Functional Description of the Proximity Tag Reader

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Revisions

Revision	Date	Changed by	Description
0.10	29-Sept-05	C.Chattaway	Initial draft.
0.20	20-Jun-06	C.Chattaway	Addition of serial number definition
1.00	June 23, 2006	F. Chow	Release

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Table of Contents

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Table of Figures

Table of Tables

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1 Scope and Objective

1.1 Related/Referenced Documents

The following documents are referenced or are recommended reading for context to this document.

Bit-By-Bit Interrogation – Protocol description	970-00001-000
eLINK System Communication Protocol	970-00002-000
“Halo” Cyclic Redundancy Check - Algorithm Implementation (CRC)	961-00001-000
Proximity Tag reader Technical Requirements Specification	

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2 Hardware

The following sections detail the various aspects of the PTR hardware. The Schematic and PCB section refers to pictorial overviews of the hardware. The Configuration and Address Switches section breaks out the meaning and use of the respective DIP switch banks. Next appears the LED Indications and Speaker Annunciations section which list the various indications and annunciations. Finally, the Serial Port and Input/Door Switch sections detail the use of these two PTR peripherals.

2.1 Schematic and PCB

The schematic and PCB are shown in Figure 2 and Figure 3 respectively. The Figure 3 picture of the PCB identifies the various features of the board.

2.2 Configuration and Address Switches

The Configuration and (local)address DIP switches can be found on the lower left hand corner of the PCB. Both switches are read right to left with the LSB of each appearing on the right hand end of the switch bank. The mode switch bits breakout in the manner illustrated in Figure 3.

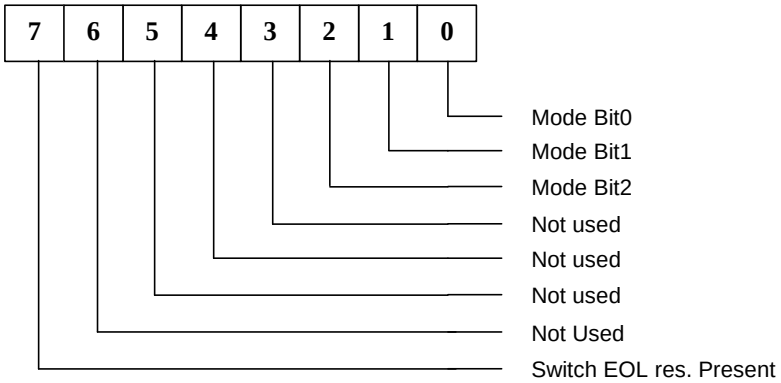

Figure 1: Bit Breakout for the Configuration Switch

The address switch defines and local/network address for the PTR. It value can be anywhere in the range 0 to 255. The address is set on the switch in a binary fashion LSb on the right, MSb on the left.

2.3 LED Indications and Speaker Annunciations

The PTR has two LEDs and a speaker for indicating and annunciating respectively. In general the Green LED is used to indicate power and 307 KHz field state (on or off). The Red LED is used to indicate events (like a tag discovery/BBB) and to indicate error states. The speaker is typically used in conjunction with the Red LED to annunciate error states, but also has a role when the device is in test mode. When the device is in test mode the Red LED and speaker indicate/annunciate complete BBB interrogations. This feature is intended for field coverage setup and is not used otherwise. The following table, Table 1, summarizes the LED/speaker indications/annunciations. Note several of these states are overlapped in the course of PTR operation, so in some cases careful observation of the LEDs is required to know what state the PTR is in.

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LED/Speaker State	Indication
Short Speaker Blip	Power up Address or Config. switch change executed
Slowly flashing Green LED	Power on / Field off
Solid Green LED	Power on /Field on
Short Red LED flash	BBB with tag complete, message sent to network
Short Red LED flash with speaker beep	Test Mode BBB with tag complete. (Note: No message is sent to network)
Fast Flashing Red LED	PTR detects one or more of it three error conditions.
Long duration Red LED flash with speaker accompaniment	Error State Annunciation, this occurs once every 12 seconds while error condition still present. Message also sent to network at this time. This is overlapped on the fast flashing Red LED state.
Short Red LED Flash once every 1.5 seconds	PTR low power mode indication Indicated main power has been lost. Message goes to the network approximately every 12 seconds or 8 LED flashes.

Table 1: LED and Speaker Indications/Annunciations

2.4 Serial Port

There is no operational functionality for the serial port at this time. The serial port is currently being used to output some debug messages, and this port will likely have some factory test functionality added in the near future.

2.5 Input/Door Switch

The input/door switch can be used in two configurations, with or with out End Of Line (EOL) resistors. The EOL resistors enable to PTR to detect faults and attempts to tamper with the door switch. The configuration DIP switch has a bit to indicate whether the EOL are present. Once the EOL resistors are installed and the EOL configuration bit is set the PTR monitors the input and expect to see levels appropriate to having resistors present. Any reading outside the expected levels will switch the PTR into an error state. While in this error state periodic error messages will be transmitted to the network.

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Figure 2: PTR Schematic

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Figure 3: PTR PCB

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3 Modes of Operation

The PTR has several modes of operation. Six of these modes are selected by the configuration switch and the seventh is entered if the PTR loses power. The following sections detail the various modes and Table 2 summarizes the modes with respect to the mode bit settings. Note that modes 110 and 111 are not defined and will cause the PTR to go into an error state if asserted.

Mode	Mode Switch Setting	Comment
Test	000	Used for adjusting field size. Field is uninterrupted and the PTR annunciates each BBB as it occurs.
Uninterrupted	001	Field always on – similar operation to Controller
Standby	010	Field turn on for 10 seconds every time the Input/Door switch changes state
Duty Cycled 1	011	Field on for 5 seconds and off for 30 seconds.
Duty Cycled 2	100	Field on for 10 seconds and off for 5 minutes.
Duty Cycled 3	101	Field on for 10 seconds and off for 30 minutes.
Low Power/Loss of Power	All Switch Settings	All peripherals off. PTR stays in this mode until main power restored.

Table 2: PTR Modes of Operation

3.1 Powered Up Modes

While main power is present the PTR stays in the mode defined by the mode bits of the configuration DIP switches. The following sections detail the functionality of the powered up modes.

3.1.1 Test

In test mode the field is turned on (uninterrupted) and BBBs are attempted. Any time a BBB is completed the red LED flashes and the speaker beeps. No “Tag Detected” network messages are transmitted during this time, but the standard startup messages are transmitted when the PTR is switched into this mode.

3.1.2 Uninterrupted

As the name suggests, the field is on all the time in this mode. In this mode the PTR works in a similar fashion to a R3 controller. The field looks for tags and informs the network when one is found. As an R3 controller would do, the PTR will do a respond command once every 12 seconds and do reset (loiter detection) once every minute. Tags are reset by the field and then reacquired. All tags found after reset will be reported to the network. The PTR does not retain any tag IDs for loiter determination. Thus any loiter functionality will need to be implemented at the host level.

3.1.3 Standby/Read on Input/Door Switch Change

In standby mode the PTR turns on the field whenever a change of state is seen on the Input/Door switch. When a change of state is seen the PTR turns the field on and tries to detect tags for 10 seconds. After the ten seconds have expired the field is turned off and the PTR waits for the next input/door switch event.

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3.1.4 Duty Cycled

The duty cycled mode has several preprogrammed field on vs field off periods. As usual the PTR looks for and reports tags while the field is on. Please see Table 2 for the actual duty cycle periods associated with the various duty cycles modes.

3.2 Low Power mode/Loss of Power

In the event that the PTR losses main power the PTR will go into a low power mode. In this mode the PTR turns off all of its peripherals and goes dormant. There are two outward signs that the PTR is in this mode. First is the LED indication. The green LED is off and the red LED is flashing approximately once every 1.5 seconds. The second outward sign is that the PTR is transmitting a “Device in Low Power Mode” message to the network approximately once every 12 seconds. The PTR will remain in this mode until main power is restored. When main power is restored the PTR will restart and go into the mode that is currently programmed on the mode bits of the configuration switches. If main power is not restored the PTR will remaining this mode until the on board super capacitor can no long support processor operation. A voltage supervisor will then hold the device in reset until main power is restored.

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4 Messages to Network

The PTR sends several messages to the network to indicate status and to relay tag detection information. The following sections detail the make up of these messages and when they are transmitted to the network. A summary of these messages can be found in Table 3 and the message formats are detailed in the following sections.

Message Type	Message Makeup	Comments
PTR Startup/PTR serial number to address relationship message	Double word message Word1 - 0111 0aaa aaaa asss ssss ssss Word2 - 0111 1aaa aaaa asss ssss ssss	Sent on startup to relate the PTR serial number to the locally set address. (a = local address, s = PTR serial number)
Tag Detected Message	Double Word message Word1 - 0111 0aaa aaaa asss ssss ssss Word2 - 0111 1aaa aaaa asss ssss ssss	Sent whenever a tag is detected by PTR through BBB. (a = local address, s = tag serial number)
Bad Mode Alarm	Single word message Word1 - 1000 0000 aaaa aaaa dddd dddd	Sent when the configuration switch is set to an undefined mode. (a = local address, d = current mode setting)
EOL Resistor Error	Single word message Word1 - 1000 0001 aaaa aaaa 0000 0000	Sent when EOL resistor error is detected (a = local address)
Main Power Low Error	Single word message Word1 - 1000 0010 aaaa aaaa 0000 0000	Sent when Vin goes below 10 volts (a = local address)
Main Power Lost Error	Single word message Word1 - 1000 0100 aaaa aaaa cccc cccc	Sent while PTR is in low power mode. Indicated that main power has been lost (a = local address, c = number of 12 second counts since power was lost.)
Status – Firmware revision	Single word message Word1 - 1000 1100 aaaa aaaa ffff ffff	Sent on startup to inform network of PTR firmware revision (a = local address, f = firmware revision)
Status – Configuration setting	Single word message Word1 - 1000 1101 aaaa aaaa cccc cccc	Sent on startup to inform network of PTR configuratuion switch setting. Also sent whenever the configuration is changed (a = local address, c = DIP switch setting)
Status – Field Strength/Vtx setting	Single word message Word1 - 1000 1100 aaaa aaaa vvvv vvvv	Sent on startup to inform network of PTR field strength setting and whenever the Vtx is changed (a = local address, v = Vtx level)

Table 3: Summary of Transmitted Messages

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4.1 PTR Serial Number and Address

One important aspect of how information is communicated to the network lies in the relationship between a PTR's serial number and it assigned (or set) address. The PTR's serial number is assigned at time of manufacture and its address is set at time of deployment. The PTR uses a serial number similar to that used on the tags. It is a 24 bit serial number where bits S_{19} and S_{18} are not used (TLM and Battery low bits respectively). This means that is serial number can range from 0x800000h thru 0x83FFFFh. The address of the PTR is assigned via the address DIP switch on the PTR. This can range from 0 to 255. The following sections detail how the serial number to address relationship is made over the air and what information over the air type 7 and type 8 messages carry.

4.2 Message Formats

The PTR use two message formats to transmit information to the network. Both message formats use the NRZ protocols that are common to the general tag population and the Mother tag. One format uses a double word transmission to relate either tag detection information or PTR serial number to local address relationship information. The second format uses the typical single word format to send status and error condition information. The following sections detail these two formats and the bit fields in them.

4.2.1 Tag Detection/Address Relationship Messages

The following two figures, Figure 4 and Figure 5, illustrate how the double word messages are formed.

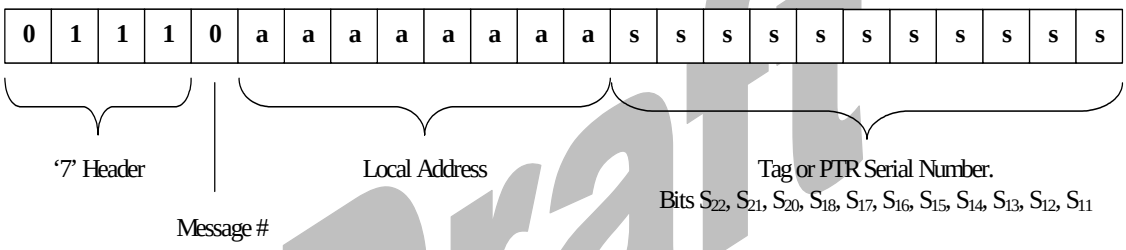

Figure 4: Format of Tag Detection/Address Relationship Message 1

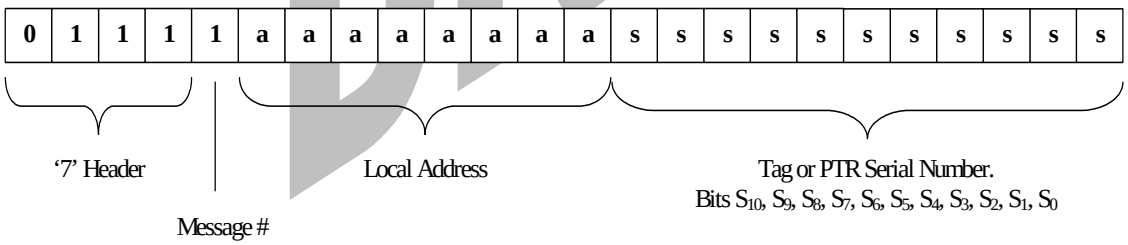

Figure 5: Format of Tag Detection/Address Relationship Message 2

Note that in these two messages there is room for 22 bits of tag (or PTR serial number). To squeeze the 24 bit serial numbers into the 22 bit space the 23rd and the 19th bits are dropped from the serial number being inserted. These are the MSb of the serial number (Tag header nibble) and the TLM bit respectively. Table 4 illustrates how the tag header mappings will occur. Note that in this scheme that RF test tags would be indistinguishable from PTRs. As a result the PTR doesn't report BBBs with the RF Test tag to the network.

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Tag/Device	Header	Maps to
PTR	‘8’ or 1000	000
Unused	‘9’ or 1001	001
Staff Tag	‘A’ or 1010	010
Asset Tag	‘B’ or 1011	011
PTAG I – Will likely be used for Ottawa Tag	‘C’ or 1100	100
PTAG II,III,IV	‘D’ or 1101	101
Umbilical Tag	‘E’ or 1110	110
Wrist Tag	‘F’ or 1111	111

Table 4: Tag Header Mapping into Double Word Messages

4.2.2 Tag Status and Fault Messages

For tag status and fault messages the PTR uses the format shown in Figure 6 to relay information to the network. This format is used for several different messages each of which is described in the following sections.

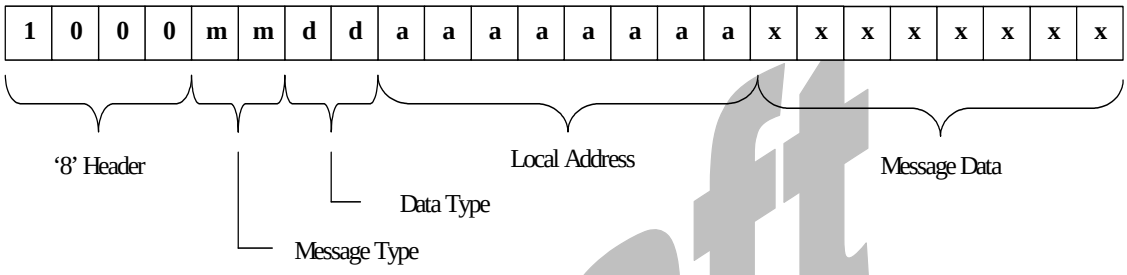

Figure 6: Format of Tag Status and Fault Message

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4.3 Startup and Status

When starting up the PTR has several jobs to do with respect to telling the network how to listen to the data coming from the PTR. Things like local address, firmware revision and configuration settings all play a role in how the data from the PTR is interpreted by the Host. To get all this information to the host the PTR follows the following start up sequence shown in Table 5.

1. PTR sends a Tag Detection/Address Relationship Message with its own serial number as the serial number payload. This tells the host the relationship between the PTR serial number and local address. This allows the Host to associate a PTR device on the floor plan to data coming from the PTR over the network.
2. Next the PTR will send a firmware revision status message to the network. The data is formatted as MSn dot LSn (i.e. rev 1.3 firmware would be sent as 0001 0011)
3. Then the PTR will send a Configuration setting status message to the network. This will tell the Host what mode the device is working in and if EOL resistors are being used in conjunction with Input/Door Switch.
4. Next the PTR will report its Vtx setting to the network. The Host will have to decide if the setting is appropriate or not. Data is formatted as a level between 0 and 255. 0 represents field off and 255 field max.
5. Finally the PTR will start looking for tags in the manner defined by the mode switch setting. As tags are detected they are reported to the network (unless the PTR is in test mode).

Table 5: PTR Message Startup Sequence

Once the PTR enters step 5, it is monitoring several operational parameters of the hardware. If one of them changes a message is sent to the network to relay the change in state.

If the configuration DIP switch is changed, the PTR will loop back to step three (of Table 5 above) and re-execute

If the Address DIP switch is changed the PTR will loop back to step one (of Table 5 above) and re-execute.

If Vtx is changed the PTR will remain in step 5 and simply report the change. In some cases this could be considered a tamper alarm by the Host.

If one of the PTR's error states becomes asserted then the PTR will continue in step 5 and report the error working around the problem the best it can.

4.4 Tag Present

When the PTR detects a tag in field it completes a BBB with the tag and then reports the tag ID to the network using the formats and techniques detailed in the above sections.

4.5 Error and Fault

There are three error messages that can be sent to the network by the PTR. In general the PTR will begin indicating and annunciating the error state with its red LED and speaker right away. Then once every 12 seconds the PTR will send a message to the network so the Host can raise the alarm at the user terminals. The following sections detail the nature of these three error states. Once the PTR has been installed and configured these error message could be considered tamper alarms. Host implementation will need to decide this.

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4.5.1 Invalid Mode Setting

The PTR will send this message to the network anytime the mode bits of the configuration DIP switch is set in an undefined mode. The PTR will exit this mode when the DIP switch is changed. Once the mode is changed the PTR will restart the sequence shown in Table 5.

4.5.2 Switch/EOL Resistor Fault

When the PTR is in the Read on Input/Door Switch change mode it also monitors the state of the EOL resistor configuration switch. If EOL is on, the PTR reports any EOL resistor error that it detects. In the event of the EOL resistors being tampered with the PTR will go into the error state and remain there until the EOL resistor error is corrected or the EOL DIP switch is turned off. The PTR sends the EOL resistor error message once every 12 seconds for the duration of the EOL error.

4.5.3 Supply Voltage Low

The PTR is also checking the state of its input voltage. In the event it was lowered but not totally removed (total removal would cause the PTR to go into low power mode). The PTR will enter the error state to indicate the low voltage both locally and network wise. As with the other error messages the “Main Power Low” error message is sent to the network once every 12 second for the duration of the error state.

4.6 Low Power mode/Loss of Power

In the event the PTR loses power the device goes into a low power mode to preserve the energy stored in the on board super capacitor. The processor runs in sleep mode and uses its Watch Dog Timer (WDT) to wake up every 1.5 second to flash the red LED. Once every eight wakeups the PTR sends the Main Power Lost error message to the network. Restoration of main power will return the PTR to an operational state. The PTR will restart by executing the startup sequence illustrated in Table 5.

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5 Conclusion

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