Eagle – 27 kV Single Phase Recloser

Settings Programming Guide

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1. Introduction

EAGLE is a single phase recloser with an in-built numerical relay for taking the appr
decisions during system fault conditions. EAGLE provides a Web-HMI over Wi-Fi which c
accessed from any handheld device (mobile phones, iPad or laptops). Through the
users can program the recloser, monitor or perform control operations.

EAGLE can be connected to CIM605 Gateway which can download/read data from EAG
send to remote control center. The Gateway also allows user to access Eagle Web-HMI c
The Gateway supports DNP3 protocol using which user can monitor and give c
commands to EAGLE.

This document describes in detail the usage of the Web-HMI along with applica
functionality descriptions of the recloser and lists function blocks, logic diagrams (wh
needed), setting parameters and technical data sorted per function. The document can b
as a technical reference during the engineering phase, installation and commissioni
and during normal service.

1.1. Intended Audience

This document addresses system engineers, installation and commissioning person
technical data during engineering, installation and commissioning, and in normal se
system engineer must have a thorough knowledge of protection systems, p
equipment, protection functions and the configurations set in the device. The installa
commissioning personnel must have a basic knowledge in handling electronic equip

1.2. Abbreviations

Sl	Abbreviation	Description
1	AR	Auto Reclose
2	BI	Binary input
3	CB	Circuit Breaker
4	CLP	Cold Load Pickup
5	CT	Current Transformer
6	DR	Disturbance Record
7	EAGLE	Single phase Recloser Device
8	FPI	Fault Pass Indicator
9	HLT	Hot Line Tag
10	LED	Light Emitting Diode
11	LP	Load profile
12	LRC	Long Range Communication cabinet
13	NRM	Non-Reclose Mode
14	OC	Over current protection
15	SCADA	Supervisory Control and Data Acquisition

2. Powering up the recloser

EALGE is a self-powered device. The energy needed to power up the electronics ins
EAGLE is harvested from the primary feeder current. The recloser has a Cu
Transformer (CT), also called a harvesting CT, which steps down the curren
through the feeder and is used to power up the electronics and the movement o
actuator. The recloser also has a Rogowski coil, connected in series with the harves
which is used for measurement of feeder current for protection and control func

Since the recloser uses the primary feeder current for energizing, EALGE is pow
only if the recloser is in CLOSED position. Once the recloser's vacuum interrupter or
breaker (CB) is closed, a set of capacitors get charged. Once fully charged, the capa
energy is used to keep the electronics powered on. Once the primary current is
the electronics can stay powered on for up to 20s. This reserve energy is used to en
that the recloser is powered during the auto-reclose (AR) cycle, continue record
and ensure a smooth power OFF for the recloser.

2.1. Initial Power up of the recloser

The initial power up of the recloser is done using mechanical handle of the EAGLE.
EAGLE is already mounted on the pole, then a hook stick can be used to engage the
operating handle to close the vacuum interrupter.

Figure 1: EAGLE Open/Close Operation using the Mechanical lever

Figure 2 Parts of EAGLE Single phase recloser (Side View)

Figure 3 Parts of EAGLE (Bottom View)

3. Connecting to the recloser through Wi-Fi

Once the recloser is powered up, the EAGLE can be programmed with relevant

can be accessed through popular browsers such as Google Chrome, Internet E
Mozilla Firefox or Safari.

Though EAGLE user interface works fine will all of the above
mentioned browsers, wherever available, Mozilla Firefox
recommended option

User connect to the eagle in any handheld device, It can tak
minutes to load webHMI.

Once the EAGLE is powered up, the Wi-Fi chip inside the electronics is activat
the first 20 seconds. The activation of Wi-Fi is indicated by the flashing of the L
Indicator LED at the bottom of the device. If the recloser has been powered off
extended period, the lockout indicator may not blink although the Wi-Fi is turne

In case the Wi-Fi has to be enabled on a device which is already powered up and r
then the user can toggle the position of the Non-Reclose Mode (NRM) handle (eithe
ON->OFF->ON or OFF->ON->OFF) to turn on the Wi-Fi.

Once the Wi-Fi is enabled, the following credentials can be used to connect to the r
through the handheld devices.

- Default Wi-Fi SSID for EAGLE : WIFI_RER605_{SERIALNUMBER}
- Default Wi-Fi password : qwerty123

Once the Wi-Fi connection is made in Access point mode, the Web HMI can be acc
using the url: https://rer605.abb.com/

Please refer to Section 7 to a full explanation regarding Acce
mode.

Once the Web-HMI opens, user will be able to see the Dashboard view in "Viewer"

EAGLE provides role-based access to the settings. Hence the users are required to
suitable passwords, depending on their role, to access the Web-HMI. EAGLE s
user roles - "Viewer", "Operator", "Engineer" & "Admin" with respectively increa
authority of access. While the Viewer has limited access to monitor & view stat
device, the Admin has full access to monitor, program and perform control ope
The default password format for accessing the Web HMI is "000x", where x increas
2 to 4 for "Operator" to "Admin" level of access. Viewer does not need a password.

- Default password for Operator : 0002

The user credentials can be entered by clicking on the user icon seen on the top r
hand corner of the Web-HMI dashboard. This opens up a dialog box where the de
user credentials can be entered.

Figure 4: Location of for entering user credentials in Web-HMI

It is Strongly Advised to change the SSID & passwords for vari
before the device is put into service to avoid unauthorized
recloser settings.

For further information on changing/resetting the passwords refer to section 7.4 a

After logging with "Admin", "Operator" or "Engineer" role, if
detects no activity over the Wi-Fi for more than 20 mins, th
HMI automatically moves to "Viewer" mode.

3.1. Role-Based Access to Web-HMI features

The access to various features of the device depends on the user credentials used for
login. The Viewer has only viewing rights with very little control options and "Admi
the maximum control on configuring and controlling the device.

The following table shows the access rights based on login credentials.

Table 1 Table of access rights to different part of Web-HMI

	open button	Yes	Yes
	Lockout RESET	Yes	Yes
	Auto reclose button	Yes	Yes
	Non reclose mode button	Yes	Yes
	cold pick up button	Yes	Yes
	Download External Events	Yes	Yes
	Download Internal Events	Yes	Yes
Events & Fault Records	Fault records	Yes	Yes
	External	Yes	Yes
	Device	Yes	Yes
	Clear All events	Yes	Yes
	Download All DRs	Yes	Yes
Disturbance Recorder	Clear All DRs	Yes	Yes
	download zip, dat, cfg	Yes	Yes
Load Profile	Download All LP	Yes	Yes
	Clear All LP	Yes	Yes
Protection		Yes	Yes
CB Maintenance		Yes	Yes
Recloser		Yes	Yes
Cold Load Pickup		Yes	Yes
DR Settings		Yes	Yes
	Export to recloser	Yes	Yes
Import / Export Settings	import from recloser	Yes	Yes
	Restore Curve	Yes	Yes
	Factory Settings	Yes	No
General configuration		Yes	No
System Time	Primary source	Yes	No
	System Time & Date	Yes	Yes
Language Select		Yes	Yes
Firmware		Yes	No
Wi-Fi Parameters	Access Point/ Station Mode	Yes	No
	reset Wi-Fi	Yes	No
	Discard changes	Yes	No
	Save	Yes	No
	Send To Device	Yes	No

For the sake of clarity, of this document will describe the fe
available to users with "Admin" credentials.

DeviceAdmin password is used for authentication of DN
messages for communication between LRC and Eagle.
different from Admin password.

4. Web-HMI Overview

Once logged in, the Web-HMI presents a Dashboard view and other Menu options
with the status of device Flags. Flags are status information of important events th
user attention.

4.1. Dashboard overview

The Dashboard of EAGLE Single phase recloser looks as in Figure 5. The Dashboard
a Single line diagram (SLD) where the status of the circuit breaker (CB) is display
RED color of the breaker indicates CB is closed and Green indicates that the CB is ope
Close and Open buttons are provided below the SLD for easy controlling of the E
circuit breaker.

The Dashboard also displays the fundamental component of the measured p
current in Amperes, MAC address of the device.

Dashboard provides easy Enable/Disable button for Auto reclose (AR) functi
Reclose Mode (NRM), Cold Load Pickup (CLP) and Operating Mode functionality
of each of these functions is shown by "Green" indication and the Disable is show
"Grey' color. Operating mode functionality works only in station mode.

Please refer to Section 7 to a full explanation regarding stat

When "Operating Mode" is enabled user will not be able to enable/disable Auto R
function, Non-Reclose Mode, Cold Load Pickup operation using Web-HMI. User w
able to do these operation through DNP3 only.

Above operation is only possible if LRC and Eagle devices have
DeviceAdmin password.

If the recloser goes through a complete AR sequence and reaches the Lockout state, it
be reset using the RESET button on the Dashboard.

Table 2: Device Status Information LEDs on Dashboard

Device Status	LED Status	Description
Ready		Device is in Normal operating con
		Device needs user attention
Pickup		Protection Pickup event occurred
		No Protection pickup event
Trip		Protection Trip occurred
		No Protection Trip event
Lockout		Device is in Lockout condition
		Device Not in Lockout condition
Auto Reclose		Auto reclose Enabled
		Auto reclose Disabled
Energy Storage		Energy Storage up to full capacity
		Energy storage is low

Table 3: Non-Reclose/HLT Mode Activation Mode Indication on Dashboard

Non-Reclose/HLT Mode	LED Status	Description
Mechanical Activated		Non-Reclose mode acti using the mechanical ha
Web-HMI Activated		Non-Reclose mode acti through Web-HMI over

Figure 6 EAGLE Web-HMI Dashboard in "Admin" mode in Station mode

The exact view and formatting of the Web-HMI can change
the display size of the device used to connect (laptop/m

Also, some browsers may not display some features based
version installed.

Refer to Section 7 for a full explanation regarding Station M
Point Mode.

4.2. Configuration

On the left side of the Web-HMI there are Menu options. On clicking each Men
a sub-menu opens presenting different features. The configuration page appea
third option on the Menu, but this page allows the user to set the fundamental

Auto Recloser	In this mode, device acts like a single phase rec configurable AR & protection functions
Breaker	Reclosing functionality is disabled and the device a protection relay
Sectionalizer	All protections are disabled and device behaves like a sw

This configuration of device can be made under the Configuration -> General pag
the Web-HMI.

4.2.1. General Settings

The tab Configuration -> General in the Web-HMI is also used to Enable/Dis
protection functions, set system frequency (50/60 Hz) and also to give a
identifier name to the EAGLE recloser (max 12 characters). The name set h
shown in Disturbance Record (DR) file for easy identification of the DR.

In Station Mode, Eagle supports Inter-trip mode & 3 Phase Open Opera
configurations can be done in Eagle Web HMI by going to "Configuration->G
(please see figure 7).

Wen a fault occur at any phase then EAGLE device, if the device is in reclose mo
unit will perform single phase reclosing and subsequently lockout if it is a pe
fault. During that time, if it is configured in inter-trip mode enabled, it will send the
message to other 2 Eagles to perform circuit breaker open. It is needed to config
Intertrip mode in all three EAGLE Web HMI by going in "General" settings.

In 3 Phase Open Operation mode when the user send an OPEN command via W
or Scada to any Eagle connected to the LRC the other two eagles will also get op
is also an intended operation but to receive 3 Phase Open Operation command v
enable this in EAGLE Web HMI by going in "General" settings.

Figure 7: View of the Configuration-> General tab

The Webpage also allows to configure the device either with
(HLT) or without.

If the device is configured to work without Hot Line Tag, n
mode is utilized where:

1. Auto reclose is disabled
2. the protection functions trip with settings as set in t
   -> Protection page
3. Hot Line Tag settings are ignored.

4.2.2. Sending Settings to Device

Once the desired configurations are made, the button "Save" can be used to te
save the settings in the Web-HMI. The user can then proceed to other sections
webpages for configuration. Once all changes are done, the "Send to device" button
to be clicked. The settings/configuration changes are then sent to the EAGLE device

In case the user wants to discard the changes made, "Discard Changes" button
pressed. Caution must be exercised when discarding changes as it discards all
done even in previously "Saved" but not yet sent to device changes.

Only "Saving" the settings will not ensure updating of settings
device. "Send to Device" must be pressed to send and ve
changes in EAGLE.

4.2.3. System Date and Time

EAGLE can sync the device time with two sources, defined as a primary and a seco
source.

- GPS signal
- System Time from handheld device (Manual)

If GPS is set as the primary source, it is recommended to set the handheld device as
secondary source (and vice versa). The format of the date, time & time zone can als
set from this page. The page also displays the time when the last GPS sync was rec
for reference. The timestamp and format selected here is reflected in events an

Figure 8: System time setting page

If manual is set as primary source , click on "System Date &time" to fetch system tim
and time zone. When we click on "Sent to device " button eagle time will synchronize
with system time. The time is further corrected when the GPS signal is available.

4.2.4. Language selection

4.3. Monitoring

Monitoring is the first Menu option in the Web-HMI below the Dashboard. M
menu offers options where user can monitor the device status, events and reco

4.3.1. Self-Supervision

The EAGLE has continuous self-monitoring capability. If any internal er
abnormalities are found, they are indicated in the Self Supervision page in the form o
error code.

The displayed error code can be shared with an ABB technical support person f
correct diagnosis of the error & subsequent actions.

4.3.2. Events & Fault Records

Event Logs are one of the most important pieces of evidence for post fault syste
investigation. They can provide the reasons for premature equipment failures a
necessary information to perform post-fault event analysis. Proper use and inte
of event records can lead to corrective action for a given system problem result
improved performance and reliability of the distribution system.

The event logging is triggered by the activation and deactivation of protection st
Binary Input (BI)/Binary Output (BO) status changes, system faults, recloser status c
setting changes etc. The logged events are stored in a non-volatile memory and
available for download as ASCII CSV text file.

Two type of event logs are maintained in the recloser:

1. Internal Events – Events related to device status
2. External Events – Events generated by user activity or protection
   operation

The events can be filtered or searched to see specific entries or only internal (i.e. De
or external events. If fault record option is selected, only the protection related e
filtered. Sorting can also be done by date, event type and description.

The pickup and dropout or assertion and desertion of events are represented by
"↓" respectively after the event description text.

Total 100 internal events and 1000 external events will be stored. If the number of ev
logged reaches maximum limit, the oldest event will be replaced and overwritten
latest event.

All events can be download on to the handheld device. All external events can be cle
if logged in as an "Admin". The view of Events page as an "Admin" is presented belo

The detailed list of internal and external events is shown in Appendix 2: List of Event

Figure 9 List of Events as seen in "Admin" mode

After Eagle issue the Final Open command latest Event & Fau
may not be available to download. To download the record
the Eagle and wait until Eagle save the Event and Fault Reco
proper file format.

4.3.3. Live Data

Under this page the live status of measurements, protection functions and supe
functions are shown. This page also allows configuration of flags. The following infor
is displayed:

- Configuration of flags
  - o Latched : Events which are configured as latched wi
    hold the status on Web-HMI even after the specific protection
    has reset. This can be used for analyzing the trips/auto reclos
    "Reset" button on the dashboard can clear these flags.
  - o Self-reset : Events which are configured as self-reset w
    soon as the function resets
- Live Measurements
  - o Fundamental primary current in Amperes
  - o Second harmonic component of the measured primary current
  - o True RMS value of the primary current
- Over current function trip/pickup status
- Non reclose status & source of activation
- Status of Inrush function

- Mechanical counter value
- Cold load pickup function status
- GPS based location information (provided GPS signal is available)

Figure 10: Live Data of the EAGLE as seen in "Admin" mode

For every Open operation of the EAGLE, the electro-mech
displayed on the device is incremented by 1.

4.3.4. Disturbance Recorder

The DR is triggered by activation of protection start, trip or digital signals. Once trig
it stores the measured current and digital channel information as per user sett
COMTRADE files, which is made available for download.

Details on the configuration of the Disturbance recorders can be found under the s
4.4.8 on Disturbance Recorder Settings.

The file name for storing the DR will be in the format RER605_DR_yyyymmddhhmmss.(
/ CFG), however in case the file is stored when power is not sufficient in such case the f
name will have additional _r (reduced format) in the file name.

The Web-HMI lists the DRs based on the date and time of recording the DR. The c

settings Overwrite Enable is activated in DR settings page) That is, at any given time, the EAGLE device shows the last 250 DRs.

The user will be able to download the DRs individually when logged in as an "Admin

Figure 11 Disturbance Records as seen in "Admin" Mode

After Eagle issue the Final Open command latest Disturbance may not be available to download. To download the record the Eagle and wait until Eagle save the Disturbance Records file format.

4.3.5. Load Profile

The load profile stores the historic load data captured at a periodic time interval. In E load profile function averages fundamental phase current, RMS current and RMS current and stores in a non-volatile memory. The value is recorded for an interv 10 minutes with recording capability of last 90 days. The device will start averag load data once it moves to healthy state and stops averaging once it detects ins power/reboot.

The recloser will record at 10-minute intervals from 00:00 hour time. For examp function is enabled or recloser is powered up at 08:12hrs, the first averaged dat recorded at 08:20hrs and first data point will be an average of 8 minutes instead minutes. Next data point will be recorded after 10 minutes at 08:30hrs. If in

The load profile data is available to user as COMTRADE file format with .dat and .
extension through the Web-HMI when logged in with "Admin" credentials.

It should be noted that the Load profile needs at least 2 data p
display the load profile COMTRADE chart.

Figure 12 Load profile as seen in "Admin" mode

4.3.6. Security Logs

Security Logs are one of the most important pieces of evidence that system/s
engineer can have during system behavior investigation. The security log will be st
non-volatile memory and made available for user as ASCII CSV text file through av
user communication interfaces.

Each log contains description, login user type, time stamp (UTC time) (MM,DD
hh,mm,ss,ms) and the activity that triggered the log entry.

At any given point of time the last 1000 security logs are stored and displayed on the We
HMI. Refer Section 8.3 for the full list of registerable security log entries.

Figure 13: Security log as viewed in "Admin" mode

4.4. Settings

4.4.1. Protection 51P-1, 51P-2 & 51P-3

The single-phase overcurrent protections, 51P-1, 51P-2 & 51P-3 are used
directional overcurrent, short-circuit protection.

The trip time characteristics for 51P-1, 51P-2 and 51P-3 can be selected to be
definite (DT) or standard inverse definite minimum time (IDMT) or user defined
definite minimum time curves through the setting Curve. The behavior can
configured through a Curve file and will be discussed in section 4.4.9 on Import
Settings/Curve file.

In the DT mode, the function trips after a predefined trip time and resets when t
current drops below the threshold. This delay time can be set using the setting t.

The trip outputs of the function can be blocked using the settings Block. Once set to
the trip output of the function is disabled and for all practical purposes the prote
not effective, though measurement will work as normal.

The over current protection function can be made sensitive to Inrush condit
enabling the setting Block during inrush. Similarly, the 51P-1, 51P-2 & 51P-3 functio
be made sensitive to Cold load pickup conditions by enabling the CLP apply.

Other needed settings Time multiplier (K) and Min trip delay (TDMin) for IDMT a
available in setting Settings - Protection page.

If the Non reclose mode is enabled either by the NRM handle or from Web HMI, ther
pickup value of the over current protection is reduced a factor of the HLT multiplier X

Parameter	Range	Unit	Step	Default	Descrip
Pickup value	10...7500	A	1	250	Pickup v
Curve	As per the user defined Curves	-	1	Definite Time	Curve Ty
t	0.00... 64.00	s	0.01	0.50	Trip dela
Block	NO YES	-	1	No	Block th
Block during Inrush	NO YES	-	1	Yes	Blocking
CLP apply	NO YES	-	1	Yes	Cold loa applicati
K	0.02...1.6	-	0.01	0.5	Curve P
TDmin	0.0...0.25	s	0.01	0.00	Min trip c curve

4.4.2. Protection - Inrush Inhibit

Inrush detection is used to coordinate transformer inrush situations. Inrush detec selectively blocks overcurrent function when the ratio of second harmonic compo over the fundamental component exceeds the set value.

Inrush current is a ratio of second harmonic current (I2) to the fundamental frequ current (I1) value. Inrush logic detects inrush conditions and blocks the over curr protection functions if following conditions are satisfied.

a) Fundamental current should be greater than 10% of rated current and less than I in *max current setting.*

b) Inrush current I2/I1 should be greater than Inrush ratio setting.

The blocking remains activated as long as these conditions are satisfied. For overcurr function to be blocked by inrush it is required that setting Blocked by inrush is set as "Yes" in respective over current protection function.

Once inrush detect output is activated and inrush condition mentioned in conditions a b remain failed for a time of 30ms, the Inrush blocking is deactivated.

Table 5 Inrush protection User settings

Parameter	Range	Unit	Step	Default	Desc
Inrush ratio	10 ... 50	-	1	30	Inrush ratio leading to

I inr max	10 ... 7500	A 1	7500	Current value above wh is ignored.

4.4.3. CB Monitoring

The module is activated whenever the Circuit Breaker (CB) is opened or closed

When the CB is opened either due to a protection trip or from a manual open commar the module adds the magnitude of current at the instance of CB opening, to the KSI o counter. The current is normalized to 100A before adding to the counter. Fractions of l than 100A are round to the closest multiple of 100 A.

Similarly, when the CB is closed, the module adds the closing current (normalized to 1 to the KSI close counter. During the close operation, the module considers the cu 40ms to 50ms after the CB close.

The updated KSI open and close counter values are available as a monitoring value o WEB-HMI.

The open and close KSI counters can be initialized to a pre-defined start value throug settings KSI $_0$ *open and KSI* $_0$ close. As soon as a new setting is saved, the function reset and the accumulation will continue from the set initial values.

KSI open alarm activates when the KSI open counter has exceeded the setting KSI op *alarm value. Similarly, KSI close alarm is activated when the KSI close counter has exceede* the setting KSI close alarm value

Table 6 User settings

Parameter	Range	Unit	Step	Default	
KSI$_0$ open	0 ... 99999	-	1	0	Preset K
KSI$_0$ close	0 ... 99999	-	1	0	Preset K
KSI open alarm value	0 ... 99999	-	1	10000	Alarm lim counter
KSI close alarm value	0 ... 99999	-	1	10000	Alarm lim counter

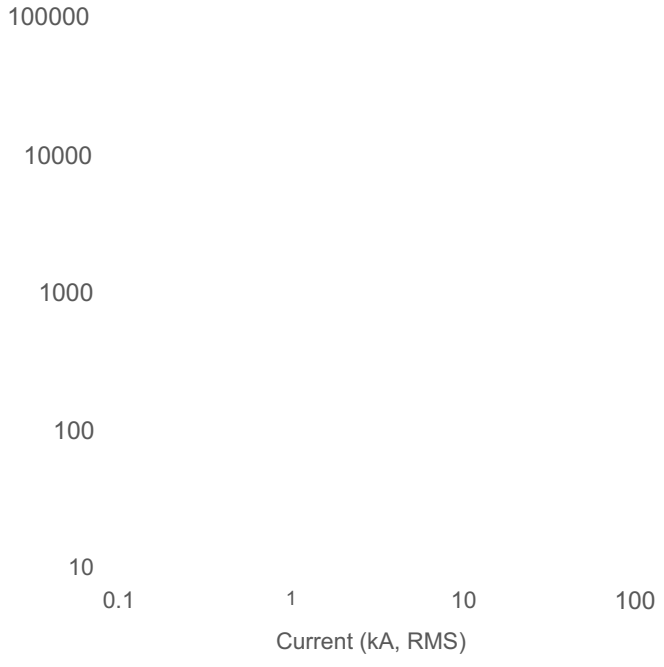


Figure 14. Eagle VG4 Life Curve

Setting Application Example

To program the open KSI alarm setting, the available fault current at the recloser loca
is required. To obtain this value, the total line impedance can be used from the
substation to the point where the recloser is installed. Using this impedance and
voltage, available fault current can be calculated using I=V/R calculation.

With a 12.47kV circuit and total line impedance of 5A where the recloser is installed,
total available fault current is roughly 2500A. Looking at 2500A on the Eagle Life Cur
the number of operations available are approximately 2400. Since the KSI values are
normalized by a factor of 100, the alarm can be set at (2500/100)*2400 = 60000.

4.4.4. Cold Load Pickup

Cold load pick-up problems occur during severe cold or hot weather. When
disrupted in the winter, many families leave their heating systems and appli
When power is restored, those heating systems cause a huge drain on the power lin
can cause line protection equipment to take the overloaded lines off line becaus
heavy load acts the same as a fault on the line. Cold-load pick-up problems also occ
the summer when families and businesses are running air-conditioning unit
pumps. Cold-load pick-up problems are prevented when customers turn off thei
heating or air-conditioning systems, lights and appliances and then, after power
restored, turn them back on over a period of time.

The cold load pickup is used to block unintentional tripping of protection elemen
sudden current detected after the recloser circuit has been open for a specified

Cold load pickup function affects only 51-P1 & 51-P2 functionalities only. Once C
activated the set X_{CLP} value is multiplied with Pickup value and the set
multiplied with time delay in the 51P1 and 51-P2 functions.

Table 7 User settings for Cold Load Pickup function

Parameter	Range	Unit	Step	Default	Desc
Auto initiation	Disabled Enabled	-	1	Enabled	Auto initiation of Cold lo
t_{CLPoff}	1 ... 180	min	1	10	Minimum time for whi de-energized after whic function activates
X_{CLP}	1.0 ... 5.0	-	0.1	1.5	Multiplier by with I> and multiplied during cold
t_{CLP}	1 ... 180	min	1	10	Time duration for which remains

4.4.5. Auto Recloser

Majority of overhead line faults are transients in nature and automatically cleared
momentarily de-energizing the line. De-energizing of the fault location for a selected ti
period is implemented through automatic reclosing, during which most of the fau
be cleared.

In case of a permanent fault, the automatic reclosing is followed by final tripping. The
reclose function can be used with any circuit breaker suitable for auto-reclosing.
function provides three programmable auto-reclose shots and can be set to perform o
to three successive auto-re closures of desired duration.

Total number of auto-reclose operation to be made available is set using Number of re
attempts setting. Maximum 3 shots are possible.

The auto-reclose function can be made off by setting Number of reclose attempts to "0

Recloser controller is responsible for issuing necessary circuit breaker close com
Typical auto-reclose sequence is as follows: Once the function is initialized (AR initiati
matrix, section 4 below), it initiates the first auto-reclose shot. At the time of
initiation, the set dead time t1 will start. Just 20ms before the set reclose time is going
elapses the function will check for the necessary conditions needed for issuing a reclo
command. The conditions checked are

b) Sufficient energy available to fully close the breaker
c) No protection trip is active and
d) Non recloser mode is not active

The close signal is a fixed pulse output. In addition, the reclaim timer will start at the of reclose time. The reclaim time is set by Reclaim time. If the network fault is cleare no new trip signal received) during reclaim time, the auto-recloser is succes function will reset to quiescent condition.

In case before the elapsing of dead time t1, if circuit breaker is detected to be in position OR any trip signal is received (by any of the protection function i.e. 51P-1, 5 & 51P-3), function will activate FINAL TRIP and will disable the AR sequence.

Duration of FINAL TRIP output will be of 200ms.

However, if the network fault is not cleared, i.e. auto-recloser is unsuccessful, a protection based on AR initiation matrix trips the breaker before expiration of the time, the next shot will be initiated (depending upon allowable AR operation set *Number of reclose attempts setting). At the time of shot initiation, the set dead time t* start.

In this way Auto reclosing sequence continues until the set Number of reclose a

Auto reclose will remain in blocked condition for Auto Recloser when CB is closed from HMI or by communication to ensure non re of CB during SOTF condition.

If NRM is activated and CB is open, then auto recloser is deactivate no further closing of CB is allowed until NRM mode is disabled.

Once function enters into block mode it remains in blocked mode for time set ec *Auto Reclose Block time.*

In case CB close does not happens after issuing a reclosing command within set Re *time, then AR goes to blocked mode.*

Auto Recloser initiation Matrix
Auto reclose initiation matrix defines which protection function should initialize c auto reclosing shots. In addition, it also defines the behavior of the function afte particular shot is finished. The matrix defined will be as shown below:

Table 8 AR initiation matrix

Protection Function	79-1	79-2	79-3
51P-1	0, 1, T, L	0, 1, T, L	0, 1, T, L
51P-2	0, 1, T, L	0, 1, T, L	0, 1, T, L
51P-3	0, 1, T, L	0, 1, T, L	0, 1, T, L

Note:

Final trip does not have the option "1" as no more AR cycle will be initiated.

- 79-1, 79-2 & 79-3 Refer to functions responsible for the first, second
  reclose shot of the device.
- If Number of reclose attempts is set as 2, in which case 79-3 column is no
  and function will consider 79-1, 79-2 and Final trip

Here:

- 0 – That particular protection function is blocked (no events, DR etc.
  captured from this protection function, behaves as if function set to "Off").
- 1 - That particular protection function is active and trip from that funct
  initiate AR cycle.
- L – That particular protection function is active and trip from that funct
  initiate AR cycle, but after the trip no further AR cycle will be started (even thoug
  cycles are remaining), and CB can be closed only after resetting the function via
  HMI. Power up resets lockout (trip status) automatically
- T - That particular protection function is active and trip from that funct
  initiate AR cycle, but after the trip no further AR cycle will be started (even thoug
  cycles are remaining), and but no restriction imposed on CB closing (i.e. re
  function is not required). Power up resets lockout (trip status) automatically

It should be noted that while setting AR initiation matrix care sh
taken that values are set properly or it may result into mal opera
function.

The following Sequence diagram shows the various times and their effect on the AR
during a successful Reclose after 3 rd shot and an un successful reclose after th

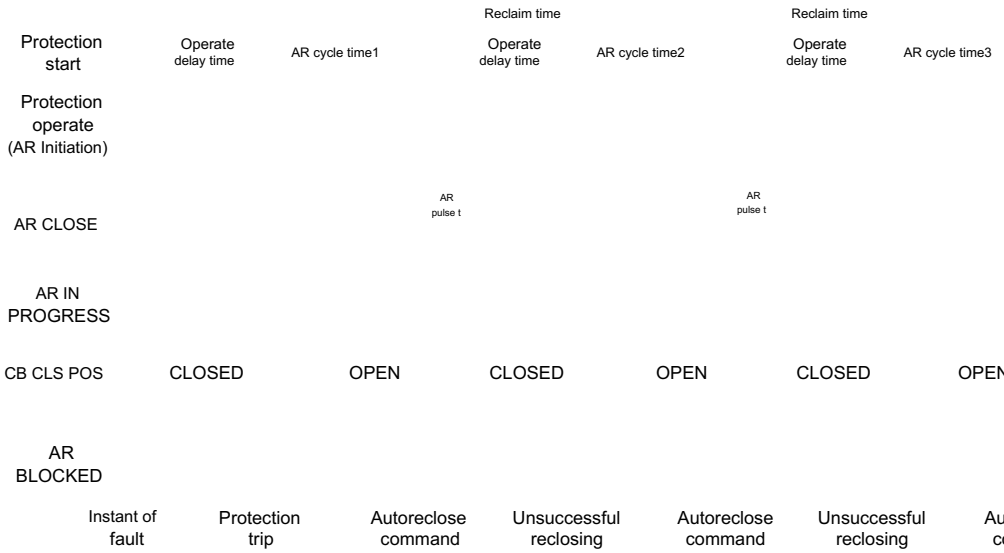


Figure 15: Sequence diagram indicating successful reclosing after 3rd

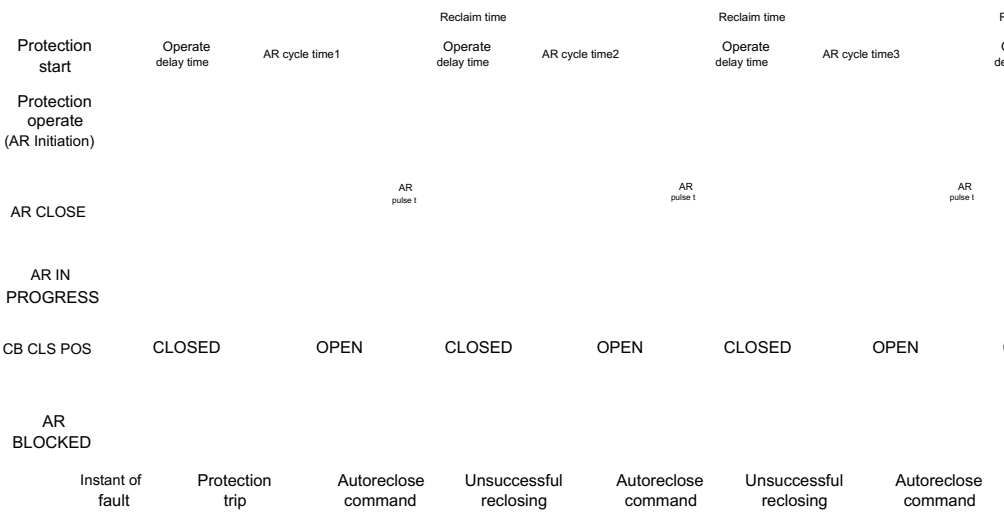


Figure 16: Sequence diagram indicating unsuccessful reclosing after 3r

Lockout Condition

Once the EAGLE enters into Lockout mode the breaker is open and the electronics will be powered up to a maximum of 20s. Once the electronics discharges completely, the W HMI will not be accessible. Users will be indicated that the device is in lockout conditi by flashing of the Lockout LED at the bottom of the EAGLE, every 4 to 5s.

Lockout LED can blink only after about 1 hour of charging at the minimum. Once fully charged the Lockout LED blinks up to around 12 hours. Lock out indicator resets whe EAGLE is closed via mechanical handle and the device is powered up.

Prolonged trip

Since EAGLE is a self-powered device, there can be situations where the device may have enough energy to perform the reclose operation once the breaker is open. The setting *Prolong trip can be used for such situations.*

If enabled, the Prolong trip setting ensures that the trip from over current protection d not immediately open the breaker, but waits such that the energy stored in the device increased to a level sufficient enough to perform the subsequent close operation. On the required energy level is achieved (due to capacitive charging from primary curren CB is opened and the device can perform the next reclose operation.

To ensure that the function does not wait indefinitely for the device to charge, the sett *Maximum prolong trip time ensures that irrespective of the available charge, the trip i* issued after elapsing of Maximum prolong trip time and the network is protected.

Table 9 Auto recloser Settings

Parameter	Range	Unit	Step	Default	
Number of reclose attempts	0 ... 3	s	1	1	Number of (0 = Auto-re
t1	0.20 ... 5.00	s	0.01	0.2	Dead time shot
t2	2.00 ... 5.00	s	0.01	2.0	Dead time reclose sh
t3	2.00 ... 20.00	s	0.01	2.00	Dead time shot
Reclaim time	1 ... 300	s	1	5	Reclaim ti
Auto recloser Block Time	0 ... 300	s	1	5	Auto reclo
Prolong trip	ENABLE DISABLE	-	-	DISABLE	Enable dela protection for closing
Maximum prolong trip time	0.04 – 10.00	s	0.01	0.04	Maximum trip in case

4.4.6. Non Reclose Mode & Hot line tag

The fundamental need of Non Reclose mode is that, it acts as a safety function by disablin
the automatic reclosing and that the EAGLE is not re-energized until the disabling of
is done by the operator.

The Non Recloser Mode can be initiated by:

1. Mechanical activation of lever.
2. Web-HMI Dashboard

The Hotline Tag setting page is enabled once Non Reclose mode is enabled. Once N
Recloser Mode is activated following actions follow automatically:

1. Auto recloser functionality is blocked.
2. The Pickup value setting of OC functions is reduced by a factor of the set X
3. The time setting of OC functions is also reduced based on the set T

Hot line

It should be noted that Non recloser mode will override the CLP activation.

Table 10 Hot line Tag Settings

Parameter	Range	Unit	Step	Default	
$X_{Hot\ line\ tag}$	0.1... 1.0	-	0.1	1	Hot line tag value
$T_{Hot\ line\ tag}$	0.0 ...1.0	-	0.1	1	Hot line tag time

4.4.7. Sectionalizer

The device can be set to work in sectionalizer mode in the Configuration page as explained
section 4.2.1 on General settings. When set in sectionalizer mode, features like CLP, NRM,
Auto reclose, overcurrent protection functionalities are disabled and only Inrush detec
logic is enabled in this mode.

In Sectionalizer mode the device behaves as a switch which senses current flow abo
set level and when upstream breaker opens to de-energize the circuit, the device cou
the current interruption. An Interruption counter counts the number of interruptions se
by the device.

The module increments its counts when the current exceeds the set Min. fault curren
value and then falls below set Deadline current and for the set Deadline time.

The current should exceed set Min. fault current for a predetermined time for activatio
of Fault Pass Indication (FPI), FPI deactivates with the current falling below the Deac
current. The sectionalizer mode of the electronics activates with the activation of FPI.
count increases only after the dead line condition is detected.

If inrush is detected, then the sectionalizer will not consider that particular count. F
activation of FPI is required after the inrush detection to increment the count.

When the number of counts reaches equal to the set Count, the device opens the CB.

While incrementing counts, if further no counts are increased within set Reset time
counter is reset back to zero.

The activation and deactivation of FPI, activation and deactivation of sectionalizer
Increment of counts & activation of Trip output are available in the events page.

Table 11 Sectionalizer Settings

Parameter	In HMI	Range	Unit	Step	Default	
Min. fault current	Min. fault current	10...1000	A	1	250	Minimum fa
Deadline current	Deadline current	3...100	A	1	10	Current to in condition
Deadline time	Deadline time	100...5000	ms	10	100	Time for whi dead before incremente
Count	Count	1.... 4	-	1	1	Count for se
Reset time	Reset time	1...600	s	1	180	Reset time a resets

4.4.8. Disturbance Recorder Settings

Disturbance Recorder (DR) can be triggered by 16 binary events. The events which can
trigger the DR can be configured from the Settings -> Disturbance Recorder page.

Pre and post recording time defines data recording time before DR trigger activatio
after DR trigger point respectively. Whereas fault recording time defines the max re
time under fault condition. The recording of analog and digital value starts before t
trigger point for time period equal to Tpre and it continues for time Tpost after deac
of DR Trigger signal. Fault time is a varying quantity which is max equal to Trec setting a
can be shorter in case were DR trigger signal deactivate before Trec time.

The device stores a maximum of 250 DRs. If settings Overwrite Enable is activated

Figure 17: Disturbance Recorder Configuration page

4.4.9. Import/Export of Settings/Curve file

Import/Export of setting file

As seen in the manual so far, the functionalities of the EAGLE can be configured sep
using the various pages in the Web-HMI. But the user can also configure the de
uploading a single setting file which can configure all the functionalities in one go. Si
the user can download the current settings that are stored in the device by dow
the setting file.

The setting file is in .CSV format.

Loading custom curves

Similar to the setting file, the Curve file which defines the operating characterist
Over current protection functions, 51P-1, 51P-2 and 51P-3 can also be uploaded an
downloaded through the Web-HMI. The curve file is in .CSV format.

For full details on the Curve file format, refer to section 8.1 on Appendix 1: Curve file
format.

Once the curve file is updated successfully, it should be displayed in the drop down
selection under Setting Curve in the Protection page.

Figure 18: Default list of Curves available in the EAGLE

4.4.10. Factory default

In case the user wants to revert to factory default settings, then the following steps c

be followed.

1. Open Web-HMI & login with "Admin" credentials
2. Navigate to Settings & Select Read/Write
3. Click on "Load Factory default"
4. Wait for the process to be complete
5. Check security log for confirmation of loading the factory defaults

Figure 19: Webpage showing Import/Export of Settings/Curve file & loading Factory

5. Test Mode

Test mode can be used by users to test if the protection and Auto reclose settin
working as expected. The device allows Test mode feature for Auto reclose func
which in turn tests the working of over current protection, inrush, NRM
functionalities. Following are the features of the Test mode functionality

1. All protection functions work as per existing settings
2. Test mode can be performed from 5s to 1500s.
3. The device considers a simulated input current of 8000A during Test mode

Once the button "79-Reclose" button is clicked, a window opens where the user can
the desired time of test mode operation and execute the test.

Figure 20: Configuring Test mode operation

It must be noted that the Test mode time should be greater t
protection function timings (or total AR sequence time). Else
exits even though protection/reclose operation is not comple

During test mode, the Disturbance Recorder (DR) & the load profile features record actual system current and not the simulated current.

If the device is configured as a Sectionalizer, then the test mode runs for only sectionalizer. If it's configured as AR, functions other than Sectionalizer can be configured.

6. Recloser Management

6.1. Firmware Information & backup

The About page in Web-HMI shows the information on the firmware version and t
date/time of the last software update. This can be useful to check if the device has
latest firmware installed or if it is in need of a firmware update.

The device stores a backup firmware incase user needs to go back to the previou
installed software. The details of the backup firmware is also displayed in this page.

Figure 21: Firmware page as seen by "Admin"

6.2. Firmware Upgrade

Firmware upgrade of EAGLE can also be performed from the Firmware page of the
through the following steps.

a. Open Web-HMI & log in as "Admin"
b. Navigate to About page
c. Click on "Select Firmware" button in the firmware update section
d. Chose the binary file shared by the ABB customer support center & upload th
e. Wait 10 to 15 minutes the firmware upgrade happens
f. After firmware update, the device reboots and Wi-Fi connection is disconne
g. Wait until the SSID name is displayed in the list of Wifi networks available & conne

Once firmware update is complete and Wi-Fi connection is available, users can logi
"Admin" credentials and check the firmware information to confirm if the update
successful.

When Eagle is configured in station mode, firmware update option is disabled. User
still rollback to backup firmware, user can also see the information of the firmwa
version and the date/time of the last firmware update.

7. Communication

7.1. Wi-Fi parameters Configuration

The users with "Admin" credentials can configure the Wi-Fi parameters a
requirement. Eagle support 2 different operating mode of WiFi, 1) Access Point Mode &
Station Mode. EAGLE can be operated under two modes, first is Access point mode an
second is Station mode.

7.1.1

In AP mode maximum number of clients that the device can connect at any given time
2 and is set with Max Clients connected settings. It is recommended to keep this to 1 to
avoid unwanted parallel connections which can reduce the overall performance o
Web-HMI.

SSID name is the name of the Wi-Fi network. The default Wi-Fi name is WIFI_RER605
more than one EAGLE is installed within a short distance, then it is recommended
change the SSID to reflect a unique device and avoid connections to the wrong device
mistake.

Hide SSID option is provided if the utility does not want the EAGLE Wi-Fi network
visible for connection to everyone.

> If Hide SSID option is enabled then the operator has to rememb
> SSID and type the same in the handheld device, else the co
> device will not be possible.

The password to connect to the device Wi-Fi can be updated through the set
WPA2_password. The default password is querty123 and it is strongly advised to
this password once the device is installed. Password update is allowed only for users w
"Admin" credentials.

Figure 22:Webpage for configuring the Wi-Fi parameters

The URL for connecting the Web-HMI can also be changed from this page. But once changed, the utility or the user needs to remember the new URL to connect to the W HMI.

To prevent Wi-Fi access attempts by unauthorized persons, an option to automatical off the Wi-FI is provided. If the setting Wi- Fi Auto Off is enabled, then if the device d no activity over the Wi-Fi communication for about 20 mins, then device Wi-FI is off automatically.

Once turned off, the Wi-Fi can be enabled by toggling the NRM handle or by using a source like a torch with a strong non divergent beam. The steps for the same can be from the instruction manual of EAGLE.

7.2 Station mode Configuration

In station mode EAGLE connects with CIM605 Gateway, with the help of gateway th of eagle and relevant information will be send to remote control center.

The users with "Admin" credentials can configure the device in Station mode and re parameters as per requirement.

SSID name is the name of the Wi-Fi network of CIM605 Gateway device. The defau name is CIM605_Eagle.

"Own Eagle IP address" is read only parameter to show the IP address of the Eagle address corresponding to Mac address configured in CIM605 Gatewa configuration page)

Similarly, if own eagle IP 192.168.1.2 then other two eagle IP Address aut
assign to 192.168.1.3 &192.168.1.1
Similarly, if own eagle IP 192.168.1.3 then other two eagle IP Address aut
assign to 192.168.1.2 &192.168.1.1

The password to connect to the device Wi-Fi can be updated through the setti
password. The default password is querty123 and it is strongly advised to upd
password once the device is installed. Password update is allowed only for us
"Admin" credentials.

Figure 23: SSID Name

Steps for connecting EAGLE in station mode:

1- In EAGLE's Web- HMI go to admin role -> Users and Access -> WiFi Parameters

Figure 24: Eagle AP mode

2- Select station mode under wifi configuration pane .

Figure 25:Eagle Wi-Fi Password configuration

Figure 26: Committing Wi-Fi configuration on Eagle.

3- Now "save" and "send to device", as shown in blue blocks in above picture.

Here the default LRC Device IP address is 192.168.1.254. IP
EAGLE1, EAGLE2 should be of same series as above, like in this
series no. should be 192.168.1.1 ,192.168.1.2.....

4- Now go to wifi in your system and select the LRC device SSID name (same as n
configured in above picture) give the password (configured in Eagle device in W
Interface panel in above picture) and connect.

Figure 27:Windows Wi-Fi discovery

5- After connection go in web browser and type https://192.168.1.254 (this IP A
is default, IP address we can see from Wireless interface panel in step-2). LRC
SSID name (from which the EAGLE is connected) will be appear at the top righ
of EAGLE's Web-HMI.

After connection to LRC it will check for valid license file, if lice
available then it will load to LRC Dashboard. If not available then c
personnel.

Figure 28:Eagle Configuration for AP mode

6- Now CIM605 Gateway Web HMI is open, click on Open Eagle WebHMI as show
below :

Figure 29:Dashboard with all 3 eagles connected

7- Following page will appear , now user is able to access EAGLE Web HMI .

Eagle is able to receive the Circuit Breaker Open/Close command from control
also NRM signals, Auto Recloser settings, Cold Load Pickup, Lockout Reset. We ca
switch from station mode to Access Point mode and vice versa using NRM, WHMI a
guide.

- By using NRM Method

We can change (either ON to OFF or OFF to ON) within interval of 8secs We have to
for 1 to 3 sec for switching modes(AP to station and vice versa) . Refer below figure f
Wi-Fi Password Reset and Wi-Fi Mode Switching using NRM Method.

Figure 31 Switching communication modes using NRM

- By using WHMI

Already covered in 7.2.

- By Using Light Guide

Using 1 to 3 sec light pulse three times within the interval of 30secs. Refer below fig
for Wi-Fi Enable , Wi-Fi Password Reset and Wi-Fi Mode Switching using Light Guid
Method.

Figure 32 Communication mode switching using Light Guide

While switching to station mode, if LRC is already in power OFF state
switch back to AP mode after 15mins.

7.4 Change Password for user roles

In case the user wants to update the password for the device Wi-Fi connection, then
following steps is to be followed.

1. Open Web-HMI and login with "Admin" credentials
2. Navigate to User & Access -> Change Password
3. Select the User role for which password needs to be updated.
4. Type the new password
5. The selected password should be of minimum 4 characters and a maximum 17 A
   characters
6. Validate the new password by retyping the same
7. Select "Send to device"

In case the passwords for users need to be reset to factory defaults:

1. Press "Reset Default Passwords"
2. Select "Apply" in the pop up

Figure 33: Webpage for changing user passwords.

7.5 Forgot Password

There can be situation where the updated passwords are misplaced or forgotte
a case the device allows to reset the passwords by following the steps mentioned be

Incase Wi-Fi password is forgotten.

1. Go near the installed EAGLE device
2. Use a strong light source (example: torch with a strong non divergent beam)
3. Point the light source to the light guide opening of the EAGLE
4. Switch on the light source for 5 to 8 sec and switch off
5. Within 10s from the last switch off, switch on again for another 5 to 8 seconds
6. With this sequence the Wi-Fi password resets to its default factory password of "querty123" for 10 mins.
7. Connect Wi-Fi using default password within 10 mins
8. Open the Web-HMI & Navigate to User & Access -> WIFI parameters
9. Change the WIFI password to a new one and store the same securely

In case a suitable light source is not available, then the Non reclose mode (NRM) han
can also be used to reset the Wi-Fi password.

1. Change the position of NRM handle from OFF -> ON or from ON-> OFF position
2. Wait for 10s
3. Change the position back to the original position ON-> OFF or from OFF -> ON pos
4. The NRM handle should return back to its original positive with in 20s from the change of position
5. With this the Wi-Fi password will be reset to its default password

Incase user credential is forgotten, then both a light source as well as a tool to toggle handle is needed to reset the password to default. The following steps needs to be followed:

1. Enable Wi-Fi via NRM or Light guide as explained in Section 7.1
2. Connect to the EAGLE Wi-Fi from a device
3. Toggle the Non Reclose Mode handle either ON->OFF-> ON or OFF->ON->OFF
4. Once the NRM handle sequence is complete, within 60Sec, use the light source point towards the light guide opening of the device
5. Switch on the light source for 5 to 8 sec and then switch off.
6. Within 10s turn on the light source again for another 5 to 8 seconds
7. Once this pattern is detected the device is ready to allow admin access
8. Connect to device Wi-Fi and open the Web HMI to enter as "Admin".
9. Navigate to User & Access & navigate to change password and select user and c the user password

7.3 Security

7.3.1 General Security deployment guidelines

General Security:

Technological advancements and breakthroughs have caused a significant evol electric power grid. As a result, the emerging "smart grid" and "Internet of Thing quickly becoming a reality. To provide end users with comprehensive re information, enabling higher reliability and greater control, automation syste become ever more interconnected. To combat the increased risks associated w interconnections, ABB offers a wide range of cyber security products and soluti automation systems and critical infrastructure.

ABB understands the importance of cyber security and its role in advancing the secu distribution networks. A customer investing in new ABB technologies can rely on solutions where reliability and security have the highest priority. At ABB, we are addr cyber security requirements on a system level as well as on a product level to suppo security standards or recommendations.

Reporting of vulnerability or cyber security issues related to any ABB product can be via cybersecurity@ch.abb.com.

System hardening rules

Today's distribution automation systems are basically specialized IT systems. T several rules of hardening an automation system apply to these systems, too. EAGL phase recloser is designed from a grid automation system perspective on the lo and closest to the actual primary system. It is important to apply defense-in information assurance concept where each layer in the system (which not only

- Recognizing and familiarizing all parts of the system and the de
  communication links
- Removing all unnecessary communication links in the system
- Rating the security level of remaining connections and improving with a
  methods
- Hardening the system by removing or deactivating all unused p
  communication ports and services
- Checking that the security system has backups available from all appli
- Collecting and storing backups of the system components and keeping
  to-date
- Changing default passwords and using strong enough passwords
- Separating public network from automation network
- Segmenting traffic and networks
- Using firewalls and demilitarized zones
- Assessing the system periodically
- Using antivirus software in devices that are used to access the device and
  those up-to-date
- Using malware prevention tools on devices used to access the device

It is important to utilize the defence-in-depth concept when designing automatio
security. It is not recommended to connect a device directly to the Internet w
adequate additional security components. The different layers and interfaces in
should use security controls. Robust security means, besides product features,
and using the available features and also enforcing their use by company p
Adequate training is also needed for the personnel accessing and using the system.

7.3.2 TCP/IP based protocols and used IP ports

The EAGLE Single phase recloser supports Wifi over HTTPS protocol and supports
station mode over MQTT protocol. CIM605 Gateway is communicating with EA
MQTT. Following table lists the supported ports in the EAGLE device.

Table 12 Supported communication ports

Port number	Type	Default state	Descriptio
443	TCP	Open (Max data transfer rate of 11 Mbps)	Web server
1883	MQTT	Open	MQTT brok

Information!

1. The default password for connecting to the device on HTTPS protoc

8 Appendix

8.3 Appendix 1: Curve file format

The Over Current Protection Functions, 51P1, 51P-2 & 51P-4, have different types c
like DT and IDMT. All the curves are user programmable. User has the possibility to desig
select up to 20 curves for selection in curve selection setting as part of over current prote
settings (Curve).

Update the curve using any notepad software.

All the curves can be updated by file transfer through communication interface. Belo
types of curves supported.

1. DT Curves:

Only Time Setting will be applicable which is present as setting parameter. Once the mea
current is above the pickup value, the protection will trip after the set delay time.

2. Recloser curves:

IEC/ANSI Standard Curves & Recloser Curves i.e. Cooper curves / 'K' & 'T' series fuse cu
work based on this formula.

$$t = \left(\frac{\beta}{\left(\frac{I}{I_{set}} \right)^{\alpha} - n} + \gamma \right) \times K$$

Where:

1. α , β , γ , n are programmable parameters by File
2. I_{set} , K are parameters are available as part of Protection Settings.

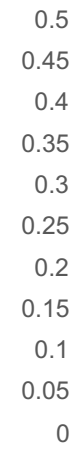
Parameter	Values	Defaul
α	0.02...4.50	2.00
β	0.0086...120.0000	28.200
γ	0.00000...0.7120	0.1217
N	0.0...1.0	1.0

The Curve file needs to be filled with values of these constants before uploading the
the device.

3. Point based curves (user defined characteristics)

User can define maximum of 20 points for the linear current vs timer characteris
can define this points and convert it into file format as specified in below format. Her
current value is the multiple of the pickup value and time is the absolute trip tim
seconds.

No	Current	Time
1	1.000	0.441
2	1.026	0.350
3	1.243	0.200
4	1.500	0.147
5	2.000	0.107
6	2.500	0.091
7	3.000	0.080
8	3.500	0.074
9	4.000	0.069
10	4.500	0.065
11	5.000	0.062
12	6.000	0.058
13	7.000	0.055
14	8.000	0.053
15	9.000	0.052
16	10.000	0.050
17	15.000	0.047
18	20.000	0.045
19	25.000	0.044
20	30.000	0.044



As there are different equations for different curves, users need to select ap
"Function Type" as indicated in below table along with curve parameters

Table 14 Definition for Function Type

Function Type Name	Function Type	Programmable Parame
DT	0	Time will be in Setting pa

Point Based Curve	5	Current(Amp), Time(second)

Table 15 Definition for Curve

Curve definition format

C, Curve Number, User defined Name, Function Type, (either Equation Value Values)

C	- Fixed character to be used at the start of defining new c
(C stands for Curve)	
Curve number	- Curve serial number. It starts from 1 to maximum up to
User defined name	- User defined curve name for the curve under definit
	- Maximum 16 characters allowed. (Ex: Fast Curve)
	- Characters allowed are 'A'-'Z', 'a'-'z', '0'-'9',_, " " (space)
	- For e.g. ANSI_VeryInverse or ANSI VI
Function type	- Function type as per equation required
Values	- Depending upon Function type, either equation param
	current-time coordinates needs to be defined
	- The sequence of parameters should be strictly followed Table 14
	- For point base curves each coordinates should be defi

File Format will be as below. The file will be a .CSV file with name starting with "Curves_xxxx", where xxxx is user defined character up to a maximum of 12 charact The format should not be changed in any case else will result into a file error. The file format should be as follows:

Table 16: Curve file format

Line Number	Comments will start with #
1	*#Fixed Format*
	@HEADER
2	*#File version*
	FV,0,0
3	*#Software version*
	SV,0,0,0
4	*#Fixed Format*
	@PARAMETERS
5	*#Total Number of Curves, Value*

T,4

6 *#C, Curve Number, User defined name, Function Type α, β / Point values*

C,1,FAST_RI,2,3,0.1

- Every Line Ends with CR, LF
- Fixed format ASCII values must be in Capital
- Total number of curves count and number of curves must be same.

Curve parameters validation cases are defined below:

1) Equation Based Curves:

- Number of parameters and sequence of parameters needs to be same as d format else it will result into discarding of file with characteristics error to use request.
- All the parameters pass through range check and if any parameters is out of rang then it will result into discarding of file with characteristic error to user reque

2) Point Based Curves:

- Maximum 20 points for a table is considered
- If points are more than 20 than it will result into error.
- If point is less or points not defined for higher range, then last point values will be considered for remaining points.
- Minimum two point (current & time) value needs to be defined.

Figure 34: Curve data File format

Sr. No.	Event Name	SR No.	Event Name
1	Firmware Update Success	21	Time Set From Web-HMI
2	Firmware Update Failure	22	PORSource LVD
3	Disturbance RecordDelete	23	PORSource PIN
4	Load Profile Delete	24	PORSource WDOG
5	External Event Delete	25	PORSource POR
6	Error File System	26	PORSource POR_LVD
7	Error SRAM	27	PORSource Bootloader
8	Error EEPROM	28	PORSource Wake up
9	Error Calibration	29	PORSource LOC
10	Error Bus Capacitor	30	PORSource JTag
11	Error WiFi Backup Capacitor	31	PORSource Core Lock
12	Error Wifi	32	PORSource SW RST
13	Warning WiFi Backup Capacitor	33	PORSource Debugger
14	Warning NAND Flash	34	PORSource Ezport
15	Warning Watchdog	35	PORSource Peripheral Fail
16	Warning GPS	36	PORSource Temper
17	Time Success	37	PORSource Wifi
18	Time Failure		
19	Time Sync With GPS		
20	Time UnSync		

8.4.2 List of External events

Following list of external events is captured which can be used for diagnostic purpose

Sr. No.	Event Name	Sr. No.	Event name
1	50P ↑	63	Curve Upload Succes
2	50P ↓	64	Curve Validation Fail
3	51P-1 Block ↑	65	Curve Validation Suc
4	51P-1 Block ↓	66	Device Mode Change
5	51P-1 Pickup ↑	67	Device Mode Chang
6	51P-1 Pickup ↓	68	Device Mode Chang
7	51P-1 Trip ↑	69	DR ↑
8	51P-1 Trip ↓	70	DR ↓
9	51P-2 Block ↑	71	Factory Reset
10	51P-2 Block ↓	72	Fault Current Activa

11	51P-2 Pickup ↑	73	Fault Current Activa
12	51P-2 Pickup ↓	74	Gang open comman
13	51P-2 Trip ↑	75	Gang open comman
14	51P-2 Trip ↓	76	Gang open comman
15	51P-3 Block ↑	77	HLT↑
16	51P-3 Block ↓	78	HLT↓
17	51P-3 Pickup ↑	79	Inrush ↑
18	51P-3 Pickup ↓	80	Inrush ↓
19	51P-3 Trip ↑	81	Inter trip command r
20	51P-3 Trip ↓	82	Inter trip command s
21	79 Block ↑	83	Inter trip command s
22	79 Block ↓	84	Iα Close Alarm ↑
23	79 Block Activated by Local	85	Iα Close Alarm ↓
24	79 Block Activated by Remote	86	Iα Open Alarm ↑
25	79 Block Deactivated by Remote	87	Iα Open Alarm ↓
26	79 Block Deactivated by Local	88	KSI Close Alarm ↑
27	79 cycle 1 ↑	89	KSI Close Alarm ↓
28	79 cycle 1 ↓	90	KSI Open Alarm ↑
29	79 cycle 2 ↑	91	KSI Open Alarm ↓
30	79 cycle 2 ↓	92	Load Profile ↑
31	79 cycle 3 ↑	93	Load Profile ↓
32	79 cycle 3 ↓	94	Lockout ↑
33	79 Final trip	95	Lockout ↓
34	79 Final Trip Latch	96	Main Handle Mechar
35	79 Reset	97	MQTT connection Su
36	79 Started	98	MQTT connection Un
37	79 Stopped	99	MQTT send Successfu
38	79 Successful	100	MQTT send Unsucce
39	79 Unsuccessful	101	NRM Local ↑
40	CB Close ↑	102	NRM Local ↓
41	CB Close ↓	103	NRM Mechanical ↑
42	CB Close Local	104	NRM Mechanical ↓
43	CB Close Remote	105	NRM Remote ↑
44	CB Closed	106	NRM Remote ↓
45	CB Closed Mechanical	107	Sectionalizer ↑
46	CB Open ↑	108	Sectionalizer ↓
47	CB Open ↓	109	Sectionalizer count 1
48	CB Open Local	110	Sectionalizer count 2
49	CB Open Mechanical	111	Sectionalizer count 3
50	CB Open Remote	112	Sectionalizer count R
51	CB Opened	113	Sectionalizer mode
52	CLP ↑	114	Sectionalizer mode

54	CLP Reset	116	Setting File change
55	CLP reset via Local	117	Setting Validation Fa
56	CLP reset via Remote	118	Test Mode↑
57	CLP set via Local	119	Test Mode↓
58	CLP set via Remote	120	Unit Ready
59	Configuration File change	121	Wi-Fi ↑
60	Curve File change	122	Wi-Fi ↓
61	Curve Points Not in Ascending Order	123	Wi-Fi Mechanical
62	Curve Upload Failed	124	Wi-Fi Password rese

8.5 List of Security logs

Following list of Security logs are available in the device. Refer Section 4.3.6 for details on Security logs format and how they can be accessed from the device.

Sr. No	User	Security Log Description
1	Operator	User Login
2	Operator	User Logout
3	Operator	Unauthorized Login
4	Operator	User Session Timeout
5	Operator	User mode changed to Local
6	Operator	User mode changed to remote
7	Engineer	User mode changed to Local
8	Engineer	User mode changed to remote
9	Engineer	User Login
10	Engineer	User Logout
11	Engineer	Unauthorized Login
12	Engineer	Config or Setting Change
13	Engineer	User Session Timeout
14	Admin	User mode changed to Remote
15	Admin	User mode changed to Local
16	Admin	Device Admin Password Change
17	Admin	AP to Station mode switching using WEBHMI
18	Admin	Station mode to AP switching using WEBHMI
19	Admin	User mode changed to Local
20	Admin	User mode changed to remote
21	Admin	Device Admin Password Change
22	Admin	Station to AP mode switching using WebHMI
23	Admin	AP to Station mode switching using WebHMI
24	Admin	User Login
25	Admin	User Logout
26	Admin	Config or Setting Change

27	Admin	Unauthorized Login
28	Admin	User Session Timeout
29	Admin	Operator Password Change
30	Admin	Engineer Password Change
31	Admin	Admin Password Change
32	Admin	Password Reset
33	Admin	Temporary Admin Access Enabled
34	Admin	Temporary Admin Access disabled
35	Admin	Firmware Update
36	Device Admin	User Logout
37	DeviceAdmin	User login
38	DeviceAdmin	User Session Timeout
39	No User	Failed to connect to router
40	No User	Station mode to AP switching using LightGuide
41	No User	AP to Station Mode switching using LightGuide
42	No User	Station mode to AP switching using NRM
43	No User	AP to Station Mode switching using NRM
44	No User	Failed connected to router
45	No User	Connection time out station to AP mode switching
46	No User	Station to AP mode switching using NRM
47	No User	AP to Station mode switching using NRM
48	No User	Station to AP mode switching using light Guide
49	No User	AP to Station mode switching using light Guide
50	No User	Config/ Setting change
51	No User	Wifi Enable Using Non Reclose Mode
52	No User	Wifi Password Reset Using Non Reclose Mode
53	No User	Wifi Password Reset Using Light Pattern
54	No User	Wifi Enable Using Light Pattern
55	No User	Wifi Enable
56	No User	Wifi Enable Failed
57	No User	Wifi Cannot Enable
58	No User	Wifi Already Enabled
59	No User	Wifi Client Connected
60	No User	Wifi Password Reset
61	No User	Wifi Password Reset Failed
62	No User	Factory Reset
63	No User	Connection timeout, Station to AP mode switching