



**POWERFACTORY**

# PowerFactory 2021

Technical Reference

General Electric UR L90

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**POWER SYSTEM SOLUTIONS**  
MADE IN GERMANY

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## 1 Model information

**Manufacturer** General Electric

**Model** UR L90

**Variants** The General Electric UR L90 PowerFactory relay model can be used to simulate the firmware versions of the GE UR L90 relay up to revision 5.6.

## 2 General description

The General Electric UR L90 is a line differential protection relay with additional distance, power swing/out of step detection, overcurrent and voltage protective elements.

The General Electric UR L90 PowerFactory relay model consists of a main relay model and the following sub relays:

- Phase Distance elements (F21)
- Ground Distance elements (F21)
- Overcurrent elements (F50 - F51 - F46)
- Voltage elements (F27 - F59)
- Out of step (F78)

The General Electric UR L90 PowerFactory relay model has been implemented trying to simulate the protective functions more commonly used.

The main relay contains the measurement and acquisition units, the differential element the output logic and all other sub relays.

The model implementation has been based on the information available in the relay manual [1] [2].

## 3 Supported features

### 3.1 Measurement and acquisition

The voltage and the current are measured by three current transformers ("Ct", "Mutual Ct" and "Neutral Ct" blocks) and one voltage transformer ("Vt" block). Two additional current transformers are used by the differential element: the "Remote Ct1" and the "Remote Ct2" block represent the CTs located at the other line terminals.

Seven measurement units ("Measurement", "Meas delta", "Measurement Seq", "Meas Neutral I", "Meas Mutual", "Measurement(remote 1)" and "Measurement(remote 2)" block) are fed by these CTs and the VT.

### 3.1.1 Available Units

- One three phase current transformer element ("Ct" block).
- One single phase current transformer measuring the ground current ("Neutral Ct" block).
- One single phase current transformer element measuring the ground current along an adjacent line ("Mutual Ct" block).
- One three phase current transformer element converting the phase currents at the first remote end of the line("Remote Ct1" block).
- One three phase current transformer element converting the phase currents at the second remote end of the line("Remote Ct2" block).
- One three phase voltage transformer element ("Vt" block).
- One three phase measurement element fed by the 'Ct' current transformer ("Measurement" block).
- One three phase measurement element calculating the phase-phase current and voltage values ("Meas delta" block).
- One three phase measurement element calculating the sequence values ("Measurement Seq" block).
- One single phase measurement element calculating the neutral current values ("Meas Neutral I" block).
- One single phase measurement element calculating the values of the neutral current along an adjacent line ("Meas Mutual" block).
- One three phase measurement element calculating the phase currents at the first remote end of the line ("Measurement (remote 1)" block).
- One three phase measurement element calculating the phase currents at the second remote end of the line ("Measurement (remote 2)" block).

### 3.1.2 Functionality

The input signals are sampled at 20 samples/cycle; a DFT filter operating over a cycle calculates then the voltage and current values used by the protective elements.

### 3.1.3 Data input

The nominal current and the nominal voltage values **MUST** be entered in all the measurement units.

## 3.2 Differential feature

### 3.2.1 Available Units

- One differential element ("Differential" block).
- Three current adapters ("Winding 1 Adapter", "Winding 2 Adapter" and "Winding 3 Adapter" block).
- One internal measurement element ("Diff RMS meas" block).

### 3.2.2 Functionality

The differential feature is implemented inside the "Differential" block, before being processed by the differential element the currents are recalculated, taking care of the different CT ratios, by the current adapters. The internal measurement element is calculating the RMS value of the differential current vectors returned by the differential element.

### 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, the addresses are MODBUS MEMORY MAP addresses):

Address	Relay Setting	Model block	Model setting	Note
6000	87L Function	Differential	Out of Service (outserv)	
6003	87L Minimum Phase Current Sensitivity	Differential	Differential Current Base Threshold (Idiff)	
6004	Current Diff CT TAP 1	Winding 1 Adapter	Current transformer ratio (CTratio)	Set equal to CT1 ratio
		Winding 2 Adapter	Current transformer ratio (CTratio)	Set equal to CT2 ratio
6010	Current Diff CT TAP 2	Winding 3 Adapter	Current transformer ratio (CTratio)	Set equal to CT3 ratio
6005	Current Diff Restraint 1	Differential	Restraint percentage 1 (Irestrpercent1)	
6006	Current Diff Restraint 2	Differential	Restraint percentage 2 (Irestrpercent2)	
6007	Current Diff Break PT	Differential	Restraint Current 2nd threshold (Ipset2)	

## 3.3 Phase Distance elements (F21) subrelay

This subrelay contains the distance protection elements which monitor the phase-phase loops.

### 3.3.1 Available Units

- Four under impedance quadrilateral elements ("Z1", "Z1E", "Z2", and "Z3" block).
- Four mho elements ("Z1Mho", "Z1EMho", "Z2Mho", and "Z3Mho" block).

- Four polarizing elements ("Polarizing 1", "Polarizing 1E", "Polarizing 2", and "Polarizing 3" block).
- Four directional element ("Dir-Z 1", "Dir-Z 1E", "Dir-Z 2", and "Dir-Z 3" block)
- Four timers ("ZT1m", "ZT1em", "ZT2m", and "ZT3m" block).
- One reclosing block ("Reclosing" block).
- One load encroachment element ("Load Area" block).
- A minimum current supervision element ("Starting" block).
- One output block ("Output Logic" block).

#### 3.3.2 Functionality

The subrelay consists of four polygonal and four mho phase-phase loop distance elements. The user is supposed to use the set of mho elements or the set of polygonal elements.

Separate polarizing and directional elements can be set for each mho/polygonal element couple. The "Z1E" and the "Z1EMho" element have been conceived to be used with the extension zone schemes; the polarizing elements associated to the zone 1E element couple are configured to provide a 25 cycle voltage memory buffer which is activated when the voltage drops below  $4\%U_n$ .

A reclosing element can be configured to provide up to 4 breaker reclosing attempts when the fault has been cleared by the polygonal elements.

A load encroachment element is limiting the trip zone of both the polygonal and the mho elements.

An unique timer is connected to each mho/polygonal element couple.

#### 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, the addresses are MODBUS MEMORY MAP addresses):

Address	Relay Setting	Model block	Model setting	Note
6700	Load Encroachment Function	Load Area	Out of Service (outserv)	
6703	Load Encroachment Reach	Load Area	R load (Ph-Ph) (Rloadphph)	
6704	Load Encroachment Angle	Load Area	PHI load Ph-Ph (philoadphph)	
7A20	Phase Distance Zone x <sup>1</sup> Function	Zx <sup>1</sup>	Out of Service (outserv)	
7A21	Phase Distance Zone x Current Supervision	Starting	Current I >>(Ip2)	
7A22	Phase Distance Zone x <sup>1</sup> Reach	Zx <sup>1</sup>	Z Reach (Zmax)	
7A23	Phase Distance Zone x <sup>1</sup> Direction	Zx <sup>1</sup>	Tripping Direction (idir)	
7A24	Phase Distance Zone x <sup>1</sup> Comparator Limit	Zx <sup>1</sup>	+X Angle (beta)	
7A25	Phase Distance Zone x <sup>1</sup> Delay	ZTx <sup>1</sup> m	Time Setting (Tdelay)	
7A2A	Phase Distance Zone x <sup>1</sup> RCA	Zx <sup>1</sup>	Relay Angle (phi)	
7A2B	Phase Distance Zone x <sup>1</sup> DIR RCA	Dir-Z x <sup>1</sup>	Directional Angle, phi (phi)	
				phi = DIR RCA + DIR Comp Limit - 90°

<sup>1</sup>x = 1,1E,2,3



### 3 Supported features

Address	Relay Setting	Model block	Model setting	Note
7A2C	Phase Distance Zone x <sup>1</sup> DIR Comp Limit	Dir-Z x <sup>1</sup>	Directional Angle, alpha (alpha)	alpha = DIR Comp Limit - DIR RCA
7A2D	Phase Distance Zone x <sup>1</sup> Quad Right Blinder	Zx <sup>1</sup>	+R Resistance (Rmax)	
7A2E	Phase Distance Zone x <sup>1</sup> Quad Right Blinder RCA	Zx <sup>1</sup>	+R Angle (gamma)	
7A2F	Phase Distance Zone x <sup>1</sup> Quad Left Blinder	Zx <sup>1</sup>	-R Resistance (Rmin)	
7A30	Phase Distance Zone x <sup>1</sup> Quad Left Blinder RCA	Zx <sup>1</sup>	-R Angle (gamma2)	
6890	Autoreclose Mode	Reclosing	Operation mode(operationmode)	in the "Opera- tion Mode" tab page
6891	Autoreclose Maximum Number of Shots	Reclosing	Operations to lockout (oplockout)	oplockout = Maximum Number of Shots + 1
689D	Autoreclose 3-Pole Dead Time 1	Reclosing	Reclosing interval 1 (recltime1)	
689E	Autoreclose 3-Pole Dead Time 2	Reclosing	Reclosing interval 2 (recltime2)	
68B1	Autoreclose 3-Pole Dead Time 3	Reclosing	Reclosing interval 3 (recltime3)	
68B2	Autoreclose 3-Pole Dead Time 4	Reclosing	Reclosing interval 4 (recltime4)	
68A2	Autoreclose Reset Time	Reclosing	Reset Time (resetime)	
6893	Autoreclose Close Time Breaker 1	Reclosing	Closing command duration (clos- ingcomtime)	

### 3.4 Ground Distance elements (F21) subrelay

This subrelay contains the distance protection elements which monitor the phase-ground loops.

#### 3.4.1 Available Units

- Four under impedance quadrilateral elements ("Z1G", "Z1EG", "Z2G", and "Z3G" block).
- Four mho elements ("Z1GMho", "Z1EGMho", "Z2GMho", and "Z3GMho" block).
- Four polarizing elements ("Polarizing 1", "Polarizing 1E", "Polarizing 2", and "Polarizing 3" block).
- Four directional element ("Dir-Z 1", "Dir-Z 1E", "Dir-Z 2", and "Dir-Z 3" block)
- Four timers ("ZT1m", "ZT1em", "ZT2m", and "ZT3m" block).
- One reclosing block ("Reclosing" block).
- One load encroachment elemnt ("Load Area" block).
- A minimum current supervision element ("Starting" block).
- One output block ("Output Logic" block).

#### 3.4.2 Functionality

The subrelay consists of four polygonal and four mho phase-ground loop distance elements. The user is supposed to use the set of mho elements or the set of polygonal elements.

Separate polarizing and directional elements can be set for each mho/polygonal element couple. The "Z1EG" and the "Z1EGMho" element have been conceived to be used with the extension zone schemes; the polarizing elements associated to the zone 1E element couple are configured to provide a 25 cycle voltage memory buffer which is activated when the voltage drops below  $4\%U_n$ .

A reclosing element can be configures to provide up to 4 breaker reclosing attempts when the fault has been cleared by the polygonal elements.

A load encroachment element is limiting the trip zone of both the polygonal and the mho elements.

An unique timer is connected to each mho/polygonal element couple.

#### 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, the addresses are MODBUS MEMORY MAP addresses):

Address	Relay Setting	Model block	Model setting	Note
6700	Load Encroachment Function	Load Area	Out of Service (outserv)	
6703	Load Encroachment Reach	Load Area	R load (Ph-Ph) (Rloadphph)	
6704	Load Encroachment Angle	Load Area	PHI load Ph-Ph (philoadphph)	

### 3 Supported features

Address	Relay Setting	Model block	Model setting	Note
7A40	Ground Distance Zone x <sup>2</sup> Function	Zx <sup>1</sup>	Out of Service (outserv)	<p>phi = DIR RCA + DIR Comp Limit - 90°</p> <p>alpha = DIR Comp Limit - DIR RCA</p> <p>in the "Operation Mode" tab page</p> <p>oplockout = Maximum Number of Shots + 1</p>
7A41	Ground Distance Zone x Current Supervision	Starting	Current I >>(Ip2)	
7A42	Ground Distance Zone x <sup>1</sup> Reach	Zx <sup>1</sup>	Z Reach (Zmax)	
7A43	Ground Distance Zone x <sup>1</sup> Direction	Zx <sup>1</sup>	Tripping Direction (idir)	
7A44	Ground Distance Zone x <sup>1</sup> Comparator Limit	Zx <sup>1</sup>	+X Angle (beta)	
7A45	Ground Distance Zone x <sup>1</sup> Delay	ZTx <sup>1</sup> m	Time Setting (Tdelay)	
7A4A	Ground Distance Zone x <sup>1</sup> Z0 Z1 Magnitude	Polarizing x <sup>1</sup>	k0 (k0)	
7A4B	Ground Distance Zone x <sup>1</sup> Z0 Z1 Angle	Polarizing x <sup>1</sup>	Angle (phik0)	
7A4C	Ground Distance Zone x <sup>1</sup> RCA	Zx <sup>1</sup>	Relay Angle (phi)	
7A4D	Ground Distance Zone x <sup>1</sup> DIR RCA	Dir-Z x <sup>1</sup>	Directional Angle, phi (phi)	
7A4E	Ground Distance Zone x <sup>1</sup> DIR Comp Limit	Dir-Z x <sup>1</sup>	Directional Angle, alpha (alpha)	
7A4F	Ground Distance Zone x <sup>1</sup> Quad Right Blinder	Zx <sup>1</sup>	+R Resistance (Rmax)	
7A50	Ground Distance Zone x <sup>1</sup> Quad Right Blinder RCA	Zx <sup>1</sup>	+R Angle (gamma)	
7A51	Ground Distance Zone x <sup>1</sup> Quad Left Blinder	Zx <sup>1</sup>	-R Resistance (Rmin)	
7A52	Ground Distance Zone x <sup>1</sup> Quad Left Blinder RCA	Zx <sup>1</sup>	-R Angle (gamma2)	
7A53	Ground Distance Zone x <sup>1</sup> Z0M Z1 Magnitude	Polarizing x <sup>1</sup>	k0m (k0m)	
7A54	Ground Distance Zone x <sup>1</sup> Z0M Z1 Angle	Polarizing x <sup>1</sup>	Angle (phik0m)	
6890	Autoreclose Mode	Reclosing	Operation mode(operationmode)	
6891	Autoreclose Maximum Number of Shots	Reclosing	Operations to lockout (oplockout)	
689D	Autoreclose 3-Pole Dead Time 1	Reclosing	Reclosing interval 1 (recltime1)	
689E	Autoreclose 3-Pole Dead Time 2	Reclosing	Reclosing interval 2 (recltime2)	
68B1	Autoreclose 3-Pole Dead Time 3	Reclosing	Reclosing interval 3 (recltime3)	
68B2	Autoreclose 3-Pole Dead Time 4	Reclosing	Reclosing interval 4 (recltime4)	
68A2	Autoreclose Reset Time	Reclosing	Reset Time (resettime)	
6893	Autoreclose Close Time Breaker 1	Reclosing	Closing command duration (closingcomtime)	

<sup>2</sup>x = 1,1E,2,3

## 3.5 Overcurrent elements (F50 - F51 - F46) subrelay

### 3.5.1 Available Units

- Two 3 phase inverse time directional overcurrent elements with voltage restrain ("Phase Toc 1" and "Phase Toc 2" block, the relevant restrain blocks are "V restraint Toc 1" and "V restraint Toc 2").
- Two 3 phase definite time directional overcurrent elements ("Phase loc 1" and "Phase loc 2" block).
- Two 3phase directional elements ("DirPhase 1" and "DirPhase 2" block).
- Two neutral current inverse time directional overcurrent elements ("Neutral Toc 1" and "Neutral Toc 2" block).
- Two neutral current definite time directional overcurrent elements ("Neutral loc 1" and "Neutral loc 2" block)
- Two neutral current directional elements ("DirNeutral 1" and "DirNeutral 2" block).
- Two ground current inverse time directional overcurrent elements ("Ground Toc 1" and "Ground Toc 2" block ).
- Two ground current definite time directional overcurrent elements ("Ground loc 1" and "Ground loc 2" block).
- Two ground current directional elements ("DirGround 1" and "DirGround 2" block).
- Two negative sequence current inverse time directional overcurrent elements ("Negative sequence Toc 1" and "Negative sequence Toc 2" block).
- Two negative sequence current definite time directional overcurrent elements ("Negative sequence loc 1" and "Negative sequence loc 2" block).
- Two negative sequence current directional elements ("DirNegSeq 1" and "DirNegSeq 2" block).
- One output block ("Output Logic" block).

### 3.5.2 Functionality

The model contains a reduced subset of the overcurrent protective elements available in the relay. Four set of overcurrent elements are available:

- Phase.
- Ground.
- Neutral current.
- Negative sequence current.

Each set consists of two inverse time characteristic overcurrent elements and two definite time overcurrent elements. Two directional elements are present in each set: the "Dirxxxx 1" directional element can be used to control the "xxxxx Toc 1" inverse time element and the "xxxxx loc 1" definite time element, the "Dirxxxx 2" directional element can be used to control the "xxxxx Toc 2" inverse time element and the "xxxxx loc 2" definite time element

The ground directional elements ("DirGround 1" and "DirGround 2" block) simulate a simplified version of the *Wattmetric ground fault* feature. Please notice that the power threshold is equal to the product of the polarizing voltage threshold and of the operating current threshold.

The phase inverse elements can be used with a voltage restraint feature. The voltage restraint feature can be activated in the "Logic" tab page of the "V restraint Toc1" and of the "V restraint Toc2" block. Set equal to one the "VrestraintON" variable to enable the feature.

The inverse time overcurrent elements support the following trip characteristics:

- "Definite time".
- "IEEE Extremely Inverse".
- "IEEE Very Inverse".
- "IEEE Moderately Inverse".
- "IEC Curve A".
- "IEC Curve B".
- "IEC Curve C".
- "IEC short inverse".
- "IAC Extremely Inverse".
- "IAC Short Inverse".
- "IAC Very Inverse".
- "IAC Inverse".
- "I2t curve".
- "Recloser Curve" (31 curves).

#### 3.5.3 Data input

The relationships between the relay settings and the model parameters can be found in the following table:

Address	Relay Setting	Model block	Model setting	Note
5900	Phase Time Overcurrent 1 Function	Phase Toc 1	Out of Service (outserv)	Set "None" if the block signals are not controlled by the directional element
5903	Phase Time Overcurrent 1 Pickup	Phase Toc 1	Current Setting (ipset)	
5904	Phase Time Overcurrent 1 Curve	Phase Toc 1	Characteristic (pcharac)	
5905	Phase Time Overcurrent 1 Multiplier	Phase Toc 1	Time Dial (tpset)	
5908	Phase TOC 1 Block For Each Phase (3 items)	Phase Toc 1	Characteristic (pcharac)	
5910	Phase Time Overcurrent 2 Function	Phase Toc 2	Out of Service (outserv)	
5913	Phase Time Overcurrent 2 Pickup	Phase Toc 2	Current Setting (ipset)	
5914	Phase Time Overcurrent 2 Curve	Phase Toc 2	Characteristic (pcharac)	

### 3 Supported features

Address	Relay Setting	Model block	Model setting	Note
5915	Phase Time Overcurrent 2 Multiplier	Phase Toc 2	Time Dial (tpset)	Set "None" if the block signals are not controlled by the directional element
5918	Phase TOC 2 Block For Each Phase (3 items)	Phase Toc 2	Characteristic (pcharac)	
5A00	Phase Instantaneous Overcurrent 1 Function	Phase loc 1	Out of Service (outserv)	
5A02	Phase Instantaneous Overcurrent 1 Pickup	Phase loc 1	Pickup Current (Ipset)	
5A03	Phase Instantaneous Overcurrent 1 Delay	Phase loc 1	Time Setting (Tset)	
5A10	Phase Instantaneous Overcurrent 2 Function	Phase loc 2	Out of Service (outserv)	
5A12	Phase Instantaneous Overcurrent 2 Pickup	Phase loc 2	Pickup Current (Ipset)	
5A13	Phase Instantaneous Overcurrent 2 Delay	Phase loc 2	Time Setting (Tset)	
5B00	Neutral Time Overcurrent 1 Function	Neutral Toc 1	Out of Service (outserv)	
5B03	Neutral Time Overcurrent 1 Pickup	Neutral Toc 1	Current Setting (ipset)	
5B04	Neutral Time Overcurrent 1 Curve	Neutral Toc 1	Characteristic (pcharac)	
5B05	Neutral Time Overcurrent 1 Multiplier	Neutral Toc 1	Time Dial (tpset)	
5B07	Neutral TOC 1 Block	Neutral Toc 1	Characteristic (pcharac)	Set "None" if the block signals are not controlled by the directional element
5B10	Neutral Time Overcurrent 2 Function	Neutral Toc 2	Out of Service (outserv)	
5B13	Neutral Time Overcurrent 2 Pickup	Neutral Toc 2	Current Setting (ipset)	
5B14	Neutral Time Overcurrent 2 Curve	Neutral Toc 2	Characteristic (pcharac)	
5B15	Neutral Time Overcurrent 2 Multiplier	Neutral Toc 2	Time Dial (tpset)	
5B17	Neutral TOC 2 Block	Neutral Toc 2	Characteristic (pcharac)	
5C00	Neutral Instantaneous Overcurrent 1 Function	Neutral loc 1	Out of Service (outserv)	
5C02	Neutral Instantaneous Overcurrent 1 Pickup	Neutral loc 1	Pickup Current (Ipset)	
5C03	Neutral Instantaneous Overcurrent 1 Delay	Neutral loc 1	Time Setting (Tset)	
5C10	Neutral Instantaneous Overcurrent 2 Function	Neutral loc 2	Out of Service (outserv)	
5C12	Neutral Instantaneous Overcurrent 2 Pickup	Neutral loc 2	Pickup Current (Ipset)	
5C13	Neutral Instantaneous Overcurrent 2 Delay	Neutral loc 2	Time Setting (Tset)	
5D00	Ground Time Overcurrent 1 Function	Ground Toc 1	Out of Service (outserv)	Set "None" if the block signals are not controlled by the directional element
5D03	Ground Time Overcurrent 1 Pickup	Ground Toc 1	Current Setting (ipset)	
5D04	Ground Time Overcurrent 1 Curve	Ground Toc 1	Characteristic (pcharac)	
5D05	Ground Time Overcurrent 1 Multiplier	Ground Toc 1	Time Dial (tpset)	
5D07	Ground TOC 1 Block	Ground Toc 1	Characteristic (pcharac)	

### 3 Supported features

Address	Relay Setting	Model block	Model setting	Note
5D10	Ground Time Overcurrent 2 Function	Ground Toc 2	Out of Service (outserv)	Set "None" if the block signals are not controlled by the directional element
5D13	Ground Time Overcurrent 2 Pickup	Ground Toc 2	Current Setting (ipset)	
5D14	Ground Time Overcurrent 2 Curve	Ground Toc 2	Characteristic (pcharac)	
5D15	Ground Time Overcurrent 2 Multiplier	Ground Toc 2	Time Dial (tpset)	
5D17	Ground TOC 2 Block	Ground Toc 2	Characteristic (pcharac)	
5E00	Ground Instantaneous Overcurrent 1 Function	Ground loc 1	Out of Service (outserv)	
5E02	Ground Instantaneous Overcurrent 1 Pickup	Ground loc 1	Pickup Current (Ipset)	
5E03	Ground Instantaneous Overcurrent 1 Delay	Ground loc 1	Time Setting (Tset)	
5E10	Ground Instantaneous Overcurrent 2 Function	Ground loc 2	Out of Service (outserv)	
5E12	Ground Instantaneous Overcurrent 2 Pickup	Ground loc 2	Pickup Current (Ipset)	
5E13	Ground Instantaneous Overcurrent 2 Delay	Ground loc 2	Time Setting (Tset)	Set "None" if the block signals are not controlled by the directional element
6300	Negative Sequence Time Overcurrent 1 Function	Negative Sequence Toc 1	Out of Service (outserv)	
6302	Negative Sequence Time Overcurrent 1 Pickup	Negative Sequence Toc 1	Current Setting (ipset)	
6303	Negative Sequence Time Overcurrent 1 Curve	Negative Sequence Toc 1	Characteristic (pcharac)	
6304	Negative Sequence Time Overcurrent 1 Multiplier	Negative Sequence Toc 1	Time Dial (tpset)	
6306	Negative Sequence TOC 1 Block	Negative Sequence Toc 1	Characteristic (pcharac)	Set "None" if the block signals are not controlled by the directional element
6310	Negative Sequence Time Overcurrent 2 Function	Negative Sequence Toc 2	Out of Service (outserv)	
6312	Negative Sequence Time Overcurrent 2 Pickup	Negative Sequence Toc 2	Current Setting (ipset)	
6313	Negative Sequence Time Overcurrent 2 Curve	Negative Sequence Toc 2	Characteristic (pcharac)	
6314	Negative Sequence Time Overcurrent 2 Multiplier	Negative Sequence Toc 2	Time Dial (tpset)	
6316	Negative Sequence TOC 2 Block	Negative Sequence Toc 2	Characteristic (pcharac)	Set "None" if the block signals are not controlled by the directional element
6400	Negative Sequence Instantaneous Overcurrent 1 Function	Negative Sequence loc 1	Out of Service (outserv)	
6402	Negative Sequence Instantaneous Overcurrent 1 Pickup	Negative Sequence loc 1	Pickup Current (Ipset)	
6403	Negative Sequence Instantaneous Overcurrent 1 Delay	Negative Sequence loc 1	Time Setting (Tset)	
6410	Negative Sequence Instantaneous Overcurrent 2 Function	Negative Sequence loc 2	Out of Service (outserv)	
6412	Negative Sequence Instantaneous Overcurrent 2 Pickup	Negative Sequence loc 2	Pickup Current (Ipset)	
6413	Negative Sequence Instantaneous Overcurrent 2 Delay	Negative Sequence loc 2	Time Setting (Tset)	
7260	Phase Directional Overcurrent 1 Function	DirPhase 1	Out of Service (outserv)	

### 3 Supported features

Address	Relay Setting	Model block	Model setting	Note
7263	Phase Directional Overcurrent 1 ECA	DirPhase 1	Max. Torque Angle (mtau)	in the "Voltage Polarizing" tab page
7264	Phase Directional Overcurrent 1 Pol V Threshold	DirPhase 1	Polarizing Voltage (upolu)	in the "Voltage Polarizing" tab page
7270	Phase Directional Overcurrent 2 Function	DirPhase 2	Out of Service (outserv)	
7273	Phase Directional Overcurrent 2 ECA	DirPhase 2	Max. Torque Angle (mtau)	in the "Voltage Polarizing" tab page
7274	Phase Directional Overcurrent 2 Pol V Threshold	DirPhase 2	Polarizing Voltage (upolu)	in the "Voltage Polarizing" tab page
7280	Neutral Directional Overcurrent 1 Function	DirNeutral 1	Out of Service (outserv)	
7283	Neutral Directional Overcurrent 1 ECA	DirNeutral 1	Max. Torque Angle (mtau)	in the "Voltage Polarizing" tab page
7284	Neutral Directional Overcurrent 1 Forward Limit Angle	DirNeutral 1	Angle Operating Sector(phise)	
7285	Neutral Directional Overcurrent 1 Forward Pickup	DirNeutral 1	Operating Current (curopu)	in the "Voltage Polarizing" tab page
7290	Neutral Directional Overcurrent 2 Function	DirNeutral 2	Out of Service (outserv)	
7293	Neutral Directional Overcurrent 2 ECA	DirNeutral 2	Max. Torque Angle (mtau)	in the "Voltage Polarizing" tab page
7294	Neutral Directional Overcurrent 2 Forward Limit Angle	DirNeutral 2	Angle Operating Sector(phise)	
7295	Neutral Directional Overcurrent 2 Forward Pickup	DirNeutral 2	Operating Current (curopu)	in the "Voltage Polarizing" tab page
72A0	Negative Sequence Directional Overcurrent 1 Function	DirNegSeq 1	Out of Service (outserv)	
72A3	Neutral Directional Overcurrent 1 ECA	DirNegSeq 1	Max. Torque Angle (mtau)	in the "Voltage Polarizing" tab page
72A4	Negative Sequence Directional Overcurrent 1 Forward Limit Angle	DirNegSeq 1	Angle Operating Sector(phise)	
72A5	Negative Sequence Directional Overcurrent 1 Forward Pickup	DirNegSeq 1	Operating Current (curopu)	in the "Voltage Polarizing" tab page
72B0	Negative Sequence Directional Overcurrent 2 Function	DirNegSeq 2	Out of Service (outserv)	
72B3	Negative Sequence Directional Overcurrent 2 ECA	DirNegSeq 2	Max. Torque Angle (mtau)	in the "Voltage Polarizing" tab page
72B4	Negative Sequence Directional Overcurrent 2 Forward Limit Angle	DirNegSeq 2	Angle Operating Sector(phise)	
72B5	Negative Sequence Directional Overcurrent 2 Forward Pickup	DirNegSeq 2	Operating Current (curopu)	in the "Voltage Polarizing" tab page
6050	Wattmetric ground fault 1 function	DirGround 1	Out of Service (outserv)	
6053	Wattmetric ground fault 1 overvoltage pickup	DirGround 1	Polarizing Voltage (upolu)	in the "Voltage Polarizing" tab page
6055	Wattmetric ground fault 1 overcurrent pickup	DirGround 1	Operating Current (curopu)	in the "Voltage Polarizing" tab page
6058	Wattmetric ground fault 1 ECA	DirGround 1	Max. Torque Angle (mtau)	in the "Voltage Polarizing" tab page
6061	Wattmetric ground fault 2 function	DirGround 2	Out of Service (outserv)	
6064	Wattmetric ground fault 2 overvoltage pickup	DirGround 2	Polarizing Voltage (upolu)	in the "Voltage Polarizing" tab page
6066	Wattmetric ground fault 2 overcurrent pickup	DirGround 2	Operating Current (curopu)	in the "Voltage Polarizing" tab page
6069	Wattmetric ground fault 2 ECA	DirGround 2	Max. Torque Angle (mtau)	in the "Voltage Polarizing" tab page



## 3.6 Voltage elements (F27 - F59) subrelay

### 3.6.1 Available Units

- Two 3 phase definite time/inverse time undervoltage elements ("Phase undervoltage 1", and "Phase undervoltage 2" block).
- One three phase definite time overvoltage element ("Phase overvoltage" block).
- Three zero sequence definite time overvoltage elements ("Neutral overvoltage 1", "Neutral overvoltage 2", and "Neutral overvoltage 3" block).
- One output block ("Output Logic" block).

### 3.6.2 Functionality

All the over/undervoltage elements available in the relay except the auxiliary over/undervoltage elements have been implemented in the model. They are modeled with a simplified layout. The undervoltage elements can be set with a definite time or with an inverse time trip characteristic.

### 3.6.3 Data input

The relationships between the relay settings and the model parameters can be found in the following table:

Address	Relay Setting	Model block	Model setting	Note
7000	Phase Undervoltage 1 Function	Phase undervoltage 1	Out of Service (outserv)	
7002	Phase Undervoltage 1 Pickup	Phase undervoltage 1	Pickup Voltage (Uset)	
7003	Phase Undervoltage 1 Curve	Phase undervoltage 1	Characteristic (pcharac)	
7004	Phase Undervoltage 1 Delay	Phase undervoltage 1	Time Delay (Tdel)	
7013	Phase Undervoltage 2 Function	Phase undervoltage 2	Out of Service (outserv)	
7015	Phase Undervoltage 2 Pickup	Phase undervoltage 2	Pickup Voltage (Uset)	
7016	Phase Undervoltage 2 Curve	Phase undervoltage 2	Characteristic (pcharac)	
7017	Phase Undervoltage 2 Delay	Phase undervoltage 2	Time Delay (Tdel)	
7100	Phase Overvoltage 1 Function	Phase overvoltage	Out of Service (outserv)	
7102	Phase Overvoltage 1 Pickup	Phase overvoltage	Pickup Voltage (Uset)	
7103	Phase Overvoltage 1 Delay	Phase overvoltage	Time Delay (Tdel)	
7F00	Neutral Overvoltage 1 Function	Neutral Overvoltage 1	Out of Service (outserv)	
7F02	Neutral Overvoltage 1 Pickup	Neutral Overvoltage 1	Pickup Voltage (Uset)	
7F03	Neutral Overvoltage 1 Pickup Delay	Neutral Overvoltage 1	Time Delay (Tdel)	
7F10	Neutral Overvoltage 2 Function	Neutral Overvoltage 2	Out of Service (outserv)	
7F12	Neutral Overvoltage 2 Pickup	Neutral Overvoltage 2	Pickup Voltage (Uset)	
7F13	Neutral Overvoltage 2 Pickup Delay	Neutral Overvoltage 2	Time Delay (Tdel)	
7F20	Neutral Overvoltage 3 Function	Neutral Overvoltage 3	Out of Service (outserv)	
7F22	Neutral Overvoltage 3 Pickup	Neutral Overvoltage 3	Pickup Voltage (Uset)	
7F23	Neutral Overvoltage 3 Pickup Delay	Neutral Overvoltage 3	Time Delay (Tdel)	

## 3.7 Out of step (F78) subrelay

### 3.7.1 Available Units

- Three under impedance quadrilateral elements ("Inner zone polygonal", "Middle zone polygonal" and "Outer zone polygonal" block).
- Three mho elements ("Inner zone mho", "Middle zone mho" and "Outer zone mho" block).
- Three out of step detection and power swing elements ("Out Of Step Middle-Inner", "Out Of Step Outer-Middle" and "Out Of Step Outer-Inner" block)
- An out of step trip additional delay element ("OS Time Delay" block)
- A minimum current supervision element ("I supervision" block)

### 3.7.2 Functionality

The subrelay implements both the two steps and the three steps operation modes for the power swing blocking feature and the out of step trip.

Please disable the "Middle zone polygonal", "Middle zone mho", "Out Of Step Middle-Inner" and the "Out Of Step Outer-Middle" block to activate the two steps operation mode. Please disable the "Out Of Step Outer-Inner" block to activate the three steps operation mode.

Both the mho operating characteristics and the quadrilateral characteristics are supported. Please use the quadrilateral characteristics also to simulate the blinder which can be used with the mho; in that case set to a very large value the "+X" reach of the quadrilateral elements and "+R Reach" and the "-R Reach" equal to the blinder intersections with the R axis.

In the three steps operation mode both the "Early" trip mode and the "Delayed" trip mode can be used. The default trip mode is "Delayed"

### 3.7.3 Data input

The relationships between the relay settings and the model parameters can be found in the following table:

Address	Relay Setting	Model block	Model setting	Note
65C3	Power Swing Supv	I supervision	Pickup current	
65C4	Power Swing Fwd Reach	Inner zone mho	Replica Impedance	
		Middle zone mho	Replica Impedance	
		Outer zone mho	+X Reach	
		Inner zone polygonal	+X Reach	
65D6	Power Swing Quad Fwd Reach Mid	Middle zone polygonal	+X Reach	
65D7	Power Swing Quad Fwd Reach Out	Outer zone polygonal	+X Reach	
65C5	Power Swing Fwd RCA	Inner zone mho	Relay Angle	
		Middle zone mho	Relay Angle	

### 3 Supported features

Address	Relay Setting	Model block	Model setting	Note
65C6	Power Swing Rev Reach	Outer zone mho	Relay Angle	Insert a negative value in the mho blocks
		Inner zone polygonal	Relay Angle	
		Middle zone polygonal	Relay Angle	
		Outer zone polygonal	Relay Angle	
		Inner zone mho	Offset Impedance	
		Middle zone mho	Offset Impedance	
		Outer zone mho	Offset Impedance	
		Inner zone polygonal	Offset Impedance	
65D8	Power Swing Rev Reach Mid	Middle zone polygonal	-X Reach	
65D9	Power Swing Rev Reach Out	Outer zone polygonal	-X Reach	
65C7	Power Swing Rev RCA	Inner zone mho	Offset Angle	
		Middle zone mho	Offset Angle	
		Outer zone mho	Offset Angle	
65C8	Power Swing Outer Limit Angle	Outer zone mho	Character.Angle	
65C9	Power Swing Middle Limit Angle	Middle zone mho	Character.Angle	
65CA	Power Swing Inner Limit Angle	Inner zone mho	Character.Angle	
65DA	Power Swing Outer RGT Blinder	Outer zone polygonal	+R Resistance	
65DC	Power Swing Middle RGT Blinder	Middle zone polygonal	+R Resistance	
65DE	Power Swing Inner RGT Blinder	Inner zone polygonal	+R Resistance	
65DB	Power Swing Outer LFT Blinder	Outer zone polygonal	-R Resistance	
65DD	Power Swing Middle LFT Blinder	Middle zone polygonal	-R Resistance	
65DF	Power Swing Inner LFT Blinder	Inner zone polygonal	-R Resistance	
65CB	Power swing Pickup Delay 1	Out Of Step Outer-Middle	tP1	"Timers" tab page, set "Out Of Step Outer-Inner" for the 2 steps operation mode
65CC	Power swing Reset Delay 1	Out Of Step Outer-Inner	tH	"Timers" tab page, set "Out Of Step Outer-Inner" for the 2 steps operation mode
		Out Of Step Outer-Middle		
65CD	Power swing Pickup Delay 2	Out Of Step Outer-Inner	tP1	"Timers" tab page, used only for the 3 steps operation mode
65CE	Power swing Pickup Delay 3	Out Of Step Middle-Inner	tP1	
65CF	Power swing Pickup Delay 4	Power Swing Pickup Delay 3	Time setting	"Timers" tab page
		Power Swing Pickup Delay 4	tP1	

### 3 Supported features

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Address	Relay Setting	Model block	Model setting	Note
65D1	Power Swing Detect Trip Mode	OS Logic	Early_trip_mode	In the "Logic" tab page. Set equal to <i>TRIP</i> to enable the <i>Early</i> trip mode, set equal to <i>NOTRIP</i> to enable the <i>Delayed</i> trip mode

### 3.8 Output logic

#### 3.8.1 Available Units

The output logic is implemented by the "Output Logic" block located in each subrelay and by the "Output Logic" block located in the main relay.

#### 3.8.2 Functionality

The "Output Logic" block located in the main relay is operating the breaker. Please disable the "Output Logic" block in the main relay and each "Output Logic" block in the subrelays to disable the relay model ability to open the power circuit. The signal operating the breaker is "yout". Height additional relay output signals ("H1" ... "H8") freely configurable are available.

#### 3.8.3 Data input

The configuration of the "H1" ... "H8" output signals can be done in the "Logic" tab page of the "Output Logic" block.

## **4 Features not supported**

### **4.1 Phase Distance elements (F21) subrelay**

The following features are not supported:

- Separated starting current values for each distance zone element.
- Pilot accelerated trips (DUTT, POTT, PUTT etc.).
- Polarizing "Self polarizing feature" ("FORCE SELF POLAR" parameter).
- Negative sequence current as operating current in the polarizing block.
- Load encroachment minimum voltage threshold, trip time delay , and reset time delay.

### **4.2 Ground Distance elements (F21) subrelay**

The following features are not supported:

- Separated starting current values for each distance zone element.
- Pilot accelerated trips (DUTT, POTT, PUTT etc.).
- Polarizing "Self polarizing feature" ("FORCE SELF POLAR" parameter).
- Negative sequence current as operating current in the polarizing block.
- Load encroachment minimum voltage threshold, trip time delay , and reset time delay.

### **4.3 Overcurrent elements (F50 - F51 - F46) subrelay**

The following features are not supported:

- Thermal overload protection.
- Line pickup.
- Sensitive directional power.
- Wattmetric zero seq directional: curve and curve time delay.
- Reset curves.
- Neutral directional element positive sequence restraint.
- FlexLogic and Flex recloser curves.

#### **4.4 Voltage elements (F27 - F59) subrelay**

The following features are not supported:

- User configurable reset delay.
- Auxiliary overvoltage.
- Auxiliary undervoltage.

#### **4.5 Generic features**

The following features are not supported:

- Breaker Failure.
- Frequency elements.

## 5 References

- [1] GE Multilin, 215 Anderson Avenue, Markham - Ontario Canada L6E 1B3. *L90 Line Differential UR Series Instruction Manual L90 Revision: 3.3x Manual P/N: 1601-0081-E2 (GEK-106413A)*, 2003.
- [2] GE Multilin, 215 Anderson Avenue, Markham - Ontario Canada L6E 1B3. *L90 Line Differential UR Series Instruction Manual L90 Revision: 5.6x Manual P/N: 1601-0081-T1 (GEK-113488)*, 2008.