

Smart Coil™ POTS/ADSL Line Conditioners

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- IMPORTANT NOTE -

For the most current, up-to-date, Smart Coil documentation, go to www.charlesindustries.com or call the Charles Industries' Technical Support Group for assistance at 1-800-607-8500.

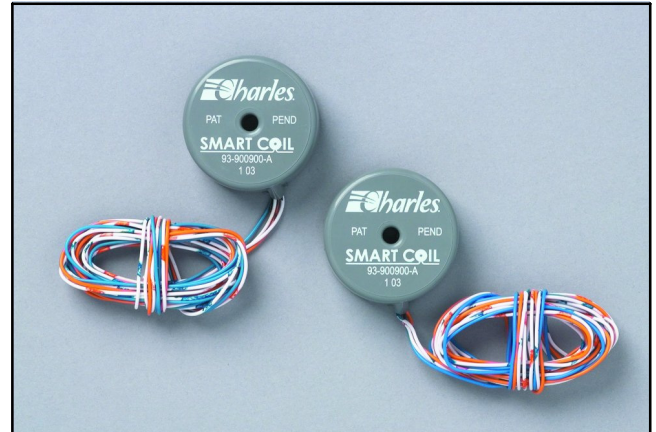


Figure 1. Two Single Smart Coils

1. GENERAL

1.1 Document Purpose

This document provides general, application, installation, operating, maintenance, troubleshooting, and specification information for Charles Industries Smart Coil™ products. Figure 1 shows a view of two typical, single, Smart Coils, Figure 2 shows three single Smart Coils placed inside a Smart Coil Kwik Kase, and Figure 3 shows an encapsulated Smart Coil Case. See Table 3 for all part numbers in the Smart Coil series.

1.2 Document Status

Whenever this practice is updated, the reason will be stated in this paragraph.

1.3 Product Description and Purpose

Smart Coil is a product that provides the line conditioning benefit of a common load coil for POTS traffic while allowing an ADSL signal to pass through. With Smart Coil, a loop that was providing either POTS or ADSL exclusively can instead handle both services on a single copper pair. Smart Coil offers an economical solution to problems and limitations associated with common load coil and build-outs, as described in the paragraphs below.

1.3.1 Problem Background. Voice quality commonly deteriorates on unloaded pairs at distances beyond 18 kft. For loops beyond this distance, common load coils and build-outs have been used for decades to provide high-quality voice service to customers beyond this distance. Passive load coils help flatten the frequency response of the audio range (300 – 3400 Hz), however, they block the higher frequency DSL signals. Unfortunately this load coil high-frequency spectrum limitation either prevents telephone companies from offering ADSL service, requires an



Figure 2. Smart Coil Kwik Kase

additional pair, or requires the physical removal of the common load coils for loaded loops.

1.3.2 Smart Coil Solution. The Smart Coil is a Charles Industries invention that provides all the functionality of a common load coil for the voice band (POTS), removes the POTS loop-length limitations, and also enables ADSL to reach its full attainable distance by allowing DSL to use frequencies above the voice band. Once installed, the Smart Coil is designed not to be removed when DSL is applied to the copper pair. In the past, while conditioning a pair or pairs for DSL or special services, it has been necessary to create a work activity to remove load coils from interfering with the clean and balanced circuit. In an effort to reduce subsequent “truck rolls” for conditioning pairs (de-loading) for these special



Figure 3. Encapsulated Smart Coil Case

services, the Charles Industries ‘Smart Coil’ was designed to give telephone companies that capability.

1.4 Features

Some Smart Coil key features are listed below.

- Smart Coils provide the line conditioning benefit of a common load coil for POTS traffic while allowing a DSL signal to pass through. With Smart Coil, a loop that was providing either POTS or DSL exclusively can instead handle both services on a single copper pair.
- Same form factors as standard coils and common coil cases
- Compatible with and identical deployment as common load coils (i.e. in the same location, using the same connections)
- Conditions new and existing loops for ADSL and POTS beyond current distance limits over a single pair
- Allows ADSL to reach its full distance
- Increase revenue by capturing new ADSL customers who were previously denied service

- Reliable performance and a long, trouble-free life in severe environmental conditions: 100% sealed for environmental toughness
- Integrates easily into existing plant
- Compatible with common coils: upgrade entire loop or just one load point
- Fits both 66 mH and 88 mH spacing: keep same splice location(s)
- Handles the most difficult environmental conditions
- Available in multiple form factors for use above ground on a pole or in aerial applications, or direct buried applications.
- Does not interfere with transmission of T1 circuits
- Upgrades existing plant, whether 66 mH or 88 mH. Spacing is typically 4.5 kft for 66 mH and 6 kft for 88 mH, with the first coil from the Central Office at half these intervals.
- Exceeds applicable Telcordia and RDUP standards
- CLASS compatible

1.5 Placement and Configuration Guidelines

Smart Coils have more spacing flexibility than common load coils and can be placed at a wider range of locations. Some placement and configuration guidelines are listed below.

- The allowable values for placement are between 3500 – 8500 feet spacing. This allows a single Smart Coil to be installed at both 4500 foot (66 mH) and 6000 foot (88 mH) spacing. The flexible spacing afforded by the Smart Coil as compared to common load coils eliminates the need for build-outs.
- As with common load coils, the end section should not exceed 9,000 feet.
- Contrary to common load coils, Smart Coils only require a 1,000 foot minimum end section between the last load and the customer.
- For optimal POTS quality and to condition the pair for future DSL service, all bridged taps, build-outs, lattice networks, etc., should be removed while installing Smart Coils.

- DSL SPAN NOTE -

In order to ensure reliable DSL transmission, all devices in the span between DSLAM and Customer Premise must be Smart Coils. If a single common coil remains, DSL transmission will be impeded.

- It is normal for an individual Smart Coil to introduce 0.45 dB of additional insertion loss at 1004 Hz compared to a common load coil.
- Most Voice Frequency Repeaters (VFRs) work with Smart Coil. However, tests should be run with single Smart Coils on loops with installed VFRs to ensure compatibility before deployment.
- Smart Coil does not show the same impedance on an ohmmeter as compared to a common coil.

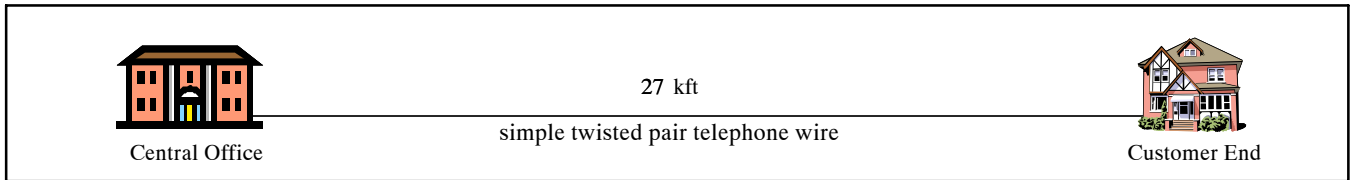


Figure 4. Simple Span, with Poor Quality

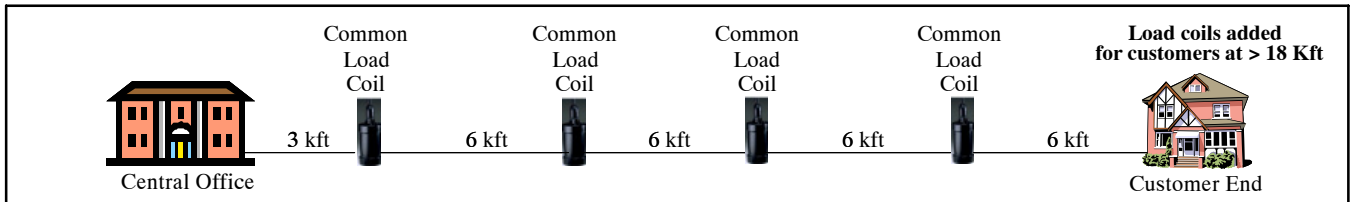


Figure 5. Simple Span, Adding Common Load Coils, Improved Quality

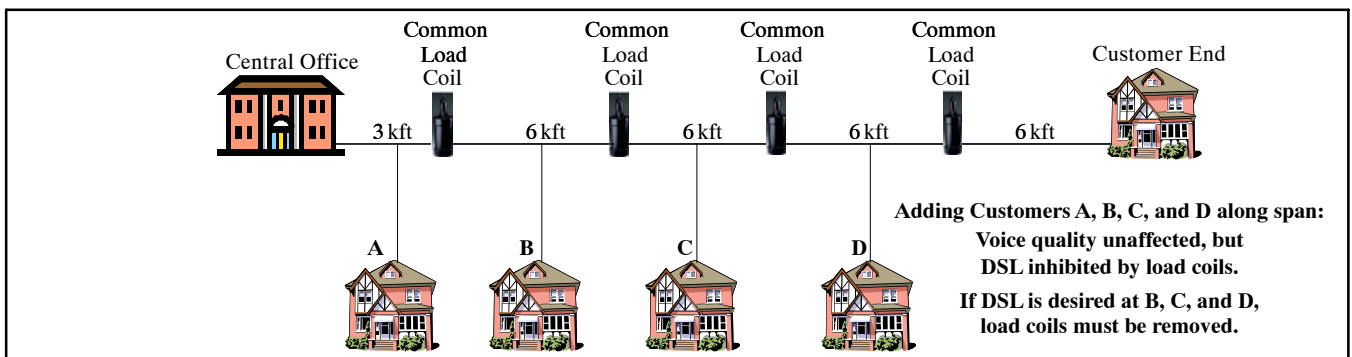


Figure 6. Adding Customers along Span, Voice Unaffected, DSL Inhibited

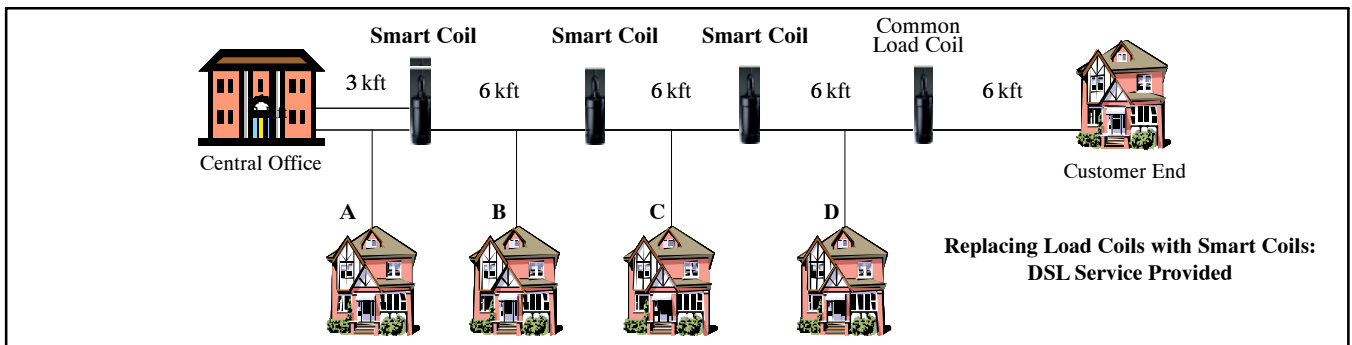


Figure 7. Adding Smart Coils along Span, DSL Enabled

- Smart Coil is not recommended for deployment on pairs carrying HDSL or ISDN circuits.

2. APPLICATIONS

2.1 The Smart Coil™ is designed to replace common load coils. It will allow DSL to reach its full distance, but not significantly change the operation of DSL or telephone voice traffic.

2.2 A typical installation of a telephone in a house 27 kft away from the Central Office might consist of a simple, twisted

pair, telephone wire, as shown in Figure 4. However, voice quality would be extremely poor. Installation of common load coils as shown in Figure 5 would correct this problem. Houses located along the cable route are typically served by accessing copper pairs at cross points and splice cases. As new houses are connected to the system, available pairs are selected. These houses may connect at any splice location along the pair, using some load coils (whether required or not) as they are currently installed. Houses A, B, and C (Figure 6), located at distances ranging from 3 kft to 18 kft from the Central Office, do not need load coils for reliable voice transmission (Figure 6). In order to provide reliable voice service to the

TYPICAL CABLE FREQUENCY RESPONSE

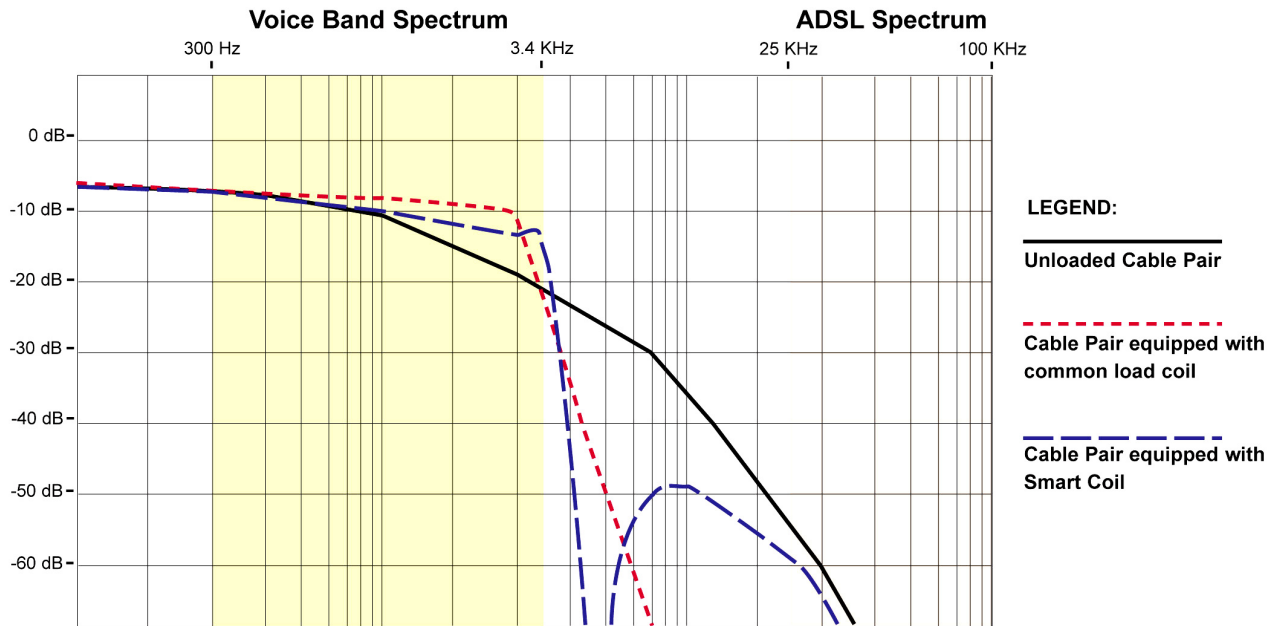


Figure 8. Typical Cable Frequency Response Chart

end customer however, load coils are utilized. These load coils do not pose a problem for voice service to houses A, B, C, and D. Since DSL uses significantly higher frequencies than standard voice, it will not pass through common load coils. Previously, the only way to provide DSL service to ‘B’, ‘C’ and ‘D’ was to remove the load coils on those pairs.

2.3 Another consideration is the limit of DSL transmission. For all practical purposes, 24 kft is currently the maximum DSL transmission while voice can go significantly farther. Houses farther than 24 kft cannot be serviced by DSL originating from the Central Office.

2.4 To provide a high-quality voice service and facilitate DSL deployment, *replace the common load coils with Smart Coils* as shown in Figure 7. The 1st three load coil cases are replaced with Smart Coils. DSL and high quality voice now pass through to all houses within 24 kft from the CO.

2.5 Theory of Operation

On an unloaded cable pair, signal roll-off is evident even before 1 kHz and continues to degrade voice quality throughout the audible range (up to 3.4 kHz). This is caused by the inherent transmission line parallel capacitance between the Tip and Ring being significantly higher than the inherent transmission line series inductance of Tip and Ring.

On a loaded cable pair, no significant signal roll-off occurs until 3 kHz, which effectively equalizes the signal throughout the voice band spectrum. However, the added inductance of common load

coils effectively blocks the entire DSL spectrum, which begins at 25 kHz. With Smart Coils installed in place of common load coils signal equalization is maintained throughout the voice band spectrum, while the DSL signal is maintained at levels similar to an unloaded pair. Refer to Figure 8 for a graphical representation.

| Frequency (kHz) | Unloaded cable (dB) | 88 mH coils (dB) | SMTC (dB) | 2 - 88 mH +2 - SC |
|-----------------|---------------------|------------------|-----------|-------------------|
| 304 | -6.4 | -6.2 | -6.4 | -6.2 |
| 404 | -6.6 | -6.1 | -6.5 | -6.2 |
| 504 | -6.9 | -6.1 | -6.6 | -6.2 |
| 1004 | -8.5 | -5.6 | -7.4 | -6.5 |
| 2504 | -13.9 | -6.6 | -8.7 | -7.3 |
| 2804 | -14.9 | -8.0 | -8.6 | -7.9 |
| 3004 | -15.5 | -8.8 | -8.5 | -9.3 |

Table 1. Frequency Response Chart (on a Typical 22 kft, 24 AWG Loop)

2.6 Smart Coil Application Requirements

POTS quality on two-wire analog loops is quantified by a number of transmission parameters, including the following:

- 1. Loop insertion loss.** This loss is dependent on several factors such as loop length, wire gauge, temperature and presence of bridged taps. Loop insertion loss is typically measured at 1004 Hz and the maximum loss is determined by the Telco’s and the local PUC. The insertion loss at 1004

HZ should typically be less than or equal to a value between 8.0 to 10.0 dB.

2. **Loss deviation.** The loss deviation quantifies the signal roll-off that typically occurs over the audible frequency range (300 Hz to 3.4 kHz). Following are some typical values:
 - Frequency range 504 to 2504 Hz: -1.5 to +7.5 dB,
 - Frequency range 404 to 2804 Hz: -1.5 to +9.5 dB,
 - Frequency range 304 to 3004 Hz: -2.5 to +11.5 dB

These limits are the maximum deviation of the loss measured at the test frequency relative to the actual measured loss at 1004 Hz. The “+” limit means more loss and the “-” limit means less loss.

3. INSTALLATION

This part describes the procedures for installing Smart Coils™. Installation consists of inspecting the equipment, following all safety precautions, determining the mounting location and type, gathering the necessary tools and equipment, preparing the installation site, mounting/installing the equipment, making installer wiring/splicing connections of the Telco and customer communication cable feeds, and site cleanup. Read the following cautions and warnings, then proceed with the paragraphs that follow.

- INSPECTION NOTE -

Visually inspect the unit for damage prior to installation. If the equipment was damaged in transit, immediately report the extent of the damage to the transportation company or according to local company practices and procedures.

- EQUIPMENT IDENTIFICATION NOTE -

Charles Industries equipment is identified by a model and serial number printed on a label on the equipment. Please include both the model and serial numbers when making product inquiries.

- CAUTION-

Do not excessively loop, bend or kink cables, to avoid cable damage.

- SAFETY PRECAUTIONS -

- Never install telephone equipment during a lightning storm.
- Never install telephone equipment in wet locations unless specifically designed for wet locations.
- Never touch uninsulated telephone wires or terminals unless the telephone line has been disconnected at the network interface.
- Use caution when installing or modifying telephone lines.

3.1 Determining Mounting Type

Prior to installing Smart Coils, the specific mounting type should be determined. Smart Coils can be mounted in buried applications, such as direct buried (Figure 9), handholes, manholes, or pedestals), in aerial or strand applications (Figure 10), or mounted on poles (Figure 11).

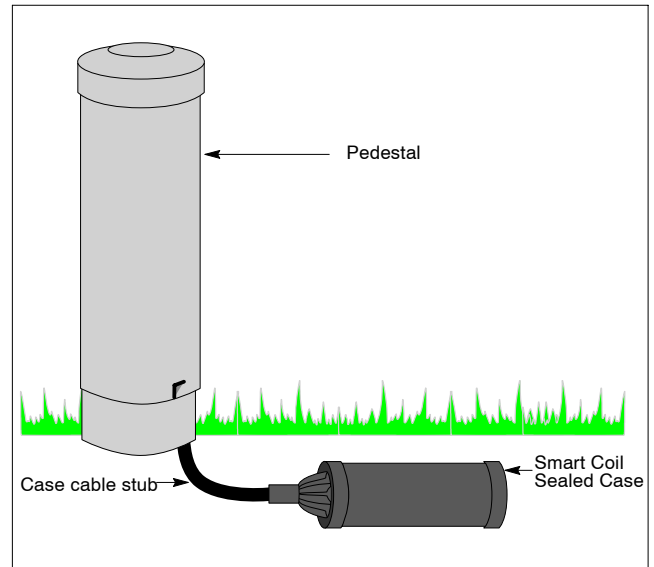


Figure 9. Direct Buried Installation

3.2 Selecting Specific Product

The specific Smart Coil used depends upon the type of mounting and application and the number of lines to be conditioned. Smart Coils come in quantities from one to 900 pairs. Single Smart coils can be conveniently and neatly installed in terminals and pedestals with the compact Kwik Kase tube. The tube’s U-shaped design (a 2/3 enclosed ABS plastic tube) allows technicians to mount the tubes easily with provided bolting hardware, then add only the amount of load coils needed. Charles Industries 770-type Smart Coil Cases are the most convenient way to deploy large pair count applications (25 to 600 pairs) of Smart coils in the outside plant. Each case (see Figure 3) houses SMTCs designed to be used in series with a given cable pair, reducing the capacitive effect of a given length of cable. Rugged, weather-tight polyethylene cases provide superior environmental protection in harsh outside plant conditions. The encapsulated coils inside each case are protected from moisture, heat, dirt and impact. Order Smart Coils per company practice, and see Table 3 for a detailed list of Smart Coil products.

3.3 Obtaining Tools and Equipment

The same equipment and tools used to install standard load coils are used to install Smart Coils.

- CAUTION -

Perform any and all bonding and grounding prior to electrical and communications connections.

- GROUNDING NOTE -

Always follow local codes and company practices whenever grounding equipment.

3.4 Installing the Smart Coil

Smart Coils are typically installed outdoors, either on a pole or in a pedestal or manhole, direct-buried, or strand-mount in aerial applications. Buried applications include single or multiple mounting Smart Coils within pedestals, direct buried near pedestals, and in manholes and handholes. Follow the steps below to install the Smart Coils.

1. **Prepare the site.** Prepare the installation site, per company practice.
2. **Mount the Smart Coil.** Mount or place the Smart Coil at the desired installation location.

Manhole/pedestal. If mounting within a hand or manhole or pedestal (Figure 9), attach the Smart Coil firmly and per company practice at the selected mounting location, using mounting brackets or Kwik Kases as needed. Kwik Kases contain a mounting bracket and mounting hardware, for easy attachment to backboards or brackets provided within pedestals, handholes, or manholes.

Aerial or strand mounting. Mount or place the Smart Coil at the desired aerial installation location (Figure 10). Use hangers of sufficient type and quantity to hang the Smart Coil case from the strand, per company practice.

Pole mounting. Mount or place the Smart Coil at the desired location on the pole (Figure 11). Use pole mount brackets of sufficient type and quantity to hold the Smart Coil on the pole, per company practice. See Table 3 for ordering information on pole mount brackets offered by Charles Industries.

3. **Prepare wires and cables.** Open and prepare cables and wires per company practice, including the existing plant cables and the Smart Coils to be installed. Cut the Smart Coil cable stub or the single coil wires to a proper length, and prepare the cable wires for splicing.
4. **Splice wires.** Splice all wires, per Table 2 and company practice. Note that wire color does not matter: either colored wire pair on the Smart Coil can be spliced to either colored pair on the line being spliced, regardless of direction (towards the CO or towards the customer).
5. **Label all connections and pairs.** Label all wire pairs and connections, per company practice.
6. **Test.** Test the installation, per company practice.
7. **Site Cleanup.** Clean up the site per company practice.

| Pair Number | Ring | Tip |
|-------------|--------|-------|
| 1 | Blue | White |
| 2 | Orange | White |

Table 2. Cable-Pair Wire Colors

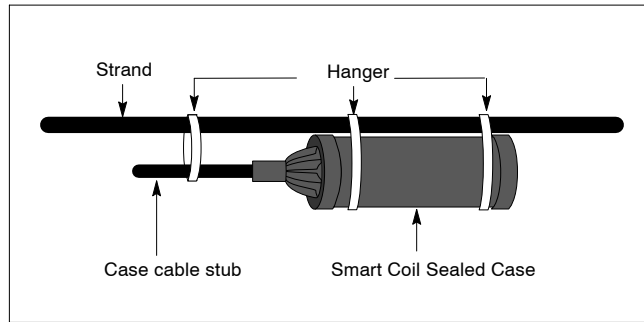


Figure 10. Strand Mounting a Sealed Smart Coil Case

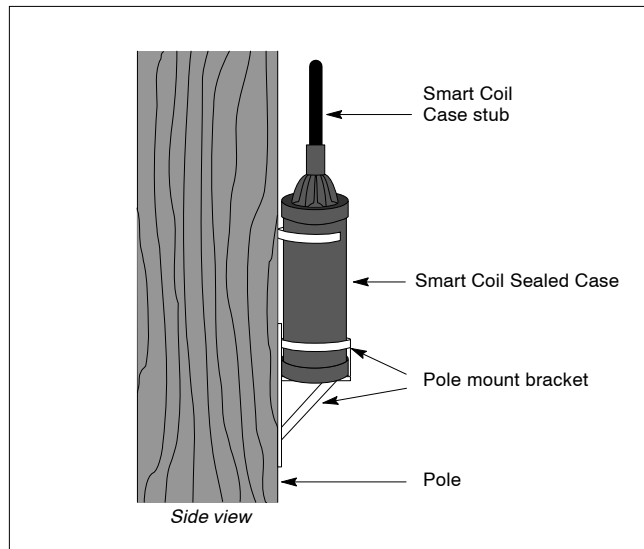


Figure 11. Pole Mounting a Sealed Smart Coil Case

4. TESTING & TROUBLESHOOTING

Test the spliced lines for proper operation per company practice.

5. MAINTENANCE

Smart Coils™ are maintenance free.

6. TECHNICAL ASSISTANCE

If technical or customer assistance is required, contact Charles Industries' Technical Services Center at:

847-806-8500
 847-806-8556 (FAX)
 800-607-8500
 techserv@charlesindustries.com (email)

| Model # | Type/Description | Dia. (In.) | Length | Wt. |
|--|--|------------|--------|---------|
| 93-900900-B | Ready-Access Single Smart Coil, with orange/white and blue/white 22 AWG leads twisted to form a quad | 1.7" | 0.6" | 2 oz. |
| Kwik Kases (Smart Coils Included, 22 AWG) | | | | |
| 93-900901-B | 6 Smart Coils in a Kwik Kase | 1.9" | 4.3" | 15 oz. |
| 93-900902-B | 12 Smart Coils in a Kwik Kase | 1.9" | 8.1" | 1.75 lb |
| 93-900903-B | 25 Smart Coils in a Kwik Kase | 1.9" | 16.6" | 4 lb. |
| Kwik Kases (Empty, Smart Coils <u>Not</u> Included) | | | | |
| 010077 | Kwik Kase for 6 Smart Coils | 1.9" | 4.3" | 3 oz. |
| 010074 | Kwik Kase for 12 Smart Coils | 1.9" | 8.1" | 4 oz. |
| 010075 | Kwik Kase for 18 Smart Coils | 1.9" | 12.1" | 5 oz. |
| 010076 | Kwik Kase for 25 Smart Coils | 1.9" | 16.6" | 6 oz. |
| Environmentally Sealed Cases (770-Type, 24 AWG) | | | | |
| 93-900911-B | 25 pair Case, 10' aircore stub | 4" | 6" | 9 lb. |
| 93-900912-B | 25 pair Case, 10' filled stub | | | 11 lb. |
| 93-900913-B | 25 pair Case, 15' aircore stub | | | |
| 93-900914-B | 25 pair Case, 15' filled stub | | | |
| 93-900915-B | 25 pair Case, 20' aircore stub | | 13 lb. | |
| 93-900904-B | 25 pair Case, 20' filled stub | | | |
| 93-900916-B | 50 pair Case, 10' aircore stub | | 10" | 15 lb. |
| 93-900917-B | 50 pair Case, 10' filled stub | | | |
| 93-900918-B | 50 pair Case, 15' aircore stub | | | 17 lb. |
| 93-900919-B | 50 pair Case, 15' filled stub | | | |
| 93-900920-B | 50 pair Case, 20' aircore stub | | | 20 lb. |
| 93-900905-B | 50 pair Case, 20' filled stub | | | |
| 93-900921-B | 100 pair Case, 10' aircore stub | | 17" | 25 lb. |
| 93-900922-B | 100 pair Case, 10' filled stub | | | |
| 93-900923-B | 100 pair Case, 15' aircore stub | 30 lb. | | |
| 93-900924-B | 100 pair Case, 15' filled stub | | | |
| 93-900925-B | 100 pair Case, 20' aircore stub | 35 lb. | | |
| 93-900906-B | 100 pair Case, 20' filled stub | | | |
| 93-900926-B | 200 pair Case, 10' aircore stub | 8" | | 55 lb. |
| 93-900927-B | 200 pair Case, 10' filled stub | | | |
| 93-900928-B | 200 pair Case, 15' aircore stub | | 63 lb. | |
| 93-900929-B | 200 pair Case, 15' filled stub | | | |
| 93-900930-B | 200 pair Case, 20' aircore stub | | 71 lb. | |
| 93-900907-B | 200 pair Case, 20' filled stub | | | |
| 93-900931-B | 300 pair Case, 10' aircore stub | | 15" | 80 lb. |
| 93-900932-B | 300 pair Case, 10' filled stub | | | |
| 93-900933-B | 300 pair Case, 15' aircore stub | | | 92 lb. |
| 93-900934-B | 300 pair Case, 15' filled stub | | | |
| 93-900935-B | 300 pair Case, 20' aircore stub | 104 lb. | | |
| 93-900908-B | 300 pair Case, 20' filled stub | | | |

Table 3 - Continued in Next Column

| Model # | Type/Description | Dia. (In.) | Length | Wt. | |
|--|--|------------|---------|---------|--|
| Environmentally Sealed Cases (770-Type, 26 AWG) | | | | | |
| 93-900936-B | 600 pair Case, 10' aircore stub | 8" | 26" | 160 lb. | |
| 93-900937-B | 600 pair Case, 10' filled stub | | | | |
| 93-900938-B | 600 pair Case, 15' aircore stub | | | 175 lb. | |
| 93-900939-B | 600 pair Case, 15' filled stub | | | | |
| 93-900940-B | 600 pair Case, 20' aircore stub | | 190 lb. | | |
| 93-900909-B | 600 pair Case, 20' filled stub | | | | |
| 93-900941-B | 900 pair Case, 10' aircore stub | | 30" | 320 lb. | |
| 93-900942-B | 900 pair Case, 10' filled stub | | | | |
| 93-900943-B | 900 pair Case, 15' aircore stub | | | 342 lb. | |
| 93-900944-B | 900 pair Case, 15' filled stub | | | | |
| 93-900945-B | 900 pair Case, 20' aircore stub | 365 lb. | | | |
| 93-900910-B | 900 pair Case, 20' filled stub | | | | |
| Mounting Brackets for 770-Type Cases | | | | | |
| 260027 | 4" diameter pole mount bracket, aluminum | | | | |
| 039828 | 4" diameter pole mount bracket, steel | | | | |
| 260004 | 8" diameter pole mount bracket, aluminum | | | | |
| 039829 | 8" diameter pole mount bracket, steel | | | | |
| 032647 | 8" diameter manhole mount bracket | | | | |

Operating temperature: -40 to +60°C. Humidity: 0-95%, non-condensing.
 The availability of features and technical specifications herein subject to change without notice.

Table 3. Smart Coil Part Numbers

7. WARRANTY & CUSTOMER SERVICE

7.1 Warranty

Charles Industries, Ltd. offers an industry-leading, 5-year warranty on products manufactured by Charles Industries. Contact your local Sales Representative at the address or telephone numbers below for warranty details. The warranty provisions are subject to change without notice. The terms and conditions applicable to any specific sale of product shall be defined in the resulting sales contract.

Charles Industries, Ltd.
 5600 Apollo Drive
 Rolling Meadows, Illinois 60008-4049

847-806-6300 (Main Office)
 847-806-6231 (FAX)