

MANUFACTURER DOCUMENT PACKAGE

# Manufacturer's Manual

Reference package for procurement and maintenance review

INVENSYS TRICONEX

## 3501T

TMR DIGITAL INPUT MODULE

Used with the applicable Tricon v9-v10 system configuration.

REFERENCE PACKAGE

OFFICIAL DOCUMENT

Selected official pages follow this cover with source pagination retained.

Invensys Tricon Technical Product Guide, 9791007-024 Rev 0, November 2012

# Product Specifications

| Description                                                                                                    | Model No.        | See |
|----------------------------------------------------------------------------------------------------------------|------------------|-----|
| <b>Documentation Sets</b>                                                                                      |                  |     |
| Tricon <i>Planning and Installation</i> , <i>Field Terminations</i> , and <i>Communication</i> printed manuals | Contact Invensys |     |
| Triconex User Documentation, includes all manuals in PDF format (CD-ROM)                                       | Contact Invensys |     |

a. I/O Bus Expansion Cables are available in custom lengths. Please contact Invensys for more information.

## Tricon I/O Modules

| Voltage                       | Description                                            | Type            | Model No.             | Points | For Details, See |
|-------------------------------|--------------------------------------------------------|-----------------|-----------------------|--------|------------------|
| <b>Digital Input Modules</b>  |                                                        |                 |                       |        |                  |
| 115 VAC/VDC                   | Opto-Isolated, Non-Commoned                            | TMR             | 3501E/3501T           | 32     | page 41          |
| 48 VAC/VDC                    | Commoned in Groups of 8, Self-Test                     | TMR             | 3502E                 | 32     | page 41          |
| 24 VAC/VDC                    | Commoned in Groups of 8, Self-Test                     | TMR             | 3503E                 | 32     | page 41          |
| 24/48 VDC                     | High-Density, DC Coupled                               | TMR             | 3504E                 | 64     | page 42          |
| 24 VDC                        | Low Threshold with Self-test, Commoned                 | TMR             | 3505E                 | 32     | page 41          |
| 24 VDC                        | Single, Opto-Isolated, Commoned                        | Single          | 3564                  | 64     | page 42          |
| Pulse Input                   | Differential, AC Coupled                               | TMR             | 3511                  | 8      | page 43          |
| Pulse Totalizer               | Opto-isolated, Non-commoned                            | TMR             | 3515                  | 32     | page 44          |
| <b>Digital Output Modules</b> |                                                        |                 |                       |        |                  |
| 115 VAC                       | Opto-Isolated, Non-commoned                            | TMR             | 3601E/3601T           | 16     | page 45          |
| 120 VDC                       | Opto-Isolated, Non-commoned<br>Opto-Isolated, Commoned | TMR             | 3603B,<br>3603E/3603T | 16     | page 45          |
| 24 VDC                        | Opto-Isolated, Non-commoned                            | TMR             | 3604E                 | 16     | page 45          |
| 48 VDC                        | Opto-Isolated, Non-commoned                            | TMR             | 3607E                 | 16     | page 45          |
| 115 VAC                       | Galvanically Isolated, Commoned., Supv.                | TMR             | 3611E                 | 8      | page 47          |
| 48 VDC                        | Galvanically Isolated, Commoned, Supv.                 | TMR             | 3617E                 | 8      | page 47          |
| 120 VDC                       | Opto-Isolated, Commoned, Supervised                    | TMR             | 3623/3623T            | 16     | page 46          |
| 24 VDC                        | Opto-Isolated, Commoned, Supervised                    | TMR             | 3624                  | 16     | page 46          |
| 24 VDC                        | Supervised/Non-Supervised, Commoned                    | TMR             | 3625/3625A            | 32     | page 46          |
| 24 VDC                        | Opto-Isolated, Commoned                                | Dual            | 3664                  | 32     | page 48          |
| 24 VDC                        | Opto-Isolated, Commoned                                | Dual            | 3674                  | 32     | page 48          |
| Relay Output                  | Non-triplicated, Normally Open                         | Non-triplicated | 3636R/3636T           | 32     | page 43          |
| <b>Analog Input Modules</b>   |                                                        |                 |                       |        |                  |
| 0-5 VDC                       | Differential, DC Coupled                               | TMR             | 3700A                 | 32     | page 49          |
| 0-10 VDC                      | Differential, DC Coupled                               | TMR             | 3701                  | 32     | page 49          |
| 0-5, 0-10 VDC                 | Differential, Isolated                                 | TMR             | 3703E                 | 16     | page 49          |
| 0-5, 0-10 VDC                 | High-Density, Differential, DC Coupled                 | TMR             | 3704E                 | 64     | page 49          |
| Thermocouple                  | Differential, DC Coupled                               | TMR             | 3706A                 | 32     | page 52          |
| Thermocouple                  | Differential, Isolated                                 | TMR             | 3708E                 | 16     | page 52          |

## TMR Digital Input Modules

Each TMR Digital Input (DI) module has three isolated input channels which independently process all data input to the module. A microprocessor on each channel scans each input point, compiles data, and transmits it to the Main Processors upon demand. Then input data is voted at the Main Processors just prior to processing to ensure the highest integrity. All critical signal paths are 100 percent triplicated for guaranteed safety and maximum availability. Each channel conditions signals independently and provides optical isolation between the field and the Tricon controller.

All TMR Digital Input Modules sustain complete, ongoing diagnostics for each channel. Failure of any diagnostic on any channel activates the module Fault indicator, which in turn activates the chassis alarm signal. The module Fault indicator points to a channel fault, *not* a module failure. The module is guaranteed to operate properly in the presence of a single fault and may continue to operate properly with certain kinds of multiple faults.

Models 3502E, 3503E, and 3505E can self-test to detect stuck-On conditions where the circuitry cannot tell whether a point has gone to the Off state. Since most safety systems are set up with a

de-energize-to-trip capability, the ability to detect Off points is an important feature. To test for stuck-On inputs, a switch within the input circuitry is closed to allow a zero input (Off) to be read by the optical isolation circuitry. The last data reading is frozen in the I/O communication processor while the test is running.

All TMR Digital Input Modules support hot-spare capability, and require a separate external termination panel (ETP) with a cable interface to the Tricon controller backplane. Each module is mechanically keyed to prevent improper installation in a configured chassis.

## 32-Point Digital Input Module Specifications

| Model Number             | 3501E/3501T                      | 3502E                       | 3503E                       | 3505E                       |
|--------------------------|----------------------------------|-----------------------------|-----------------------------|-----------------------------|
| Type                     | TMR                              | TMR with Self-Test          | TMR with Self-Test          | TMR, Low Threshold          |
| Voltage                  | 115 VAC/VDC                      | 48 VAC/VDC                  | 24 VAC/VDC                  | 24 VDC                      |
| Points                   | 32, non-commoned, isolated       | 32, commoned in groups of 8 | 32, commoned in groups of 8 | 32, commoned in groups of 8 |
| AC Range/DC Range        | 90-155 VAC/VDC                   | 35-95 VAC/VDC               | 20-42.5 VAC/VDC             | 20-42.5 VDC                 |
| Frequency Range          | DC or 47-63 Hz                   | DC or 47-63 Hz              | DC or 47-63 Hz              | n/a                         |
| Maximum Voltage          | 155 VAC/VDC                      | 95 VAC/VDC                  | 42.5 VAC/VDC                | 42.5 VDC                    |
| Switching Level          |                                  |                             |                             |                             |
| Off to On <sup>a</sup>   | < 86 VAC/VDC                     | < 32 VAC/VDC                | < 18 VAC/VDC                | < 12 VDC                    |
| On to Off <sup>b</sup>   | > 28 VAC/VDC                     | > 11 VAC/VDC                | > 6 VAC/VDC                 | > 4 VDC                     |
| Nominal Turn-On          | 6-9 mA                           | 6-9 mA                      | 6-9 mA                      | 3 mA to 5 mA                |
| Typical Hysteresis       | 32 VAC/VDC                       | 7 VAC/VDC                   | 4 VAC/VDC                   | 2 VDC                       |
| Input Delay              |                                  |                             |                             |                             |
| OFF to ON/ON to OFF      | < 8 ms/< 15 ms                   | < 8 ms/< 15 ms              | < 8 ms/< 15 ms              | < 8 ms/< 15 ms              |
| Point Isolation          | 1,500 VDC/ 2500 VDC <sup>c</sup> | 1,500 VDC                   | 1,500 VDC                   | 1,500 VDC                   |
| Nominal Input Impedance  | > 8.5 K $\Omega$                 | > 2.9 K $\Omega$            | > 1.25 K $\Omega$           | > 1.25 K $\Omega$           |
| Nominal Field Power Load |                                  |                             |                             |                             |
| Per On point             | 1.5 watts                        | 1.0 watts                   | 0.5 watts                   | 0.5 watts                   |
| @ max. field voltage     | 2.9 watts                        | 3.2 watts                   | 1.5 watts                   | 1.5 watts                   |
| Diagnostic Indicators    |                                  |                             |                             |                             |
| Input Status             | 1 per point                      | 1 per point                 | 1 per point                 | 1 per point                 |
| Module Status            | PASS, FAULT, ACTIVE              | PASS, FAULT, ACTIVE         | PASS, FAULT, ACTIVE         | PASS, FAULT, ACTIVE         |
| Stuck Test               | n/a                              | On                          | On                          | On                          |
| Color Code               | Red                              | Dark Red                    | Dark Red                    | Dark Red                    |

a. Off to On transition is guaranteed at or above this level but it might occur at a lower voltage, depending on the module's hysteresis.

b. On to Off transition is guaranteed at or below this level but it might occur at a higher voltage, depending on the module's hysteresis.

c. For 3501T.

Match your I/O module number in the first column with termination options on the right. An I/O module can be wired to a maximum of two termination panels, which may be of two different types—for example, commoned and non-commoned.

| Module Model # | Module Description                       | Commoned Term Panels                             | Non-Common. Term Panels | Basic Term Panels                | Nonincendive Term Panels | RG 1.180 Term Panels | Fanned-out Cables | Bypass Panels      | ERT Loop-Back Cables/Panels |
|----------------|------------------------------------------|--------------------------------------------------|-------------------------|----------------------------------|--------------------------|----------------------|-------------------|--------------------|-----------------------------|
| 3501E<br>3501T | DI, 115 VAC/VDC, 32 pts.                 | 9561-810F                                        | 9561-110F               | 9551-110F                        | n/a                      | n/a                  | 9101-010F         | n/a                | 9141-010F                   |
| 3502E          | DI, 48 VAC/VDC, 32 pts.                  | 9562-810F                                        | n/a                     | 9552-610F                        | n/a                      | n/a                  | 9101-010F         | n/a                | 9142-010F                   |
| 3503E          | DI, 24 VAC/VDC, 32 pts.                  | 9563-810F<br>9563-910F                           | n/a                     | 9553-610F                        | 9572-610F                | n/a                  | 9101-010F         | BP9228-010F        | 9143-010F                   |
| 3504E          | DI, 24/48 VDC, non-isolated, 64 pts.     | 9566-810F, 24V<br>9565-810F, 48V                 | n/a                     | 9750-310F, 24V<br>9750-410F, 48V | 9570-610F, 24V<br>n/a    | n/a                  | n/a               | BP9229-010F<br>n/a | n/a                         |
| 3505E          | DI, 24 VDC, low threshold, 32 pts.       | 9563-810F<br>9563-910F                           | n/a                     | 9553-610F                        | 9572-610F                | n/a                  | 9101-010F         | BP9228-010F        | 9143-010F                   |
| 3510           | PI, 20-20,000 Hz, 8 pts.                 | n/a                                              | n/a                     | 9753-110F                        | n/a                      | n/a                  | n/a               | n/a                | n/a                         |
| 3511           | PI, 20-20,000 Hz, 8 pts.                 | n/a                                              | n/a                     | 9753-110F                        | 9793-110F                | 9794-110F            | n/a               | n/a                | n/a                         |
| 3515           | Pulse totalizer, 24 VDC, 32 pts.         | n/a                                              | n/a                     | 9753-110F                        | 9572-610F                | n/a                  | n/a               | n/a                | n/a                         |
| 3564           | DI, 24 VDC, single, 64 pts.              | 9566-710F                                        | n/a                     | 9553-610F                        | 9571-610F                | n/a                  | 9101-010F         | n/a                | n/a                         |
| 3601E          | DO, 115 VAC, 16 pts.                     | 9661-610F<br>9663-610F                           | 9661-110F<br>9664-110F  | 9651-110F                        | n/a                      | n/a                  | 9101-010F         | n/a                | 9670-110F<br>9670-610F      |
| 3601T          | DO, 115 VAC, 16 pts.                     | 9663-610F                                        | 9664-110F               | n/a                              | n/a                      | n/a                  | n/a               | n/a                | n/a                         |
| 3603B          | DO, 120 VDC, 16 pts.                     | n/a                                              | 9251-210                | n/a                              | n/a                      | n/a                  | n/a               | n/a                | n/a                         |
| 3603E          | DO, 120 VDC, 16 pts.                     | 9661-910F <sup>a</sup><br>9664-810F <sup>a</sup> | n/a                     | 9651-110F                        | n/a                      | n/a                  | 9101-010F         | n/a                | 9673-810F <sup>a</sup>      |
| 3603T          | DO, 120 VDC, 16 pts.                     | 9664-810F <sup>a</sup>                           | n/a                     | n/a                              | n/a                      | n/a                  | n/a               | n/a                | 9673-810F <sup>a</sup>      |
| 3604E          | DO, 24 VDC, 16 pts.                      | 9662-810F                                        | 9662-110F               | 9653-610F                        | 9671-610F                | n/a                  | 9101-010F         | n/a                | 9671-810F                   |
| 3607E          | DO, 48 VDC, 16 pts.                      | 9667-810F                                        | 9667-110F               | 9652-610F                        | n/a                      | n/a                  | 9101-010F         | n/a                | 9672-810F                   |
| 3611E          | DO, 115 VAC, 8 pts.                      | 9661-510F                                        | n/a                     | n/a                              | n/a                      | n/a                  | n/a               | n/a                | n/a                         |
| 3613E          | DO, 120 VDC, 8 pts.                      | 9661-810F                                        | n/a                     | n/a                              | n/a                      | n/a                  | n/a               | n/a                | n/a                         |
| 3614E          | DO, 24 VDC, 8 pts.                       | 9662-910F                                        | n/a                     | n/a                              | n/a                      | n/a                  | n/a               | n/a                | n/a                         |
| 3615E          | DO, 24 VDC, low power, 8 pts.            | 9662-710F                                        | n/a                     | n/a                              | n/a                      | n/a                  | n/a               | n/a                | n/a                         |
| 3617E          | DO, 48 VDC, 8 pts.                       | 9667-910F                                        | n/a                     | n/a                              | n/a                      | n/a                  | n/a               | n/a                | n/a                         |
| 3623           | DO, 120 VDC, 16 pts.                     | 9661-910F                                        | n/a                     | 9651-110F                        | n/a                      | n/a                  | 9101-010F         | n/a                | n/a                         |
| 3623T          | DO, 120 VDC, 16 pts.                     | 9664-810F                                        | n/a                     | n/a                              | n/a                      | n/a                  | n/a               | n/a                | n/a                         |
| 3624           | DO, 24 VDC, self-protected, 16 pts.      | 9662-610F                                        | n/a                     | 9653-610F                        | 9671-610F                | n/a                  | 9101-010F         | n/a                | n/a                         |
| 3625<br>3625A  | DO, 24 VDC, self-protected, 32 pts.      | 9662-610F                                        | n/a                     | 9653-610F                        | 9671-610F                | n/a                  | 9101-010F         | n/a                | 9671-810F <sup>b</sup>      |
| 3636R<br>3636T | Relay output (non-triplicated), 32 pts.  | n/a                                              | 9668-110F               | 9651-110F                        | n/a                      | n/a                  | 9101-010F         | n/a                | n/a                         |
| 3664           | Dual DO, 24 VDC, self-protected, 32 pts. | 9662-610F                                        | n/a                     | 9653-610F                        | 9671-610F                | n/a                  | 9101-010F         | n/a                | 9671-810F <sup>b</sup>      |