Swedish Neutral
Premium Power Protection

Automatic Tuning Device

SN-NM-A1

Introduction

Resonance grounding by Petersen Coils (Arc Suppression Coils) has been used in Scandinavia and other European countries for some eighty years. The excellent properties of this grounding concept are mirrored by very low outages rates.

Resonance grounding is mainly used in overhead networks where most of the faults are single phase-to-ground and often of transient nature. The Petersen coil chokes the fault current below the level of self-extinction (< 35 A) by compensating for the capacitive fault current of the network. By this action all transient faults can be cleared without feeder tripping.

To enable the Arc Suppression Coil [ASC] to do its job accurately the coil needs to be tuned to the network. Combining an ASC with an Automatic Tuning Device will ensure that the ASC is adequately tuned at all times, regardless of changes in the network.

The Swedish Neutral Automatic Tuning Device provides fast and accurate tuning of an ASC using the Swedish Neutral Locus Measurement. The Locus measurement uses a two point measurement which enables accurate tuning of ASCs in all weather conditions, even during rough weather with floating neutral displacement.

Automatic Tuning Device

- Easy to use

- Robust and reliable Arc Suppression Coil tuning

    - ✓ Fast – tunes the coil <1sec

    - ✓ Reliable – works during harsh weather conditions with floating neutral displacement – keeps the ASC tuned when the risk for earth fault is the greatest

    - ✓ Supplies additional network information
        - Damping
        - Dissymmetry
        - Mismatch
        - Harmonics

- ASC position in mA

- Capable of tuning all types of Arc Suppression Coils

- Earth fault alarm with detection of high impedance earth faults

- Remote connection via hardwire, protocol and modem

- Works in networks with multiple Automatic Tuning Devices

- Can be used to remotely control a Neutral Earthing Resistor

- Works in very symmetrical networks, i.e. cable networks
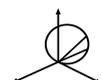
Basic Theory

To reduce the capacitive fault current during an earth fault effectively the ASC needs to be tuned to the capacitive leakage of the network at the time of the earth fault (IL=IC). The capacitive leakage to ground is determined by the present size of the network, which in turn is determined by the number of feeders, overhead/cable, length of the feeders and other factors.
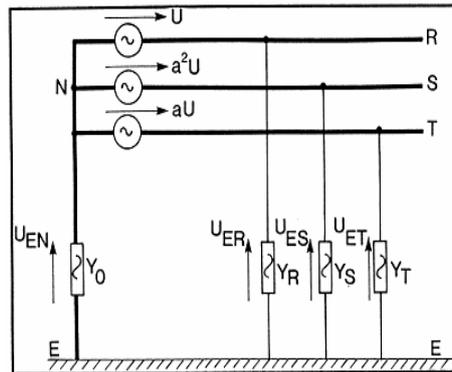

Three-phase system with its equivalent connections to earth

The capacitive leakage in a network can change for different reasons. One example is when a feeder is disconnected (reducing the sum of the capacitive leakage of the network); another is when an additional feeder is connected to the network (increasing the sum of the capacitive leakage of the network). When this happens the ASC needs to be tuned to a new position to compensate for the new total capacitive leakage of the network.

Locus curve U (EN) = f(v)
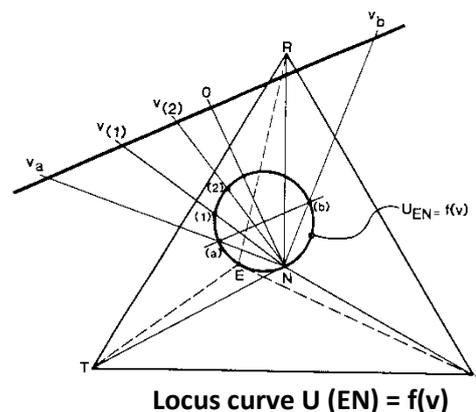
This action can be done automatically by the Automatic Tuning Device which continuously monitors the network and tunes the ASC to the correct value. The Swedish Neutral Automatic Tuning Device employs the Locus Measurement which enables very fast and accurate retuning of the ASC.
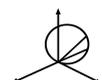
Single Line Diagram

In *Manual* mode the ASC can be set manually using the HMI of the Automatic Tuning. The ASC can also be controlled from a standard PC using the terminal software (NMterm) included in the delivery. To remotely control the ASC, protocol connection (serial or network), modem or digital inputs can be used.

In *Automatic* mode the Automatic Tuning Device will automatically adjust the ASC to the resonance point (IL=IC).
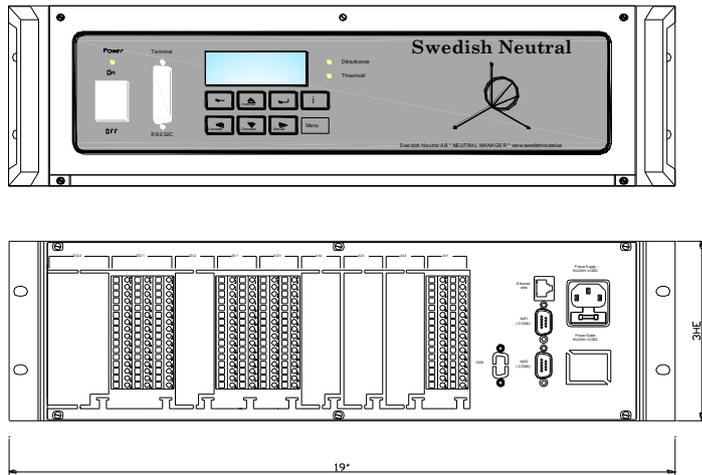
In case of an earth fault the system will trigger an alarm. The criteria for earth fault are as standard set to 30% neutral displacement. The Automatic Tuning Device also includes a sensitive earth fault detection function. The Automatic Tuning Device can detect this and give an alarm for very high impedance earth faults.

Network parameters, such as damping (d), dissymmetry (k) and mismatch (v) are continuously monitored and displayed. A system log or event list is stored and can be reviewed using NMTerm. Thresholds for the network parameters are adjustable.
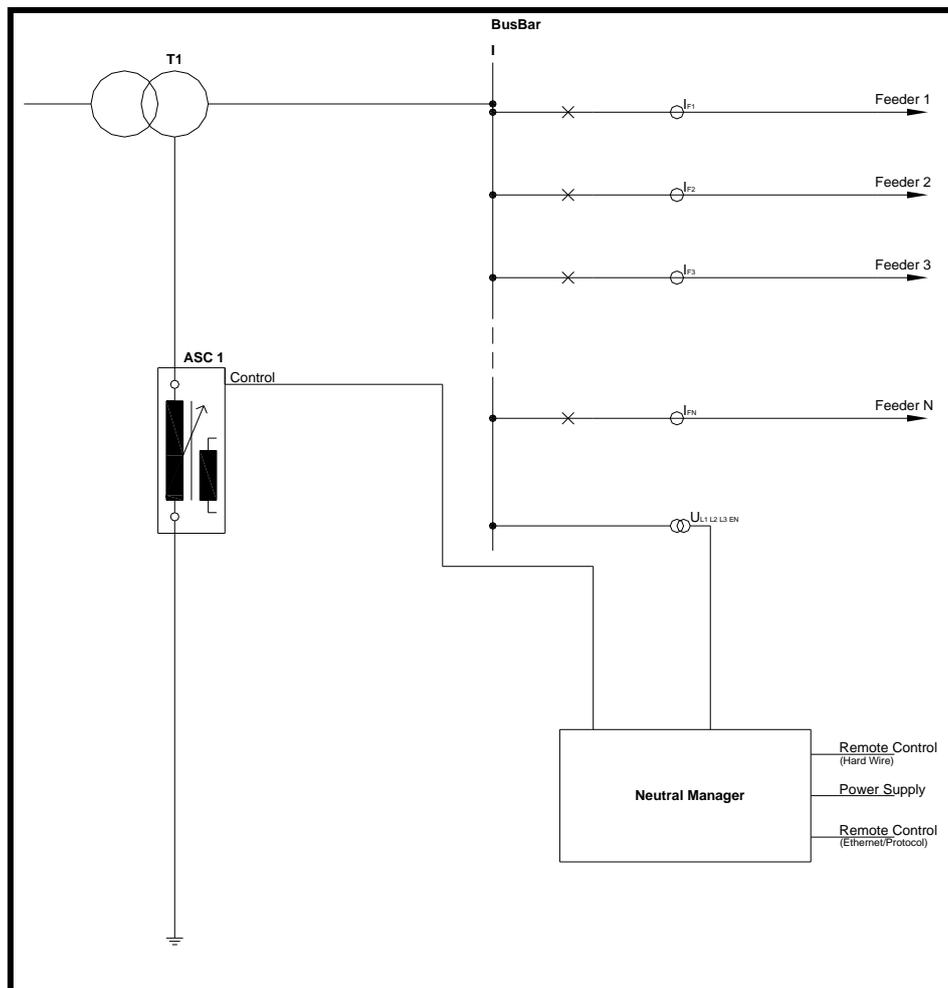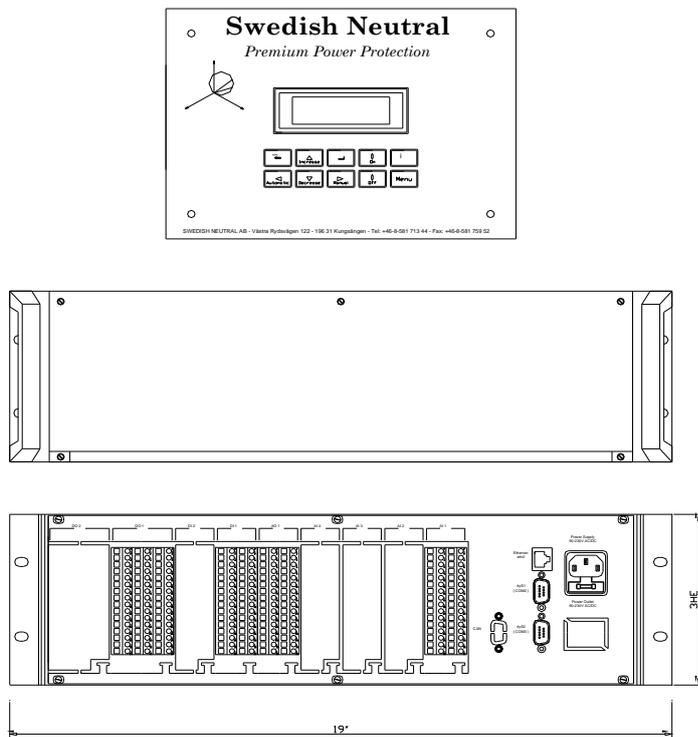
Hardware

Separate Rack Mounting

ASC Built In Mounting

Cable Plan

Separate Rack Mounting

STATION BUILDING

ARC SUPRESSION COIL

POWER SUPPLY

KS2

230VAC
16A

AUTOMATIC
TUNING DEVICE

4 G 2.5

X1

1.1   1 X 70

90-230V AC/DC
6A

3 G 1.5

X1

BUSBAR VT's

L1 L2 L3 UEN

6 X 1.5

X1

X2

19 X 1.5

X2

REMOTE CONTROL

Hard Wire
24-110 VDC

18 X 1.5

X3

Ethernet,
Protocol

Ethernet eth0

Hard Wire

7 X 1,5

X0

ASC Current

2 X 2,5 + screen

X0:5-6

1.2   1 X70

OPTION

TRANSFORMER-
NEUTRAL
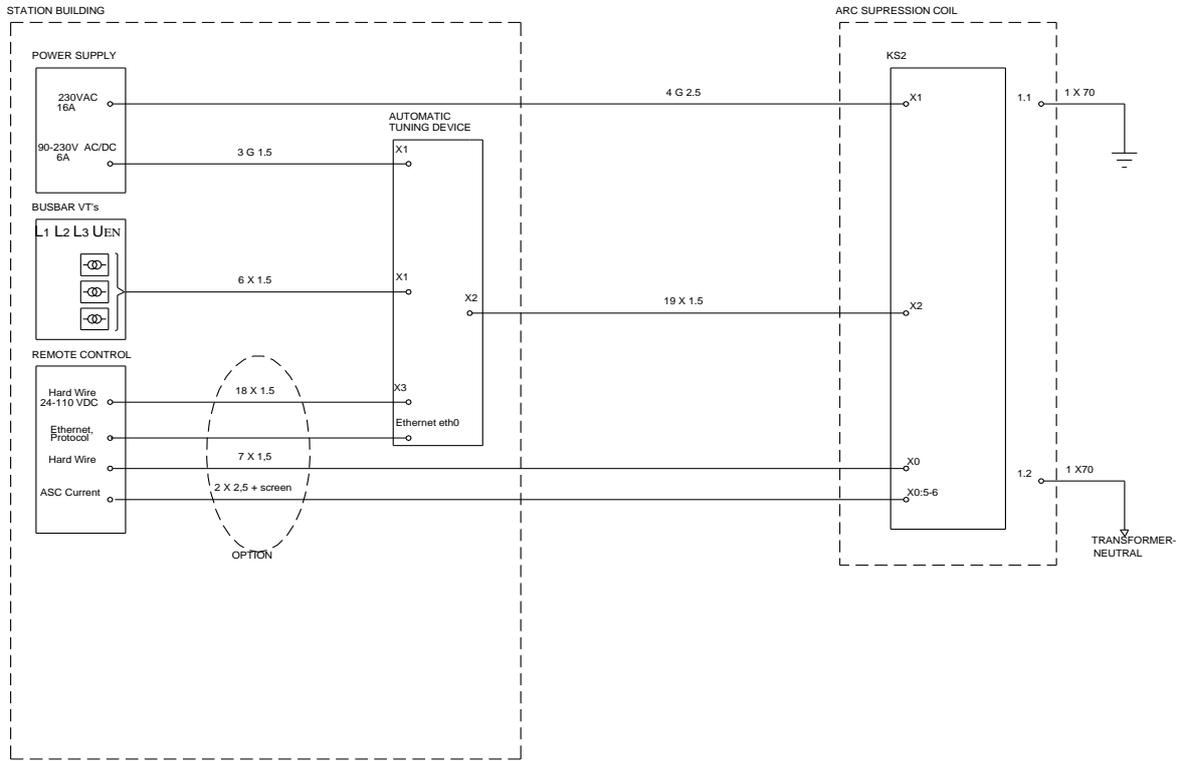
All recommended wire sizes are for Cu cable

ASC Built In Mounting

STATION BUILDING

ARC SUPRESSION COIL

POWER SUPPLY

KS2

230VAC 16A

4 G 2.5

X1

1.1   1 X 70

REMOTE CONTROL

ASC Current

2 X 2,5 + screen

X0:5-6

Hard Wire
24-110 VDC

18 X 1,5

X4

Hard Wire

7 X 1,5

X0

Ethernet,
Protocol

Ethernet

1.2   1 X70

OPTION

TRANSFORMER-
NEUTRAL
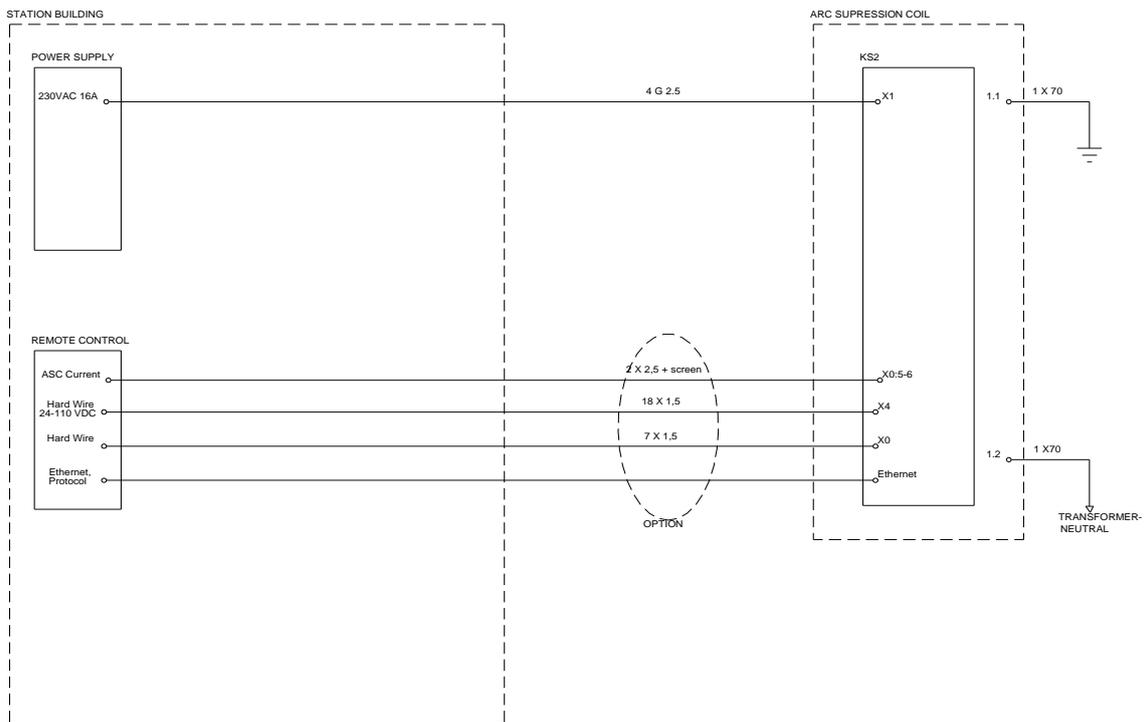
All recommended wire sizes are for Cu cable

Local Control Panel (HMI)

The Automatic Tuning Device comes with a local control panel (HMI). The HMI enables local control and monitoring of the Automatic Tuning Device.

Local control panel

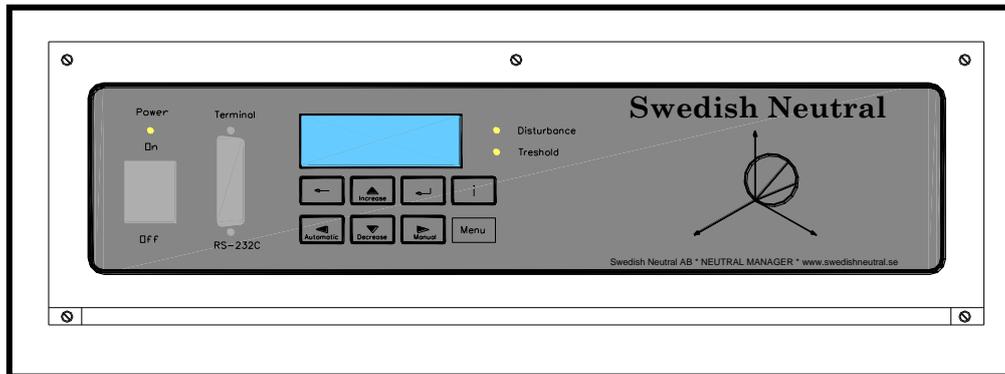- ✓ Switch between *Manual* and *Automatic* operating modes

- ✓ Adjust the ASC up and down

- ✓ Control Neutral Earthing Resistor On/Off

Monitoring and change of settings

- ✓ Two separate LEDs for group alarms

- ✓ Alarms are grouped in two different categories "Threshold" and "Disturbance".

- ✓ In the event of an alarm *"X Alarm(s)"* will be displayed in the LCD. The "information" button can be pushed for additional information regarding the alarm.

- ✓ Confirmation of alarms via the local control panel

Examples of self-monitoring functions

- ✓ Computer health alarm

- ✓ Failed ASC tuning alarm

- ✓ Main voltage monitoring

Local Control Panel - display

In normal operating mode the status of the system is continuously monitored. Measurements, results of the locus calculations, coil position and alarms are displayed.

A rotating heartbeat indicator is a sign that the computer is on and functioning.

Row	Description
1	System Mode, ASC position
2	Measurements (U_{RS}, U_{EN}, U_{EN} angle)
3	Locus Results (d, k, beta, v)
4	Alarms, Heartbeat

```
Manual                    100.0A

110.0   110.0     360.0

0.00    0.000     360   +0.00

No alarms                   /
```

Local Control Panel - buttons

Button	Function	Button	Function
▲ Increase	ASC increase	▼ Decrease	ASC decrease
←	Not used	▶ Manual	Manual mode
◀ Automatic	Automatic mode	i	Information
↵	Not used	Menu	Menu mode

NMTerm Terminal Software
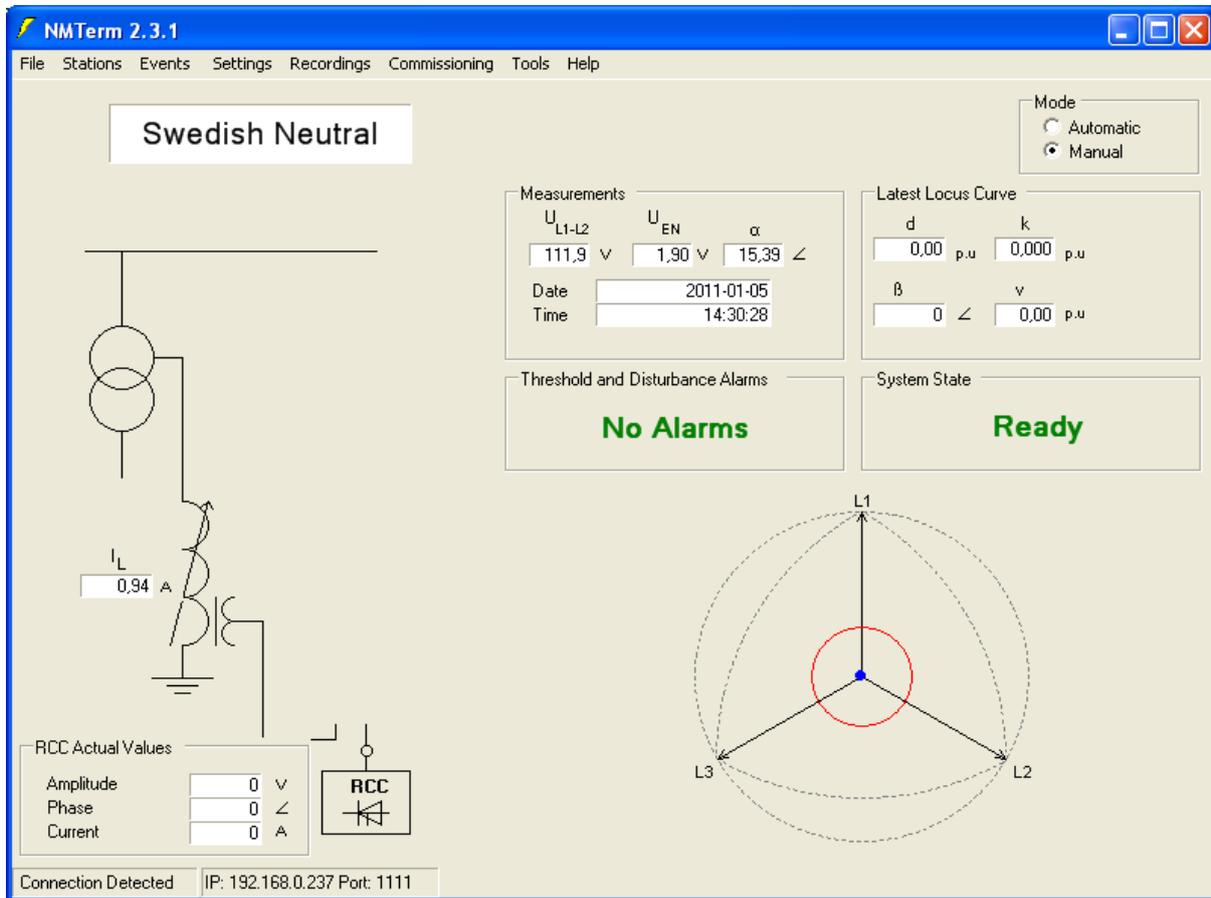
NMTerm enables easy access to the different features of the Automatic Tuning Device. NMTerm can be installed on any PC using a Windows operating system.

- o Choose language (English, Swedish, German, Russian, Czech and Portuguese)

- o Monitor

- o Set *Automatic* / *Manual*

- o Manual Control of ASC

- o Change settings

- o Test functions

Digital and Analog Board Specifications

Analog input board (AI)

Voltage Inputs

Voltage input	**0 – 110 VAC**
Burden	**< 0.x VA (0.x Ω)**
Insulation level	**>1 kV 1s (IEC 60204-1:1997)**

Analog output board (AO)

Current output 1	**0 – 20 mA DC corresponds to ASC position 0-100%**
Current output 2	**0 – 16 – 20 mA DC corresponds to Neutral Voltage 0-10-100%**
Insulation level	**>1 kV 1s (IEC 60204-1:1997)**

Digital input board (DI)

24-110 V model

Input voltage	**Input 1-8: 19-40 (min-max) VDC**
	Input 9-16: 20-140 (min-max) VDC
Burden	**Input 1-8: 0.32 VA (1.8 k Ω) @ 24 VDC**
	Input 9-16: 0.59 VA (20.4 k Ω) @ 110 VDC
Insulation level	**>1 kV 1s (IEC 60204-1:1997)**

110-220 V model

Input voltage	**Input 1-8: 19-40 (min-max) VDC**
	Input 9-16: 72-250 (min-max) VDC
Burden	**Input 1-8: 0.32 VA (1.8 k Ω) @ 24 VDC**
	Input 9-16: 0.53 VA (91 k Ω) @ 220 VDC
Insulation level	**>1 kV 1s (IEC 60204-1:1997)**

Digital output board (DO)

Switching voltage	**0-250 VAC/DC**
Max continuous current load	**6 A**
Insulation level	**>1 kV 1s (IEC 60204-1:1997)**

Standard Protocols Interoperability Reference

Protocols

The Automatic Tuning Device can be controlled and monitored though protocol. Protocols supported by the Automatic Tuning Device listed below.

IEC103

Ref.	Client system	
	Vendor	**Type**
1	Siemens	SINAUT
2	Siemens	SICAM PAS
3	Areva	
4	Cybectec	SMP
5	ABB	
6	Foxboro	C 50
7	Foxboro	SCD 5200

IEC61850

Ref.	Client system	
	Vendor	**Type**
1	Siemens	SICAM PAS V5.11
2	Siemens	SICAM PAS V6.0
3	Areva	C264C
4	ABB	RTU 560

IEC104

Ref.	Client system	
	Vendor	**Type**
1	Cybectec	SMP
2	ABB	800xA With OPC Server: Matrikon 1.0.4.0

DNP 3

Note: By means of external IEC103/DNP3 protocol converter.

Ref.	Client system	
	Vendor	**Type**
1	Cybectec	SMP
2	Abbey Systems	

SPA

Ref.	Client system	
	Vendor	**Type**
1	Cybectec	SMP
2	ABB	

U0-injector

An U0-injector is used in networks with very small dissymmetry, i.e. low neutral displacement. The purpose of the U0-injector is to increase the neutral displacement to allow for correct and accurate tuning of the ASC.

Design

The U0-injector is designed to handle full neutral displacement continuously.

The U0-injector is installed in the control cabinet of the ASC. The U0-injector can be connected in different combinations dependent on the desired amount of dissymmetry required to be added. Passive overload protection is included in the design.

The U0-injector is connected a secondary winding of the ASC.

Warning! When service work to the ASC is initiated make sure to switch off the U0-injector. Injection of power on the secondary winding results in high voltage on the primary winding.

External Connections
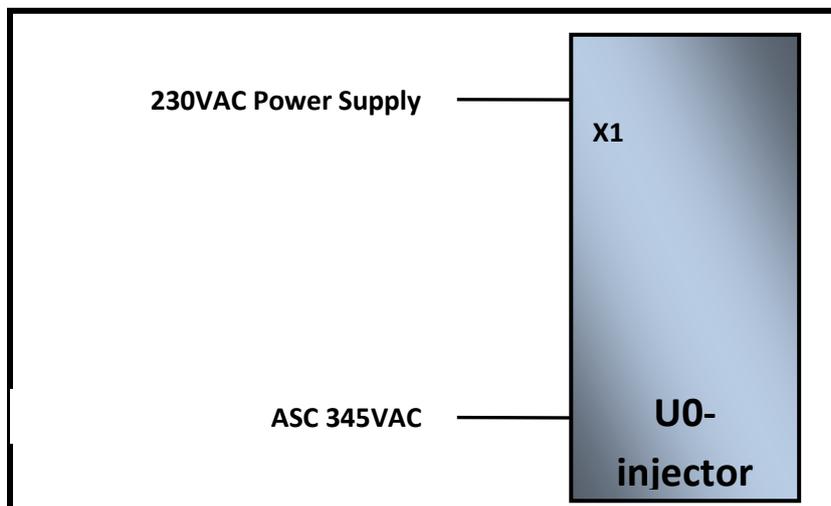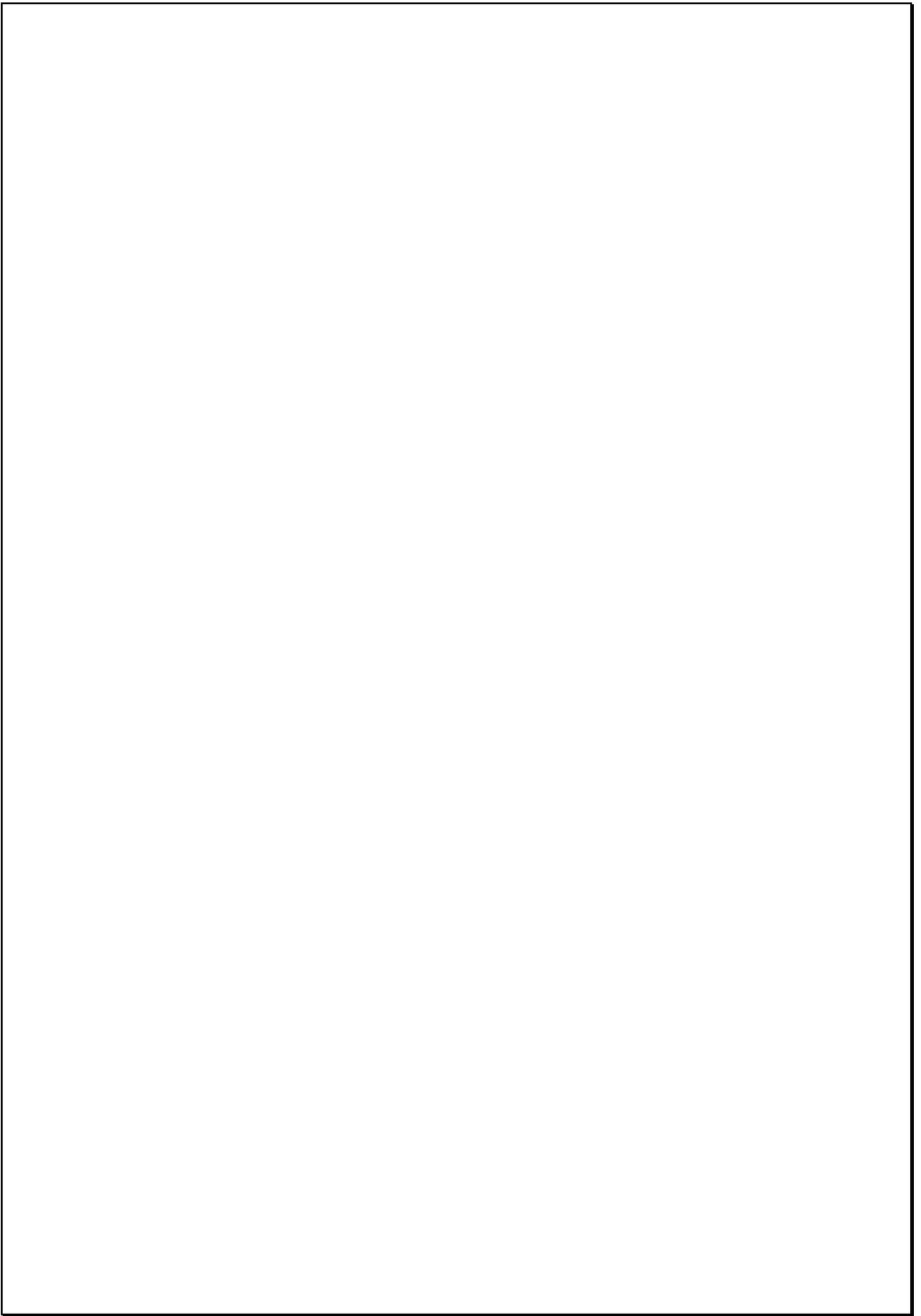
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