TIWAY I PROTOCOL EMULATION

1.1 GENERAL DESCRIPTION

This section briefly describes the TIWAY I communication protocol for reference purposes only. The appropriate TEXAS INSTRUMENTS documentation should be consulted for complete details of the TIWAY protocol.

TIWAY I is an industrial Local Area Network (LAN) which provides a means of obtaining, evaluating, modifying and replacing data stored in the separate program memories of a network of interconnected Texas Instruments Programmable Controllers or other devices emulating the programmable controller. TIWAY I is a "hosted" network: a Primary (host) computer controls up to 254 separate Secondaries. TIWAY I uses the standard High Level Data Link (HDLC) protocol operating in the Unbalanced Normal Response Mode (UNRM) to exchange information. No routing decisions are required by any Secondary on the network.

The Primary station controls who transmits, and when. Each Secondary has a specific "address" defined at initialization time. When the Primary transmits, the message flows away to the ends of the TIWAY network and each Secondary examines it. Only the Secondary to whom it is addressed accepts it and transmits a response. A Secondary on TIWAY I must respond to a message from the Primary within a specific time frame. A response from a Secondary flows away from the Secondary to the ends of the bus, but is accepted only by the Primary.

TIWAY I uses baseband signaling over a single transmission channel. Baseband systems require timing information to be transmitted along with the message serial bit stream in order to maintain synchronization between the transmitter and receiver. In synchronous systems, the modems supply the timing information by providing a separate clock signal to both the transmitter and receiver. In asynchronous systems, the timing information is included in the serial bit stream. In a character oriented protocol, the start and stop bits, which bracket each transmitted character, are sensed by the receiver and used to resynchronize the internal clock of the receiver. Internal receiver clocks are designed to maintain accuracy over short periods of time corresponding to the transmission time of one character. Since each character causes resynchronization, this accuracy is sufficient to maintain overall system synchronization.

In bit oriented protocols such as HDLC, a message is transmitted in a continuous serial bit stream and is not segmented into characters as with a character oriented protocol. Under bit oriented protocol operation, synchronous systems maintain transmitter/receiver synchronization with clocks provided by the modems in the same manner as with character oriented protocols.

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Asynchronous systems, however, must use a different synchronization technique since there are no start and stop bits used. This technique is implemented by designing the receiver to force resynchronization of its internal clock each time a transition in incoming signal level is sensed. This transition occurs whenever subsequent bits in the serial bit stream change value (i.e., 1 to 0 or 0 to 1). To maintain synchronization over extended periods of time, the serial bit stream must contain these transitions of a frequent basis. In TIWAY I, NRZI data encoding along with a "bit stuffing" technique is used to insure synchronization.

NRZI encoding is simply changing the state of the transmission line (either from 0 to 1 or from 1 to 0) for each logic 0 to be transmitted. The line remains static for a logic 1 transmission. Bit stuffing inserts a 0 into the transmitted bit stream if a sequence of five or more logic 1's are to be transmitted. The receiving logic uses the transition forced by the zero to resynchronize its clock and then strips off the 0.

1.2 TIWAY I HDLC FRAME

The TIWAY 1 commands and responses are encapsulated inside HDLC frames according to the following format:

FLAG	ADDRESS	CONTROL	INFORMATION	FCS	FLAG

Figure J-1 TIWAY I HDLC Frame

1.2.1 Flag Fields

The flag fields are HDLC message delimiters that consist of one zero followed by six ones and ending with a zero. No other bit streams on the communication link can have this pattern. This requires that the sender and the receiver perform bit stuffing and bit removal on any bit stream of five consecutive bits of ones.

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The objective of zero bit insertion is to achieve complete transmission transparency of the TIWAY I bit stream while maintaining the flag as a unique sequence. The bit stuffing/bit removal is accomplished by the Comm-Troller serial port hardware using the following rules:

- **TRANSMITTER: examines the frame content for five consecutive ones and inserts a zero after the fifth one.**
- **RECEIVER: examines the frame content for five consecutive ones. If the sixth bit is a one a flag is assumed. If the sixth bit is a zero, the zero is removed from the bit stream and discarded.**

1.2.2 Address Field

The Address Field will contain the destination Secondary address when sent with a Primary command and it will contain the Secondary address when sent with a secondary response. The Secondary address is read from the configuration file by the Comm-Troller when power is first applied. There are 254 address combinations with the 0 address reserved as a null address and 255 reserved as a broadcast address.

1.2.3 Control Field

The Control Field is used to convey commands from primary to secondary and responses from secondary to primary. These commands are designed to control the flow of data between TIWAY I stations. The Control Field is formatted differently for the different types of command/response functions provided in the HDLC protocol.

BIT POSITION	7	6	5	4	3	2	1	0
INFORMATION	N(RECV)			/F	N(SENT)			
NUMBERED SUPERVISORY	N(RECV)			/F	S			
UNNUMBERED CONTROL	N			/F	M			

Figure J-2 Control Field Format

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1.2.3.1 Information Frames

Information frames are defined to be any frame received that has the least significant bit of the control field set to 0. Information frames in TIWAY I always contain an information field following the control field.

1.2.3.2 Numbered Supervisory Frames

Numbered Supervisory Frames are defined as any frame that has the least significant two bits of the control field set to 01. Numbered Supervisory Frames contain a two-bit "S" code which is used to define the type of supervisory frame. There is no information field. Valid "S" codes are:

- **00** **Receive Ready (RR)**
- **01** **Receive Not Ready (RNR)**
- **11** **Reject (REJ)**

1.2.3.3 Unnumbered Control Frames

Unnumbered Control Frames are defined as any frame that has the least significant two bits of the control field set to 11. Unnumbered Control Frames contain a two-bit "M" code and a three-bit "N" code to define the type of control frame. There may be an information field following. Valid "M" and "N" codes are:

- **00 000** **Unnumbered Information (UI)**
- **00 001** **Solicit Response (UP)**
- **00 010** **Disconnect Command (DISC)**
- **00 011** **Unnumbered Acknowledge (UA)**
- **00 100** **Set Normal Response Mode (SNRM)**
- **01 100** **Frame Reject (FRMR)**
- **11 000** **Disconnect Mode Response (DM)**

1.2.3.4 Control Field Poll/Final Bit

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The P/F bit is designated "P" when used with a command frame and is designated "F" when used with a response frame. The "P" bit is used by the primary to solicit a response from a secondary when it is set to one. The secondary will respond with the "F" bit set to one to indicate the end of transmission. Unbalanced configurations may only have one outstanding command frame with the "P" bit set at any given time. Before the primary can send another command frame with the "P" bit set, it must receive a response frame with the "F" bit set to one. The only exception to this is if the secondary does not respond to the primary poll within the system time-out limits. Since TIWAY I uses a window size of one the P/F bit will always be set to one.

1.2.3.5 Control Field Number Received and Number Sent

The N(R) field is the message sequence number received and the N(S) field is the message sequence number sent.

Each frame is sequenced to check against any type of duplication or error that might occur from retransmission. The transmitting device sequences and counts its frames in the N(S) field. The secondary then compares what it thinks the frame count ought to be against the received frame count and then sequences its own receiver count N(R), incrementing one step every time it receives a new frame. If the count of the received sequence count does not match the count of the send sequence from the transmitter, then an error has occurred and the message must be retransmitted. Arriving frames with the wrong sequence count or which are out of sequence or are duplicates are rejected

COMMAND FORMAT	LENGTH (16-BITS)	PRIMITIVE CODE	DESCRIPTOR FIELD(s)	DATA UNIT FIELDS(s)
RESPONSE FORMAT	LENGTH (16-BITS)	PRIMITIVE CODE	SECONDARY STATUS	DATA UNIT FIELDS(s)

Figure J-3 Basic Primitive Structure

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1.2.4 Information Field

The information field in a TIWAY I message contains the Primitive Structure. Primitives have the basic structure shown in Figure J-3 below. There is a Command Format and a Response Format as shown. All fields are an even multiple of 8 bits long.

1.2.5 Frame Check Sequence (FCS) Field

TIWAY I uses a 16-bit Cyclic Redundancy Code for error detection. The CRC is calculated on the address, control and information fields of each message frame by the transmitting device. The resulting 16-bit CRC is transmitted in the FCS field of the message. The receiving device also calculates the CRC and checks it against the FCS received. If there is a match then the message is processed. If there is no match the message is discarded. The error check generator polynomial used is the standard CRC-CITT polynomial $X^{16} + X^{12} + X^5$ 1. The FCS is initialized to all ones prior to the start of the calculation.

1.3 TIWAY I PRIMITIVES

The data portion of a message delivered using the HDLC protocol uses special coded instructions known as "Primitives". The Primitives are a special language which is common to all TIWAY I conformant Secondaries attached

SYMBOL	DESCRIPTION
AAAA	DATA ELEMENT LOCATION (ADDRESS)
DDDD	BASIC DATA UNIT
HH	DEVICE STATUS
LLLL	LENGTH
NN OR NNNN	NUMBER OF LOCATIONS
PP	PRIMITIVE CODE
TT	DATA ELEMENT TYPE

Figure J-4 Field Symbols

Primitive Code	Description	**Implemented**
0	Exception Response	Y
1	Native Primitive Code	N
2	Status Primitive Code	N
3	Configuration Primitive Code	N
4	Format Configuration Primitive Code	N
10	Change State Primitive Code	N
11	Self Diagnostics Primitive Code	N
20	Read Block Primitive Code	N
21	Read Random Primitive Code	Y
30	Write Block Primitive Code	Y
31	Write Random Primitive Code	N
32	Fill Block Primitive Code	N
33	Buffered Write Primitive Code	N
40	Locate Primitive Code	N
41	Remove Primitive Code	N
42	Insert Primitive Code	N
50	Define Primitive Code	Y
51	Gather Primitive Code	Y
52	Write and Gather Primitive Code	N
53	Program Condition Primitive Code	N
54	Poll Condition Primitive Code	N

Figure J-5 TIWAY I Primitive Codes

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to the network. In a command from the Primary to a Secondary using a Primitive, the Network Manager on the Secondary translates the coded instruction into a format understandable to the Secondary device. When data is sent back to the Primary, it too is embedded in a Primitive. The Comm-Troller with TIWAY protocol is a TIWAY I Compatible product which recognizes the primitives shown in Figure J-5 on the following page. The following paragraphs further detail the primitives that are recognized by the Comm-Troller. The primitive definitions use the symbols shown in Figure J-4.

1.3.1 EXCEPTION PRIMITIVE

ERROR CODE	MEANING
0000	Primitive not implemented
0001	Data type (specified by TT) is not defined
0002	Data element location (specified by TT) is out of range
0003	Primitive has excess data unit bytes
0004	Primitive has insufficient data unit bytes
0005	The number of information bytes received does
	not match the number of information bytes specified in the length field
0006	Device in wrong mode for primitive execution
0007	User program in device has disabled communication to network
	communication module.
0008	Written data type location (specified by TT) did not verify
0009	Data type location (specified by TT) is write protected.
000A	Device fails to respond
000B	Primitive aborted due to a fatal error condition in the specific device addressed.
000C	Data type (specified by TT) now has an invalid value due to primitive execution
000D	An error was encountered while executing the requested primitive
	with the specified data type (TT)
000F	Data pattern requested was not found

Figure J-6 Exception Response Error Codes

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ERROR CODE	MEANING
0010	The number of locations requested exceeds the maximum allowed.
0011	The number assigned to a data acquisition block exceeds the maximum
0012	The block number requested has not been defined
0013	The number of data bytes in the requested blocks exceeds the maximum allowed
0014	The request number report by condition data type locations exceeds the maximum
0015	Primitive not allowed while device is in local mode
0016	Data type (specified by TT) has not been programmed in the attached device
0017	The attached device did not respond properly
0018	Data type (specified ty TT) is not implemented in the NIM, but exists in the PLC
0019	The resulting data element location (specified by TT) formed by the starting
	address plus the number of data elements to access is out of range
001A	The attached device communications is not established
001B	The store and forward buffer is full and the store and forward message discarded
001C	The data element field (specified by TT) is improperly formatted
80DD	Exception generated in the attached device is not identified. DD contains the
	attached device error code

Figure J-6 (cont) Exception Response Error Codes

When an error is detected during the interpretation of a primitive or during the execution of a primitive the Exception Primitive is used to form the response. The form of the exception response primitive is:

00 PP DDDD (TT)

PP is defined as the request primitive that contains the error and (TT) is an optional field depending on the exception containing the Type code and DDDD is an error code from the table below.

1.3.2 READ RANDOM PRIMITIVE

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The Read Random primitive will access data element locations that may or may not be contiguous. Each data location accessed is specified.

REQUEST:

21 TT AAAA [TT AAAA]

RESPONSE:

21 HH DDDD [DDDD]

where DDDD is defined by the element type accessed and is returned in the same order in which they were requested.

1.3.3 WRITE BLOCK PRIMITIVE

The Write Block Primitive will replace contiguous data element locations from a starting element location with the data specified in the request.

REQUEST:

30 TT AAAA DDDD [DDDD]

RESPONSE:

30 HH

1.3.4 DEFINE PRIMITIVE

The Define primitive specifies up to 32 random blocks of data element types. Each block can be a maximum of 128 words. The blocks are referenced by number ranging from 1 to 32 (20 hex). Only one Define primitive is allowed per Comm-Troller. A block once defined can be redefined to a different data element type and location by simply specifying that block number and providing the required information for a new block. A block can be defined to the initial state of undefined by specifying the number of words in the block to zero.

REQUEST:

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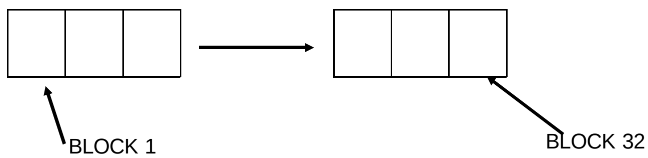
50 CC TT NNNN AAAA [CC TT NNNN AAAA]

RESPONSE:

50 HH



1.3.5 GATHER PRIMITIVE

The Gather primitive specifies which of the blocks defined by the current Define primitive will be read. The blocks are specified through a 32-bit mask. The total number of bytes returned may not exceed the maximum size specified for the device type. The response will return the data associated with the requested blocks starting with the lowest block number and increasing to the highest block number. A data block separator is not provided.

REQUEST:

51 EEEEEEEE

where EEEEEEEE is 32 bits defined as :

RESPONSE:

51 HH EEEEEEEE DDDD [DDDD]

where EEEEEEEE is the mask received from the request primitive and DDDD is defined by the data type being accessed. The order of return blocks is from the lowest numbered block to the highest.

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1.4 Message Types

TIWAY I communications exchanges can basically be divided into two types: data requests and control requests. In data requests, the host transmits a message requesting data values from the secondary. The secondary responds by transmitting the requested data values. These data values may be discrete (status), analog, accumulator, calculated variables, remote parameters, PLC status, analog outputs or discrete outputs. The format of the data types are as required by the host. Some variations may exist from site to site provided the host and remote are consistent in the data format (e.g. if the host expects BCD accumulator values, the remote

PLC "TYPE'TT "TYPE"NAMESIZEMAX REGISTERS

0003Discrete Input (X)bit8 (128 elements)

0006Discrete Input Packed (X)bit8 (128 elements)

0109Word Input (WX)2-byte128

020FTimer or Counter Current (TCC)2-byte60

0304Discrete Output (Y)bit8 (128 elements)

0307Discrete Output Packed (Y)bit8 (128 elements)

040AWord Output (WY)2-byte128

0501Variable2-byte256

0602Constant2-byte256

0705Control Register (CR)bit16 (256 elements)

0708Control Register Packed (CR)bit16 (256 elements)

080ETimer or Counter Preset (TCP)2-byte60

Figure J-7 Comm-Troller Type to TI Type Mapping

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must transmit BCD accumulator values). Note that the Comm-Troller does not do any processing on the data collected from the PLC. The PLC ladder logic must perform any data formatting that is required prior to placing the information in the data area which is read by the Comm-Troller.

Control requests are defined as any message from the host requesting the secondary to change the state of a field device or to change or modify an internal condition of the secondary.

1.5 TIWAY I DATA TYPES

The Comm-Troller continuously updates its internal memory with data from the PLC. The Comm-Troller classifies all the data it reads into one of 14 data types. The size, number and starting PLC address for each data type is specified in the Comm-Troller configuration table. The configuration table is located in PLC memory and will be discussed in detail later in this appendix.

There is a direct correlation between TIWAY I types (TT) and the Comm-Troller data types as detailed in the following figure.

1.6 TIWAY 1 ADDRESS/COMM-TROLLER ADDRESS MAPPING

The TIWAY I address numbers used in the message transactions between the host and the Comm-Troller are assigned according to the following rules.

1.6.1 Bit Type Data

Bit type data is accessed using TIWAY I types (TT's) 03 thru 08. The least significant bit (the rightmost bit) in the PLC register for a specific type is address 0001. The next bit to the left is address 0002 and so on up to address 0016. TIWAY address 17 is the least significant bit of the next register. The state of each of the inputs is accessed by the TIWAY I master using TT's 03, 04 or 05 to obtain a byte of data representing the current state of each bit or by using TT's 06, 07 or 08 to access current data in a packed (8-bits per byte) format.

1.6.2 2-Byte Data

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The 2-byte data types are 01, 02, 09, 0A, 0E, 0F and 12. For this type of data the first register read for each type is assigned to TIWAY I address 0001; the second register is address 0002 and so on. Data formatting is consistent with standard PLC data representation. That is the least significant portion of the register is the rightmost portion of the word. The most significant byte is the left byte.

1.6.3 1-Byte Data

The 1-byte data types are TT's 10 and 11. For this type of data the least significant byte of the first register accessed is TIWAY I address 0001; the most significant byte of the first register is address 0002. The least significant byte of the next register is address 0003 and so on up to the maximum number allowed (0010)

1.6.4 4-Byte Data

TIWAY I type 17 is a 4-byte data type. Only one address is allowed (0001). The registers accessed are returned in the order read i.e. the first register in the type is the high order two bytes of the variable and the second register is the low order two bytes.

1.7 MULTIPLE PLC's

Data can be collected from up to 8 PLCs by a single Comm-Troller. The data from each of the PLCs is collected by the Comm-Troller and then merged into a single data base which will appear to the Host as a single TIWAY secondary. In this case for example, if an application has two (2) PLCs, the first with five (5) word inputs (TT = 09) and the second with three (3) word inputs the host will read the first five as word inputs 0001 thru 0005 and the remaining 3 as addresses 0006 thru 0008 all from the same secondary address.

Any or all data types can be defined for each of the PLC's up to the maximum allowable for the particular data type (see Figure J-7).

1.8 TIWAY I CONFIGURATION TABLE

All setup and operation information that the Comm-Troller requires for operation is obtained from the "Configuration Table". The configuration table is a contiguous area of memory in the PLC that is initialized by the PLC programmer using standard programming tools. The Comm-Troller automatically reads this table whenever power is first applied. Once the table has been read into the Comm-Troller memory normal operation begins. The Comm-Troller

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continuously reads data from the PLC(s) that may be required by the host. The data read is placed in a dual ported memory bank that is accessible by the TIWAY I emulation microprocessor. When a request for information is received it is answered using data already present in the dual-ported memory. Control commands received from the host are first validated

Word	Byte #	Function
0	0,1	Secondary Address; Number of data Tables to Read
1	2,3	Reserved-set to 0000_H
2	4,5	Baud Rate; Reserved
3-7	6-15	Reserved set to 0000_H
8	16,17	RTS/CTS Delay (10 ms per count)
9	18,19	RTS OFF Delay (10 ms per count)
10-24	20-49	Reserved-set to 0000_H

Figure J-8 Configuration Header

by the Comm-Troller and if correct a message is sent to the PLC to perform the desired control action. The configuration table consists of a header and from one to eight data sections as defined below. The header contains general type information such as the Secondary address, communications baud rate, RTS/CTS delay times and other information as defined in section 1.8.1 below. A data section is defined for each block of data to be read from a PLC. Each data section contains the address of the PLC where the data is located as well as the number of items the starting address for each type of data.

1.8.1 TIWAY I Configuration Header

The Comm-Troller interprets the configuration header as a string of bytes. Each byte is used to specify a certain option as defined in the table below. The PLC uses words (2-bytes) as storage. The Comm-Troller numbers bytes starting with the first word hi-order (leftmost) byte as byte #0. Byte #1 is the low-order (rightmost) 8 bits of the word. Byte #2 is the hi byte of the next word, byte #3 is the low byte and so on up to the end of the header. When entering data into the configuration table it is usually most convenient to display and enter the number using hexadecimal notation. When using hexadecimal notation each word is represented by 4 hex characters. The left 2 define the hi-byte and the right 2 the low-byte. The figure below defines both the PLC word and the Comm-Troller byte number for the configuration header.

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Byte #0 in the configuration header is used to define the TIWAY secondary address to which the Comm-Troller will respond when communicating with the host. This entry is an 8-bit binary number in the range of 1 to 254 (00000001 to 11111110).

Byte #1 is used to define the number of data table sections defined for the system. This entry is a 4 bit binary number which is right justified in the byte. The valid range for this number is from 1 to 8 (00000001 to 00001000). The Comm-Troller will use this number to determine the number of PLC Configuration blocks to read.

Bytes #2 and 3 are reserved for use as a Radio Delay Timer. The current implementation of the TIWAY I protocol in the Comm-Troller ignores these bytes.

Byte #4 is used to define the baud rate which will be used by the secondary when communicating with the host. This entry is a binary number which is right justified in the byte. Valid selections are: 300 baud (00000100), 600 baud (00000101), 1200 baud (00000110) , 2400 baud (00001000), 4800 baud (00001001) and 9600 baud (00001011).

Bytes #5 thru 15 are not used in the TIWAY I Comm-Troller. Set all bytes to 00_H.

Bytes #16 and 17 are used to define the RTS/CTS delay time. The delay equal to the binary count contained in word 8 times 10 msec. If a modem is used the RTS/CTS delay time will be the longer of the modem or the delay time set in word 8.

Bytes #18 and 19 are used to define a "RTS hold time" at the end of a message. The hold time may be required to insure that the last character makes its way completely thru the modem before turning off the modem. The delay time is equal to 10 msec. times the count contained in word 9.

Bytes #20 thru 49 are not used for the TIWAY I Comm-Troller.

1.8.2 PLC Data Configuration for TIWAY I Protocol

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Word	Byte	DESCRIPTION
0	0,1	PLC Address; Type Size = 02
1	2,3	Number of registers TT 03 & 06 ; Start address Hi
2	4,5	Start Address Low; Type Size = 02
3	6,7	Number of registers TT 09; Start Address Hi
4	8,9	Start Address Low; Type Size = 02
5	10,11	Number of registers TT 0F; Start Address Hi
6	12,13	Start Address Low; Type Size = 02
7	14,15	Number of registers TT 04 & 07 ; Start address Hi
8	16,17	Start Address Low; Type Size = 02
9	18,19	Number of registers TT 0A; Start Address Hi
10	20,21	Start Address Low; Type Size = 02
11	22,23	Number of registers TT 01; Start Address Hi
12	24,25	Start Address Low; Type Size = 02
13	26,27	Number of registers TT 02 ; Start address Hi
14	28,29	Start Address Low; Type Size = 02
15	30,31	Number of registers TT 05 & 08; Start Address Hi
16	32,33	Start Address Low; Type Size = 02
17	34,35	Number of registers TT 0E; Start Address Hi
18	36,37	Start Address Low; Type Size = 02
19	38,39	Number of registers TT 10; Start address Hi
20	40,41	Start Address Low; Type Size = 02
21	42,43	Number of registers TT 11; Start Address Hi
22	44,45	Start Address Low; Type Size = 02
23	46,47	Number of registers TT 12; Start Address Hi
24	48,49	Start Address Low; Type Size = 02
25	50,51	Number of registers TT 17 ; Start address Hi
26	52,53	Start Address Low; Reserved set to 00_H
27	54,55	Reserved set to 0000_H
28	56,0	Reserved set to 00_H; Start of next table (PLC Address)

Figure J-9 PLC Data Section Config.

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The PLC Data Configuration section(s) are each 57 bytes long. There is one section for each block of data to be read from the PLC or PLCs connected to the Comm-Troller. Each data section can specify a unique PLC address. Multiple reads from a single PLC can be accomplished by using the hi two bits in the PLC address field as detailed below. The number of PLCs and thus the number of configuration sections to read is defined by byte #1 in the header section of the configuration table. Up to eight (8) data configuration sections can be defined.

The Comm-Troller interprets the configuration data sections as a string of bytes just like the header section. Each byte is used to specify a certain option as detailed in the table below. The PLC uses words (2-bytes) as storage. The Comm-Troller numbers bytes starting with the first word hi-order (leftmost) 8 bits as byte #0. Byte #1 is the low-order (rightmost) 8 bits of the word. Byte #2 is the hi byte of the next word, byte #3 is the low byte and so on up to the end of the table. When entering data into the configuration table it is usually most convenient to display and enter the number using hexadecimal notation. When using hexadecimal notation each word is represented by 4 hex characters. The left 2 define the hi byte and the right 2 the low byte. The figure below defines both the PLC word and the Comm-Troller byte number for a typical data section. The first data section must start at the next address following the end of the configuration header. Subsequent data sections if any follow immediately behind the first.

Byte #0 is used to define the address of the PLC that the data is to be collected from.

Byte #1 is used to define the number of bytes of data for data type 0. This byte will always be set to 02 for the TIWAY I Comm-Troller.

Byte #2 is used to define the number of registers to be accessesed for data type 0. Comm-Troller data type 0 is used for TIWAY types (TTs) 03 and 06. The maximum number of registers (total over all tables) for type 0 is 8.

Bytes #3 and 4 define the starting address in the PLC for the data.

Bytes #5, 6, 7 and 8 are used in a similar fashion to define the size (02) number and starting address for Comm-Troller type 1 data. Comm-Troller type 1 data is used for TIWAY type 09. The maximum number of registers (total over all tables) is 128.

Bytes #9, 10, 11 and 12 are used in a similar fashion to define the size (02) number and starting address for Comm-Troller type 2 data. Comm-Troller type 2 data is used for TIWAY type 0F. The maximum number of registers (total over all tables) is 60.

Bytes #13, 14, 15 and 16 are used in a similar fashion to define the size (02) number and starting address for Comm-Troller type 3 data. Comm-Troller type 3 data is used for TIWAY types 04 and 07. The maximum number of registers (total over all tables) is 8.

Bytes #17, 18, 19 and 20 are used in a similar fashion to define the size (02) number and starting address for Comm-Troller type 4 data. Comm-Troller type 4 data is used for TIWAY type 0A. The maximum number of registers (total over all tables) is 128.

Bytes #21, 22, 23 and 24 are used in a similar fashion to define the size (02) number and starting address for Comm-Troller type 5 data. Comm-Troller type 5 data is used for TIWAY type 01. The maximum number of registers (total over all tables) is 256.

Bytes #25, 26, 27 and 28 are used in a similar fashion to define the size (02) number and starting address for Comm-Troller type 6 data. Comm-Troller type 6 data is used for TIWAY type 02. The maximum number of registers (total over all tables) is 256.

Bytes #29, 30, 31 and 32 are used in a similar fashion to define the size (02) number and starting address for Comm-Troller type 7 data. Comm-Troller type 7 data is used for TIWAY types 05 and 08. The maximum number of registers (total over all tables) is 16.

Bytes #33, 34, 35 and 36 are used in a similar fashion to define the size (02) number and starting address for Comm-Troller type 8 data. Comm-Troller type 8 data is used for TIWAY type 0E. The maximum number of registers (total over all tables) is 60.

Bytes #37, 38, 39 and 40 are used in a similar fashion to define the size (02) number and starting address for Comm-Troller type 9 data. Comm-Troller type 9 data is used for TIWAY type 10. The maximum number of registers (total over all tables) is 5.

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Bytes #41, 42, 43 and 44 are used in a similar fashion to define the size (02) number and starting address for Comm-Troller type 10 data. Comm-Troller type 10 data is used for TIWAY type 11. The maximum number of registers (total over all tables) is 5.

Bytes #45, 46, 47 and 48 are used in a similar fashion to define the size (02) number and starting address for Comm-Troller type 11 data. Comm-Troller type 11 data is used for TIWAY type 12. The maximum number of registers (total over all tables) is 10.

Bytes #49, 50, 51 and 52 are used in a similar fashion to define the size (04) number and starting address for Comm-Troller type 12 data. Comm-Troller type 12 data is used for TIWAY type 17. The maximum number of registers (total over all tables) is 2.

Bytes #53, 54, 55. and 56 are not used. Set to 00_H.

JUMPER	POSITION
J1	1-2
J2	IN
J3	NOT USED
J4	2-3
J5 - J11	1-2
J12, J13	NOT USED
J14 - J19	1-2
LED ADAPTER BOARD JUMPERS	
JP1	3-4 AND 11-12
JP2	3-4 AND 11-12
JP3	5-6 AND 9-10

TIWAY I Protocol Communication is on Port P3 (next to bottom), PLC Communication is on Port P2 (next to top)
U12 = #194-005-0
U26 = #194-006-0
SW3 = PLC AddresS
SW2 = Pointer Address MS
SW1 = Pointer Address LS

Figure J-10 Jumper Option Selections

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1.9 CONFIGURATION TABLE POINTER WORD

The Configuration Table can start at any convenient address in the PLC. If a PLC-5 system is used, create an integer (or binary) type file with a file number that is the decimal equivalent of the octal address of the Data Highway interface module that connects to the protocol converter. For example, if a 1785-KE is used to connect the protocol converter and its Data Highway address is set to 11_8, then the Configuration Table will be located in N9. The Configuration Table can start at any address in file N9. All Configuration data is contiguous. That is, all entries occupy consecutive memory locations in file N9. Two switches (SW2 and SW1) on

PIN	SIGNAL NAME
1	GND Signal Ground
2	TXD Transmit Data (output)
3	RXD Receive Data (input)
4	RTS Request To Send (output)
5	CTS Clear To Send (input)
6	DSR Data Set Ready (input)
7	GND Signal Ground
8	DCD Data Carrier Detect (input)

Figure J-11 Allen-Bradley Port Connections

the Comm-Troller module are used to define a "Configuration Table Pointer word". A third switch (SW3) is used to set the Highway Address of the PLC that contains the Configuration FIle. The pointer word switches are set to the Hexadecimal **<u>BYTE</u>** address of the pointer word divided by 10_{16}. The content of the pointer word is the BYTE address of the actual start of the configuration file. For example, if the Configuration Table starts at N9:10, the Pointer Word will be initialized to 20 (14_{HEX}). The Pointer Word can be located at any address that is not already

PIN	SIGNAL NAME
1	DCD Data Carrier Detect (input)
2	RXD Receive Data (input)
3	TXD Transmit Data (output)
4	DTR Data Terminal Ready (output)
5	GND Signal Reference
6	RX-CLK Receive Clock (input)
7	RTS Request To Send (output)

Figure J-12 TIWAY Port Connections

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used in file N10 and is a multiple of 10_{HEX}. Possible address are N9:0, N9:8 (before the Configuration Table) and possiblly N9:64, N9:72, N9:80 and so on after the table. Typical applications use address 0000 for the Pointer Word with the Configuration Table starting at 10 (word 0000 = 20).

1.10 ERROR WORD

Protocol	TIWAY I (Secondary Address =01)
Comm. Data	Modem, 1200 baud, RTS/CTS Delay = 30 ms., RTS OFF=20ms
Num. of Discrete Inputs	80 (TTs=03 & 06)
Num. of Discrete Outputs	5 (TTs=04 & 07)
Num. of Variables	6 (TT=01)
Num. of Word Inputs	15 (TT=09)
Num. of Word Outputs	6 (TT=0A)
Desired start location of configuration table at Register 20_{10}	
Desired starting location of data at register 200_{10}	
Desired location for Config. Table address pointer 128_{10}	
PLC is at Highway Address 12_8	
Highway Interface Moudle is at Address 11_8	

Figure J-13 Example System Info.

The word following the pointer word is used by the Comm-Troller as an error word. The error word will be written whenever an error occurs, is is never cleared by the Comm-Troller. Refer to Section 4 for a list of the possible error codes.

1.11 JUMPER SELECTIONS FOR TIWAY I PROTOCOL

The Comm-Troller jumper selections and EPROM part numbers for TIWAY I protocol operation when used with an Allen-Bradley Host is detailed in the following figure.

1.12 PORT CONNECTION PIN ASSIGNMENTS

1.12.1 Allen Bradley Connection

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The Allen-Bradley Data Highway Interface Module is connected to the Protocol Converter port P2, a 15-pin "D" female type connector. The figure belew defines the connector pinouts for the Allen-Bradley connection. Typical cable diagrams are shown in Section 3 of this manual. All signals are RS232C compatible.

1.12.2 TIWAY Connection

The TIWAY interface is connected to the Protocol Converter port P3, a 9-pin "D" female type connector. The figure belew defines the connector pinouts for the TIWAY connection port. All signals are RS232C compatible.

PLC WORD	VALUE (HEX)
N9:128	0028
N9:020	0101
N9:021	0000
N9:022	0600
N9:023	0000
N9:024	0000
N9:025	0000
N9:026	0000
N9:027	0000
N9:028	0003
N9:029	0002
N9:030-44	0000

PLC WORD	VALUE (HEX)
N9:045	0A02
N9:046	0501
N9:047	9002
N9:048	0F01
N9:049	9A02
N9:050	0000
N9:051	0002
N9:052	0101
N9:053	B802
N9:054	0601
N9:055	BA02
N9:056	0601
N9:057	C600
N9:058 -072	0000
N9:073	00XX

Figure J-14 Example Configuration Table Entries

1.13 EXAMPLE CONFIGURATION FILE

The following figures detail a sample configuration file for a typical TIWAY I protocol application. The configuration information is based on the following information:

1.13.1 Comm-Troller Switch Settings

The location of the word which points to the start of the configuration table must be specified by setting the three (3) address selection switches on the Comm-Troller. For this example the switch selections are:

Pointer Address= 128_{10} (decimal word address)
= 256_{10} (decimal byte address)
= 0100_H (hex byte address)
Set Comm-Troller switches SW2 and SW1 to 10 (least significant 0 is implied)
Set SW3 to A (12_8)

1.13.2 Example Table Entries

The Configuration Data will be entered in file N9 starting at location N9:20 as shown below. The Pointer word is at N9:128, the error word is N9:129.

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