VIBRATION ANALYSIS HARDWARE

SC320 Series Signal Conditioner Product Manual

Table of Contents

Introduction

This document contains information on the operation, installation, and maintenance of the SC320 Series Signal Conditioner. The signal conditioner is a device that converts a sensor input to 0-20 mA, 4-20 mA, 0-5 VDC, or 0-10 VDC output signals and provides a buffered dynamic output of the vibration waveform. The signal conditioner accepts input from an accelerometer, velocity transducer, or proximity probe. The signal conditioner's outputs can be configured proportional to acceleration, velocity, or displacement depending on the input transducer type. Additionally, the signal conditioner also contains dedicated pins for input from a temperature sensor and a 4-20 mA signal proportional to the temperature sensor input voltage.

SC320 Series Overview

The SC320 signal conditioner is a DIN rail mountable component used in continuous machinery monitoring applications. It provides signal conditioning, signal conversion, and re-transmission. All settings are configured using downloadable and easy to use software (requires PC and a micro USB cable). A general list of features includes:

- 4-20 mA output signal for temperature
- Two independent selectable channels offering 0-5 VDC, 0-10 VDC, 4-20 mA, or 0-20 mA output signals proportional to vibration
- Built-in selectable 24 VDC, 4 mA IEPE sensor excitation
- LED indicator for unit operation and basic troubleshooting
- Selectable configurations for 0-Pk, Pk-Pk, RMS, as well as peak and hold for each channel
- Input selectable between acceleration, velocity, and displacement
- Ultrasound compatible up to 40 kHz
- Independent and selectable digital bandpass filters for each channel
- Outputs scalable for Metric and English

- Outputs independently selectable between acceleration, velocity, or displacement (varies by configuration)
- Ten available full-scale ranges from 0.5 to 500 for each channel (g's, IPS, mm/sec, mils; the maximum full-scale range varies based on input sensor activity)
- Two buffered dynamic outputs, one via BNC and one via terminal blocks
- 35 mm DIN rail mountable
- Removable terminal blocks facilitates easy wiring

Installation

Electrical Connections

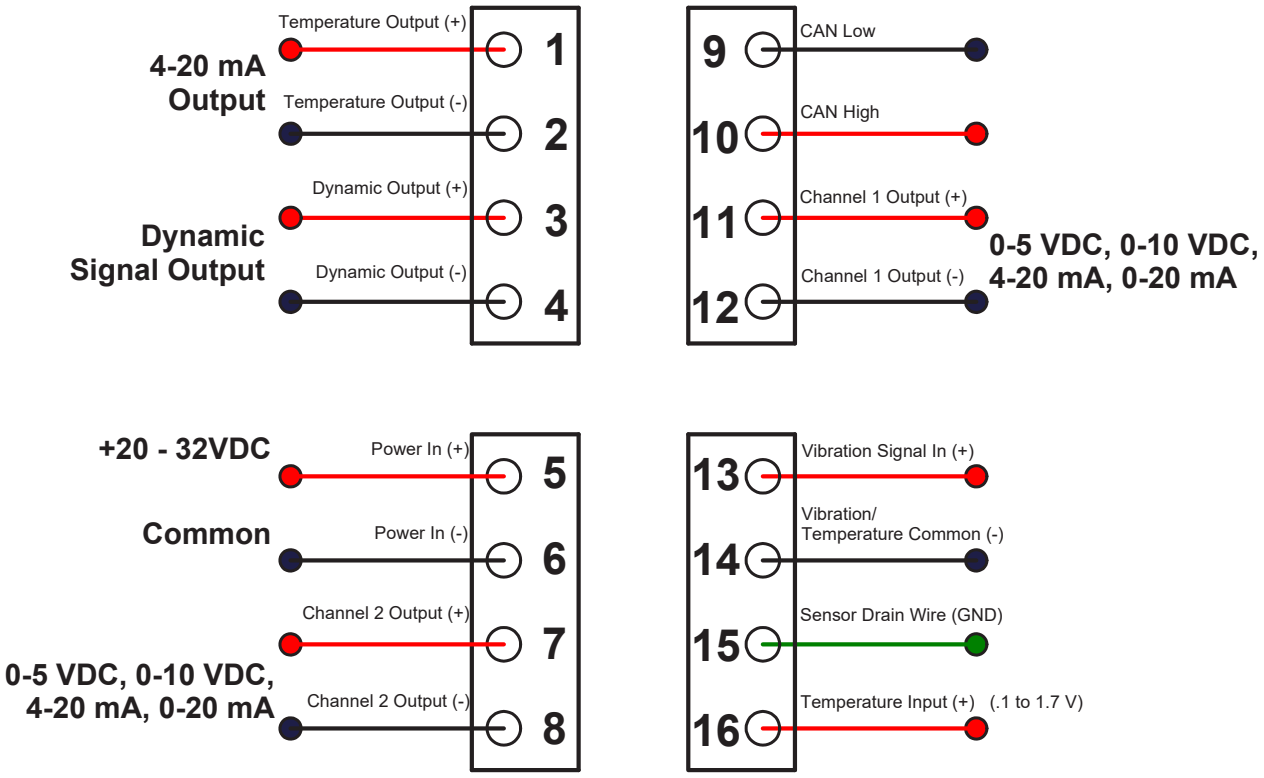


Figure 1. Signal Conditioner Electrical Wiring Diagram for Two Channel IEPE Accelerometer Input, with Temperature

1. Connect the +20 - 32 V_{DC} power lead to the terminal marked 5 and the negative or common to the terminal marked 6.
2. For single channel accelerometer input connection, wire the sensor leads to 13(+), 14(-), and 15(shield drain wire) as shown in Figure 1. If using a TA series sensor, the temperature out lead is attached to terminal 16.
3. Connect the output device to terminals 11(+) and 12(-) for channel one's 4-20 mA signal proportional to the vibration level.
4. Connect output device to terminals 1(+) and 2(-) to obtain the 4-20 mA signal representative of temperature level.
5. Connect the output device to terminals 7(+) and 8(-) to obtain channel two's 4-20 mA signal proportional to the vibration level.
6. The dynamic signal output can be obtained from the BNC connector at the top of the signal conditioner or from terminals 3(+) and 4(+).

Figure 2. Signal Conditioner — Dynamic Signal Output BNC

Terminal connections are also listed on the side of the signal conditioner.

Wiring for Biaxial/Triaxial Accelerometers

The SC300 series signal conditioners are compatible with biaxial and triaxial sensors; however, the wiring will be different than connecting a single-axis accelerometer or piezo-velocity sensor. Each vibration input will require a unique signal conditioner, so a triaxial sensor will require three SC300 units, and each biaxial sensor will require two SC300 units. Each axis of vibration will have its own signal conductor wire, which will then be run to a separate SC300 on terminal 13. The black common conductor will be run to one of the signal conditioners at terminal 14, **then must be daisy chained** to terminal 14 of the remaining signal conditioners. For more information or questions, please contact CTC.

Mounting

The signal conditioner is designed to be mounted on a 35 mm DIN rail. The mounting clip is spring-loaded to facilitate simple permanent locating. To remove the signal conditioner, use a small flathead screwdriver as a lever on the spring-loaded mounting clip. With the clip disengaged, slide the signal conditioner from the mounting rail.

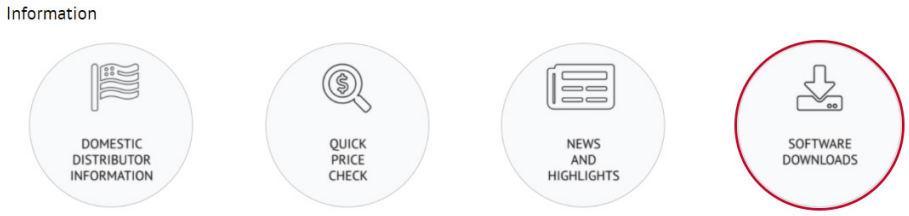
Signal Conditioner Configuration

Requirements

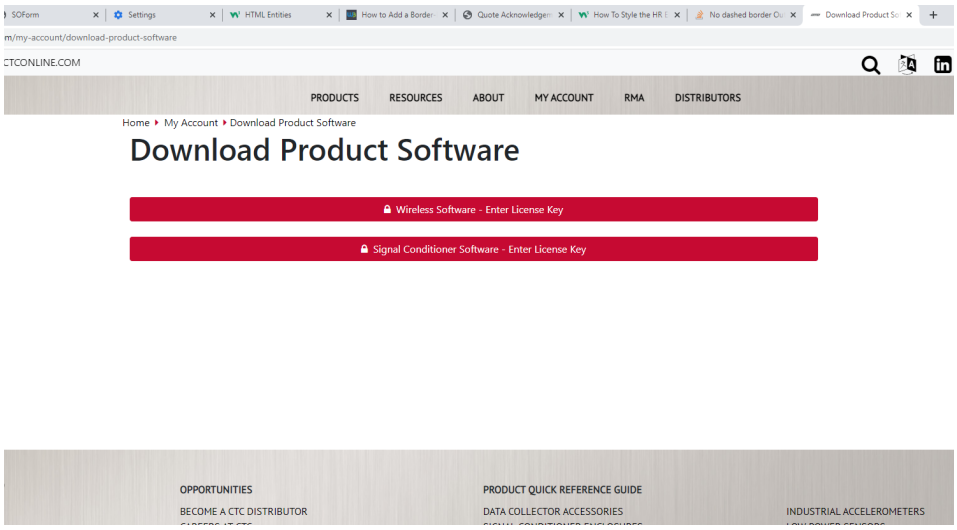
- Windows 10 minimum build version: 1703 ***or*** .NET Framework 4.7.2 (*https://dotnet.microsoft.com/download/dotnet-framework/thank-you/net472-web-installer*)
- Approximately 1 GB of free storage (5GB recommended) to create application files, log files, and database records.

Installing the Configuration Software

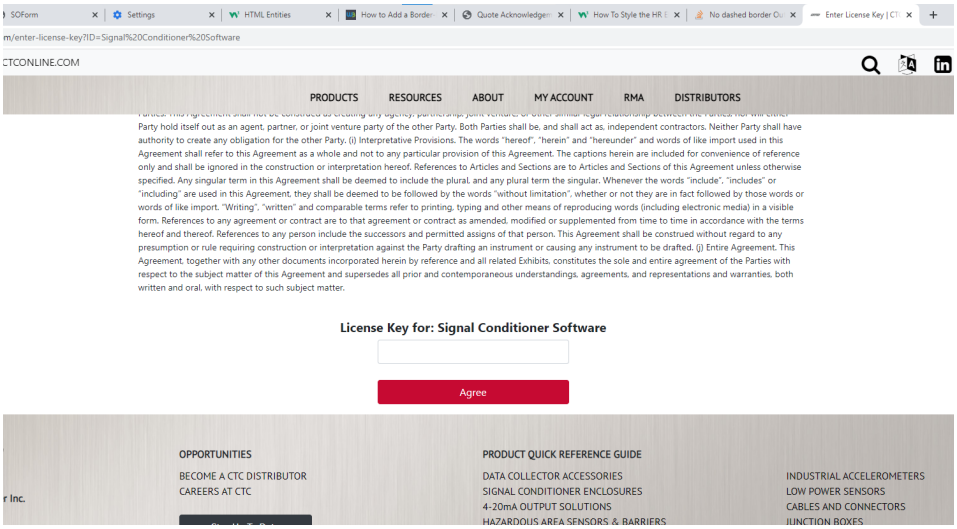
1. Log into your account on the CTC website.
   a. On the resulting page, scroll down to the information panel, and click the "Software Downloads" button.



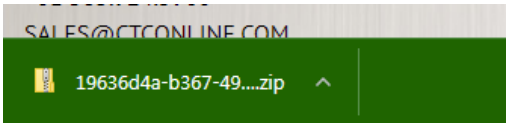
2. Click the Signal Conditioner Software button.



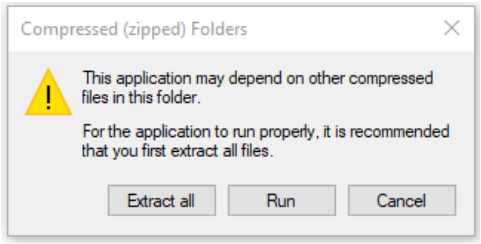
   a. If you have not downloaded the signal conditioner software previously, you will be prompted to insert a liscence key. This is the serial number of your signal conditioner.



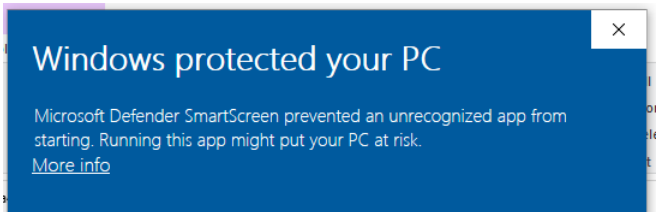
3. A compressed .zip folder will download. Find this in your browser's download manager and open the file.



   a. A window may pop up asking about compressed folders. Click Extract all.

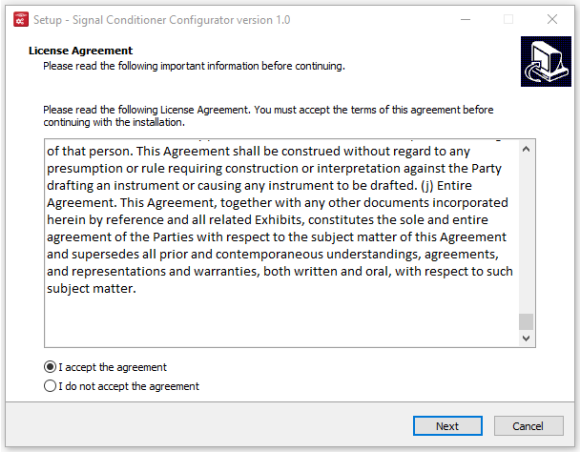


4. Double click the .exe file located in the folder to launch the installer.
   a. Windows security might attempt to block the installer on launch. If this is the case, click the "More info" line.

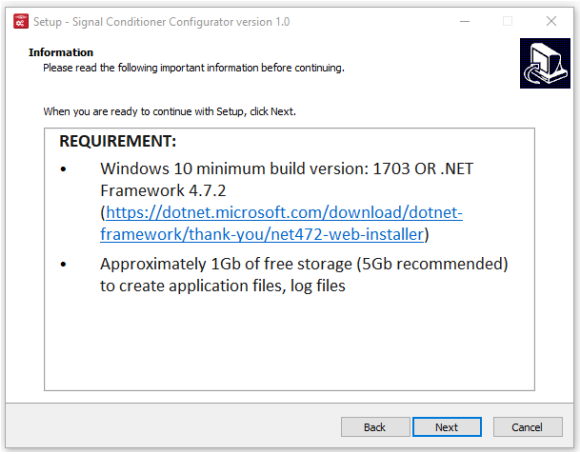


   b. Click the Run Anyway button. This will launch the software installer.

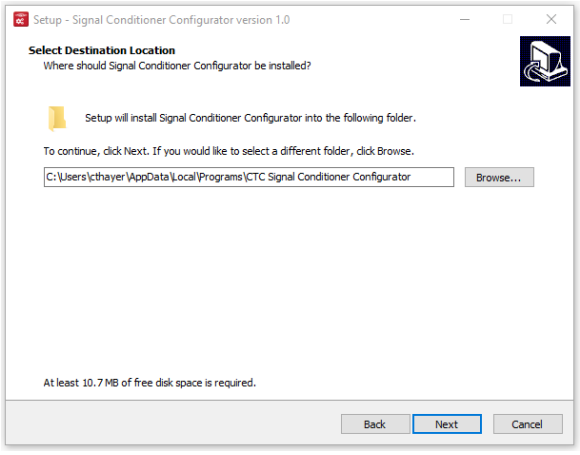
5. Read and accept the licence. Click Next.



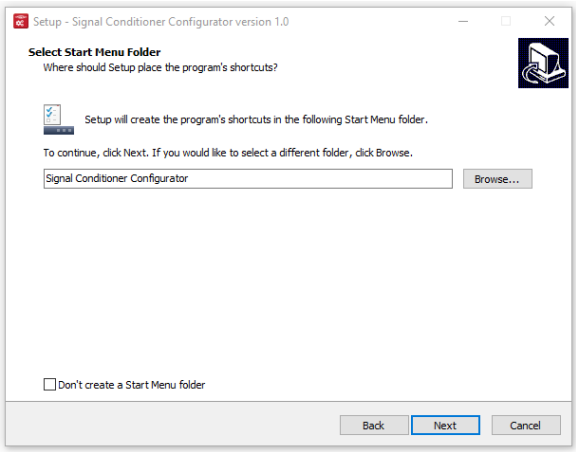
6. Review the system requirements. Click Next.



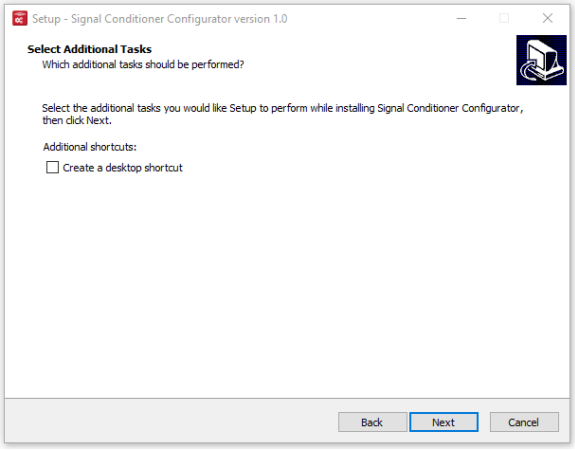
7. Review the location for the program files to be installed. If a different location is preferred, click Browse, and set the new destination. Click Next.



8. By default, the program will add a launch button to the Windows Start Menu. If this is not desired, click the “Don’t create a Start Menu folder” checkbox. Click Next to proceed.

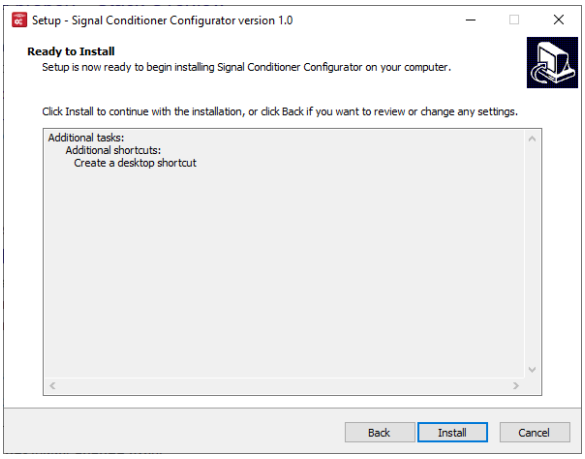


9. If a desktop icon is desired, click the "Create a desktop shortcut" checkbox. Click Next.



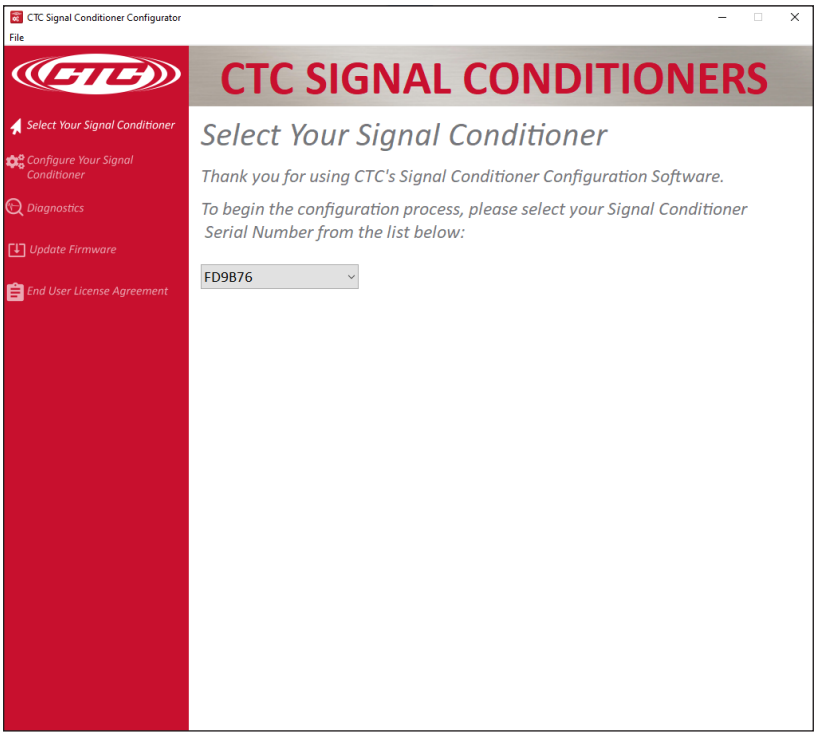
   a. For ease of access, it is highly recommended to include either a desktop icon or a Windows Start Menu launcher. If neither of these options were included during installation, it is still possible to launch the software by typing "Signal Conditioner Configurator" in the Windows search bar.

10. Click Install to finalize installation preferences and install the program to the computer.



Running the application

When you run the CTC Signal Conditioner Application, the first thing that will appear is a device select screen. This is where all units currently plugged into the computer will appear. If no Signal conditioners are plugged in to the computer, a pop up window will display requesting that one be connected. **Note:** It is currently discouraged to plug multiple devices in at the same time due to a limitation of the USB serial drivers that cause the devices to lock up if any two USB COM ports read or write at the same time. If this occurs, unplugging the devices should resolve the issue. From this window, if a signal conditioner is connected to the computer, it will appear automatically in the list and will be selected as soon as it's detected.



Clicking the Configure Your Signal Conditioner button on the left of the screen will take you to the page in Figure 3.

Configuration Software

There are several different controls for changing the configuration of the selected device. The Part Number text box will display the part number for the currently selected configuration values. The Part Number text box will also change the selected configuration values if a part number is typed or pasted into the box.

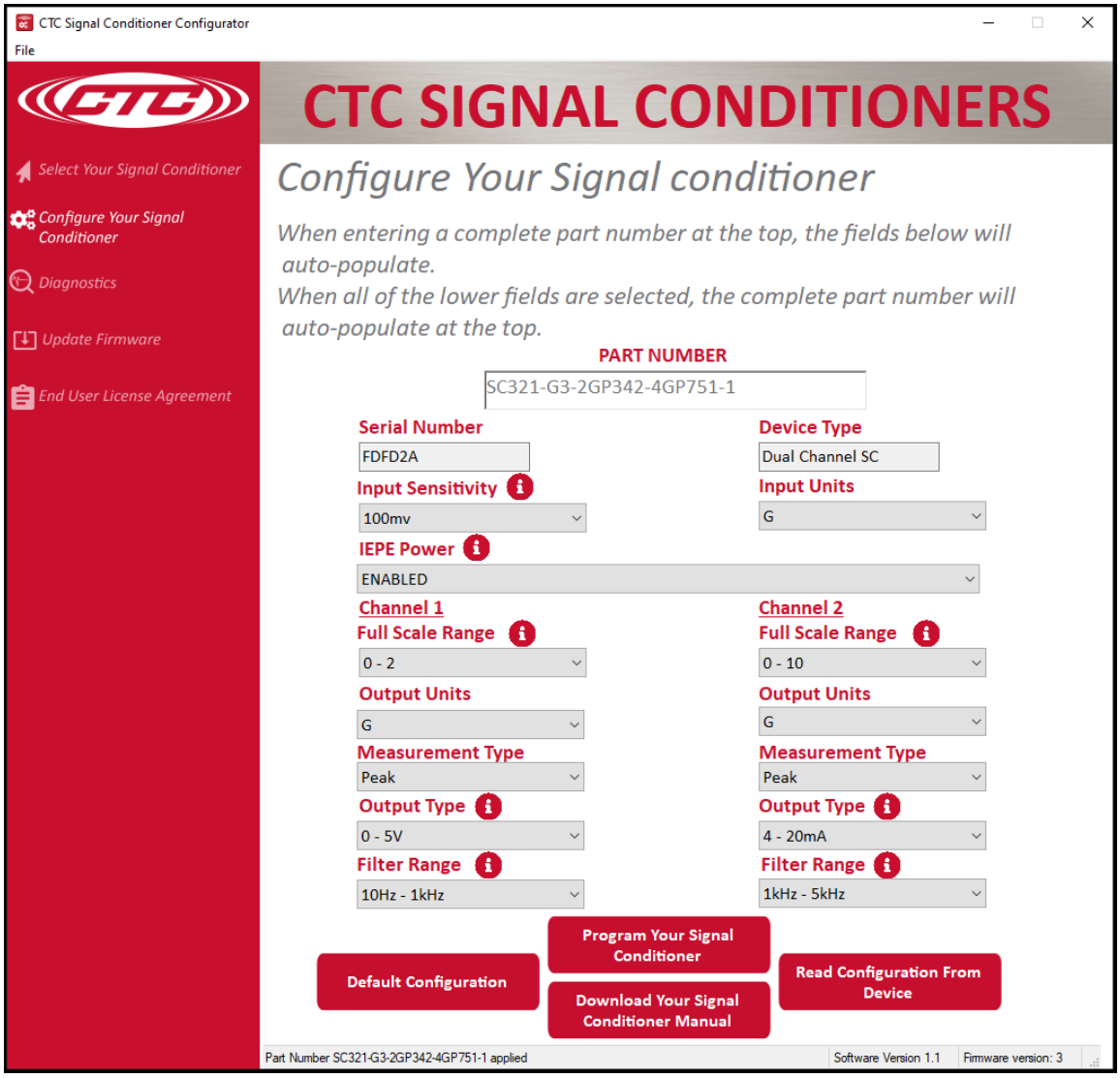


Figure 3. Signal Conditioner Configuration Window

The Serial Number box will display the serial number of the currently selected device.

The Device Type box will show whether the currently selected Signal Conditioner is Single Channel or Dual Channel.

In the configuration tab are the configuration settings for the unit. The "Input Sensitivity" and "Input Units" dropdown menus define the sensor connected to the signal conditioner. Input Sensitivity refers to the sensor's sensitivity, and the input unit refers to the sensor's measurement type (g's for acceleration, IPS and mm/s for velocity, and mils for displacement). In Figure 3, the signal conditioner is configured to accept input from a 100 mV/g accelerometer. It is essential that this correctly matches the sensor type used to ensure proper scaling and accurate calculations. The software will allow you to use combinations of input sensitivity and input units that do not currently exist as sensors. If you do this, the software will alert you that the "Part number is invalid or the software is out of date. Config can still be applied" and produce a part number with a space in it.

The "IEPE Power" dropdown menu controls whether or not the built-in IEPE supply on the device is enabled or disabled. In Figure 3, the IEPE power supply is configured to "ENABLED," so once configured and plugged in, the signal conditioner will supply a constant 4 mA to the sensor. The sensor input and thus settings described above are shared by both channels. Below, the "IEPE Power" dropdown menu is where each channel's scaling settings are configured.

"Full-Scale Range" corresponds to the dynamic range of the measurement and, combined with "Output Units," make up the scaling for the output control signal. The maximum selectable full-scale range is dependent on the sensor sensitivity. For more information, please visit *https://documents.ctconline.com/archive/full-scale-range-limitations*. The output unit selections are the same as the input unit selections and depend on the sensor type. The output unit can either be straight through or integrated. In a straight-through configuration, the output unit matches the sensor input unit (e.g., g's in and g's out). In an integrated configuration, the output is integrated and then measured (e.g., an accelerometer signal in g's can be integrated to measure velocity in either IPS or mm/s). Conversion can also take place between mm/s and IPS. The "Measurement Type" describes how the signal conditioner measures the sensor signal for scaling calculations. This can be either peak, peak to peak, or RMS, peak hold.

For example, the input sensor in Figure 3 is 100 mV/g, the full-scale range of Channel 1 is 0-2 with a unit of g's, and the measurement type is peak. Therefore, a midscale condition will occur when the sensor outputs a signal corresponding to 1 g peak (halfway between 0 g and 2 g). If the measurement type were RMS instead, a mid-scale condition would occur if the RMS of the sensor signal was equal to 1 g (a peak value of 1.414 g). If the signal was integrated and the output unit was IPS, a mid-scale condition would occur if the sensor were outputting a signal corresponding to 1 IPS after integration.

The “Output Type” dropdown determines what kind of process signal each channel will output. Selectable options are 0-20 mA, 4-20 mA, 0-5 VDC, and 0-10 VDC. The level of the output signal corresponds to where it falls in the full-scale range. So, continuing the example from Figure 3, if the signal from Channel 1 is at midscale vibration (1g peak for this configuration), and the output type is 0-5 VDC, then the output signal will read 2.5 V.

The “Filter Range” describes the cutoff frequencies of a digital bandpass filter used to filter the sensor signal on each channel. In the configuration in Figure 3, Channel 1’s frequency range is 10 Hz - 1 kHz. Channel 1 will attenuate frequencies below 10 Hz and above 1 kHz. To maximize precision, it is beneficial to keep the primary frequencies of interest in the middle of the passband. There are also computational limitations that put a limit on bandwidth for filtering. If it is necessary to observe frequencies from 10 Hz to 5 kHz, this will not work on a single channel. Having multiple configurable channels is advantageous in these situations. Channel 1 could be set to measure frequencies from 10 Hz to 1 kHz, and Channel 2 could handle frequencies from 1 kHz to 5 kHz. This is also useful to split up the output units, such as integrating for velocity on Channel 1 and monitoring Channel 2 for acceleration.

The “Default Configuration” button will load all dropdown menus with the standard ISO configuration, corresponding to a 100 mV/g sensor in and IEPE Power on. Channel 1 will display a 0-2 full-scale range, IPS output units, RMS, and a frequency range of 10 Hz - 1 kHz. Channel 2 will display a 0-10 full-scale range, output units of G, Peak, and a frequency range of 1 kHz - 5 kHz. Both channels will show 4-20 mA.

The “Read Configuration From Device” button will clear whatever configuration is currently selected and replace it with the last one saved on the device (only on devices above firmware version 2). This happens every time a device over firmware version 2 is connected, and this button is meant to allow you to see what was previously configured without unplugging the device. The feature will falsely claim that the filters are 10 Hz-1 kHz and 1 kHz-5 kHz after updating past firmware version 2 until the device is programmed again. This error is because the device will not know what the previous filters were before firmware version 2.

Once the desired configuration is set, the device will need to be programmed by pressing the “Program Your Signal Conditioner” button. A new window will pop up and show the current progress. If this process fails, be sure to read the troubleshooting guide. The “Update Firmware” tab shown in Figure 4 is where the user can update the signal conditioner’s firmware by clicking “Update Firmware.”

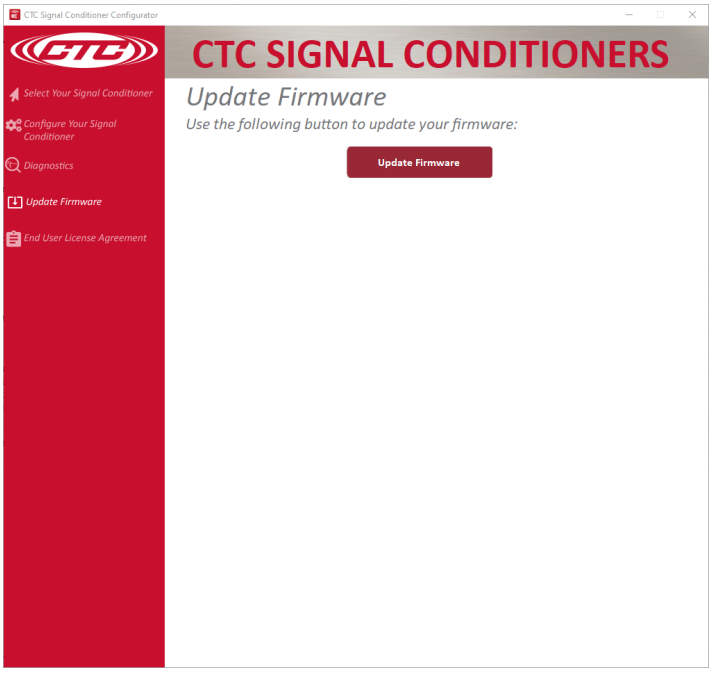


Figure 4. Update Firmware

The Diagnostics tab shown in Figure 5 is where device errors and warnings can be read off the signal conditioner (see Indicators in the Operation section) by clicking "View Errors." If errors are present on the device, View Errors will read them and display information about the error(s) for corrective action. Any errors that appear may be cleared from the device by clicking the "Clear Errors." Both operations are done via the USB port, like when programming the device.

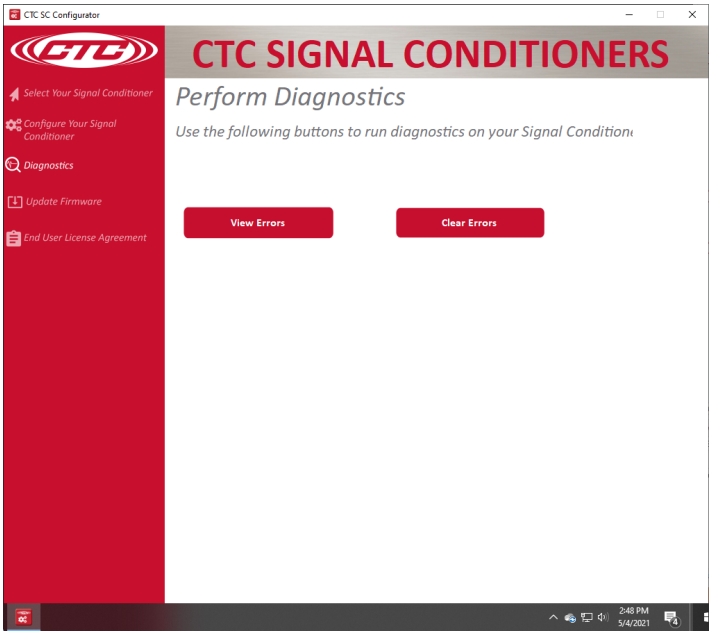
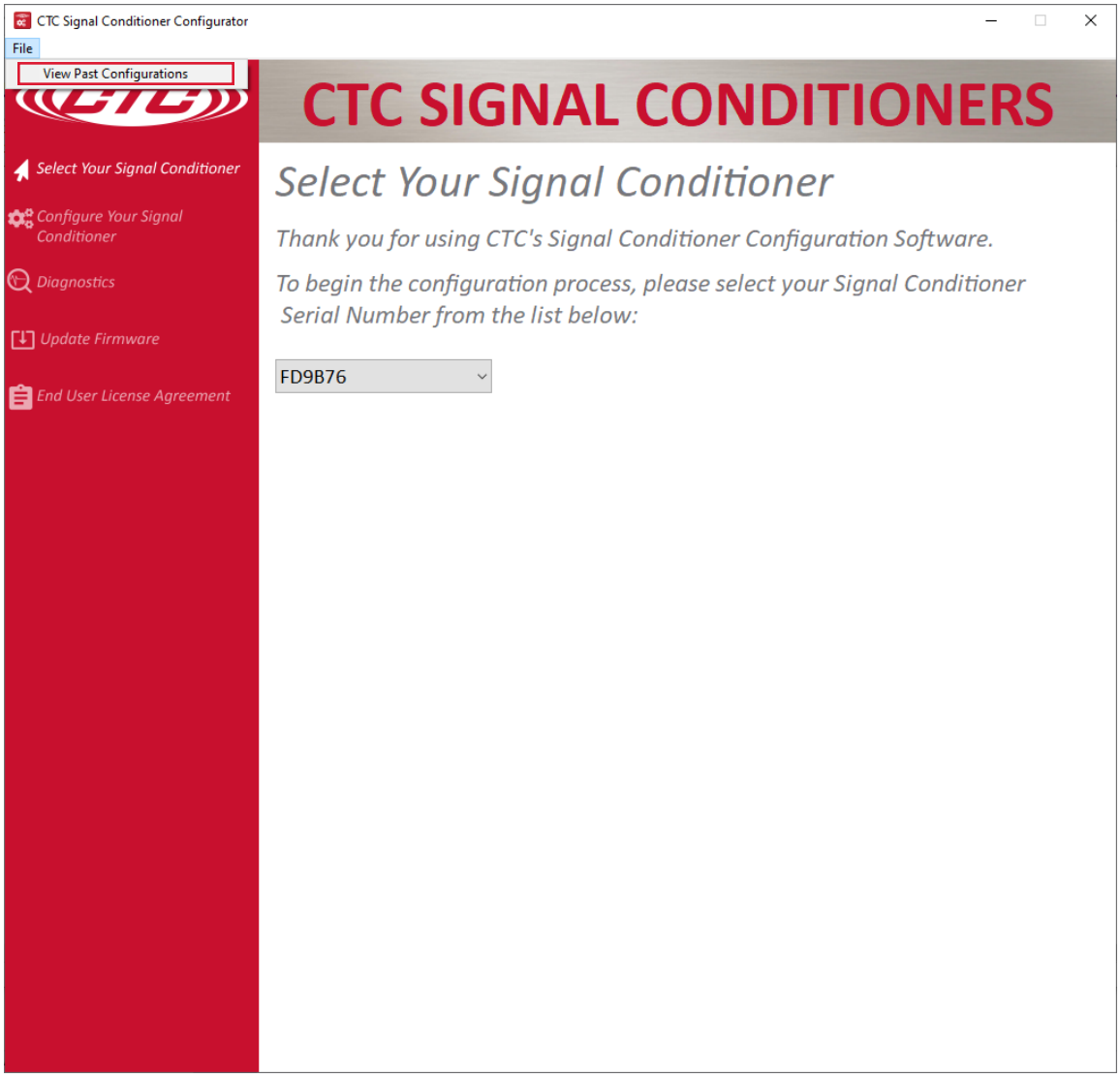


Figure 5. Diagnostics

Accessing Configuration History

Clicking “File” in the top menu will allow the user to select an option to view previous configurations. Selecting this option will open the computer’s default text file viewer with a log containing the date, time, serial number, part number, and full configuration.



Operation

Once all wires are connected, apply power to begin operating the signal conditioner. Make sure the status light settles to normal mode.

Note: When the software reports an error, it does not necessarily mean that the error is currently present on the signal conditioner. It just means that the error has been encountered at some time and recorded for reporting. For example, if the signal conditioner was powered before any output wiring was complete, the device will record an output error. If wiring is then completed, the output error will go away if the wiring is correct but would show up in an error report if not cleared. Always reference the LED indicator for live device status, and remove any erroneous/out-of-date errors.

Calibration

The signal conditioner is calibrated internally during startup. The digital calibration eliminates the need for any adjustments to the analog output.

Indicators

The LED on the front of the signal conditioner will indicate the status of the signal conditioner.

State 1 - Normal Operation

- LED is solid green

State 2 - Input Short Detected

- LED is rapidly flashing red

A short circuit is indicative of a lack of electrical resistance, removing the ability to measure the impact from a change in voltage. This instance is largely driven by an incorrect wiring setup. Verify that all wiring connections are attached in the correct polarity, and that no signal and common wires are touching. Ensure that the signal conditioner is configured with IEPE power ON if the sensor is not being powered from any separate source. Lastly, ensure that the system is free of water and other contaminants.

State 3 - Input Open Detected

- LED is solid red

An open circuit implies a physical disconnect somewhere on the electrical path of the circuit. When receiving this error, verify that there is no physical separation within the system, such as unattached or broken cabling. Be sure that the connector is firmly secured to the accelerometer, and that the accelerometer is in good working order.

State 4 - Device Warning Detected

- LED is flashing green in 1-second intervals

A detected warning can be due to several things, such as incorrect output wiring (e.g., an open circuit detected on a current output or a short circuit detected on a voltage output) or corrupted configuration memory. The device will still be processing input data. However, it may be running in a reduced state or return unexpected results (e.g., if memory is corrupted, the unit will default to the standard ISO configuration until reprogrammed). If this state is detected, carefully inspect all wiring for secure connections and cycle power to the device. If the warning persists, the configurator can be used to determine the root cause and corrective action.

State 5 - Fatal Error

- LED is flashing red in 1-second intervals

In the case of a fatal error, the device has detected some non-recoverable hardware issue which could have been caused due to physical damage or misuse. Processing will be disabled in this case. Communication with the configurator may or may not work depending on the root cause but should be attempted as it may state the error that occurred. In some cases, cycling power to the device can remedy the issue.

State 6 - Programming and Startup

- LED is solid orange

This state occurs when the signal conditioner starts up, confirms there is an available configuration, and sets up its peripherals and outputs. If the USB cable is connected and plugged into a PC, this state will persist. Plugging in the USB cable at any point will also cause the device to enter this state. Regular operation will not occur while the USB cable is plugged in.

State 7 - Bootloader

- LED is flashing between red and green

This state occurs during device startup and indicates the bootloader is running. This state will persist if new firmware is being written for the duration of the update. If no firmware update handshake is received from the configurator within 5 seconds, the device leaves this state and continues with the startup.

Temperature Output Guide

This chart is for reference purposes only and illustrates typical temperature output signal behavior. This chart is not based on actual test results, nor does it map an exact voltage from the temperature sensor to an exact 4-20 mA value. This functionality is only applicable with a CTC TA200 Series dual output sensor.

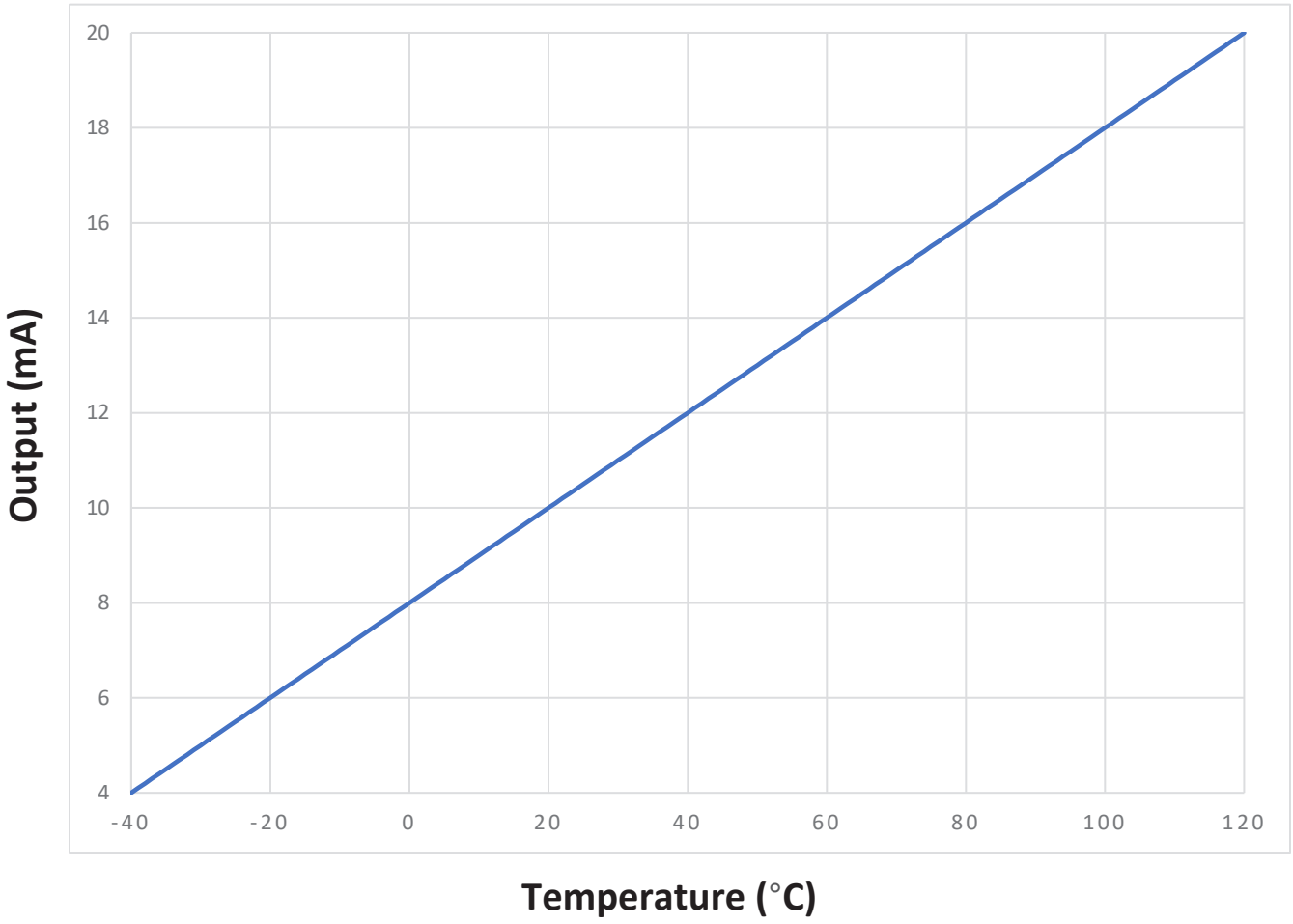


Figure 6. Sample Temperature Output Chart

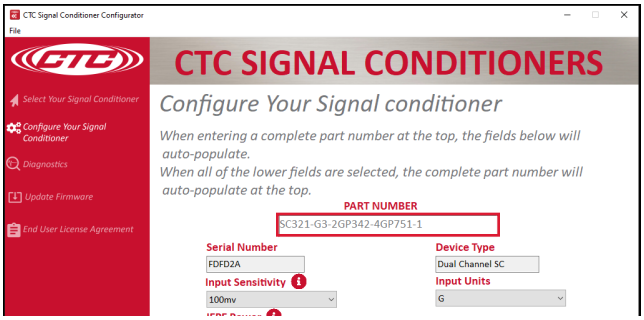
Portable Data Collector Interfacing

When collecting waveform data from the BNC jack on the signal conditioner using a portable data collector that supplies constant current power, it is recommended that the data collector is configured so that power to the sensor is turned off. Although the BNC connector circuitry offers short circuit protection and can safely sink the current, long-term degradation may occur due to increased power dissipation depending on the magnitude of the IEPE current. There is no need for the data collector sensor power to be turned on for the data collection to be made, and it is the safest way to make measurements if possible.

Figure 7. Signal Conditioner, BNC

Verifying Driver Support for Configuration

If the SC300 is correctly connected via USB and the software properly installed, the serial number of the device will appear in the dropdown menu.

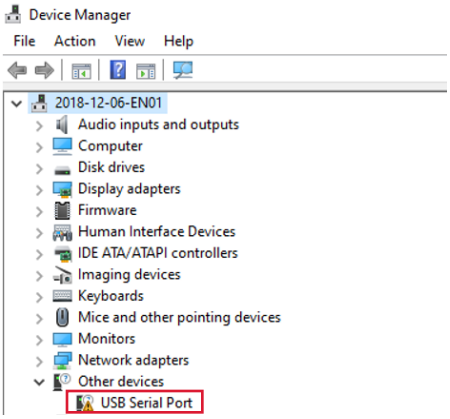


If a serial number doesn't appear, follow the troubleshooting steps below.

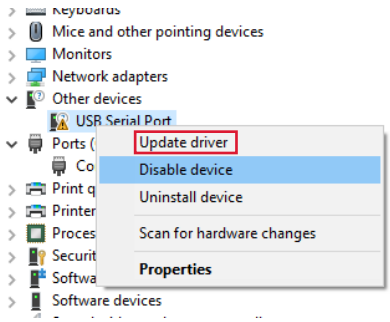
- Check the USB connection to make sure it is secure.
- Confirm that the LED indicator on the SC300 unit is lit up with a solid orange light (LED will blink when first plugged in and should then turn solid orange).

If both steps above are confirmed, then the device might be missing critical PC drivers needed to read the USB.

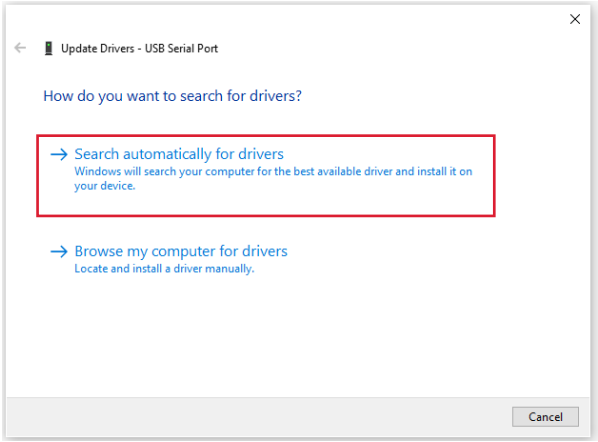
In this case, navigate to the Device Manager program (through the Start menu on Windows Devices) and look for the drop-down menu on the left side of the page.



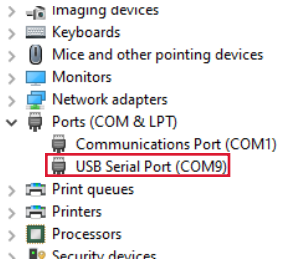
Look for and select the “Other Devices” option, then right-click on “USB Serial Port.” Select the “Update Driver” option.



Select “Search Automatically for Drivers,” and the computer should search for and install the necessary driver.



If the driver updates correctly, there will no longer be a “USB Serial Port” option in the “Other Devices” section, and a new option will appear in the “Ports” section of the drop-down tree.



Once this is completed, open the CTC Signal Conditioner program. The SC300 will appear with a serial number, and all functions will perform correctly.

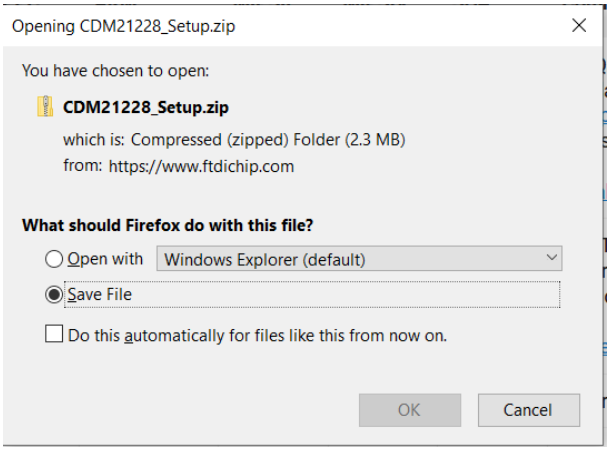
If a notification appears that there is no available upgrade, the driver will have to be installed manually.

The first step is to go to the link below –
https://ftdichip.com/drivers/vcp-drivers/

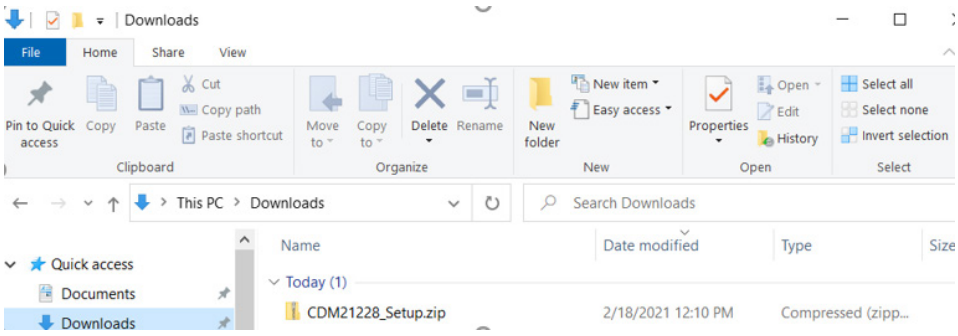
Scroll down to the download link section and select the setup executable option on the left side.

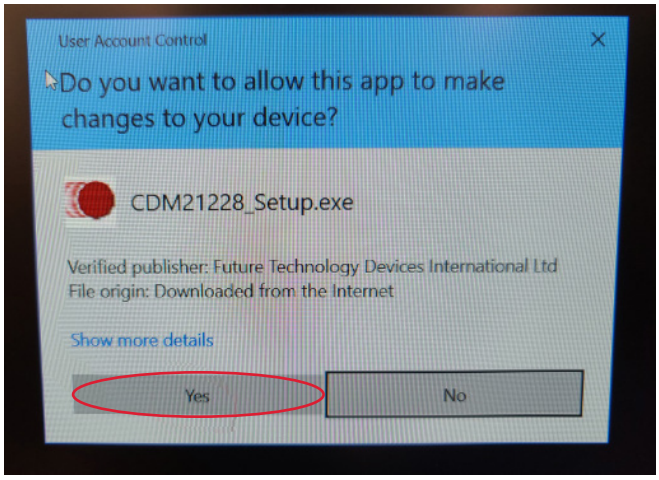
Operating System	Release Date	X86 (32-bit)	X64 (64-bit)	PPC	ARM	MIPSII	MIPSIV	SH4	Comments
Windows*	2017-08-30	2.12.28	2.12.28	-	-	-	-	-	WHQL Certified. Includes VCP and D2XX. Available as a setup executable Please read the Release Notes and Installation Guides.

Save the file – it will be saved as CDMXXXX_Setup.

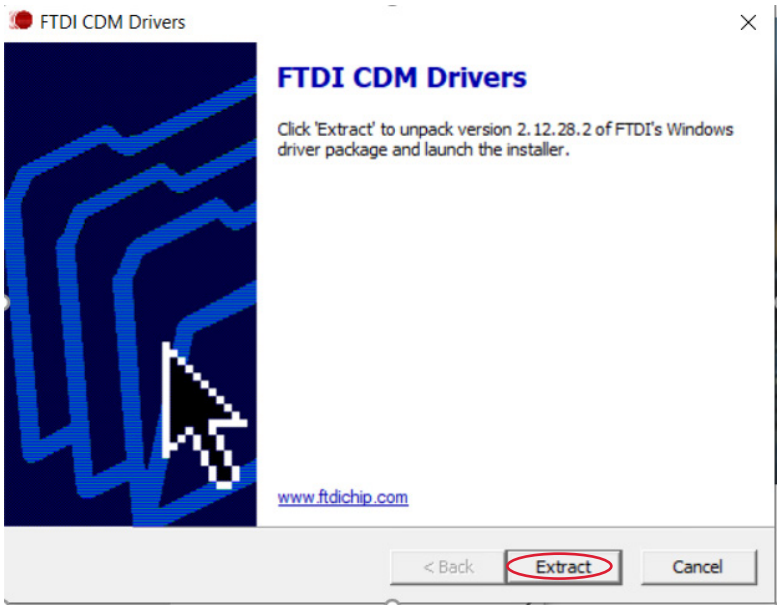


Retrieve the file from the Downloads section of your File Manager, and run the program.

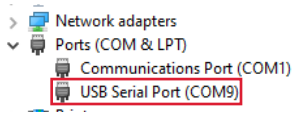




A standard installation wizard will open. Follow it to completion.



When this is complete, return to the Device Manager. If all is correct, USB Serial Port (ComX) will be displayed in the Ports section of the drop-down menu.



When this appears, open the CTC Signal Conditioner program. The SC300 will appear with a serial number, and all functions will perform correctly. Please feel free to contact CTC for any technical assistance.

Troubleshooting

Troubleshooting the Software

Problem Description	Recommended Actions
Application does not open	Verify that the minimum requirements for the software are met. Reinstall the software. Read the log file located in the install directory.
USB device not recognized	Make sure the drivers for the device are installed. A new COM port should be displayed in Device Manager a few seconds after the device is plugged in and the LED has turned Amber. If the drivers are not installed see the Verifying Driver Support for Configuration page. The device may take as long 40 seconds for the software to recognize the signal conditioner. This will be especially true with signal conditioners older than firmware version 2. Try unplugging the signal conditioner and closing the software. Only have one signal conditioner plugged in at a time. Try using a different USB cable. Try using a different USB port. Check wiring for correctness/ robustness; ensure signal conditioner is not tied to earth/chassis ground.
View Errors/Clear Errors/Program Device failed	Try unplugging the signal conditioner and closing the software. Only have one signal conditioner plugged in at a time. Update to latest firmware version.

Troubleshooting

Troubleshooting the Hardware

Problem Description	Recommended Actions
4-20 mA or 0-5/10 V_{DC} output is non-functional	Check status LED; ensure signal conditioner is in Normal mode. Ensure it was correctly programmed and make sure all wiring is correct. Refer to Figure 1 for wiring diagram. Use the configurator's error reporter to read potential hardware issues.
No waveform data from BNC jack	Check status LED; ensure signal conditioner is in Normal mode. Make sure sensor is properly wired. Refer to Figure 1 for wiring diagram. Ensure the sensor power option is correctly programmed.
4-20 mA or 0-5/10 V_{DC} output is lower than expected	Check filter settings. Make sure low-pass and high-pass filters have been set to range capable of capturing the expected frequencies. Ensure the rest of the configuration is correct.
4-20 mA signal is less than 2 mA	Check output cabling for damage. Ensure load resistance is no more than 1 kΩ.
Filter data or configuration profile did not send correctly	Ensure that the connection to the PC is secure and did not come loose during programming. Also make sure that the signal conditioner does not lose power during programming. LED status light should remain solid orange while plugged in. Check that the configuration is correct and try programming again.

Problem Description	Recommended Actions
Open circuit detected on CH1	Check output wiring, ensure all connections are present and secure, there are no breaks in the wires, and there is no exposed conductors that can cause short circuits. Ensure that the end measurement device (DCS, DAQ, PLC, multimeter, etc.) is correctly configured to read the signal conditioner's output signal (current for 0-20/4-20 mA, voltage for 0-5/0-10 V_{DC}). If a resistive load is being used for measurement, ensure it is properly valued. Load should be 1k Ω minimum for voltage configurations. For current configurations, load must be configured so that compliance voltage (voltage powering the device) is not exceeded (1k Ω maximum recommended for a compliance voltage of 24 V_{DC}).
Short circuit detected on CH1	
Open circuit detected on CH2	
Short circuit detected on CH2	
CH1 overheat detected	The signal conditioner detected a temperature outside of its operating range while running. Ensure operating environment/enclosure does not exceed 80 °C.
CH2 overheat detected	
Hardware configuration error	Power cycle the device. Check wiring for correctness/ robustness; ensure signal conditioner common is NOT tied to earth/chassis ground. Try re-programming. Try setting to ISO.
Internal communication bus fault	

Problem Description	Recommended Actions
No response from signal conditioner when programming	Ensure that the connection to the PC is secure and did not come loose during programming. Also make sure that the signal conditioner does not lose power during programming. LED status light should remain solid orange while plugged in. Check that the configuration is correct and try programming again.
Error writing configuration to memory	Close the application and reconnect the signal conditioner and attempt to reprogram the device. If communication errors persist, follow the USB device not recognized section in the Troubleshooting the software section of the user manual.
Configuration memory corrupted	
Error configuring CH1	
Error configuring CH2	
Error configuring CH1 (CRC)	
Error configuring CH2 (CRC)	
Once installed and connected to an online system (PLC, DCS, SCADA), the values that the system receives do not match what is expected (too high, too low, etc.)	Ensure that the PLC/DCS input settings (unit, scaling, filtering) match the chosen configuration of the signal conditioner exactly. Confirm wiring from the signal conditioner to the system is correct according to manual instructions and diagram, with consideration for noise, along with radio frequency and electromagnetic interference. **Note:** the SC300 Series signal conditioner features shared commons between each channel and between multiple units if wired into one of our SCE or SCD enclosures. The SC300 does not require an isolated analog input card for the monitoring system. Ensure that there is a strong earth ground connection to avoid noise and loop interference.

Software End User License Agreement

This END USER LICENSE AGREEMENT ("Agreement"), is a binding agreement between Connection Technology Center, Inc., a New York corporation, with offices at 7939 Raw Boulevard, Victor, NY 14564 ("CTC") and the entity registered with CTC ("Licensee") as the purchaser of the SC300 Series signal conditioner (the "Signal Conditioner"). Licensee and CTC are individually hereinafter referred to as a "Party" and collectively as the "Parties".

THE SIGNAL CONDITIONER IS A PROPRIETARY PRODUCT MANUFACTURED AND MARKETED BY CTC THAT IS DESIGNED TO MONITOR THE INTERNAL BEARINGS OF INDUSTRIAL EQUIPMENT FOR FAILURE AND REPLACEMENT. CTC HAS DEVELOPED SOFTWARE ("Software") TO, AMONG OTHER THINGS, INTERFACE WITH THE SIGNAL CONDITIONER TO TRACK INPUT READINGS AND PROVIDE ALERTS BASED ON USER DEFINED LIMITS AND VARIANCES. CTC PROVIDES THE SOFTWARE SOLELY ON THE TERMS AND CONDITIONS SET FORTH IN THIS AGREEMENT AND ON THE CONDITION THAT LICENSEE ACCEPTS AND COMPLIES WITH THEM. BY ENTERING THE SERIAL NUMBER FROM THE SIGNAL CONDITIONER IN THE BOX AND CLICKING "ACCEPT" YOU (A) ACCEPT THIS AGREEMENT AND AGREE THAT LICENSEE IS LEGALLY BOUND BY ITS TERMS; AND (B) REPRESENT AND WARRANT THAT YOU HAVE THE RIGHT, POWER, AND AUTHORITY TO ENTER INTO THIS AGREEMENT ON BEHALF OF LICENSEE AND BIND LICENSEE TO ITS TERMS. IF LICENSEE DOES NOT AGREE TO THE TERMS OF THIS AGREEMENT, CTC WILL NOT AND DOES NOT LICENSE THE SOFTWARE TO LICENSEE AND THE SOFTWARE AND DOCUMENTATION MUST NOT BE DOWNLOADED.

1. Definitions. Unless otherwise specifically provided, and in addition to the other defined terms set forth herein, the following terms will have the meanings set forth below:

   "Authorized Users" means persons authorized by Licensee to use and access the Software solely for Internal Business Purposes and in accordance with the terms and conditions of this License, including Licensee's employees, consultants, and contractors.

   "Documentation" means user manuals, technical manuals, and any other materials provided by CTC, in printed, electronic, or other form, that describe the installation, operation, use, or technical specifications of the Software.

   "Intellectual Property Rights" means any and all registered and unregistered

rights granted, applied for, or otherwise now or hereafter in existence under or related to any patent, copyright, trademark, trade secret, database protection, or other intellectual property rights laws, and all similar or equivalent rights or forms of protection, in any part of the world.

"Internal Business Purposes" means purposes directly related to Licensee's use of a Signal Conditioner in its internal business operations as permitted by this Agreement and expressly excludes direct or indirect distribution of the Software as a stand-alone offering to third parties independent of Licensee's use of a Sensor.

"Person" means an individual, corporation, partnership, joint venture, limited liability company, governmental authority, unincorporated organization, trust, association, or other entity.

"Software" has the meaning set forth above but refers only to the object code version made available by CTC to Licensee for download.

"Territory" means the United States.

2. License Grant and Scope. Subject to and conditioned upon Licensee's strict compliance with all terms and conditions set forth in this Agreement, CTC hereby grants to Licensee a non-exclusive, non-transferable, non-sublicensable, limited license in the Territory during the Term to, solely by and through its Authorized Users: (a) download and install in accordance with the Documentation a copy of the Software on a server owned or leased, and controlled by, Licensee; (b) use and run such Software for Internal Business Purposes; (c) download or otherwise make copies of the Documentation solely for Internal Business Purposes in support of its licensed use of the Software; and (d) make a reasonable number of copies of the Software and Documentation for disaster recovery, backup, testing and archival purposes, Any copies of the Software or Documentation made in accordance with this license (i) will remain the exclusive property of CTC; (ii) will be subject to the terms and conditions of this Agreement; and (iii) must include all trademark, copyright, patent, and other Intellectual Property Rights notices contained in the original.

3. Third-Party Materials. The Software may include software, content, data, or other materials, including related documentation, that are owned by Persons other than CTC and that are provided to Licensee on licensee terms that are in addition to and/or different from those contained in this Agreement

("Third-Party Licenses"). A list of all materials, if any, included in the Software and provided under Third-Party Licenses is set forth on Schedule A to this Agreement, and the applicable Third-Party Licenses are accessible via links therefrom. Licensee is bound by and shall comply with all Third-Party Licenses. Any breach by Licensee or any of its Authorized Users of any Third-Party License is also a breach of this Agreement.

4. Use Restrictions. Licensee shall not, and shall require its Authorized Users not to, directly or indirectly:

   (a) use (including make any copies of) the Software or Documentation beyond the scope of the license granted under Section 2;

   (b) provide any other Person, other than an Authorized User, with access to or use of the Software or Documentation;

   (c) modify, translate, adapt, or otherwise create derivative works or improvements, whether or not patentable, of the Software or Documentation or any part thereof;

   (d) combine the Software or any part thereof with, or incorporate the Software or any part thereof in, any other programs;

   (e) reverse engineer, disassemble, decompile, decode, or otherwise attempt to derive or gain access to the source code of the Software or any part thereof;

   (f) remove, delete, alter, or obscure any trademarks or any copyright, trademark, patent, or other intellectual property or proprietary rights notices provided on or with the Software or Documentation, including any copy thereof;

   (g) except as expressly set forth in Section 2, copy the Software or Documentation, in whole or in part;

   (h) rent, lease, lend, sell, sublicense, assign, distribute, publish, transfer, or otherwise make available the Software, or any features or functionality of the Software, to any third party for any reason, whether or not over a network or on a hosted basis, including in connection with the internet or any web hosting, wide area network (WAN), virtual private network (VPN), virtualization, time-sharing, service bureau, software as a service, cloud, or other technology or service;

   (i) use the Software or Documentation in, or in association with, the design, construction, maintenance, or operation of any hazardous environments or systems, including: (i) power generation systems; (ii) aircraft navigation or communication systems, air traffic control systems, or any

other transport management systems; (iii) safety-critical applications, including medical or life-support systems, vehicle operation applications, or any police, fire, or other safety response systems; and (iv) military or aerospace applications, weapons systems, or environments;

(j) use the Software or Documentation in violation of any law, regulation, or rule; or

(k) use the Software or Documentation for purposes of competitive analysis of the Software, the development of a competing software product or service, or any other purpose that is to CTC's commercial disadvantage.

5. Responsibility for Use of Software. Licensee is responsible and liable for all uses of the Software and Documentation resulting from access provided by Licensee, directly or indirectly. Specifically, and without limiting the generality of the foregoing, Licensee is responsible and liable for all acts and omissions of Authorized Users, and any act or omission by an Authorized User that would constitute a breach of this Agreement if taken by Licensee will be deemed a breach of this Agreement by Licensee. Licensee shall take reasonable efforts to make all Authorized Users aware of this Agreement's provisions as applicable to such Authorized User's use of the Software, and shall cause Authorized Users to comply with such provisions.

6. Compliance Measures. Licensee authorizes CTC to enter its premises during regular business hours in order to audit Licensee's use of the Software and Documentation to ensure Licensee's compliance with this Agreement. Licensee shall reasonably cooperate with CTC's personnel conducting such audits and provide all reasonable access requested by CTC. CTC shall only examine information directly related to the Licensee's use of the Software and Documentation.

7. Intellectual Property Rights.

(a) Licensee acknowledges and agrees that the Software and Documentation are provided under license, and not sold, to Licensee. Licensee does not acquire any ownership interest in the Software or Documentation under this Agreement, or any other rights thereto, other than to use the same in accordance with the license granted and subject to all terms, conditions, and restrictions under this Agreement. CTC and its CTCs and service providers reserve and shall retain their entire right, title, and interest in and to the Software and all Intellectual Property Rights arising out of or relating to the Software and Documentation, and any derivative works thereof, and nothing in this License shall restrict, impair, transfer,

license, convey or otherwise alter or deprive CTC of any of its Intellectual Property Rights.

(b) Licensee shall use commercially reasonable efforts to safeguard all Software (including all copies thereof) from infringement, misappropriation, theft, misuse, or unauthorized access. Licensee shall promptly notify CTC if Licensee becomes aware of any infringement of CTC's Intellectual Property Rights in the Software or Documentation and reasonably cooperate with CTC in any legal action taken by CTC to enforce its Intellectual Property Rights.

(c) If Licensee or any of its Authorized Users sends or transmits any communications or materials to CTC by mail, email, telephone, or otherwise, suggesting or recommending changes to the Software or Documentation, including without limitation, new features or functionality relating thereto, or any comments, questions, suggestions, or the like ("Feedback"), CTC is free to use such Feedback irrespective of any other obligation or limitation between the Parties governing such Feedback.

8. Term and Termination.

(a) (a) This Agreement and the license granted hereunder shall remain in effect until] terminated as set forth herein (the "Term"). Licensee may terminate this Agreement by ceasing to use and destroying all copies of the Software and Documentation. CTC may terminate this Agreement, (a) effective upon written notice to Licensee, if Licensee, breaches this Agreement and such breach: (i) is incapable of cure; or (ii) being capable of cure, remains uncured thirty (30) days after CTC provides Licensee with written notice of such breach; or (b) CTC may terminate this Agreement, effective immediately, if Licensee files, or has filed against it, a petition for voluntary or involuntary bankruptcy or pursuant to any other insolvency law, makes or seeks to make a general assignment for the benefit of its creditors or applies for, or consents to, the appointment of a trustee, receiver, or custodian for a substantial part of its property.

(b) Upon termination of this Agreement, Licensee shall immediately cease using, and delete, destroy, or return, all copies of the Software and Documentation and certify in writing to the CTC that the Software and Documentation has been deleted or destroyed. All obligations that have accrued prior to the date of termination shall survive termination of this Agreement. The obligations of Licensee under Sections 5, 6, 7(b), 10, 11 and 12 shall survive termination of this Agreement.

9. Limited Warranty, Exclusive Remedy, and Disclaimer/Warranty Disclaimer.

   (a) The Software, when properly installed on a computer meeting the specifications set forth in and operated in accordance with the Documentation, will perform in accordance with the Documentation, in all material respects. The preceding warranty does not apply to software with Third Party Licenses or if Licensee or an Authorized User installs or uses the Software on or in connection with any hardware or software not specified in the Documentation, or modifies, damages or misuses the Software, including in any manner not specified in the Documentation.

   (b) In the event of a warranty failure, CTC will, subject to Licensee's promptly notifying CTC in writing of such failure, repair or replace the Software, provided that Licensee provides CTC with all information CTC requests to resolve the reported failure, including sufficient information to enable CTC to recreate such failure; or

   (c) EXCEPT FOR THE LIMITED WARRANTY SET FORTH IN SECTION 10(a), THE SOFTWARE AND DOCUMENTATION ARE PROVIDED TO LICENSEE "AS IS" AND WITH ALL FAULTS AND DEFECTS WITHOUT WARRANTY OF ANY KIND. TO THE MAXIMUM EXTENT PERMITTED UNDER APPLICABLE LAW, CTC, ON ITS OWN BEHALF AND ON BEHALF OF ITS AFFILIATES AND ITS AND THEIR RESPECTIVE LICENSORS AND SERVICE PROVIDERS, EXPRESSLY DISCLAIMS ALL WARRANTIES, WHETHER EXPRESS, IMPLIED, STATUTORY, OR OTHERWISE, WITH RESPECT TO THE SOFTWARE AND DOCUMENTATION, INCLUDING ALL IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, TITLE, AND NON-INFRINGEMENT, AND WARRANTIES THAT MAY ARISE OUT OF COURSE OF DEALING, COURSE OF PERFORMANCE, USAGE, OR TRADE PRACTICE. WITHOUT LIMITATION TO THE FOREGOING, THE CTC PROVIDES NO WARRANTY OR UNDERTAKING, AND MAKES NO REPRESENTATION OF ANY KIND THAT THE LICENSED SOFTWARE WILL MEET THE LICENSEE'S REQUIREMENTS, ACHIEVE ANY INTENDED RESULTS, BE COMPATIBLE, OR WORK WITH ANY OTHER SOFTWARE, APPLICATIONS, SYSTEMS, OR SERVICES, OPERATE WITHOUT INTERRUPTION, MEET ANY PERFORMANCE OR RELIABILITY STANDARDS OR BE ERROR FREE, OR THAT ANY ERRORS OR DEFECTS CAN OR WILL BE CORRECTED.

10. Limitation of Liability. IN NO EVENT WILL CTC BE LIABLE UNDER OR IN CONNECTION WITH THIS AGREEMENT UNDER ANY LEGAL OR EQUITABLE THEORY, INCLUDING BREACH OF CONTRACT, TORT (INCLUDING NEGLIGENCE), STRICT LIABILITY, AND OTHERWISE, FOR ANY:

(A) CONSEQUENTIAL, INCIDENTAL, INDIRECT, EXEMPLARY, SPECIAL, ENHANCED, OR PUNITIVE DAMAGES; (B) INCREASED COSTS, DIMINUTION IN VALUE OR LOST BUSINESS, PRODUCTION, REVENUES, OR PROFITS; (C) LOSS OF GOODWILL OR REPUTATION; (D) USE, INABILITY TO USE, LOSS, INTERRUPTION, DELAY OR RECOVERY OF ANY DATA, OR BREACH OF DATA OR SYSTEM SECURITY; OR (E) COST OF REPLACEMENT GOODS OR SERVICES, IN EACH CASE REGARDLESS OF WHETHER LICENSOR WAS ADVISED OF THE POSSIBILITY OF SUCH LOSSES OR DAMAGES OR SUCH LOSSES OR DAMAGES WERE OTHERWISE FORESEEABLE. IN NO EVENT WILL LICENSOR'S AGGREGATE LIABILITY ARISING OUT OF OR RELATED TO THIS AGREEMENT UNDER ANY LEGAL OR EQUITABLE THEORY, INCLUDING BREACH OF CONTRACT, TORT (INCLUDING NEGLIGENCE), STRICT LIABILITY, AND OTHERWISE EXCEED THE LESSER OF $100 OR THE TOTAL AMOUNT PAID TO CTC UNDER THIS AGREEMENT IN THE 12 MONTH PERIOD PRECEDING THE EVENT GIVING RISE TO THE CLAIM. THE LIMITATIONS SET FORTH IN SECTION 8.2 AND SHALL APPLY EVEN IF THE LICENSEE'S REMEDIES UNDER THIS AGREEMENT FAIL OF THEIR ESSENTIAL PURPOSE

11. Confidential Information.

(a) "Confidential Information" means any information in possession of or disclosed by CTC to Licensee, except for information which is (i) already known by the Licensee, (ii) becomes, through no act or fault of the Licensee, publicly known, (iii) received by Licensee from a third party without a restriction on disclosure or use, or (iv) independently developed by Licensee without reference to the other Party's Confidential Information. For purposes of clarification, CTC's Confidential Information shall include, without limitation, the Software and Documentation (including its Source Code and Object Code).

(b) For so long as the Confidential Information of CTC retains commercial value, Licensee shall hold such Confidential Information in confidence and shall not disclose any such Confidential Information to any third party other than to its employees, directors, officers, partners, Affiliates, subsidiaries, contractors, agents or other persons working under Licensee's direction who need to know such information, in each case only to the extent such information is necessary to be known, and each of whom are bound by restrictions regarding disclosure and use of such Confidential Information comparable to and no less restrictive than those set forth herein. Licensee shall be responsible for any act or omission of a third party for which it has provided Confidential Information in the same manner as if such act or omission was made by

Licensee. Licensee will employ at least the same methods and degree of care, but no less than a reasonable degree of care, to prevent disclosure of the Confidential Information as Licensee employs with respect to its own confidential information.

(c) Upon CTC's written request, Licensee shall destroy or return to CTC all Confidential Information in its custody or control. This provision will survive any termination of this Agreement.

12. Miscellaneous.

(a) Notices. All notices required or permitted under this Agreement will be in writing and will be deemed received when (i) delivered personally; (ii) three (3) days after having been sent by registered or certified mail; or (iii) one day after deposit with a recognized commercial express courier specifying next day delivery. All communications will be sent to CTC at the address in the preamble to this Agreement and to Licensee at the address on file with CTC for purchase of the Sensor, or any other address subsequently identified by a Party giving notice pursuant to this paragraph.

(b) Injunctive Relief. Licensee acknowledges and agrees that a breach or threatened breach by Licensee of any of its obligations under Section 9 or, in the case of Licensee, Sections 2, 4, 7(b), 11 or 12, would cause the other Party irreparable harm for which monetary damages would not be an adequate remedy and agrees that, in the event of such breach or threatened breach, the other Party will be entitled to equitable relief, including a restraining order, an injunction, specific performance, and any other relief that may be available from any court, without any requirement to post a bond or other security, or to prove actual damages or that monetary damages are not an adequate remedy. Such remedies are not exclusive and are in addition to all other remedies that may be available at law, in equity, or otherwise.

(c) Assignment. Licensee may not assign or transfer any of its rights or delegate any of its obligations hereunder, in each case whether voluntarily, involuntarily, by operation of law or otherwise, without the prior written consent of CTC. Any purported assignment, transfer, or delegation in violation of this Section is null and void. No assignment, transfer, or delegation will relieve the assigning or delegating Party of any of its obligations hereunder. For purposes of this provision, a sale of controlling equity to, or all or substantially all of the assets of Licensee, to a third party, or the merger of Licensee with a third party, shall also

constitute an impermissible assignment. This Agreement is binding upon and inures to the benefit of the Parties hereto and their respective permitted successors and assigns.

(d) Governing Law. This Agreement is governed by and construed in accordance with the internal laws of the State of New York without giving effect to any choice or conflict of law provision or rule that would require or permit the application of the laws of any jurisdiction other than those of the State of New York. Any legal suit, action, or proceeding arising out of or related to this Agreement or the licenses granted hereunder will be instituted exclusively in the federal courts of the United States or the courts of the State of New York in each case located in the city of Rochester and County of Monroe, and each Party irrevocably submits to the exclusive jurisdiction of such courts in any such suit, action, or proceeding.

(e) Severability. If any provision or provisions of this Agreement shall, for any reason, be deemed unenforceable or in violation of law, such unenforceability or violation shall not affect the remaining provisions of this License, which shall continue in full force and effect and be binding upon the parties hereto.

(f) Section Headings. The headings of the sections, paragraphs, and appendices herein are for the Parties' convenient reference only and shall not define or limit any of the terms or provisions hereof.

(g) Amendment & Waiver. No amendment to or modification of this Agreement is effective unless it is in writing and signed by an authorized representative of each Party. No waiver by any Party of any of the provisions hereof will be effective unless explicitly set forth in writing and signed by the Party so waiving. Except as otherwise set forth in this Agreement, (i) no failure to exercise, or delay in exercising, any rights, remedy, power, or privilege arising from this Agreement will operate or be construed as a waiver thereof and (ii) no single or partial exercise of any right, remedy, power, or privilege hereunder will preclude any other or further exercise thereof or the exercise of any other right, remedy, power, or privilege.

(h) Status of Parties. This Agreement shall not be construed as creating any agency, partnership, joint venture, or other similar legal relationship between the Parties; nor will either Party hold itself out as an agent, partner, or joint venture party of the other Party. Both Parties shall be, and shall act as, independent contractors. Neither Party shall have authority to create any obligation for the other Party.

(i) Interpretative Provisions. The words "hereof", "herein" and "hereunder" and words of like import used in this Agreement shall refer to this Agreement as a whole and not to any particular provision of this Agreement. The captions herein are included for convenience of reference only and shall be ignored in the construction or interpretation hereof. References to Articles and Sections are to Articles and Sections of this Agreement unless otherwise specified. Any singular term in this Agreement shall be deemed to include the plural, and any plural term the singular. Whenever the words "include", "includes" or "including" are used in this Agreement, they shall be deemed to be followed by the words "without limitation", whether or not they are in fact followed by those words or words of like import. "Writing", "written" and comparable terms refer to printing, typing and other means of reproducing words (including electronic media) in a visible form. References to any agreement or contract are to that agreement or contract as amended, modified or supplemented from time to time in accordance with the terms hereof and thereof. References to any person include the successors and permitted assigns of that person. This Agreement shall be construed without regard to any presumption or rule requiring construction or interpretation against the Party drafting an instrument or causing any instrument to be drafted.

(j) Entire Agreement. This Agreement, together with any other documents incorporated herein by reference and all related Exhibits, constitutes the sole and entire agreement of the Parties with respect to the subject matter of this Agreement and supersedes all prior and contemporaneous understandings, agreements, and representations and warranties, both written and oral, with respect to such subject matter.

Maintenance

There are no customer replaceable parts on the signal conditioner. The device has been designed to self calibrate and monitor its own operational status. It is designed to provide trouble-free continuous service under normal operating conditions. Should the instrument require repair, visit ctconline.com for a return material authorization.

Warranty and Refund

Warranty

All CTC products are backed by our unconditional lifetime warranty. If any CTC product should ever fail, we will repair or replace it at no charge.

Refund

All stock products can be returned for a 25% restocking fee if returned in new condition within 90 days of shipment. Stock products qualify for free cancellation if your order is cancelled within 24 hours of purchase. Built-to-order products qualify for a 50% refund if returned in new condition within 90 days of shipment. Custom products are quoted and built specifically to the requirements of the customer, which may include completely custom product designs or private labeled versions of standard products for OEM customers. Custom products ordered are non-cancellable, non-returnable and non-refundable.