Report for IEEE RODE Discussion Group on Automatic Circuit Recloser Interfaces

March 29, 2022

Introduction

IEEE RODE Discussion Group on Automatic Circuit Recloser Interfaces met six times and minutes were produced for all meetings:

- Fall 2017 (October 11, 2017) Portland, Maine
- Spring 2018 (April 23, 2018) Orlando, Florida
- Fall 2018 (October 17, 2018) Kansas City, Missouri
- Fall 2019 (October 7, 2019) San Diego, California
- Spring 2021 (April 20, 2021) online
- Fall 2021 (October 12, 2021) online

It started out as a Task Force, but then was changed to a more informal Discussion Group, as a Task Force has only a one-year life.

This report includes:

- Scope review
- Details of existing, known recloser interfaces in North America
- Details of consensus on the definition of 69a and 69b contacts
- Summary of pros and cons of going to a common recloser interface and other considerations.
- Looking toward the next step of producing a technical paper on the consideration of a common recloser interface.
- Emails of Chris Ambrose (Elecro-Mechanical Corp.) and Ian Rokser (Eaton), in that they provided written feedback (initially requested of all) to the Fall 2019 meeting questions:
    - Why move to a common recloser interface?
    - What are we giving up by going to such a common interface?

  Chris and Ian's feedback (in Annex 3 and Annex 4, respectively) was well thought out and spurred good discussion at the Spring 2021 meeting that contributed much to the substance of this report.

Scope

Following is the latest scope from the Fall 2018 meeting minutes. It was revised per input from the initial meeting (Fall 2017), where mention was made to have it also encompass power system voltages [including low-energy analog (LEA) devices] and input power:

> This discussion group is set up to consider interfaces between the control unit and switching device of an automatic circuit recloser (three-phase units, including those with single-phase operation capability). It will look at existing, in-service interfaces and document their signals, for ease of comparison and to understand "where we have been" as an industry. Interface considerations are not constrained to just one entrance on the control unit, nor to just signals originating within the switching device (e.g., voltage sensors can be installed without the switching device and their signals brought into the control unit). The total interface can include traditional signals (trip/close, system current, open/closed status, and yellow handle status), system voltages (traditional and low-level sensor outputs), input power to the control unit, and other signals. Communications interfaces will not be considered. The discussion group will produce a report of its findings and summarize what future common interface work should be done, if any.

Existing, Known Recloser Interfaces in North America

An initial focus of the discussion group was to address the first part of the scope:

> … look at existing, in-service interfaces and document their signals, for ease of comparison and to understand "where we have been" as an industry.

Annex 1 contains this information, describing parameters of existing, known recloser interfaces in North America:

- pin/signal functions
- dc voltage level
- first manufacturer to offer said interface
- short summary of unique, distinguishing characteristics

In general, the newer interface, the more pins/signals it has. Manufacturers were asked to provide feedback/corrections/clarifications to the listed information.

In Annex 2 is a comparison of common and redundant pins/signals for triple-single reclosers, which are the newer offerings (with the most pins/signals) listed in Annex 1. The apparent commonality (for the five recloser interfaces with the most pins/signals) is the nominal 155 Vdc trip/close voltage.

Consensus on the Definition of 69a and 69b Contacts

From discussion group conversation, the following were agreed upon definitions/drawing portrayals of 69a and 69b contacts:

- A 69a contact physically opens (and remains open) when the corresponding manual operating lever on the recloser is pulled to the lock-open position. A 69a contact is physically closed when the manual operating lever is in the opposite (reset) position. Drawing portrayal of a 69a

contact is an open contact, like the drawing portrayal of a traditional 52a (circuit breaker auxiliary "a") contact.
- A 69b contact physically closes (and remains closed) when the corresponding manual operating lever on the recloser is pulled to the lock-open position. A 69b contact is physically open when the manual operating lever is in the opposite (reset) position. Drawing portrayal of a 69b contact is an open contact with a diagonal slash through it, like the drawing portrayal of a traditional 52b (circuit breaker auxiliary "b") contact.

69a contacts are often embedded in the trip/close circuitry of reclosers to prevent further recloser operation after the manual operating lever is pulled to the lock-open position. The 69a contact creates an open circuit (for the lock-open position) and commands from the recloser control (via the recloser interface) cannot get through to cause a recloser operation. At the very least, any type of close operation is effectively blocked.

69b contacts are often connected from the recloser to the recloser control (via the recloser interface) to signal to the recloser control that the manual operating lever is in the lock-open position.

The following references were used in deriving the preceding 69a and 69b contact definitions.

- In IEC 62271-111 / IEEE Std C37.60-2018 "Automatic circuit reclosers for alternating current systems up to and including 38 kV," subclause 6.7 "Independent unlatched operation (independent manual or power operation)," reference is made to "a manual operating lever to open the recloser." This lever is variously referred to as a "yellow handle" or "yellow operating handle" (amongst other designations) in recloser (and recloser control) instruction manuals/literature. For consistency with IEEE Std C37.60-2018, "manual operating lever" is used in the preceding 69a and 69b contact definitions.
- IEEE Std C37.2-2008 "IEEE Standard Electrical Power System Device Function Numbers, Acronyms, and Contact Designations" provides the following definitions which were used to derive the preceding 69a and 69b contact definitions:
    - subclause 3.1.69 "Device number 69 – permissive control device"
    - subclause 4.1 "Auxiliary, position, and limit switch contacts" - provides the definitions of "a" and "b" contacts (corresponding to 69a and 69b, respectively)

Note: In most implementations of manual operating levers on reclosers, the pulling of the lever to the lock-open position also causes the recloser to open its main contacts. But the subsequent return of the manual operating lever to the opposite (reset) position does not cause the recloser to close its main contacts (they remain open). The recloser main contacts are then closed by command issued from the recloser control.

Question: Should these manual operating lever, 69a contact, and 69b contact details be more clearly discussed/documented in a future revision of IEC 62271-111 / IEEE Std C37.60-2018, subclause 6.7 "Independent unlatched operation (independent manual or power operation)"?

Pros and Cons of going to a Common Recloser Interface

Pros:

- Having complimentary/opposing signals (e.g., 52a and 52b) available provides "intermediate position" information and greater opportunity to alarm for failure modes (e.g., disconnected cable), as "a" and "b" contacts are expected to be in different states for steady state conditions.
- Other possible signals/alarms can be accommodated: loss of vacuum, trip/close circuit continuity, loss of SF6, and other future diagnostics alarms from the recloser.
- The obvious, overriding convenience of "any recloser can connect to any control." Utility comment that for a common recloser interface to realistically work, they would need the minimum available choice of 2 recloser controls and 2 reclosers (all, of course, interchangeable) that adhere to such a standard.
- Reduced training and maintenance expenses as there are fewer equipment operational differences.

Cons:

- Doesn't guarantee "plug and play" (e.g., variation in trip and close pulse durations). This puts greater responsibility on utilities to make necessary setting adjustments, etc.
- Low-level signals [e.g., low-energy analogs (LEA's)] require that signal quality/noise be handled well. A common recloser interface may not be attuned to such particulars.
- If a common recloser interface is seen as "mandatory," then "winners and losers" can result for both vendors and utilities (e.g., going to a possibly higher cost platform).
- Innovation can be stifled (e.g., not being able to use a different, improved connector for particular environmental concerns).
- Cooperation between vendors on the recloser and recloser control sides is essential (not optional) to make a common recloser interface a success. Such cooperation would need to handle such things as the preceding mentioned variation in trip and close pulse durations.
- Existing common interfaces in other equipment have seen slow adoption and are more costly (than existing interfaces) due to lack of use (e.g., "universal interface" in clause 11 of IEC 60076-21/IEEE Std C57.15-2017 "Standard requirements, terminology, and test code for step-voltage regulators").

"You Can't Predict the Future" vs. "Plan for the Future"

If a common recloser interface is settled on, two distinct philosophies/approaches rather manifest themselves:

- every pin on the interface should have a defined function and be used only for that function (any unused pins are left unused).

vs.

- there should be extra pins for future functions.

Additional thoughts concerning extra pins and "the future":

- if extra pins are set aside for the future … then when "the future arrives," past intended ideas are not workable anyway (thus negating the "good intentions" of the extra pins) … you can't predict the future!
- extra pins can end up being used for applications that were originally unforeseen and this can cause problems in that various installations become "uncommon."
- if a pin isn't used in a certain installation (and each pin has a defined function), leave it unused … don't use it for some other function, as that defeats the intention of a common interface and can cause problems.

Important Hardware Considerations for any Recloser Interface

- "Scoop-proof" connectors prevent pins from inadvertently touching outer shells of mating connectors as well as preventing non-assigned pins/receptacles from coming in contact with each other.
- Correct seal placement in a connector is important for keeping out moisture.
- Because of various signal magnitude ranges, it is not desirable to have all signals in the same entrance on the control unit (e.g., nominal 120 Vac input power is substantially higher in magnitude than other relatively low-level voltage signals). Shielding should be looked at where such close-proximity signal disparities can't be avoided.
- IEEE 789-2013 "Standard Performance Requirements for Communications and Control Cables for Application in High-Voltage Environments" may very well have significant applicability to a common recloser interface (e.g., subclause 10.5.4 Crosstalk).

Beyond Pins/Metal

- If it can be communicated in a digital format, then it doesn't need to be "pin/metal."
- Only items involved with power transfer need "pin/metal" connection (e.g., power supply input; energy to trip/close the actual recloser).
- There are substation standards for non-metallic communication (e.g., IEC 61850-9-2) involving merging units (MU's) with sampled value (SV) output.
- If the common recloser interface is non-metallic (e.g., fiber), then future innovation (e.g., previously discussed future diagnostics alarms from the recloser) is possibly easier (just send a firmware upgrade). But, this rather implies electronics/"smarts" at both ends (recloser and recloser control) of the non-metallic communication link – both need firmware upgrades.
- Additionally, the power to operate the recloser may come more locally (e.g., from the top of the pole) and not via a cable from the recloser control.

Next Step: Technical Paper

Consensus from the Fall 2021 meeting was that a technical paper should be written on the consideration of a common recloser interface, looking more into depth on previously listed items (and other challenging issues) such as:

- How signal quality/noise can be handled well
- Applicability of existing standards (e.g., IEEE 789-2013 "Standard Performance Requirements for Communications and Control Cables for Application in High-Voltage Environments")
- Existing substation standards/practices that may be applicable "outside the fence" [e.g., non-metallic communication (e.g., IEC 61850-9-2) involving merging units (MU's) with sampled value (SV) output]

Annex 1

Following are a listing of existing, known recloser interfaces in North America.

The following recloser interface listing is ascending in number of pins (from 14 to 42). Often, more than one vendor uses the interface – first vendor to offer the interface is listed.
Please provide feedback / corrections / clarifications.

14-pin Recloser Interface (Eaton)
The de facto standard for decades. 24 Vdc trip and close "get things going."
Separate "low-voltage" close cable brings 120 Vac to recloser to provide close power for main contacts and wind the tripping springs. Different recloser versions use primary voltage to provide close power.

Pin # / letter	**Function**	**Description / comments**
A	power	24 Vdc power for trip and close circuit
B	status	Monitored trip circuit point, between trip coil (-) and 52a (+)
C	trip/status	Monitored trip circuit point, between 52a (-) and control trip output
D	status	Paralleled with Pin B
E	close/status	Monitored close circuit point, between close coil (-) and control close output
F	status	Monitored close circuit point, between close coil (+) and 69 (yellow handle) contact (-)
G	current	Phase 1 current
H	current	Phase 2 current
J	current	Phase 3 current
K	current	Residual current return; connected to ground at bottom of control cabinet
L	ground	connected to ground at bottom of control cabinet
M	ground	Connection to recloser tank; connected to ground at bottom of control cabinet
N	none	Not connected
P	none	Not connected

In some traditional reclosers (14-pin), an accessory battery-charging current transformer was connected to pins K and L – coming effectively shorted out in a standard configuration (pins K and L both connected to ground at bottom of control cabinet.

19-pin Recloser Interface (Eaton)

Trip/close power (53 Vdc) brought into recloser via control cable (no extra "low-voltage" close cable needed). Energy storage in recloser.

120 Vac (for recloser heater) brought into recloser via control cable.

LEA (low-energy analog) voltages can be brought in via separate cable. Exclusively resistive divider?

Pin # / letter	**Function**	**Description / comments**
A		
B		
C	trip/status	Monitored trip circuit point, between 52a (-) and control trip output
D		connected to ground at bottom of control cabinet
E	close/status	Monitored close circuit point, between 52b (-) and control close output
F	enable	VTC interface
G	current	Phase 1 current
H	current	Phase 2 current
J	current	Phase 3 current
K	current	Residual current return; connected to ground at bottom of control cabinet
L	power	Return for 53 Vdc power; connected to ground at bottom of control cabinet
M	ground	Connection to recloser tank; connected to ground at bottom of control cabinet
N	power	Return for 53 Vdc power; connected to ground at bottom of control cabinet
P		connected to ground at bottom of control cabinet
R	power	53 Vdc power for trip and close circuit
S	power	53 Vdc power for trip and close circuit
T	power	53 Vdc power for trip and close circuit
U	power	120 Vac power (H) for recloser heater
V	power	120 Vac power (N) for recloser heater

24-pin Recloser Interface (ABB)
Triple-single capability (53 Vdc). “H-bridge” trip/close circuits.
120 Vac (for recloser heater) brought into recloser via control cable.
LEA (low-energy analog) voltages brought in via control cable. Exclusively capacitive divider?

Pin # / letter	**Function**	**Description / comments**
1	power	120 Vac power (H) for recloser heater
2	voltage	Source-side phase 2 LEA voltage
3	voltage	Source-side LEA voltage wye neutral point; connected to ground at bottom of control cabinet
4	status	69b (yellow handle) contact
5	status	52a-1 contact
6	status	52b-2 contact
7	whetting voltage	12 Vdc whetting voltage for 52a, 52b, and 69 (yellow handle) contacts
8	trip/close	Trip-3 (+), Close-3 (-)
9	trip/close	Trip-2 (+), Close-2 (-)
10	trip/close	Trip-1 (+), Close-1 (-)
11	current	Phase 2 current
12	current	Residual current return; connected to ground at bottom of control cabinet
13	power	120 Vac power (N) for recloser heater
14	voltage	Source-side phase 3 LEA voltage
15	voltage	Source-side phase 1 LEA voltage
16	status	52a-2 contact
17	status	52a-3 contact
18	status	52b-3 contact
19	status	52b-1 contact
20	trip/close	Close-3 (+), Trip-3 (-)
21	trip/close	Close-2 (+), Trip-2 (-)
22	trip/close	Close-1 (+), Trip-1 (-)
23	current	Phase 3 current
24	current	Phase 1 current

26-pin Recloser Interface (Eaton)

Triple-single capability (53 Vdc). Separate trip and close circuits for each phase.

LEA (low-energy analog) voltages brought in via control cable. Exclusively resistive divider?

Pin # / letter	Function	Description / comments
A	power	53 Vdc power for trip and close circuit 1
B	power	53 Vdc power for trip and close circuit 2
C	power	53 Vdc power for trip and close circuit 3
D	whetting voltage	12 Vdc whetting voltage for 69 (yellow handle) contacts
E	trip/status	Monitored trip circuit point, between 52a-1 (-) and control trip output
F	trip/status	Monitored trip circuit point, between 52a-2 (-) and control trip output
G	trip/status	Monitored trip circuit point, between 52a-3 (-) and control trip output
H	close/status	Monitored close circuit point, between 52b-1 (-) and control close output
J	close/status	Monitored close circuit point, between 52b-2 (-) and control close output
K	close/status	Monitored close circuit point, between 52b-3 (-) and control close output
L	whetting voltage	Return for 12 Vdc whetting voltage for 69 (yellow handle) contacts
M	ground	Connection to recloser tank; connected to ground at bottom of control cabinet
N	power	Return for 53 Vdc power for trip and close circuit 1; connected to ground at bottom of control cabinet
P	power	Return for 53 Vdc power for trip and close circuit 2; connected to ground at bottom of control cabinet
R	power	Return for 53 Vdc power for trip and close circuit 3; connected to ground at bottom of control cabinet
S	status	69-1 (yellow handle) contact
T	status	69-2 (yellow handle) contact
U	status	69-3 (yellow handle) contact
V	current	Phase 1 current
W	current	Phase 2 current
X	current	Phase 3 current
Y	current	Residual current return; connected to ground at bottom of control cabinet
Z	voltage	Source-side phase 3 LEA voltage
a	voltage	Source-side phase 1 LEA voltage
b	voltage	Source-side phase 2 LEA voltage
d		

27-pin Recloser Interface (Joslyn)

Triple-single capability (155 Vdc). Separate trip and close circuits for each phase.
Each phase current has both leads brought out.

Pin # / letter	Function	Description / comments
A	close	Close-1
C	close	Close-1 return; connected to ground at bottom of control cabinet
D	close	Close-2
E	close	Close-2 return; connected to ground at bottom of control cabinet
F	close	Close-3
G	close	Close-3 return; connected to ground at bottom of control cabinet
H	trip	Trip-1
I	trip	Trip-1 return; connected to ground at bottom of control cabinet
J	trip	Trip-2
K	trip	Trip-3
L	trip	Trip-3 return; connected to ground at bottom of control cabinet
M	current	Phase 1 current return
N	current	Phase 1 current
R	current	Phase 2 current return
S	trip	Trip-2 return; connected to ground at bottom of control cabinet
T	current	Phase 3 current return
U	current	Phase 3 current
V	status	69a (yellow handle) contact
W	status	52a-1 contact
X	current	Phase 2 current
Y	whetting voltage	12 Vdc whetting voltage for 52a and 69 (yellow handle) contacts
Z	status	52a-2 contact
a	status	52a-3 contact
b		
c		
d		
e		

32-pin Recloser Interface (G&W Electric)
Triple-single capability (155 Vdc). "H-bridge" trip/close circuits.
LEA (low-energy analog) voltages brought in via control cable (optionally from both sides). Exclusively capacitive divider? Resistive divider LEAs for Elastimold.
Per-phase 69b contacts combined in parallel and then brought into interface wiring.

Pin # / letter	Function	Description / comments
A	current	Phase 1 current
B	current	Phase 2 current
C	current	Phase 3 current
D	current	Residual current return
E		
F	whetting voltage	12 Vdc whetting voltage for 52a and 69 (yellow handle) contacts
G	ground	Connection to recloser tank and residual current return circuit; connected to ground at bottom of control cabinet
H		
J	voltage	Load-side phase 1 LEA voltage
K	voltage	Load-side phase 2 LEA voltage
L	voltage	Load-side phase 3 LEA voltage
M	voltage	Load-side LEA voltage wye neutral point
N	voltage	Source-side phase 1 LEA voltage
P	voltage	Source-side phase 2 LEA voltage
R	voltage	Source-side phase 3 LEA voltage
S	voltage	Source-side LEA voltage wye neutral point
T		
U	status	52a-1 contact
V	status	52a-2 contact
W	status	52a-3 contact
X	status	Paralleled 69b-1, 69b-2, and 69b-3 (yellow handle) contacts
Y	trip/close	Close-1 (+), Trip-1 (-)
Z	trip/close	Trip-1 (+), Close-1 (-)
a		
b		
c		
d		
e		
f	trip/close	Close-2 (+), Trip-2 (-)
g	trip/close	Trip-2 (+), Close-2 (-)
h	trip/close	Close-3 (+), Trip-3 (-)
j	trip/close	Trip-3 (+), Close-3 (-)

32-pin Recloser Interface - Rectangular (Tavrida)
Not triple-single capable (155 Vdc). "H-bridge" trip/close circuits paralleled into one trip/close input on Tavrida recloser.
LEA (low-energy analog) voltages brought in via control cable from both sides. Capacitive divider with bottom capacitor on terminal block inside control enclosure.
Pins 4, 8, 22, 23, 24, 30, 31, and 32 are all connected together via a terminal block inside the enclosure.
It has a separate circuit (not part of the recloser interface) that detects 69 (yellow handle) contact operation in the trip/close circuit.

Pin # / letter	**Function**	**Description / comments**
1	trip/close	Close (+), Trip (-)
2		
3	trip/close	Trip (+), Close (-)
4	ground	connected to ground at bottom of control cabinet
5	status	52b-1 contact
6		
7	whetting voltage	12 Vdc whetting voltage for 52b-1 contact
8	ground	connected to ground at bottom of control cabinet
9	status	52b-2 contact (not connected to control)
10	current	Phase 1 current
11	current	Phase 2 current
12	current	Phase 3 current
13	status	52b-2 contact (not connected to control)
14	current	Residual current return
15		
16		
17	status	52b-3 contact (not connected to control)
18	voltage	Source-side phase 1 LEA voltage
19	voltage	Source-side phase 2 LEA voltage
20	voltage	Source-side phase 3 LEA voltage
21	status	52b-3 contact (not connected to control)
22	voltage	Source-side phase 1 LEA voltage neutral point
23	voltage	Source-side phase 2 LEA voltage neutral point
24	voltage	Source-side phase 3 LEA voltage neutral point
25	status	52a contact (not connected to control)
26	voltage	Load-side phase 1 LEA voltage
27	voltage	Load-side phase 2 LEA voltage
28	voltage	Load-side phase 3 LEA voltage
29	status	52a contact (not connected to control)
30	voltage	Load-side phase 1 LEA voltage neutral point
31	voltage	Load-side phase 2 LEA voltage neutral point
32	voltage	Load-side phase 3 LEA voltage neutral point

37-pin Recloser Interface (Eaton)

Triple-single capability (constant voltage or constant current operation). “H-bridge” trip/close circuits.
LEA (low-energy analog) voltages brought in via control cable. LEA power supply circuit included.
52b contacts brought in for each phase, in addition to 52a contacts for each phase.
69 contacts brought in per-phase and combined.

Pin # / letter	Function	Description / comments
A	current	Phase 1 current
B	current	Phase 2 current
C	current	Phase 3 current
D	current	Residual current return
E	ground	Connection to recloser tank (on recloser tank side); connected to ground at bottom of control cabinet
F	trip/close	Close-1 (+), Trip-1 (-) (Constant current)
G	trip/close	Alt. Close-1 (+), Trip-1 (-) (Constant voltage)
H	trip/close	Trip-1 (+), Close-1 (-)
J	trip/close	Close-2 (+), Trip-2 (-) (Constant current)
K	trip/close	Alt. Close-2 (+), Trip-2 (-) (Constant voltage)
L	trip/close	Trip-2 (+), Close-2 (-)
M	trip/close	Close-3 (+), Trip-3 (-) (Constant current)
N	trip/close	Alt. Close-3 (+), Trip-3 (-) (Constant voltage)
P	trip/close	Trip-3 (+), Close-3 (-)
R	power	12 Vdc (+) power for LEA power supply
S	power	12 Vdc (-) power for LEA power supply
T	ground	Ground
U	status	Paralleled 69b-1, 69b-2, and 69b-3 (yellow handle) contacts
V	whetting voltage	12 Vdc whetting voltage for 52a, 52b, and 69 (yellow handle) contacts
W	status	52a-1 contact
X	status	52a-2 contact
Y	status	52a-3 contact
Z	status	52b-1 contact
a	status	52b-2 contact
b	status	52b-3 contact
c	status	69a-1 (yellow handle) contact
d	status	69a-2 (yellow handle) contact
e	status	69a-3 (yellow handle) contact
f	ground	LEA voltage sensor shield
g	voltage	LEA voltage neutral point
h	voltage	Source-side phase 1 LEA voltage
k	voltage	Source-side phase 2 LEA voltage
m	voltage	Source-side phase 3 LEA voltage
n	voltage	Load-side phase 1 LEA voltage
p	voltage	Load-side phase 2 LEA voltage
q	voltage	Load-side phase 3 LEA voltage
r	voltage	LEA voltage neutral point

40-pin Recloser Interface (Siemens)   pins D1 through D10 not used
Triple-single capability (155 Vdc). "H-bridge" trip/close circuits.
120 Vac (for recloser heater) brought into recloser via control cable.
Each phase current has both leads brought out.
LEA (low-energy analog) voltages brought in via separate cable. Exclusively resistive divider?

Pin # / letter	**Function**	**Description / comments**
A1	current	Phase 1 current
A2	current	Phase 1 current return
A3		
A4	status	69b-1 (yellow handle) contact
A5	status	52a-1 contact
A6	status	52b-1 contact
A7	whetting voltage	12 Vdc whetting voltage for 52a-1, 52b-1, and 69-1 (yellow handle) contacts
A8	power	120 Vac power (N) for recloser heater
A9	trip/close	Trip-1 (+), Close-1 (-)
A10	trip/close	Close-1 (+), Trip-1 (-)
B1	current	Phase 2 current
B2	current	Phase 2 current return
B3		
B4	status	69b-2 (yellow handle) contact
B5	status	52a-2 contact
B6	status	52b-2 contact
B7	whetting voltage	12 Vdc whetting voltage for 52a-2, 52b-2, and 69-2 (yellow handle) contacts
B8		
B9	trip/close	Trip-2 (+), Close-2 (-)
B10	trip/close	Close-2 (+), Trip-2 (-)
C1	current	Phase 3 current
C2	current	Phase 3 current return
C3		
C4	status	69b-3 (yellow handle) contact
C5	status	52a-3 contact
C6	status	52b-3 contact
C7	whetting voltage	12 Vdc whetting voltage for 52a-3, 52b-3, and 69-3 (yellow handle) contacts
C8	power	120 Vac power (H) for recloser heater
C9	trip/close	Trip-3 (+), Close-3 (-)
C10	trip/close	Close-3 (+), Trip-3 (-)

42-pin Recloser Interface

Rather an extension of 32-pin interface (G&W Electric), with the following additions:
LEA voltage neutral points brought in separately for each phase. LEA power supply circuit included.
52b contacts brought in for each phase, in addition to 52a contacts for each phase.
Per-phase 69b contacts combined in parallel and then brought into interface wiring.
Existing 32-pin reclosers can work with 42-pin control via adapter cable.

Pin # / letter	Function	Description / comments
1	status	52a-3 contact
2	trip/close	Close-1 (+), Trip-1 (-)
3	trip/close	Trip-1 (+), Close-1 (-)
4	trip/close	Close-2 (+), Trip-2 (-)
5	trip/close	Trip-2 (+), Close-2 (-)
6	trip/close	Close-3 (+), Trip-3 (-)
7	trip/close	Trip-3 (+), Close-3 (-)
8	status	52a-2 contact
9	status	52a-1 contact
10		
11	power	12 Vdc (+) power for LEA power supply
12	power	12 Vdc (-) power for LEA power supply
13		
14		
15	status	Paralleled 69b-1, 69b-2, and 69b-3 (yellow handle) contacts
16	status	52b-3 contact
17	status	52b-2 contact
18		
19		
20		
21	current	Phase 1 current
22	status	52b-1 contact
23		
24		
25	ground	Connection to recloser tank and residual current return circuit (on recloser tank side); connected to ground at bottom of control cabinet
26		
27	current	Residual current return
28	current	Phase 2 current
29	whetting voltage	12 Vdc whetting voltage for 52a, 52b, and 69 (yellow handle) contacts
30	voltage	Load-side phase 1 LEA voltage neutral point
31	voltage	Load-side phase 2 LEA voltage neutral point
32	voltage	Load-side phase 3 LEA voltage neutral point
33	voltage	Source-side phase 2 LEA voltage neutral point
34	voltage	Source-side phase 3 LEA voltage neutral point
35	current	Phase 3 current
36	voltage	Load-side phase 1 LEA voltage
37	voltage	Load-side phase 2 LEA voltage
38	voltage	Load-side phase 3 LEA voltage
39	voltage	Source-side phase 1 LEA voltage neutral point
40	voltage	Source-side phase 1 LEA voltage

41	voltage	Source-side phase 2 LEA voltage
42	voltage	Source-side phase 3 LEA voltage

Notes:

10-23-2018: corrected last five pins of 27-pin Recloser Interface (Joslyn) … made them lower-case letters (a, b, c, d, e).

10-02-2019: clarified that certain “69” contacts are “69b” contacts in 24-pin, 32-pin (G&W et al), 40-pin, and 42-pin interfaces. Clarified that “69” contact is a “69a” contact in 27-pin interface. Added following “Common and redundant signals/pins for triple-single reclosers” table.

Annex 2

Common and redundant signals/pins for triple-single reclosers

feature	24-pin (ABB)	26-pin (Eaton)	27-pin (Joslyn)	32-pin (G&W et al)	37-pin (Eaton)	40-pin (Siemens)	42-pin (G&W et al)
4-wire current	X	X		X	X		X
6-wire current			X			X	
3 – 52a	X	X (1)	X	X	X	X	X
3 – 52b	X	X (1)			X	X	X
3 – 69a					X		
3 – 69b		X (2)				X	
1 – 69a			X				X (3)
1 – 69b	X						
1 – three parallel 69b's				X	X		X (3)
1 – Vdc whetting	X	X	X	X	X		X
3 – Vdc whetting						X	
1 – Ground		X		X	X		X
2-wire heater Vac power	X					X	
2-wire LEA Vdc power					X		X
4-wire LEA (source side)	X			X	X		X
3-wire LEA (source side)		X					
4-wire LEA (load side)				X	X		X
1 – LEA shield					X		
6-wire H-bridge trip/close	X			X	X	X	X
3-wire alternate trip/close					X		
Trip/close Vdc	53	53	155	155	155	155	155
Redundant signals/pins (?)		Trip/close power and return (4)	Current returns (5); Trip/close return (4)	LEA neutral (6)	LEA neutral (6); two Ground wires	Current returns (5); Vdc whetting	LEA neutral (three each side, source and load)

(1): 52a and 52b contacts embedded in trip and close circuits, respectively.

(2): 69a contacts embedded in yellow lockout handle circuitry, producing effective 69b behavior.

(3): single 69a contact for Tavrida OSMAl_4; three parallel 69b's for other reclosers

(4): probably needed for trip/close current ampacity
(5): function of 6-wire current (two wires each phase)
(6): wiring convenience for 4-wire LEA (separate source and load neutral connections at control)

Annex 3

Chris Ambrose (Electro-Mechanical Corp.) January 2, 2020 email

1) Why move to a common recloser interface?

The advantage of a common interface between the "interrupter section" and the "control section" is that this would allow more "plug and play" modularity, allowing replacement and/or upgrades of specific modules within the "recloser system", without the need to replace the entire recloser "system". This would also allow components from various manufacturers to be seamlessly integrated into the "reclose systems".

This, to me, would be bringing our interface technology up to at least the 1990's technology level of the PC world with the introduction of the USB connections, and the subsequent upgrades since.

The following (through below Figure 1) is taken from: A Technical Introduction to USB 2.0
https://www.usb.org/sites/default/files/usb_20g.pdf

Historical Perspective– Universal Serial Bus

The Universal Serial Bus was originally developed in 1995 by many of the same industry leading companies currently working on USB 2.0. The major goal of USB was to define an external expansion bus which makes adding peripherals to a PC as easy as hooking up a telephone to a wall-jack. The program's driving goals were ease-of-use and low cost. These were enabled with an external expansion architecture, as shown in Figure 1, which highlights:

- PC host controller hardware and software,
- robust connectors and cable assemblies,
- peripheral friendly master-slave protocols,
- expandable through multi-port hubs.

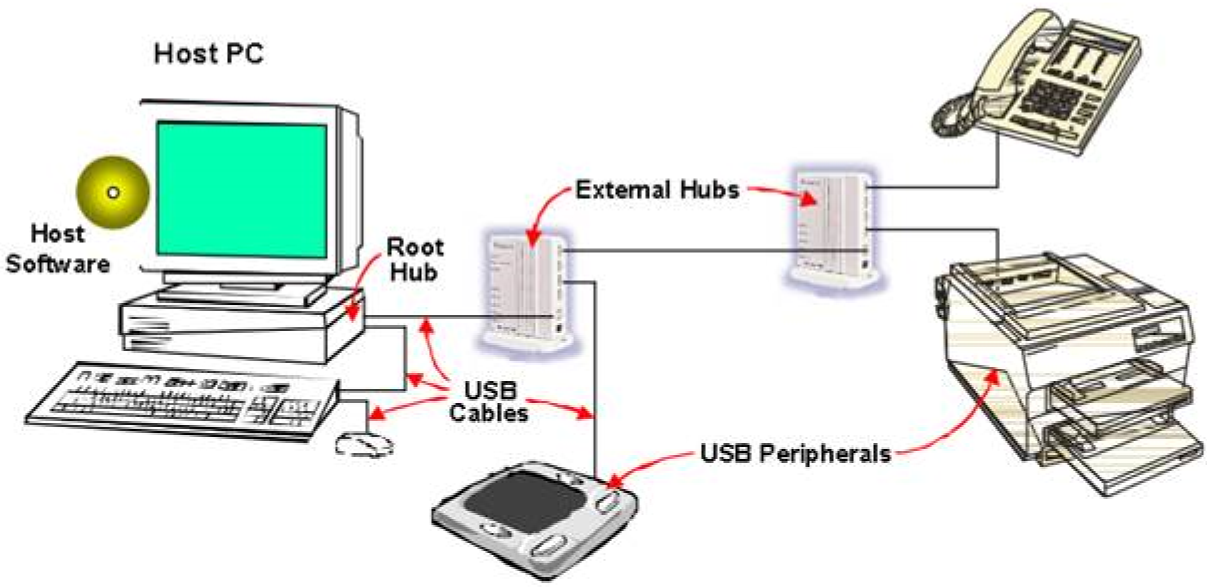

Figure 1. Example USB 1.1 System Configuration

In addition, this would serve to allow technological advances and customizations in each section of the recloser section.

As an ex-user and now a manufacturer of switchgear and components, this seems to be the path forward for the industry.

This would probably also be more adaptable to “smart grid” and other similar “system” topologies.

2) What are we giving up by going to such a common interface?

Perhaps technical advancements in communications.

There may be some “finger pointing” in the event of a malfunction.

As I think about this, rather than worrying about “pins”, the interfaces probably should be USB 3/4 based, with the actual connections between major components be implemented with fiber, due to cable lengths and the various electrical issues that may be involved (ground potential differences, system and induced surges, etc.).

We need to get “out of the weeds” and move away from the pins and multistrand cables.

Annex 4

Ian Rokser (Eaton) **September 28, 2020**
email

1) Why move to a common recloser interface?

- Potentially simplifies standardization across new asset base for some users, though users already can standardize and specify common connectors if this is important to them, thus rendering this point somewhat moot
- Standardizing the interface should ultimately drive the per unit cost of the interface lower
    - Experience in this regard after the creation of the IEEE standard regulator control interface 4 years ago (IEC 60076-21/IEEE Std C57.15-2017, clause 11 Universal interface) is that adoption has been slow and the cost of the standard interface is still higher than individual proprietary interfaces due to lack of use.
- Connector manufacturers will be more responsive to continuous improvement opportunities
- Eliminates ambiguity in signal pin assignments and naming conventions

2) What are we giving up by going to such a common interface?

Technical Concerns

- A common interface will not guarantee interoperability. While the interface is consistent with other recloser control manufacturers, this does not assure full system performance across all suppliers. Each manufacturer may require different voltage and current profiles to properly operate their recloser to satisfy the industry standard requirements. Controls may need to allow for this by way of recloser-specific profiles. Would need to clearly define limitations of interoperability
    - This creates confusion around preexisting IEEE standards mandating packaged certification between reclosers and controls making it appear that un-certified products are compatible
- Manufacturers lose the ability to perform packaged system calibration
- Manufacturers lose the ability to manage the environmental protection offered by the connector interface and optimize the overall design for specific applications, environments, needs, desired outcomes, or preferences of individual customers
- Manufacturers lose the ability to fully control signal crosstalk or implement a preferred shielding philosophy: Ideal design choices may depend on recloser configuration, e.g. resistive vs. capacitive voltage sensors
- Manufacturers lose the ability to adaptively optimize control operation for a specific recloser. The responsibility for ensuring recloser optimization is shifted from the OEM to the user (example: using a “multi-recloser” type control, selecting the correct recloser type in the control software is the user’s responsibility)

Future-Proofing Concerns

- May limit recloser/control functionality that would require different or additional pin configurations, wire gauges, or other features/characteristics
- May reduce recloser/control innovation that benefits users
- Assumes use of existing system construction (power sources, sensing sources, signal transmission methods) to perpetuity

Customer-Facing Concerns

- For utilities that have existing standards and/or large installed bases, changing to a new standard design introduces more variability and may require additional investment
- Limits potential for differentiation or non-standard features

Cost Concerns

- Potentially increases connector costs by driving all applications to higher common denominator with respect to connector specifications

Legal Concerns

- IEEE SA Antitrust policy: A standard cannot specify a manufacturer's product (e.g. Amphenol). It can only specify an interface which is documented as a standard (e.g., SAE AS50551 referenced in aforementioned clause 11 of IEC 60076-21/IEEE Std C57.15-2017) which any manufacturer can choose to meet. This necessitates that the interface chosen to standardize on be known and implemented by connector manufacturers - and that those connectors must be physically compatible with one another. Policy available at:
  https://standards.ieee.org/content/dam/ieee-standards/standards/web/documents/other/antitrust.pdf

Competitive Marketplace Concerns

- Necessitates the selection of one standard that will benefit some manufacturers and users, while having negative impacts on other manufacturers and users