# VisConnect® VC-2xxx Series Converter

# Product Manual


Products Covered in this manual:

- VC-2010 CANopen Converter

# Revision Table

| Revision | Date | Change |
|---|---|---|
| A | April 2012 | Initial Release |
| B | July 2012 | Added detailed information on using the LSS features of the CANopen Converter.<br><br>Added new section for the CANopen NMT State Machine.<br><br>Updated references to CiA specifications. |

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# Manual Acronyms and Notations

| | |
|---|---|
| 0h: | 'h' is the letter used to identify a number in hexadecimal format. |
| 0d: | 'd' is the letter used to identify a number in decimal format. |
| LED: | Light emitting diode |
| OEM: | Original Equipment Manufacturer |
| SPI: | Serial Peripheral Interface |
| VC: | The VisConnect® Product identifier. |
| VS: | The ViSmart® Sensor identifier. |

Note: CANopen protocol specific acronyms will generally not be defined in this manual. The reader is encouraged to review CiA 301. Additional information is available at CAN in Automation, http://www.can-cia.org.

# OVERVIEW

The VisConnect® VC-2xxx Series Converters are electronic devices which interrogate the VS-25xx ViSmart® Series Solid-State Viscosity Sensors to provide measurements of viscosity and temperature. The viscosity and temperature outputs are provided at intervals of once per second.

Below is a high level block diagram of the VC-2010 CANopen Converter electronic assembly located within the housing.

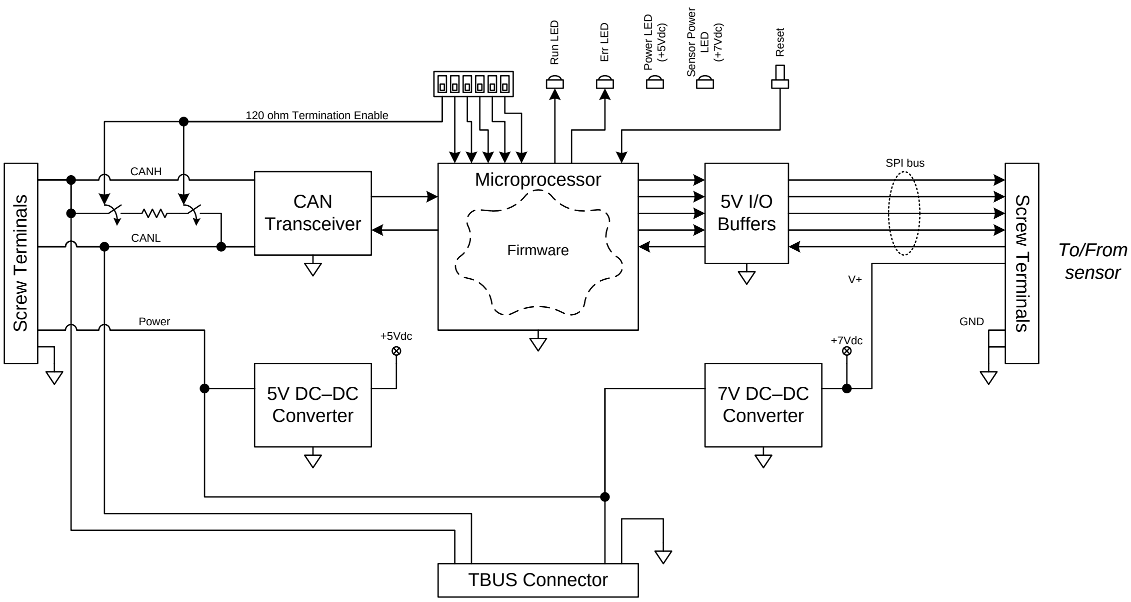


**Figure 1: Converter Block Diagram**

The VC-2xxx Series Converters are DIN rail mountable and have easily accessible screw terminal connections for process interface connections and Sensor connections. The Converters can also be connected to a optional DIN rail TBUS connector which minimizes system wiring and decreases installation time.

The DIP switches available on the top of the Converter, minimize system setup by allowing fast bus configuration. Settings for bus bit rate, node ID, and bus termination are available.

Status LEDs easily help identify Converter and Sensor Status.

The Converters are powered using a DC power supply.

# TECHNICAL DATA

The following table displays some of the technical data for the VC-2xxx Series Converter. The VisConnect Converter Datasheet, available at www.SenGenuity.com, will have additional information.

**Table 1: Electrical and Mechanical Technical Data**

| | |
|---|---|
| Power Supply | $9V_{DC}$ to $36V_{DC}$, < 100mA w/ Sensor connected |
| Operating/Storage Temperature | 0 to 60ºC / -40 to 85ºC |
| Dimensions | 70.4mm (height) x 85mm (depth) x 22.5mm (width) |
| Mounting | 35 mm DIN rail |
| Connector Type - Screw Terminals:<br><br><br><br><br><br>TBUS Plugs | Pitch: 5.0 mm pitch:<br>Wire sizes: 0.14 $mm^2$ to 2.5 $mm^2$<br>26 awg to 14 awg<br>Tightening torque: 0.5 Nm (min) to 0.6 Nm (max)<br>Stripping length: 8 mm<br><br>Pitch: 3.81 mm pitch:<br>Wire sizes: 0.14 $mm^2$ to 1.5 $mm^2$<br>26 awg to 15 awg)<br>Tightening torque: 0.22 Nm (min) to 0.25 Nm (max)<br>Stripping length: 7 mm<br>*Phoenix Contact P/Ns: 1719697 & 1719707* |
| Vibration | EN 60068-2-6 & EN 60068-2-64 |
| Shock | EN 60068-2-27 |
| Protection Degree | IP 20 |

# CONVERTER INSTALLATION

## FIELD INSTALLATION

VC-2xxx Series Converters are not approved for use in Hazardous Area classified locations. It is strongly recommended that the VC-2xxx Converters be installed in an enclosure NEMA type I, or equivalent.

Follow Table 1 for the recommended use of wires and strip lengths for the screw terminals and TBUS plugs.

## CONVERTER INSTALLATION ON DIN RAIL

The VC-2xxx Series Converters are intended to be installed on a standard 35 mm DIN rail. When mounting to a DIN rail, engage the Converter DIN rail guides first then pivot the Converter onto the DIN rail. The spring loaded clasp will latch around onto the DIN resulting in a firmly seated product.


**Figure 2: Converter Installation on DIN Rail**

When using the optional TBUS DIN rail connector, snap the TBUS connector first into the rail, then mount Converter to the rail in the same method specified above. The TBUS connector and Converter can be mated in one way only. Do not force the Converter onto the TBUS connector otherwise product damage may result!

Figure 3 shows the optional TBUS connector with male and female plugs available with the Converters. The Converters may be ordered with just the center TBUS connector or with all three shown in the figure.

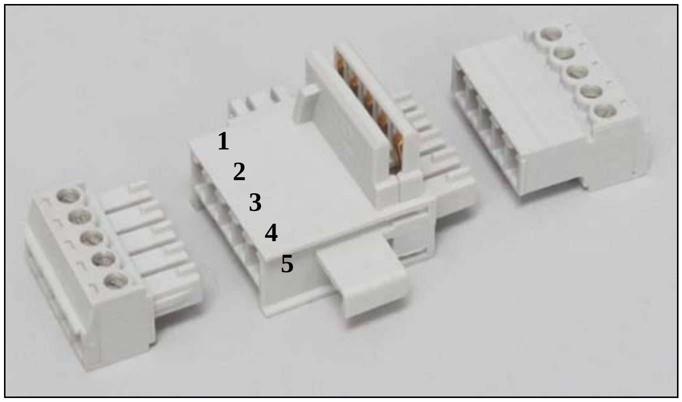


**Figure 3: Optional TBUS Connectors**

The TBUS connector allows side-by-side installations of the Converters. Figure 4 shows multiple TBUS connectors installed on a DIN rail. First, install the TBUS connector onto the DIN rail, then slide into adjacent TBUS connector.

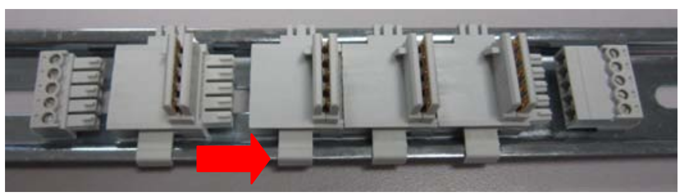

**Figure 4: TBUS Connectors on a DIN Rail**

## CONVERTER REMOVAL FROM DIN RAIL

To remove the Converter from the DIN Rail, use a flat blade tool to pry the spring loaded clasp away from the DIN rail in the manner shown in Figure 5. Next pivot the Converter up away from the DIN rail and remove.

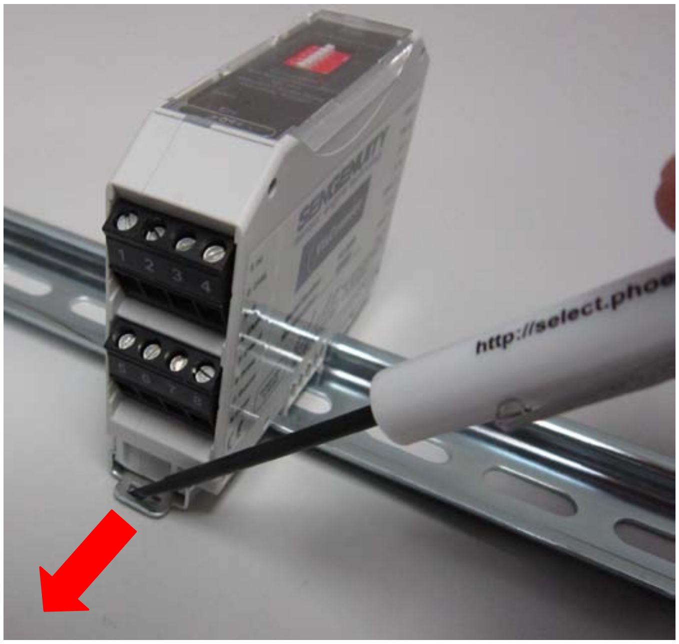


**Figure 5: Converter Removal from DIN Rail**

## GROUNDING

The Converter signals named Ground and GND are internally (electrically) connected. Further, the Converter contains a metal clip on the DIN rail side of the package which is also electrically connected to the Ground and GND signals. As such, when the Converter is mounted on the DIN rail, the DIN rail is electrically connected to the ground on the Converter. Care should be taken during installation to minimize and/or eliminate ground loops between the Converter grounds and Earth ground.

In order to minimize ground loops, it is recommended that the sensor cable shield be connected at one location only, as shown in Figure 6 below.

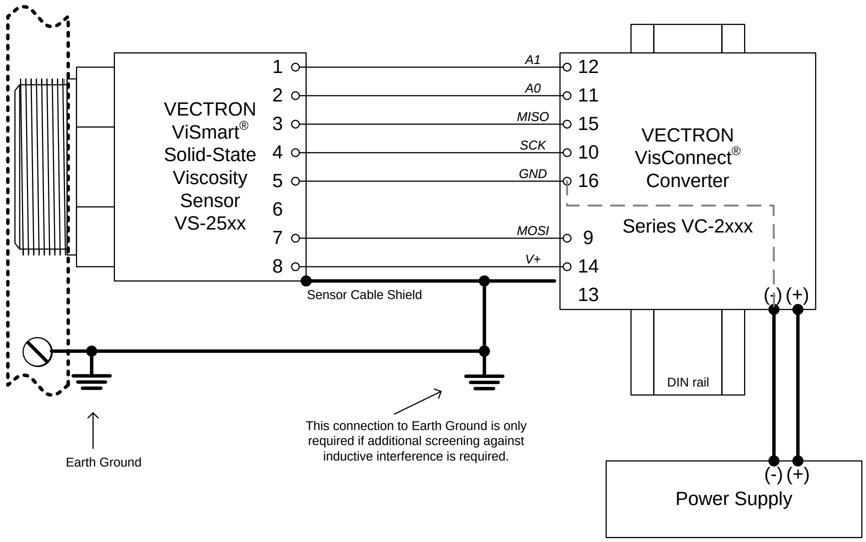


**Figure 6: VC-2xxx Grounding Diagram**

In noisy electromagnetic installations, where for example highly inductive loads are switching, it may be necessary to ground the sensor cable shield at one or more locations along the cable length.

# CONNECTOR ASSIGNMENT

This section identifies the screw terminal assignments and TBUS connectors for the VC-2xxx Series Converters.

## VC-2010 CANopen Converter Connector Assignments

For the VC-2010, the following table summarizes the screw terminal pin assignments.

**Table 2: VC-2010 Screw Terminal Assignments**

| Terminal Number | Signal Name |
|---|---|
| 1 | nc |
| 2 | CANL |
| 3 | nc |
| 4 | CANH |
| 5 | Ground |
| 6 | Power |
| 7 | Ground |
| 8 | Power |

| Terminal Number | Signal Name |
|---|---|
| 9 | MOSI |
| 10 | SCK |
| 11 | A0 |
| 12 | A1 |
| 13 | SHIELD |
| 14 | V+ |
| 15 | MISO |
| 16 | GND |

For the VC-2010, the Table 3 summarizes the TBUS connector assignments. Use Figure 7 as well to help cross reference the TBUS connector pin number with Signal Name.

The Sensor terminals 9-16, should be connected only when the Converter power is off. It is permissible to wire the Sensor to the Converter before the Converter is mounted to the DIN rail.

**Table 3: VC-2010 TBUS Connector Assignment**

| TBUS Number | Signal Name |
|---|---|
| 1 | Power |
| 2 | Ground |
| 3 | nc |
| 4 | CANH |
| 5 | CANL |

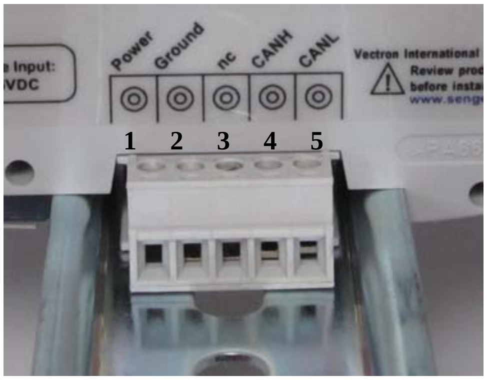


**Figure 7: TBUS Connector Pin Numbers**

The TBUS connector allows the Converter to be "hot swappable". This allows minimal interruptions to the other devices on the DIN rail. The Converters may be installed and removed while DC power is applied to the TBUS connecter.

### Converter, Sensor Cable, and Sensor Wire Color Assignment

Table 4 below shows the wire color assignments when using the recommended Vectron sensor cable. The arrows indicate the direction in which the electrical signals are actively driven.

**Table 4: Converter & Sensor Cable Wiring Assigment**

| | VC-2010 | | VS-25xx |
|---|---|---|---|
| **Signal Name** | **Terminal Number** | **Sensor Cable Color** | **M12 Pin Number** |
| **MOSI** | 9 | → (blue) | 7 |
| **SCK** | 10 | → (yellow) | 4 |
| **A0** | 11 | → (brown) | 2 |
| **A1** | 12 | → (white) | 1 |
| **V+** | 14 | → (red) | 8 |
| **MISO** | 15 | ← (green) | 3 |
| **GND** | 16 | ← (gray) | 5 |

The recommended Vectron Sensor cable has eight conductors. The eighth conductor, a pink wire, is a 'no connect' inside then sensor and should be grounded at terminal 16.

## VC-2010 CANopen Converter Signal Descriptions

### Process Signals/Connections

| | |
|---|---|
| Power | The Power screw terminals and TBUS connection are electrically shorted together. This connection should be used to wire the DC power to the Converter. Table 1 provides the DC supply voltage range. |
| Ground | The Ground screw terminals and TBUS connection are electrically shorted together. This connection should be used to wire the DC power supply return (ground) to the Converter. |
| CANH/CANL | These signals should connect to the CAN_H and CAN_L signals on the CAN bus. This Converter supports CANopen protocol only. |
| nc | These screw terminals and TBUS connection should not be connected. |

### Sensor Signals/Connections

| | |
|---|---|
| A1, A0 | These signals encode the chip selects within a VS-25xx Series Viscosity Sensor. They are actively driven from a VC-2xxx Series Converter. |
| SCK, MOSO | These signals carry the clock and data outputs used for the SPI bus communication between a VS-25xx Series Viscosity Sensor and VC-2xxx Series Converter. These signals are actively driven from a VC-2xxx Series Converter. |
| MISO | This signal carries the encoded SPI bus data from the VS-25xx Series Viscosity Sensor to the VC-2xxx Series Converter. The signal is actively driven from the VS-25xx Series Viscosity Sensor. |
| V+ | This signal carries the DC power to the VS-25xx Series Viscosity Sensor. It is sourced from a DC-to-DC regulator within a VC-2xxx Series Converter and is typically around +7V. |
| GND | This is the signal ground reference for the SPI signals and V+. |
| SHIELD | This terminal connection can be used to ground the shield on the sensor cable. In most installations, it is not necessary. |

# VC-2010 CANOPEN CONVERTER

The VC-2010 CANopen Converter transmits viscosity and temperature data on the CAN bus signals at intervals of once per second. The Converter's CAN Node ID, bit rate, and bus termination are easily set from the DIP switches on the top side of the package, ensuring a fast system setup time.

## CANOPEN CONFORMANCE

The Converter supports the CANopen application layer and communication profile as defined in EN 50325-4. At the time of release of this manual, theVC-2010 CANopen Converter is not yet a CiA[1] compliant device. Vectron International is actively pursuing compliance to EN 50325-4 and expects to be fully compliant in Q2 2012. The Vectron International CANopen Vendor ID is 0324h.

## CANOPEN CONVERTER STATE MACHINES

Effectively, two separate state machines operate in parallel on the CANopen Converter. The first state machine called from power up is named the Firmware State Machine. It is responsible for initializng the Converter and calling the processes to initialize the second state machine name the NMT State Machine.

### Firmware State Machine

Figure 8 below shows a simplified block diagram for the Converter firmware. After power up, the Converter initializes the microcontroller oscillators, timers, and I/O buffers, then immediately starts and reads conversions on the ViSmart Sensor's analog-to-digital converters (A/Ds). The Converter then calculates the floating point temperature and viscosity values. Not shown in the diagram, however, is that after the floating point calculation the Converter transmits the temperature and viscosity values as TxPDOs.

[1] CiA: CANopen in Automation, http://www.can-cia.org.

The entire state machine repeats once per second while continuously updating the microcontrollers Watchdog Timer and internal error status registers.

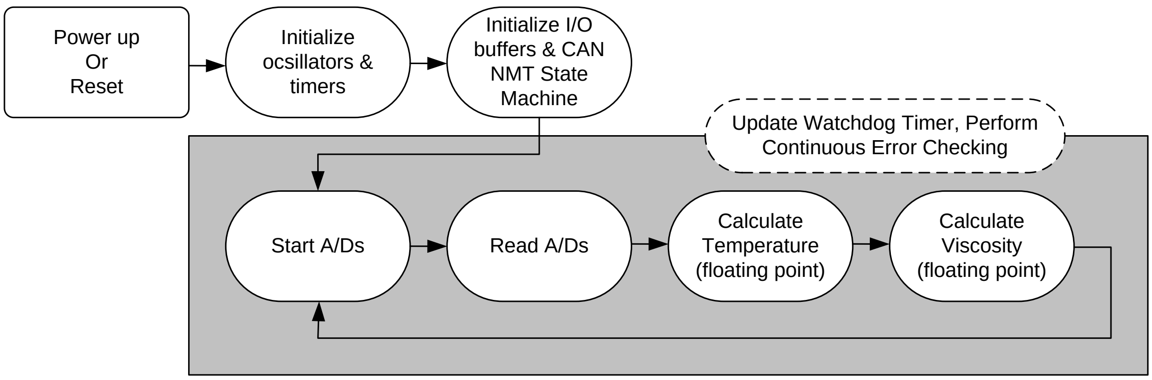


**Figure 8: Firmware Block Diagram**

## NMT State Machine

The NMT State Machine follows CiA 301 and is started after the Converter initializes the microcontroller I/O buffers. Figure 9 shows a very simplified NMT State Machine. A complete diagram of the NMT State Machine can be found in CiA 301.

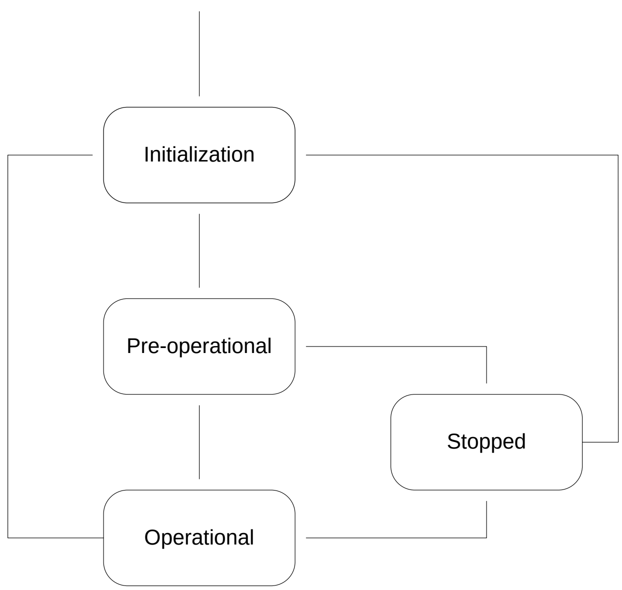


**Figure 9: NMT State Machine**

During the Initialization state, the Converter automatically transmits the boot-up message which contains the Node ID and a value of 0.

Immediately after the Initialization state, the Converter automatically enters the Pre-operational state. In this state, the Converter can communicate via SDOs and reconfigure the TxPDOs. When using a configuration tool and LSS, the Converters Node ID and Bit

Rate can be changed in this state. If enabled, heartbeat messages are transmitted in the pre-op state.

Once in the Operational state, the Converter will automatically transmit the Viscosity and Temperature TxPDOs. The Converter must be commanded with the NMT service start remote node message to transition into the Operational state. If enabled, heartbeat messages are transmitted in the pre-op state.

The Stopped state is entered when the Converter receives the NMT service stop remote node indication. In this state, the TxPDOs are not transmitted. however, the heartbeat messages are transmitted.

## DIP SWITCH SETTINGS

The DIP switches are provided to manually configure the CANopen node-ID, bit rate, and bus termination. Switches 1 through 4 set the node-ID sequentially starting at 10 and ending at 25. Switch 5 sets the bit rate at either 125 kbps or 250 kbps. Switch 6 sets the 120 ohm bus termination resistor. The DIP switches are accessed by opening the transparent top cover. The switch can be toggled using a small flat blade screwdriver, or equivalent tool, as shown in Figure 10.

**Figure 10: DIP Switch Configuration**

The firmware samples the dip switches on a reset either by cycling power or by using the momentary push-button RESET switch. Once sampled, the firmware writes the settings into the internal EEPROM. The user is welcome to change the dip switches while the Converter is powered, however, a reset must be initiated afterward.

The CANopen Converter also has the capability to use the Layer Setting Services, as defined in the CANopen specification CiA 305. Within this mode, the CANopen

Converter can be set to any node-ID or bit rate. The Converter supports all bit rates, except 10 and 20 kbps. To utilize the LSS, switches 1-5 must all be set to the ON position. Once again, a reset condition must be induced for this setting to take place.

The tables below show the DIP switch settings for node-ID and bit rate configurations for the CANopen Converter.

**Table 5: CANopen Converter DIP Switch Node IDs**

| CANopen Converter Node-ID Addressing Table | | | | |
|---|---|---|---|---|
| **Node-ID** | **DIP 1** | **DIP 2** | **DIP 3** | **DIP 4** |
| 10 | OFF | OFF | OFF | OFF |
| 11 | OFF | OFF | OFF | **ON** |
| 12 | OFF | OFF | **ON** | OFF |
| 13 | OFF | OFF | **ON** | **ON** |
| 14 | OFF | **ON** | OFF | OFF |
| 15 | OFF | **ON** | OFF | **ON** |
| 16 | OFF | **ON** | **ON** | OFF |
| 17 | OFF | **ON** | **ON** | **ON** |
| 18 | **ON** | OFF | OFF | OFF |
| 19 | **ON** | OFF | OFF | **ON** |
| 20 | **ON** | OFF | **ON** | OFF |
| 21 | **ON** | OFF | **ON** | **ON** |
| 22 | **ON** | **ON** | OFF | OFF |
| 23 | **ON** | **ON** | OFF | **ON** |
| 24 | **ON** | **ON** | **ON** | OFF |
| 25 | **ON** | **ON** | **ON** | **ON** |

**Table 6: CANopen Converter DIP Switch Bit Rate**

| CANopen Converter Bit Rate, DIP Switch 5 | |
|---|---|
| OFF | = 125 kbps |
| ON | = 250 kbps |

Note: *Setting the DIP switches 1-5 to all ON enables the Layer Setting Services to set Node-ID and bit rate. The CANopen Converter firmware will not configure the node-ID to 25 and bit rate to 250 kbps.*

**Table 7: CANopen Converter SIP Switch Bus Termination**

| CANopen Converter Bus Termination Settings, DIP Switch 6 | |
|---|---|
| ON | = 120Ω termination enabled |
| OFF | = 120Ω termination disabled |

Note: *If more than one Converter is used on the same physical CAN bus, then only one of the CANopen Converters should have the 120 ohm termination resistor set to the ON position.*

## CANOPEN LAYER SETTING SERVICES

The CANopen Converter firmware supports the use of the Layer Setting Services. In order to utilize the LSS, the DIP switches 1-5 must all be ON and the Converter reset by pushing the Reset switch.

In this mode, the initial Converter Node ID and bit Rate will be the previously stored EEPROM values. For instance, if the DIP switches 1-5 were OFF, then after changing to LSS mode, the Node and ID and Bit rate are 10h, and 125kbps, respectively. These values remain until the LSS changes the Node ID and Bit Rate.

The Node ID and Bit Rate set using the LSS is stored in EEPROM and will remain until either the LSS provides new values, or the DIP switches are changed. Each time after a new Node ID or Bite Rate is changed, the Reset switch must be pressed.

Note: caution should be exercised when using the higher bit rates. Ensure appropriate bus wire lengths are used at the higher bit rates.

Note: when using the LSS, one CANopen Converter should be physically on the CAN bus and to the bus master.

It is recommended that the Node ID and Bit Rate be changed when the Converter is in the Pre-Operational state.

### LSS Re-Configuration Examples

The following sample CAN bus trace shows the packets to reconfigure both the Node ID and Bit Rate.

**Table 8: Example of a LSS Trace - Successful**

| **Identifier (hex)** | **Data (hex)** | **Comment** |
|---|---|---|
| 70A | 00 | boot-up message |
| 7E5 | 04 01 00 00 00 00 00 00 | configuration state |
| 7E5 | 11 **01** 00 00 00 00 00 00 | change Node-ID to **01** |
| 7E4 | 11 00 00 00 00 00 00 00 | response OK |
| 7E5 | 13 00 **03** 00 00 00 00 00 | change bit rate to **250 kbps** |
| 7E4 | 13 00 00 00 00 00 00 00 | response OK |
| 7E5 | 17 00 00 00 00 00 00 00 | store configuration |
| 7E4 | 17 00 00 00 00 00 00 00 | response OK |

Packets with message identifier 7E5 are transmitted from the LSS master to the Converter. Packets with message identifier 7E4 are the responses from the Converter.

The ‘store configuration’ packet must be transmitted by the LSS master in order for the CANopen Converter to store the values into EEPROM.

The table below shows the values required to write when using the LSS to change the Bit Rate. The Bit Rates shown below are the only Bit Rates supported by the CANopen Converter.

**Table 9: LSS Values for Bit Rate**

| Value | Bit Rate |
|---|---|
| 02 | 500 kbps |
| 03 | 250 kbps |
| 04 | 125 kbps |
| 05 | 100 kbps |
| 06 | 50 kbps |

If values other than what are shown in Table 9 are written, the CANopen Converter will not switch to the new Bit Rate and will keep the previously selected bit rate. The Converter will also transmit an error packet as follows:

**Table 10: Example of a LSS Trace - NOT Successful**

| Identifier (hex) | Data (hex) | Comment |
|---|---|---|
| 70A | 00 | boot-up message |
| 7E5 | 04 01 00 00 00 00 00 00 | configuration state |
| 7E5 | 11 **FF** 00 00 00 00 00 00 | change Node-ID to **FF** |
| 7E4 | 11 01 00 00 00 00 00 00 | response **NOT** OK |
| 7E5 | 11 **00** 00 00 00 00 00 00 | change Node-ID to **00** |
| 7E4 | 11 01 00 00 00 00 00 00 | response **NOT** OK |
| 7E5 | 13 00 **01** 00 00 00 00 00 | change bit rate to **800 kbps** |
| 7E4 | 13 01 00 00 00 00 00 00 | response **NOT** OK |
| 7E5 | 13 00 **07** 00 00 00 00 00 | change bit rate to **20 kbps** |
| 7E4 | 13 01 00 00 00 00 00 00 | response **NOT** OK |

## CANopen Diagnostic LEDs

The VC-2010 CANopen Converter has 4 light emitting diodes (LEDs) installed for easy diagnostic information and can be viewed on the top panel.


**Figure 11: VC-2010 CANopen Converter Top Panel**

Two LEDs are reserved for Converter Power and Sensor Power, while the other two CANopen specific, Err and Run. The Err and Run LEDs follow the CiA 303 implementation for two LEDs.

Table 11 summaries the functions of the 4 LEDs. Not all LED states are defined for the Err and RUN LEDs. The reader is referred to the CiA 303 for a complete list of states.

**Table 11: VC-2010 CANopen Converter LEDs**

| LED Name | Color | Function | |
|---|---|---|---|
| Power | Red | On: | Converter is powered, $+5V_{DC}$ is present on circuit assembly. |
| | | Off: | Converter is either not powered or a fault exists on $+5V_{DC}$ regulator circuit. |
| Sensor Power | Red | On: | $+7V_{DC}$ is present on circuit assembly and available to Sensor on V+ screw terminal. |
| | | Off: | Converter is either not powered or a fault exists on $+7V_{DC}$ regulator circuit. |
| Err | Red | On: | Bus off; the CAN controller is bus off. |
| | | Blinking: | Invalid configuration; general CAN bus configuration error. |
| | | Off: | No bus error; the device is in working condition. |
| Run | Green | On: | Operational; the device is in the Operational state. |
| | | Blinking: | Pre-Operational state; the device is in the Pre-Operational state. |
| | | Off: | Bus off; the CAN controller is bus off. |

## CANopen Electronic Datasheet File (EDS File)

The VisConnect EDS file is available for download on the http://www.SenGenuity.com website. Please consult the website for the latest release. The revision of the EDS file must match the firmware revision of the CANopen Converter for proper Converter and bus functionality.

## CANopen Object Dictionary & Supported Functions

The following sections list the supported Object Dictionary Entries on the VC-2010 CANopen Converter. All CiA designated 'mandatory' objects, per CiA 301, are fully supported.

### 1000h Device Type

This entry describes the CANopen Converter, per CiA 401, and it's functionality. Please reference CiA 401 for more information on this entry.

| | |
|---|---|
| Name | Device Type |
| Type | Unsigned 32 |
| Default Value | 00040191h |
| Access | Read Only |

### 1001h Error Register

The CANopen Converter supports only bit 0 of this entry. When the Error Register value is 1, the Converter has detected a Generic Error.

| | |
|---|---|
| Name | Error Register |
| Type | Unsigned 8 |
| Default Value | 0h |
| Access | Read Only |

If value = **0**: No errors detected in Converter. Operation is normal.
If value = **1**: Error detected in the Converter. Read 6002h Sensor Status TxPDO for detailed error status information.

### 1017h Producer Heartbeat Time

The CANopen Converter supports producer heartbeats. The units are multiples of 1 millisecond.

| | |
|---|---|
| Name | Producer Heartbeat Time |
| Type | Unsigned 16 |
| Default Value | 0h |
| Access | Read/Write |

If value = **0**: Converter does not transmit heartbeat message.
If value = **1-65535**: Converter transmits heartbeat messages at the value written into the entry.

If enabled and required, the recommended minimum time for a heartbeat message is 100 ms.

### 1018h Identity Object

This entry contains information about the Converter, Vendor ID, Product Code, Firmware Revision number, and Sensor Serial number. All entries are read only.

SUB-INDEX 0
The Number of Entries sub-index contains the number of entries in 1018h. The value is always 4.

| | |
|---|---|
| Name | Number of Entries |
| Type | Unsigned 8 |
| Default Value | 4h |
| Access | Read Only |

SUB-INDEX 1
The Vendor ID sub-index contains the CiA assigned Vendor ID.

| | |
|---|---|
| Name | Vendor ID |
| Type | Unsigned 32 |
| Default Value | 324h |
| Access | Read Only |

SUB-INDEX 2
The Product Code sub-index contains an unsigned 32 bit integer which may be assigned a unique OEM number by Vectron. This Product Code should only be used by OEMs.

| | |
|---|---|
| Name | Product Code |
| Type | Unsigned 32 |
| Default Value | 0h |
| Access | Read Only |

Values read from this sub-index are OEM proprietary.

SUB-INDEX 3
The VisConnect Firmware Revision Number sub-index contains an unsigned 32 bit integer which corresponds to the firmware revision of the VisConnect.

| | |
|---|---|
| Name | VisConnect Firmware Revision Number |
| Type | Unsigned 32 |
| Default Value | 3884h |
| Access | Read Only |

The revision number is updated at a new release of firmware. The CANopen converter does not support field firmware updates. At the time of release of this manual the revision number is 3884h.

SUB-INDEX 4
The Sensor Serial Number sub-index contains an unsigned 32-bit integer which is read from the sensor EEPROM and placed at this sub-index.

| | |
|---|---|
| Name | Sensor Serial Number |
| Type | Unsigned 32 |
| Default Value | 0h |
| Access | Read Only |

If value = **4xxxxxd**: Sensor serial number, read from sensor EEPROM.
If value = **999999d**: Cannot read sensor EEPROM and/or no sensor connected.

**1200h Server SDO Parameter**

SUB-INDEX 0
The Number of Entries sub-index contains the number of entries in 1200h. The value is always 2.

| | |
|---|---|
| Name | Number of Entries |
| Type | Unsigned 8 |
| Default Value | 2h |
| Access | Read Only |

SUB-INDEX 1
The COB-ID Client to Server (rx) defines the Communication Object Identifier used to access the Object Dictionary of the CANopen Converter node.

| | |
|---|---|
| Name | COB-ID Client -> Server (rx) |
| Type | Unsigned 32 |
| Default Value | Node ID + 00000600h |
| Access | Read Only |

SUB-INDEX 2
The COB-ID Server to Client (tx) defines the Communication Object Identifier used by the CANopen Converter node to respond to Object Dictionary requests.

| | |
|---|---|
| Name | COB-ID Server -> Client (tx) |
| Type | Unsigned 32 |
| Default Value | Node ID + 00000580h |
| Access | Read Only |

**1800h, 01, 02 Transmit PDO Parameters**

The Transmit PDO Parameters Object Dictionary entry contains the TxPDO parameters for the three supported TxPDOs in the CANopen Converter. This section covers Object Dictionary entries 1800h, 1801h, and 1802h.

SUB-INDEX 0
The Largest Sub-Index Supported sub-index contains the number of entries in 1800h, 01, and 02h. The value is always 2.

| | |
|---|---|
| Name | Largest Sub-Index Supported |
| Type | Unsigned 8 |
| Default Value | 2h |
| Access | Read Only |

SUB-INDEX 1
The COB-ID Used by PDO sub-index defines the COB ID of the TxPDOs.

| | |
|---|---|
| Name | COB-ID Used by PDO |
| Type | Unsigned 32 |
| Default Value | 1800h: Node ID + 00000180h<br>1801h: Node ID + 00000280h<br>1802h: Node ID + 00000380h |
| Access | Read/Write |

SUB-INDEX 2
The Transmission Type sub-index defines the transmission types of the TxPDOs. The value for all three is 255, which is an asynchronous PDO.

| | |
|---|---|
| Name | Transmission Type |
| Type | Unsigned 32 |
| Default Value | 1800h: 255d<br>1801h: 255d<br>1802h: 255d |
| Access | Read/Write |

**1A00h, 01, 02 Transmit PDO Mapping**

The Transmit PDO Mapping Object Dictionary entry defines where the process data is stored in a PDO. This section covers Object Dictionary entries 1A00h, 1A01h, and 1A02h.

SUB-INDEX 0
The Number of Mapped Application Objects sub-index contains the allowable variables mapped to the PDO. The maximum value is 8.

| | |
|---|---|
| Name | Number of Mapped Application Objects |
| Type | Unsigned 8 |
| Default Value | 1h |
| Access | Read/Write |

SUB-INDEX 1
The first Mapped Object sub-index defines first TxPDO Object Dictionary Index, sub-index, and number of bits to transmit.

| | |
|---|---|
| Name | 1. Mapped Object |
| Type | Unsigned 32 |
| Default Value | 1A00h: 60010120h<br>1A01h: 60020120h<br>1A01h: 60030120h |
| Access | Read/Write |

Example: A value of 60010120h transmits the 32 bit (20h) PDO at Index 6001h, sub-index 01.

SUB-INDEX 2 - 8
These sub-indexes can be used to assign additional mapping to the three default CANopen Converter TxPDOs.

| | |
|---|---|
| Name | 2 – 8. Mapped Object |
| Type | Unsigned 32 |
| Default Value | 1A00h: none<br>1A01h: none<br>1A01h: none |
| Access | Read/Write |

If additional mapped object are required, the user is reminded to first disable the TxPDO by writing a zero to sub-index 0 first. Next, sub-indexes 2 through 8 can be written with the new mapping. Lastly, write the new number of supported mapped objects to sub-index 0.

**6000h Temperature Reading**

The Temperature Reading Object Dictionary entry contains the 32 bit floating point sensor temperature. This asynchronous TxPDO transmits automatically once per second.

SUB-INDEX 0
The Number of Objects sub-index contains the number of supported objects for this entry.

| | |
|---|---|
| Name | Number of Objects |
| Type | Unsigned 8 |
| Default Value | 1h |
| Access | Read Only |

SUB-INDEX 1
The Temperature sub-index contains sensor's measured temperature in a 32 bit floating point number. The number format is REAL32[2] and the temperature units are Celsius.

| | |
|---|---|
| Name | Temperature |
| Type | REAL32 |
| Default Value | 0h |
| Access | Read Only |

Note: Measured values between -50ºC and 150ºC will not be flagged as an error.

If value = **-999.**: Sensor is disconnected or has measured an invalid sensor temperature. Read Sensor Status TxPDO for debug information.

**6001h Viscosity Reading**

The Viscosity Reading Object Dictionary entry contains the 32 bit floating point sensor acoustic viscosity. This asynchronous TxPDO transmits automatically once per second.

SUB-INDEX 0
The Number of Objects sub-index contains the number of supported objects for this entry.

| | |
|---|---|
| Name | Number of Objects |
| Type | Unsigned 8 |
| Default Value | 1h |
| Access | Read Only |

SUB-INDEX 1
The Viscosity sub-index contains sensor's measured viscosity in a 32 bit floating point number. The number format is REAL32 and the viscosity units are Acoustic Viscosity.

| | |
|---|---|
| Name | Temperature |
| Type | REAL32 |
| Default Value | 0h |
| Access | Read Only |

Note: Values between 0AV and 1e9AV will not be flagged as an error. However, the typical calibrated sensor range is between 0 and 400AV so caution should be exercised when the reading exceeds typical application limits.

If value = **-999.**: Sensor is disconnected. Read Sensor Status TxPDO for debug information.

[2] The reader is strongly encouraged to review CiA 301 for the 32 bit conversion to a floating point number.

**6002h Sensor Status**

The Sensor Status Object Dictionary entry contains critical information about the status of the CANopen Converter and Sensor. This asynchronous TxPDO is only transmitted if an error condition is detected. It is transmitted after the Error Register has updated and the Temperature and Viscosity TxPDOs are transmitted.

SUB-INDEX 0

The Number of Objects sub-index contains the number of supported objects for this entry.

| | |
|---|---|
| Name | Number of Objects |
| Type | Unsigned 8 |
| Default Value | 1h |
| Access | Read Only |

SUB-INDEX 1

The Sensor Status Word contains an unsigned 32-bit integer which can be used help identify error conditions within the CANopen Converter and Sensor. Each bit, if implemented, represents a specific error flag. Not all bits are used.

| | |
|---|---|
| Name | Sensor Status Word |
| Type | Unsigned 32 |
| Default Value | 0h |
| Access | Read Only |

Table 12 below defines the Sensor Status Word for the Sensor CANopen Converter. One or more bits may be set at a time. The bit is set when the value is 1, otherwise it will be 0.

**Table 12: Sensor Status Word**

| Bit | Error Description | Meaning |
|---|---|---|
| 0 | Sleep Bit Set | The Converter has received an illegal instruction to SLEEP. The sleep instruction should not occur in normal operation and indicates a firmware or microcontroller malfunction. |
| 1 | Watchdog Timer | The Converter watchdog timer timed out and the processor reset. The watch dog timer should never timeout in normal operation and indicates a firmware or microcontroller malfunction. |
| 2 | Reset Instruction | The Converter previously received an instruction to perform a reset. |
| 3-5 | reserved | Not implemented, always 0 |
| 6 | FFs Read from Sensor EEPROM | The Converter has read all FF's from the sensor's EEPROM. |
| 7 | reserved | Not implemented, always 0 |

| | | |
|---|---|---|
| 8 | Temp. A/D read Timeout | The Converter cannot read from the sensor's temperature A/D and has timed out. |
| 9 | Temp. A/D overflow high | The Converter has detected that the sensor's temperature A/D has overflowed high in the analog input voltage. |
| 10 | Temp. A/D overflow low | The Converter has detected that the sensor's temperature A/D has overflowed low in the analog input voltage. |
| 11 | Temp. conversion is above cal range | The Converter has detected that the sensor's temperature A/D reading exceeds the sensor's high calibration limit of 150C. |
| 12 | Temp. conversion is below cal range | The Converter has detected that the sensor's temperature A/D reading is below the sensor's low calibration limit of -50C. |
| 13-15 | reserved | Not implemented, always 0 |
| 16 | Viscosity A/D read Timeout | The Converter cannot read from the sensor's viscosity A/D and has timed out. |
| 17 | Viscosity A/D overflow high | The Converter has detected that the sensor's viscosity A/D has overflowed high in the analog input voltage. |
| 18 | Viscosity A/D overflow low | The Converter has detected that the sensor's viscosity A/D has overflowed low in the analog input voltage. |
| 19 | Viscosity conversion is above cal range | The Converter has detected that the sensor's viscosity A/D reading exceeds a value of 1e9. |
| 20 | Viscosity conversion is below cal range | The Converter has detected that the sensor's viscosity A/D reading is below the sensor's low calibration limit of 0. |
| 21-31 | reserved | Not implemented, always 0 |

Note: If bits 6, 8, and 16 are set to 1, then the Sensor is either disconnected or has malfunctioned.

## CIA SPECIFICATION REFERENCES

The specifications below were referenced in this Product Manual and should be reviewed for information outside the scope of this Product Manual. Each is available at the CAN in Automation website, http://www.can-cia.org/.

CiA 301: CANopen application layer and communication profile
CiA 303: Recommendation for indicators
CiA 305: CANopen Layer Setting Services and Protocol
CiA 401: Device Profile for Generic I/O Modules

# VC-2010 CANOPEN CONVERTER TROUBLESHOOTING GUIDE

Use the following section to help identify probable causes for typical troubleshooting and/or installation issues specific to the CANopen Converter.

| Symptom | ▪ Probable Cause |
|---|---|
| Power LED not lit | ▪ Ensure correct range of DC voltage is wired to Converter.<br>▪ Double check wire polarity (Power/Ground) to screw terminals.<br>▪ If using TBUS, double check wire polarity (Power/Ground) to TBUS connection.<br>▪ If using TBUS, ensure Converter is seated correctly.<br>▪ Ensure all terminal connections are tight.<br>▪ Ensure all wires have been stripped to the correct length. |
| Sensor Power LED not lit | ▪ Ensure correct range of DC voltage is wired to Converter.<br>▪ Double check wire polarity (Power/Ground) to screw terminals.<br>▪ If using TBUS, double check wire polarity (Power/Ground) to TBUS connection.<br>▪ If using TBUS, ensure Converter is seated correctly.<br>▪ Ensure all terminal connections are tight.<br>▪ Ensure all wires have been stripped to the correct length. |
| Err and Run LEDs flashing | ▪ Ensure bus master is connected and initialized.<br>▪ Double check wiring polarity on CAN_H and CAN_L to the Converter.<br>▪ Ensure all terminal connections are tight.<br>▪ Ensure all wires have been stripped to the correct length.<br>▪ Check for correct bus Application Layer configuration.<br><br>*Review CiA 303 implementation for two LEDs for full state descriptions.* |
| Err and Run LEDs flashing and Converter not communicating | ▪ Check for correct Bit Rate DIP switch configuration.<br>▪ Check for correct or duplicate Node ID assignments on other Converters.<br>▪ Ensure only one bus termination switch is ON. |
| General bus problem | ▪ Check bus wire lengths vs. Bit rate<br>▪ Check for bus termination at the bus master.<br>▪ Ensure only one bus termination switch is ON. |
| Data error in packets | ▪ Check for appropriate CAN bus shielding.<br>▪ Ensure appropriate sensor cable shield grounding between Converter and Sensor. |

| | |
|---|---|
| Temperature and Viscosity TxPDOs read -999 | ▪ Ensure all wire connections between the Sensor and Converter exist and all wires stripped and tightened to specification.<br>▪ Ensure all correct Sensor to Converter wire assignments. See Table 2. |
| Sensor Status TxPDO is transmitted | ▪ Review Table 12 to decode the unsigned 32 bit word. |
| Viscosity TxPDO value jumped to very high value. | ▪ Ensure sensor power (v+) signal is connected.<br>▪ Ensure sensor face is clean. |
| Sensor Status Reads 00 01 01 40h | ▪ Ensure Sensor MISO signal is connected.<br>*Temperature & Viscosity TxPDOs will read -999.*<br>▪ Ensure Sensor cable is seated firmly to Sensor. |
| Sensor Status Reads 00 01 01 00h | ▪ Ensure Sensor A1 signal is connected.<br>*Temperature & Viscosity TxPDOs will read -999.* |
| Sensor Status Reads 00 08 00 40h | ▪ Ensure Sensor A0 & MOSI signal is connected.<br>*Viscosity TxPDOs will read 1e9.*<br>*Temperature TxPDO will read normally.* |
| Sensor Status Reads 00 00 01 40h | ▪ Ensure Sensor SCK signal is connected.<br>*Viscosity TxPDOs will read 160.*<br>*Temperature TxPDO will close to -250C.*<br>▪ |
| Temperature and Viscosity TxPDOs intermittently read -999. | ▪ Check Sensor GND and V+ connections. |

☺ END OF PRODUCT MANUAL ☺