

SIEMENS

Ingenuity for life



2nd Harmonic Blocking of 3I0 Protection

SIPROTEC 5 Application

2nd Harmonic Blocking of 3I0 Protection

SIPROTEC 5 Application

2nd Harmonic Blocking of 3I0 Protection

APN-059, Edition 1

Content

1	2 nd Harmonic Blocking of 3I0 Protection	3
1.1	Introduction.....	3
1.2	2 nd harmonic detection.....	3
1.3	Test Cases.....	7
1.4	Conclusion.....	11

1 2nd Harmonic Blocking of 3I0 Protection

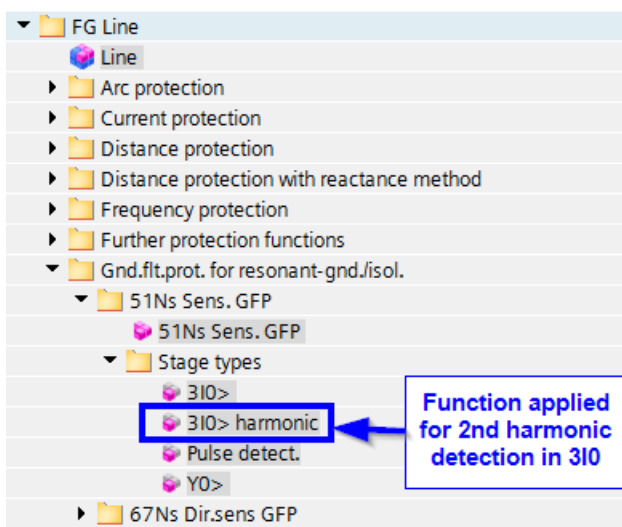
1.1 Introduction

The residual current (3I0) protection stages can require very sensitive settings, in some cases smaller than 5% nominal current. For such stages there is significant risk of maloperation due to transients introduced on the primary side, e.g. in-rush current on power transformers; or on the secondary side due to saturation of phase CTs when the residual current is calculated or measured in the star-point of the phase CTs.

A characteristic of the conditions described above is a strong presence of 2nd harmonic component in the measured residual current. This application note will describe a method that can be applied to block the sensitive 3I0-stages with 2nd harmonic current detection.

1.2 2nd harmonic detection

The following protection stage will be applied for 2nd harmonic detection (here shown in the FG Line of 7SL86):



The 3I0> harmonic function is applied to the 3I0 current as it is measured. For the FG line it is a 3phase measuring point alternatively a FG VI 1ph could use a single phase measuring point:

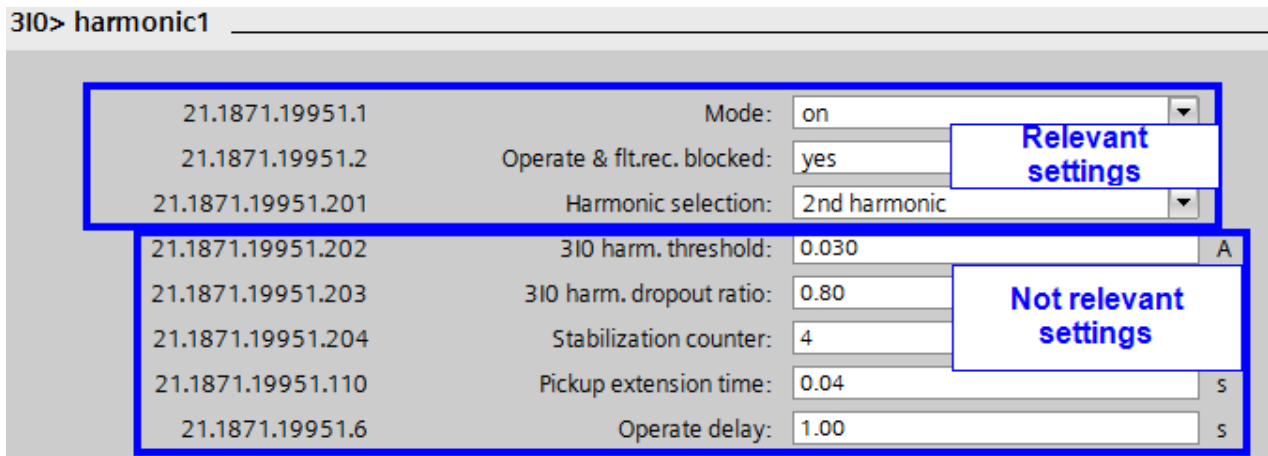
Current-measuring points		Base module				Expansion module 3			
		1A				3A			
		1A1-1A2	1A3-1A4	1A5-1A6	1A7-1A8	3A1-3A2	3A3-3A4	3A5-3A6	3A7-3A8
Measuring point	Connection type	IP 1A1	IP 1A2	IP 1A3	IP 1A4	IP 3A1	IP 3A2	IP 3A3	IM 3A4
(All)	(All)	(All)	(All)	(All)	(All)	(All)	(All)	(All)	(All)
Meas.point I-3ph 1	3-phase + IN	IA	IB	IC	IN				
Meas.point I-1ph 1									Ix
Add new									

Annotations in the table: A blue box highlights the '3 - phase MP' row. Another blue box highlights the 'Single phase MP' row.

SIPROTEC 5 Application

2nd Harmonic Blocking of 3I0 Protection

1.2.1 Setting options



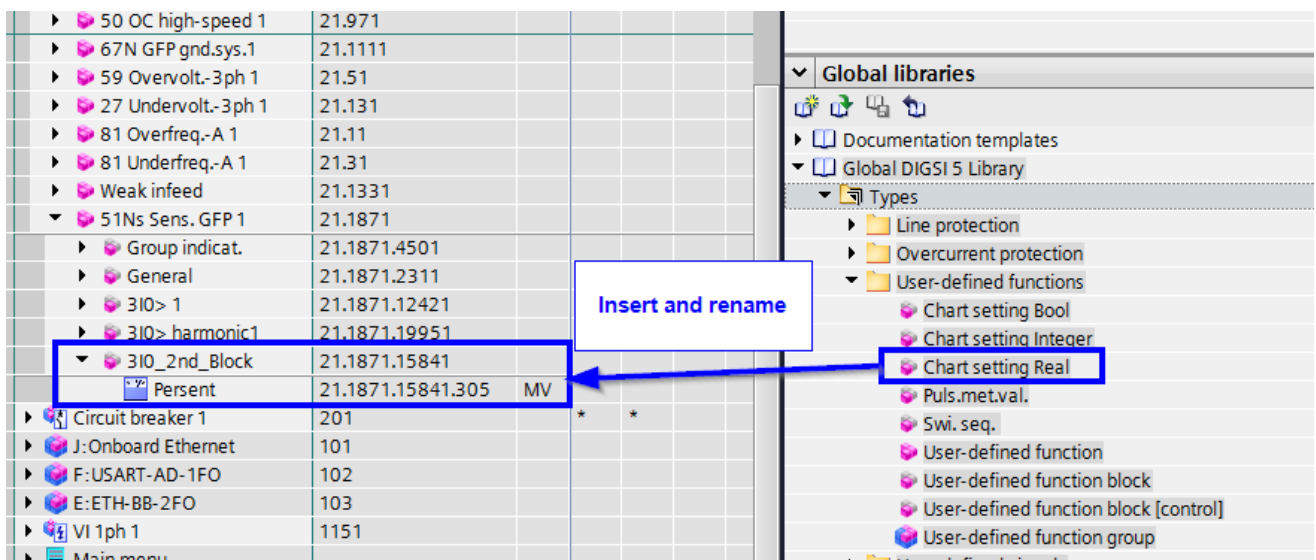
Above the setting options are shown. As the blocking will be derived via CFC logic with the 2nd harmonic measured value, the only relevant settings for this application are:

- Mode: on
- Operate & ft.rec.blocked: yes (this function will not be used for tripping)
- Harmonic selection: 2nd harmonic

1.2.2 Percentage restraint – user defined setting parameter

Blocking with the 2nd harmonic component must be applied in the form of a percentage restraint. For this purpose, the following is required.

For the setting value of the restraint (e.g. 15%) a chart setting value from the library as shown below must be inserted, and may then be renamed as desired:



The setting value can then be applied in the function as follows:

The screenshot shows the configuration interface for 3I0 harmonic blocking. The breadcrumb path is: Schweden_2nd_Harm > 7SL86_2nd_Harm > Settings > Line 1 > 51Ns Sens. GFP 1. The interface is in 'Edit mode: secondary' and 'Active: settings group 1'. The main section is titled '3I0> harmonic1' and contains a table of settings:

21.1871.19951.1	Mode:	on	
21.1871.19951.2	Operate & fit.rec. blocked:	yes	
21.1871.19951.201	Harmonic selection:	2nd harmonic	
21.1871.19951.202	3I0 harm. threshold:	0.006	A
21.1871.19951.203	3I0 harm. dropout ratio:	0.80	
21.1871.19951.204	Stabilization counter:	4	
21.1871.19951.110	Pickup extension time:	0.04	s
21.1871.19951.6	Operate delay:	1.00	s

Buttons: Add new stage, Delete stage

The second section is titled '3I0_2nd_Block' and contains a single setting:

21.1871.15841.105	Value:	15.000	%
-------------------	--------	--------	---

Buttons: Add new stage, Delete stage

1.2.3 CFC Logic

A CFC logic will be required to derive the blocking signal. (optional additional signals may be applied to obtain entries in the logs/recorders when the blocking is active – in this example user defined signals are applied for this purpose)

The 'Add new chart' dialog box shows the following configuration:

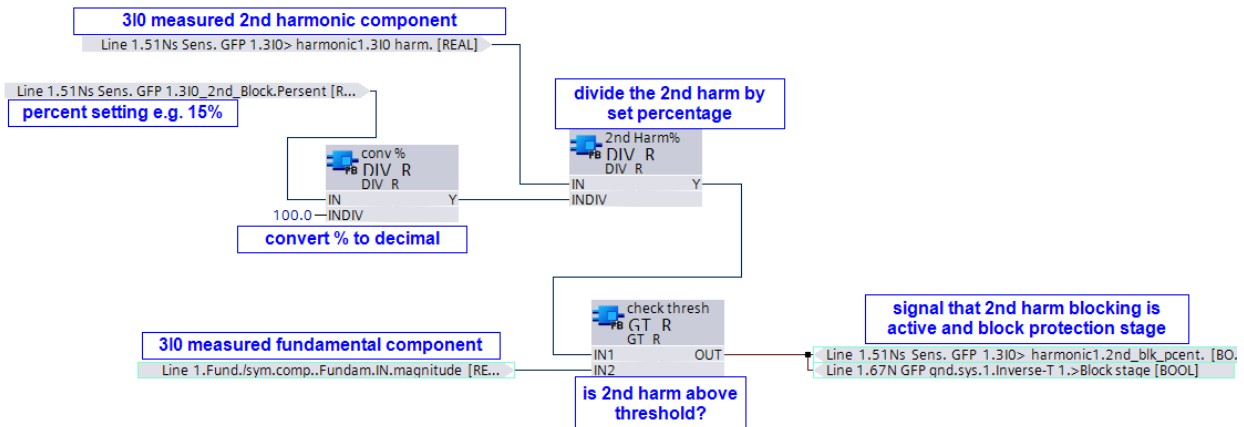
- Name: 2nd_Harm_3I0
- Task description: Use this task level for the processing of measured values. Functions on this task level are processed cyclically every 500 ms.
- Additional information: Add and open

Buttons: OK, Cancel

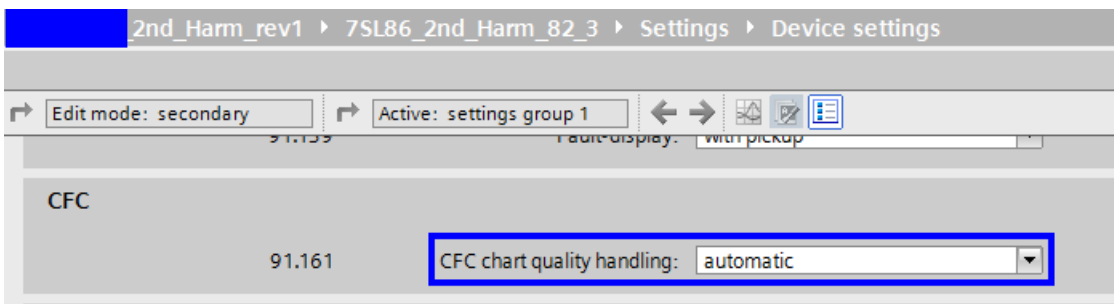
The chart is applied in the "Measurement" task as measured values will be processed.

SIPROTEC 5 Application

2nd Harmonic Blocking of 3IO Protection



The CFC chart quality handling is done automatically by default. If the setting under device settings shown below is changed to manual, the CFC chart above must be extended to prevent the blocking output when the measured values are invalid:



With the above logic the 15% chart setting value is converted to a factor = 0.15. This factor is then used to make the measured 2nd harmonic comparable with the measured 3IO (use the fundamental component). If the harmonic is above 15% the output indicates this and in turn will block the 67N or other 3IO protection stages that have their blocking input routed here.

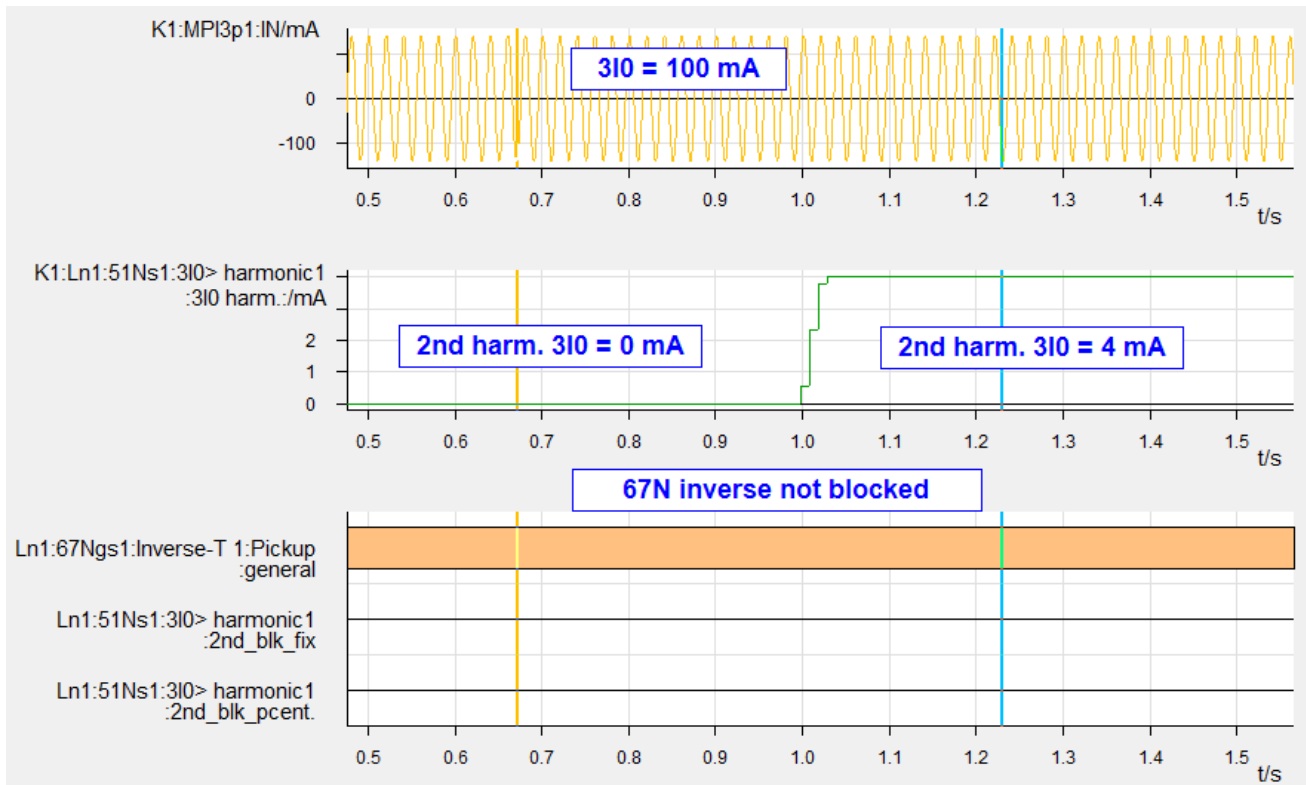
1.3 Test Cases

1.3.1 Case 1 – 2nd harmonic 4 mA

The following conditions apply:

Current	Mag	2 nd Harm %	2 nd Harm mA
IA	0,8	0,5%	4 mA
IB	0,7	0 %	
IC	0,7	0 %	
3I0	0,1	4 %	4 mA

There should be no blocking of the 67N stage as the harmonic component is only 4%:



SIPROTEC 5 Application

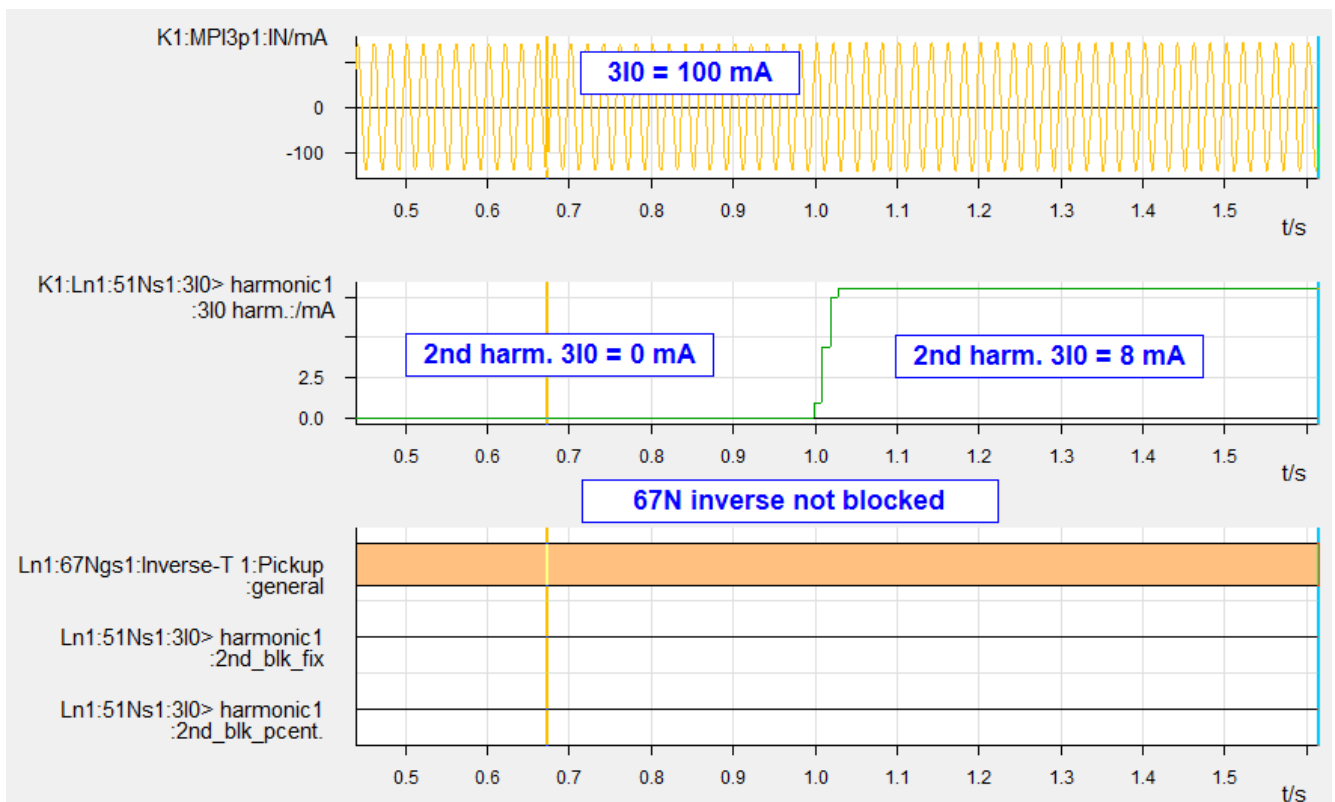
2nd Harmonic Blocking of 3I0 Protection

1.3.2 Case 2 – 2nd harmonic 8 mA but below 15%

The following conditions apply:

Current	Mag	2 nd Harm %	2 nd Harm mA
IA	0,8	1%	8 mA
IB	0,7	0 %	
IC	0,7	0 %	
3I0	0,1	8 %	8 mA

There should be no blocking of the 67N stage as the harmonic component is only 8%:

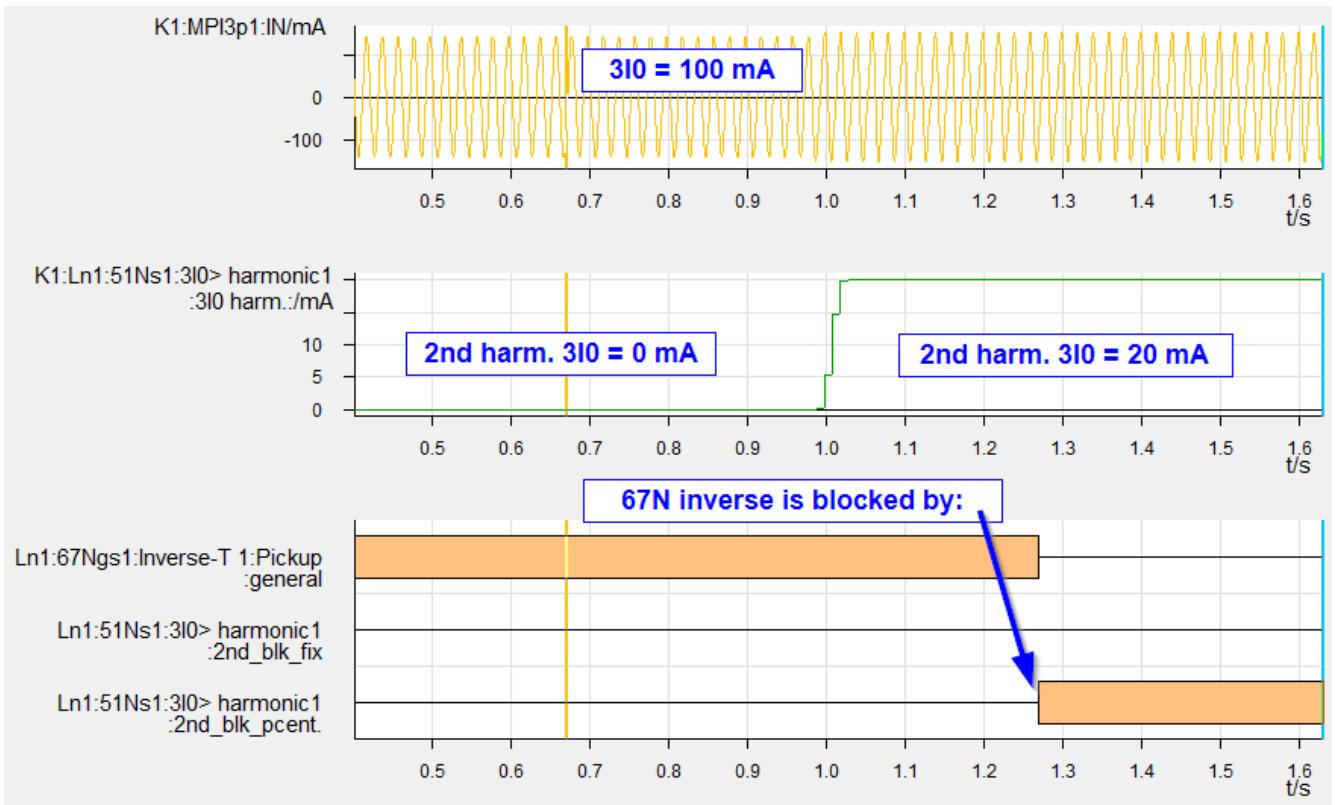


1.3.3 Case 3 – 2nd harmonic 20 mA and 20%

The following conditions apply:

Current	Mag	2 nd Harm %	2 nd Harm mA
IA	0,8	2,5%	20 mA
IB	0,7	0 %	
IC	0,7	0 %	
3I0	0,1	20 %	20 mA

There should be blocking of the 67N stage as the harmonic component is above 15%:



SIPROTEC 5 Application

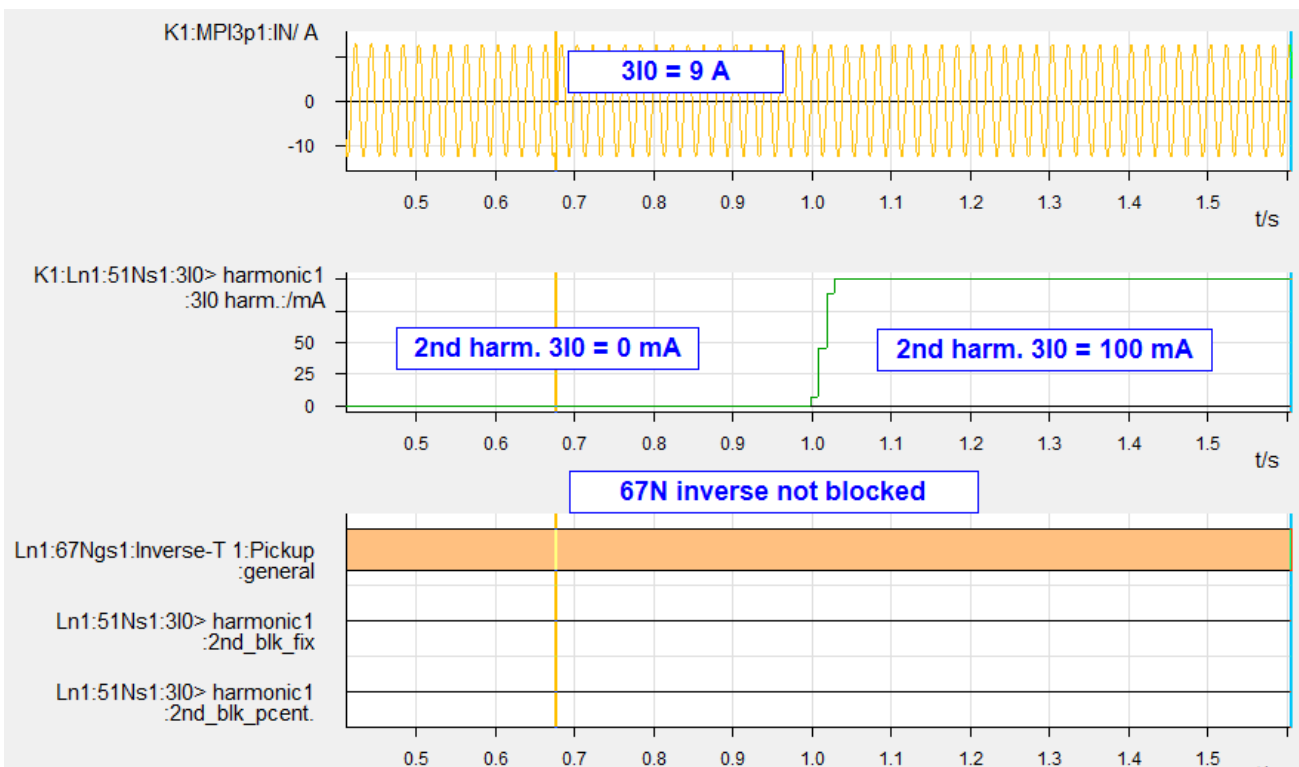
2nd Harmonic Blocking of 3I0 Protection

1.3.4 Case 4 –3I0 = 9A and 2nd harmonic 100 mA

The following conditions apply:

Current	Mag	2 nd Harm %	2 nd Harm mA
IA	10	1%	100 mA
IB	1	0%	
IC	1	0%	
3I0	9	1,1%	100 mA

There should be no blocking of the 67N stage as the harmonic component is only 1.1%:

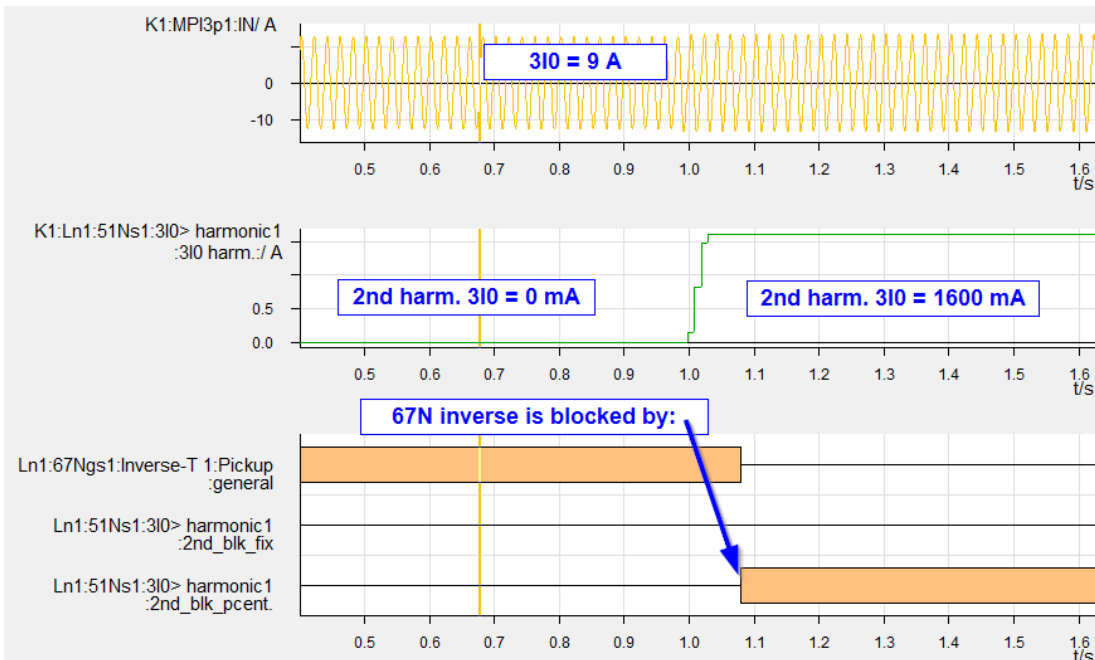


1.3.5 Case 5 – 3I0 = 9A and 2nd harmonic 1600 mA %

The following conditions apply:

Current	Mag	2 nd Harm %	2 nd Harm mA
IA	10	16%	1600 mA
IB	1	0 %	
IC	1	0 %	
3I0	9	17,8 %	1600 mA

There should be blocking of the 67N stage as the harmonic component is above 15%:



1.4 Conclusion

The functional measured value (3I0 harmonic) applied via CFC is very effective as blocking criterium for sensitive 3I0 stages in the presence of non-linear disruptions of primary or secondary systems.

Published by
Siemens AG

Smart Infrastructure
Digital Grid
Humboldtstrasse 59
90459 Nuremberg, Germany

www.siemens.com/siprotec

For more information, please
contact our Customer Support
Center.

Tel.: +49 180 524 70 00

Fax: +49 180 524 24 71

(Charges depending on provider)

Customer Support: www.siemens.com/csc

For the U.S. published by
Siemens Industry Inc.

100 Technology Drive
Alpharetta, GA 30005
United States

© 2019 Siemens. Subject to changes and errors.
The information given in this document only contains
general descriptions and/or performance features which
may not always specifically reflect those described, or
which may undergo modification in the course of further
development of the products. The requested performance
features are binding only when they are expressly agreed
upon in the concluded contract.

For all products using security features of OpenSSL, the
following shall apply:
This product includes software developed by the OpenSSL
Project for use in the OpenSSL Toolkit.
(<http://www.openssl.org/>)
This product includes cryptographic software written by
Eric Young (eay@cryptsoft.com)
This product includes software developed by Bodo Moeller.