Using Buffered Outputs and Patch Panels with the SETPOINT™ Machinery Protection System

Overview

The SETPOINT Machinery Protection System provides three separate facilities for accessing buffered transducer signals:

1. Programmable BNC connectors (qty 3); available only when optional touchscreen is supplied.
2. 60-pin connector pair on Rack Connection Module (RCM); available on all racks.
3. RJ45 connectors on the front of each Universal Monitoring Module (UMM) with all 4 channels; available on all racks with installed UMMs.

This note discusses each of the above and offers guidance on the most suitable applications of each method. Applications that would benefit from a permanent patch panel are also discussed, along with recommendations for how to implement such a patch panel.

What are Buffered Outputs?

Buffered Outputs are simply the raw transducer signal before any signal conditioning has been applied, such as filtering or integration, and without any gain. They allow the sensor signal coming into the rack to be shared with other external instrumentation, such as oscilloscopes, multi-meters, and data acquisition recorders. Thus, for example, if the sensor has any output sensitivity of 200mV/mil, the buffered output will reflect this as well. These outputs are DC-coupled, allowing the transducer bias voltage to pass through and provide a composite (DC plus AC) signal to any connected instrumentation.

"Buffered" Versus "Isolated"

A small (550 Ω) resistance internal to the SETPOINT rack is provided in each buffered output circuit to ensure that a short will not result in excessive current flow and corresponding damage to the SETPOINT protection system. A unity gain amplifier is used to buffer and replicate the transducer input signal, ensuring that a short in the buffered output does not affect the input transducer and thus interfere with machinery protective functions.

SETPOINT's buffered outputs are not optically isolated, and this is also true of most all commercially available monitoring systems. As such, ground loops can occur if the instrumentation connected to the buffered outputs does not share the same ground as the SETPOINT rack. If optical isolators are required, they should be examined to ensure they provide DC-coupling. AC-only coupling blocks the gap or bias voltages and is therefore unsuitable for machinery diagnostics and instrument verification. The gap voltage is particularly important for proximity probe measurements as it is used on shaft-centerline plots, DC-coupled orbits, rod drop / rod position measurements, axial (thrust) position measurements, and numerous others.

Input Impedance Considerations for External Instruments

The output impedance of each SETPOINT buffered output connection is 550 ohms and ensures that if one or more of these connections are shorted, excessive current will not flow. As long as the input impedance of the connected external instrument is suitably large (54.5 kΩ or greater), the voltage divider formed by the input and output impedances in series will contribute a measurement error of less than 1%. This is rarely a problem with modern test and data acquisition instruments as their input impedances are typically 1 MΩ or more. However, if using the SETPOINT buffered outputs for connection to another permanent vibration monitor, the input impedance must be accounted for to assess the voltage divider effect. For example, the input impedance of a typical machinery protection system proximity probe channel is 10kΩ and will contribute a 5% error when connected to a SETPOINT buffered output due to this voltage divider effect. Input impedances for seismic transducers are generally higher. For example, the input impedance for IEPE-compatible 2-wire sensors is 5MΩ or more and will contribute a negligible voltage divider effect. The

input impedance for moving-coil velocity sensors can vary from as low as 10kΩ on some systems (such as Bently Nevada) to 100kΩ or higher on other systems (such as GE turbine control systems or SETPOINT moving-coil channels). Consult the manufacturer's specifications.

Programmable Buffered Output Connectors

SETPOINT racks equipped with an integral touchscreen on the door have 3 programmable BNC outputs as shown in Figure 1.

Figure 1: SETPOINT door and touchscreen showing its 3 programmable buffered output connectors

A detailed discussion of these outputs is provided in the SETPOINT Operation & Maintenance Manual (doc 1079330). Refer specifically to the section titled "Switchable BNC Connectors".

The primary intent of these connectors is when temporarily connecting portable instrumentation, such as route-based data collectors, oscilloscopes, or other test gear when no more than 3 channels are required simultaneously. Most portable data collectors have only three channels (two vibration channels + one phase channel) and use of SETPOINT's programmable BNC outputs allow the desired channels to be assigned "on the fly" without the need to move BNC cables from point to point each time data is collected from a different bearing or measurement point(s). The user simply assigns different channels in the rack to the outputs using the touchscreen.

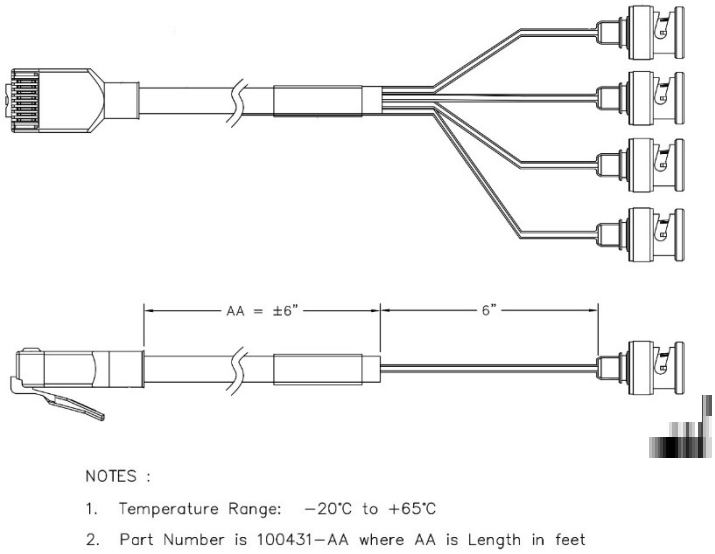
When temporary connection to signals from more than 3 channels are required simultaneously, the multiple buffered output connectors on each UMM can be used instead.

UMM Buffered Output Connectors

Figure 2: UMM's RJ45 BUFF OUT connector

Each Universal Monitoring Module (UMM) has an RJ45 style connector on its faceplate labeled BUFF OUT, as shown in Figure 2. This connector is not programmable and contains the analog buffered output signals from all four channels in the UMM. Refer to the SETPOINT Operation & Maintenance Manual (doc 1079330) for pin-out information, length limitations, and other details.

A common misconception is that RJ45 connectors are used only for digital signals, such as in hardwired Ethernet networks. However, although less common, these connectors can also be used for analog signals and are actually ideal for carrying all 4 UMM channels over 8 conductors (4 individually twisted pairs) on a single cable. In fact, this connector style is sometimes also referred to as an 8P8C (8 pin 8 connector) modular plug. Each of the 4 channels in a UMM is assigned its own 2 pins on the connector and a special RJ45-to-BNC breakout cable is used (p/n 100431-10). This cable is 10 feet (3m) long and is shown in Figure 3. When longer distances are required, standard CAT5 / CAT6 cable can be used to carry the analog signals over relatively long distances and an RJ45 inline coupler can be used to transition from the CAT5 / CAT6 to the breakout cable. This arrangement is depicted in Figure 4.



Wiring Table			
RJ45 Pin	BNC #	BNC PIN	Wire Color
1	1	Center	Wht/Or
2	1	Shell	Or
3	2	Center	Wht/Grn
4	3	Shell	Blue
5	3	Center	Wht/Blue
6	2	Shell	Grn
7	4	Center	wht/Brn
8	4	Shell	Brn

Figure 3: Details of 4-channel RJ45-to-BNC Breakout Cable

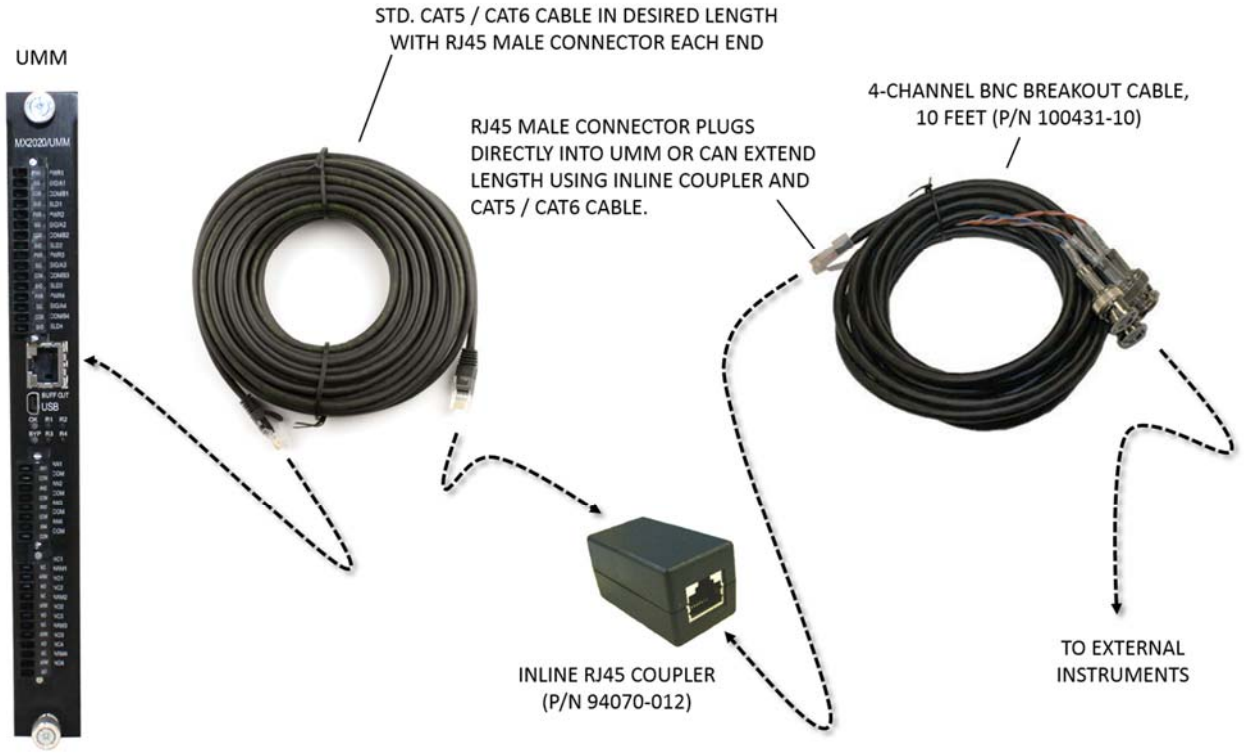


Figure 4: Extending the reach of RJ45-to-BNC Breakout Cable using standard CAT5 / CAT6 cable and an inline RJ45 coupler.

SETPOINT engineers chose to use the RJ45 connector style to carry analog buffered output signals for several important reasons:

- The connector is very compact and allows 4 channels of signals to consume only as much space on the UMM faceplate as a single BNC connector.
- A special RJ45-to-BNC breakout cable can be used when instruments are within 10' (3m) of the UMM; when longer distances are involved, standard CAT5 / CAT6 network cable can be used in the required length, and an RJ45 inline coupler used to transition to the breakout cable.
- Standard CAT5 and CAT6 cables can be used to carry 4 channels of signals. Because these cables have *individually* twisted pairs, there is less cross-talk between channels over relatively long cable runs (up to 100 feet or more).
- CAT5 and CAT6 cables are lighter and less expensive than coaxial cables, which are limited to one analog signal at a time.
- CAT5 and CAT6 cables in various lengths with the RJ45 connectors pre-installed are readily available at most electronics stores.
- Custom cable lengths can be easily fabricated in the field using bulk CAT5 / CAT6 cable, loose RJ45 connectors, and an appropriate RJ45 crimping tool. All are readily available at most electronics stores.

RCM Buffered Output Connectors

The Rack Connection Module (RCM) has a connector pair labeled BUFFERED SIGNALS, as shown in Figure 5. It is not programmable and the signals from all UMMs installed in rack slots 3-16* have dedicated pin assignments. Unlike the RJ45 connectors on each UMM, the RCM connectors do not have individual commons for each channel, and it is thus not possible to isolate channels as fully as when individually twisted pairs are used. For this reason, the cable lengths when using the RCM BUFFERED SIGNALS connector pair are limited to 5m (15 feet).

Figure 5: RCM's BUFFERED SIGNALS connector pair

The RCM BUFFERED SIGNALS connector pair is normally used only under two circumstances:

1. For connection of all buffered outputs in the SETPOINT rack to dedicated BNC connectors on a permanent patch panel** located within 15' of the rack.

2. For connection of the SETPOINT protection system to the data acquisition hardware of a third-party condition monitoring platform. Examples would include the TDISecure™ hardware used by GE in conjunction with their System 1™ software, and the CSI6500 Machinery Health™ Monitor hardware used by Emerson in conjunction with their AMS Suite software.

The top connector is used for accessing the buffered output signals in rack slots 3-9. The bottom connector is for rack slots 10-16. Use one cable 100473-AAA for each connector (i.e., two cables are required when accessing slots 3-16). For pinouts, connector part numbers, wire color coding, cable length ordering information, and other details, refer to drawing 100473 and to the SETPOINT Operation & Maintenance Manual (doc 1079330). Both are available on our website.

Figure 6: 28-Channel Cable 100473 is used with each RCM BUFFERED SIGNALS connector

NOTES:

***** For racks with a UMM in slot 2, its buffered output signals will not be available at the RCM connector pair. Only the signals from slots 3-16 are available. This situation is rare as slot 2 is normally used for a communications module (SAM) rather than a UMM.

******The RJ45 connectors on each UMM can alternatively be used for connecting to a permanent patch panel, as shown in the next section.

Permanent Patch Panels

Permanent patch panels can use one of two connection methods to a SETPOINT rack:

Method 1: Using the BUFFERED SIGNALS connector pair on the RCM and 100473-AAA cable(s)

This method is viable when there are many channels in the SETPOINT rack and you wish to keep the number of cables to a minimum by placing 28 channels on a single cable (2 cables for all 56 channels in a rack). As noted in the previous section, each of the two connectors on the RCM carries 28 channels and each connector splits the signals out into 14 channels per 15-conductor cable (14 SIGNAL + 1 COMMON). The drawback of this method is that it is generally more labor-intensive because one end of the 100473 cable is blunt cut and must be stripped, dressed, and soldered to the BNC connectors on the patch panel.

Method 1 is depicted in Figure 7 below.

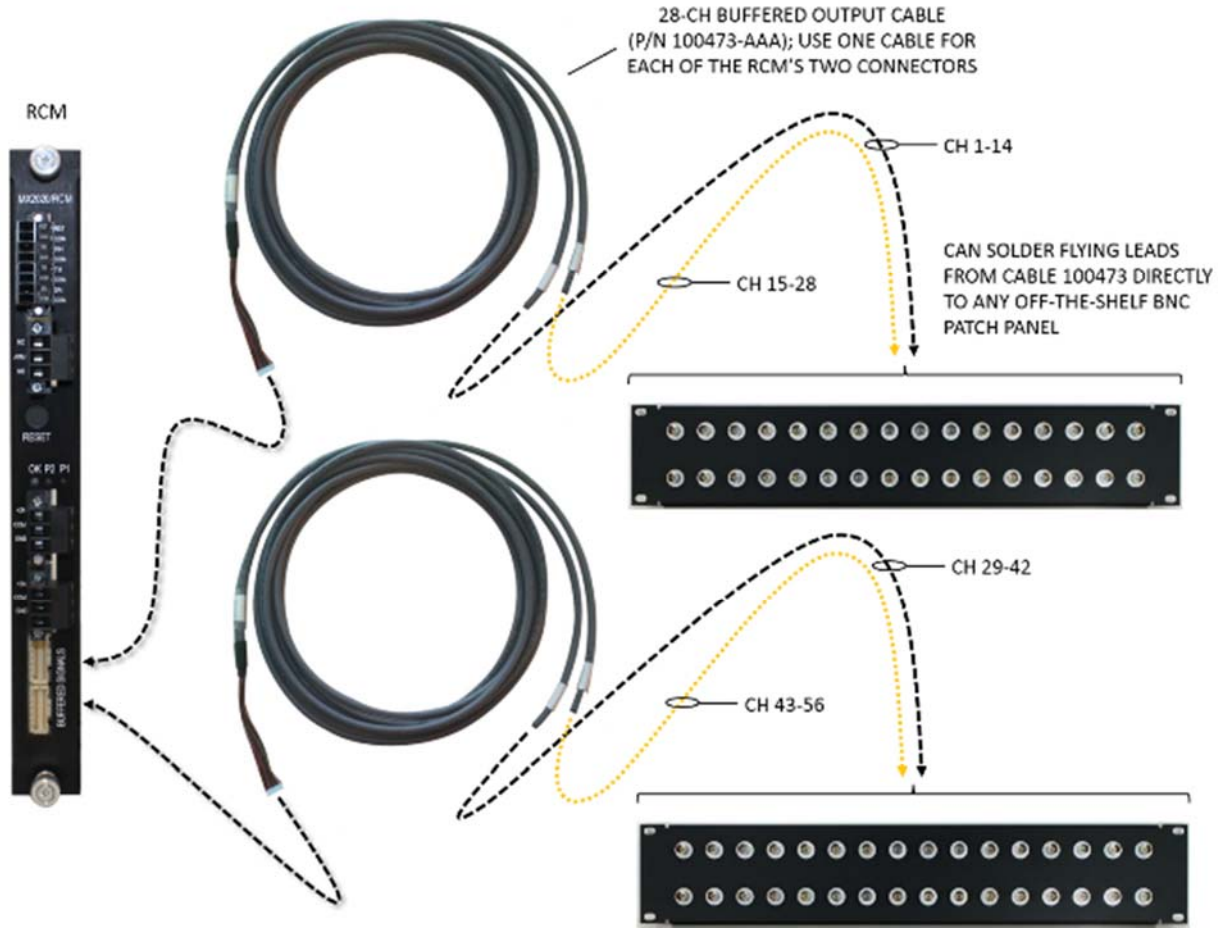


Figure 7: Connection of a permanent patch panel using the RCM's BUFFERED SIGNALS connector pair and cable 100473-AAA.

Method 2: Using the BUFF OUT RJ45 connector on each UMM and corresponding 100431-10 cables.

This method has the disadvantage of more cables (1 cable for every 4 channels instead of 1 cable for every 14 channels). However, each channel is transmitted via individually twisted pairs and is thus less susceptible to cross-talk. It also uses pre-terminated cable on both ends and eliminates the need for soldering at the patch panel.

Method 2 is depicted in Figure 8 below. When the patch panel will be located further from the SETPOINT rack than can be reached by the 10-foot length of each 100431-10 cable, simply extend using CAT5/CAT6 cable and couplers as shown in Figure 4.

When is a Patch Panel Recommended?

Permanent patch panels can be useful on racks that reflect one or more of the following:

- The rack has no integral display and therefore the programmable BNC connectors are not available.
- The rack is frequently connected to external instruments that can accept more than 3 simultaneous channels.
- The door on the rack cannot be easily opened to access the RJ45 connectors on each UMM.

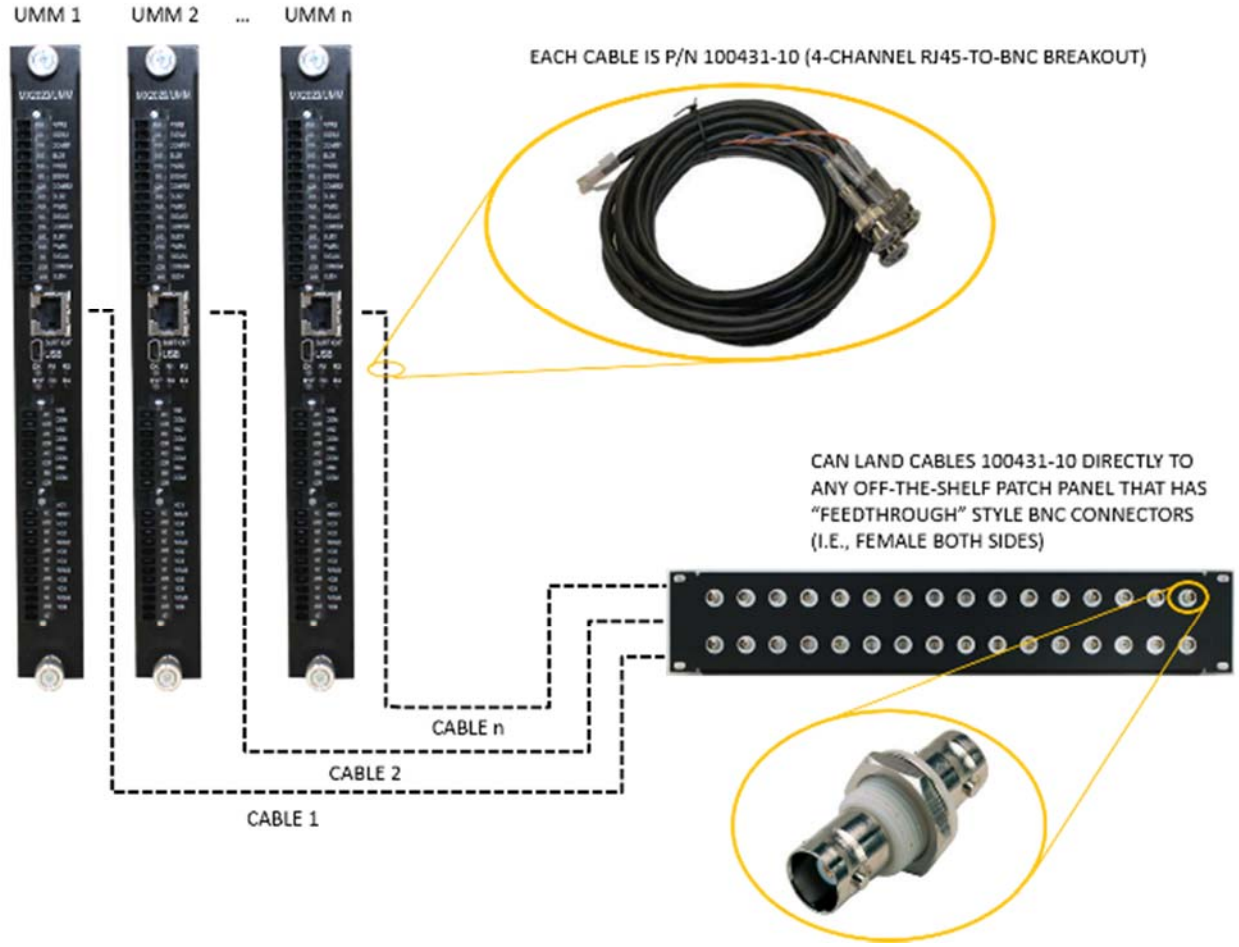


Figure 8: Connection of a permanent patch panel using each UMM's BUFF OUT RJ45 connector and cable(s) 100431-10. Lengths greater than 10 feet can be accommodated by using CAT5 / CAT6 cable and inline couplers as shown in Figure 4.

Custom Products

When panel space is at a premium and/or a typical 19” EIA patch panel format is not desirable, there is often adequate space on the SETPOINT door for a patch panel. In such cases, our doors can be custom fabricated with dedicated BNC connectors and labels (Figure 9). 8-position racks without a touchscreen (and 16-position racks with a touchscreen) have approximately 95 in^2 (610 cm^2) of surface area for BNC connectors and labels. 16-position racks without a touchscreen have approximately 150 in^2 (970 cm^2) for this purpose. Contact the factory for further details and with pricing requests.

Figure 9: Door for 16-position rack with custom patch panel, trip multiply, and danger defeat switches/annunciators.

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