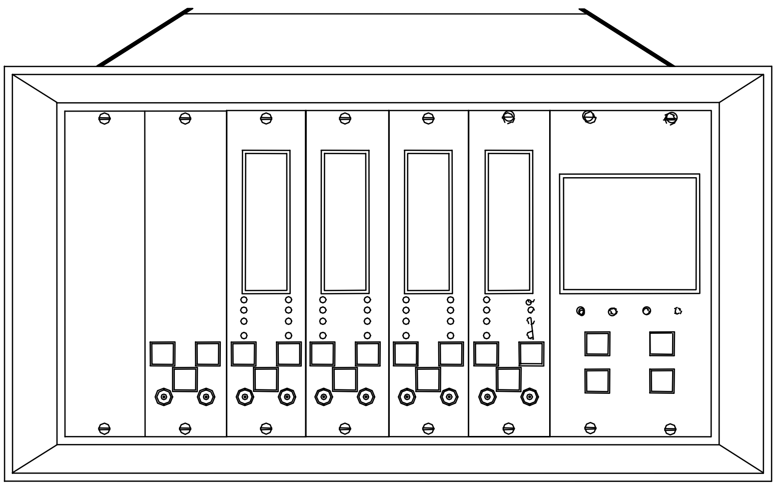
Operation Manual

Bently Nevada™ Asset Condition Monitoring



3300/02 Transient Data Embedded System Monitor

imagination at work

Part Number 167388-01
Rev. B (08/07)

Contact Information

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Additional Information

Notice:

This manual does not contain all the information required to operate and maintain the product. Refer to the following manuals for other required information.

3300 System Overview (Part Number 80171-01)

3300 System Installation Instructions (Part Number 80172-01)

3300 System Troubleshooting (Part Number 80173-01)

3300/12 Power Supply (Part Number 89602-01)

Allen-Bradley Data Highway / Data Highway Plus Protocol and Command Set, 1770-6.5.16-November 1988

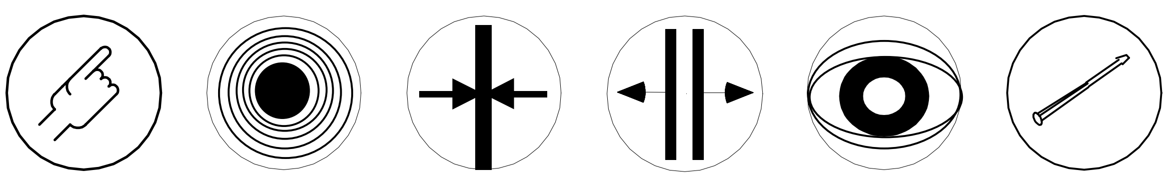
Gould Modbus Protocol Reference Guide, PI-MBUS-300 Rev B January 1985

Product Disposal Statement

Customers and third parties, who are not member states of the European Union, who are in control of the product at the end of its life or at the end of its use, are solely responsible for the proper disposal of the product. No person, firm, corporation, association or agency that is in control of product shall dispose of it in a manner that is in violation of any applicable federal, state, local or international law. Bently Nevada LLC is not responsible for the disposal of the product at the end of its life or at the end of its use.

Symbols

The following special symbols are used in the manual to illustrate step-by-step processes:



Press | Flashing | Connect | Disconnect | Observe | Screwdriver

Contents

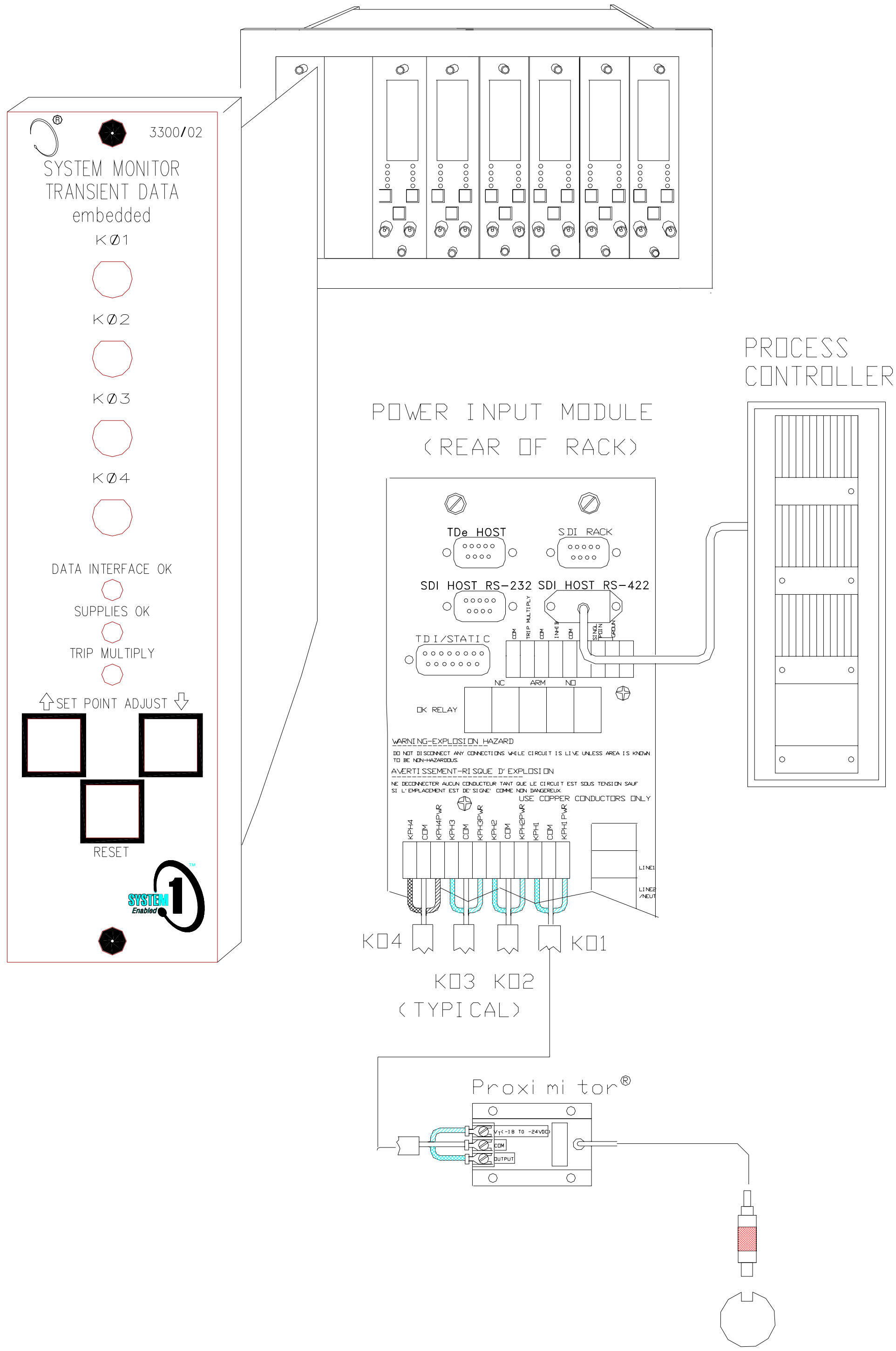
1. Introduction

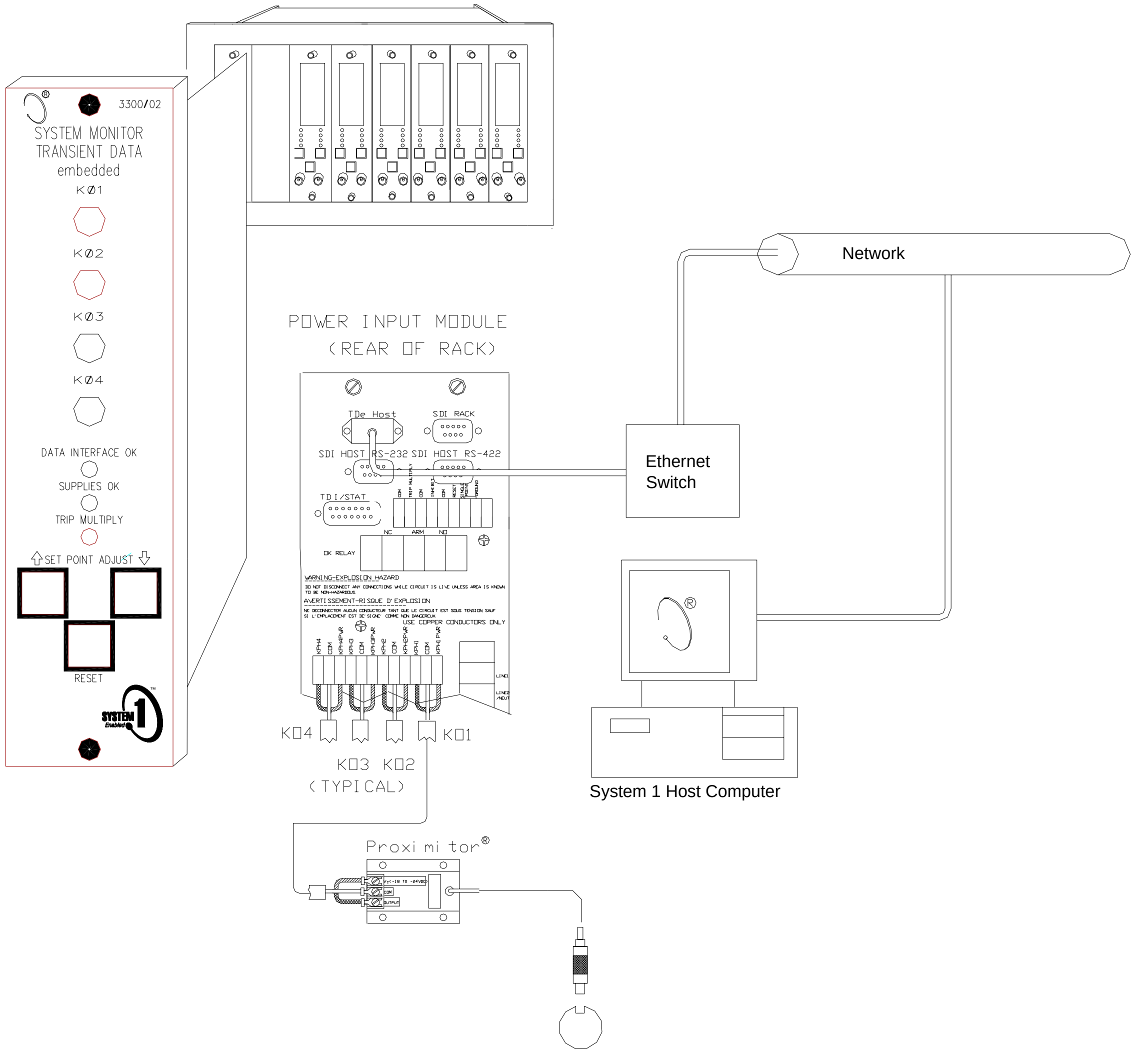
1.1 System Description

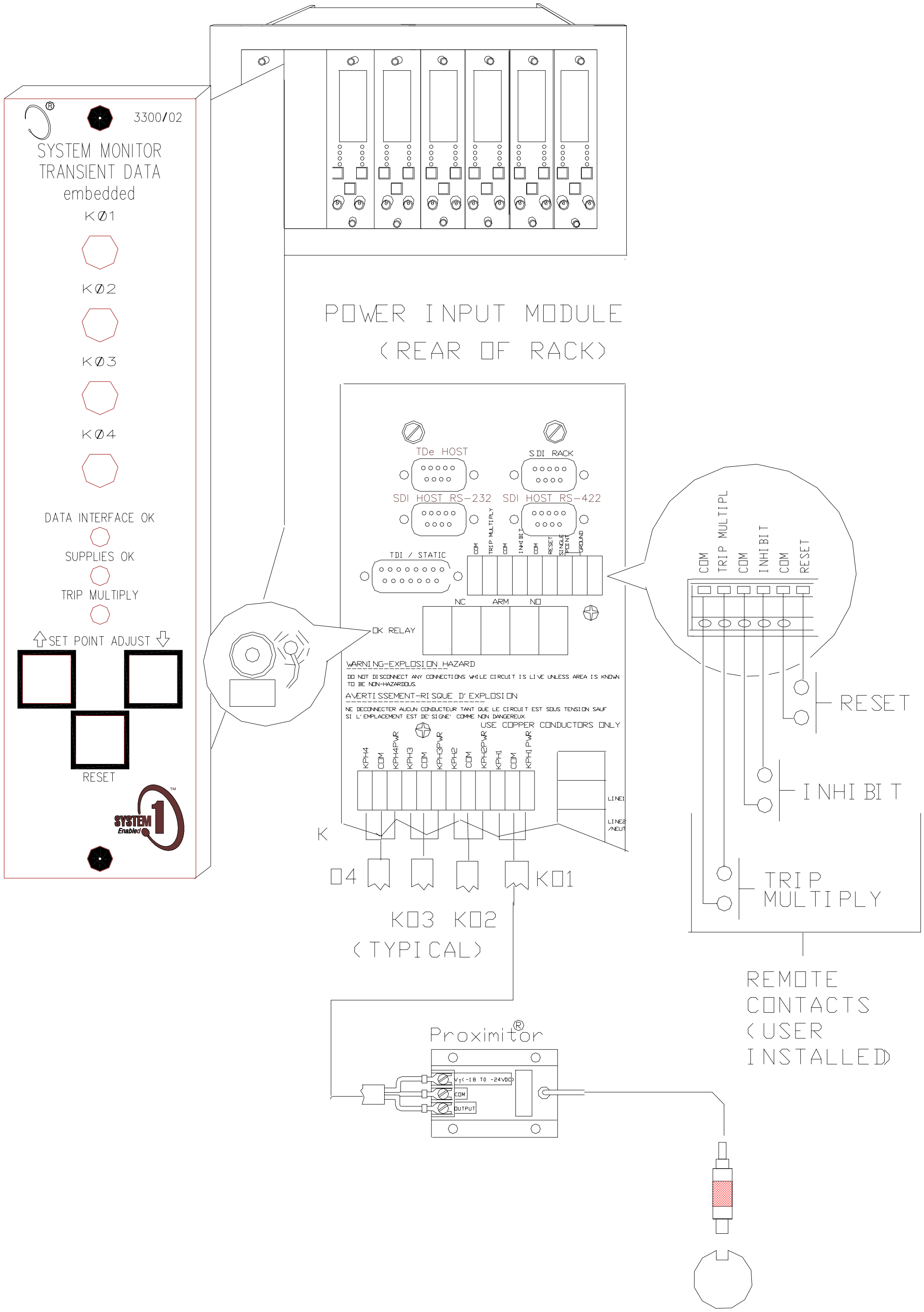
The 3300/02 System Monitor combines the functions of a system monitor and a communications processor so that you can access data from 3300 Monitoring Systems from a DCS control system or from a System 1 Data Acquisition Server.

The 3300/02 functions as a system monitor by managing the communication within the rack and administering functions that apply to the entire 3300 rack. Section 0 on page 5 describes these functions and features.

The 3300/02 functions as a communications processor by collecting and temporarily storing information from the monitors in the rack and then communicating this information either to a DCS control system or to a Bently Nevada System 1 Data Acquisition Server. Data collection and communication features are described in Section 1.3 beginning on page 8.


3300/02
SYSTEM MONITOR
TRANSIENT DATA
embedded
KØ1
KØ2
KØ3
KØ4
DATA INTERFACE OK
SUPPLIES OK
TRIP MULTIPLY
SET POINT ADJUST
RESET
PROCESS CONTROLLER
POWER INPUT MODULE
(REAR OF RACK)
TDe HOST
SDI RACK
SDI HOST RS-232
SDI HOST RS-422
TDI/STATIC
NC
ARM
NO
OK RELAY
WARNING-EXPLOSION HAZARD
AVERTISSEMENT-RISQUE D'EXPLOSION
USE COPPER CONDUCTORS ONLY
KO4
KO1
KO3 KO2
(TYPICAL)
Proximitor®


3300/02
SYSTEM MONITOR
TRANSIENT DATA
embedded
KØ1
KØ2
KØ3
KØ4
DATA INTERFACE OK
SUPPLIES OK
TRIP MULTIPLY
SET POINT ADJUST
RESET
SYSTEM 1
POWER INPUT MODULE
(REAR OF RACK)
TDe Host
SDI RACK
SDI HOST RS-232
SDI HOST RS-422
TDI/STAT
OK RELAY
WARNING-EXPLOSION HAZARD
AVERTISSEMENT-RISQUE D'EXPLOSION
USE COPPER CONDUCTORS ONLY
K04
K01
K03 K02
(TYPICAL)
Proximitor®
Network
Ethernet
Switch
System 1 Host Computer


3300/02
SYSTEM MONITOR
TRANSIENT DATA
embedded
KØ1
KØ2
KØ3
KØ4
DATA INTERFACE OK
SUPPLIES OK
TRIP MULTIPLY
SET POINT ADJUST
RESET
SYSTEM 1 Enabled
POWER INPUT MODULE
(REAR OF RACK)
TDe HOST
SDI RACK
SDI HOST RS-232
SDI HOST RS-422
TDI / STATIC
NC
ARM
NO
OK RELAY
WARNING-EXPLOSION HAZARD
AVERTISSEMENT-RISQUE D'EXPLOSION
USE COPPER CONDUCTORS ONLY
COM
TRIP MULTIPL
INHIBIT
RESET
INHIBIT
TRIP MULTIPLY
REMOTE CONTACTS (USER INSTALLED)
KO4
KO3
KO2
KO1
(TYPICAL)
Proximitor
COM
OUTPUT

1.2 System Monitor Functions

SYSTEM POWER-UP INHIBIT

The System Monitor provides a Power-up Inhibit function. This function allows each monitor to inhibit its alarms during power-up or whenever a system supply voltage falls below its operating level. After power-up, the inhibit function remains active for approximately 2 seconds.

RACK INHIBIT

When activated by an external contact closure this function places all monitors in bypass, disables all alarms, zero scales all outputs, and de-energizes the system OK relay. The connections for this function are located on the power input module (PIM) at the rear of the rack.

SUPPLY VOLTAGES OK

Seven LEDs located behind the front panel of the System Monitor are ON to indicate the voltage supplies are functioning. The voltage supplies are +VRH, +VRL, +7.5V, +5V, REF, -7.5V, and -VT. There is a green LED (SUPPLIES OK) on the front panel of the System Monitor. When this LED is on all of the voltage supplies are functional.

SYSTEM RESET

The System Monitor provides the ability to cause a System Reset. Closing external contacts through terminals on the PIM or pressing the RESET switch on the front panel will cause a System Reset.

TRIP MULTIPLY

The most common use of this function is to prevent unwanted monitor alarms during certain conditions of machine operation. In the operation of some machinery, it is impossible to avoid some periods of "higher than normal" vibration. Examples include startup and coast down, especially if the operating speed is above rotor system balance resonances ("critical speeds"), structural and other resonances, and changes in machine load or other operating conditions.

The Trip Multiply function causes the monitor alarm setpoints (both Alert and Danger) to increase by a fixed amount, either two times (2X) or three times (3X), according to the ordering option. Only those monitors ordered with this option will be affected. The Trip Multiply function is performed in the System Monitor, but is an ordering option for each monitor. It must be specified at the time of order placement and be installed at the factory.

Trip Multiply is activated by contact closure on the PIM. A red LED on the System Monitor front panel indicates that the Trip Multiply function is active.

OK RELAY

The purpose of this relay is to provide a means to annunciate a problem that is detected with any transducer system connected to the rack. The OK Relay is connected to the OK Circuit of every monitor in the rack. The OK Circuit continuously checks the condition of the transducer(s) associated with that monitor. If the circuit detects a transducer problem, the OK LED on the front of the affected monitor goes off and a relay drive signal is sent to the OK Relay in the System Monitor.

The OK Relay is located on the System Monitor PIM, is normally energized, and is a single-pole, double-throw (SPDT) relay. Since it is normally energized, the relay also can be used to annunciate when mains power to the rack is lost or interrupted. Either a system power-up inhibit signal from the System Monitor or a not OK signal from any monitor in the rack will cause the OK Relay to change state.

ALARM SETPOINT ADJUST

The System Monitor has two switches on the front panel that adjust alarm setpoint levels on each monitor. One switch is for upscale adjustments, and the other switch is for downscale adjustments.

DATA INTERFACE

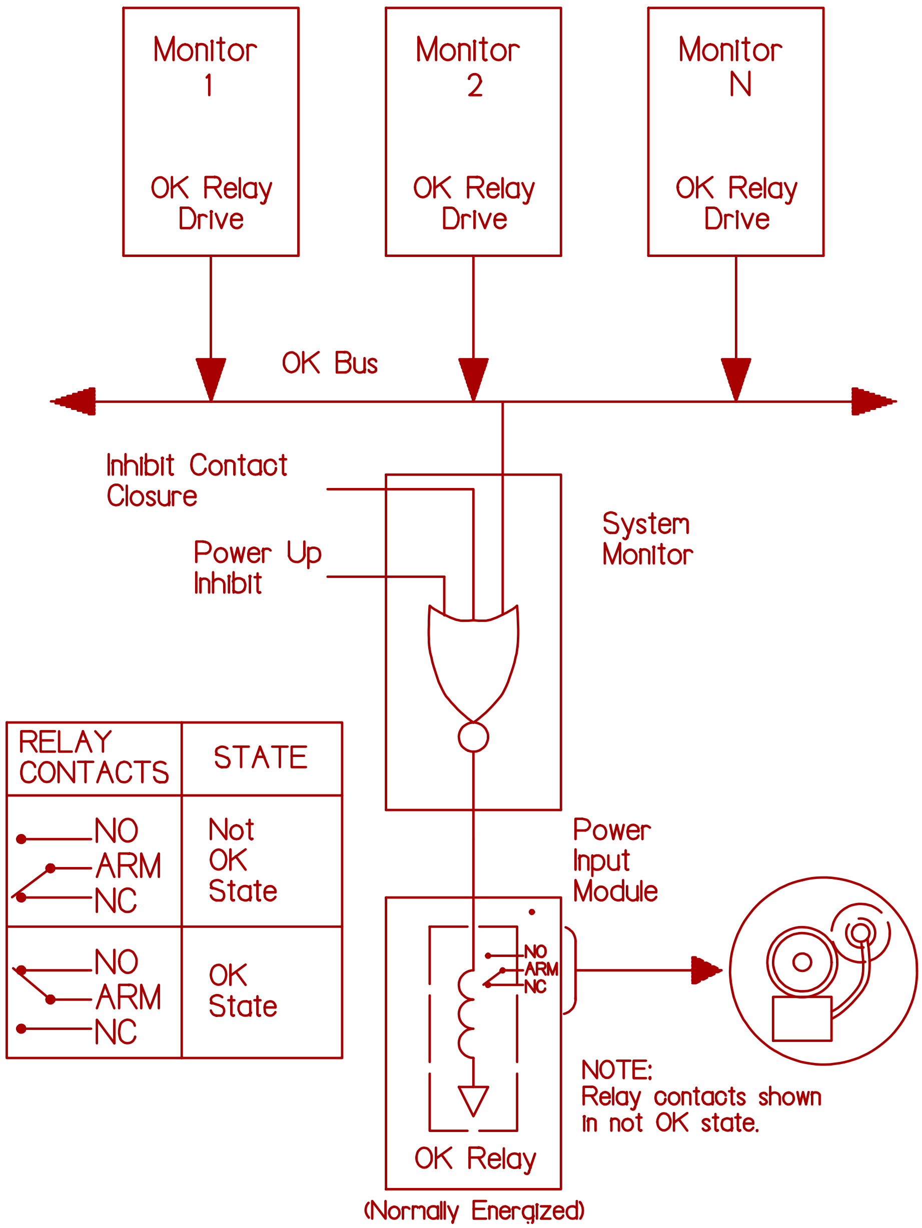
As a communications processor, the TDe handles serial communications between the Bently Nevada host computer running System 1 and/or digital control system (DCS) and the monitor rack. The host communication uses 10 Mbit Ethernet normally using TCP/IP and the DCS communication uses RS-422 or RS-232 as its standard.

Keyphasor® TRANSDUCERS

The System Monitor receives input from four Keyphasor® transducers through terminals on the PIM. Two of the Keyphasor® transducers are available to the monitors within the rack. All four of the Keyphasor® transducers are available to the TDe. Buffered Keyphasor® signals are also available from the coaxial connectors on the front panel. The System Monitor also provides short-circuit protected Keyphasor® transducer power.

1.2.1 OK Relay Configuration

The following diagram shows the functional concept of the OK Relay.



1.3 TDe Functions

The TDe collects and temporarily stores dynamic machinery information under steady state and transient operating conditions from system monitors. It communicates this information to the Bently Nevada host (a computer running System 1 software) and/or programmable logic controller (PLC) in the digital control system (DCS). The following sections describe how the TDe collects and stores trend, normal, alarm, and transient information and how it communicates this information from a monitor rack to the Bently Nevada host or DCS. This information includes data from the monitored machinery during startup, shutdown, and steady state operation. Special collection commands acquire data to support Bently Nevada Decision Support systems.

1.3.1 Data Collection

The TDe collects data sampled both at fixed time intervals and at intervals of machine speed. Collection and storage of both data types is done in the TDe for all data channels simultaneously and independently.

Data sets include two types: 1) Static data which represents the data taken at a single point in time although the data source may have pre-conditioned the data by filtering, smoothing, rms calculations, etc.; and 2) Wave form data which is a group of data points taken at a high enough sample rate to represent the real time performance of the data source.

Data is comprised of records, each containing a combination of static and wave form data. At regular time intervals, TDe gathers a record comprised of a number of static and wave form data sets. These records are also separately captured at speed intervals when machine speed changes dictate that RPM based data records should be captured.

1.3.1.1 Definitions

The following definitions may be helpful in understanding the data collection and initiation.

Enabled State. A state where a transient buffer is ready to “trigger” rpm based data collection. A buffer is “enabled” to capture startup or coast-down data when the rpm value enters a specific rpm range. We will define this range as the “enabled” range. In this state, the buffer has **not** collected a delta time history or any delta rpm samples.

Triggered State. A state where the transient buffer has detected a startup/coast-down (SUSD) event. This occurs when the machine’s speed crosses one of the High or Low RPM boundary values. At this point, the buffer is initially filled with 40 delta time records, but it has not yet collected any rpm based records.

Collection State. A state where the transient buffer is collecting delta-rpm samples after the buffer has triggered. Transient data records are collected according to the rules of the transient buffer mode: startup, shutdown or both (both refers to a mode, not to ‘both’ startup and shutdown).

High RPM. RPM value which defines the maximum value in a range or the high trigger value for a specific keyphasor. These are used to establish operation of the transient buffers data capture.

Low RPM. RPM value which defines the minimum value in a range or the low trigger value. These are used to establish operation of the transient buffers data capture.

Delta RPM. Value which defines the difference expressed in CPM between subsequent samples in RPM based transient buffers. Data capture RPM points are integer multiples of this value regardless of the trigger value.

Valid RPM. A speed value which is not in error. Errors arise from 1) speed values below 60 rpm or, 2) a shaft's speed value (i.e. period) for a revolution which is either greater than 112 ½% or less than 87 ½% of the previous shaft revolution, or 3) speed values above 15000, 30000 or 60000 rpm for synchronous samples per revolution of 128, 64 or 32 respectively. Speed values 'in error' are **not** used to establish action within the TDe.

Buffer Full. A state where all 320 records of the transient buffers have data assigned. No further data can be collected for this buffer until it is uploaded or aborted. Collection in other buffers continues regardless of the status of the full buffer.

Synchronous Sample Rate. The number of samples taken for each revolution of the shaft for synchronous data. This is set in the host software (SYSTEM 1) keyphasor configuration. There are 3 choices (128, 64 and 32) with a maximum machine speed of 15000, 30000 and 60000 rpm respectively. The highest sample rate will give the best waveform and orbit presentation (sample every 2.8°), but the lowest spectral resolution (0.125 X line spacing), whereas the lowest sample rate will give the lowest waveform and orbit resolution (sample every 11.24°) but the highest spectral resolution (0.0312 X line spacing).

Reset State. (Overwrite option) A state where the rpm buffer resets itself for a new cycle of transient data collection. "Reset" means that TDe clears the buffer by erasing any previous data collected up to that point. This normally occurs when the machine's rpm exits and re-enters its "enabled" range when the buffer is set to overwrite. If this occurs, we return to the "enabled" state in order to initiate the SUSD process again.

Overwrite. A condition which causes all stored data in a collection buffer to be erased and ready to be replaced with new data. This process can be done on the transient buffers and alarm buffers.

End Data Collection State/Data Upload State. The process that transfers SUSD data from TDe to the SYSTEM 1 Data Acquisition host computer. This can be done manually or automatically. Manual upload is initiated from the SYSTEM 1 Display's "Transient Data Control" option. Automatic upload is configured in SYSTEM 1 Configuration as previously discussed. If at any point the user chooses to abort a SUSD event, the data collection state will end, and the buffer will erase any delta time and delta rpm data contained in its registers. If the data is uploaded or the SUSD data collection process is aborted, the rpm buffer will re-enter the "enabled state" when it enters the "enabled" rpm range. At this point the buffer is ready to capture SUSD events again.

Simulated Keyphasor. A speed value that is configured in place of an actual Keyphasor®. The system collects synchronous data based on this rate. Values such as 1X, & 2X phase will be marked invalid when the unit is configured for simulated Keyphasor.

1.3.1.2 Current Values Collection

TDe provides the most current waveform or static values data for use in real time observation or to allow the System 1 software to trend values over time.

1.3.1.3 Normal Data Collection (Delta-time Sampling)

A display of data taken using normal (Delta-time) sampling shows the static data change as time changes and is typically used to observe the steady state, or normal, behavior of the monitored system. This is often referred to as Fast Trend data. Unlike trend data which is a combination of a number of data points, normal data is simply the parameter value at the time the data was collected.

TDe uses a programmable time interval to periodically collect a data record in normal sampling. When the TDe is used with System 1, the interval is set to one record every 4 seconds. The TDe is always taking and storing delta-time records. Every ten records are accompanied by a wave form data set including both synchronous (number of samples per shaft revolution) and asynchronous (number of samples per time interval) sampled wave forms. These data records are kept in a buffer that holds a maximum of 320 delta time records. For TDe this normally represents a period of 21 minutes, 20 seconds. Accompanying are 32 wave forms taken every 40 seconds. This 320 element buffer replaces the oldest record with the most recent so the 320 elements always represent the most recent 21 minutes. Wave form records are taken on the even minute (within the 4 seconds), at 40 seconds after the even minute, and at 20 seconds after the odd minute. This allows the wave form data from one TDe to be compared to others by having waveforms all taken at nearly the same time.

1.3.1.4 Alarm Data Collection

In the event that there is an alarm signal, the most recent 40 delta time records (including 3 wave form files) are saved and a set of synchronous and asynchronous waveforms is taken immediately to create a 4th waveform record. This represents the data for the 160 seconds immediately preceding the alarm and the values when the alarm was detected.

Since alarms happen at any time, the second most recent wave form in the 40 delta time records can occur any time from 4 to 40 seconds prior to the waveforms taken at the time of the alarm.

Alarm signals are associated with a particular machine train and it's Keyphasor® sensor phase reference, so data is only saved for the train indicating the alarm and only to others if they are configured to save that data.

1.3.1.5 Transient Data Collection (Delta-RPM sampling)

A change in machine speed, rather than a time interval, determines when samples are taken when performing delta-RPM sampling. This sampling mode lets you observe transient operating conditions and determine how the machine parameters change as RPM increases (startup operation), decreases (coast-down operation), or both increases or decreases (both mode). Examples of information presentations using machine speed include Bode' and polar plots. The TDe can collect two independent sets of transient data using any combination of delta-RPM modes.

Transient data is acquired into a 320 record buffer, similar to the delta time buffer. When the collection is initiated, a 40 record set is saved from the delta time buffer representing the 160 seconds just prior to the initiation. The remaining 280 records are then collected based on the operating speed of the machine. These buffers relate to a particular machine train and so each train collects data based on its speed independent of other trains. When the first 40 records are saved, the 4 associated waveform records are also saved. After that, a waveform is saved every tenth record regardless of how much time has elapsed.

1.4 Transient Operating Modes

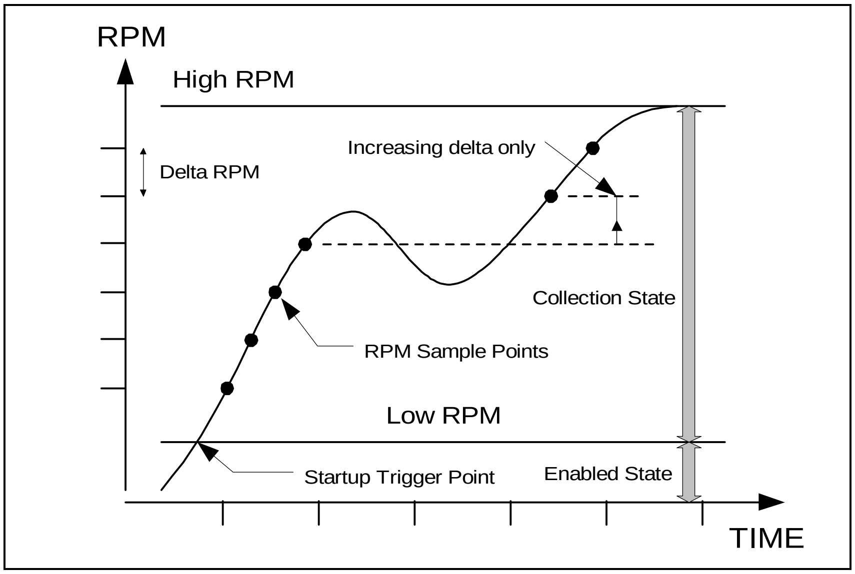
TDe can capture transient data in one of three modes. Each mode has unique characteristics for enabling, triggering, and collecting data. The characteristics of these modes are described below.

1.4.1 Startup Mode.

Enabled State: The Startup buffer is "*enabled*" when the speed is less than the Low RPM value**.**

Trigger State: TDe "*triggers*" data collection when the speed crosses from a value less than the Low RPM value (i.e. in the "enabled" state) to a value greater. At the time the buffer triggers, it will collect 40 static values and 4 waveforms from the delta time history. Executing the System 1 display software command to "*Initiate Startup/Shutdown*" has the same effect as entering the triggered state.

Collection State: TDe *"collects"* data every time the speed rpm value increases a delta rpm increment. The startup mode only collects data for increasing rpm values. If there is a decrease in speed, the startup process will not capture any data. In fact, it will not collect another record until the next delta increase in rpm from the last data point collected. This is illustrated below.



To configure the TDe for collecting startup data perform the following:

1. Enter the SYSTEM 1 Configuration program.

Note
Configuration changes will cause stored data loss in the TDe.

2. In the configuration program select the appropriate rack, and select Keyphasor® parameters. Note the synchronous samples per revolution value. If the value is 128 the maximum Keyphasor® speed is 15000 rpm, if it is 64 the maximum Keyphasor® speed is 30000 rpm, if it is 32 then the maximum Keyphasor® speed is 60000 rpm.
3. Select "Delta RPM Buffer" in the Keyphasor® screen.
4. Select either "Buffer 1" or "Buffer 2" and select "Startup" as the mode.
5. Check "Overwrite Transient Data" if desired. Normally overwrite is **not** selected. If the "overwrite" box is checked, each time the startup enabled state is entered, the existing information in the buffer will be deleted and the buffer will be prepared to capture a new data set. If the box is not checked, then the data that is collected will remain until it is uploaded either manually or automatically or the data is aborted manually.
6. Enter the Low RPM value. This is the "trigger" rpm value. Do not set this value too low. TDe will operate down to 60 rpm, however a speed value less than the Low RPM must be detected before it will be in the enable state. Speed values in error are not used.

Machines with fast start or stop performance may violate the 12 ½% per revolution maximum change and may not be without error until speeds of several hundred rpm.

7. Set the High RPM. Set this value to the normal operating speed of the machine. The value is not used in determining data collection.
8. Set the delta RPM value. To determine a value that covers the entire startup range, take the difference between the Low RPM and running speed and divide by 280. Select the next reasonable value higher than this value.

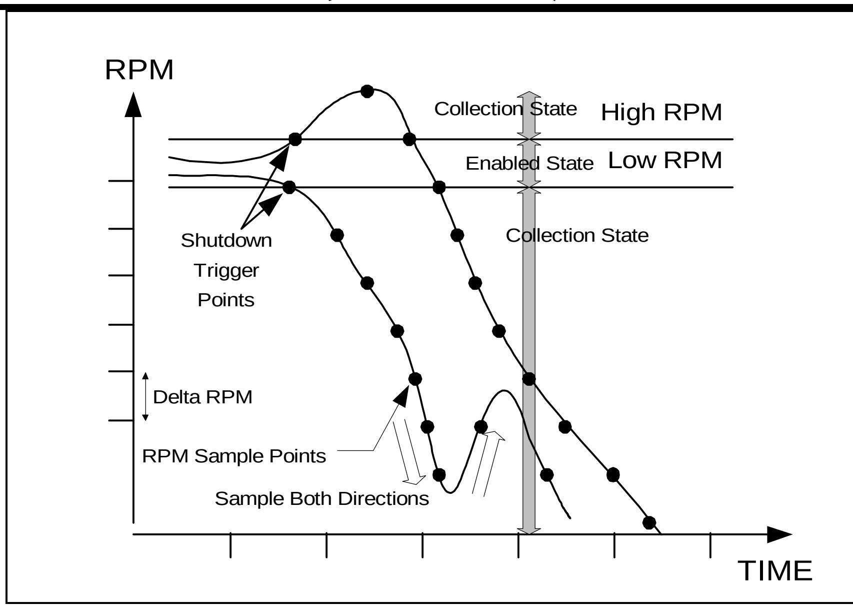
While in the collecting state and when the speed drops by 2 delta values, a flag is set which will alert the other buffer of a potential shutdown (i.e. a shutdown enable). It uses this flag to enable shutdown data collection. If a startup delta value is entered, the shutdown buffer is reset.

1.4.2 Shutdown Mode

Enabled State: The shutdown buffer "*enabled*" state is entered when the speed value lies between the Low and the High RPM values. It is also entered when the second buffer is a startup buffer and it drops two delta rpm values.

Trigger State: TDe "*triggers*" data collection either when the speed crosses from a value greater than the "Low" value to a value less than this value or when the speed crosses from a value less than the "High" value to a value greater than this value (i.e. exits the enable range). At the time the buffer triggers, it will collect 40 static values and 4 waveforms from the delta time history. Executing the SYSTEM 1 display software command to "*Initiate Startup/Shutdown*" has the same effect as entering the triggered state.

Collection State: TDe "*collects*" a new record every time the speed changes a specified rpm amount (Delta rpm). The shutdown buffer is primarily designed to capture coast-down data; however, because it can collect data for both increasing and decreasing speeds, it will also capture an overspeed event and it will capture speed reversals during coast-down. This is illustrated below:



To configure the TDe for collecting shutdown data perform the following:

9. Enter the SYSTEM 1 Configuration program.

Note
Configuration changes will cause stored data loss in the TDe.

10. In the configuration program select the appropriate rack, and select Keyphasor® parameters. Note the synchronous samples per revolution value. If the value is 128 the maximum keyphasor speed is 15000 rpm, if it is 64 the maximum keyphasor speed is 30000 rpm, if it is 32 then the maximum keyphasor speed is 60000 rpm.

11. Select “Delta RPM Buffer” in the Keyphasor® screen.

12. Select either “Buffer 1” or “Buffer 2” and select “Shutdown” as the mode.

13. Check “Overwrite Transient Data” if desired. If the “overwrite” box is checked, each time the shutdown enabled state is entered, the existing information in the buffer will be deleted and the buffer will be prepared to capture a new data set. If the box is not checked, then the data that is collected will remain until it is uploaded either manually or automatically or the data is aborted manually.

14. Enter the Low RPM value. This is the lower “trigger” rpm value. It should be set at a value less than the normal operating speed of the machine.

15. Enter the High RPM. This is the upper “trigger” rpm value. Set this value higher than the normal maximum operating speed of the machine.

> **Important**: To assure reliable capture of shutdown operation, the “High” value should be set above the highest normal operating speed of the machine, and the Low value should be set below the normal low operating speed.

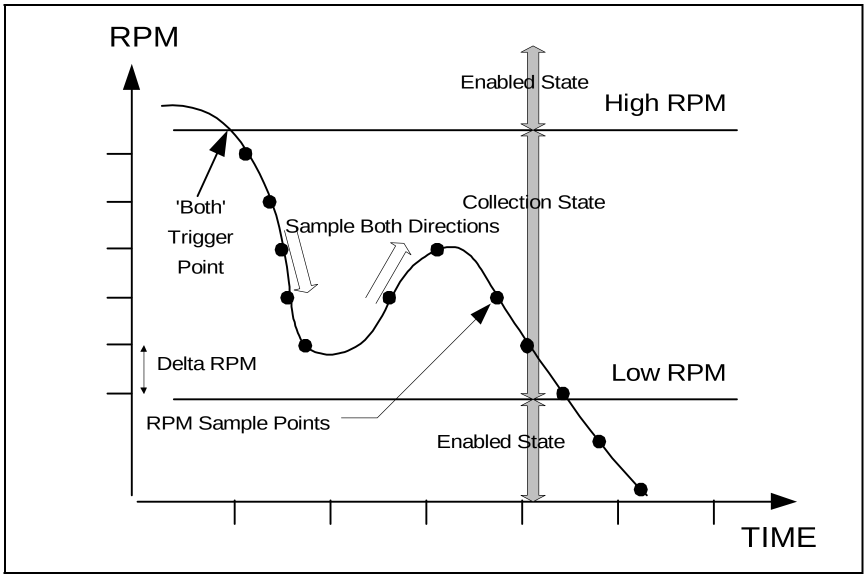
16. Set the delta RPM value. To determine a value that covers the entire shutdown range, take the Low RPM and divide by 280. Select the next reasonable value higher than this value. If the machine will overspeed or if speed fluctuates as it coasts down, select a higher delta to allow enough records to cover the speed fluctuations.

1.4.3 Both mode.

Enabled State: The Both buffer enabled mode is when the speed is outside the speed range between the Low and the High rpm value.

Trigger State: TDe "triggers" the buffer to collect data when the speed transition across a High or Low boundary value. This means that data collection begins when the speed crosses from a rpm value less than the "Low" value to one higher, or when the speed crosses from a rpm value greater than the "High" value to a rpm value lower. Again, it will collect 40 static values and 4 waveform from the delta time history. Executing the SYSTEM 1 software command to "*Initiate Startup/Shutdown*" has the same effect as entering the triggered state.

Collection State: The Both buffer "collects" a new data record every time the speed changes the specified "Delta" rpm interval. The rpm change applies for both increasing and decreasing rpm values. Applications for using the Both mode buffer include collecting startups, shutdowns, and targeted data capture over specific speed ranges such as over mechanical resonance.



To configure the TDe for collecting data using the Both buffer perform the following:

17. Enter the SYSTEM 1 Configuration program.

> **Note**
>
> Configuration changes will cause stored data loss in the TDe.

18. In the configuration program select the appropriate rack, and select Keyphasor® parameters. Note the synchronous samples per revolution value. If the value is 128 the maximum Keyphasor® speed is 15000 rpm, if it is 64 the maximum Keyphasor® speed is 30000 rpm, if it is 32 then the maximum Keyphasor® speed is 60000 rpm.

19. Select “Delta RPM Buffer” in the Keyphasor® screen.

20. Select either “Buffer 1” or “Buffer 2” and select “Both” as the mode.

21. Check “Overwrite Transient Data” if desired. If the “overwrite” box is checked, each time the both enabled state is entered, the existing information in the buffer will be deleted and the buffer will be prepared to capture a new data set. If the box is not checked, then the data that is collected will remain until it is uploaded either manually or automatically or the data is aborted manually.

22. Enter the Low RPM value. This is the lower “trigger” rpm value. It should be set at a value less than the lower range of operating speed that is desired for capture.

23. Enter the High RPM. This is the upper “trigger” rpm value. Set this value higher than the upper operating speed that is desired for capture.

24. Set the delta RPM value. To determine a value that covers the entire range, take the difference between the High RPM and the Low RPM and divide by 280. Select the next reasonable value higher than this value. If the machine speed fluctuates as passes through the range, select a delta higher to allow enough records to cover the speed fluctuations.

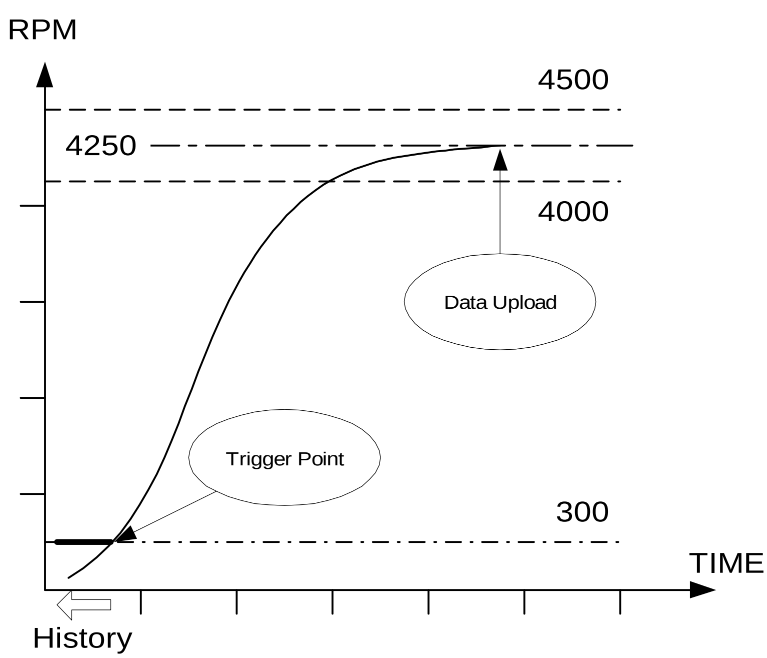
1.4.3.1 Examples

Example 1: Normal startup, machine starts and ramps continuously to running speed.

TDe Buffer Configuration		
Buffer #	1	2
Overwrite	No	No
Mode	Startup	Shutdown
Hi	4250	4500
Low	300	4000
Delta	15	15
Auto Upload	None	None

Transient conditions: TDe automatically initiates capture of startup. At 4250 rpm, machine is operational (steady state).

Operator request a manual upload of the TDe buffers after machine is in steady state operation at 4250 rpm.



Results: Data uploaded from the buffers is:

Buffer 1: History of 40 delta time records representing the 160 seconds prior to crossing the 300 rpm speed; 263 delta rpm SU samples from 300 to 4245 rpm in 15 rpm increments.

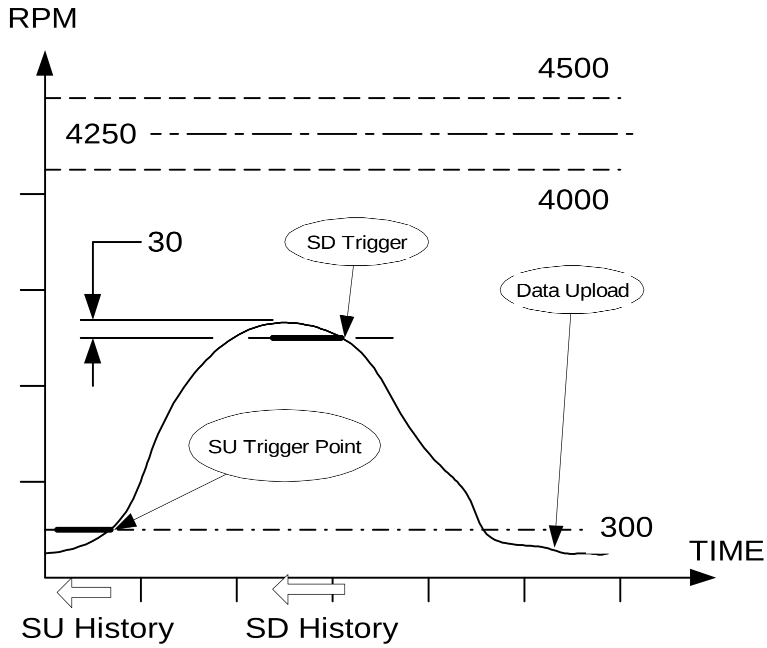
Buffer 2: No data records. As a shutdown buffer, it was not triggered. The buffer was enabled when it crossed the 4000 rpm Low value.

Example 2: Startup aborted before reaching running speed.

TDe Buffer Configuration		
Buffer #	1	2
Overwrite	No	No
Mode	Startup	Shutdown
Hi	4250	4500
Low	300	4000
Delta	15	10
Auto Upload	None	None

Transient conditions: Machinery startup proceeds normally from 200 to 3000 rpm. At 3000 rpm, machinery problems cause a forced shutdown.

Operator request a manual upload of transient data following the shutdown.



Results: Data uploaded from the buffers is:

Buffer 1: Startup history contains 40 delta time records representing the 160 seconds prior to crossing the 300 rpm speed; remainder is 181 delta rpm SU records from 300 to 3000 rpm in 15 rpm increments.

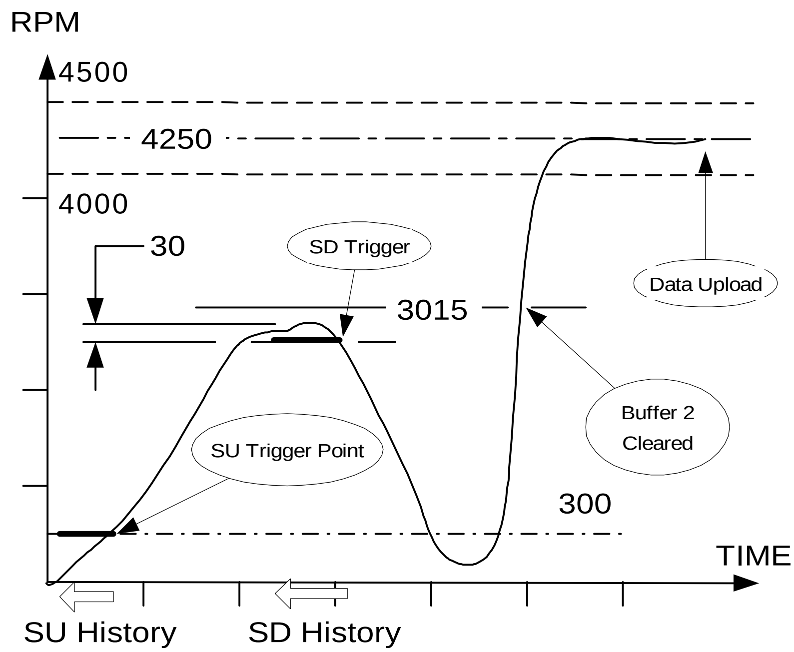
Buffer 2: Shutdown history contains 40 delta time records representing the 160 seconds prior to the coast-down speed of 2970 rpm. The speed drop of two *startup* delta rpm values (30 rpm) enables buffer 2 and the speed value less than the Low setting of 4000 rpm triggers collection. Remainder contains 280 records from 2970 to 170 rpm at 10 rpm increments. The shutdown buffer filled all 320 records, 40 delta time based and 280 rpm based.

Example 3: Startup aborted before reaching running speed, problem corrected and the machine restarted.

TDe Buffer Configuration		
Buffer #	1	2
Overwrite	No	No
Mode	Startup	Shutdown
Hi	4250	4500
Low	300	4000
Delta	15	15
Auto Upload	SS 15	SS 15

Transient conditions: Unexpected problems cause a shutdown at 3000 rpm back to slow roll. Machine is fixed within 10 minutes and re-started to normal operating speed with no problems.

Auto upload of transient data configured for 15 minutes of steady state operation.



Results: Data uploaded from the buffers is:

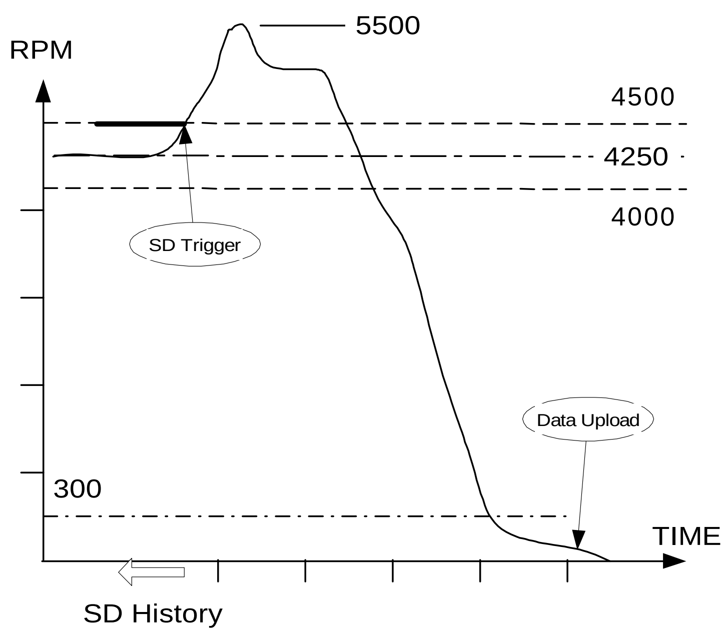
Buffer 1: Startup history with 40 delta time records representing the 160 seconds prior to crossing the 300 rpm speed; 181 delta rpm records from 300 to 3000 rpm in 15 rpm increments prior to the coast-down, and 82 delta rpm records from 3015 to 4245 in 15 rpm increments during the re-start.

Buffer 2: No data in buffer 2. 218 records were captured on the coast-down from 3270 down to 60 rpm in 15 rpm increments, and another 62 during the restart from 60 to 990 rpm. At 990 rpm on the restart buffer 2 was filled. Since there was additional data in the start up buffer, the coast down data was not preserved. If the machine had stayed in slow roll for the 15 minute steady state period, the data would have been automatically uploaded and a new startup would have been captured. Also, if the operator wanted to preserve the data he could manually invoke the upload during the slow roll period and again the second startup would have been captured in total.

Example 4: Machine at running speed, breaks coupling, over-speeds and then shuts down.

TDe Buffer Configuration		
Buffer #	1	2
Overwrite	No	No
Mode	Startup	Shutdown
Hi	4250	4500
Low	300	4000
Delta	15	15
Auto Upload	rpm 4200	rpm 90

Transient conditions: Machine is at running speed, then over-speeds to 5500 rpm before beginning to coast down. Automatic upload of data when speed reaches 4200 or 90 rpm.



Results: Data uploaded from the buffers is:

Buffer 1: No data since there was no startup event.

Buffer 2: Shutdown history begins at 4500 rpm over-speed for 40 records just prior to event. Up to 66 records to 5490 rpm, then 214 records from 5475 down to 2265 rpm. The buffer would be full at this time. The automatic upload would begin when the speed reaches 90 rpm. To capture more of the coast-down, the delta could be set at wider spacing.

1.5 Communication

As a communications processor, the TDe handles serial communications between the Bently Nevada host computer or digital control system (DCS), and monitor rack. The host communication uses 10 Mbit Ethernet normally using TCP/IP, whereas the DCS communication uses RS-232 or RS-422 as its standard.

The sections below describe each serial channel.

1.5.1 TDe Link

The TDe communicates with the Bently Nevada host computer over the TDe local area network (LAN) connection. This link is a 10 Mbit Ethernet link and uses TCP/IP with the proprietary Bently Nevada protocol encapsulated as the message content. The TDe LAN is ISO/IEC 8802.3 (ANSI/IEEE-802.3) compliant and subject to all the limitations in communication lengths that this standard imposes. Each TDe is assigned a unique Ethernet address which is permanently programmed on the CPU assembly. The configuration allows setting the IP address and sub-net mask. When delivered the default IP address is 192.168.0.1 with a sub-net of 255.255.255.000.

When used on a LAN during the highest communication activity, the effective LAN bandwidth used by the TDe is 500 Kbits/sec. This is due to the protocol using less than the maximum allowed message length for many requests and responses and the message preparation time. This rate is only used during transfers of startup/shutdown data files or alarm files. During routine operation, the LAN is only required for several messages each second.

The utility programs, Transient Data Manager Initialization and TDXnet Test Communications, use UDP broadcasts to communicate with TDe. Broadcasting is only done in those instances where the IP and/or communication rack addresses are unknown or being established. These programs may not operate in networks where broadcasts are blocked between subnets within the system.

The TDe provides connection to the LAN using a 10 Base T 9 Pin DSUB connection.

1.5.2 SDI Link (Allen-Bradley/Modbus Protocol)

The DCS channel (also called the serial data interface or SDI link) connects the TDe with the digital control system and process logic controller (PLC) over this link. This link communicates using RS-232 or RS-422 interface standard using either Allen-Bradley or

Modbus message protocols. Other sections in this manual describe the use of the protocol to extract information from the TDe. Three 9-pin D-sub connectors are available to make the connection.

1.5.3 Monitor Rack Link

The following table summarizes the available protocols for the TDe and SDI links with the supported baud rates and maximum cable lengths for each.

TDe Serial Channel Operating Specifications

Serial Channel	Protocol	Maximum Cable Length (ft)	Baud Rates Supported
TDe Link	10 BaseT	328 (2 nodes)	10 Mbit
SDI Link	RS-422	4000	2400 4800 9600 19.2 K
	RS-232	100	2400 4800 9600 19.2 K

2. Installation

2.1 Upgrading your 3300 rack

Use the following approach to upgrade your 3300 racks with a 3300/02 TDe System Monitor:

> ⚠CAUTION
>
> **Machine protection will be lost while power is removed from the protection system. Plant personnel need to ensure the safety of personnel in the area during this period.**

> ⚠CAUTION
>
> **The OK relay will go to a not OK state when power is removed. Bypass the OK relay and any relays wired to trip before shutting off power to the rack.**

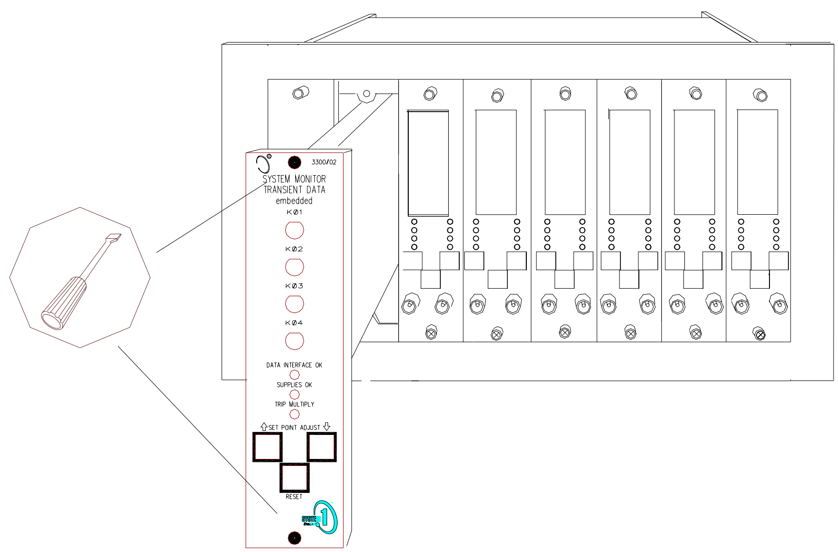
Step	Refer to section...
1. Review the above cautions and take action in accordance with plant policy.	
2. Remove power from the rack that will be retrofitted with the 3300/02.	
3. Replace the existing 3300 System Monitor with the 3300/02.	Section 2.2 on page 25
4. Create a connection between the PIM and the host system: • For a connection to a DCS. • For a System 1 connection using the exiting serial wiring that was used to connect an old DDI System Monitor to a DM2000 Host. • For a System 1 connection using standard 10 Base T Ethernet communications.	Section 2.4 on page 29 Section 2.5.3 on page 36 Section 2.5.2 on page 34
5. Verify the communication between the 3300/02 and the host system.	Section 3.3 on page 45
6. Initialize the TDe module.	Section 2.6 on page 38

2.2 Assembly and Disassembly Procedure

2.2.1 Removing and installing the System Monitor

Use this procedure to update a 3300 rack with a 3300/02 TDe or to remove a TDe for servicing. The only tool you need is a screwdriver.

> **CAUTION**
>
> **Removing or installing 3300 modules while the rack is powered will damage the module.**
>
> **Power down the rack when installing or removing a monitor.**



7. Remove power from the 3300 rack.

8. Remove the existing 3300 system monitor by loosening the screws on the front panel and pulling the System Monitor out from the rack.

9. Set the jumper for transducer power.

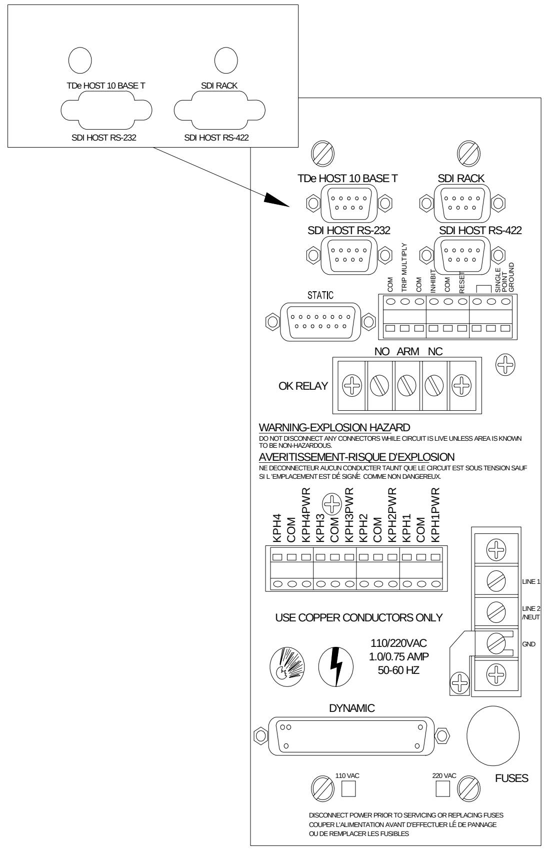
10. Record the MAC address off of the CPU module and the serial number from the baseboard. The MAC address will be needed to identify the unit during configuration. The serial number will be needed to determine which channel enabler disk to use when adding the channels to System 1.

11. Insert the 3300/02 into the rack by sliding the module into the system monitor slot and then tightening the screws on the front panel.

12. Set the DDI Host option on the PIM to RS-232. For Instructions consult the Power Supply manual.

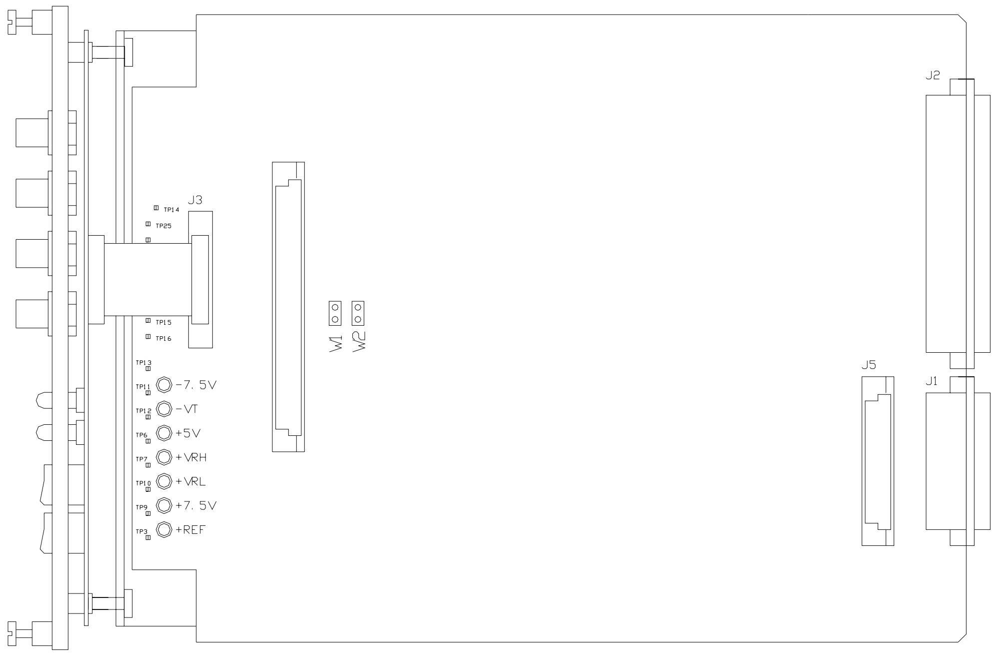
13. Place Overlay label (167437) on the Power Input Module.

14. Reapply Power



2.3 Programmable Options

The System Monitor has jumper-programmable options for selecting the transducer voltage. Change these options by removing and installing jumpers on the base board circuit board. See Section 2.3.2 regarding how to access the base board.



Jumper Locations

-VT Options

To set the -VT option according to the option set on the Power Supply, remove jumpers from headers W1 and W2 and install jumpers as specified in Table 2.

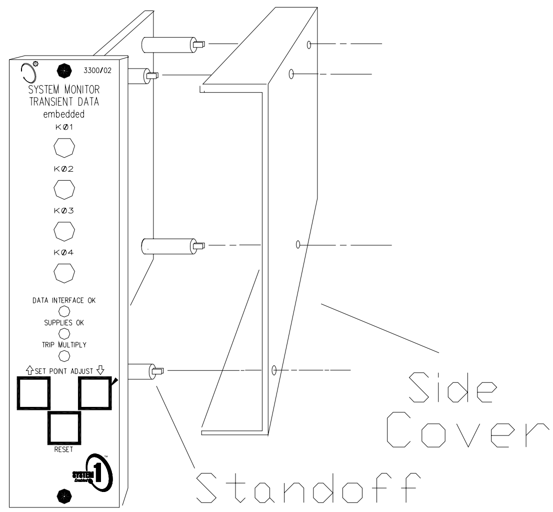
Table 2. -VT Options

OPTION	INSTALL JUMPER	REMOVE JUMPER
-VT = -18 Volts	W2	W1
-VT = -24 Volts	W1	W2

2.3.1 Circuit Board Removal

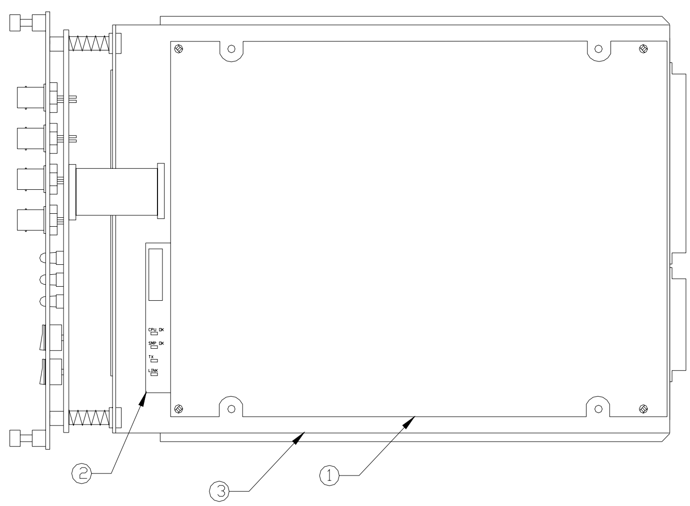
Circuit boards must be removed in order to adjust jumper settings or update firmware. Notice, however, that the 3300/02 TDe cannot be serviced in the field. If a problem with the TDe is detected, contact you local Bently Service representative.

15. Remove the side cover by pinching the protruding tip of each of the 4 standoffs.



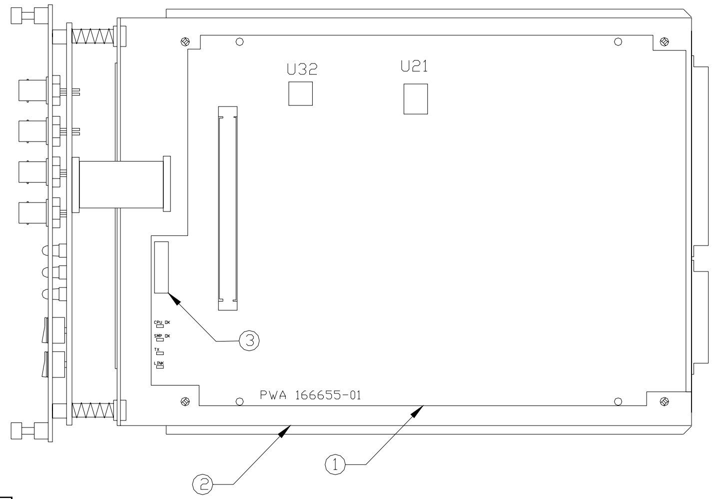
16. Remove the Sampler circuit board by pinching the protruding tip on each of the 4 standoffs and gently prying the Sample board away from the CPU board.

1) Sampler Board
2) CPU Board
3) Base Board



17. Remove the CPU circuit board by gently prying it away from the two mating connectors and 4 standoffs on the System Monitor circuit board.

1) CPU Board
2) Base Board
3) MAC Address



CAUTION

The I.C. number U32 on the CPU circuit board contains lithium. Breaking open the I.C. may expose lithium. Improper handling of exposed lithium may cause injury.

2.3.2 MAC ADDRESS LOCATION

The MAC address is a unique number used for Ethernet communications. This number will be needed to initially configure the TDe to communicate across a network. The number is located on a label on the front edge of the CPU PWA (middle board).

2.4 Connection to DCS

2.4.1 Introduction

This section describes how to connect the SDI to the host computer system. The part numbers for the cables used in this section are listed in section 5.2 beginning on page 56. Be sure to set the configuration for SDI channels as described in the Configuring TDe section. Verify that the communication options are correctly set on the Power Input Module (PIM). (Refer to the Power Supply manual for the PIM option configurations.)

This section is divided into three parts. Each part corresponds to a different wiring configuration used to connect the SDI or TDe to the host system.

SECTION	HOST SYSTEM
2.4.2	Upgrading from a SDI Installation
2.4.2	Allen-Bradley 1770-KF2
2.4.4	Allen-Bradley 1771-KE or 1785-KE
2.4.5	Honeywell PLC[7] Gateway or Data Highway Port

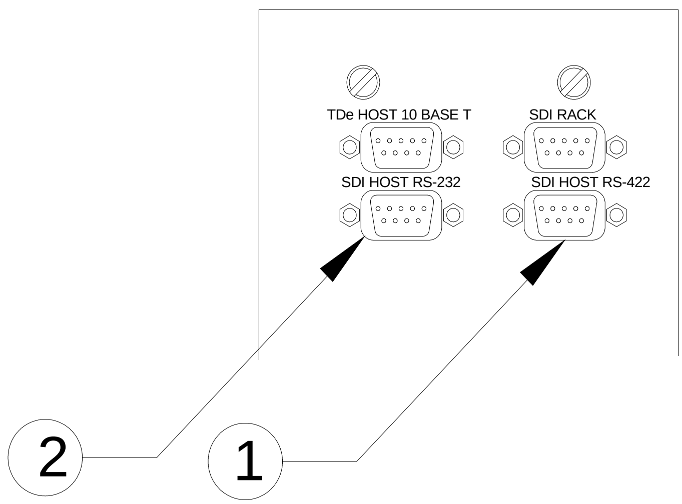
NOTE: The part numbers for the cables shown in the following sections have been abbreviated to simplify the drawings. For a complete part number consult the Accessories section of the manual beginning on page 56.

Test Package

Bently Nevada offers a test package to verify the SDI connections and protocol settings. The package name is SDI/SI Test Package, part number 101209-02 for 31/2 in disks. Call your local Bently Nevada representative to order this package.

2.4.2 Upgrading a Installation with a existing SDI Connection

If upgrading from a system that was already connected to a DCS there is only one case where the SDI cabling needs to be changed. If the RS-232 is being used for SDI the RS-232 cable must be disconnected from the PIM and shifted to the adjacent connector. Move the cable from connector 1 over to connector 2.



1) Connector used for RS-232 & RS-422 DCS Host Communications for the 3300/03. With the 3300/02 this connector is only used for RS-422 DCS Host Communications.
2) Connector used for DDI Host Communications for the 3300/03. With the 3300/02 this connector is used for RS-232 DCS Host Communications.

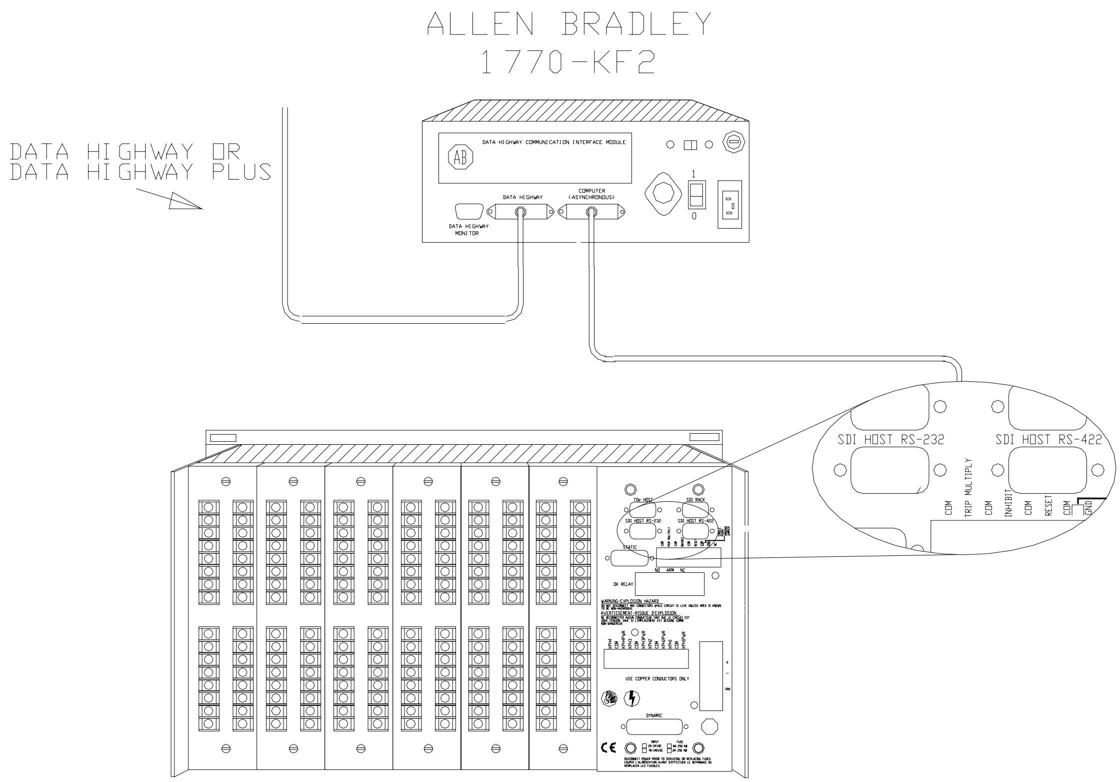
2.4.3 Cable Connection to Allen-Bradley 1770-KF2 Communications Module

The 1770-KF2 is a stand alone communication interface which provides a RS-232C or RS-422A link between asynchronous devices and an Allen-Bradley Data Highway or Data Highway Plus communications network.

With the KF2 module, either RS-232C or RS-422A may be used and the interface used is determined by which connector is used. If RS-232C is selected, connections between the KF2 and the Power Input Module (PIM) should be made with cable part number 89968. If RS-422A is specified, use cable part number 89970. Connect the cable to the SDI HOST connector on the PIM.

The maximum cable length for RS-232C is 100 feet (30.5 metres). The maximum cable length for RS-422A is 4000 feet (1219.2 metres). Use the RS-422A interface whenever possible.

NOTE: Since the Allen-Bradley protocols are full duplex, only one 3300 rack may be connected per KF2 module.

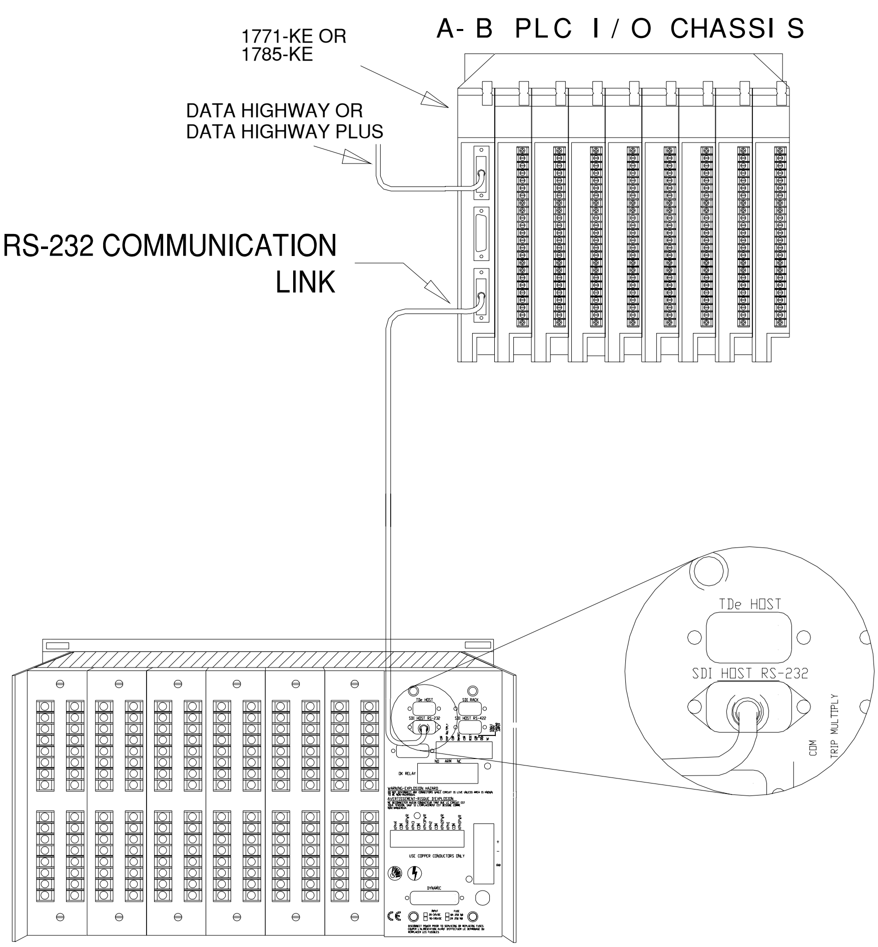


2.4.4 Cable Connection to Allen-Bradley 1771-KE or 1785-KE Communications Modules

Both the 1771-KE and the 1785-KE are designed to be installed in an I/O chassis. A 1771-KE provides an interface between a RS-232C communication link and an Allen-Bradley Data Highway Communication link. A 1785-KE provides an interface between a RS-232C communication link and an Allen-Bradley Data Highway Plus communication link.

Connect the Allen-Bradley module to the PIM using cable part number 89969. Connect the cable to the SDI HOST RS-232 connector on the PIM. The 89969 cable is available in lengths of 10, 25, 50 and 100 feet (3, 7.6, 15.2 and 30.5 meters). When distances beyond 100 feet are required, install a pair of modems in the communications link.

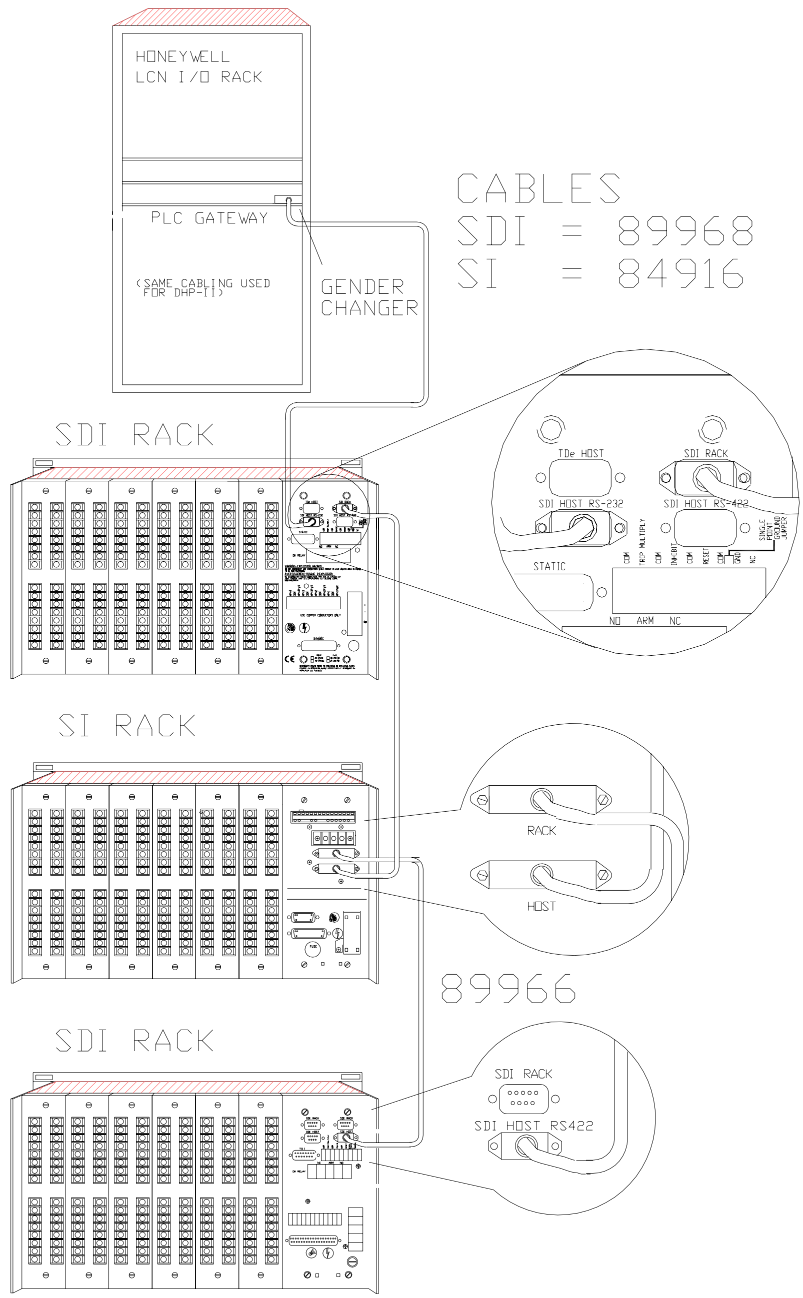
NOTE: Since the Allen-Bradley protocols are full duplex, only one 3300 rack may be connected per KE module.



2.4.5 Cable Connection to Honeywell PLC Gateway or Data Highway Port

The Honeywell PLC Gateway (PLCG) provides an interface between RS-232C devices using Modicon Modbus protocol and the TDC 3000 Local Control Network (LCN). The DHP-II provides a similar interface to the Honeywell Data Highway.

Connect the Honeywell interface and the PIM with cable part number 89968. Connect the cable to the SDI HOST RS-232 connector on the PIM. This cable is limited to 100 feet (30.5 metres). Since the Modbus protocol is master/slave, multiple 3300 racks may be connected in a daisy chain. Connect daisy chained racks by attaching the male end of a cable to the SDI RACK connector on the first rack and then connecting the female end of the cable to the **SDI HOST RS-422** connector of the next rack. The following table gives the part number of the cable to use based upon connecting both SDIs and Serial Interfaces (SI) in a daisy chain. * See Section 5.2 on page 56 for more information.



HOST	RACK	CABLE
PLCG or DHP-II	SDI	89968
PLCG or DHP-II	SI	84916
SDI	SDI	47125
SDI	SI	89967
SI	SDI	89966
SI	SI	84915

Since rack-to-rack communication uses the RS-422A standard, it can support cable distances up to 4000 feet between racks.

2.5 Connection to System 1 DAQ Computer

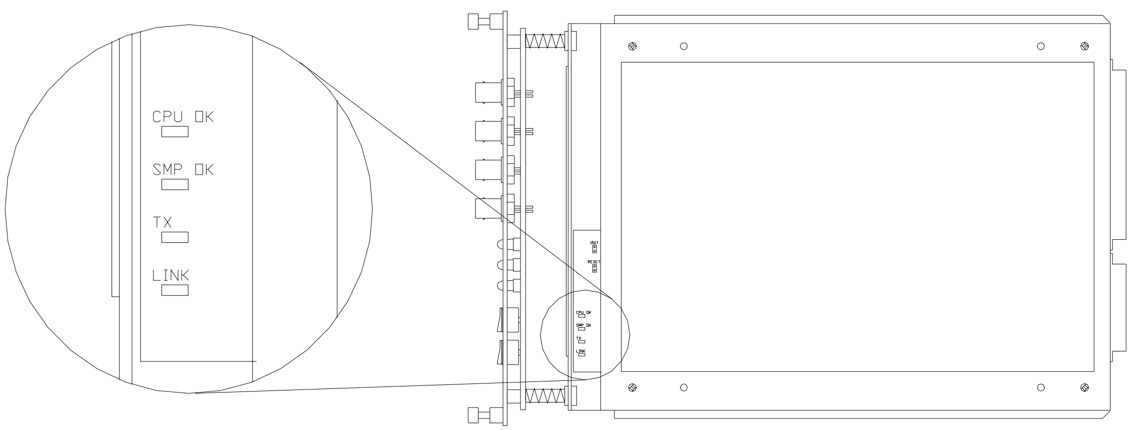
2.5.1 Introduction

The 3300/02 TDe can connect to a System 1 Data Acquisition (DAQ) host using two connection methods. The standard connection uses Ethernet network cabling and the RS-422 connection uses existing RS-422 cabling with Media Converters at each end of the cable. The following two sections explain how to use each connection.

There are two LEDs on the CPU Board to assist with the connection to an Ethernet network.

LINK LED – When on the TDe module is connect to an active Ethernet network.

TX LED – This LED flashes when the TDe detects traffic on the network.

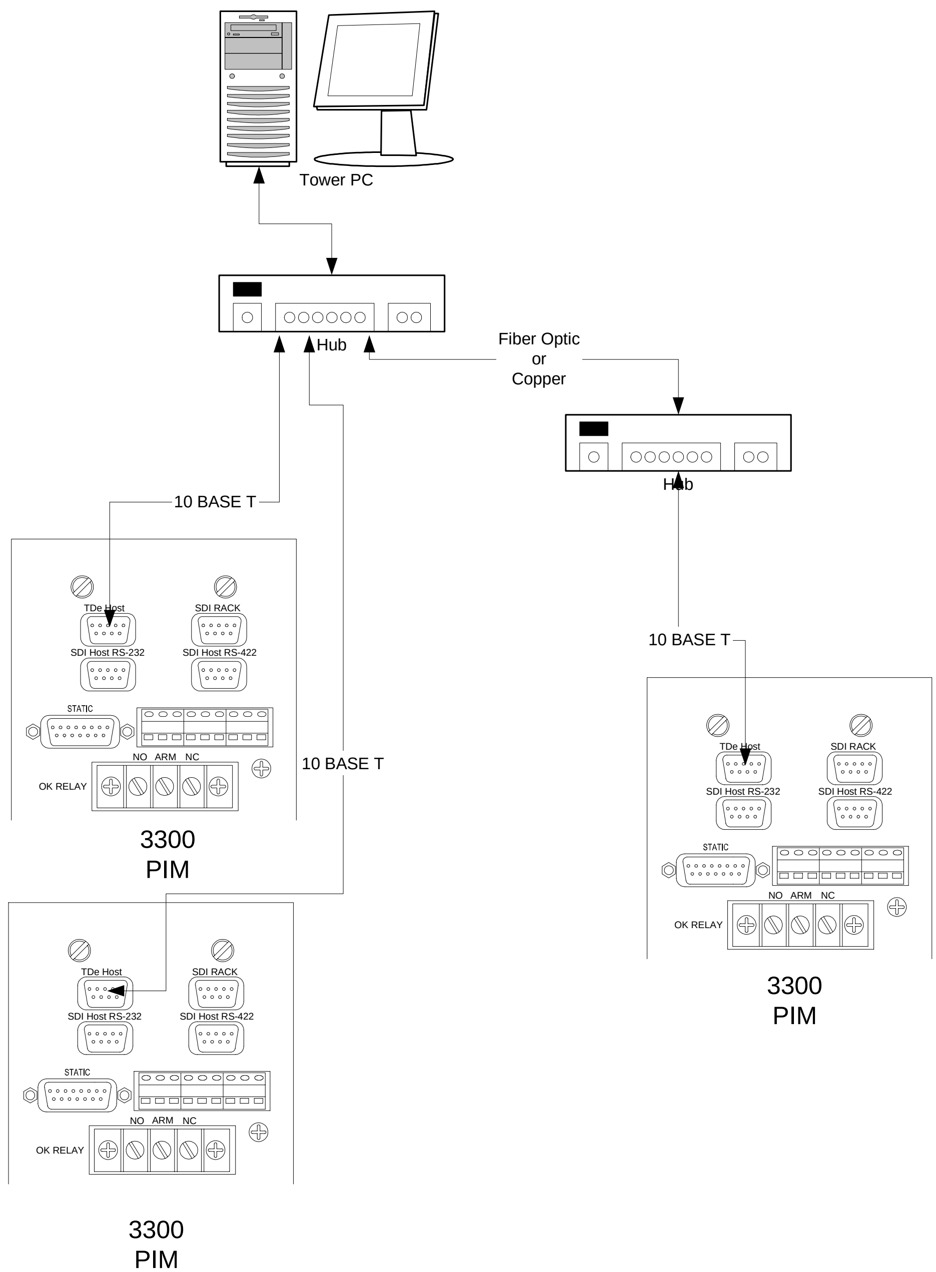


After you have connected your 3300/02 TDe to the host with one of these connection methods, use Verification and System Diagnostics on page 43 to verify that your connection is working correctly.

2.5.2 Standard Connection

The standard connection is shown in the diagram below. This connection uses a cable that connects to the 9-pin DSUB connector labeled “TDe Host” on the PIM and provides a RJ-45 connector for interfacing to standard Ethernet Devices. This cable uses 10 Base T Ethernet communications, is 802.3 compliant, and has a maximum length of 100 m (320 ft). Refer to section 5.2 on page 56 for ordering information for this cable.

After you have completed the connections, verify that the TDe is communicating properly by using the information in Verification and System Diagnostics on page 43.



2.5.3 RS-422 Connection

The RS-422 connection provides a way to make a network connection between the TDe and a System 1 DAQ using the existing RS-422 cabling that was previously used to connect an old DDI System Monitor to a DM2000 host. This connection is shown in the diagram on the next page.

This connection requires a Media Converter on each end of the RS-422 cable. A Host converter (master) is connected to the network where the host computer is located. The Remote converter (slave) is connected to the rack using a cross over cable. To connect to multiple TDes, an Ethernet switch is required between the Remote converter and the networked TDes. The Media Converters require a +12V or +24 V supply.

If the 3300 racks are daisy chained then an additional set of converters is required to go between racks. The Host converter is placed at the end of the cable closest to the Host computer.

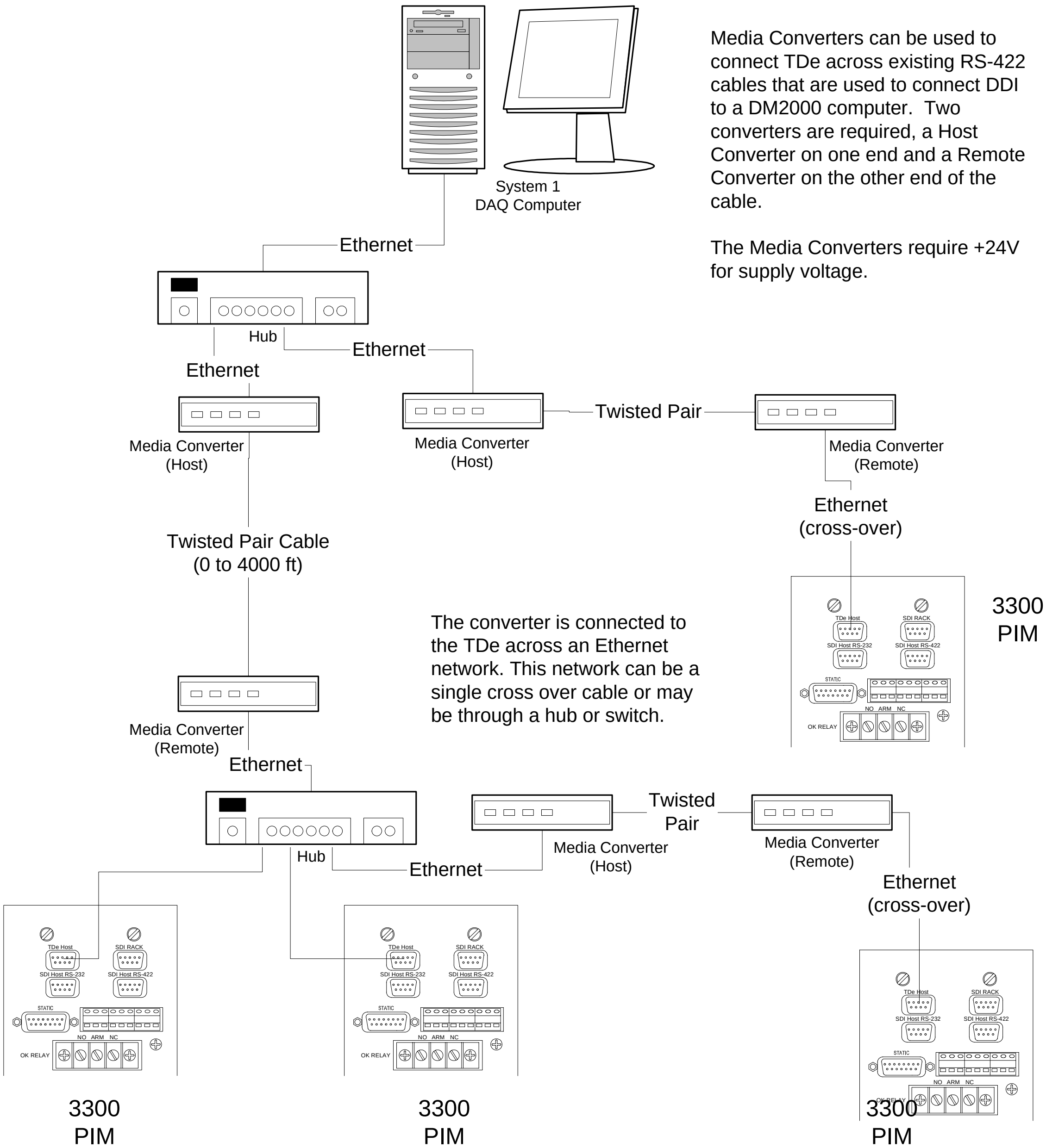
Refer to Media Converters on page 57 for ordering information about the Media Converters and to RS422 3300/02 to 3300/02 or 3300/03 Cables on page 58 for information about the required cables.

After you have completed the connections, verify that the TDe is communicating properly by using the information in Verification and System Diagnostics on page 43.

Connecting TDe Across RS-422 Cabling

Media Converters can be used to connect TDe across existing RS-422 cables that are used to connect DDI to a DM2000 computer. Two converters are required, a Host Converter on one end and a Remote Converter on the other end of the cable.

The Media Converters require +24V for supply voltage.



The converter is connected to the TDe across an Ethernet network. This network can be a single cross over cable or may be through a hub or switch.

2.6 Configuration of TDe

Transient Data Manager Initialization utility is a software configuration utility that is supplied with the Bently Nevada System 1 software. Use the Transient Data Manager Initialization utility to:

- Choose initialization settings
- Save settings to disk
- Load settings from disk
- Print current settings
- Download setting choices to the TDe
- Upload settings from the TDe

To prepare a TDe for use you must first initialize it and then configure it. Initialization consists of using the Transient Data Manager Initialization utility to choose operating parameters for the TDe. These parameters specify Keyphasor and communication characteristics, allowing it to communicate on the host and SDI links. Since the parameters are stored in non-volatile memory in the download process, you only need to initialize the TDe once unless you decide to change the parameters.

Transient Data Manager Initialization contains a factory-default configuration for the TDe so that it can begin operation. The System 1 configuration software must be used to download monitor-related information to the TDe so that it can collect data correctly. The program supports TDIX, TDXnet, FMIM and TDe, but this manual only discusses using the program with TDe.

2.6.1 Setting the Initialization Parameters

When you start the program you must specify that the TDe is the communication processor type that you wish to configure since the program also supports several other communication processors. When the program begins, all initialization settings contain default values including a default IP address. Communication with the TDe in the Transient Data Manager Initialization program uses UDP broadcast network communications. Each TDe contains a unique Ethernet address (this is different from the IP address which is set by the user) which is programmed at the factory in non-volatile RAM on the CPU board of the TDe. This address is referred to as the MAC address and can be found on the label on the CPU board.

Modify the values with drop-down screens under the TDe Parameters menu: TDI Parameters, SDI Parameters, and Keyphasor Parameters.

TDI Parameters

TDI Parameters control communications with the host computer over the TDe host link.

Rack Address specifies the address that the TDe responds to when in normal operating mode. Valid addresses are from 1 to 255 decimal. Each Communications Processor in the same local area network must be set for a unique address. The TDe SDI communications port uses the same address as the rack address. Modbus communications allow the address range of 1 to 247. Transient Data Manager Initialization program does not assure that the rack address does not violate the Modbus requirement.

IP Addresses are permanently assigned by the Transient Data Manager Initialization program. If the TDe is to be used on a LAN, the system administrator should issue the IP addresses to be used and should also know that they are permanent addresses. TDe does not support dynamic IP addressing (such as DHCP). When delivered from the factory, the IP address is defaulted to 192.168.0.1. These must be changed to make them unique using the Transient Data Manager Initialization program prior to putting the system into operation with the SYSTEM 1 Data Acquisition software.

Sub-net Mask allows sub-netting of the LAN. The system administrator should be consulted if sub nets are going to be used on the LAN. The default sub net is 255.255.255.0.

SDI Parameters

SDI Parameters control communications with the DCS computer over the SDI link.

Serial Protocol sets the communications protocol (Modicon Modbus or Allen-Bradley) that will be used on the SDI link.

Serial Format specifies the data format (Hex or BCD) that the TDe will use on the SDI link if the option is available.

Speed (bps) sets the baud rate the TDe will use on the SDI link.

Stop Bits determines the number of stop bits (1 or 2) the TDe uses on the SDI link. You should normally select 1 stop bit for this field.

Parity Mode sets the parity type (Even, Odd, or None) the TDe uses on the SDI link.

Timeout specifies the amount of time, in byte transmission time units, that the TDe uses to recognize the end of an incoming message. The timeout period begins when bytes stop arriving.

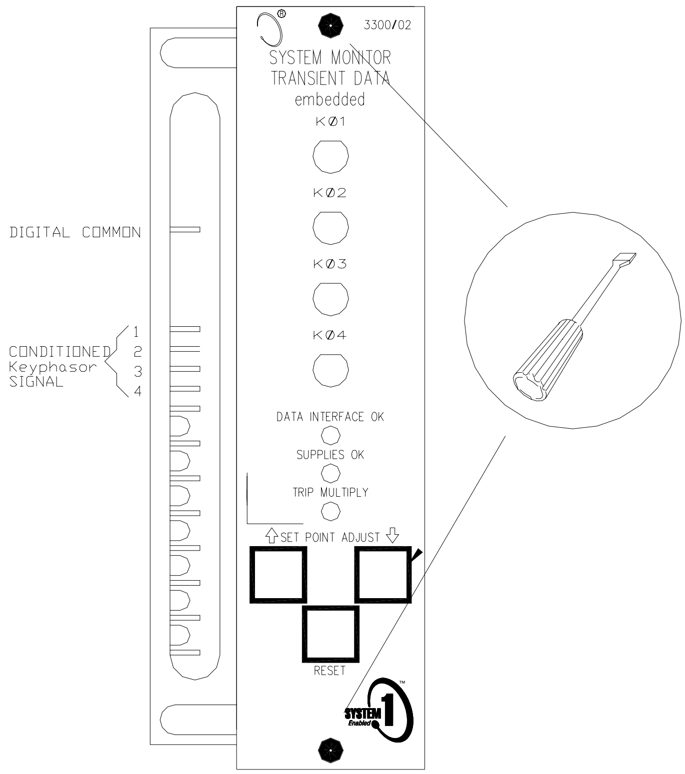
The default value of three bytes is suitable for direct-wired installations. In general, choose the shortest timeout that works reliably.

Enable SDI is enabled if you are using the SDI link. You should disable this field if you are not using the SDI link.

Enable CRC is enabled to improve error detection. Since CRCs (cyclic redundancy checks) are time-consuming to calculate, you will reduce throughput by enabling this field.

Keyphasor Parameters

Keyphasor Parameters specify the characteristics of the Keyphasor signals.



KPH Number determines the Keyphasor being configured.

Threshold sets the voltage level at which Keyphasor triggering occurs. Automatic specifies that the TDe will determine the trigger level. Manual specifies that Keyphasor® triggering will occur at the voltage value entered in Manual Threshold. Automatic is generally preferable, as the shaft may change position during machine operation. If the Keyphasor pulse is especially narrow or has a low duty cycle, however, you may need to use Manual Threshold.

Note
Keyphasor® Parameters apply only to the currently selected Keyphasor®. Select the number of the Keyphasor® you wish to configure before changing settings in this field.

Hysteresis determines the minimum voltage level shift used for detecting Keyphasor state changes. The default is 0.5 volts but a different value may be appropriate depending on machine speed and electrical noise levels. A noisy signal may benefit from greater hysteresis.

Edge defines the signal edge at which Keyphasor triggering occurs. Select Notch to trigger the Keyphasor on a falling edge, or Projection to trigger on a rising edge.

2.6.2 Initializing the TDe

18. Connect the TDe Host connector to the LAN where the Transient Data Manager Initialization program is running. If there is only a direct 10Base-T connection between the computer network card and the TDe, it must have a crossover cable to operate properly.

19. Run the Transient Data Manager Initialization program.

20. Click on the TDe Initialization icon . From the TDe Initialization window click on Browse. The software will return all of the TDes on the network along with their rack address, IP address and MAC address. If the units have never been configured the rack address will be 1 and the IP will be 192.168.0.1. The Ethernet Address (MAC) will have to be used to determine which rack to access. This address can be found by examining the CPU board.

21. From the Browse Results window select the TDe that you want to configure. Click on **"Enter Init Mode"**, this will place the TDe into initialization mode.

22. Establish the configuration that you want for the TDe.

> **NOTE**
>
> The Transient Data Manager Initialization program only establishes a part of the configuration. SYSTEM 1 monitor configuration must also be run to finish configuring the TDe.

23. Select "**Send to TDe"** when the configuration is correct. After the download is complete the TDe confirms the settings by sending them back to the computer. If the settings do not agree an error message will be displayed.

24. When the download has successfully finished you may exit Transient Data Manager Initialization by selecting **'Reset TDe'**. The TDe must be reset otherwise it will remain in initialization mode.

25. After passing self test, the TDe will being operating with the configuration stored in its non-volatile memory.

2.6.3 Changing Initialization Settings of a TDe

Use this procedure to modify settings in a TDe that has previously been initialized.

26. Connect the TDe Host connector to the LAN where the Transient Data Manager Initialization program is running. If there is only a direct 10Base-T connection between the computer network card and the TDe, it must have a crossover cable to operate properly.

27. Run the Transient Data Manager Initialization program.

28. Click on the TDe Initialization icon . From the TDe Initialization window click on Browse. The software will return all of the TDes on the network along with their rack address, IP address and MAC address.

29. From the Browse Results window select the TDe that you want to configure. Click on **"Enter Init Mode"**, this will place the TDe into initialization mode.

30. Retrieve the TDe's current settings with **'Get from TDe'**.

31. Change the settings as desired. You may want to save your new choices with the Files/Save As command.

32. Select **'Send to TDe'**. After the download is complete the TDe confirms the settings by sending them back to the computer. If the settings do not agree an error message will be displayed.

33. When the download has successfully finished exit Transient Data Manager Initialization by selecting **'Reset TDe'**.

After passing self test, the TDe will being operating with the configuration stored in its non-volatile memory.

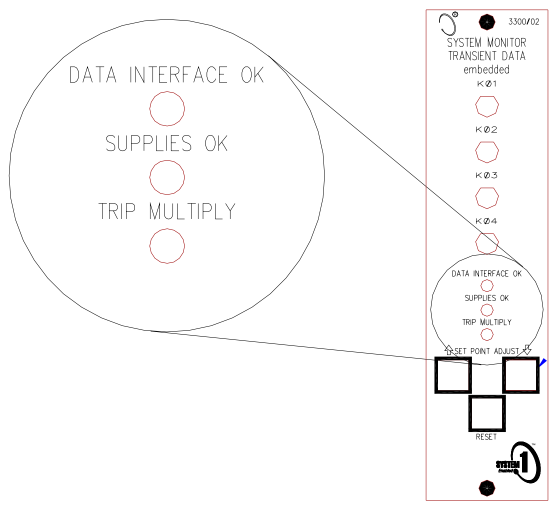
3. Verification and System Diagnostics

The operating status of the 3300/02 TDe monitor and state of the communication between the rack and a host are indicated by the following LEDs:

LED type	LED location	Refer to section
Front panel LEDs	Monitor front panel	3.1 on page 43
Status LEDs	Base board	3.2 on page 44
CPU LEDs	CPU board (middle board)	3.3 on page 45

3.1 Front panel LEDs

The LEDs on the front panel indicate the operating status of the 3300/02 as follows:



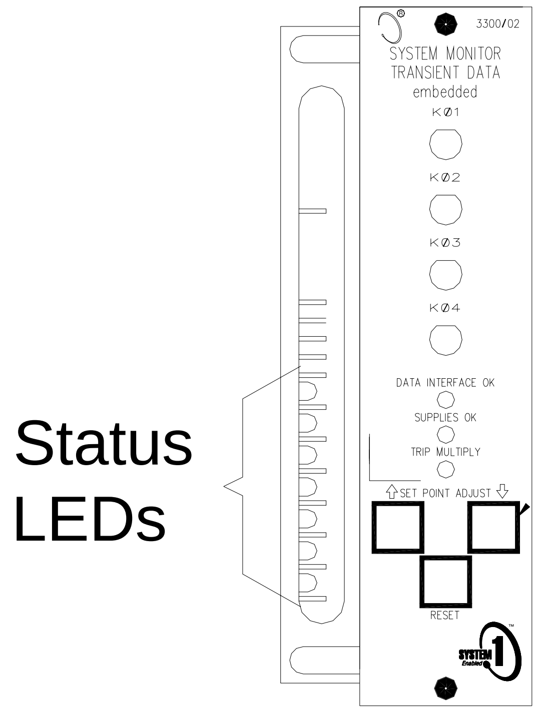
LED	Meaning	
	On	**Off**
Data Interface OK	the TDe is functioning correctly	an error is detected in the TDe module. (Refer to TDe Status LEDs on page 45 for information about determining the specific location of the problem)
Supplies OK	All 3300 supplies for the rack are operating correctly	One of the 3300 supplies is outside its specifications. Further diagnostics regarding which supply is not OK can be acquired by examining the LEDs on the base board (see section 3.2 on page 44).
Trip Multiply	the rack is in Trip Multiply (see TRIP MULTIPLY on page 5)	the rack is not in Trip Multiply

3.2 Supply Status LEDs

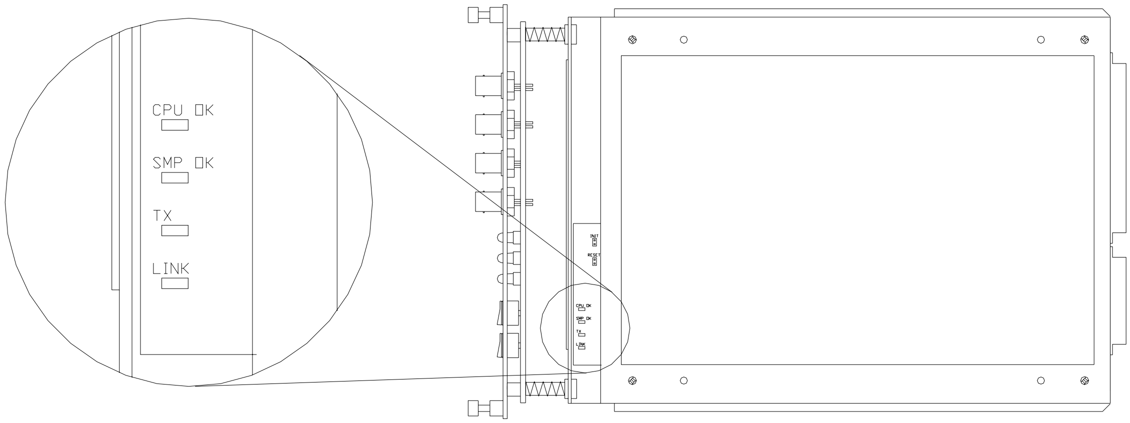
The individual Supply Status LEDs are located behind the front panel of the monitor.

From top to bottom these are: -7.5V, -VT, +5V, +VRH, +VRL, +7.5V, and +REF. The status LEDs are illuminated if the supply is within its operational limits.

Directly above each LED is a test point where the supply voltage can be measured. The last test point is ACOM and can be used as the reference for measuring the supply voltage.



3.3 TDe Status LEDs



The LEDs on the CPU board indicate the status of the CPU and sampler boards and the status of the network communication as listed in the following table. Notice that these LEDs are on the middle board of the 3300/02 module and that you view these LEDs by sliding the front panel of the module to the left.

LED	Meaning	
	On	**Off**
Link	TDe module is connect to an Ethernet network	TDe module is not connected to an Ethernet network
TX	Flashes when traffic is detected on the network.	Network traffic is not detected or a network communication problem exists.
CPU OK*	The CPU board is operating correctly.	A problem has been detected on the CPU board.
SMP OK*	The sampler board is operating correctly	A problem has been detected on the sampler board.
* These two status LEDs are used to determine which of the TDe modules has a problem when the Data Interface OK LED on the front panel indicates a fault.		

3.4 Inputs

Power Consumption: 9 watts

Transducer Signal:	Accepts up to 24 buffered signals from the monitors in the 3300 rack.
Input Impedance:	51kΩ
Frequency Range:	DC to 22.1kHz, Low Pass Filter @ 22.1kHz
DC Signal Range:	+5V to –24V
Amplitude:	24V peak to peak maximum
Keyphasor® Signal:	Accepts up to four proximity probe Keyphasor® signals.
Input impedance:	10 k Ω.
Frequency Range:	60 to 60,000 cpm (rpm).
Duty Cycle:	Greater of 1% or 50 µs.
Amplitude:	0.5 V peak-to-peak minimum.
Dc Signal Range:	0 to –24 V (VT = -24 Vdc); 0 to –18 V (VT = -18 Vdc).

3.5 Ethernet Communications

Baud Rate:	10 MBPS
Protocol:	TCP/IP with Bently Nevada proprietary message content.
Interface	Interface conforms to ISO/IEC 8802-3 1996 (IEEE 802.3)
Cable Length:	100m (328 feet) maximum
Connection:	9-pin female D style connector

3.6 RS422 Communications

Impedance:	4 k Ω.
Input Threshold:	0.2 V.
Baud Rate:	19.2 k baud maximum

Output Levels:	High 2.5 V, minimum; Low 0.5 V, maximum.
Distance:	1200 meters (4000 feet) maximum.

4. Specifications

4.1 RS232 Communications

Impedance: 3 k Ω to 7 k Ω.

Input Levels: High +3 to +25 V;
Low -3 to -25V.

Baud Rate: 19.2 k baud maximum

Output Levels: High +5 V, minimum;
Low -5 V, maximum.

Distance: 30 meters (100 feet) maximum.

4.2 Signal Conditioning – Specified at +25°C (+77°F)

4.2.1 1X, 2X Amplitude:

Accuracy: ±1% of Full Scale

Filter Response: Constant Q filter, Q=9. Stopband begins at ±0.15 times the center frequency. Minimum rejection in stopband is –50db. Filter settles in 19 shaft revolutions (100% settled)

4.2.2 1X, 2X Phase:

Accuracy: ±1 degree (100mV minimum amplitude at 60,000 cpm)

Filter Response: Constant Q filter, Q=9. Stopband begins at ±0.15 times the center frequency. Minimum rejection in stopband is –50db. Filter settles in 19 shaft revolutions (100% settled)

Minimum Amplitude: Phase is marked invalid for signal amplitudes less than 5.4mV.

4.2.3 Not 1X:

1X Rejection:	Constant Q notch filter. Q=3. Stopband begins at 0.97 and 1.03 times the center frequency (1X). Minimum rejection in stopband is 35 db.
Accuracy:	± 3% of Full Scale
Frequency Range:	7.2 Hz to 15.8 times speed (32x sampling rate)

4.3 Keyphasor Signal Conditioning

Speed Accuracy:	±0.1% of Full Scale (7 Vpp square wave input)
Minimum Amplitude:	0.5 V pp (square wave)
Error Detection:	Data invalid for changes greater than 12.5% between shaft revolutions.
Phase Reference:	Selectable for leading edge of notch or projection.

4.4 Outputs

Buffered Keyphasor® Outputs:	Four coaxial connectors on front panel.
Output Impedance:	100 Ω.
Keyphasor® Transducer Power Supply:	User-programmable for -24 Vdc or -18 Vdc. Voltages are short-circuit protected.
Indicators:	Three LEDs on front panel
Supplies OK:	ON when all system supply voltages are within tolerance. LEDs behind the slide-away front panel indicate the condition of the various monitored supply voltages. The appropriate Supply voltage LED and the SUPPLIES OK LED on the front panel turn OFF if a voltage is out of tolerance.
Trip Multiply:	ON when Trip Multiply function is active.
Data Interface OK:	OFF when either the TDe hardware is not functioning properly. LEDs behind the slide away front panel indicate the status of the CPU and Sampler modules.

4.5 System OK Relay

One hermetically sealed, normally energized, single-pole double-throw relay is used for annunciation of a NOT OK condition in the monitoring rack and/or a problem with the primary (mains) power to the rack.

Contact Ratings - Standard:

5A at 28 Vdc
5A at 120 Vac, 50/60 Hz
3A at 220 Vac, 50/60 Hz

CSA Approval:

5A at 28 Vdc
5A at 120 Vac, 50/60 Hz

4.6 Controls

Front Panel:

Two switches control the Up and Down adjustment of monitor alarm setpoints. A third switch controls the alarm RESET function.

Rear Panel:

Terminals provide connections for Rack Inhibit, Trip Multiply, and Alarm Reset contact closures.

4.7 Environmental Limits

Operating Temperature: 0°C to +65°C (+32°F to +150°F).

Storage Temperature: -40°C to +85°C (-40°F to +185°F).

Relative Humidity: To 95%, noncondensing.

4.8 CE Mark Directives

EMC Directive Certificate of Conformity: 158710

Low Voltage Directive Certificate of Conformity: 135300

4.9 Hazardous Area Approvals

CSA /NRTL/C	Class 1, Division 2 Groups A,B,C,D T4 @ Ta = 65°C, **Pending**

4.10 Physical

Rack Space Requirements:	One rack position, installs only in position two (next to the Power Supply).
Weight:	0.9 kg (2.2 lbs.).

4.11 Data Collection

Synchronous Waveforms: **Sample Rate:**	Software selectable ▪ 128 samples per revolution (60 to 15,000 cpm) ▪ 64 samples per revolution (60 to 30,000 cpm) ▪ 32 samples per revolution (60 to 60,000 cpm)
Length:	1024 samples.
Filter Response:	No anti-alias filters on synchronous path
Asynchronous Waveforms: **Frequency Spans:**	Software Selectable – 20, 50, 100, 200, 500, 1000, 2000, 5000, 10k, and 25k Hz
Length:	1024 samples
Filter Response:	Frequencies outside of the configured frequency span are attenuated by –80 dB minimum.

4.12 Data Buffers

Delta Time Buffer:

Capacity:	320 static records and 32 waveform records.
Capture Interval:	Static records every 4 seconds. Waveforms every 40 seconds (10:1 ratio).

Transient (RPM based) Buffer:

Quantity:	2 independent buffers
Capacity:	320 static records and 32 waveform records. (40 static and 4 waveform time based collect records just prior to buffer trigger, 280 static and 28 waveform records are post-trigger rpm based.)
RPM capture interval:	1 to 60,000 rpm.
Trigger Modes:	Startup captures data in increasing rpm direction only; Coast-down captures data in both increasing and decreasing directions.

Alarm Buffer:

Capacity:	40 static records and 4 waveform records.
Update Rate:	Static records every 4 seconds. Waveforms every 40 seconds (10:1 ratio). A waveform is taken at the time of the alarm buffer trigger.
Trigger Modes:	Alert or danger alarm event in monitor.

4.13 SDI Data

Protocols:	Configurable for Allen-Bradley or Modbus protocols.
Connection:	RS422 or RS232 communication link.
Data:	Data returned are monitor values plus 1X, 2X, high resolution gap and Not 1X static data. Speed values and status for the four 3300 Keyphasor® Inputs.
Registers:	Registers organized both by channel and proportional value type configurations.

4.14 System Requirements

Software	Compatible with System 1 version 5.0 with Service Pack 1 or later.
Rack	Requires a 3300 rack that is compatible with the 3300/03. Consult the "3300 System Compatibility Guide" BN doc # 104003-01.
Power Supply	Requires either the 3300/12 or 3300/14 power supply. Consult the "3300 System Compatibility Guide" BN doc # 104003-01.
Monitors	Requires 3300 monitors that are compatible with the 3300/03. Consult the "3300 System Compatibility Guide" BN doc # 104003-01.
Communications	TDe uses 10 Base T Ethernet to communicate between the System 1® DAQ computer and the TDe module. Accessory Media Converter modules are available to extend Ethernet across RS-422 cabling.

5. Ordering Information

5.1 3300/02 TDe System Monitor

3300/02 - AXX-BXX-CXX-DXX- EXX-FXX-GXX-HXX-IXX-JXX-KXX-LXX-MXX-NXX
Options Description

A: Data Collection Slot 3

0 0 Static Data Only
0 1 1 Channel of Steady-State Waveform Data
0 2 2 Channels of Steady-State Waveform Data
1 0 1 Channel of Transient Waveform Data
2 0 2 Channel of Transient Waveform Data

B: Data Collection Slot 4

0 0 Static Data Only
0 1 1 Channel of Steady-State Waveform Data
0 2 2 Channels of Steady-State Waveform Data
1 0 1 Channel of Transient Waveform Data
2 0 2 Channel of Transient Waveform Data

C: Data Collection Slot 5

0 0 Static Data Only
0 1 1 Channel of Steady-State Waveform Data
0 2 2 Channels of Steady-State Waveform Data
1 0 1 Channel of Transient Waveform Data
2 0 2 Channel of Transient Waveform Data

D: Data Collection Slot 6

0 0 Static Data Only
0 1 1 Channel of Steady-State Waveform Data
0 2 2 Channels of Steady-State Waveform Data
1 0 1 Channel of Transient Waveform Data
2 0 2 Channel of Transient Waveform Data

E: Data Collection Slot 7

0 0 Static Data Only
0 1 1 Channel of Steady-State Waveform Data
0 2 2 Channels of Steady-State Waveform Data
1 0 1 Channel of Transient Waveform Data
2 0 2 Channel of Transient Waveform Data

F: Data Collection Slot 8	**0 0**	Static Data Only
	0 1	1 Channel of Steady-State Waveform Data
	0 2	2 Channels of Steady-State Waveform Data
	1 0	1 Channel of Transient Waveform Data
	2 0	2 Channel of Transient Waveform Data
G: Data Collection Slot 9	**0 0**	Static Data Only
	0 1	1 Channel of Steady-State Waveform Data
	0 2	2 Channels of Steady-State Waveform Data
	1 0	1 Channel of Transient Waveform Data
	2 0	2 Channel of Transient Waveform Data
H: Data Collection Slot 10	**0 0**	Static Data Only
	0 1	1 Channel of Steady-State Waveform Data
	0 2	2 Channels of Steady-State Waveform Data
	1 0	1 Channel of Transient Waveform Data
	2 0	2 Channel of Transient Waveform Data
I: Data Collection Slot 11	**0 0**	Static Data Only
	0 1	1 Channel of Steady-State Waveform Data
	0 2	2 Channels of Steady-State Waveform Data
	1 0	1 Channel of Transient Waveform Data
	2 0	2 Channel of Transient Waveform Data
J: Data Collection Slot 12	**0 0**	Static Data Only
	0 1	1 Channel of Steady-State Waveform Data
	0 2	2 Channels of Steady-State Waveform Data
	1 0	1 Channel of Transient Waveform Data
	2 0	2 Channel of Transient Waveform Data
K: Data Collection Slot 13	**0 0**	Static Data Only
	0 1	1 Channel of Steady-State Waveform Data
	0 2	2 Channels of Steady-State Waveform Data
	1 0	1 Channel of Transient Waveform Data
	2 0	2 Channel of Transient Waveform Data

L: Data Collection Slot 14	**0 0** Static Data Only
	0 1 1 Channel of Steady-State Waveform Data
	0 2 2 Channels of Steady-State Waveform Data
	1 0 1 Channel of Transient Waveform Data
	2 0 2 Channel of Transient Waveform Data
M: System Extended Warranty	**0 0** None
	0 1 Extended Warranty
N: Approvals Option	**0 0** None
	0 1 CSA/NRTL/C, **Pending**
	0 2 ATEX, **Pending**

5.2 Accessories

5.2.1 TDe Host Ethernet Cable – Standard

10 Base T 3300/02 to Ethernet network	167887-AXXX-BXX
A: Cable Length	**0 0 3** 3 feet (1 metres)
	0 0 6 6 feet (2 metres)
	0 1 0 10 feet (3 metres)
	0 2 5 25 feet (7.5 metres)
	0 5 0 50 feet (15 metres)
	1 0 0 100 feet (30 metres)
	2 0 0 200 feet (61 metres)
	2 5 0 250 feet (76 metres)
	3 2 0 320 feet (100 metres)
B: Insulation Option	**0 1** PVC Insulated – Non Plenum
	0 2 PVC Insulated - Plenum

5.2.2 TDe Host Ethernet Cable – Cross Over

10 Base T 3300/02 to Ethernet network	167974-AXXX-BXX
A: Cable Length	**0 0 3** 3 feet (1 metres)
	0 0 6 6 feet (2 metres)
	0 1 0 10 feet (3 metres)
	0 2 5 25 feet (7.5 metres)
	0 5 0 50 feet (15 metres)
	1 0 0 100 feet (30 metres)
	2 0 0 200 feet (61 metres)
	2 5 0 250 feet (76 metres)
	3 2 0 320 feet (100 metres)
B: Insulation Option	**0 1** PVC Insulated – Non Plenum
	0 2 PVC Insulated - Plenum

5.2.3 Media Converters

These devices can be used to connect the TDe to a Ethernet network by using existing RS-422 cables. A Host and Remote Media Converter are required each cable run.

Media Converter Host	167919
Media Converter Remote	167920
+24V Power Supply	02200794

5.2.4 Serial Data Interface Cables

RS232 3300/02 to Allen-Bradley 1770-KF2 Communication Module or Honeywell PLC® Gateway or Data Highway	89968 - AXXXX-BXX-CXX
RS232 3300/02 to Allen-Bradley 1771-KE or 1785-KE Communications Module	89969 - AXXXX-BXX-CXX

RS422 3300/02 to Allen-Bradley 1770 KF2 Communications Module

89970 - AXXXX-BXX-CXX

Option Descriptions

A: Cable Length

0 0 1 0 10 feet (3 metres)
0 0 2 5 25 feet (7.5 metres)
0 0 5 0 50 feet (15 metres)
0 1 0 0 100 feet (30 metres)

B: Assembly Option

0 1 Not Assembled
0 2 Assembled

C: Protection Option

0 0 No Surge Protection
0 1 Surge Protection provided

RS422 3300/02 to 3300/02 or 3300/03 Cables

47125 – AXXXX-BXX-CXX-DXX

Option Descriptions

A: Cable Length

0 0 1 0 10 feet (3 metres)
0 0 2 5 25 feet (7.5 metres)
0 0 5 0 50 feet (15 metres)
0 1 0 0 100 feet (30 metres)
0 2 0 0 200 feet (61 metres)
0 2 5 0 250 feet (76 metres)
0 5 0 0 500 feet (152 metres)
1 0 0 0 1000 feet (305 metres)
2 0 0 0 2000 feet (610 metres)*
4 0 0 0 4000 feet (1220 metres)*
*Note: Can not be ordered assembled.

B: Assembly Option

0 1 Not Assembled
0 2 Assembled

C: Insulation Option

0 1 PVC Insulated
0 2 Teflon® Insulated

D: Protection Option	**0 0** No Surge Protection
	0 1 Surge Protection provided

5.2.5 RS422 3300/02 to 3300/01 (3300/01 electrically closest to host computer)

89966 - AXXXX-BXX-CXX

5.2.6 RS422 3300/01 to 3300/02 (3300/02 electrically closest to host computer)

89967 - AXXXX -BXX-CXX

Option Descriptions

A: Cable Length	**0 0 1 0** 10 feet (3 metres)
	0 0 2 5 25 feet (7.5 metres)
	0 0 5 0 50 feet (15 metres)
	0 1 0 0 100 feet (30 metres)
	0 2 5 0 250 feet (76 metres)
	0 5 0 0 500 feet (152 metres)
B: Assembly Option	**0 1** Not Assembled
	0 2 Assembled
C: Surge Protection	**0 0** No Surge Protection
	0 1 Surge Protection Provided

5.2.7 Surge Protector Kit

(for existing installations, not required when surge protection option is specified with new cables).

109959-AXX

Option Descriptions

(Note: Each communication cable requires one device at each end of the cable).

A: Surge Protector Kit

- **0 1** TDM Comm Processor end of cables 81650 and 78205
- **0 2** Host Computer end of TDM cable 78205; both Host and Comm Processor end of DDI cable 89950; Comm Processor end of DDI cable 89949.
- **0 3** Host Computer end of TDM cable 81650 and DDI cable 89949.
- **0 4** Comm Processor end of cable 78206 (TDM Host to First Comm Processor), 103629 (TDM2 Host to first Comm Processor) and 132632 or 132633 (DM2000 Host to First Comm Processor); both ends of cable 47125 (DDM/PDM/ TDM Comm Processor to Comm Processor); 3300/02 rack end of cables 89966, 89967, and 89970.
- **0 5** Host Computer end of cable 78206 (TDM Host to First Comm Processor).
- **0 6** Host Computer end of cable 103629 (TDM2 Host to first Comm Processor).
- **0 7** Host Computer end of cables 132632 and 132633 (DM2000 Host to First Comm Processor)
- **0 8** Allen-Bradley Communications Module end of cable 89969 (3300/02 to Allen-Bradley 1771-KE).
- **0 9** 3300/02 rack end of cables 89968 (3300/02 to Allen-Bradley 1770-KF2) and 89969 (3300/03 to Allen-Bradley 1771-KE).
- **1 0** 3300/01 rack end of cables 89966 (3300/02 to 3300/01) and, 89967 (3300/02 to 3300/01) and on AB Comm Module end of cable 89970 (3300/02 to Allen-Bradley Comm Module).
- **1 1** Allen-Bradley Communication Module end of cable 89968 (3300/02 to Allen-Bradley 1770-KF2).

6. Allen Bradley Protocol

6.1 Introduction

The TDe Serial Data Interface (SDI) works with an Allen-Bradley Data Highway or Data Highway Plus Network via communication interface module. Internal communications circuitry interfaces the TDe with the Allen-Bradley Data Highway. The protocol implemented on the SDI link is the Full Duplex DF1 protocol.

6.2 Message types

6.2.1 Message Types

For a complete description of the Allen-Bradley message formats, refer to the Allen-Bradley Data Highway/Data Highway Plus Protocol and Command Set Publication 1770-6.5.16 - November 1988.

The following messages from the Allen-Bradley basic command set are supported by the Transient Data Interface:

COMMAND NAME	COMMAND CODE	FUNCTION CODE
Diagnostic Counter Reset	6	7
Diagnostic Read	6	1
Diagnostic Status	6	3
Diagnostic Loop	6	0
Unprotected Read	1	N/A
Unprotected Write	8	N/A

6.2.2 Message Type Descriptions

DIAGNOSTIC COUNTERS RESET - This command resets all diagnostic counters to zero.

DIAGNOSTIC READ - During TDe operation, the firmware will keep track of two error event types. When a particular error occurs, the TDe will increment the associated counter. The diagnostic read command accesses the diagnostic counters. To read the diagnostic counters, configure the Allen-Bradley module to pass on all diagnostic messages. All counters are 16 bit counters and will wrap around to zero when they overflow. The counters implemented by the TDe in the order that they are returned are:

1. The number of times a communications error occurred during a received message

2. Always zero - Not Implemented

3. Always zero - Not Implemented

4. The number of times a communications overrun has occurred.

DIAGNOSTIC STATUS - This command reads the current revision letters of the TDe firmware. The response message contains the diagnostic status as two bytes in the following order:

Major Rev Number	Updated whenever functions and features are added to the firmware.
Minor Rev Number	Updated whenever minor changes, minor improvements or performance improvements are made.

DIAGNOSTIC LOOP - Check the integrity of the transmission over the communications link. This command message can transmit up to 243 data bytes to the interface. The TDe will reply to this command by transmitting the same data back to the original station.

UNPROTECTED READ - Read words of data from the TDe memory. Use this command to read direct and status values from the TDe.

UNPROTECTED WRITE - Write words of data to the TDe memory. Use this command to set the real time clock by writing to the time and day registers. Setting the real time clock is only allowed if the TDe host has not set the date and time, which it does shortly after establishing communications with TDe. Once the TDe host has set the date and time, the SDI link cannot be used to set the real time clock. The host also resets the real time clock every day.

6.3 Data Addressing

The Transient Data Interface uses fixed protocol addresses for the starting location of data in a rack. The data addresses are used in the protocol messages to access data which is available from the interface and are not the physical data addresses in the interface memory. The addresses which were established in the 3300/01-02 Serial Interface are maintained in this product as well. The protocol starting addresses are as follows:

DATA TYPE	RACK REGISTER ADDRESSES	
	WORD ADDR	BYTE ADDR
Direct Values	8 - 43	16 - 86
Monitor Status	48 - 83	96 - 166
Current Proportional Values	100 - 291	200 - 582
Fast Trend Time Stamp	300 - 306	600 - 612
Fast Trend Interval	307	614
Number of Fast Trend Samples	308	616
Fast Trend Samples	310 - 7,989	620 - 15,978
Monitor Mode Statuses	10,000 - 10,095	20,000 - 20,190
Channel Alarm Statuses	10,096 - 11,631	20,192 - 23,262
Monitor Communication Statuses	11,632 - 11,643	23,263 - 23,286

Note 1

The addresses for Direct Values and Monitor Status are compatible with the 3300/01-02 Serial Interface. All other addresses are the enhanced data types available from the 3300/03-02 and 3300/02-02 Serial Data Interface. For addressing purposes, a 2-channel double-wide monitor looks like a 2-channel single-wide monitor in the left slot followed by an empty right slot. A single channel monitor is treated as a dual channel monitor with an invalid data value for channel 2. Except for the six channel temperature monitors (3300/30 and 3300/35), these addresses do not function properly with any monitor which has more than 2 channels. Obtain the data from monitors with more than two channels by using the Current Proportional Values addresses.

Note 2

For all unprotected reads, at the message level, the Allen-Bradley protocol refers to addresses as byte addresses. Since the TDe addresses are word based (2 bytes), the address that is placed into the protocol message is the word address multiplied by two. Byte addresses will always be even and the byte count at the message level is the word count multiplied by two.

6.3.1 Data Type Descriptions

DIRECT VALUES - Direct values have a starting address of 8 and occupy contiguous protocol addresses. The first monitor (monitor slot 1) is the leftmost monitor, just to the right of the System Monitor. Each monitor has two direct values associated with it, except for 6-channel temperature monitors (3300/30, or 3300/35), that have 6 direct values. The channel direct values are ordered first to last channel. Use the configuration of the rack and this simple formula to calculate the starting address of the direct values of a monitor:

Starting Address = 8 + 2[(monitor slot number -1) + (number of 6-channel temperature monitors located to the left of the selected monitor)]

Use the UNPROTECTED READ command (command code 1) to access the direct values for the rack.

Example 1

Read the direct values from a 3300 rack which contains 5 dual vibration monitors installed in slots 1, 2, 3, 4 and 5. Assume the rack address is set to 1, and the source address is set to 0.

The message request should be an unprotected read command specifying 10 data words (20 bytes) starting at word address 8 (byte address is 8•2 = 16). The Allen-Bradley command format will have the ADDR field set to 16 (10 Hex), and the SIZE field set to 20 (14 Hex). See note 2 above.

The following is the format for the command and reply messages.

COMMAND FORMAT:

DLE	STX	DST	SRC	CMD	STS	TNS		ADDR			SIZE	DLE	ETX	CRC	
10	02	01	00	01	00	01	00	10	10	00	14	10	03	??	??

REPLY FORMAT:

DLE	STX	DST	SRC	CMD	STS	TNS		Direct Mn1 Ch1		Direct Mn1 Ch2	
10	02	00	01	41	00	01	00	low	hi	low	hi

(continued)

Direct Mn2 Ch1		Direct Mn2 Ch2		Direct Mn3 Ch1		Direct Mn3 Ch2		Direct Mn4 Ch1		Direct Mn4 Ch2		Direct Mn5 Ch1	
low	hi	low	hi	low	hi	low	hi	low	hi	low	hi	low	hi

(continued)

Direct Mn5 Ch2		DLE	ETX	CRC	
low	hi	10	03	??	??

Note 3

The address (10 Hex) was duplicated in the message since DLE (10 Hex) is a control character in Allen-Bradley protocol. To send a 10 Hex character in the data fields requires a second 10 Hex to be sent.

Example 2

Read the direct values from a 3300 rack which has dual vibration monitors installed in slots 1 and 2, and a 6-channel temperature monitor in slot 5.

The data consists of 10 values contained in non-sequential locations starting at word address 8. To retrieve the data most efficiently, request the first 14 words which will include the values for the empty monitor slots 3 and 4. The host computer should then discard the invalid data from monitor slots 3 and 4. The Allen-Bradley command format will have the ADDR field set to 16 (10 Hex), and the SIZE field set to 28 (1C Hex). See note 2 in the Allen-Bradley Protocol Data Addressing section and note 3 above.

The following is the format for the command and reply messages.

COMMAND FORMAT:

DLE	STX	DST	SRC	CMD	STS	TNS		ADDR		
10	02	01	00	01	00	01	00	10	10	00

(continued)

SIZ E	DLE	ETX	CRC	
1C	10	03	59	58

REPLY FORMAT:

DLE	STX	DST	SRC	CMD	STS	TNS		Direct Mn1 Ch1	
10	02	00	01	41	00	01	00	low	hi

(continued)

Direct Mn1 Ch2		Direct Mn2 Ch1		Direct Mn2 Ch2		no data Mn3 Ch1		no data Mn3 Ch2		no data Mn4 Ch1	
low	hi	low	hi	low	hi	low	hi	low	hi	low	hi

(continued)

no data Mn4 Ch2		temp 1 Mn5 Ch1		temp 2 Mn5 Ch2		temp 3 Mn5 Ch3		temp 4 Mn5 Ch4		temp 5 Mn5 Ch5	
low	hi	low	hi	low	hi	low	hi	low	hi	low	hi

(continued)

temp 6 Mn5 Ch6		DLE	ETX	CRC	
low	hi	10	03	??	??

Note

In the above examples, addresses are given in hex. When programming the Allen-Bradley devices, you may need to convert address to octal.

MONITOR STATUS - The monitor status indicators are returned as 16-bit words with a value of 1 or 0. Each monitor has three status words associated with it, Alert, Danger, and not OK. Individual channel status is not available by reading these addresses (see Channel Alarm Statuses in the Allen-Bradley Data Addressing section). If any channel of a monitor is in Alert, then the monitor status is Alert.

The monitor status indicators are in the order Alert, Danger, and Not OK and occupy contiguous protocol addresses starting at word address 48 (60 octal). Use the UNPROTECTED READ command (command code 1) to read the monitor statuses.

Example

Read monitor status from a 3300 rack which has a dual vibration monitor in slot 1 and a 6-channel temperature monitor in slot 3.

The UNPROTECTED READ command should request 9 status words (18 bytes) starting at word address 48. The status from the nonexistent monitor in slot 2 should be ignored by the host computer. The Allen-Bradley command format will have the ADDR field set to 96 and the SIZE field set to 18. See note 2 in the Allen-Bradley Protocol Data Addressing section.

The following is the format for the command and reply messages.

COMMAND FORMAT:

DLE	STX	DST	SRC	CMD	STS	TNS	
10	02	01	00	01	00	01	00

(continued)

ADDR		SIZE	DLE	ETX	CRC	
60	00	12	10	03	79	50

REPLY FORMAT:

DLE	STX	DST	SRC	CMD	STS	TNS		RV Mon #1 Alert	
10	02	00	01	41	00	01	00	low	hi

(continued)

RV Mon #1 Danger		RV Mon #1 Not OK		Empty Slot Alert (empty)		Empty Slot Danger (empty)	
low	hi	low	hi	low	hi	low	hi

(continued)

Empty Slot Not OK (empty)		Temp Mon #3 Alert		Temp Mon #3 Danger		Temp Mon #3 Not OK	
low	hi	low	hi	low	hi	low	hi

(continued)

DLE	ETX	CRC	
10	03	??	??

A status value would look like the following as it is transmitted from the interface.

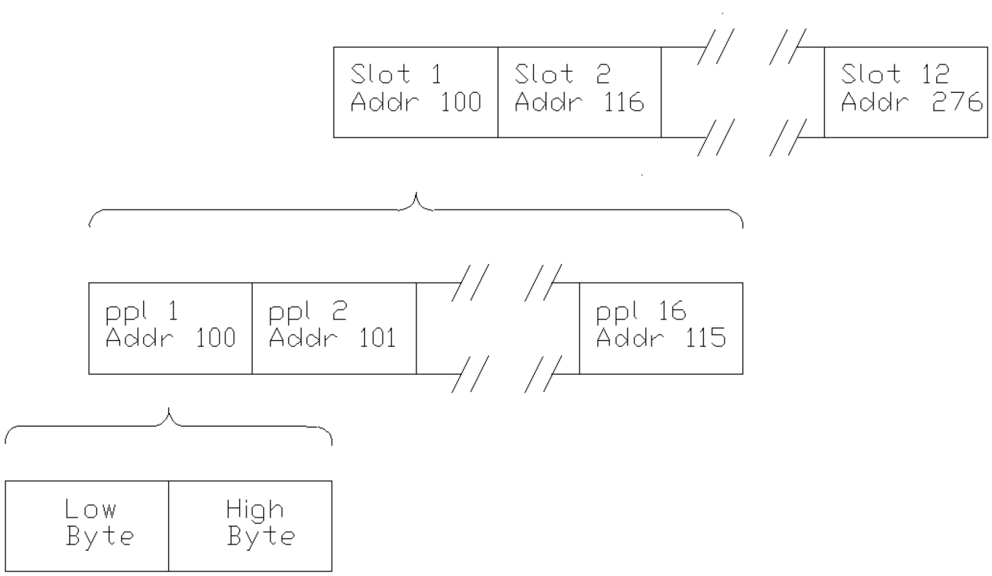
Alert		Danger		Not OK	

first last

Note

In this example, Alert and Danger are active (true) and the monitor is OK (NOT OK = false). Also, the least significant byte is sent first and the true condition sets only the least significant bit.

CURRENT PROPORTIONAL VALUES - The proportional values include monitor values such as direct (e.g. overall vibration amplitude), probe gap, 1X and 2X amplitude and phase. These values are different for each monitor type. See the 3300 Proportional Data Value Types Appendix for monitor values specific to a particular monitor type. Proportional values have space for 16 values per monitor slot. Each slot can return from 1 to 16 channels, and 1 to 8 values per channel, but not more than 16 values total per slot. The number of values per channel is constant for all channels of a monitor. Each value is sent low byte to high byte. Addresses corresponding to a position for a nonexistent monitor or the 2nd slot of a double wide 2-slot monitor contain invalid data. This diagram shows the organization of the current proportional values.



Addr = Address

ppl = proportional value

If a monitor is a double wide 2-slot monitor, the memory space for the first slot (up to 16 values) is used before the space defined for the second slot. For example, since a six-channel temperature monitor occupies two monitor slots, and its data fits in the memory space for one slot, the memory space for the second slot will contain invalid data. As another example, consider a 2-slot monitor which contains 30 proportional values. The first slot would contain 16 proportional values, and the second slot would contain the other 14. Use the UNPROTECTED READ command (command code 1) to access the current proportional values for the rack.

Example:

Read the current proportional values from a 3300 rack which contains 2 dual vibration monitors (3300/16) installed in slots 1 and 2. Assume the Transient Data Interface address is 1 and the source station address is 0.

The message request should be an UNPROTECTED READ command specifying 32 data words (64 bytes) starting at word address 100 (byte address is 100 • 2 = 200). The Allen-Bradley command format will have the ADDR field set to 200 (C8 Hex), and the SIZE field set to 64 (40 Hex). See note 2 in the Allen-Bradley Protocol Data Addressing section. This table shows the addresses.

MONITOR 1		MONITOR 2	
VALUE	**ADDRESS**	**VALUE**	**ADDRESS**
Channel 1 direct	100	Channel 1 direct	116
Channel 1 gap	101	Channel 1 gap	117
Channel 2 direct	102	Channel 2 direct	118
Channel 2 gap	103	Channel 2 gap	119
not used	104 - 115	not used	120 - 132

The following is the format for the command and reply messages.

COMMAND FORMAT:

DLE	STX	DST	SRC	CMD	STS	TNS	
10	02	01	00	01	00	01	00

(continued)

ADDR		SIZE	DLE	ETX	CRC	
C8	00	40	10	03	B9	59

REPLY FORMAT:

DLE	STX	DST	SRC	CMD	STS	TNS		Direct Mn1 Ch1		Gap Mn1 Ch1	
10	02	00	01	41	00	01	00	low	hi	low	hi

(continued)

Direct Mn1 Ch2		Gap Mn1 Ch2		unused Mn1		unused Mn1		unused Mn1		unused Mn1		unused Mn1	
low	hi	low	hi	low	hi	low	hi	low	hi	low	hi	low	hi

(continued)

unused Mn1		unused Mn1		unused Mn1		unused Mn1		unused Mn1		unused Mn1	
low	hi	low	hi	low	hi	low	hi	low	hi	low	hi

(continued)

unused Mn1		Direct Mn2 Ch1		Gap Mn2 Ch1		Direct Mn2 Ch2		Gap Mn2 Ch2		unused Mn2	
low	hi	low	hi	low	hi	low	hi	low	hi	low	hi

(continued)

unused Mn2		unused Mn2		unused Mn2		unused Mn2		unused Mn2		unused Mn2		unused Mn2	
low	hi	low	hi	low	hi	low	hi	low	hi	low	hi	low	hi

(continued)

unused Mn2		unused Mn2		unused Mn2		unused Mn2		DLE	ETX	CRC	
low	hi	low	hi	low	hi	low	hi	10	03	??	??

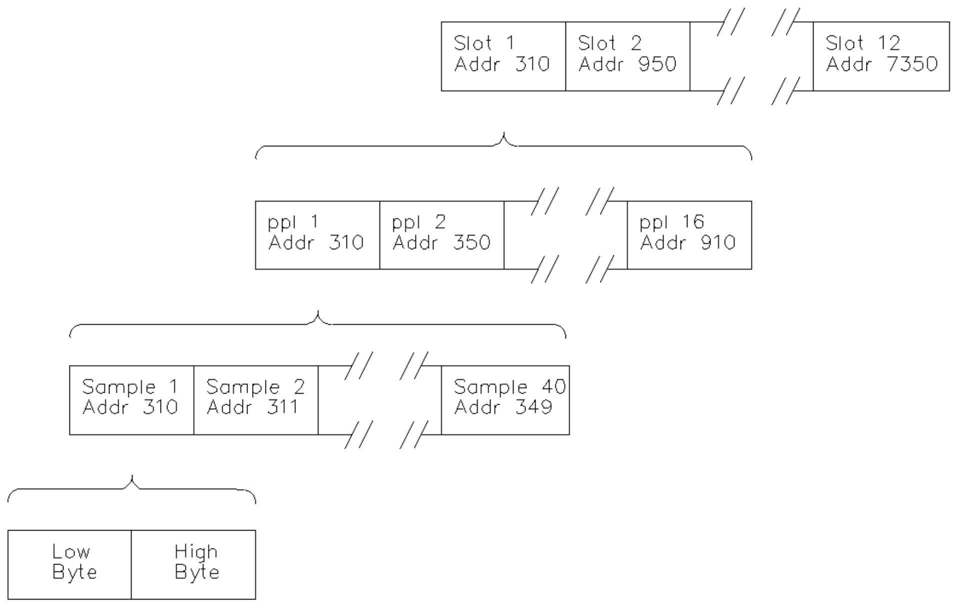
FAST TREND DATA - Fast Trend Data consists of 40 samples for each data location where current proportional values are taken. The data is ordered from oldest to newest with the oldest sample in the lower address for the slot. The samples are typically taken once every 4 seconds. The interval is read from a single word and is in units of tenths of a second. When reading the fast trend values use the following method: Read the date and time stamp each time the fast trend values are read so that you know if a fast trend update has occurred between reads of proportional values in a monitor. Use the UNPROTECTED READ command (command code 1) to access the fast trend data values for the rack.

The Number of Fast Trend Samples will usually be 40. However, if the fast trend data is requested just after a power-up condition or a configuration command is received from the TDe, the number of samples could be less than 40.

The date/time stamp corresponds to the newest sample taken and consists of the following fields, each of which occupy 1 word:

FIELD NAME	CODE RANGE	NOTES
Year	0 - 99	
Month	1 - 12	Months are in sequential order (e.g. 1 = January)
Day	1 - 31	
Hour	0 - 23	24 hour clock: 12 = Noon and 00 = midnight
Minute	0 - 59	
Second	0 - 59	
1/100 Second	0 - 99	

The following diagram shows the organization of the fast trend sample values.



Example:

Read the fast trend values for the first proportional value from a dual vibration monitor (3300/16). As stated above, read the date and time stamp first. The monitor is installed in slot 1 of a 3300 rack. Assume the Transient Data Interface address is 1 and the source station address is 0.

The message request should be an unprotected read command specifying 50 data words (100 bytes) starting at word address 300 (byte address is 300 • 2 = 600). The Allen-Bradley command format will have the ADDR field set to 600 (258 Hex), and the SIZE field set to 100 (64 Hex). See note 2 in the Allen-Bradley Protocol Data Addressing section.

The following is the format for the command and reply messages.

COMMAND FORMAT:

DLE	STX	DST	SRC	CMD	STS	TNS	
10	02	01	00	01	00	01	00

(continued)

ADDR		SIZE	DLE	ETX	CRC	
58	02	64	10	03	38	F7

REPLY FORMAT:

DLE	STX	DST	SRC	CMD	STS	TNS		Time Stamp Year	
10	02	00	01	41	00	01	00	low	hi

(continued)

Time Stamp Month		Time Stamp Day		Time Stamp Hour		Time Stamp Minute		Time Stamp Second	
low	hi	low	hi	low	hi	low	hi	low	hi

(continued)

Time Stamp Hundredth		Fast Trend Interval		Number of Fast Trend Samples		Blank Reg		Ppl 1 Sample 1	
low	hi	low	hi	low	hi	low	hi	low	hi

(continued)

Ppl 1 Sample 2		Ppl 1 Sample 3		Ppl 1 Sample 4		Ppl 1 Sample 5		Ppl 1 Sample 6		Ppl 1 Sample 7	
low	hi	low	hi	low	hi	low	hi	low	hi	low	hi

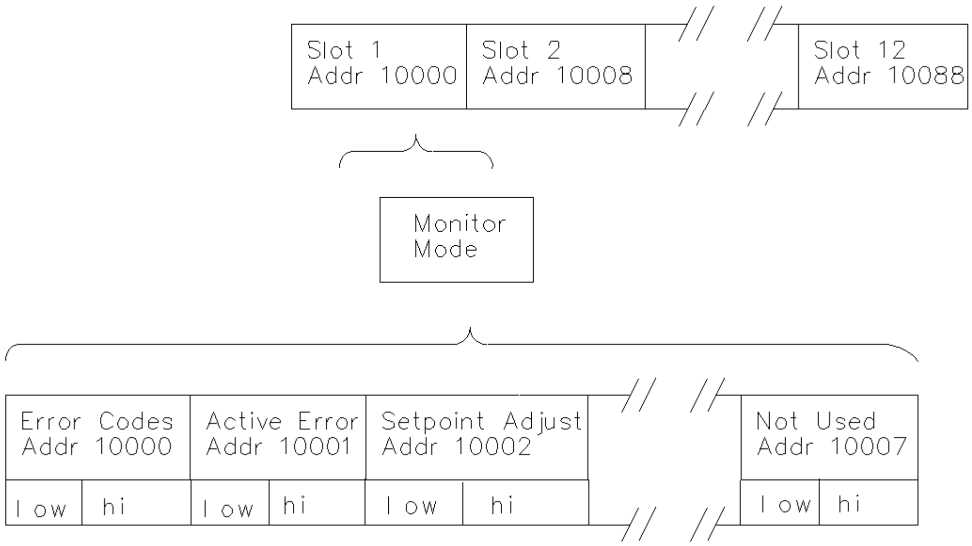
(continued)

Ppl 1 Sample 39		Ppl 1 Sample 40		DLE	ETX	CRC	
low	hi	low	hi	10	03	??	??

MONITOR MODE STATUSES - The TDe stores the Monitor Mode Status for each monitor as a register value in the following order:

1. Error Codes are stored in the monitor
2. An active error exists in the monitor; monitor is not monitoring
3. Monitor is in Setpoint Adjust Mode
4. Monitor is in Calibration / Program Mode
5. Monitor is in Trip Multiply Mode
6. Monitor has Danger Bypass Switch Active
7. (Not Used)
8. (Not Used)

This diagram shows the organization of the Monitor Mode Statuses.



Use the UNPROTECTED READ command (command code 1) to access the monitor mode status values for the rack.

Example:

Read the monitor mode status from a 3300 rack which has a dual vibration monitor in slot 2. Assume the Transient Data Interface address is 1 and the source station address is 0.

The message request should be an unprotected read command specifying 8 data words (16 bytes) starting at word address 10008 (byte address is 10008 • 2 = 20016). The Allen-Bradley command format will have the ADDR field set to 20016 (4E30 Hex), and the SIZE field set to 16 (10 Hex). See note 2 in the Allen-Bradley Protocol Data Addressing section.

The following is the format for the command and reply messages.

COMMAND FORMAT:

DLE	STX	DST	SRC	CMD	STS	TNS	
10	02	01	00	01	00	01	00

(continued)

ADDR		SIZE		DLE	ETX	CRC	
30	4E	10	10	10	03	B3	0E

REPLY FORMAT:

DLE	STX	DST	SRC	CMD	STS	TNS		Mon 2 Status 1	
10	02	00	01	41	00	01	00	low	hi

(continued)

Mon 2 Status 2		Mon 2 Status 3		Mon 2 Status 4		Mon 2 Status 5		Mon 2 Status 6		Mon 2 Status 7	
low	hi	low	hi	low	hi	low	hi	low	hi	low	hi

(continued)

Mon 2 Status 8		DLE	ETX	CRC	
low	hi	10	03	??	??

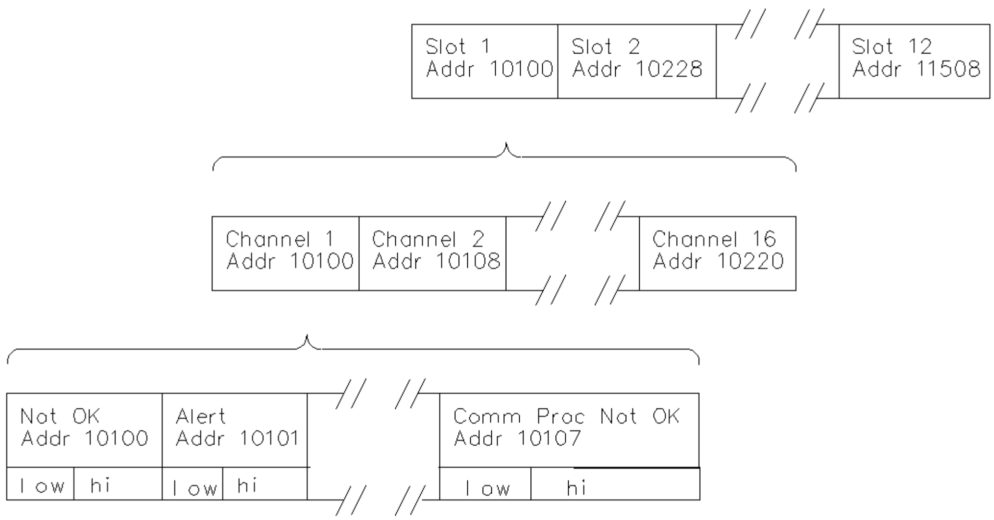
Status Truth Table

True	False

CHANNEL ALARM STATUSES - The TDe stores a true/false value for the Channel Alarm Statuses for each channel in the following order:

1. Not Ok
2. Alert
3. Danger
4. Channel is in Bypass Mode
5. Channel Off
6. Keyphasor Not Ok
7. Signal Path Not Ok
8. Communication Processor Channel Not OK

The following diagram shows the organization of the Channel Alarm Statuses.



Use the UNPROTECTED READ COMMAND (command code 1) to access the channel alarm status values for the rack.

Example:

Read the channel alarm statuses from a 3300 rack which has a dual vibration monitor (2 channels) in slot 12. Assume the Transient Data Interface address is 1 and the source station address is 0.

The message request should be an unprotected read command specifying 16 data words (32 bytes) starting at word address 11504 (byte address is 11504 • 2 = 23,008). The Allen-Bradley command format will have the ADDR field set to 23,008 (59E0 Hex), and the SIZE field set to 32 (20 Hex). See note 2 in the Allen-Bradley Protocol Data Addressing section.

The following is the format for the command and reply messages.

COMMAND FORMAT:

DLE	STX	DST	SRC	CMD	STS	TNS	
10	02	01	00	01	00	01	00

(continued)

ADDR		SIZE	DLE	ETX	CRC	
E0	59	20	10	03	CB	DD

REPLY FORMAT:

DLE	STX	DST	SRC	CMD	STS	TNS		Mon 12 Ch1 Alarm 1	
10	02	00	01	41	00	01	00	low	hi

(continued)

Mon 12 Ch1 Alarm 2		Mon 12 Ch1 Alarm 3		Mon 12 Ch1 Alarm 4		Mon 12 Ch1 Alarm 5		Mon 12 Ch1 Alarm 6	
low	hi	low	hi	low	hi	low	hi	low	hi

(continued)

Mon 12 Ch1 Alarm 7		Mon 12 Ch1 Alarm 8		Mon 12 Ch2 Alarm 1		Mon 12 Ch2 Alarm 2		Mon 12 Ch2 Alarm 3	
low	hi	low	hi	low	hi	low	hi	low	hi

(continued)

Mon 12 Ch2 Alarm 4		Mon 12 Ch2 Alarm 5		Mon 12 Ch2 Alarm 6		Mon 12 Ch2 Alarm 7		Mon 12 Ch2 Alarm 8	
low	hi	low	hi	low	hi	low	hi	low	hi

(continued)

DLE	ETX	CRC	
10	03	??	??

6.3.1.1 MONITOR COMMUNICATION STATUSES

The TDe stores a true/false value for the Monitor Communication Statuses for each monitor. A "1", or true, indicates a communication fault. When a fault occurs, this indicates that a previously communicating monitor is no longer communicating with the TDe. If all previously communicating monitors enter a non-communicating state, i.e, a loss of power to the rack etc., the TDe will fail to respond to any register query with the **ONLY** exception being a loopback command (Command Code 6 Function 0). Therefore, a distinction can be made between failure to communicate to a rack and failure to communicate to the TDe. If the TDe responds to the loopback command but not to any queries for monitor information, then the TDe is communicating properly and the monitor rack has entered a non-communicating state.

6.4 Data Format

The Transient Data Interface retrieves data from the 3300 monitors in a serial digital format. Each monitor returns the data in a 24-bit format. The Transient Data Interface then truncates the lower 12 bits and sends the upper 12 bits in the message response. See the example below:

LOW	HI
XXXX XXXX	0000 XXXX

6.5 Embedded Responses

An embedded response occurs when a device sends a command to the TDe. The TDe will send an ACK (acknowledge) message if everything is correct and then start sending the response. If during the response another device sends a command to the TDe, it will send an ACK or NAK (not acknowledge) message to the second device during the response to the first command. The ACK or NAK message is inserted into the response message of the first command.

The Transient Data Interface implements embedded responses with Allen-Bradley protocol. It will accept embedded responses within incoming messages, and it may insert embedded responses in outgoing messages. However, because up to 60 bytes may be transferred before inserting an imbedded response in an outgoing message, it may be necessary to increase the response timeout when you use lower baud rates (4800 baud or lower).

6.6 Exception Responses

The TDe will return error codes in the response message when it receives a message with an illegal function, address, or data range. Error codes returned in the message are Allen-Bradley type REMOTE error codes, 10 Hex and 50 Hex.

ERROR CODE	ERROR CONDITION
10	The command message was incorrect. This includes the command code, subcommand code, and the size of the command or the requested size.
50	An attempt to access an illegal address in the interface has aborted message execution.

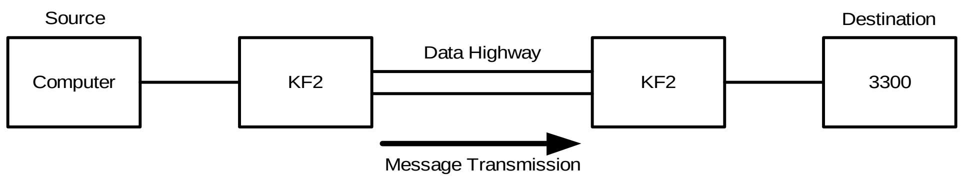
Data requests which are outside the address ranges established in the Allen-Bradley Protocol Data Addressing section of this manual will result in an error code 10 or an error code 50 message response. Error code 10 will occur if the starting address is valid, but the number of values requested results in a data address outside of the valid range. Error code 50 occurs if the starting address is outside the valid address range.

Although data addressing may overlap the following intervals, these overlapping requests may not cross from a register value to a status value boundary.

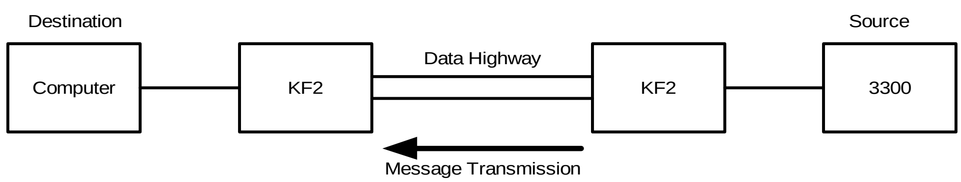
DATA TYPE	NUMBER OF ADDRESSES	STARTING ADDRESS	ENDING ADDRESS
Direct Values	36	8	43
Monitor Status	36	48	83
Current Proportional Values	192	100	291
Fast Trend Time Stamp	7	300	306
Fast Trend Interval	1	307	307
Number of Fast Trend Samples	1	308	308
Fast Trend Samples	7680	310	7989
Monitor Mode Statuses	96	10000	10095
Channel Alarm Statuses	536	10096	11631
Monitor Communication Statuses	12	11632	11643

6.7 Protocol Description

Each message packet contains a source and a destination address. When operating full duplex with a KF2, set the Transient Data Interface address to the same address as is set on the KF2 module. When a message is sent to the Transient Data Interface, the source address is that of the remote device initiating the message and the destination address is that of the KF2 module that receives the message, which is then relayed to the 3300 rack. See figure below.



When a reply message is formulated at the 3300 rack and sent back to the computer, the KF2 module intercepts the message and inserts its address into the source field of the message. The Transient Data Interface takes the source address from the preceding command message and inserts that address in the destination field of the reply message.



Because the 3300 rack is not a computer and is not programmable, it can execute commands but not initiate them.

DF1 protocol is ASCII character based and uses the following ASCII control characters.

ABBREVIATION	HEXADECIMAL CODE
STX	02
ETX	03
ENQ	05
ACK	06
DLE	10
NAK	15

One or more of the following code characters may be combined into a protocol "code":

DLE STX - is a message used to indicate the start of a message

DLE ETX BCC/CRC - is a message used to terminate a message

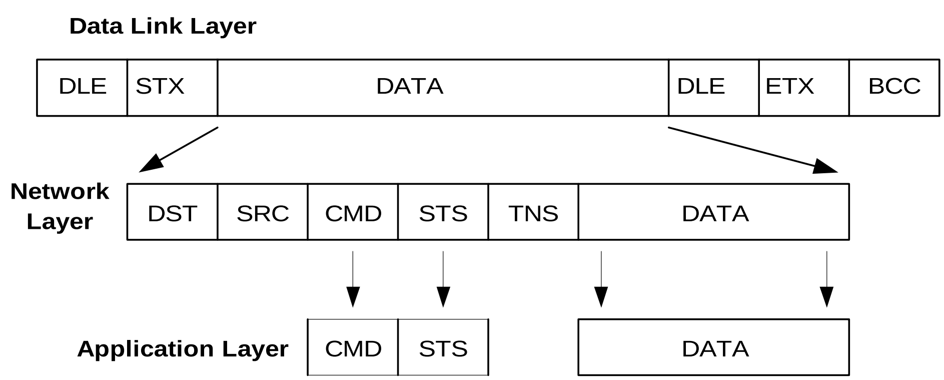
DATA 00-0F and 11-FF - are the encoded values in the message itself. DLE DLE is a code used to encode the value 10 in the message.

DLE ACK - is a response code that indicates that a message has been successfully received.

DLE NAK - is a response code that indicates that an attempt to transfer a message has failed.

DLE ENQ - is a message code. It requests the retransmission of the last received code.

The following figure shows the format of a message packet:



As shown above, a message packet starts with a DLE STX and ends with a DLE ETX BCC/CRC. There are data codes between the start and end of the message. The response codes can also occur between a DLE STX and a DLE ETX BCC/CRC. Those response codes, called embedded responses, are not part of the message packet.

6.8 Block Check

The block check character (BCC) is a means of checking the accuracy of each message packet transmission. The character is the 2's complement of the 8-bit sum (modulo-256 arithmetic sum) of all data bytes between the DLE STX and the DLE ETX BCC and does not include any other message packet codes or response codes.

Example 1: If a message contains the data codes 02, 03, 04, 05, 06 and 07, the message will be (in hex):

10	02	02	03	04	05	06	07	10	03	E5
DLE	STX	DATA						DLE	ETX	BCC

The sum of the data bytes in this message packet is 1B hex. The BCC is the 2's complement of this sum, or E5 hex. This is shown in the following binary calculation.

0001 1011	1B hex
1110 0100	1's complement
+1	
1110 0101	2's complement (E5 hex)

Example 2:To transmit the data value 10 hex, use the data code DLE DLE. However, only one of these DLE data bytes is included in the BCC sum. For example, to transmit the values 02, 03, 04, 05, 00, 10, 06, and 07 hex, use the following message codes:

10	02	02	03	04	05	00	10	10	06	07	10	03	D5
DLE	STX	DATA									DLE	ETX	BCC

In this case, the sum of the data bytes is 2B hex because only one DLE text code is included in the BCC. So the BCC is D5 hex.

The BCC algorithm provides a medium level of data security, because it cannot detect transposition of bytes during transmission of a packet or detect the insertion or deletion of data values of zero within a packet.

6.9 Cyclic Redundancy Check (CRC)

Calculate the CRC value of the data bytes and the ETX byte using the polynomial $x^{16} + x^{15} + x^2 + x^0$. To transmit the data value of 10 hex, use the data code DLE DLE. However, only one of these DLE data bytes is included in the CRC value. Embedded responses are not included in the CRC value.

At the start of a message packet, the transmitter clears a 16-bit register for the CRC value. As a byte is transmitted, it is exclusive-ORed (with bit 0 to the right) to the right eight bits of the register. The register is then shifted to the right eight times with 0s inserted to the left. Each time a 1 is shifted to the right, the following binary number is exclusive-ORed with the 16-bit register value:

1010 0000 0000 0001

As each additional byte is transmitted, it is included in the value in the register the same way. After the ETX value is included in the value in the register and is transmitted, the value in the register is transmitted (right bit first) as the CRC field.

The receiver also calculates the CRC value and compares it to the received CRC value to verify the accuracy of the data received.

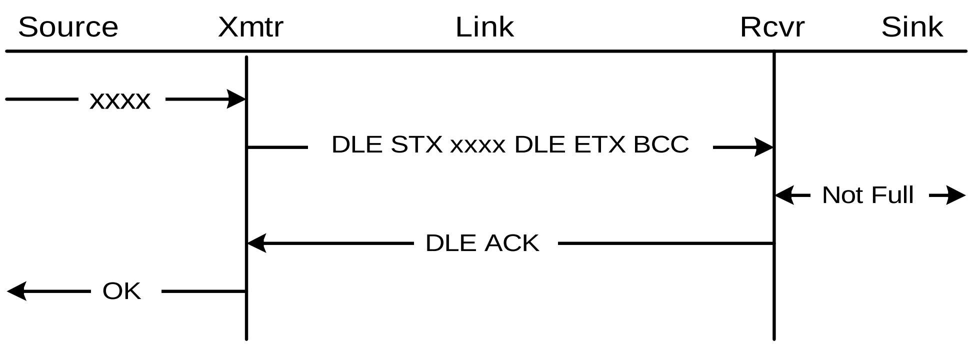
6.10 Message Characteristics

Full duplex protocol places the following restrictions on the messages that are submitted to it for transfer:

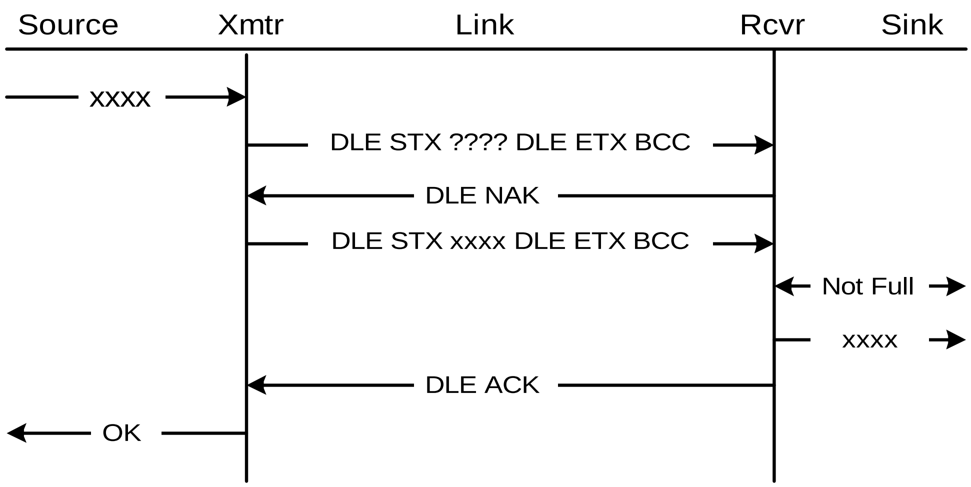
1. The minimum size of a valid message is 6 bytes; the maximum is 250 bytes (not including control codes).
2. As part of the duplicate message detection algorithm, the receiver checks the second(SRC), third(CMD), fifth(TNS), and sixth(TNS) bytes of each message. At least one of these bytes must be different from one message to the next for the algorithm to recognize a message as distinct from the previous message. If the algorithm detects a duplicate message, the receiver returns an ACK with no response to the command.

The following figures show some events that can occur on the various interfaces. Time is represented as increasing from the top of the figure to the bottom. Data bytes are represented by "xxxx"; corrupted data by "????".

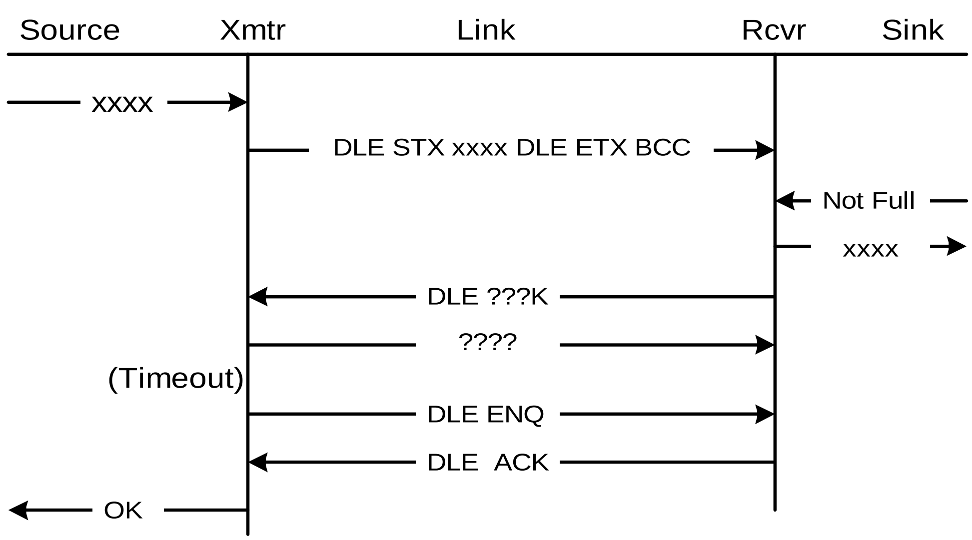
Normal Message Transfer



Message Transfer with NAK



Message Transfer with Retransmission



Retransmission occurs when noise occurs on both sides of the line. This type of noise destroys the DLE ACK and produces invalid characters at the receiver. The result is that the receiver changes its last response to NAK and the transmitter retransmits the original message.

6.11 Protocol Field Descriptions

DST -- destination station of the message

SRC -- source station of the message

CMD -- command code

STS -- status code

TNS -- transaction code (2 bytes)

FNC -- function code

EXT STS -- extended status code (Not implemented)

ADDR -- address of memory location (2 bytes)

SIZE -- number of bytes to be transferred

DATA -- data values being transferred by the message

DST and SRC: The DST (destination) byte contains the number of the station that is the ultimate destination of the message. The SRC (source) byte is the number of the station that originates the message.

CMD and FNC: The CMD (command) and FNC (function) bytes together define the activity to be performed by the command message at the destination station. CMD defines the command type and FNC, if used, defines the specific function under that command type.

STS and EXT STS: The STS (status) and EXT STS (extended status) bytes indicate the status of the message transmission. In command messages, the application program should always set the STS value to 0. The EXT STS is not implemented in the Transient Data Interface.

TNS: The TNS (transaction) bytes contain a unique 16-bit transaction identifier.

ADDR: The ADDR (address) field contains the address of a memory location which specifies the address where the command is to begin executing. For example, if the command is to read data from the Transient Data Interface, ADDR specifies the address of the first byte of data to be read.

SIZE: The SIZE byte specifies the number of data bytes to be transferred by a message. This field appears in read commands, where it specifies the number of data bytes that the Transient Data Interface must return in its reply message. The allowed value for SIZE will vary with the type of command.

DATA: The DATA field contains binary data from the Transient Data Interface.

7. Modbus Protocol

7.1 Introduction

The TDe Serial Data Interface (SDI) implements the Modicon Modbus Protocol. This allows the TDe SDI to provide data to a number of control and automation products that support Modbus protocol.

7.2 Message Types

For a complete description of the Modbus message formats, refer to the Gould Modbus Protocol Reference guide, Publication PI-MBUS-300 Rev B - January 1985 or later.

Note

All input point and input register addresses referenced in this manual are zero based. Modicon programmable controller (PC) locations are one based. The address references in this manual relate directly to the Modbus message format. If local host programming uses Modicon PC addresses, convert the appropriate base from one to zero. For example, if the input point address is 0, the Modicon PC point will be 10001. If the input register address is 0, the Modicon PC register will be 30001.

When configured in a Modbus connection, the Transient Data Interface will act only as a slave device. The mode of transmission is Remote Terminal Unit (RTU). The TDe supports these messages:

MESSAGE	FUNCTION CODE	MODBUS Programmable Controller Register (1-based)*		Query Address (zero-based)	
		Format	Range	Format	Range
Read Input Status	2	1XXXX	10001-19999	XXXX	0000-9998
Read Output Register	3	4XXXX	40001-49999	XXXX	0000-9998
Read Input Register	4	3XXXX	30001-39999	XXXX	0000-9998
Preset Single Register	6	4XXXX	40001-49999	XXXX	0000-9998
Loopback/Maintenance	8	N/A **		N/A **	
Preset Multiple Registers	16	4XXXX	40001-49999	XXXX	0000-9998
Report Slave ID	17	N/A **		N/A **	

* The function code works only on the Modbus address registers with the starting address as stated, i.e., function 2 will read 10000-19999 series registers.

** This command is used to communicate to specific TDe registers.

7.2.1 Message Type Descriptions

READ INPUT STATUS - Reads monitor alarm status values from the Transient Data Interface. A maximum of 2000 coils (bits) may be read.

READ OUTPUT REGISTER - Reads a query register which determines which set-point to retrieve.

READ INPUT REGISTER - Reads the proportional values from the Transient Data Interface. A maximum of 125 registers (250 bytes) may be read.

PRESET SINGLE REGISTER - Set up one of a number of registers to determine which set-point to retrieve.

PRESET MULTIPLE REGISTERS - Set up registers to determine which monitor set-point to retrieve or to set the real time clock. Once the TDe is active, the TDe host link controls the real time clock and locks out setting of the clock from the SDI link.

LOOPBACK/MAINTENANCE - Allows multiple functions, depending on the diagnostic code which is embedded in the request message.

DIAGNOSTIC CODE	MEANING
0	Return query data
2	Return Diagnostic register
10	Clear counters
11	Return message count
12	Return communication error count
13	Return exception count
18	Return character overrun count

Counters and the diagnostic register are cleared only by power-up or diagnostic code 10. All counters count modulo 65536 (1 00 00 Hex).

REPORT SLAVE ID - This command reads the version of the Transient Data Interface firmware. Two bytes are returned in the response message in the following order:

Major Rev Number	Begins at 1.0 and is updated whenever functions and features are added to the firmware.
Minor Rev Number	Updated whenever minor changes, minor improvements or performance improvements are made.

7.3 Data Addressing

The Transient Data Interface uses fixed protocol addresses for the starting locations of the data in a rack. The data addresses are used in the protocol messages to access data which is available from the interface and are not the physical data addresses in the Transient Data Interface memory. The addresses which were established in the 3300/01-02 Serial Interface are maintained in this product as well. The protocol starting addresses are as follows:

DATA TYPE	QUERY ADDRESSES (Decimal), Zero Based	CONTROLLER ADDRESSES (Decimal), One Based	NOTES
DATA VALUES			
Direct Values[1]	0 - 35	1 - 36	2
Most Recent Set-point	90 - 96	91 - 97	2
Current Proportional Values(See Appendix C)	100 - 291	101 - 292	2
Fast Trend Time Stamp	300 - 306	301 - 307	2
Fast Trend Interval	307	308	2
Fast Trend Samples Count	308	309	2
Fast Trend Samples Value	310 - 7989	311 - 7990	2
Proportional Values (re-ordered)	9100-9291	9101-9292	2
KPH Speed Values	9292-9295	9293-9296	2
Real Time Clock	9300-9306	9301-9307	2
STATUS			
Monitor Status[1]	0 - 35	1 - 36	3
KPH Speed Status	36-39	37-40	3
Monitor Mode Statuses	40 - 135	41 - 136	3
Channel Alarm Statuses	136 - 1671	137 - 1672	3
Monitor Communication Statuses	1672 - 1683	1673 - 1684	3
Monitor Alarm Status	8000-8002	8001-8003	3
Monitor Mode Status	8003-8010	8004-8011	3
Channel Alarm Status	8011-8138	8012-8139	3
Monitor Communication Statuses	8139-8140	8140-8141	3
CONTROL			
Data Length Control Register	7990	7991	
Data Length Register	7991	7992	
Set-point Location	9000-9002	9001-9003	
Real Time Clock	9300-9306	9301-9307	

NOTES

1. These addresses are compatible with the 3300/01-02 Serial Interface. The other addresses specified are the enhanced data types available from TDe. For addressing purposes: a) a 4 channel monitor looks like two 2-channel monitors with channel 1 and 2 in the first and 3 and 4 in the second, b) a 2-channel double-wide monitor looks like a 2-channel single-wide monitor in the left slot followed by an empty right slot c) a single channel monitor is treated as a dual channel monitor with an invalid data value for channel 2 d) the six channel temperature monitor (3300/30 and 3300/35) has 6 proportional values representing the 6 channels in the first monitor position and a blank in the second. Obtain the additional proportional channel data from monitors by using the Current Proportional Values addresses.
2. These data types refer to "Registers" as being a 2 byte word. The data length can be set between 12 and 16 bits by setting the data length register and its control. "Analog" type data is stored here, and will contain values between 0 and 4095 (decimal) for 12 bit representation and 0 to 65535 (decimal) for 16 bit representation. This value is a linear function representing the range from minimum to maximum of the monitor meter full scale range. For example, if your full scale range is 5 mils (this could refer to a vibration measurement), and the data in the register is 2048 (decimal) (i.e. half scale), then the displayed value is 2.5 mils (half-scale). See Appendix C.
3. These data types refer to a "point" as being a block of data containing "digital" (on/off) information. For Monitor Status, Monitor Mode Status, and Channel Alarm Status, a "Point" refers to 1 Bit of data.

7.3.1 Register Data Values Descriptions

DIRECT VALUES - The direct values address range is compatible with the 3300/01-02 Serial Interface System Monitor. Direct values have a starting address of 0 and occupy contiguous protocol addresses. The first monitor (slot 1) is the left most monitor just to the right of the System Monitor. The entire rack's direct values are located sequentially in adjacent addresses. Each monitor will have two direct values associated with it, except 3300 6-channel temperature monitors (3300/30, 3300/35). Six channel temperature monitors in the 3500 family (3500/60 or 3500/61) that have 6 direct values each and the 3500/62 Process Variable Monitor which also has 6 direct values and other monitor types that have more than 2 direct values only report back the first two direct. The channel direct values are ordered first to last channel. Use the configuration of the rack and this simple formula to calculate the starting address of the direct values query of a monitor.

*Starting Query = 2**[(*Monitor slot -1*) + *qty of 6 channel 3300 temperature monitors to left*]

Use either the READ INPUT REGISTERS command (Function Code 4) or READ OUTPUT REGISTERS command (Function Code 3) to access the direct values for the rack.

DIRECT VALUES			
Command	Function Code	Query Address	Controller Register
Read Input Registers	4	0-35	30001-30036
Read Output Registers	3	0-35	40001-40036

MOST RECENT SET-POINT - Monitor set-points may be read, but not written or changed in the monitor. Set-point values are acquired one at a time. To obtain a new set-point, write the identification of the set-point to the query registers with the appropriate values defined below. Once the query registers have been written, the set-point information will be returned in the set-point input registers.

Since set-point acquisition is a low priority process in the Transient Data Interface firmware, it may take up to 1.5 seconds before the set-point value will appear in the query registers. Reading the query registers before this time will yield the previous set-point value from the previous set-point request. If the query registers values are changed before the previous set-point is acquired, then the previously requested set-point will not be acquired but the newly specified one will.

Use the PRESET MULTIPLE REGISTERS command (function code 16) or PRESET SINGLE REGISTER (function code 6) to write to the query registers. Once a set-point value is written to the set-point input registers, use the READ INPUT REGISTERS command (Function Code 4) or READ OUTPUT REGISTERS command (Function Code 3) to acquire the set-point data. The locations of the set-point data are as follows:

DATA VALUE		FUNCT CODE	QUERY ADDRESS	CONTROLLER REGISTER
Description	Range			
Monitor Number	1 - 12	3	90	40091
Channel Number	1 - 32	3	91	40092
Set-point Number	1 - 255	3	92	40093
Set-point Type1	0 - 255	3	93	40094
Set-point Current Value2	0 - 4095	3	94	40095
Set-point Lower Range2	0 - 4095	3	95	40096
Set-point Upper Range2	0 - 4095	3	96	40097
Monitor Number	1 - 12	4	90	30091
Channel Number	1 - 32	4	91	30092
Set-point Number	1 - 255	4	92	30093
Set-point Type1	0 - 255	4	93	30094
Set-point Current Value2	0 - 4095	4	94	30095
Set-point Lower Range2	0 - 4095	4	95	30096
Set-point Upper Range2	0 - 4095	4	96	30097

NOTES:

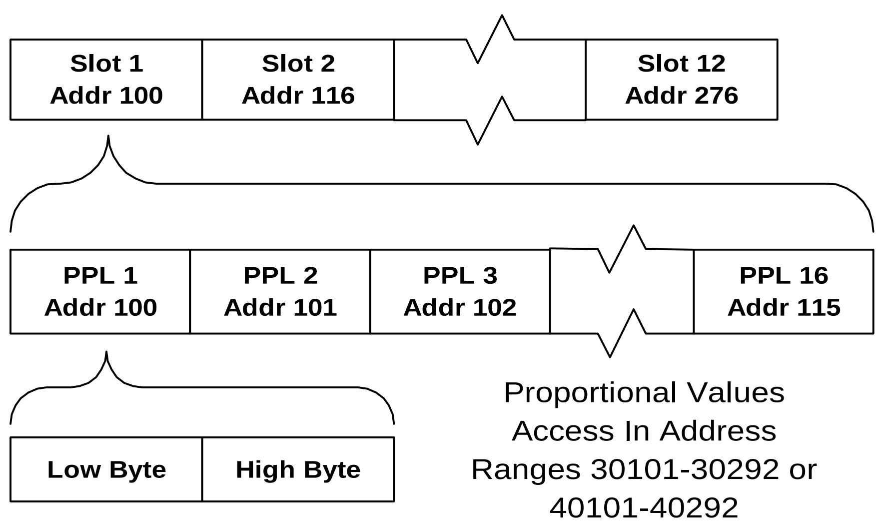
1. See set-point types in the appendix.
2. 12 bit values shown. If the 16 bit range is set, the range is 0 to 65535.

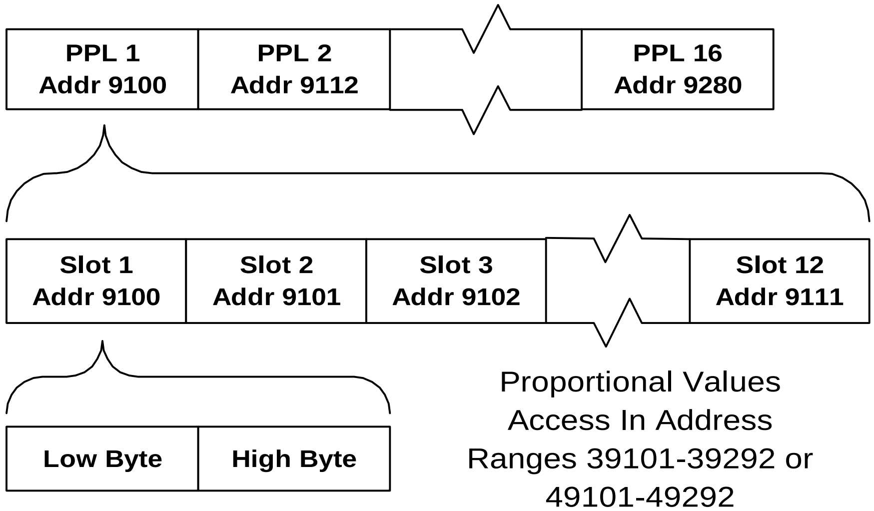
The query registers which direct the Transient Data Interface to acquire a set-point are as follows:

DATA VALUE	VALUE RANGE	FUNCT	QUERY ADDR.	REGISTER NUMBER
Monitor Number	1 - 12	6 or 16	9000	49001
Channel Number	1 - 32	6 or 16	9001	49002
Set-point Number	1 - 255	6 or 16	9002	49003

CURRENT PROPORTIONAL VALUES - The proportional values include monitor values such as direct (e.g. overall vibration amplitude), probe gap, 1X and 2X amplitude and phase. These values are different for each monitor type. See the Proportional Data Value Appendix for monitor values specific to a particular monitor type for 3300, 3500 and 2201 monitors. Proportional values are organized for a maximum of 16 values per monitor slot. Each slot can return from 0 to 16 channels, and 0 to 8 values per channel, but not more than 16 values total per slot. The number of values per channel is constant for all channels of a monitor. Note that monitors that have more than 2 channels are handled differently depending on the channel type and organization. Refer to the tables in the appendix for the proportional data from the different monitor types. Each proportional value is sent high byte first then low byte. Register locations outside of those supplied by the corresponding monitor or for a nonexistent monitor or the 2nd slot of a double wide 2-slot monitor will contain invalid data.

Use either the READ OUTPUT REGISTERS command (Function code 3) or READ INPUT REGISTERS command (Function Code 4) to access the current proportional values for the rack. The data can be accessed in either of two ways, each with different data organizations. In one address range, the data is arranged by monitor, in the second address range the data is arranged by proportional values number. The drawing below shows the arrangement of this matrix.





FAST TREND DATA - Fast Trend Data consists of 40 samples, ordered from oldest to newest, for each data location where current proportional values are taken. The samples are typically taken once every 4 seconds. The interval is read from a single register and is in tenths of a second units. When reading the fast trend values, read the date and time stamp each time any fast trend values are read. This will let you know if a fast trend update has occurred between reads of proportional values in a monitor.

Use the READ OUTPUT REGISTERS command (Function code 3) or READ INPUT REGISTERS command (Function Code 4) to access the fast trend data values for the rack.

The number of fast trend samples will usually be 40 (e.g. 160 seconds of data). However, if the fast trend data is requested just after a power-up condition or configuration change, the number of samples could be less than 40.

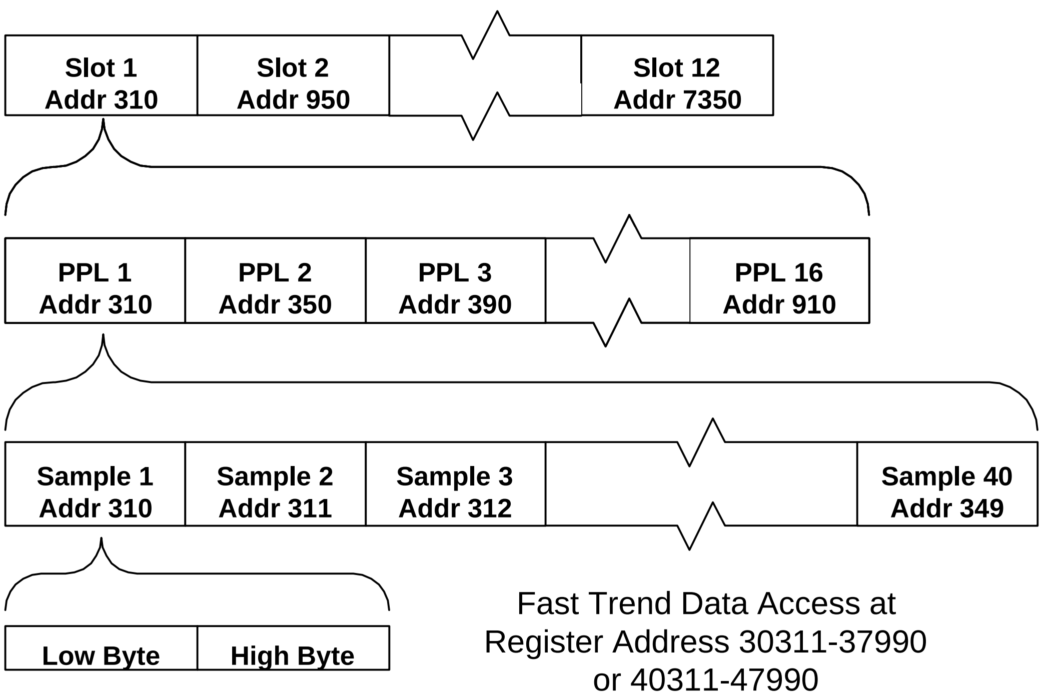
The date/time stamp corresponds to the newest sample taken and consists of the following registers, each of which occupy 1 word:

FIELD NAME	VALUE RANGE	QUERY ADDR	REG ADDR FC=4	REG ADDR FC=3	NOTES
Year	0-99	300	30301	40301	
Month	1-12	301	30302	40302	1=Jan., 12= Dec.
Day	1-31	302	30303	40303	
Hour	0-23	303	30304	40304	0=Midnight
Minute	0-59	304	30305	40305	
Second	0-59	305	30306	40306	
Hundredths of Second	0-99	306	30307	40307	

The following shows information regarding the fast trend:

FIELD NAME	VALUE RANGE	QUERY ADDR	REG ADDR FC=4	REG ADDR FC=3	NOTES
Interval	10-4095	307	30308	40308	In tenths of seconds
Quantity of Fast Trend Samples	0-40	308	30309	40309	40 is maximum quantity

The following diagram shows the organization of the fast trend sample values.



KEYPHASOR RPM DATA - The Keyphasor RPM Data consists of 4 registers, one for each Keyphasor in the system. The data is proportional to full scale, the full scale being determined by the configuration of the system. If the sampling of the system is set for 128 samples for each revolution, then the full scale is 15000 RPM, if it is set for 64 samples then full scale is 30000 RPM and if the samples per revolution are 32 then the full scale is 60000 RPM. The data and the register locations are given below.

FIELD NAME	VALUE RANGE	QUERY ADDR	REG ADDR FC=4	REG ADDR FC=3	NOTES
KPH 1	0-4095	9292	39293	49293	
KPH 2	0-4095	9293	39294	49294	
KPH 3	0-4095	9294	39295	49295	
KPH 4	0-4095	9295	39296	49296	

Use the READ OUTPUT REGISTERS command (Function code 3) or READ INPUT REGISTERS command (Function Code 4) to access the Keyphasor RPM values from the TDe.

7.4 Register Status Values Descriptions

MONITOR ALARM STATUS - The monitor status indicators have a value of 1 or 0. Each monitor slot will have three status points associated with it, Alert, Danger, and not OK. Individual channel status is not available by reading these addresses. If any channel of a monitor is in Alert, then the Alert status of the entire monitor slot is true (status bit equals 1).

The monitor status indicators are in the order Alert, Danger, and not OK and occupy contiguous query addresses starting at 0. Use the READ INPUT STATUS command (Function Code 2) to read the monitor statuses. A simple formula for computing the starting address for any monitor's status value is:

starting address = 3•(Monitor slot number - 1)

If a 6 channel monitor is in the rack, its status bits will be placed in the monitor location corresponding to the first monitor position. Four channel monitors will appear to occupy 2 monitor slots. When a monitor position is not filled with a monitor, then the status for that position will be indeterminate.

The coil query locations of the status bits are shown below if they are accessed using READ INPUT STATUS commands (Function Code 2).

MONITOR ALARM STATUSES QUERY ADDRESSES			
Monitor Slot	**Alert**	**Danger**	**Not OK**
1	0	1	2
2	3	4	5
3	6	7	8
4	9	10	11
5	12	13	14
6	15	16	17
7	18	19	20
8	21	22	23
9	24	25	26
10	27	28	29
11	30	31	32
12	33	34	35

The Coil addresses of the Monitor Alarm Statuses are given below:

The response to a status request using the Function Code 2 is a series of data packed into bytes with each coil represented with one bit. The LSB (bit 0) of the first byte returned is the first query address status, the next bit (bit 1) of the first byte is the next query address status and so on until all are returned. The response contains as many bytes as necessary to fulfill the request. For the monitoring systems, all of the monitor alarm statuses can be packed into 5 bytes.

MONITOR ALARM STATUSES COIL ADDRESSES			
Monitor Slot	**Alert**	**Danger**	**Not OK**
1	10001	10002	10003
2	10004	10005	10006
3	10007	10008	10009
4	10010	10011	10012
5	10013	10014	10015
6	10016	10017	10018
7	10019	10020	10021
8	10022	10023	10024
9	10025	10026	10027
10	10028	10029	10030
11	10031	10032	10033
12	10034	10035	10036

Note

The query starting point can be anywhere and does not have to be point zero or a monitor boundary. Starting at any other point will change the response message data locations. The total number of status points is 36.

Monitor Alarm Statuses are also available in three register locations and can be accessed using READ OUTPUT REGISTERS command (Function code 3). The returned data from this request must be interpreted. The three registers are shown in the table below:

FIELD NAME	QUERY ADDR	REG ADDR FC=3	NOTES
Alert Alarm Status	8000	48001	12 Monitor Slots
Danger Alarm Status	8001	48002	12 Monitor Slots
Not OK Alarm Status	8002	48003	12 Monitor Slots

Only the least significant 12 bits are used, with the LSB representing the status of monitor slot 1, the next most significant (Bit 1) representing monitor slot 2 with the 12th bit (Bit 11) representing monitor slot 12. This arrangement of bits is used for all three addresses.

KEYPHASOR RPM STATUS REGISTERS - Four coil addresses are used to indicate the status of the keyphasor RPM values. A "1" or ON status indicates that the keyphasor value is in error. The keyphasor is in error if it is not reporting a good value for the primary real keyphasor; simulated or backup keyphasors will be reported as in error.

KEYPHASOR RPM STATUS REGISTERS			
Keyphasor	Function Code	Query Address	Coil Address
1	2	36	10037
2	2	37	10038
3	2	38	10039
4	2	39	10040

Keyphasor status is also available from a single register location immediately following the RPM values of the keyphasor signals. This register can be accessed by a READ OUTPUT REGISTERS command (Function code 3) at query address 9296 (register address 49297). Although the register contains 2 bytes, only the least significant 4 bits are significant with the LSB representing the status of keyphasor 1, the next significant keyphasor 2, etc. through keyphasor 4. It is suggested that the values of the keyphasors and the status be read in a single block to remove latency between the data and the status.

MONITOR MODE STATUSES - The TDe stores the Monitor Mode Status for each of the 12 monitor slots as a series of 8 points in the following order organized so they can be read as bytes:

1. (Bit 0, LSB) Error Codes exist in the monitor
2. (Bit 1) An active error exists in the monitor; monitor is not monitoring
3. (Bit 2) Monitor is in Set-point Adjust Mode
4. (Bit 3) Monitor is in Calibration / Program Mode
5. (Bit 4) Monitor is in Trip Multiply Mode
6. (Bit 5) Monitor has Danger Bypass Switch Active

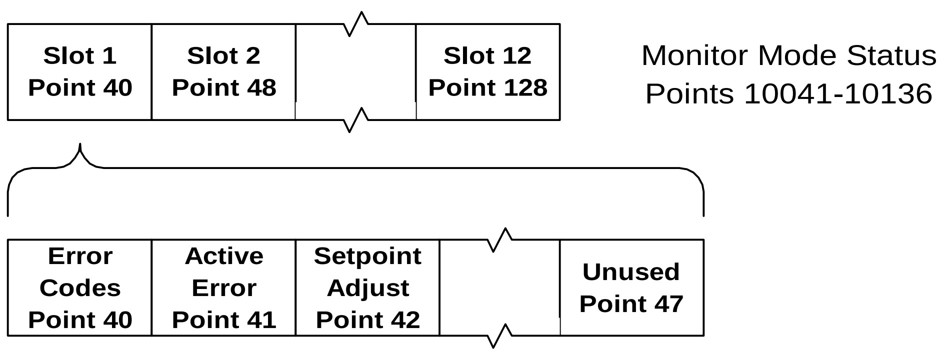
7. (Bit 6) Not Used

8. (Bit 7, MSB) Not Used

Use the READ INPUT STATUS command (Function Code 2) to access the monitor mode status values for the rack. The response will take the first status point requested as the LSB in the first byte and then continue to add status bits, and bytes as necessary until all queried locations are included.

MONITOR MODE STATUS ADDRESSES			
Monitor Slot	Function Code	Query Address Range	Coil Address Range
1	2	40-47	10041-10048
2	2	48-55	10049-10056
3	2	56-63	10057-10064
4	2	64-71	10065-10072
5	2	72-79	10073-10080
6	2	80-87	10081-10088
7	2	88-95	10089-10096
8	2	96-103	10097-10104
9	2	104-111	10105-10112
10	2	112-119	10113-10120
11	2	120-127	10121-10128
12	2	128-135	10129-10136

This diagram shows the organization of the Monitor Mode Statuses.



Note

The query starting point can be anywhere and does not have to be at a monitor boundary. Starting at other than a monitor boundary point will change the response message data locations. The total number of status points available is 96.

The monitor mode statuses are also available as register locations which can be accessed using READ OUTPUT STATUS command (Function Code 4). The arrangement of the data for these is each of 8 registers contains the particular error for all of the 12 monitors.

Only the least significant 12 bits are used, with the LSB representing the status of monitor slot 1, the next most significant (Bit 1) representing monitor slot 2 with the 12th bit (Bit 11) representing monitor slot 12. This arrangement of bits is used for all eight addresses.

MONITOR MODE STATUS ADDRESSES			
Monitor Status	**Function Code**	**Query Address**	**Register Address**
Error Codes exist	3	8003	48004
Monitor is not monitoring	3	8004	48005
Set-point Adjust Mode	3	8005	48006
Calibration / Program Mode	3	8006	48007
Trip Multiply Mode	3	8007	48008
Danger Bypass Switch Active	3	8008	48009
Not Used	3	8009	48010
Not Used	3	8010	48011

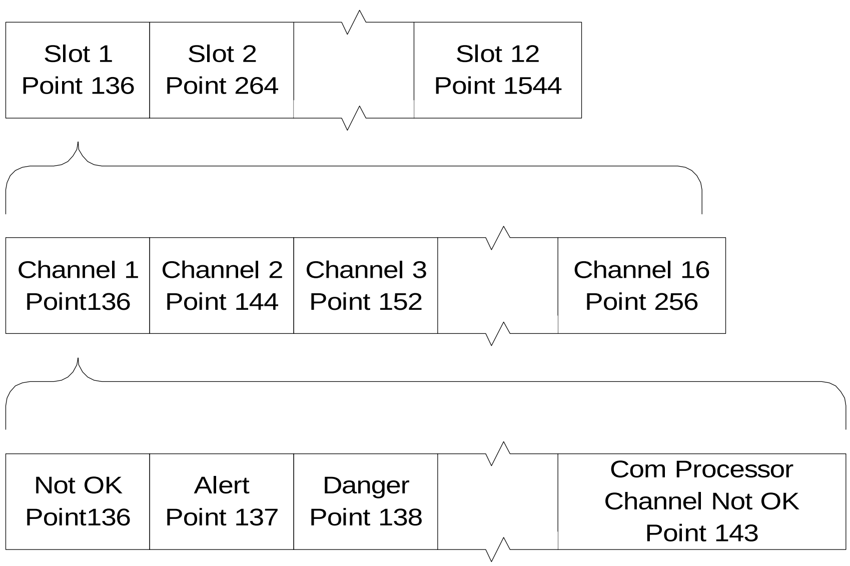
CHANNEL ALARM STATUSES - The TDe stores a true/false value for the Channel Alarm Statuses for each channel. Each monitor slot is allocated 16 channels of information. Each channel has 8 status values organized to appear as a single byte. For each channel the status contents are listed below and occur in the following order:

1. (Bit 0, LSB) Not OK
2. (Bit 1) Alert
3. (Bit 2) Danger
4. (Bit 3) Channel is in Bypass Mode
5. (Bit 4) Channel Off
6. (Bit 5) Keyphasor Not OK
7. (Bit 6) Signal Path Not OK
8. (Bit 7, MSB) Communication Processor Channel Not OK

Use the READ INPUT STATUS command (Function Code 2) to access the channel alarm status values for the rack. The response will make the first status point requested the LSB in the first byte and then continue to add status bits, and bytes as necessary until all queried locations are included.7 Modbus Protocol

CHANNEL ALARM STATUS ADDRESSES			
Monitor Slot	**Function Code**	**Query Address Range**	**Coil Address Range**
1	2	136-263	10137-10264
2	2	264-391	10265-10392
3	2	392-519	10393-10520
4	2	520-647	10521-10648
5	2	648-775	10649-10776
6	2	776-903	10777-10904
7	2	904-1031	10905-11032
8	2	1032-1159	11033-11160
9	2	1160-1287	11161-11288
10	2	1288-1415	11289-11416
11	2	1416-1543	11417-11544
12	2	1544-1671	11545-11672

In monitor slot one there are 128 points of information, 8 points each of the 16 possible channels. Space is allocated for all channels even though they are unused in the actual monitor. The following diagram shows the organization of the Channel Alarm Statuses.



Note

The query starting point can be anywhere and does not have to be at a monitor boundary. Starting at other than a monitor boundary point will change the response message data locations. The total number of status points available is 1536.

The channel alarm statuses are also available as register locations which can be accessed using READ OUTPUT STATUS command (Function Code 4). The arrangement of the data for these is each of 128 registers contains the particular status for one particular channel alarm status for all of the 12 monitors.

CHANNEL ALARM STATUS ADDRESSES			
Alarm Status	**Function Code**	**Query Address**	**Register Address**
Channel 1-16 Not OK	3	8011-8026	48012-48027
Channel 1-16 Alert	3	8027-8042	48028-48043
Channel 1-16 Danger	3	8043-8058	48044-48059
Channel 1-16 in Bypass Mode	3	8059-8074	48060-48075
Channel 1-16 Off	3	8075-8090	48076-48091
Channel 1-16 Keyphasor Not OK	3	8091-8106	48092-48107
Channel 1-16 Signal Path Not OK	3	8107-8122	48108-48123
Channel 1-16 Com Processor Not OK	3	8123-8138	48124-48139

Only the least significant 12 bits are used, with the LSB representing the status of monitor slot 1, the next most significant (Bit 1) representing monitor slot 2 with the 12^{th} bit (Bit 11) representing monitor slot 12. This arrangement of bits is used for all 128 addresses.

Most monitors only have two channels, so reading the first 2 registers of each status type will give the channel status for most monitors.

MONITOR COMMUNICATION STATUSES - The TDe stores a true/false value for the Monitor Communication Statuses for each monitor. A "1", or true, indicates a communication fault. When a fault occurs, this indicates that a previously communicating monitor is no longer communicating with the TDe.

If all previously communicating monitors enter a non-communicating state, i.e, a loss of power to the rack etc., the TDe will fail to respond to any Modbus query with the **ONLY** exception being a loopback command (Function 8). Therefore, a distinction can be made between failure to communicate to a rack and failure to communicate to the TDe. If the TDe responds to the loopback command but not to any queries for monitor information, then the TDe is communicating properly and the monitor rack has entered a non-communicating state.

Use the READ INPUT STATUS command (Function Code 2) to access the monitor communication status values for the rack. The response will make the first status point requested the LSB in the first byte and then continue to add status bits, and bytes as necessary until all queried locations are included.

MONITOR COMMUNICATION STATUS ADDRESSES			
Monitor Slot	**Function Code**	**Query Address Range**	**Coil Address Range**
1	2	1672	11673
2	2	1673	11674
3	2	1674	11675
4	2	1675	11676
5	2	1676	11677
6	2	1677	11678
7	2	1678	11679
8	2	1679	11680
9	2	1680	11681
10	2	1681	11682
11	2	1682	11683
12	2	1683	11684

Monitor communication status is also available from a single register location. This register can be accessed by a READ OUTPUT REGISTERS command (Function code 3) at query address 8140 (register address 48141). The register contains 2 bytes, only the least significant 12 bits of the 16 are significant with the LSB representing the status of monitor 1, the next significant monitor 2, etc. through monitor 12.

7.4.1 Setting Control Registers

DATA LENGTH CONTROL REGISTER - The length of the data is ordinarily 12 bits in a two byte register field. Data in the TDe is 16 bits long in most cases. If the DCS is capable of accepting data with more resolution, then it can be adjusted using the data length control register. This register is the first of two registers used to change the register resolution. To change resolution first write the hexadecimal value “AA” to the Data Length Control Register and then the desired length from 12 to 16 in the Data Length Register using PRESET SINGLE REGISTER (Function code 6) or PRESET MULTIPLE REGISTERS (Function code 16). When the length has taken place, the control register content will be 0 which can be read using the READ OUTPUT DATA command (Function Code 3).

On power up a data length of 12 is the default and will remain so until changed. If it is set to a different value and power is lost on the communication processor, when the communication processor powers up, it will be 12 bits once again.

DATA LENGTH CONTROL REGISTER ADDRESSES			
Register Function	**Function Code**	**Query Address**	**Register Address**
Data Length Control	3, 6 or 16	7990	47991
Data Length (12-16 range)	3, 6 or 16	7991	47992

REAL TIME CLOCK - To set the real time clock, write to the real time clock registers using PRESET MULTIPLE REGISTERS (Function code 16). This feature is only allowed if the TDe host has not set the date and time. Once the TDe host has set the date and time, the SDI link can not be used to set the real time clock. Because of system latency it is very difficult to set the time to better than 0.1 seconds.

To read the clock value use the READ OUTPUT DATA command (Function code 3). The location of the time registers is given below:

REAL TIME CLOCK ADDRESSES				
Register Function	**Range**	**Function Code**	**Query Address**	**Register Address**
Year	0-99	3 or 16	9300	49301
Month	1-12	3 or 16	9301	49302
Day	1-31	3 or 16	9302	49303
Hour	0-23	3 or 16	9303	49304
Minute	0-59	3 or 16	9304	49305
Second	0-59	3 or 16	9305	49306
Hundredths of a Second	0-99	3 or 16	9306	49307

7.5 Example Modicon PC Register Map

The following tables give an example of a register map based upon a 3300 rack with only a 3300/16 Dual RV monitor in slots 4 and 7 and a 3300/30 Six Channel Temperature monitor in slots 5 and 6. The addresses are formatted as **decimal Ones-based** registers.

Table below shows the Register Map for the Monitor Status and Monitor Mode Status registers:

Slot	Monitor Model #	Monitor Status		Monitor Mode Status	
4	3300/16	Alert Monitor	10010	Error Codes Stored	10065
		Danger Monitor	10011	Error Codes Active	10066
		Not Ok Monitor	10012	In Set-point Adjust	10067
				In Calibrate/Program	10068
				In Trip Multiply	10069
				Danger Bypass SW Active	10070
5 & 6	3300/30	Alert Monitor	10013	Error Codes Stored	10073
		Danger Monitor	10014	Error Codes Active	10074
		Not Ok Monitor	10015	In Set-point Adjust	10075
				In Calibrate/Program	10076
				In Trip Multiply	10077
				Danger Bypass SW Active	10078
7	3300/16	Alert Monitor	10019	Error Codes Stored	10089
		Danger Monitor	10020	Error Codes Active	10090
		Not Ok Monitor	10021	In Set-point Adjust	10091
				In Calibrate/Program	10092
				In Trip Multiply	10093
				Danger Bypass SW Active	10094

Table below shows the Register Map for the Direct Values and Channel Alarm Status registers:

Slot	Channel	Direct Values Register	Channel Alarm Status	
4	1	30007	Not OK	10521
			Alert	10522
			Danger	10523
			Channel in Bypass Mode	10524
			Channel Off	10525
			Keyphasor Not OK	10526
			Signal Path Not OK	10527
			Communication Processor Channel Not OK	10528
	2	30008	Same as Slot 4 Channel 1	10529 - 10536
5 & 6	1	30009	Not OK	10649
			Alert	10650
			Danger	10651
			Channel in Bypass Mode	10652
			Channel Off	10653
			Keyphasor Not OK	10654
			Signal Path Not OK	10655
			Communication Processor Channel Not OK	10656
	2	30010	Same as Slot 5 & 6 Channel 1	10657 - 10664
	3	30011	Same as Slot 5 & 6 Channel 1	10665 - 10672
	4	30012	Same as Slot 5 & 6 Channel 1	10673 - 10680
	5	30013	Same as Slot 5 & 6 Channel 1	10681 - 10688
	6	30014	Same as Slot 5 & 6 Channel 1	10689 - 10696
7	1	30015	Same as Slot 4 Channel 1	10905 - 10912
	2	30016	Same as Slot 4 Channel 2	10913 - 10920

Table below shows the Register Map for the Proportional Values and the Fast Trend Data:

Slot	Channel	Proportional Value		PPL #	Fast Trend Data Addresses
4	1	Direct	30149	1	32231 - 32270
		Gap	30150	2	32271 - 32310
		Not 1X	30151	3	32311 - 32350
		1X Amplitude	30152	4	32351 - 32390
		1X Phase	30153	5	32391 - 32430
		2X Amplitude	30154	6	32431 - 32470
		2X Phase	30155	7	32471 - 32510
	2	Direct	30156	8	32511 - 32550
		Gap	30157	9	32551 - 32590
		Not 1X	30158	10	32591 - 32630
		1X Amplitude	30159	11	32631 - 32670
		1X Phase	30160	12	32671 - 32710
		2X Amplitude	30161	13	32711 - 32750
		2X Phase	30162	14	32751 - 32790
5 & 6	1	Direct	30165	1	32871 - 32910
	2	Direct	30166	2	32911 - 32950
	3	Direct	30167	3	32951 - 32990
	4	Direct	30168	4	32991 - 33030
	5	Direct	30169	5	33031 - 33070
	6	Direct	30170	6	33071 - 33110
7	1	See Slot 4 Channel 1	30197 - 30203	1 - 7	34151 - 34430
	2	See Slot 4 Channel 2	30204 - 30210	8 - 14	34431 - 34710

Table below shows the Register Map for the Monitor Communication Statuses:

Rack Slot	Monitor Model #	Monitor Communication Status Register
4	3300/16	11676
5	3300/30	11677
6	3300/30	Not Applicable
7	3300/16	11679

Table below shows the Register Map for registers common to all 3300 racks, i.e., not monitor dependent:

Most Recent Set-point		Fast Trend		Fast Trend Time Stamp	
Monitor Number	30091	Interval	30308	Year	30301
Channel Number	30092	Samples	30309	Month	30302
Set-point Number	30093			Day	30303
Set-point Type	30094			Hour	30304
Set-point Current Value	30095			Minute	30305
Set-point Lower Range	30096			Second	30306
Set-point Upper Range	30097			1/100 Second	30307

7.5.1 Examples on Accessing Register Map Data

All of the Modbus command examples will be accessing the registers shown in the section Example Register Address Map.

7.5.1.1 Read Direct Values

Retrieve the direct value for Monitors 4 through 7. The 3300 Rack consists of two 3300/16 monitors, slots 4 and 7, and one 3300/30 monitor, slots 5 and 6.

Query

Address:	01 or whatever TDe Rack is defined as
Use Function Code:	04
Starting Register:	0006 (Register 30007)
Number of Registers:	000A or (0010 Decimal)

Response

Address:	01
Function Code:	04
Byte Count:	14 (20 Decimal)
Returns:	Two bytes returned for each PPL. 10 Direct PPL types returned.

7.5.1.2 Read Monitor Set-points

Retrieve the Alarm set-point for channel 1 of monitor 4. The 3300 Rack consists of two 3300/16 monitors, slots 4 and 7, and one 3300/30 monitor, slots 5 and 6.

Step 1: Write to Set-point Request Registers

Query

Address:	01 or whatever TDe Rack is defined as
Function Code:	10 (16 Decimal)
Starting Register	2328 (9000 Decimal) (Register 49001)
Number of Registers:	0003
Byte Count:	06
Register 49001:	0004 (Monitor 4)
Register 49002:	0001 (Channel 1)
Register 49003:	0001 (Over, Alert, Direct Set-point)

This Query wrote to the TDe a request to read the alarm set-point data for Monitor 4, Channel 1. Alternatively, Function code 06 could have been used to preset a single register such as Set-point Number. This is useful when several different set-points for a particular channel are needed.

Step 2: Read from Set-point Registers

Query

Address:	01 or whatever TDe Rack is defined as
Function Code:	04
Starting Register	005A (90 Decimal)(Register 30091)
Number of Registers:	0007

Response

Address:	01
Function Code:	04
Byte Count:	0E (14 Decimal)
Return Format:	Two bytes returned for each Set-point Register. Seven registers read.

7.5.1.3 Read Current Proportional Values

Retrieve the Proportional (PPL) values for Monitor 7, channels 1 and 2. The 3300 Rack consists of two 3300/16 monitors, slots 4 and 7, and one 3300/30 monitor, slots 5 and 6.

Query

Address:	01 or whatever TDe Rack is defined as
Function Code:	04
Starting Register	00C4 (196 Decimal)(Register 30197)
Number of Registers:	000E or (0014 Decimal)

Response

Address:	01
Function Code:	04
Byte Count:	1C (28 Decimal)
Return Format:	Two bytes returned for each PPL value. Fourteen registers read (seven for each channel) for a total of 28 bytes. Reference section on 3300 Proportional Data Value Types for the proper range of the returned value(s).

7.5.1.4 Read Fast Trend Data

Retrieve the Fast Trend data for Monitor 5; all 6 channels. The 3300 Rack consists of two 3300/16 monitors, slots 4 and 7, and one 3300/30 monitor, slots 5 and 6.

> Note:
> A maximum of 125 registers may be read with one query.

Step 1: Get Fast Tend Time Stamp

Query

Address:	01 or whatever TDe Rack is defined as
Function Code:	04
Starting Register	012C (300 Decimal)(Register 30301)
Number of Registers:	0007

Response

Address:	01
Function Code:	04
Byte Count:	0E (14 Decimal)
Return Format:	Steven time stamp registers.

Step 2: Get Fast Trend Data Channels 1-3

Query

Address:	01 or whatever TDe Rack is defined as
Function Code:	04
Starting Register	0B36 (2870 Decimal)(Register 32871)
Number of Registers:	0078 or (120 Decimal)

Response

Address:	01
Function Code:	04
Byte Count:	F0 (240 Decimal)
Return Format:	Channels 1-3 Fast Trend Data. 120 registers (240 bytes) total.

Step 3: Repeat Step 1 for Time Stamp query in case values have been updated.
Get Fast Trend Data channels 4-6

Query

Address:	01 or whatever TDe Rack is defined as
Function Code:	04
Starting Register	0BAE (2990 Decimal)(Register 32991)
Number of Registers:	0078 or (120 Decimal)

Response

Address:	01
Function Code:	04
Byte Count:	F0 (240 Decimal)
Return Format:	Channels 4-6 Fast Trend Data. 120 registers (240 bytes) total.

7.5.1.5 Read Monitor Alarm Status

Retrieve the Monitor Alarm Status information for all three monitors. The 3300 rack consists of two 3300/16 monitors, slots 4 and 7, and one 3300/30 monitor, slots 5 and 6.

Query

Address:	01 or whatever TDe Rack is defined as
Function Code:	02
Starting Register	0009 (Register 10010)
Number of Registers:	000C or (12 Decimal)(4 slots x 3 coils per slot)

Response

Address:	01
Function Code:	02
Byte Count:	02
Return Format:	Two packed status bytes returned. Bits 0-2 are monitor 4, bits 3-5 are monitor 5 & 6, bits 9-11 are monitor 7.

7.5.1.6 Read Monitor Mode Statuses

Retrieve the Monitor Mode Status information for all three monitors. The 3300 Rack consists of two 3300/16 monitors, slots 4 and 7, and one 3300/30 monitor, slots 5 and 6.

Query

Address:	01 or whatever TDe Rack is defined as
Function Code:	02
Starting Register	0040 (64 Decimal)(Register 10065)
Number of Registers:	001E or (30 Decimal)(3 slots x 8 coils each plus 6 for the monitor in position 7)

Response

Address:	01
Function Code:	02
Byte Count:	04
Return Format:	Four packed status bytes returned. Bits 0-5 are monitor 4, bits 8-13 (byte 2) are monitor 5 & 6, bits 24-29 are monitor 7 (byte 4). Bits 6, 7, 14, 15, 30 and 31 are not used and 16-23 are not used since they are the bits for slot 6.

7.5.1.7 Read Channel Alarm Statuses

Retrieve the Channel Alarm Status information for monitor 4. The 3300 Rack consists of two 3300/16 monitors, slots 4 and 7, and one 3300/30 monitor, slots 5 and 6.

Query

Address:	01 or whatever TDe Rack is defined as
Function Code:	02
Starting Register	0208 (520 Decimal)(Register 10521)
Number of Registers:	0010 or (16 Decimal)(2 channels x 8 coils each)

Response

Address:	01
Function Code:	04
Byte Count:	02
Return Format:	Two packed status bytes returned. Bits 0-7 are monitor 4 Channel 1, bits 8-15 (byte 2) are monitor 4 Channel 2.

7.5.1.8 Set the Real Time Clock

Set the Real Time Clock in the TDe.

Query

Address:	01 or whatever TDe Rack is defined as
Use Function Code:	10 (16 Decimal)
Starting Register	2454 (9300 Decimal)(Register 49301)
Number of Registers:	0007
Byte Count:	0E (14 Decimal)
Time Stamp Year:	Two Bytes
Time Stamp Month:	Two Bytes
Time Stamp Day:	Two Bytes
Time Stamp Hour:	Two Bytes
Time Stamp Minute:	Two Bytes
Time Stamp Second:	Two Bytes
Time Stamp Hundredth:	Two Bytes

The SDI Modbus communications transactions are carried out in a half duplex mode even though the wiring will support full duplex. A transaction consists of a master sending a command and the slave device returning a response. The commands and responses are communicated asynchronously via a bit serial protocol. By design, modbus can support multiple stations with one master and up to 247 responder stations multi-dropped on a common line. Assign each responder a unique fixed device address in the range 1 to 247 by setting the address in the Transient Data Interface configuration (TDXInit Utility program).

In Transient Data Interface connections, the TDe will behave as a slave on the communication link. A separate interfacing device, called a gateway, will serve as the master on this connection and usually as a protocol converter between Modbus protocol and a higher level Data Highway system. This document is concerned only with the Modbus communication link and does not discuss any special features or requirements of the gateway or the data highway.

7.6 Message Definition

When the word **status** is used in the MODBUS context, it means alarm status or control bit status. This is discrete data, which usually is represented as a single bit in a 16-bit word. Likewise, the word coil means a discrete data point usually representing a control bit in the TDe. 16 status bits or 16 coils can be packed into 1 word of memory.

When the word **register** is used in MODBUS, it represents an analog data value, which is a 16-bit word (2 bytes) of memory. Analog data represents Direct, Proportional, and Fast Trend values in the TDe.

7.7 Frame Format

Each MODBUS transaction consists of the transmission of a query and response frame. These frame types are all similar and are subdivided into four fields: station address, function code, information, and error check.

First	Order of Transmission		Last
Station Address	Function Code	Information	CRC

The length of each field is an integral multiple of 8-bit bytes. The station address field is sent first and the other fields follow in the order shown.

STATION ADDRESS - The **station address** field of both the query and the response frames contains the station address of the affected responder station. Since there is only one initiator station, the initiator is not addressed explicitly.

The station address field is one byte long and is defined for the values 0 to 255, as follows:

0	Signifies Broadcast frame, all stations are selected. TDe does not respond to any broadcast messages.
1 to 247	Selects the corresponding Transient Data Interface
248 to 255	Reserved by Modbus Protocol

Note
The station address for Modbus is the same as the SYSTEM 1 assigned Rack Address. The configuration does NOT check if station addresses in the reserved range are being used.

FUNCTION CODE - The **function code field** is one byte long. The TDe implements the following values:

CODE	FUNCTION
2	Read Input Status
3	Read Output Register
4	Read Input Register
6	Preset Single Register
8	Loopback/Maintenance
16	Preset Multiple Registers
17	Report Slave ID

INFORMATION FIELD - The **information field** contains all other information necessary to specify a requested function or its response.

ERROR CHECK FIELD - The **error check field** contains no application information but is appended to the frame to detect transmission errors between the sending and receiving stations.

The error check field is cyclic redundancy check (CRC-16) and is 2-bytes long. It's value is a function of the preceding data in the frame. The transmitter uses the following method to calculate the CRC value:

1. Load the 16-bit CRC register with FFFF hex (all 1s).
2. Exclusive OR the first 8-bit byte of the message with the low-order byte of the 16-bit CRC register and place the result in the CRC register.
3. Shift the CRC register one bit to the right (toward the LSD) and insert a zero in the MSB.
4. Extract and examine the LSB:

   If LSB = 0: repeat Step 3.

   If LSB = 1: exclusive OR the CRC register with the polynomial value A001 hex (1010 0000 0000 0001).
5. Repeat steps 3 and 4 until 8 shifts have been performed. When this is done, a complete 8-bit byte will have been processed.
6. Repeat steps 2 through 5 for the next 8-bit byte of the message. Continue doing this until all bytes have been processed.

The final contents of the CRC register is the CRC value. As each additional byte is transmitted, it is included in the value in the register the same way. The receiver also calculates the CRC value and compares it to the received CRC value to verify the accuracy of the data received.

Example

Slave Address	Function Code	Start Addr High Byte	Start Addr Low Byte	No. of Points High Byte	No. of Points Low Byte	CRC High Byte	CRC Low Byte
01	02	00	00	00	60	78	22

The above example shows a Read Input Status Command (the byte values are in Hex) that retrieves 36 Monitor Statuses and 60 Monitor Mode Statuses starting at register address zero and has a CRC value of 7822 hex.

7.8 Exception Conditions

If the addressed TDe receives a query frame without a communications error and if some condition stops the TDe from responding, the interface returns an exception response containing the appropriate error code to the master. When first powering up the TDe will not respond to queries until data is available. This time can be several minutes since a self test must be completed and communication with the monitor rack established before the response. Once communication is established and if the configuration is changed, or any action which would make the data values unknown, the TDe will return the exception response 6.

The high order bit (Hex 80) of the function code field is set to 0 in a query or normal response frame and set to1 in an exception response. Regardless of the function code, the information field of all exception response frames is one byte long. This byte contains the exception (EXCPT) code, defined below.

CODE	EXCEPTION CONDITION
1	Illegal function. If a poll was issued, this code indicates no program function preceded it.
2	Illegal data address in information field.
3	Illegal data value in information field.
6	Unable to respond at this time, try at a later time.

The TDe implements EXCPT codes 1, 2, 3 and 6.

7.9 Loopback/Maintenance — Function Code 8

A Diagnostic function code causes the slave to echo the data regardless of the status of the associated device. The code also restarts or interrogates the communication option in the slave without affecting the associated slave device.

Address	Function	Diagnostic Code (2 Bytes)		Data 1 Byte	Data 2 Byte	CRC (2 Bytes)	
01	08					??	??

The following table lists the Diagnostic codes.

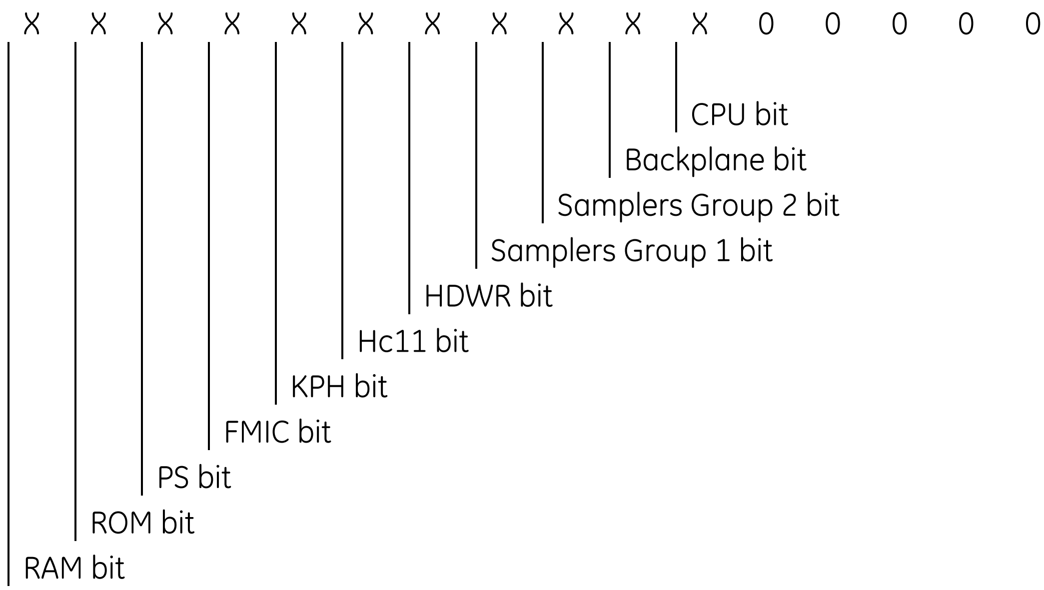
CODE	MEANING	DATA
0	Return query register	Data1 = arbitrary Data2 = arbitrary
2	Return diagnostic register	See diagnostics in this section
10*	Clear counters and diagnostic registers	16-bit response
11	Return message count	16-bit response
12	Return communication error count	16-bit response
13	Return exception count	16-bit response
18	Return char overrun count	16-bit response

* Only power-up or diagnostic code 10 clears counters and diagnostic registers. All counters count modulo 65536. See the diagnostic section for details on counters.

RESPONSE:

The response is the same as the query except that the DATA field depends on the Diagnostic code.

Diagnostics



Definitions:

CPU bit	Set to a '1' if a failure has been detected with the real time clock
Backplane bit	Set to a '1' if a failure has been detected with the sampler Backplane. Unable to communicate with any sampler.
Samplers Group 2 bit	Set to a '1' if a failure has been detected with at least one sampler (Sampler 9 through 12)
Samplers Group 1 bit	Set to a '1' if a failure has been detected with at least one sampler (Sampler 1 through 8)
HDWR bit	Set to a '1' if the hardware switches do not match the configuration stored in the TDe
HC11 bit	Set to a '1' if a failure has been detected with the HC11 on the Keyphasor board
KPH bit	Set to a '1' if a failure has been detected during one of the Keyphasor tests.
FMIC bit	Set to a '1' if a failure has been detected during one of the FMIC tests
PS bit	Set to a '1' if a failure has been detected with one of the power supplies
ROM bit	Set to a '1' if a failure has been detected with the TDe ROM
RAM bit	Set to a '1' if a failure has been detected with the TDe RAM

7.10 Report Slave ID – Function Code 17

Use function code 17 to obtain device dependent status and configuration information from the TDe.

The following is the format for the query and response messages.

QUERY:

Address	Function	CRC	
01	11	C0	2C

RESPONSE:

Address	Function	Byte Count	0	0	Major Rev Number		Minor Rev Number		CRC	
01	11				hi	lo	hi	lo	??	??

Major Rev Number Updated whenever functions and features are added to the firmware.

Minor Rev Number Updated whenever minor changes, minor improvements or performance improvements are made.

8. Data Types

8.1 Monitor Proportional Value Types

The following tables show the proportional data types returned from the different monitors that interface with TDe (See the end of this section for a Proportionality for PPLs (except for values with a symbol)

> **Note:**
>
> **Bold text** indicates that the monitor returned values is always over written by TDe. Shaded text denotes that PPL values are selected from monitor value or TDe. *Italics values* are appended by TDe.

Mon. Num.	Mon. Description	# of Ch	Ch #	Static and Dynamic Proportional Values							
3300 SINGLE SLOT MONITORS				**PPL1/9**	**PPL2/10**	**PPL3/11**	**PPL4/12**	**PPL5/13**	**PPL6/14**	**PPL7/15**	**PPL8/16**
3300/04	Transducer Output Panel -	4	1-2	*Not1X*	*Gap*	*1x Amp*	*1x Phase*	*2x Amp*	*2x Phase*	*Not1X*	*Gap*
	(Pseudo Monitor)			*1x Amp*	*1x Phase*	*2x Amp*	*2x Phase*				
			3-4	Not Supported by TDXnet or TDIX							
3300/15	Dual Vibration	2	1-2	Direct	**Gap**	*Not1x*	*1x Amp*	*1x Phase*	*2x Amp*	*2x Phase*	Direct
	Monitor			**Gap**	*Not1x*	*1x Amp*	*1x Phase*	*2x Amp*	*2x Phase*		
3300/16	Dual Vibration/w Gap Alarm	2	1-2	Direct	**Gap**	*Not1x*	*1x Amp*	*1x Phase*	*2x Amp*	*2x Phase*	Direct
	Monitor			**Gap**	*Not1x*	*1x Amp*	*1x Phase*	*2x Amp*	*2x Phase*		
3300/17	Aeroderivative Dual Vibration	2	1-2	Direct	**Gap**	*Not1x*	*1x Amp*	*1x Phase*	*2x Amp*	*2x Phase*	Direct
	Monitor			**Gap**	*Not1x*	*1x Amp*	*1x Phase*	*2x Amp*	*2x Phase*		
3300/20	Dual Thrust	2	1-2	Direct	**Gap**	*Not1x*	*1x Amp*	*1x Phase*	*2x Amp*	*2x Phase*	Direct
	Position Monitor			**Gap**	*Not1x*	*1x Amp*	*1x Phase*	*2x Amp*	*2x Phase*		
3300/25	Dual Accel.	2	1-2	Direct	*Not1x*	*1x Amp*	*1x Phase*	*2x Amp*	*2x Phase*	Direct	*Not1x*
	Monitor			*1x Amp*	*1x Phase*	*2x Amp*	*2x Phase*				
3300/26	Dual RMS Accel	2	1-2	Direct	*Not1x*	*1x Amp*	*1x Phase*	*2x Amp*	*2x Phase*	Direct	*Not1x*
	Monitor			*1x Amp*	*1x Phase*	*2x Amp*	*2x Phase*				
3300/36	Dual Temperature Monitor	2	1-2	Direct	Direct						

Mon. Num.	Mon. Description	# of Ch	Ch #	Static and Dynamic Proportional Values							
3300/39	Dual Process Variable Monitor	2	1-2	Direct	Direct						
3300/40	Eccentricity Monitor	1	1	Pk-to-Pk	Direct	**Gap**	Max Dir	Min Direct	*Not1x*	*1x Amp*	*1x Phase*
				2x Amp	*2x Phase*						
3300/45	Dual Differential Expansion Monitor	2	1-2	Direct	**Gap**	*Not1x*	*1x Amp*	*1x Phase*	*2x Amp*	*2x Phase*	Direct
				Gap	*Not1x*	*1x Amp*	*1x Phase*	*2x Amp*	*2x Phase*		
3300/46	Ramp Differential Expansion Monitor	2	1-2	Direct	**Gap**	*Not1x*	*1x Amp*	*1x Phase*	*2x Amp*	*2x Phase*	No Type
				Gap	*Not1x*	*1x Amp*	*1x Phase*	*2x Amp*	*2x Phase*		
3300/47	Complimentary Input DE Monitor	2	1-2	Direct	**Gap**	*Not1x*	*1x Amp*	*1x Phase*	*2x Amp*	*2x Phase*	No Type
				Gap	*Not1x*	*1x Amp*	*1x Phase*	*2x Amp*	*2x Phase*		
3300/48	Case Expansion Monitor	2	1-2	Comp.	Direct	No Type	Direct				
3300/50-01	Dual Setpoint Tachometer	2	1-2	RPM	**Gap**	Peak Speed	No Type	**Gap**	No Type		
3300/50-02	Zero Speed Tachometer	2	1-2	RPM	**Gap**	Peak Speed	No Type	**Gap**	No Type		
3300/50-03	Rotor Acceleration Tachometer	2	1-2	RPM	**Gap**	Peak Speed	RPM per min	**Gap**	No Type		
3300 DUAL SLOT MONITORS											
3300/30	6-channel Temperature Monitor -TC	6	1-6	Direct	Direct	Direct	Direct	Direct	Direct		
3300/35	6-channel Temperature Monitor -RTD	6	1-6	Direct	Direct	Direct	Direct	Direct	Direct		
3300/52**#**	Reverse Rotation Tachometer	2	1-2	RPM	**Gap**	Peak Speed	No Type	**Gap**	# Rev Rot		

Mon. Num.	Mon. Description	# of Ch	Ch #	Static and Dynamic Proportional Values							
3300/53**#**	Overspeed Tachometer	1	1	RPM	**Gap**	Peak Speed					
3300/54	Dual REBAM Monitor	2	1-2	Direct	Prime Spike	**Gap**	*Not1x*	*1x Amp*	*1x Phase*	*2x Amp*	*2x Phase*
				Direct	Prime Spike	**Gap**	*Not1x*	*1x Amp*	*1x Phase*	*2x Amp*	*2x Phase*
3300/55	Dual Velocity	2	1-2	Direct	*Not1x*	*1x Amp*	*1x Phase*	*2x Amp*	*2x Phase*	Direct	*Not1x*
	Monitor			*1x Amp*	*1x Phase*	*2x Amp*	*2x Phase*				
3300/61	Dual Vector	2	1-2	Direct	**Gap**	**1x Amp**	**1x Phase**	**2x Amp**	**2x Phase**	*Not1x*	Direct
	Monitor			Gap	**1x Amp**	**1x Phase**	**2x Amp**	**2x Phase**	*Not1x*		
3300/65	Dual Probe	2	1-2	Direct	**Gap**	*Not1x*	*1x Amp*	*1x Phase*	*2x Amp*	*2x Phase*	Direct
	Monitor			Seismic	*Not1x*	*1x Amp*	*1x Phase*	*2x Amp*	*2x Phase*		
3300/70	Dual Valve Position Monitor	2	1-2	Direct	Direct						
3300/75	32-Channel	32	1-6	Direct	Direct	Direct	Direct	Direct	Direct	Direct	Direct
$	Temperature		7-12	Direct	Direct	Direct	Direct	Direct	Direct	Direct	Direct
	Monitor		13-24	Direct	Direct	Direct	Direct	Direct	Direct	Direct	Direct
			25-32	Direct	Direct	Direct	Direct	Direct	Direct	Direct	Direct
3300/80	6-Channel Rod	6	1-6	Direct	**Gap**	*Not1x*	*1x Amp*	*1x Phase*	*Direct*	Gap	*Not1x*
or /81	Drop Monitor			*1x Amp*	*1x Phase*	Direct	**Gap**	*Not1x*	*1x Amp*	*1x Phase*	Direct
&				Gap	*Not1x*	*1x Amp*	*1x Phase*	Direct	**Gap**	No Type	No Type
				No Type	Direct	**Gap**	No Type	No Type	No Type		
3300/85	Torque Indicator Monitor	1	1	Direct	**Gap**	RPM	Power	Peak Torque	Peak Speed	Peak Power	*Not1x*
			1	*1x Amp*	*1x Phase*	*2x Amp*	*2x Phase*				

Mon. Num.	Mon. Description	# of Ch	Ch #	Static and Dynamic Proportional Values							
3300/90	Multi-Channel Diagnostic Instrument	Not Supported by TDXnet or TDIX									
3300/95	Aeroderivative	4	1-4	Direct	**Gap**	*Not1x*	*1x Amp*	*1x Phase*	*2x Amp*	*2x Phase*	Direct
	Gas Turbine			**Gap**	*Not1x*	*1x Amp*	*1x Phase*	*2x Amp*	*2x Phase*	No Type	**Gap**
	Monitor			*Not1x*	*1x Amp*	*1x Phase*	*2x Amp*	*2x Phase*	No Type	**Gap**	*Not1x*
				1x Amp	*1x Phase*	*2x Amp*	*2x Phase*				

PROPORTIONAL VALUES (Except those with Special symbols)

PPL NAME	TDe VALUE	Value is proportional to
GAP	0 - 4095 (0 - FFFh)	-25V to +25V
1X PHASE	0 - 4095 (0 - FFFh)	0 to 359 deg
2X PHASE	0 - 4095 (0 - FFFh)	0 to 359 deg
All other PPL values from Monitor	0 - 4095 (0 - FFFh)	Monitor full scale
All other PPL values fromTDe	0 - 4095 (0 - FFFh)	Direct value full scale configured value

Note: For those Static Values where the data may come either from TDe or the Monitor (shaded areas in table) use the appropriate selection above based on the configuration.

Example 1: Use the following formula to calculate the gap voltage:

Gap V = (50/4095)*TDe VALUE - 25V

EXCEPTIONS (symbol definitions)

SYMBOL	MONITOR	NAME	TDe VALUE	Value is proportional to
&	3300/80 or 3300/81	Direct	0 - 4095 (0 - FFFh)	-999 to +999
#	3300/52 & 3300/53	RPM	0 - 4095 (0 - FFFh)	0 - 20,000 RPM
$	3300/75	Direct	0 - 4095 (0 - FFFh)	-99 to +999

8.2 Monitor Setpoint types

The monitor setpoint types are structured in an eight bit format. Each bit in the eight bit word has a specified meaning. The eight bit word is broken down as shown below.

MSB LSB
WW X YYYYY

Where:

WW	=	0 → OVER / FROM
		1 → UNDER / TO
		2 → DIFFERENTIAL
		3 → UNUSED
X		0 → ALERT / ALARM 1
	=	1 → DANGER / ALARM 2
YYYYY		0 → NO TYPE
	=	1 DIRECT
		2 GAP
		3 1X AMPLITUDE
		4 1X PHASE CCW
		5 2X AMPLITUDE
		6 2X PHASE CCW
		7 MAX VALUE
		8 MIN VALUE
		9 PEAK TO PEAK
		10 1X PHASE CW
		11 2X PHASE CW
		12 RPM
		13 PRIME SPIKE
		14 NOT 1X
		15 RPM/MIN
		16 COMPOSITE
		17 nX AMPLITUDE
		18 nX PHASE CCW
		19 nX PHASE CW
		20 SHAFT CENTERLINE AMPLITUDE
		21 SHAFT CENTERLINE PHASE CCW
		22 SHAFT CENTERLINE PHASE CW
		23 POWER
		24 PEAK TORQUE
		25 PEAK SPEED
		26 PEAK POWER
		27 SEISMIC
		28 SMAX AMPLITUDE
		29 BANDPASS
		30 UNUSED
		31 GENERIC

NOTE: The NO TYPE setpoint type is used in cases where a monitor has a differing number of measurements in each channel. This allows the monitor to return the same number of values for each channel. An example is the 3300/47, differential expansion monitor; channel 1 returns the DIRECT (complimentary input differential expansion) measurement and probe 1 GAP, channel 2 returns a NO TYPE and probe 2 GAP.

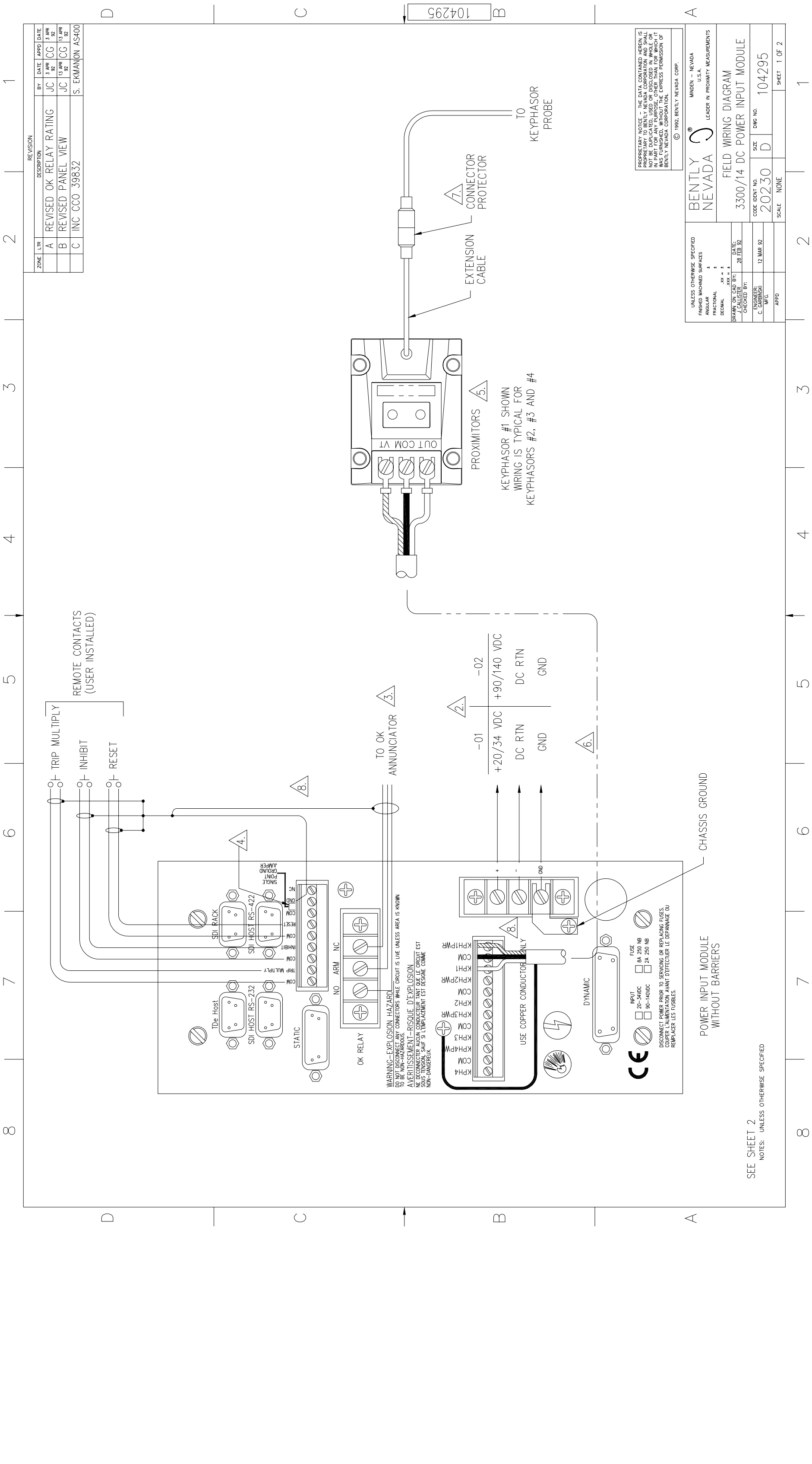
EXAMPLE: A returned value for an UNDER ALERT GAP setpoint type is 0 1 0 0 0 0 1 0, which is hex 42.

9. Field Wiring Diagrams and Notes

The following pages contain information for connecting the Keyphasor Proximitors with or without external barriers to the 3300/02.

⚠ CAUTION
Disconnect all power from the 3300 rack and Proximitors before making any connections. Follow all wiring directions and specifications exactly as directed in the field wiring diagrams and notes. Failure to do so can result in improper operation, loss of operation, or damage to the 3300/02 or Proximitors.

⚠ CAUTION
Machine protection will be lost while power is removed from the protection system.


FIELD WIRING DIAGRAM
3300/14 DC POWER INPUT MODULE
104295
BENTLY NEVADA
REVISED OK RELAY RATING
REVISED PANEL VIEW
INC CCO 39832
TO KEYPHASOR PROBE
CONNECTOR PROTECTOR
EXTENSION CABLE
PROXIMITORS
KEYPHASOR #1 SHOWN
WIRING IS TYPICAL FOR
KEYPHASORS #2, #3 AND #4
REMOTE CONTACTS
(USER INSTALLED)
TRIP MULTIPLY
INHIBIT
RESET
TO OK ANNUNCIATOR
-01
+20/34 VDC
DC RTN
GND
-02
+90/140 VDC
DC RTN
GND
CHASSIS GROUND
POWER INPUT MODULE
WITHOUT BARRIERS
OK RELAY
STATIC
DYNAMIC
USE COPPER CONDUCTORS ONLY
SEE SHEET 2

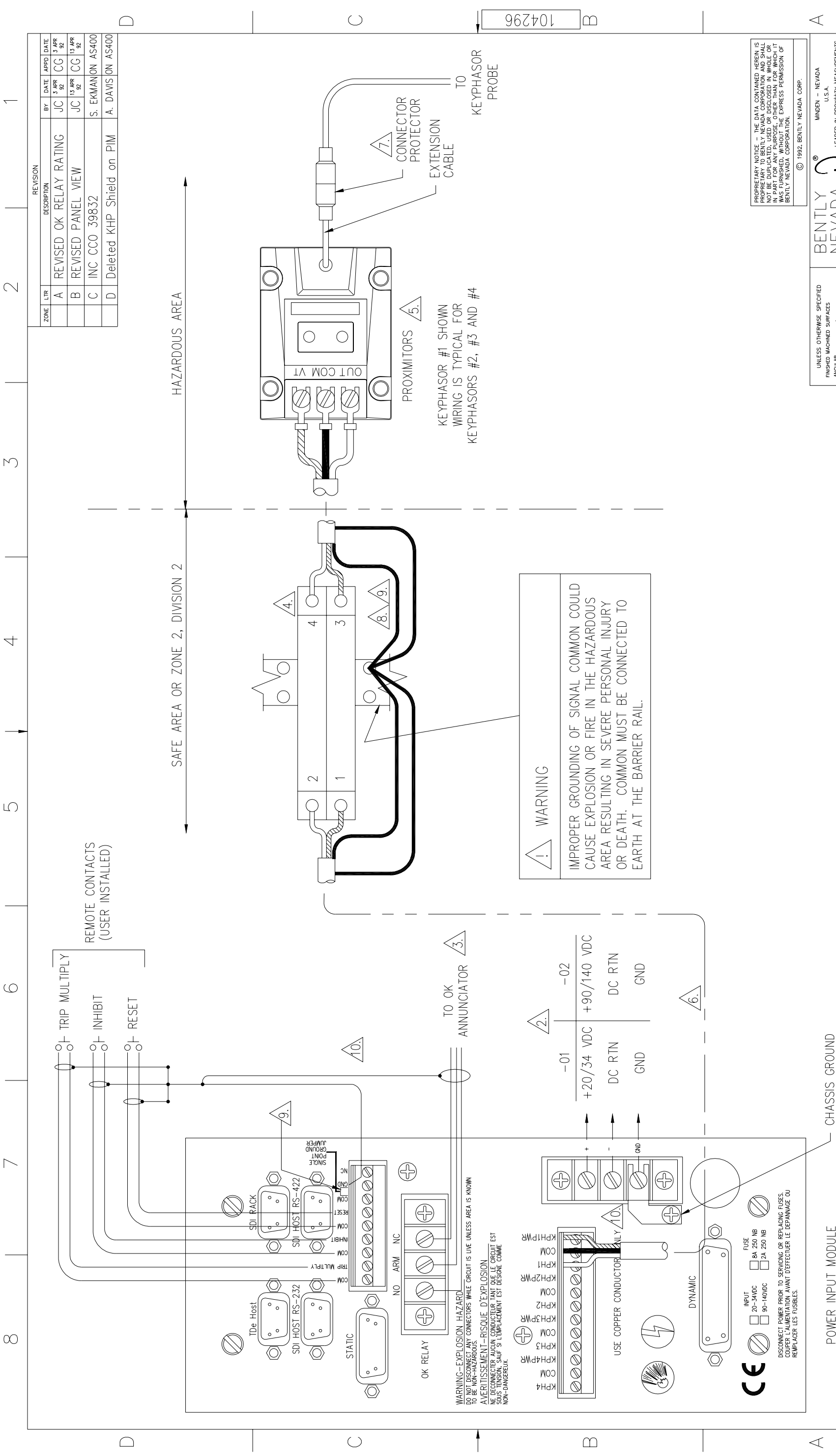
REVISION						
ZONE	LTR	DESCRIPTION	BY	DATE	APPD	DATE
		SEE SHEET 1	—	—	—	—

NON-BARRIER SYSTEM FIELD WIRING NOTES

1. WIRING RECOMMENDATIONS:
   POWER INPUT MODULE TO PROXIMITORS: 18AWG TO 22AWG STRANDED 3 WIRE SHIELDED WITH INSULATING SHEATH.
   POWER INPUT MODULE TO REMOTE CONTACTS: 18AWG TO 22AWG STRANDED 2 WIRE WITH INSULATING SHEATH.
2. WIRE GAUGE AND TYPE SELECTED PER LOCAL CODE REQUIREMENTS. POWER REQUIREMENTS ARE: 20–34 VDC, 5.5 AMP MAX.
   90–140 VDC, 1.5 AMP MAX.
3. OK RELAY CONTACT RATING: 5 A @28 VDC, OR 5A @ 120VAC, 50/60 HZ, OR 3 A @ 220 VAC, 50/60 HZ, RESISTIVE MAXIMUM.
4. TO MINIMIZE GROUND LOOP NOISE PROBLEMS, A SINGLE POINT EARTH GROUND (GND) TO SYSTEM COMMON (COM) CONNECTION IS RECOMMENDED.
5. THE 3000 AND 7200 PROXIMITOR CASES MUST BE ELECTRICALLY ISOLATED FROM EARTH GROUND. ELECTRICAL ISOLATION: 500 VAC (RMS) MINIMUM. ISOLATION KIT P/N 19094–01 MAY BE USED TO SATISFY ISOLATION REQUIREMENTS. WIRING FOR THE 7200 AND 3000 PROXIMITORS IS THE SAME AS SHOWN FOR THE 3300 PROXIMITOR.
6. MAXIMUM CABLE LENGTH BETWEEN POWER INPUT MODULE AND PROXIMITORS SHOULD NOT EXCEED 1000 FEET (305 METRES).
7. TO ELECTRICALLY ISOLATE AND PROTECT COAXIAL CONNECTIONS, USE CONNECTOR PROTECTOR KIT 40113–02.
8. SHIELDS ARE SPLICED INTO A SINGLE WIRE, THEN GROUNDED AS SHOWN, TERMINATING AT THE CHASSIS IN TWO PLACES. SHIELDS SHOULD BE INSULATED.

NOTES: UNLESS OTHERWISE SPECIFIED

CODE IDENT NO.	SIZE	DWG NO.
20230	D	104295
SCALE NONE		SHEET 2 OF 2


HAZARDOUS AREA
SAFE AREA OR ZONE 2, DIVISION 2
TO KEYPHASOR PROBE
CONNECTOR PROTECTOR
EXTENSION CABLE
PROXIMITORS
KEYPHASOR #1 SHOWN WIRING IS TYPICAL FOR KEYPHASORS #2, #3 AND #4
WARNING
IMPROPER GROUNDING OF SIGNAL COMMON COULD CAUSE EXPLOSION OR FIRE IN THE HAZARDOUS AREA RESULTING IN SEVERE PERSONAL INJURY OR DEATH. COMMON MUST BE CONNECTED TO EARTH AT THE BARRIER RAIL.
REMOTE CONTACTS (USER INSTALLED)
TRIP MULTIPLY
INHIBIT
RESET
TO OK ANNUNCIATOR
-01
+20/34 VDC
DC RTN
GND
-02
+90/140 VDC
DC RTN
GND
CHASSIS GROUND
POWER INPUT MODULE WITH EXTERNAL BARRIERS
SEE SHEET 2
REVISED OK RELAY RATING
REVISED PANEL VIEW
INC CCO 39832
Deleted KHP Shield on PIM
BENTLY NEVADA
FIELD WIRING DIAGRAM
3300/14 DC POWER INPUT MODULE
20230
104296
SHEET 1 OF 2

REVISION						
ZONE	LTR	DESCRIPTION	BY	DATE	APPD	DATE
		SEE SHEET 1	—	—	—	—

EXTERNAL BARRIER SYSTEM FIELD WIRING NOTES

1. WIRING RECOMMENDATIONS:
   POWER INPUT MODULE TO BARRIERS – BARRIERS TO PROXIMITORS: 14AWG TO 18AWG STRANDED 3 WIRE, SHIELDED WITH INSULATING SHEATH.
   POWER INPUT MODULE TO REMOTE CONTACTS: 18AWG TO 22AWG STRANDED 2 WIRE WITH INSULATING SHEATH.

2. (△) WIRE GAUGE AND TYPE SELECTED PER LOCAL CODE REQUIREMENTS. POWER REQUIREMENTS ARE: 20/34 VDC, 5.5 AMP MAX.
   90–140 VDC, 1.5 AMP MAX.

3. (△) OK RELAY CONTACT RATING: 5 A @ 28 VDC, OR 5 A @ 120 VAC, 50/60 HZ, OR 3 A @ 220 VAC, 50/60HZ, RESISTIVE MAXIMUM.

4. (△) USE MTL BARRIER PER DRAWING BA22000, NOTE 14.

5. (△) THE 7200 PROXIMITOR CASES MUST BE ELECTRICALLY ISOLATED FROM EARTH GROUND. ELECTRICAL ISOLATION: 500 VAC (RMS) MINIMUM. ISOLATION KIT P/N 19094-01 MAY BE USED TO SATISFY ISOLATION REQUIREMENTS. WIRING FOR THE 3000 AND 7200 PROXIMITORS IS THE SAME AS SHOWN FOR THE 3300 PROXIMITOR.

6. (△) MAXIMUM CABLE LENGTH BETWEEN POWER INPUT MODULE AND PROXIMITORS SHOULD NOT EXCEED 1000 FEET (305 METRES).

7. (△) TO ELECTRICALLY ISOLATE AND PROTECT COAXIAL CONNECTIONS, USE CONNECTOR PROTECTOR KIT 40113-02.

8. (△) TRANSDUCER SHIELDS ARE JOINED AS SHOWN TERMINATING AT BARRIER GROUND. SHIELDS SHOULD BE INSULATED.

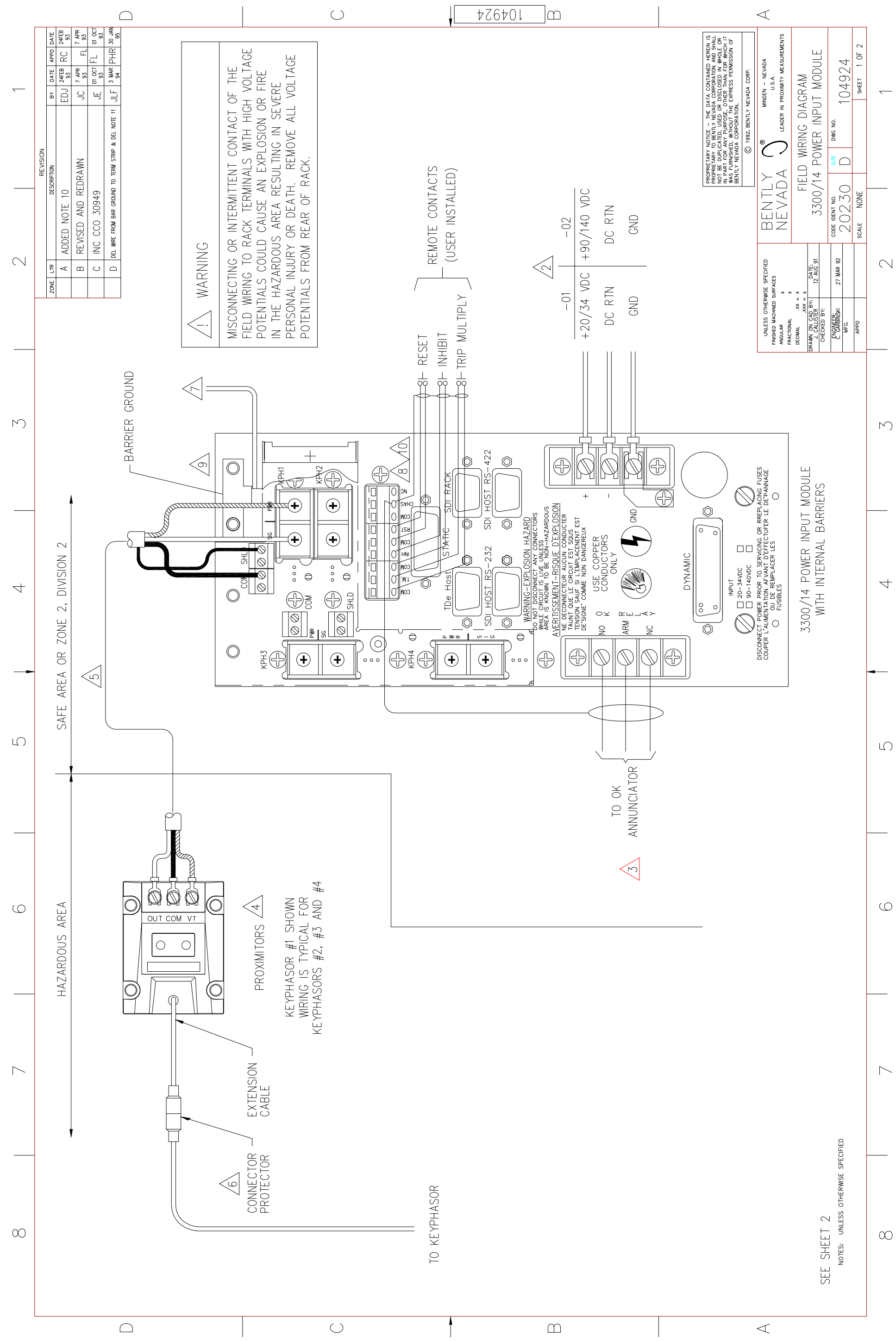
9. (△) BARRIERS ARE MOUNTED TO BARRIER RAIL WHICH IS THE POTENTIAL EQUALIZATION BUS BETWEEN SYSTEM GROUND AND EARTH GROUND. TO MINIMIZE GROUND LOOP PROBLEMS, A SINGLE POINT EARTH GROUND (GND) TO SYSTEM COMMON (COM) CONNECTION IS RECOMMENDED AT THE BARRIER RAIL. TOTAL EARTH LOOP IMPEDANCE MUST NOT EXCEED 1 OHM. REMOVE THE SINGLE POINT GROUND JUMPER ON THE 3300 POWER INPUT MODULE.

10. (△) SHIELDS ARE SPLICED INTO A SINGLE WIRE, THEN GROUNDED AS SHOWN, TERMINATING AT THE CHASSIS IN TWO PLACES. SHIELDS SHOULD BE INSULATED.

NOTES: UNLESS OTHERWISE SPECIFIED

CODE IDENT NO.	SIZE	DWG NO.
20230	D	104296
SCALE NONE		SHEET 2 OF 2

104296



WARNING
MISCONNECTING OR INTERMITTENT CONTACT OF THE FIELD WIRING TO RACK TERMINALS WITH HIGH VOLTAGE POTENTIALS COULD CAUSE AN EXPLOSION OR FIRE IN THE HAZARDOUS AREA RESULTING IN SEVERE PERSONAL INJURY OR DEATH. REMOVE ALL VOLTAGE POTENTIALS FROM REAR OF RACK.
REMOTE CONTACTS (USER INSTALLED)
RESET
INHIBIT
TRIP MULTIPLY
-01
+20/34 VDC
DC RTN
GND
-02
+90/140 VDC
DC RTN
GND
BARRIER GROUND
SAFE AREA OR ZONE 2, DIVISION 2
HAZARDOUS AREA
TO OK ANNUNCIATOR
PROXIMITORS
KEYPHASOR #1 SHOWN WIRING IS TYPICAL FOR KEYPHASORS #2, #3 AND #4
EXTENSION CABLE
CONNECTOR PROTECTOR
TO KEYPHASOR
OUT COM VT
3300/14 POWER INPUT MODULE WITH INTERNAL BARRIERS
SEE SHEET 2
NOTES: UNLESS OTHERWISE SPECIFIED
BENTLY NEVADA
FIELD WIRING DIAGRAM
3300/14 POWER INPUT MODULE
20230
D
104924
SHEET 1 OF 2
SCALE NONE
REVISION
A ADDED NOTE 10
B REVISED AND REDRAWN
C INC CCO 30949

REVISION						
ZONE	LTR	DESCRIPTION	BY	DATE	APPD	DATE
	D	SEE SHEET 1				

INTERNAL BARRIER SYSTEM FIELD WIRING NOTES

1. WIRING RECOMMENDATIONS:
POWER INPUT MODULE TO PROXIMITORS: 14AWG TO 18AWG STRANDED
3 WIRE, SHIELDED WITH INSULATING SHEATH.
POWER INPUT MODULE TO REMOTE CONTACTS: 18AWG TO 22AWG STRANDED
2 WIRE WITH INSULATING SHEATH.

⚠2. WIRE GAUGE AND TYPE SELECTED PER LOCAL CODE REQUIREMENTS. POWER REQUIREMENTS
20–34 VDC, 5.5A MAX.
90–140 VDC, 1.5A MAX.

⚠3. OK RELAY CONTACT RATING: 5A @ 28VDC, OR 5A @ 120VAC, 50/60 HZ, OR 3A @ 220VAC, 50/60 HZ, RESISTIVE, MAXIMUM.

⚠4. THE 7200 PROXIMITOR CASES MUST BE ELECTRICALLY ISOLATED FROM EARTH GROUND. ELECTRICAL ISOLATION: 500 VAC (RMS) MINIMUM. ISOLATION KIT P/N 19094–01 MAY BE USED TO SATISFY ISOLATION REQUIREMENTS. WIRING FOR THE 3000 AND 7200 PROXIMITORS IS THE SAME AS SHOWN FOR THE 3300 PROXIMITOR.

⚠5. MAXIMUM CABLE LENGTH BETWEEN POWER INPUT MODULE AND PROXIMITORS SHOULD NOT EXCEED 1000 FEET (305 METRES).

⚠6. TO ELECTRICALLY ISOLATE AND PROTECT COAXIAL CONNECTIONS, USE CONNECTOR PROTECTOR KIT 40113–02.

⚠7. REDUNDANT CONNECTIONS TO THE MAIN EARTH BUS. IF EXTERNAL BARRIERS ARE ALSO USED WITH THIS RACK, THESE CONNECTIONS MUST BE MADE TO THE EXTERNAL BARRIER RAIL. TOTAL EARTH LOOP IMPEDANCE (INCLUDING BARRIER RAIL) MUST NOT EXCEED 1 OHM.

⚠8. SHIELDS ARE SPLICED INTO A SINGLE WIRE, THEN GROUNDED AS SHOWN, TERMINATING AT THE CHASSIS. SHIELDS SHOULD BE INSULATED.

⚠9. AT BARRIER GROUND, SCREWS MUST BE TIGHT TO MAINTAIN PROPER GROUNDING.

⚠10. DO NOT CONNECT SYSTEM COMMON TO CHASSIS GROUND WHEN BARRIERS ARE BEING USED.

⚠11. DELETED

NOTES: UNLESS OTHERWISE SPECIFIED

CODE IDENT NO.	SIZE	DWG NO.
20230	D	104924
SCALE NONE		SHEET 2 OF 2

104924

10. Index