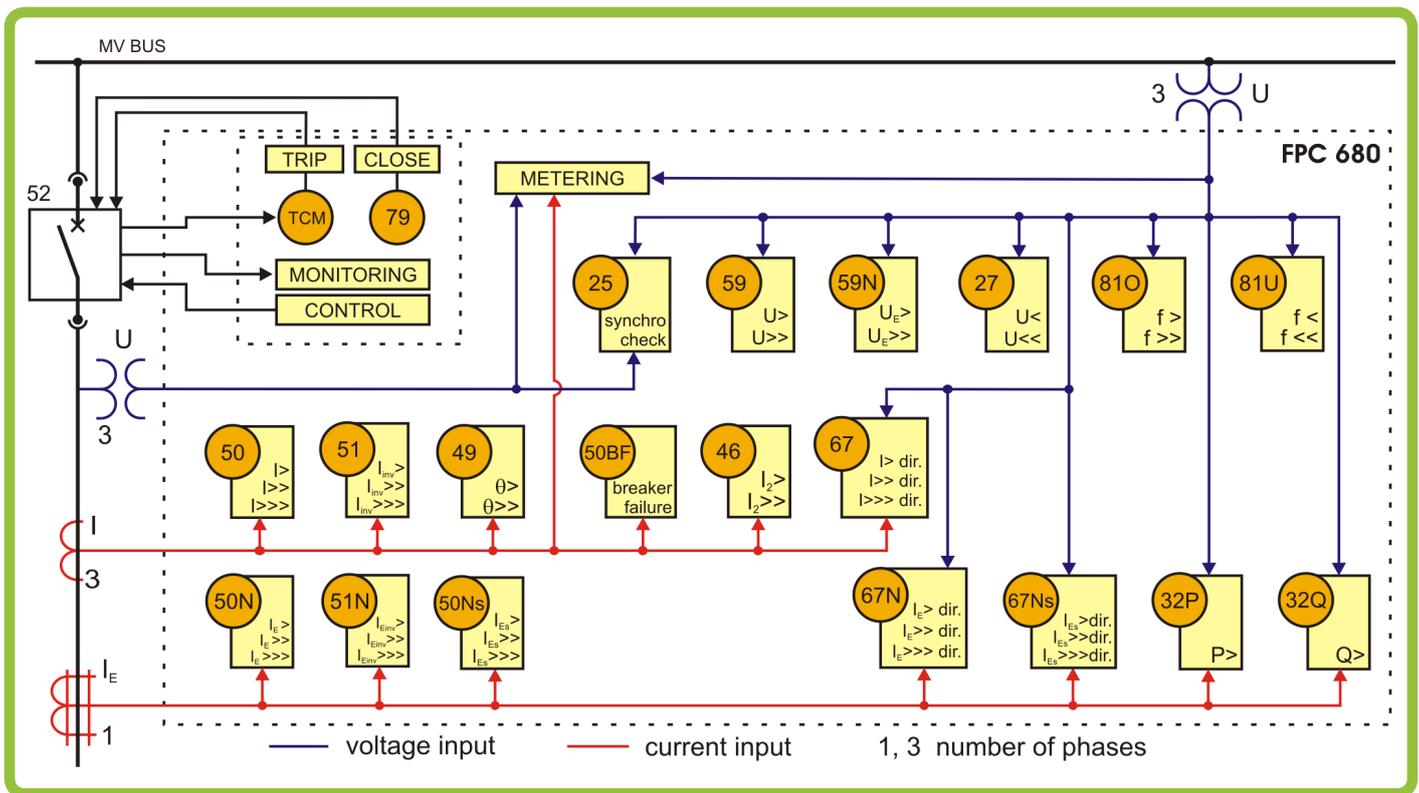
#### Communication

- Communication via dual fiber optic or RJ45 Ethernet with support for redundancy rings HSR, and RSTP.
- Serial communication – RS232, RS485 or optical.
- Front and/or back RJ45 Ethernet interface for NEO 3000® Power System Manager® parameterizing and analysis tools
- Communication using IEC 61850 (optional DNP3, IEC 60870-5-10x or Modbus protocols)
- System time synchronization over NTP/SNTP or through other communication protocols



# FPC 680

## Multifunctional feeder terminal



### Application

- Control and protection of medium voltage distribution and industrial overhead or cable feeders, bus couplers, motors and transformers
- Suitable for solidly earthed, resistor earthed, Petersen-coil compensated and insulated power networks
- Backup protection for power lines, power transformers and busbars of all voltage levels

### Control and monitoring

FPC 680 is much more than just a powerful numerical relay because it also comprehends all the control functions that perfect IED for integration in distributed substation control systems. All information from FPC 680 can be also transmitted through IEC 61850 communication protocol to higher level equipment (e.g. SCADA, protocol gateways, control centers,...) and also via GOOSE transmission to other IED supporting IEC 61850.

### Inputs and outputs

FPC 680 acquires electrical values and digital signaling through analogue and digital inputs. As current inputs are indispensable for most protection functions, voltage inputs expand the functionality of device also for monitoring the feeder's power flow, energy, power quality (PQM) and useful disturbance recorder. All together the device offers up to 9 current and voltage analog inputs, 1 DC (mA or voltage) analog input, up to 44 digital inputs and up to 16 digital outputs. Each digital input is configured to type and input logic of digital signal, while digital outputs can be freely configured for external signaling and switchgear control.

### Circuit breaker ware monitoring

Circuit breaker monitoring is realized with I2t function that determines circuit breaker poles ware through determination of switching current. I2t function records circuit breaks due protection tripping and due control command. When cumulative number of breaks at nominal current approaches to set value that is defined by circuit breaker characteristic, the alarm signal is issued. I2t function also collects complete per-phase statistics of circuit breaker, such as number of all breaks, breaks due short circuit, CB poles ware, etc.

### Protection conditional operation

For example when malfunction occurs on voltage measuring circuits, under-voltage protections would operate although the feeder voltage remains unchanged. That undesired protection operation can be eliminated by using the auxiliary contacts of the miniature circuit breaker for voltage measuring circuits that are hardwired to digital input of FPC 680. Voltage protection can be therefore blocked by using configured digital input.

Same principle can be applied to any other protection function. Therefore user can configure easily which external conditions shall affect operation of each protection function.

### Synchro-check (25)

Synchro-check function provides supervised joining of the feeder to busbars in single or double busbar systems. Using measurements of voltage, frequency and phase angle of busbars and feeder the FPC 680 can perform manual or automatic feeder synchronization. Mode of operation is synchronous or asynchronous.

### Local/remote control

Using input and output capabilities FPC 680 offers complete control of switchgear either locally or remotely. FPC 680 provides acquisition of digital and analogue values, and control over relay outputs. In that way it is ideal solution for complete control of switchgear from different control levels.

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Local control is possible via optional Local Display Unit (LDU) that displays single line diagram, measurements, metering, statistic counters, alarm lists and enables user SCADA-like supervision over feeder. LDU can also be ordered as decoupled unit from FPC 680 it can be used on the cubicle door while FPC 680 is situated inside low-voltage compartment. Selection of control level can be applied via LDU Local/Remote button (or hardware lock) or external digital input (selection switch). Remote control is possible from substation level SCADA or remotely from dispatch center.

### Fault locator (21)

Provides accurate distance to fault calculation and information about fault type, resistance and amplitude. It can minimize the outages after a persistent fault. It can also be used to find weak spot on the line.

## Communication

FPC 680 comprehends two Ethernet communication ports for use with IEC 61850 communication protocol (optional DNP3 TCP/IP, IEC 60870-5-104). Front Ethernet port on LDU is used for bay level configuration by using NEO 3000 Power System Manager (PSM) application software. Optional FPC 680 includes two serial communication ports for protocols like DNP3, IEC 60870-5-103 and IEC 60870-5-101.

Ethernet ports can be delivered with RJ45 or ST Glass Fiber Optic interface, while serial ports can be RS232, ST Glass Fiber Optic or RS485 interface. Accurate time is distributed via Ethernet NTP/SNTP protocol or via protocol clock sync.

### Measuring and Metering

Measurements are acquired using voltage and currents inputs. Nominal values of each input are configurable.

Following measurements are performed by FPC 680:

- currents: I1, I2, I3, IE,
- voltages: U1, U2, U3, UE, U12, U23, U31
- power measurements: P, Q, S
- power factor: PF
- frequency: f
- active and reactive energy: forward and reverse, high and low tariff
- energy metering using external digital input for external energy counter pulse output.
- current symmetrical sequence component calculations (I1, I2, IO)
- voltage symmetrical sequence component calculations (U1, U2, U0)
- Power quality measurements (harmonics up to 40, THD, RMS...)

### Local Display Unit (LDU)

FPC 680 is equipped with integrated (optional standalone) Local Display Unit (LDU). LDU represents graphical or textual simple screen operation panel that enable local control from cubicle door and hence avoiding the need of push-buttons.

#### Hardware properties:

- LCD size with resolution of 128x64 or 240x128 pixels
- navigation buttons (6)
- control buttons (3)
- Local/Remote/Bypass button with LEDS
- programmable LEDS (16)
- programmable function keys (up to 6)

#### Functions:

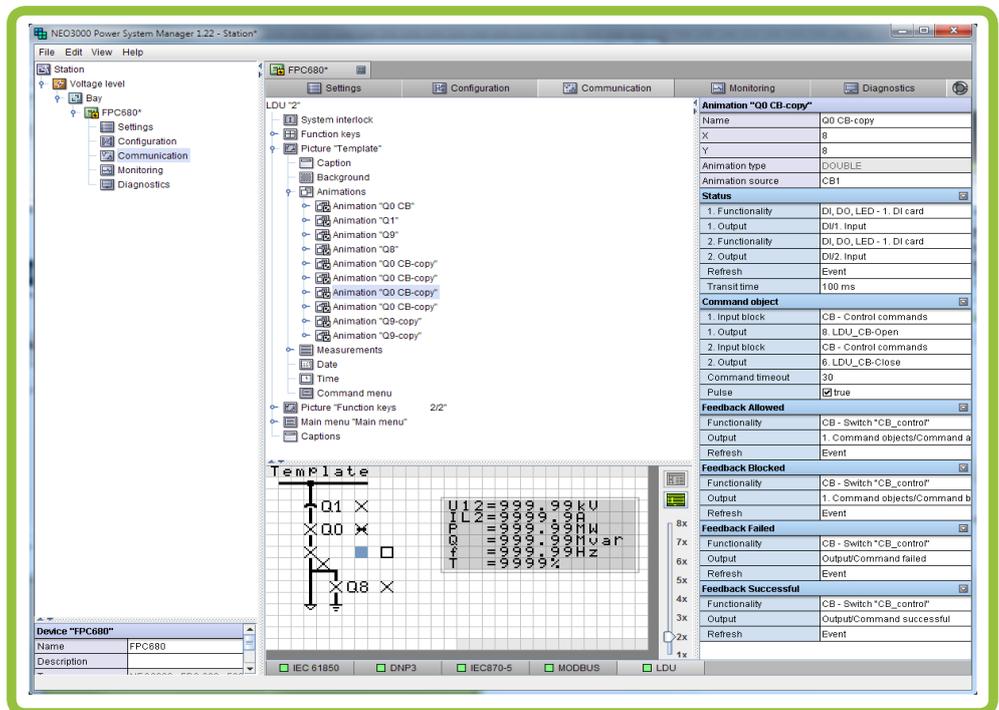
- display of single line diagram with interactive representation and control of circuit breakers, disconnection switches, etc.
- chronological event list
- alarm list
- measurements (U, I, P, Q cos , f,...)
- change protection parameters settings via LDU
- selection between Local/Remote bay control
- 16 programmable LEDS for alarm indication
- 6 programmable function keys

### Device configuration with PC

FPC 680 is a part of NEO 3000 Substation protection and control system.

Since all communication between device and NEO3000 Power System Manager tool is done via TCP/IP media, there are several ways to establish remote diagnostics, configuration and testing of device behavior. For local access optional USB Ethernet adapter is available.

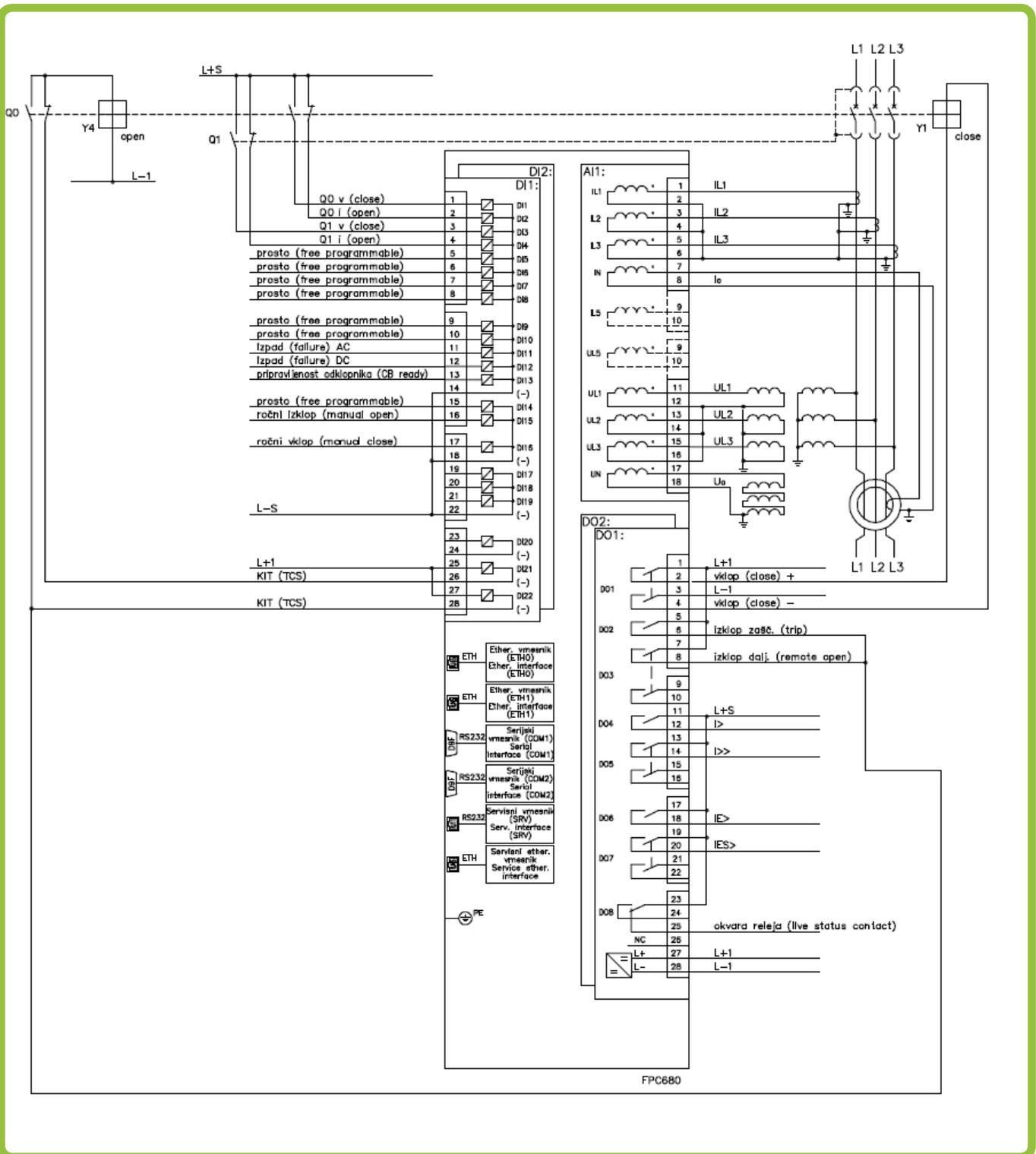
Local display is completely user configurable. User can create new picture or he can choose from the predefined. Animated elements can also be user created (up to 10). There are max. number of 5 pages/images, each can contain up to 50 animations and 6 measurements.



# FPC 680

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Typical wiring of the FPC680 unit



# FPC 680

## Multifunctional feeder terminal

### Device Web Interface

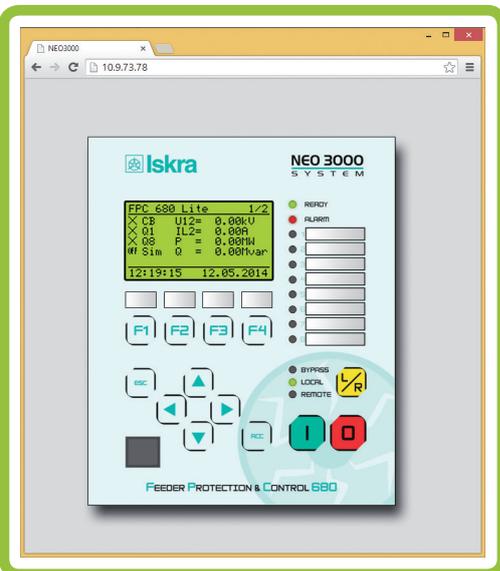
### Analysis and parameterizing software

Basic tool for nowadays engineers are laptop computers that makes surveillance of IEDs easier. FPC 680 uses a software package NEO 3000 Power System Manager (PSM) for parameterizing, analysis and commissioning.

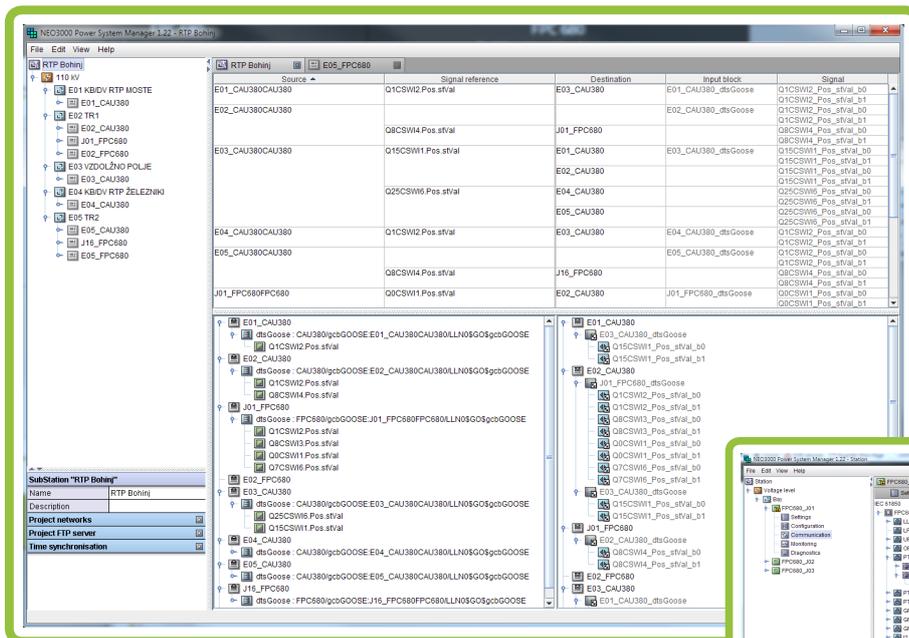
#### NEO 3000 Power System Manager

NEO 3000 Power System Manager is PC based software that makes handling with NEO 3000 substation control and protection system simple. Under password protected access the user can set parameters of FPC 680 device via transparent graphical and tree based menus. It enables online or offline setting of device parameters.

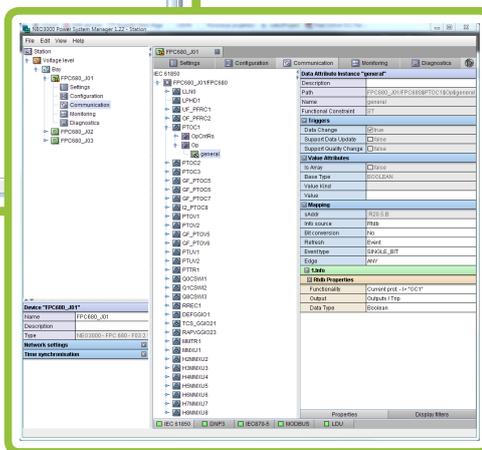
It also provides a powerful tool for configuring communication protocols - it supports DNP3 (serial or ethernet), IEC870-5-101, IEC870-5-103, IEC870-5-104, Modbus and 61850 MMS and GOOSE.



### NEO3000 Power System Manager



GOOSE is mapped via source - destination views. Connection from one device to another is created by selecting data set or its member from the left (source) window and clicking on the device in the right (destination) window.



61850 MMS configuration editor gives user the possibility of connecting device process data to logical nodes, objects and attributes. User can create and configure data sets and control blocks.

# FPC 680

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### Technical data

#### Protection

##### Phase definite time over-current directional/non-directional protection (50, 51, 67)

No. Stages:	3
Pickup levels:	0,05-40,00 In
Delay time:	0,00-300,00 s

##### Phase inverse time over-current directional/non-directional protection (50, 51, 67)

No. Stages:	3
Pickup levels:	$I_{p>}$ : 0,05-4,00 In
Delay time:	0,00-300,00 s
Time multiplier k:	0,05-1,00
Trip charact. (IEC):	inverse, very inverse, extremely inverse, long time inverse

##### Earth definite time over-current directional/non-directional protection (50N, 50Ns, 67N, 67Ns)

No. Stages:	3
Pickup level:	0,005-40,000 In
Delay time:	0,00-300,00 s

##### Earth inverse time over-current directional/non-directional protection (50N, 50Ns, 67N, 67Ns)

No. Stages:	3
Pickup levels:	$I_{p>}$ : 0,005-4,000 In
Delay time:	0,00-300,00 s
Time multiplier k:	0,05-1,00
Trip charact. (IEC):	inverse, very inverse, extremely inverse, long time inverse

##### Watt-metric earth protection (32NP)

Stage:	P>, Pdir>
Modes:	Positive and negative active neutral power, Positive active neutral power

##### Var-metric earth protection (32NQ)

Stage:	Q>, Qdir>
Modes:	Positive and negative reactive neutral power, Positive reactive neutral power

##### Thermal overload protection (49)

No. Stage:	2
Heat./Cool. factor k:	0,10-4,00 In
Time constant:	1-1000 min
Qalarm/Qtrip:	45,00-99,00 %

##### Negative sequence overcurrent protection (46)

No. Stage:	2
Pickup level:	0,10-3,00 In
Delay time:	0,00-300,00 s

##### Phase unbalance protection (46DP)

Unbalance setting:	10,0 - 100 %
Definite time:	0,05 - 300,00 s
Minimal voltage:	0,05 - 1,00 In

##### Under-voltage protection (27)

No. Stage:	2
Pickup level:	0,10-2,00 Un
Delay time:	0,00-300,00 s

##### Overvoltage protection (59)

Stages:	2
Pickup level:	0,05 - 2,00 Un
Delay times:	0,00 - 300,00 s

##### Residual overvoltage protection (59N)

Stages:	2
Pickup level:	0,01-2,00 Un
Delay times:	0,00-300,00 s

##### Under-frequency protection (81U)

No. Stages:	2
Pickup level:	45,00 - 50,00 Hz
Delay times:	0,00 - 300,00 s

##### Over-frequency protection (81O)

No. Stages:	2
Pickup level:	50,00 - 55,00 Hz
Delay times:	0,00 - 300,00 s

##### External protection

Delay time:	0,00 - 300,00 s
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##### Auto-recloser (79)

Number of recloses:	5 shot / 10 scenarios
Dead time:	0,0 - 300,0 s
Reclaim time:	0,5 - 300,0 s

##### Fault locator (21)

No. of Triggers:	10
Line resistance, inductance:	0,00 - 10 ohm/km
Ground resistance, inductance:	0,00 - 10 ohm/km

# FPC 680

## Multifunctional feeder terminal

### Inputs and outputs

Current inputs									
Rated current $I_n$ :	1 or 5 A								
Range:	up to $80 \times I_n$ (phase current input) up to $2 \times I_n$ (neutral current input)								
Consumption:	< 0,07 VA at $I_n$ ; < 0,1 VA at $20 \times I_n$								
Overload:	<table border="0"> <tr> <td>continuous:</td> <td><math>4 \times I_n</math></td> </tr> <tr> <td>10 s:</td> <td><math>30 \times I_n</math></td> </tr> <tr> <td>1 s:</td> <td><math>100 \times I_n</math></td> </tr> <tr> <td>10 ms:</td> <td><math>250 \times I_n</math></td> </tr> </table>	continuous:	$4 \times I_n$	10 s:	$30 \times I_n$	1 s:	$100 \times I_n$	10 ms:	$250 \times I_n$
continuous:	$4 \times I_n$								
10 s:	$30 \times I_n$								
1 s:	$100 \times I_n$								
10 ms:	$250 \times I_n$								
Accuracy:	$\leq \pm 0,5\% I_n$ ( $0.1 I_n \leq I \leq 4 I_n$ ; 50 Hz) $\leq \pm 0.1\% I_n$ sensitive ( $0.001 I_n \leq I \leq 2 I_n$ )								

Voltage inputs	
Rated voltage Un:	100 or 200 V
Range:	0,005 - 1,5 Un
Consumption:	< 0,23 VA at 150 V, < 0,4 VA at 300 V
Overload:	400 V continuous
Accuracy:	$\leq \pm 0.1\% U_n$ ( $0.005 \leq U \leq 1.5 U_n$ ; 50 Hz)
Frequency:	50 Hz
Range:	40,00 – 60,00 Hz

Digital inputs	
Quantity of inputs:	22 (optional up to 44)
Nominal voltage:	24V DC / 48-60V DC / 110-125V DC 220V DC 230 V AC
Permitted voltage offset:	+/- 20%
Consumption:	< 0,5 mA

Relay outputs							
Quantity of relays:	8 (optional up to 16)						
Contacts:	4 x DO: 2xNO, 3 x DO: 1xNO						
Ready relay (8th DO):	1xCO						
Trip/signal output assignment:	programmable						
Switching capacity:	<table border="0"> <tr> <td>make:</td> <td>14 A</td> </tr> <tr> <td>break:</td> <td>1000 W @ <math>\cos \phi = 1</math></td> </tr> <tr> <td>permanent:</td> <td>8 A</td> </tr> </table>	make:	14 A	break:	1000 W @ $\cos \phi = 1$	permanent:	8 A
make:	14 A						
break:	1000 W @ $\cos \phi = 1$						
permanent:	8 A						
Switching voltage:	250 V DC, AC						

DC analog inputs	
Nominal values	$\pm 5$ ; $\pm 10$ ; $\pm 20$ mA / $\pm 2,5$ ; $\pm 5$ ; $\pm 10$ V
Accuracy:	$\leq \pm 0.08\%$ nom. ( $0.02 \leq m.v. \leq 1$ nom.)

### Control and monitoring

Metering	
Currents:	IL1, IL2, IL3, IE
Voltages:	U1, U2, U3, UE, U12, U23, U31
Power:	Active (P), Reactive (Q), Apparent (S)
Range:	0,05 - 8 Pn
Accuracy:	< 0,5% Pn ( $I > 0,1 I_n$ ; $U > 0,5 U_n$ ; PF > 0,7)
Power factor:	$\cos \phi$ , total power
Energy:	active, reactive energy
Acquisition:	internally calculated, pulse counters
No. of tariffs:	two
Measuring method:	four quadrant

Power Quality Monitoring (PQM)	
Monitoring values:	Spectral analysis up to 40th harmonic, THD, TRMS, sags & swells

Synchro-check (25)	
Amplitude diff.:	3-100 % Un
Angle diff.:	3 – 80°
Frequency diff.:	0,01 – 2,00 Hz
Maximal synchronization time:	0,00 - 300,00 s

Disturbance Recorder	
Data channels:	9 analog, 64 digital
Sampling rate:	32/64/128 samples per cycle
Trigger source:	external digital input and internal digital data
Storage capacity:	up to 20 recordings, up to 9s each
Storage media:	non-volatile flash, remote FTP server
Recording format:	COMTRADE

Statistic counters	
C. per protection element:	0-100000
C. per each ARC stage:	0-100000
C. of definite trips:	0-100000

Breaker monitoring									
Operation counters:	I2t (L1, L2, L3), common I2t, I>>, All								
Counter values:	<table border="0"> <tr> <td>I2t (L1, L2, L3):</td> <td>max 100000</td> </tr> <tr> <td>Common I2t:</td> <td>max 100000</td> </tr> <tr> <td>I&gt;&gt;:</td> <td>max 100000</td> </tr> <tr> <td>Counter All:</td> <td>max 100000</td> </tr> </table>	I2t (L1, L2, L3):	max 100000	Common I2t:	max 100000	I>>:	max 100000	Counter All:	max 100000
I2t (L1, L2, L3):	max 100000								
Common I2t:	max 100000								
I>>:	max 100000								
Counter All:	max 100000								
Setting of I2t characteristics:	<table border="0"> <tr> <td>I:</td> <td>0,01 – 150,00 kA</td> </tr> <tr> <td>No. open.:</td> <td>max 100000</td> </tr> </table>	I:	0,01 – 150,00 kA	No. open.:	max 100000				
I:	0,01 – 150,00 kA								
No. open.:	max 100000								

Trip circuit supervision	
	Using two binary inputs

# FPC 680

## Multifunctional feeder terminal

### Communication interfaces

Front port on LDU	
Layout:	100BaseTx (RJ45)
Usage:	used for local configuration, diagnosis and testing (optional USB Ethernet adapter available)

Rear ports (Ethernet, Serial, System)	
Up to 2 x Ethernet:	100BaseTx (RJ45), 100BaseFx (ST glass FO)
Up to 2 x Serial:	RS232 (DB9), RS485, ST MM glass FO
System:	RS232 (RJ11)
Serial Baud rate:	up to 115,2 kbps
PSM, LDU Ethernet:	100BaseTx (RJ45)
Protocols:	IEC 61850 (MMS + Goose) IEC 60870-5-101 (optional) IEC 60870-5-103 (optional) IEC 60870-5-104 (optional) DNP3 (optional)

Time synchronization	
	NTP/SNTP Ethernet
	via comm. protocol

Power supply	
Rated voltage:	24V DC, 48-60V DC, 110-125V DC, 220-250 V DC
Permissible tolerance:	-20/+30%
Power consumption:	<20 W, typ. 15W
Voltage loss hold-up time:	>20 ms

Operating conditions		
Temperature:	Storage:	-20°C to +70°C
	Operate:	-10°C to +55°C
	Operate:	-10°C to +70°C (housing for extended temp. range)
Humidity:	up to 95% non-condensing	

Mechanical design	
Material:	stainless steel
Protection class:	IP 54 (front LDU), IP40 (housing), IP20 (housing for extended temp. range)
Mounting type:	flush or surface
Dimensions:	Small housing (1/2 19", 4U) (WxHxD): 220x176x187 mm
	Medium housing (2/3 19", 4U) (WxHxD): 290x176x187 mm
	Extended temp. range (WxHxD): 170x90x175 mm
	Extended temp. range (slots S1, S2) (WxHxD): 220x190x175 mm
Weight:	Small housing, size 170 and 220 (1/2 19", 4U): max. 4,1 kg
	Medium housing (2/3 19", 4U): max. 5,1 kg

Type tests		
Rated insulation voltage	IEC 60255-5, table 1	500 V
Dielectric voltage	IEC 60255-5, table 1, series B, clause 6	2.0 kV RMS
Insulation resistance	IEC 60255-5, clause 7	100 MΩ at 500 V <sub>DC</sub>
Impulse voltage	IEC 60255-5, clause 8	5 kV, 1.2/50 μs, 0.5 J
Electrical disturbances	IEC 60255-22-1, class 3	2.5 kV common mode, 1.0 kV differential mode
Electrostatic discharge immunity	IEC 61000-4-2, level 4	15 kV air discharge, 8 kV direct discharge
Radiated immunity	IEC 61000-4-3, level 3; IEC 60255-22-3, class 3; IEC 61000-4-3, class 3; ENV 50204 (GSM), level 3;	80 MHz to 1 GHz 27 to 500 MHz 50 kHz to 1 GHz 10 V/m, 2 W at 0.6 m
Fast transient/burst immunity	IEC 61000-4-4, level 4; IEC 60255-22-4, class 4; ANSI/IEEE C.37.90.1;	4 kV 4 kV 4-5 kV
Surge immunity	IEC 61000-4-5, level 4	2 kV / 4 kV
Conducted immunity	IEC 61000-4-6, level 3	10 V
Power frequency magnetic field immunity	IEC 61000-4-8, level 4	30 A/m
Pulse magnetic field immunity	IEC 61000-4-9, level 5	1000 A/m
Damped oscillatory magnetic field immunity	IEC 61000-4-10, level 4	30 A/m
Oscillatory transient immunity	IEC 61000-4-12, level 4; IEC 61000-4-18, level 3; ANSI/IEEE C.37.90.1;	Ring wave Damped oscillatory wave 2.5 kV
Emissions test	IEC 60255-25	20 to 1000 MHz
Power interruption test	IEC 60255-11	20 ms, 12% ripple
Power frequency immunity test	IEC 60255-22-7; IEC 61000-4-16	In compliance with IEC 60255-16, table 6
Temperatures	IEC 60068-2-1; IEC 60068-2-2	from 0°C to 60°C
Temperature gradient	IEC 60068-2-14	up to 30°C
Humidity	IEC 60068-2-30	up to 95% at 40°C drop from 40°C to 25°C at 95% relative humidity up to 29 g/m <sup>3</sup>
Damp heat, steady state	IEC 60068-2-78	In compliance with IEC60255-27, chapter 10.5.1.5
Vibration (sinusoidal)	IEC 60068-2-6	2 g acceleration, from 9 to 350 Hz
Shock and bump	IEC 60068-2-27	15 g, 11 ms test
Seismic	IEC 60255-21-3	under voltage, in compliance with IEC60255-27, chapter 10.5.2.1.4
Communication test:	IEC 61850-6, 7-1, 7-2, 7-3, 7-4, 8-1	IEC 61850 Certificate Level A (IEC 61850-10 Ed1)

# FPC 680

## Multifunctional feeder terminal

Product type comparison		Software type:	F01	F02	F03	F04	M01	M03	T01	T03
<b>Current protections</b>										
50/51/51B	3 phase overcurrent / IDMT / Inrush r. / CLPU		3		4	4	3	4	3	4
67	3 phase directional overcurrent		opt.		✓	✓	opt.	✓	opt.	✓
50/51 N/G	Earth fault overcurrent / IDMT / Inrush r. / CLPU		4		6	8	4	6	4	6
67N/51N	Earth fault directional overcurrent		opt.		✓	✓	opt.	✓	opt.	✓
67Ns	Earth-fault directional sensitive o.c.		opt.		✓	✓	opt.	✓	opt.	✓
32NQ	Earth fault directional watt-metric		opt.		✓	✓	opt.	✓	opt.	✓
32NP	Earth fault directional VAr-metric		opt.		✓	✓	opt.	✓	opt.	✓
64REF	Restricted earth-fault					4	2	4	2	4
46	Negative sequence overcurrent / unbalance		2		4	4	2	2	2	4
46DP	Phase unbalance protection				2	4		2		2
<b>Voltage protections</b>										
27	Phase-to-phase undervoltage			4	4	4		4		4
27R	Remanent undervoltage			1	2	2		✓		✓
27D	Positive sequence undervoltage			2	2	2		2		2
27S	3 phase undervoltage			1	1	1		✓		✓
59	Phase-to-phase overvoltage			2	4	4		2		4
59N	Neutral voltage displacement			4	2	2				
47	Negative sequence overvoltage			2	2	2		2		2
59N	Residual overvoltage			2	4	2		2		4
81H	Overfrequency			1	2	2		2		2
81L	Underfrequency			2	2	4		2		2
<b>Power and machine protections and diagnostic</b>										
49F	3 phase thermal overload (feeders & cables)		2		2	2	2	2	2	2
49T	3 phase thermal overload (transformers)								2	2
49M (RMS)	3 phase thermal overload (motors)						2	2		
38/49T	Temperature monitoring (up to 8 sensors)		✓		✓	✓	✓	✓	✓	✓
48/51LR/14	Locked rotor, excessive starting time						1	2		
66	Starts per hour						1	2		
26/63	Thermostat / Buchholz switch				✓	✓			✓	✓
	External trip		2	2	2	2	2	2	2	2
<b>Automation and diagnostic</b>										
94/69	Circuit breaker control and monitoring		2	2	2	2	1	2	2	2
50BF/62BF	Circuit breaker failure		✓	✓	✓	✓	✓	✓	✓	✓
74TCS	Trip circuit supervision (TCS)		2	2	2	2	2	2	2	2
79	Auto-reclosure		1	1	1	2			1	1
25	Synchro-check			1		1	1	1		1
	Voltage regulator			1		1				1
69	Disconnecter control		4	4	6	4	4	6	4	4
86LR/94	Lockout Relay		✓	✓	✓	✓	✓	✓	✓	✓
60	Fuse failure supervision		opt.							
21FL	Fault locator				✓	✓		✓		✓
	Running hours		✓	✓	✓	✓	✓	✓	✓	✓
	IEC 6 1131 Function Blocks		✓	✓	✓	✓	✓	✓	✓	✓

Type F05 is based on F03 with Shunt protection. Type F06 is based on F03 with IuB protection.

# FPC 680

## Multifunctional feeder terminal

### Ordering

Extra Small housing	SW	H	AI	C1	C2	C3	C4	PS								
Small housing	SW	H	AI	C1	C2	C3	C4	PS	S1	S2						
Medium housing	SW	H	AI	C1	C2	C3	C4	PS	S1	S2	S3	S4				
Large housing	SW	H	AI	C1	C2	C3	C4	PS	S1	S2	S3	S4	S5	S6	S7	
My configuration																

#### SW – Software type

- F01 – Current protection
- F02 – Voltage protection
- F03 – Current and Voltage protection
- F04 – Current and Voltage with Synchro check
- F05 – Current and Voltage protection with Shunt protection
- F06 – Current and Voltage protection with IuB protection
- F07 – Current and Voltage protection with Differential protection
- T01 – Transformer Current protection
- T03 – Transformer Current and Voltage protection
- M01 – Current protection for motors
- M03 – Current and Voltage protection for motors

#### H – Housing layout

##### Type

- T – flush mounting with integrated Textual LDU
- L – flush mounting with integrated LDU
- N – surface mounting without LDU
- D – surface mounting with detachable LDU
- Z – surface mounting with integrated LDU

##### Size

- 1 – Small housing (1/2 19", 4U) (slots S1 ... S2)
- 2 – Medium housing (2/3 19", 4U) (slots S1 ... S4)
- 3 – Large housing (19", 4U) (slots S1 ... S8)
- 4 – Small housing for extended temp. range (1/2 19", 4U) (slots S1 ... S2)
- 5 – Medium housing for extended temp. range (2/3 19", 4U) (slots S1 ... S4)
- 6 – Large housing for extended temp. range (19", 4U) (slots S1 ... S8)
- 7 – Extra small (170 mm x 190 mm) for extended temp. range
- 8 – Small (220 mm x 190 mm) for extended temp. range (slots S1, S2)

#### AI – AI AC configuration

##### AC board type

- N – none
- D – 3 CT + 1 CTs<sup>(1)</sup> + 4 VT
- E – 3 CT + 2 CTs<sup>(1)</sup> + 4 VT
- F – 4 CT + 1 CTs<sup>(1)</sup> + 4 VT
- G – 3 CT + 1 CTs<sup>(1)</sup> + 5 VT
- H – 3 CT + 1 CTs<sup>(1)</sup> + 4 VT + 3 CT + 1 CTs<sup>(1)</sup>
- M – 4 CT + 1 CTs<sup>(1)</sup> + 7 VT

##### Current measuring inputs<sup>(4)</sup>

- N – none
- 1 – 1 A current inputs
- 5 – 5 A current inputs
- M – mixed current inputs (1 A and 5 A)

##### Voltage measuring inputs

- N – none
- 1 – 150 V voltage input
- 3 – 300 V voltage input

##### DC measuring input (1 pcs)

- N – none
- C – 1 AI DC input 20 mA
- V – 1 AI DC input +/- 10 V

#### C1, C2 – Ethernet Communication ports

##### Connector

- N – none (only system)
- E – 100BaseTx (RJ45)
- F – 100BaseFx (ST Glass F.O.)

##### Communication protocol

- N – none
- G – IEC 61850 MMS with GOOSE
- 4 – IEC 60870-5-104
- D – DNP3 (TCP/IP)

#### C3, C4 – Serial Communication ports

##### Connector

- N – none (only system)
- 2 – RS232 (DB9 female)
- 5 – RS485
- F – ST Glass F.O.

##### Communication protocol

- N – none
- 1 – IEC 60870-5-101
- 3 – IEC 60870-5-103
- D – DNP3
- M – Modbus

#### PS – Auxiliary supply voltage

- 1 – 19...30 V DC with 8 DO
- 2 – 38...72 V DC with 8 DO
- 3 – 88...150 V DC with 8 DO
- 4 – 176...300 V DC with 8 DO
- 5 – 170...330 V AC with 8 DO
- M1 – 19...30 V DC with 5 DO and 8 DI
- M2 – 38...72 V DC with 5 DO and 8 DI
- M3 – 88...150 V DC with 5 DO and 8 DI
- M4 – 176...300 V DC with 5 DO and 8 DI
- M5 – 170...330 V AC with 5 DO and 8 DI

- 11 – 19...30 V DC with 7 DO and 16 DI
- 12 – 38...72 V DC with 7 DO and 16 DI
- 13 – 88...150 V DC with 7 DO and 16 DI
- 14 – 176...300 V DC with 7 DO and 16 DI
- 15 – 170...330 V AC with 7 DO and 16 DI

#### S1..S7 – Slot configuration

- NN – none
- R8 – DO board (8 Digital Outputs)<sup>(2)(3)</sup> (5 or 8 Digital Output are default on PS board)
- B1 – DI board (22 Digital Inputs) 24 V DC (with LEDs)<sup>(3)</sup>
- B2 – DI board (22 Digital Inputs) 48-60 V DC (with LEDs)<sup>(3)</sup>
- B3 – DI board (22 Digital Inputs) 110-125 V DC (with LEDs)<sup>(3)</sup>
- B4 – DI board (22 Digital Inputs) 220 V DC (with LEDs)<sup>(3)</sup>
- B5 – DI board (22 Digital Inputs) 230 V AC (with LEDs)<sup>(3)</sup>
- M1 – DIO board (15 Digital Inputs) 24 V DC + 4 Digital Outputs (with LEDs)<sup>(3a)</sup>
- M2 – DIO board (15 Digital Inputs) 48-60 V DC + 4 Digital Outputs (with LEDs)<sup>(3a)</sup>
- M3 – DIO board (15 Digital Inputs) 110-125 V DC + 4 Digital Outputs (with LEDs)<sup>(3a)</sup>
- M4 – DIO board (15 Digital Inputs) 220 V DC + 4 Digital Outputs (with LEDs)<sup>(3a)</sup>
- M5 – DIO board (15 Digital Inputs) 230 V AC + 4 Digital Outputs (with LEDs)<sup>(3a)</sup>
- D2 – AI DC board (2 inputs)
- D8 – AI DC board (8 inputs)
- T8 – AI RTD board (8 inputs)

#### Legend:

- <sup>(1)</sup> CTs – sensitive current input for sensitive earth current protection stages
- <sup>(2)</sup> up to 2 boards max
- <sup>(3)</sup> sum of all DI and DO boards up to 7 boards max
- <sup>(3a)</sup> DIO board uses addressing of two boards (DI + DO board)
- <sup>(4)</sup> Current measuring inputs range is user selectable

#### Ordering examples:

FPC 680 – F04 / L1 / D11N / FG / FG / NN / NN / 3 / B3 / B3  
 FPC 680 – F04 / L2 / D11N / ED / NN / 53 / NN / 3 / B3 / M3 / D8 / T3  
 FPC 680 – F03 / T7 / D11N / EG / EG / NN / NN / I3