CLAIMS

1. A method for automatic protocol detection of a field device for a process control network in response to the field device being attached to a port of a field switch of the process control network, the field switch comprising a plurality of ports and a plurality of channels, each port being connected to a respective channel, each port being configured to connect a field device to the channel connected to the port, each channel being configurable to transmit data to and from the port connected to the channel, the field switch comprising a set of one or more protocol detection circuits, each protocol detection circuit of the set of one or more protocol detection circuits being compatible with a respective field device protocol different from the field device protocols of the remainder of the set of one or more protocol detection circuits and being capable of transmitting data to and receiving data from the port connected to the channel when connected to the channel, the set of one or more protocol detection circuits not being connected directly to any channel of the plurality of channels at the start of the method, the method comprising the steps of:

(a) in response to attaching a field device to a port of the plurality of ports of the field switch, connecting a first protocol detection circuit of the set of one or more protocol detection circuits to the channel connected to the port while

maintaining the other protocol detection circuits disconnected from the channel;

(b) attempting to communicate with the attached field device through the protocol detection circuit connected to the channel using the protocol of the protocol detection circuit connected to the channel;

(c) if step (b) determines the attached field device is compatible with the protocol of the connected protocol detection circuit, identify the field device as having a protocol associated with the connected protocol detection circuit and then performing steps (d) and (e):

(d) disconnecting the connected protocol detection circuit from the channel; and

(e) ending the method;

(f) if step (b) determines the field device is not compatible with the protocol of the connected protocol detection circuit, proceed with the steps of:

(g) disconnecting the connected protocol detection circuit from the channel;

(h) determining whether there are remaining protocol detection circuits in the set of one or more protocol detection circuits that have not been connected to the channel;

(i) if step (h) determines there are no remaining protocol detection circuits that have not been connected to the channel, performing the steps (j) and (k):

(j) identifying the field device as having an unidentified protocol; and

(k) ending the method; and

(l) if step (h) determines there are one or more protocol detection circuits that have not been connected to the channel, repeating the method starting at step (a) with the next protocol detection circuit of the set of one or more protocol detection circuits that has not been connected to the channel connected to the field device in place of the first protocol detection circuit,

whereby at the end of the method all the protocol detection circuits of the set of one or more protocol detection circuits are disconnected from the plurality of channels.

2. The method of claim 1 wherein step (b) comprises the steps of:

(m) transmitting a command to the field device through the first protocol detection circuit; and

(n) determining whether the field device responded to the command or did not respond to the command.

3. The method of claim 1 wherein the channel connected to the port comprises a power line whereby the connected field device can receive power through the power line when connected to the channel, and step (a) comprises the steps of:

(m) in response to attaching the field device to the port, determining whether the field device is drawing power

through the channel power line before connecting the first protocol circuit to the channel;

(n) if step (m) determines the field device is not drawing power through the channel power line, when performing the method connecting to the channel only those protocol detection circuits of the set of one or more protocol detection circuits that are associated with data-only protocols; and

(o) if step (m) determines the field device is drawing power through the channel power line, when performing the method connecting to the channel only those protocol detection circuits of the set of one or more protocol detection circuits that are associated with data-and-power protocols.

4. The method of claim 1 wherein the channel connected to the port comprises a power line whereby the connected field device can receive power through the power line when connected to the channel, and step (a) comprises the steps of:

(m) in response to attaching the field device to the port, determining whether the field device is drawing power through the channel power line before connecting the first protocol circuit to the channel;

(n) if step (m) determines the field device is not drawing power, opening the channel power line to prevent power from being transmitted through the channel to the field device while the field device is attached to the port.

5. The method of claim 1 wherein the channel connected to the port comprises a power line whereby the connected field device can receive power through the power line when connected to the channel, and step (a) comprises the steps of:

(m) in response to attaching the field device to the port, determining whether the field device is drawing power through the channel power line before connecting the first protocol circuit to the channel;

(n) if step (m) determines the field device is drawing power, limiting the power transmitted through the channel power line to a minimum safe power for protection of the attached field device while attempting to determine the protocol of the field device.

6. The method of claim 5 wherein step (e) comprises the step of:

(o) before ending the method, increasing the power transmitted to the field device to at most the maximum power permitted by the identified protocol.

7. The method of claim 1 wherein the one or more protocol detection circuits are each selectively connectable and dis-connectable with each channel of the plurality of channels, and each protocol detection circuit comprises a normally open first relay, and step (a) comprises the step of:

(m) closing the first relay of the first protocol detection circuit as part of connecting the first protocol detection circuit to the channel connected to the field device; and

step (d) comprises the step of:

(n) opening the first relay closed in step (m) as part of disconnecting the protocol detection circuit attached to the channel from the channel.

8. The method of claim 7 wherein each channel of the plurality of channels is configured to transmit data through the channel compatible with a channel protocol not associated with any protocol detection circuit of the set of one or more protocol detection circuits;

each channel of the plurality of channels comprises a data line being configured to transmit data through the channel using the channel protocol;

the data line of each channel of the plurality of channels comprises a respective second relay in the data line; and

step (a) comprises the steps of:

(o) transmitting data using the channel protocol through the data line of the channel while maintaining the second relay in the data line of the channel in a closed state and all the first relays in the set of one or more protocol detection circuits in an open state to determine whether the field device is compatible with the channel protocol;

(p) if step (o) determines the field device is compatible with the channel protocol, identify the field device as having the channel protocol and terminate step (a) to end the method while maintaining the second relay in the data line of the channel in the closed state;

(q) if step (o) determines the field device is not compatible with the channel protocol, open the second relay in the data line of the channel connected to the field device and maintain the second relay in the opened state throughout the remainder of the method.

9. The method of claim 8 wherein step (e) further comprises, before ending the method, the steps of:

(r) attaching a protocol adapter compatible with the identified protocol in a protocol adapter connecter disposed in the channel, the protocol adapter being configured to translate between the identified protocol and the channel protocol.

10. The method of claim 7 wherein each protocol detection circuit of the set of one or more protocol detection circuits is connected in parallel with each channel of the plurality of channels by a respective channel data line extending from the protocol detection circuit to the channel, each channel data line comprising a normally open respective third relay in the channel data line, and step (a) further comprises the step of:

(o) closing the normally open third relay in the channel data line extending from the common data line to the channel connected to the port as part of connecting the first protocol detection circuit to the channel; and

steps (e) and (k) each comprise the step of:

(p) as part of ending the method, opening the relay closed in step (o) and thereby disconnecting the channel from all the protocol detection circuits of the set of two or more protocol detection circuits.

11. The method of claim 10 wherein the set of one or more protocol detection circuits comprises a set of two or more protocol detection circuits and step (l) comprises the step of:

(q) maintaining the closed third relay in the closed state while repeating the method with the next protocol detection circuit.

12. The method of claim 1 wherein each channel of the plurality of channels is configured to transmit data compatible with a channel protocol not associated with any protocol of the set of one or more protocol detection circuits; and

step (a) comprises the steps of:

(m) before connecting the first protocol detection circuit to the channel, when starting the method, determine whether the field device is compatible with the channel protocol;

(n) if step (m) determines the field device is compatible with the channel protocol, identify the field device as having the channel protocol and terminate step (a) to end the method; and

(o) if step (n) determines the field device is not compatible with the channel protocol, continue with the remainder of step (a) by connecting the first protocol detection circuit with the channel.

13. The method of claim 12 wherein each channel of the plurality of channels comprises a respective protocol adapter connector, the protocol adapter connector being capable of receiving a protocol adapter that, when attached to the protocol adapter connector, converts data transmitted through the protocol adapter connecter between the channel protocol and a field device protocol different than the channel protocol; and

step (e) comprises the step of:

(p) before ending the method, attaching a protocol adapter compatible with the identified field device protocol to the protocol adapter connector of the channel connected to the port.

14. The method of claim 13 wherein the protocol adapter connector of each channel of the plurality of channels normally opens the channel; and

step (a) comprises the step of:

(q) before performing step (m), providing electrical continuity across the protocol adapter connector of the channel connected to the field device.

15. The method of claim 13 wherein:

step (q) comprises attaching a pass-through connector to the protocol adapter connector of the channel connected to the field device, the attached pass-through connector providing channel continuity across the protocol adapter connector; and

step (p) comprises, prior to attaching the protocol adapter to the protocol adapter connector, removing the pass-through connector attached to the protocol adapter connector in step (q) from the protocol adapter connector.

16. The method of claim 14 wherein the field switch comprises a plurality of slots, each slot being open to a respective protocol adapter connector of the plurality of channels to receive a protocol adaptor into the slot;

step (q) comprises attaching a cover to the field switch closing the slot open to the protocol adapter connector of the channel connected to the port, the cover when attached to the field switch providing channel continuity across the protocol adapter connector; and

step (p) comprises removing the cover from the field device to open the slot prior to attaching the protocol adapter to the protocol adapter connector.

17. The method of claim 12 wherein the channel protocol of each channel of the plurality of channels is compatible with the Ethernet Advanced Physical Layer (APL) specification.

18. The method of claim 1 wherein the field switch can transmit power through the plurality of channels to field devices connected to the channels of the plurality of channels, and prior to performing step (a), the method comprises the steps of:

(m) detecting a start of power transmission through a channel of the plurality of channels to detect a field device has been connected to the channel; and

(n) initiating step (a) in response to detecting the connection of the field device to the channel.

19. The method of claims 1-18 wherein the field switch comprises a controller connected to each channel of the plurality of channels and to each protocol detection circuit of the set of one or more protocol detection circuits, the controller being configured to execute stored instructions to perform the method of detecting the protocol of the field device.

20. The method of claim 19 wherein step (c) comprises the controller generating an output signal used to identify to a user of the field switch the identified protocol of the field device.

21. A field switch for connecting a plurality of field devices to a process control network connected to the field switch, the field device capable of identifying the protocol of a field device connected to the field switch, the field switch comprising:

one or more terminals for connecting the field switch to the process control network, the one or more terminals being configured to enable the field switch to receive power into the field switch and to receive data into the field switch and to transmit data from the field switch to the process control network;

a plurality of channels for transmitting data and power between the terminals and field devices connected to the channels, each channel comprising a respective port being configured to connect a field device to the channel, the channel being configurable to transmit data to and from a field device attached to the port;

a set of one or more protocol detection circuits being the sole protocol detection circuits of the field device, each protocol detection circuit of the set of one or more protocol detection circuits being compatible with a respective field device protocol different from the field device protocols of the remainder of the set of one or more protocol detection circuits;

each protocol detection circuit of the set of one or more protocol detection circuits being selectively connectable to each channel of the plurality of channels, the protocol detection circuit being capable of transmitting data to and receiving data from the port connected to the channel using the protocol associated with the protocol detection circuit when connected to the channel;

a controller comprising a microprocessor being configured to execute instructions stored in non-volatile memory for performing protocol detection, the controller being connected to each protocol detection circuit of the set of one or more protocol detection circuits, the controller capable of selectively connecting and disconnecting each protocol detection circuit of the set of protocol detection circuits to each channel of the plurality of the channels; and

the controller being capable of sequentially connecting the protocol detection circuits of the set of one or more protocol detection circuits to a channel of the plurality of channels when a field device is connected to the channel and determining whether or not the protocol of the field device can be identified using the protocol detection circuits of the set of one or more protocol detection circuits; and

the controller being capable of disconnecting all the protocol detection circuits of the set of one or more protocol detection circuits from the channel after determining whether or not the protocol of the field device connected to the channel can be identified using the set of one or more protocol detection circuits and thereby enabling the set of one or more protocol detection circuits to be used in identifying the protocol of a next field device connected to the field switch.

22. The field switch of claim 21 wherein the field switch is configured to connect to a process control network utilizing a network protocol and each channel of the plurality of channels comprises a respective protocol adapter connector disposed in the channel in series with the port of the channel, the protocol adapter connector being configured to removably receive a protocol adapter into the channel of the type that converts between the network protocol and a different protocol to enable a field device connected to the channel utilizing the different protocol to communicate through the process control network, thereby enabling field devices having protocols incompatible with the protocol of the process control network and connected to the field switch to be used on the process control network.

23. The field switch of claim 22 wherein the protocol adapter connector of each channel of the plurality of channels normally opens the channel, and the protocol adapter connector is configured to removably attach a pass-through connector into the channel, the pass-through connector providing electrical continuity for power and data across the protocol adapter connector and thereby closing the channel and enabling power and data transfer across the protocol adapter connector when attached to the protocol adapter connector.

24. The field switch of claim 23 wherein the field switch comprises a plurality of slots, each slot being open to a respective protocol adapter connector of the plurality of channels to receive a protocol adaptor into the slot;

and the pass-through connector is configured as a cover capable of being attached to the field switch to close a slot of the field switch, the cover when closing a slot providing electrical continuity across the protocol detector in the slot.

25. The field switch of claim 22 wherein the controller, upon identifying the protocol of a field device connected to the field switch, is configured to generate and transmit data used to inform a user of the protocol of the field device.

26. The field switch of claim 21 wherein each protocol detection circuit of the set of one or more protocol detection circuits comprises a normally open first relay disposed in the circuit, the first relays of the set of one or more protocol detection circuits being operatively connected to the controller and enabling the controller to selectively open and close the first relays when attempting to identify the protocol of a connected field device.

27. The field switch of claim 26 wherein the field switch is configured to connect to a process control network utilizing a network protocol different from any of the protocols of the set of one or more protocol detection circuits;

each channel of the plurality of channels is connected to the controller;

each channel of the plurality of channels comprises a respective second relay in the channel, the second relays of the plurality of channels being operatively connected to the controller wherein the controller can selectively open and close the second relays when the controller is attempting to identify the protocol of connected field devices; and

the controller when attempting to identify the protocol of a field device attached to a channel of the plurality of channels is configured to initially close the second relay of the channel and open the first relays to determine whether or not the field device is compatible with the network protocol.

28. The field switch of claim 27 wherein the controller when attempting to identify the protocol of a field device attached to a channel of the plurality of channels is configured to maintain the second relay of the channel in an open state if the attached field device is not compatible with the network protocol.

29. The field switch of claim 27 wherein the controller when attempting to identify the protocol of a field device attached to a channel of the plurality of channels is configured to maintain the second relay of the channel in a closed state while the field device is attached to the channel after determining the field device is compatible with the network protocol.

30. The field switch of claim 26 wherein each protocol detection circuit of the set of detection circuits is connected to each channel of the plurality of channels by a channel data line extending from the channel;

each of the respective channel data lines comprises a respective third switch disposed in the channel data line, the third switches of the channel data lines being operatively connected to the controller wherein the controller can selectively open and close the third relays when the controller is attempting to identify the protocol of connected field devices; and

the controller while attempting to identify the protocol of a field device attached to a channel of the plurality of channels is configured to maintain the third relay of the channel data line extending from the channel in the closed state and maintain the other third relays in an open state.

31. The field switch of claim 30 wherein the set of one or more protocol detection circuits is a set of two or more protocol detection circuits;

the set of two or more protocol detection circuits are connected to a common data line; and

each of the channel data lines extending from the plurality of channels are connected to the common data line.

32. The field switch of claim 21 wherein each channel of the plurality of channels is capable of transmitting power through the channel to a field device connected to the channel;

each channel of the plurality of channels comprises a power limiting device that can selectively limit the power transmitted from the channel to a field device attached to the channel, the power limiting device operatively connected to the controller wherein the controller can selectively limit the power transmitted to a field device attached to the channel; and

the controller is configured to detect power being transmitted to a field device attached to a channel of the plurality of channels and is configured to limit power being transmitted to the field device through the channel to a minimum safe power while the controller is attempting to determine the protocol of the field device.

33. The field switch of claim 32 wherein the controller is configured to increase the power transmitted to the field device through the channel after determining the protocol of the field device whereby the power transmitted to the field device is at most the maximum power allowed by the protocol of the field device.

34. The field switch of claim 21 wherein the controller is configured to detect the start of power being transmitted to a field device attached to any channel of the plurality of channels, and to initiate an attempt to identify the protocol of the attached field device in response thereto.

35. The field switch of claim 21 wherein the controller, upon identifying the protocol of a field device connected to the field switch, is configured to generate and transmit data used to inform a user of the protocol of the field device.

36. The field switch of claim 21 wherein the controller, upon failing to identify the protocol of a field device connected to the field switch, is configured to generate and transmit data used to inform a user of the field switch of the failure.

37. The field switch of claim 21 wherein each channel of the plurality of channels comprises a power line that transmits power through the channel to a power-and-data field device attached to the channel;

each channel of the plurality of channels includes a relay in the power line of the channel, the relays of the plurality of channels being operatively connected to the controller and enabling the controller to selectively open and close each of the relays; and

the controller being configured to maintain the relay of a channel of the plurality of channels in an opened state if the controller determines that a data-only field device is attached to the channel.