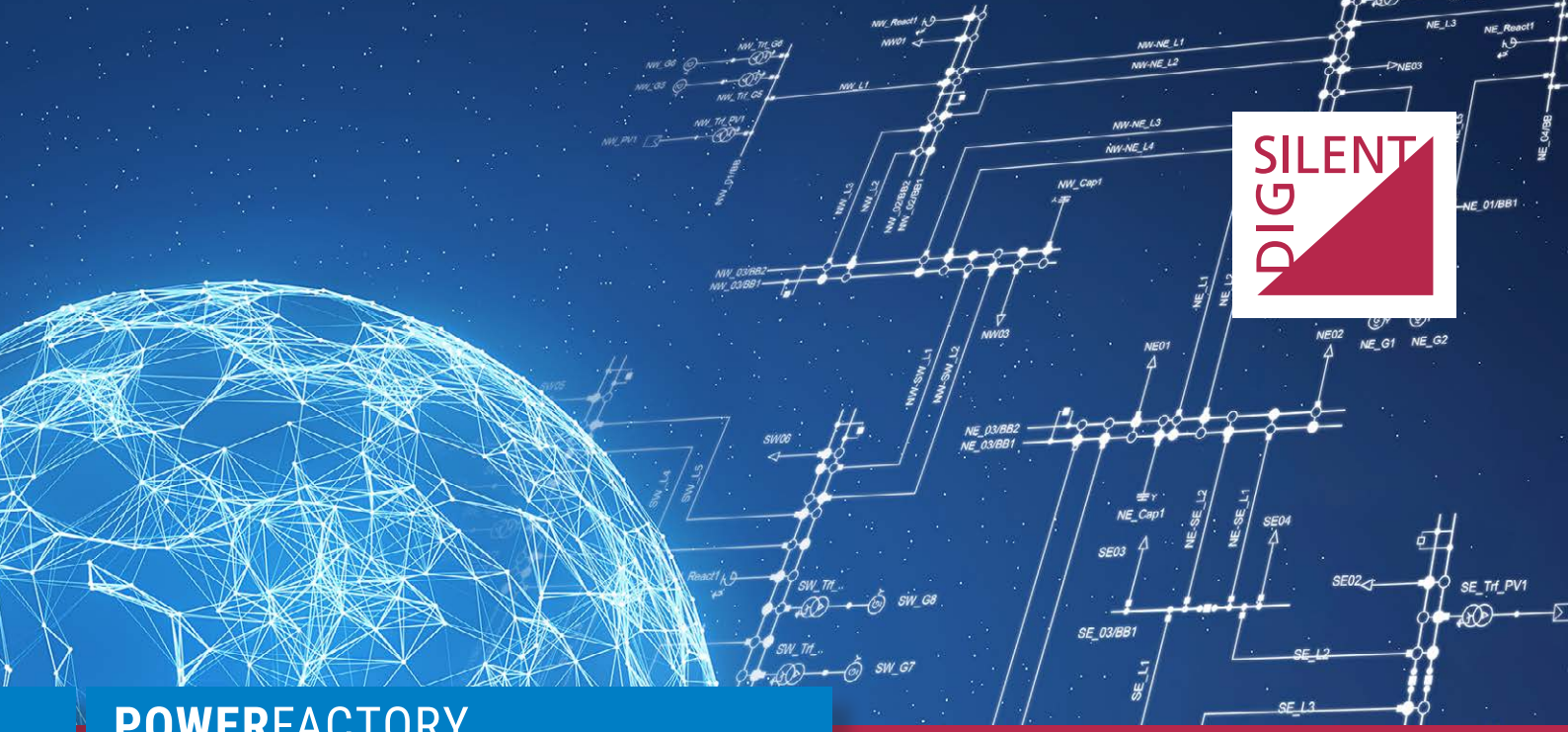


# PowerFactory 2021

## Technical Reference

### Siemens 7UM62X

PF2021

**POWER SYSTEM SOLUTIONS**
MADE IN GERMANY

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November 15, 2019
PowerFactory 2021
Revision 924

# Contents

# 1 Model information

**Manufacturer** Siemens

**Model** 7UM62X

**Variants** The Siemens 7UM62X PowerFactory relay models can be used to simulate the different firmware versions of the Siemens 7UM621, and 7UM622 Multifunction Generator, Motor and Transformer Protection relays. The relay version used to implement the model is Siemens 7UM62X V4.6 . However please consider that the model has been implemented with a reduced set of the features available in the relays.

# 2 General description

The SIPROTEC 4 7UM62 is a numerical machine protection unit from the ”7UM6 Numerical Protection” series. It provides all functions necessary for protection of generators, motors and transformers. As the scope of functions of the 7UM62 can be customized, it is suited for small, medium-sized and large generators. The 7UM62 device is usable for further applications such as

- Transformer protection, as the 7UM62 has in addition to differential and overcurrent protection a large variety of protection functions that allow, for instance, monitoring of the voltage and frequency load.
- Protection of synchronous and asynchronous motors.

The Siemens 7UM62X relays has been modeled using two PowerFactory relay models; the following relay models are available:

- Siemens 7UM62X 1 A
- Siemens 7UM62X 5 A

Each relay model consists of a main relay and of the following seven sub relays:

- Siemens 7UM62X overcurrent elements (50/.
- Siemens 7UM62X voltage elements (F27/59).
- Siemens 7UM62X frequency (F81).
- Siemens 7UM62X power (F32).
- Siemens 7UM62X loss of field (F40).
- Siemens 7UM62X distance elements (F21).
- Siemens 7UM62X differential.

The main relays includes the measurement and acquisition elements, the seven subrelays and the output logic.

The model implementation has been based on the information available in the relay documentation provided by the manufacturer and freely available [1].

# 3 Supported features

## 3.1 Measurement and acquisition

It represents the interface between the power system and the relay protective elements. The currents flowing in the power system are converted by two elements which model two 3 phase CTs, one element modeling a single phase CT which measures the neutral current and by an element which models a 3 phase VT; the secondary currents and voltages are then measured by five elements which model the digital filters of the relay and calculate the voltage and frequency RMS values and vector components.

### 3.1.1 Available Units

- Two 3 phase current transformers (”Ct” and ”Remote Ct” block).
- One single phase current transformers (”Neutral Ct” block).
- One three phase voltage transformer (”Vt” block).
- One 3 phase current and voltage measurement element (”Side 1 Measurement” block).
- One sequence current and voltage measurement element (”Side 1 Measurement Seq” block).
- One 3 phase phase-phase voltage measurement element (”Side 1 Measurement DVoltage” block).
- One single phase measurement element (”Meas Neutral I” block).
- One 3 phase current measurement element (”Side 2 Measurement” block).

### 3.1.2 Functionality

The ”Ct”, the ”Remote Ct”, and the ”Neutral Ct” block represent ideal CTs. Using the CT default configuration the current at the primary side are converted to the secondary side using the CT ratio. The CT saturation and/or its magnetizing characteristic are not considered. Please set the ”Detailed Model” check box in the ”Detailed Data” tab page of the CT dialog and insert the data regarding the CT burden, the CT secondary resistance and the CT excitation parameter if more accurate simulation results are required.

The input currents are sampled at 20 samples/cycle.

The measurement blocks calculate the first harmonic components of the currents using a DFT filter operating over a full cycle.

The 3phase voltage measurement element (”Side 1 Measurement DVoltage” block) calculates the phase-phase voltages which, depending upon the relay settings, can be used by the over/under voltage elements instead of the phase-ground voltages.

The ”Side 2 Measurement” block measure the 3phase current at a remote location and represent the $2^{nd}$ measurement source for the differential elements.

The single phase measurement element (”Meas Neutral I” block) measures the neutral current converted by the core Ct (”Neutral Ct” block). If no core CT is available please select the 3 phases CT also in the ”Neutral Ct” slot: the earth current will be calculated assuming that an Holmgreen’s connection of the phases is used.

### 3.1.3 Data input

No user input is required but the relay model version with the secondary rated value which matches the CT rated current must be used.

## 3.2 Siemens 7UM62X overcurrent elements (50/ subrelay

### 3.2.1 Available Units

- One 3 phase definite time overcurrent element with seal in feature (”I> (50-51)”, ”U< (I>)”, and ”tI>” block).
- One 3 phase direction definite time overcurrent element (”I>>” block).
- One 3 phase directional element (”Line angle” block).
- One simplified thermal image element (”Thermal image” block).
- One 3 phase overcurrent element with voltage restraint (”Ip 51V” and ”V restraint” block).
- One negative sequence element with $I^2T = k$ characteristic (”I2>” block).
- On negative sequence define time element (”I2>>” block).
- One earth directional definite time overcurrent element acting as 90-%-Stator Earth Fault Protection (”3Io>” block).
- One earth directional element (”Ground Dir. Angle” block).
- Two definite time sensitive earth fault elements (”IEE>” and ”IEE>>” block).

### 3.2.2 Functionality

The overcurrent subrelay consists of a thermal image element and of a set of phase, negative sequence and zero sequence overcurrent elements. One phase overcurrent element (”I>>” block) and one zero sequence element (”3Io>” block) are directional elements. One phase overcurrent element ((”I> (50-51)” block) can be set with the seal in feature activated by the voltage collapse and one phase overcurrent element (”Ip 51V” block) has a more common voltage restrain feature.

The inverse time overcurrent element (”Ip 51V” ) supports the following inverse characteristics:

- ANSI Definite Inverse.
- ANSI Extremly Inverse.
- ANSI Inverse.
- ANSI Moderately Inverse.
- ANSI Very Inverse.
- Definite Time.
- IEC Extremely Inverse.
- IEC Normal Inverse.
- IEC Very Inverse.

The inverse time trip characteristic equations comply with the IEC 60255-3 and the IEEE standard equations. The thermal image element (”Thermal overload” block) calculates the trip time using the IEC 60255-8 equation.

### 3.2.3 Data input

The relationships between the relay settings and the model parameters can be found in the following table(the relay model parameter names are listed between brackets):

| Address | Relay Setting | Model block | Model setting | Note |
|---|---|---|---|---|
| 1201 | O/C I> | I> (50-51) | Out of service (outserv) | |
| 1202 | I> | I> (50-51) | Pickup Current (Ipsetr) | |
| 1203 | T > | t> | Time Setting (Tdelay) | |
| 1204 | U< SEAL-IN | U< (>) | Out of service (outserv) | |
| 1205 | U< | U< (>) | Pickup Voltage (Usetr) | |
| 1206 | T-SEAL-IN | T-SEAL IN | Time Setting (Tdelay) | |
| 1301 | O/C I>> | I>> | Out of service (outserv) | |
| 1302 | I>> | I>> | Pickup Current (Ipsetr) | |
| 1303 | T I>> | I>> | Time Setting (Tset) | |
| 1304 | Phase Direction | I>> | Tripping Direction (idir) | |
| 1305 | LINE ANGLE | Line angle | Max Torque Angle (mtau) | In the "Voltage Polarizing" tab page |
| 1401 | O/C Ip | Ip 51V | Out of service (outserv) | |
| 1402 | Ip | Ip 51V | Current Setting (Ipsetr) | |
| 1403 | T Ip | Ip 51V | Time Dial (Tpset) | Active when the trip characteristic is inverse time |
| 1404 | TIME DIAL: TD | Ip 51V | Time Dial (Tpset) | Active when the trip characteristic is *Definite time* |
| 1405 | IEC CURVE | Ip 51V | Characteristic(pcharac) | |
| 1406 | ANSI CURVE | Ip 51V | Characteristic(pcharac) | |
| 1407 | VOLT. INFLUENCE | V restraint | VrestraintON | In the "Logic" tab page, set equal to 1 when the realy setting is *Volt. restraint* |
| 1601 | Ther. OVER LOAD | Thermal image | Out of service (outserv) | |
| 1602 | K-FACTOR | Thermal image | Current Setting (Ipset) | |
| 1603 | TIME CONSTANT | Thermal image | Time Dial (Tpset) | |
| 1701 | UNBALANCE LOAD | I2> | Out of service (outserv) | |
| 1702 | I2> | I2> | Current Setting (Ipset) | |
| 1704 | FACTOR K | I2> | Time Dial (Tpset) | |
| 1705 | T COOL DOWN | I2> | Reset Delay (ResetT) | |
| 1706 | I2>> | I2>> | Pickup Current (Ipset) | |
| 1707 | T I2>> | I2>> | Time Setting (Tset) | |
| 5001 | S/E/F PROT. | 3Io> | Out of service (outserv) | |
| 5002 | U0> | Ground Dir. Angle | Polarizing Voltage (upolur) | In the "Voltage Polarizing" tab page |
| 5003 | 3I0> | 3Io> | Pickup Current (Ipsetr) | |
| 5004 | DIR. ANGLE | Ground Dir. Angle | Max. Torque Angle (mtau) | In the "Voltage Polarizing" tab page |
| 5005 | T S/E/F | 3Io> | Time Setting (Tset) | |
| 5101 | O/C PROT. IEE | IEE> | Out of service (outserv) | |
| | | IEE>> | Out of service (outserv) | |
| 5102 | IEE> | IEE> | Pickup Current (Ipsetr) | |
| 5103 | T IEE> | IEE> | Time Setting (Tset) | |
| 5104 | IEE>> | IEE>> | Pickup Current (Ipsetr) | |
| 5105 | T IEE>> | IEE>> | Time Setting (Tset) | |

## 3.3 Siemens 7UM62X voltage elements (F27/59) subrelay

The *Siemens 7UM62X voltage elements (F27/59)* subrelay contains a set of phase-phase and phase-ground overvoltage elements, one set of positive sequence undervoltage elements and two overfluxing elements.

### 3.3.1 Available Units

- Two phase-ground define time overvoltage elements (”U> Ph-E” and ”U>> Ph-E” block).
- Two phase-phase define time overvoltage elements (”U> Ph-Ph” and ”U>> Ph-Ph” block).
- One positive sequence definite time undervoltage element(”Up<” block).
- Two positive sequence define time undervoltage elements (”U<” and ”U<< ” block).
- One inverse time overfluxing element (”U/f>” block).
- One definite time overfluxing element (”U/f>>” block).

### 3.3.2 Functionality

The set consisting of two 3 phase overvoltage and two 3phase undervoltage elements is duplicated: one set is fed by the phase-phase voltages , one set is fed by the phase-ground voltages; only one set, accordingly with the value of the ”VALUES” (address 4107A) relay parameter, can be active at the same time.

The flux value is calculated by the ”V/Hz calculator” block.

### 3.3.3 Data input

The relationships between the relay settings and the model parameters can be found in the following table (the relay model parameter names are listed between brackets):

| Address | Relay Setting | Model block | Model setting | Note |
|---|---|---|---|---|
| 4001 | UNDERVOLTAGE | U< | Out of Service (outserv) | |
| | | U<< | Out of Service (outserv) | |
| 4002 | U< | U< | Pickup Voltage(Usetr) | |
| 4003 | T U< | U< | Time Delay (Tdel) | |
| 4004 | U<< | U<< | Pickup Voltage(Usetr) | |
| 4005 | T U<< | U<< | Time Delay (Tdel) | |
| 4101 | OVERVOLTAGE | U> Ph-Ph | Out of Service (outserv) | |
| | | U>> Ph-Ph | Out of Service (outserv) | |
| | | U>> Ph-E | Out of Service (outserv) | |
| | | U>> Ph-E | Out of Service (outserv) | |
| 4102 | U> | U> Ph-Ph | Pickup Voltage (Usetr) | |
| | U> | U> Ph-E | Pickup Voltage(Usetr) | |
| 4103 | T U> | U> Ph-Ph | Time Delay (Tdel) | |
| | T U> | U> Ph-E | Time Delay (Tdel) | |
| 4104 | U>> | U>> Ph-Ph | Pickup Voltage(Usetr) | |
| | U>> | U>> Ph-E | Pickup Voltage(Usetr) | |
| 4105 | T U>> | U>> Ph-Ph | Time Delay (Tdel) | |
| | T U>> | U>> Ph-Ph | Time Delay (Tdel) | |

| Address | Relay Setting | Model block | Model setting | Note |
|---|---|---|---|---|
| 4107A | VALUES | U> Ph-Ph | Out of Service (outserv) | |
| | | U>> Ph-Ph | Out of Service (outserv) | |
| | | U>> Ph-E | Out of Service (outserv) | |
| | | U>> Ph-E | Out of Service (outserv) | |
| 4301 | OVEREXC. PROT. | U/f> | Out of Service (outserv) | |
| | | U/f>> | Out of Service (outserv) | |
| 4302 | U/f > | U/f> | Input Setting (Ipsetr) | |
| 4303 | T U/f > | U/f> | Time dial (Tpset) | |
| 4304 | U/f >> | U/f>> | Input Setting (Ipsetr) | |
| 4305 | T U/f >> | U/f>> | Time dial (Tpset) | |
| 4306 | t(U/f=1.05) | V/Hz user defined curve 1 | Cell ”Y1”,”2” | Curve defined in the |
| 4307 | t(U/f=1.10) | V/Hz user defined curve 1 | Cell ”Y1”,”3” | ”7UT6xx Tripping |
| 4308 | t(U/f=1.15) | V/Hz user defined curve 1 | Cell ”Y1”,”4” | Curves” folder located |
| 4309 | t(U/f=1.20) | V/Hz user defined curve 1 | Cell ”Y1”,”5” | inside the relay type |
| 4310 | t(U/f=1.25) | V/Hz user defined curve 1 | Cell ”Y1”,”6” | 4 user defined curves |
| 4311 | t(U/f=1.30) | V/Hz user defined curve 1 | Cell ”Y1”,”7” | are available and |
| 4312 | t(U/f=1.35) | V/Hz user defined curve 1 | Cell ”Y1”,”8” | can be used to set 4 |
| 4313 | t(U/f=1.40) | V/Hz user defined curve 1 | Cell ”Y1”,”9” | sets of V/Hz points |
| 4314 | T COOL DOWN | U/f> | Reset Delay (ResetT) | |
| 4401 | INV. UNDERVOLT. | Up< | Out of Service (outserv) | |
| 4402 | Up< PICKUP | Up< | Current Setting (Ipsetr) | |
| 4403 | T MUL | Up< | Time Dial (Tpset) | |
| 4404 | T Up< | Up< | Time Addder (Tadder) | |

## 3.4 Siemens 7UM62X frequency (F81) subrelay

The *Siemens 7UM62X frequency (F81)* subrelay contains the elements which simulate the Frequency Protection (ANSI 81) and the Rate-of-Frequency-Change Protection df/dt (ANSI 81R) protective feature.

### 3.4.1 Available Units

- Eight frequency elements (”f1 (1st threshold)”, ”f1 (2nd threshold)”, ”f2 (1st threshold)”, ”f2 (2nd threshold)”, ”f3 (1st threshold)”, ”f3 (2nd threshold)”, ”f4 (1st threshold)” and ”f4 (2nd threshold)” block).
- Two definite time undervoltage elements (”U MIN” and ”Umin” block).
- Four rate of frequency change elements (”df1/dt”, ”df2/dt”, ”df3/dt”, and ”df4/dt” block).
- One frequency calculation element (”Meas Freq” block).

### 3.4.2 Functionality

Two independent under voltage elements can be used to block the frequency element set (”Umin” block) and the rate of frequency change element set (”U MIN” block).

The frequency is measured by the ”Meas Freq” block which uses by default the phase A - phase B voltage.

### 3.4.3 Data input

The relationships between the relay settings and the model parameters can be found in the following table (the relay model parameter names are listed between brackets):

| Address | Relay Setting | Model block | Model setting | Note |
|---|---|---|---|---|
| 4201 | O/U FREQUENCY | f1 (1st threshold) | Out of Service (outserv) | |
| | | f1 (2nd threshold) | Out of Service (outserv) | |
| | | f2 (1st threshold) | Out of Service (outserv) | |
| | | f2 (2nd threshold) | Out of Service (outserv) | |
| | | f3 (1st threshold) | Out of Service (outserv) | |
| | | f3 (2nd threshold) | Out of Service (outserv) | |
| | | f4 (1st threshold) | Out of Service (outserv) | |
| | | f4 (2nd threshold) | Out of Service (outserv) | |
| 4202 | f1 PICKUP | f1 (1st threshold) | Frequency (Fset) | |
| 4203 | f1 PICKUP | f1 (2nd threshold) | Frequency (Fset) | |
| 4204 | T f1 | f1 (1st threshold) | Time Delay (Tdel) | |
| | | f1 (2nd threshold) | Time Delay (Tdel) | |
| 4205 | f2 PICKUP | f2 (1st threshold) | Frequency (Fset) | |
| 4206 | f2 PICKUP | f2 (2nd threshold) | Frequency (Fset) | |
| 4207 | T f2 | f2 (1st threshold) | Time Delay (Tdel) | |
| | | f2 (2nd threshold) | Time Delay (Tdel) | |
| 4208 | f3 PICKUP | f3 (1st threshold) | Frequency (Fset) | |
| 4209 | f3 PICKUP | f3 (2nd threshold) | Frequency (Fset) | |
| 4210 | T f3 | f3 (1st threshold) | Time Delay (Tdel) | |
| | | f3 (2nd threshold) | Time Delay (Tdel) | |

| Address | Relay Setting | Model block | Model setting | Note |
|---|---|---|---|---|
| 4211 | f4 PICKUP | f4 (1st threshold) | Frequency (Fset) | |
| 4212 | f4 PICKUP | f4 (2nd threshold) | Frequency (Fset) | |
| 4213 | T f4 | f4 (1st threshold) | Time Delay (Tdel) | |
| | | f4 (2nd threshold) | Time Delay (Tdel) | |
| 4215 | Umin | Umin | Pickup Voltage (Usetr) | |
| 4501 | df/dt Protect. | df1/dt | Out of Service (outserv) | |
| | | df2/dt | Out of Service (outserv) | |
| | | df3/dt | Out of Service (outserv) | |
| | | df4/dt | Out of Service (outserv) | |
| 4503 | STAGE df1/dt | df1/dt | Gradient df/dt (dFset) | |
| 4504 | T df1/dt | df1/dt | Time Delay (Tdel) | |
| 4507 | STAGE df2/dt | df2/dt | Gradient df/dt (dFset) | |
| 4508 | T df2/dt | df2/dt | Time Delay (Tdel) | |
| 4511 | STAGE df3/dt | df3/dt | Gradient df/dt (dFset) | |
| 4512 | T df3/dt | df3/dt | Time Delay (Tdel) | |
| 4515 | STAGE df4/dt | df4/dt | Gradient df/dt (dFset) | |
| 4516 | T df4/dt | df4/dt | Time Delay (Tdel) | |
| 4518 | U MIN | U MIN | Pickup Voltage (Usetr) | |

Separated blocks are use to model each frequency element (i.e. ”f1 (1st threshold)” and ” f1 (2nd threshold)” are modeling the ”f1” relay element); please consider that the time delay is an unique value so the same time delay must be set in both blocks.

## 3.5 Siemens 7UM62X power (F32) elements (F21) subrelay

The *Siemens 7UM62X power (F32) elements (F21)* subrelay models the main features of the active over/underpower elements and of the reverse power element.

### 3.5.1 Available Units

- One forward over activepower definite time element (”Pf>” block).
- One forward under activepower definite time element (”Pf<” block).
- Two reverse over active power definite time elements (”P> Reverse T-SV-OPEN” and ”P>Reverse T-SV-CLOSED” block).
- Two elements calculating the forward and the reverse active power (”PQ calc” and ”Power Calculator” block).

### 3.5.2 Functionality

The ”P> Reverse T-SV-OPEN” or the ”P>Reverse T-SV-CLOSED” block must be enabled manually to simulate the effect of the binary input which transfer the emergency tripping valve position. Both blocks must be set with an identical trip threshold.

### 3.5.3 Data input

The relationships between the relay settings and the model parameters can be found in the following table (the relay model parameter names are listed between brackets):

| Address | Relay Setting | Model block | Model Parameter | Note |
|---|---|---|---|---|
| 3101 | REVERSE POWER | P> Reverse T-SV-OPEN | Out of Service (outserv) | |
| | | P> Reverse T-SV-CLOSED | Out of Service (outserv) | |
| 3102 | P> REVERSE | P> Reverse T-SV-OPEN | Pickup Current (Ipsetr) | |
| | | P> Reverse T-SV-CLOSED | Pickup Current (Ipsetr) | |
| 3103 | T-SV-OPEN | P> Reverse T-SV-OPEN | Time Setting (Tset) | |
| 3104 | T-SV-CLOSED | P> Reverse T-SV-CLOSED | Time Setting (Tset) | |
| 3201 | FORWARD POWER | Pf> | Out of Service (outserv) | |
| | | Pf< | Out of Service (outserv) | |
| 3202 | Pf< | Pf< | Pickup Current (Ipsetr) | |
| 3203 | Pf> | Pf> | Pickup Current (Ipsetr) | |
| 3204 | T-Pf< | Pf< | Time Setting (Tset) | |
| 3205 | T-Pf> | Pf> | Time Setting (Tset) | |

## 3.6 Siemens 7UM62X loss of field (F40) subrelay

The *Siemens 7UM62X loss of field (F40)* subrelay models 3 loss of field characteristics with voltage supervisioning.

### 3.6.1 Available Units

- Five admittance blinder elements (”Characteristic1-A”, ”Characteristic1-B”, ”Characteristic2”, ”Characteristic3-A”, and”Characteristic3-B” block).
- Three timers (”Characteristic 1 Trip delay”, ”Characteristic 2 Trip delay”, and ”Characteristic 3 Trip delay” block).
- One overvoltage element (”Voltage supervision” block).
- One polarizing element (”Polarizing” block).

### 3.6.2 Functionality

The subrelay processes all three phase currents all three phase voltages. The ”Characteristic1-A” admittance blinder and the ”Characteristic1-B” admittance blinder model the *Characteristic 1* shape. The ”Characteristic3-A” admittance blinder and the ”Characteristic3-B” admittance blinder simulate the *Characteristic 3* shape. A different timer is associated to each characteristic.

The admittance blinder elements are not displayed in the PowerFactory R-X digram.

### 3.6.3 Data input

The relationships between the relay settings and the model parameters can be found in the following table (the relay model parameter names are listed between brackets):

| Address | Relay Setting | Model block | Model Parameter | Note |
|---|---|---|---|---|
| 3001 | IMPEDANCE PROT. | Characteristic1-A | Out of Service (outserv) | |
| | | Characteristic1-B | Out of Service (outserv) | |
| | | Characteristic2 | Out of Service (outserv) | |
| | | Characteristic3-A | Out of Service (outserv) | |
| | | Characteristic3-B | Out of Service (outserv) | |
| 3002 | 1/xd CHAR. 1 | Characteristic1-A | Admittance (B) | |
| | | Characteristic1-B | Admittance (B) | |
| 3003 | ANGLE 1 | Characteristic1-A | Relay Angle (phi) | |
| | | Characteristic1-B | Relay Angle (phi) | |
| 3004 | T CHAR. 1 | Characteristic 1 Trip delay | Time Setting (Tdelay) | |
| 3005 | 1/xd CHAR. 2 | Characteristic2 | Admittance (B) | |
| 3006 | ANGLE 2 | Characteristic2 | Relay Angle (phi) | |
| 3007 | T CHAR. 2 | Characteristic 3 Trip delay | Time Setting (Tdelay) | |
| 3008 | 1/xd CHAR. 3 | Characteristic3-A | Admittance (B) | |
| | | Characteristic3-B | Admittance (B) | |
| 3009 | ANGLE 3 | Characteristic3-A | Relay Angle (phi) | |
| | | Characteristic3-B | Relay Angle (phi) | |
| 3010 | T CHAR 3 | Characteristic 3 Trip delay | Time Setting (Tdelay) | |
| 3012 | EXCIT. VOLT. | Voltage supervision | Out of Service (outserv) | |
| 3014A | Umin | Voltage supervision | Pickup Voltage (Usetr) | |

The ”Polarizing” block doesn’t require any input.

## 3.7 Siemens 7UM62X distance elements (F21) subrelay

The *Siemens 7UM62X distance elements (F21)* subrelay contains 3 polygonal distance zones which check both the phase and the ground loop impedances and two out of step zones with phase and negative sequence release logic.

### 3.7.1 Available Units

- One distance starting element (”Starting” block).
- One polarizing element (”Polarizing” block).
- Three polygonal distance elements (”Z1”, ”Z1b”, and ”Z2” block).
- Three timers associated to the polygonal zones (”Zone#1 Trip delay”, ”Zone#1b Trip delay”, and ”Zone#2 Trip delay” block).
- One power swing detector element (”Power Swing” block).
- Two out of step detector elements (”Out of Step Characteristic 1” and ”Out of Step Characteristic 2” block).
- Two out of step zone elements (”OOS Characteristic 1” and ”OOS Characteristic 2” block).
- One positive sequence overcurrent element (”I1> Release” block).
- One negative sequence overcurrent element (”I2< Release” block).
- One additional timer (”T END” block).

### 3.7.2 Functionality

The polygonal zones, controlled by an overcurrent starting logic (”Starting” block), check both the phase and the ground loops impedances calculated by the polarizing element (”Polarizing” block). A separate timer is associate to each distance zone (”Zone#1 Trip delay”, ”Zone#1b Trip delay”, and ”Zone#2 Trip delay” block). The distance zones are blocked when a power swing condition has been detected by the power swing detector element (”Power Swing” block).

Two separate elements (”Out of Step Characteristic 1” and ”Out of Step Characteristic 2” block) can be used to detect an out of step condition and to trip the relay. The out of step zones (”OOS Characteristic 1” and ”OOS Characteristic 2” block) are enabled only when the positive sequence current is greater than an user defined threshold (”I1> Release” block) and the negative sequence current is smaller than another user defined threshold (”I2< Release” block).

A backup delayed trip can be triggered by an additional timer (”T END” block).

### 3.7.3 Data input

The relationships between the relay settings and the model parameters can be found in the following table (the relay model parameter names are listed between brackets):

| Address | Relay Setting | Model block | Model Parameter | Note |
|---|---|---|---|---|
| 3301 | IMPEDANCE PROT. | Z1 | Out of Service (outserv) | |
| | | Z1b | Out of Service (outserv) | |
| | | Z2 | Out of Service (outserv) | |
| 3302 | IMP I> | Starting | Iph> (Iphg) | In the ”Under-impedance / Overcurrent” tab page |
| 3306 | ZONE Z1 | Z1 | +X Reach (Xmax) | |
| | | Z1 | +R Resistance (PH-E) (REmax) | |
| 3307 | T-Z1 | Zone#1 Trip delay | Time Setting (Tdelay) | |
| 3308 | ZONE Z1B | Z1b | +X Reach (Xmax) | |
| | | Z1b | +R Resistance (PH-E) (REmax) | |
| 3309 | T-Z1B | Zone#1b Trip delay | Time Setting (Tdelay) | |
| 3310 | ZONE Z2 | Z2 | +X Reach (Xmax) | |
| | | Z2 | +R Resistance (PH-E) (REmax) | |
| 3311 | T-Z2 | Zone#2 Trip delay | Time Setting (Tdelay) | |
| 3312 | T END | T END | Time Setting (Tdelay) | |
| 3313 | POWER SWING | Power Swing | Out of Service (outserv) | |
| 3314 | P/SPOL-TPOL | Power Swing | Delta Z (dZ) | In the "External Polygon Settings" tab page |
| 3317A | T-ACTION P/S | Power Swing | tH(tH) | In teh "Timers" tab page |
| 3501 | OUT-OF-STEP | Out of Step Characteristic 1 | Out of Service (outserv) | |
| | | Out of Step Characteristic 2 | Out of Service (outserv) | |
| 3502 | I1> RELEASE | I1> Release | Pickup Current (Ipset) | |
| 3503 | I2< RELEASE | I2< Release | Pickup Current (Ipset) | |
| 3504 | Za | OOS Characteristic 1 | +R Resistance (Rmax) | |
| | | OOS Characteristic 2 | +R Resistance (Rmax) | |
| 3505 | Zb | OOS Characteristic 1 | -X Reach (Xmin) | |
| 3506 | Zc | OOS Characteristic 1 | +X Reach (Xmax) | |
| 3507 | Zd-Zc | OOS Characteristic 2 | +X Reach (Xmax) | +X Reach =”Zd-Zc”+”Zc” |
| 3508 | PHI POLYGON | Out of Step Characteristic 1 | Relay Angle (phi) | |
| | | Out of Step Characteristic 2 | Relay Angle (phi) | |
| 3509 | REP. CHAR. 1 | Out of Step Characteristic 1 | OOS, No. of Crossings (iooscrossnum) | |
| 3510 | REP. CHAR. 2 | Out of Step Characteristic 2 | OOS, No. of Crossings (iooscrossnum) | |

## 3.8 Siemens 7UM62X differential subrelay

The *Siemens 7UM62X differential* subrelay contains a 3 phase differential element with harmonic blocking and a REF differential element.

### 3.8.1 Available Units

- One 3 phase differential element (”Phase Differential” block).
- One 3 phase differential current measurement element (”Ph Diff RMS Measure” block, ancillary to the 3 phase differential element).
- One single phase differential element (”Earth differential” block).
- One single phase current measurement element (”Earth Diff RMS Measure” block, ancillary to the single phase differential element).
- Four frequency measurement elements (”CT1 2nd Harmonic Measurement”, ”CT1 5th Harmonic Measurement”, ”CT2 2nd Harmonic Measurement”, and ”CT2 5th Harmonic Measurement” block).
- One 3 phase definite time overcurrent element (”REF I> BLOCK” block).
- One single phase definite time overvoltage element (”REF Uo> RELEASE” block).

### 3.8.2 Functionality

**Differential Protection (ANSI 87G/87M/87T)** :

The following features are available in the 3phase differential element (”Phase Differential” block):

- Double bias current percentage restraint differential with user configurable differential threshold and user configurable restraint slopes and slopes thresholds.
- Unrestrained differential with user configurable threshold.
- User configurable time delay (shared by both differentials).
- $2^{nd}$ harmonic restraint of the first differential with user configurable threshold.
- $5^{th}$ harmonic restraint of the first differential with user configurable threshold.

The differential element calculates for each phase the average of the input currents. The average values are then used to calculate the differential threshold considering the user configurable double bias current percentage restraint.

The measurement element (”Ph Diff RMS Measure” block) is used to calculate the RMS value of the differential current. The differential current vector components (or instantaneous values during the EMT simulation) are calculated by the differential element.

The second restrain uses the $5^{th}$ harmonic.

**Earth Current Differential Protection (ANSI 87GN,TN)** :

The earth differential element is a REF(Restricted Earth Fault) differential which compares the neutral current with the zero sequence current measured by the ”Ct” CT.

The following features are available in the earth differential element (”Earth differential” block):

- Single bias current percentage restraint differential with user configurable differential threshold and user configurable restraint slope.
- User configurable time delay.
- Minimum phase current threshold (”REF I> BLOCK” block).
- Minimum zero sequence voltage activation threshold (”REF Uo> RELEASE” block).

The restricted earth fault element calculates the average of the neutral current and of the zero sequence current. This value is used to calculate the earth fault differential threshold considering the user configurable single bias current percentage restraint.

The measurement element (”Earth Diff RMS Measure” block) is used to calculate the RMS value of the restricted earth fault differential current. The restricted earth fault differential current vector components (or instantaneous values during the EMT simulation) are calculated by the differential element.

The differential element is blocked when the zero sequence voltage is below the threshold set in the ”REF Uo> RELEASE” block or when the phase current is above the threshold set in the ”REF I> BLOCK” block.

### 3.8.3 Data input

**Differential Protection (ANSI 87G/87M/87T)** :

The relationships between the relay settings and the model parameters can be found in the following table (the relay model parameter names are listed between brackets):

| Address | Relay Setting | Model block | Model Parameter | Note |
|---|---|---|---|---|
| 2001 | DIFF PROT. | Phase Differential | Out of Service (outserv) | |
| 2006 | INRUSH 2.HARM. | Phase Differential | Disable harmonic blocking (harmblockdisable) | In the ”Harmonic blocking” tab page, shared with 2007 |
| 2007 | RESTR. n.HARM. | Phase Differential | Disable harmonic blocking (harmblockdisable) | In the ”Harmonic blocking” tab page, shared with 2006 |
| 2021 | I-DIFF> | Phase Differential | Differential Current base threshold (Idiff) | |
| 2026A | T I-DIFF> | Phase Differential | Time Setting (Tset) | In the model unique parameter shared with 1236A |
| 2031 | I-DIFF>> | Phase Differential | Unrestrained Differential threshold (Idiffunrest) | |
| 2036A | T I-DIFF>> | Phase Differential | Time Setting (Tset) | In the model unique parameter shared with 1236A |
| 2041A | SLOPE 1 | Phase Differential | Restrain Percentage 1 (Irestepercent1) | |
| 2042A | BASE POINT 1 | Phase Differential | Restraint Current 1st Threshold (Ipset1) | |

| Address | Relay Setting | Model block | Model Parameter | Note |
|---|---|---|---|---|
| 2043A | SLOPE 2 | Phase Differential | Restrain Percentage 2 (Irestepercent2) | |
| 2044A | BASE POINT 2 | Phase Differential | Restraint Current 2nd Threshold (Ipset2) | |
| 2071 | 2. HARMONIC | Phase Differential | 2nd Harmonic blocking threshold (H2threshold) | In the ”Harmonic blocking” tab page |
| 2076 | n. HARMONIC | Phase Differential | 5th Harmonic blocking threshold (H5threshold) | In the ”Harmonic blocking” tab page |
| 2078A | IDIFFmax n.HM | Phase Differential | Harm blocking disabling threshold(hblckdisthr) | In the ”Harmonic blocking” tab page |

**Earth Current Differential Protection (ANSI 87GN,TN)** :

The relationships between the relay settings and the model parameters can be found in the following table (the relay model parameter names are listed between brackets):

| Address | Relay Setting | Model block | Model Parameter | Note |
|---|---|---|---|---|
| 2101 | REF PROT. | Earth differential | Out of Service (outserv) | |
| 2102 | REF I> BLOCK | REF I> BLOCK | Pickup Current (Ipset) | |
| 2103 | REF U0> RELEASE | REF Uo> RELEASE | Pickup Voltage (Usetr) | |
| 2110 | I-REF> | Earth differentialt | Differential Current base threshold (Idiff) | |
| 2112 | T I-REF> | Earth differential | Time Setting (Tset) | |
| 2113A | SLOPE | Earth differential | Restrain Percentage 1 (Irestepercent1) | |
| 2114A | BASE POINT | Earth differential | Restraint Current 1st Threshold (Ipset1) | |

## 3.9 Output logic

It represents the output stage of the relay; it's the interface between the relay and the power breaker. A set of eleven relay output contacts is available and can be configured using any custom logic.

### 3.9.1 Available Units

- One output element (”OutputLogic” block).

### 3.9.2 Functionality

The ”OutputLogic” block gets the trip signals coming from the differential element, the restricted earth fault element and from the seven subrelay; it operates the relay output contacts and the power breaker.

The following relay output contacts are available:

- OUT1
- OUT2
- OUT3
- OUT4
- OUT5
- OUT6
- OUT7
- OUT8
- OUT9
- OUT10
- OUT11

They are operated by any (differential/restricted earth fault element or subrelay elements) protection element trip. By default the behavior of these output contacts is identical. Any custom relay output logic can be inserted in the ”Logic” tab page of the ”OutputLogic” block.

The relay output contact which operates the breaker is ”OUT1”.

### 3.9.3 Data input

To disable completely the relay model ability to open the power circuit breaker disable the ”OutputLogic” block.

# 4 Features not supported

The following features are not supported:

- Startup overcurrent Protection (ANSI 51).
- 100% stator earth fault protection with 3rd harmonics and with 20Hz Voltage injection (ANSI 64G).
- Sensitive earth fault protection B (ANSI 51 GN).
- Interturn protection (ANSI 59N).
- Rotor earth fault protection (ANSI 64 R).
- Sensitive Rotor Earth Fault Protection with 1 to 3 Hz Square Wave Voltage Injection 8 ANSI 64 R).
- Motor starting time supervision (ANSI 48).
- Restart inhibit for motors (ANSI 66).
- Breaker failure protection (ANSI 50BF).
- Inadvertent energization (ANSI 50,27).
- Loss of field (F40) excitation voltage supervision pickup.
- DC voltage current protection (ANSI 59NDC/51NDC).

# 5 References

[1] Siemens, P. O. Box 48 06, D-90026 Nurnberg, Germany. *SIPROTEC Multifunctional Machine Protection 7UM62 V4.6 Manual C53000-G1176-C149-5*, 1995.