RFID Labeling Reference Manual

Thermal RFID Printers

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Table of Contents

1 *Reference Notes*

Overview

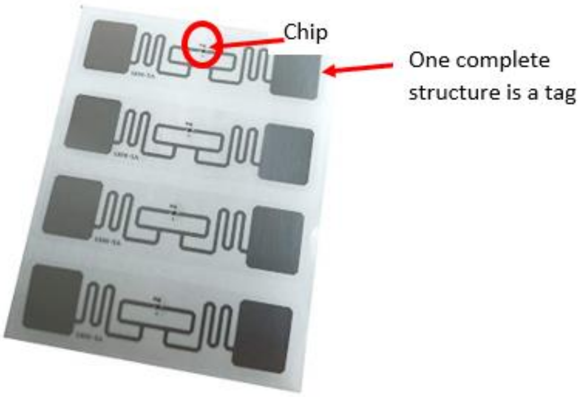
This manual covers the RFID functions available in the TSC | Printronix Auto ID T800, T4000 and T6000e Multi-protocol RFID printers running RAIN Class 1 (UHF Gen2, EPCglobal®, ISO/IEC 18000-63) RFID tags and labels. It is to be used in conjunction with information provided in each printer's Administrators Manual. For the latest version of this reference manual and the Administrators Manual for each of the printers, visit the Support/Downloads & Drivers page at https://usca.tscprinters.com/en/printronix-auto-id-enterprise-printers. TSC | Printronix Auto ID is a proud member of the RAIN RFID global alliance, formed to promote the universal adoption of UHF RFID technology. RAIN uses the GS1 UHF Gen2 protocol which ISO/IEC has standardized as part of ISO/IEC 18000-63:2015. The word RAIN is an acronym derived from RAdio frequency IdentificatioN.

GS1's EPC Gen2 protocol defines the physical and logical requirements for RFID systems and passive tags, operating in the 860 MHz - 960 MHz UHF range Industrial, Scientific, and Medical (ISM) band used in item management applications. GS1 maintains an overview of frequency allocations supporting RFID at UHF bands around the world.

Basic Terms

Here are some basic RFID terms:

1. Chip and Tag: An RFID tag consists of a chip connected to an antenna and then this construction is placed on some type of substrate. The chip consists of an RF front-end, a power converter, and a relatively small memory bank to store the unique tag number, the unique item number or even additional data in a user-memory portion. The chip is essentially a small computer. In the picture below, the chip is the barely visible tiny black dot (circled in red) in the middle of the squiggly antenna. A tag is the chip + antenna + substrate:



2. Inlay and Smart Label: The terms tag and inlay are often used interchangeably, but an inlay specifically refers to a tag that gets sandwiched between a label carrier and the label itself. This produces what we call a smart label as shown below:

3. Antenna, Encoder, Reader: An antenna receives and sends radio waves; an encoder (a specialized radio) programs the chip; a reader reads the chip. An RFID-enabled thermal printer actually contains all three of these elements. The antenna (or coupler) is positioned within the path of the labels. The reader and encoder are contained within a combined module that is mounted in the printer's electronics bay and is connected to the antenna by a small coaxial cable. In the RFID printer, the antenna mounted in the path of the label "talks" with the antenna embedded within the smart label as the label moves through the printing process.

   Readers are also available in handheld, portable models as well as fixed readers that can be mounted at a warehouse entrance, etc. Fixed readers generally have better performance and range but lack mobility.

What to Expect when Running an RFID Application

The Printronix Auto ID printers with the RFID option perform two separate functions. The first is thermal label printing. The second is the encoding of an embedded RFID tag within the smart label. Smart labels are based on an EEPROM technology that requires time to be programmed. When dealing with smart labels, it is possible that an occasional RFID tag may need to be written and verified more than once (retry) before being considered acceptable. In this event each retry time will be added to the inter-label pause. This added pause is necessary to better ensure consistent quality and improved reliability.

Static electricity can damage the smart labels. Open the media cover of the printer and touch an unpainted metal part of the printer before you handle smart labels. This will discharge any static electricity that may have built up on your hands.

Smart Label Characteristics

Printronix Auto ID printers with the RFID option have been tested for compatibility with a wide range of smart label constructions and tags from multiple makers. Printronix RFID printers work with both standard and on-metal smart labels.

On-Metal Tags

Metal can interfere with radio signals and thus impact an RFID solution. For this reason, special tags and labels have been developed for application to metal surfaces. These tags and labels are called "on-metal" and are not only designed to function well in metal-rich environments, but many of them actually exploit the presence of metal to achieve better performance. The Printronix Auto ID T4000 and T6000e are available for on-metal tag applications.

IMPORTANT: You may purchase additional smart labels directly from Printronix Auto ID to assure the highest level of performance and reliability. For more information visit our website at https://usca.tscprinters.com/en/printronix-auto-id-enterprise-printers.

2 Setting up an RFID Printer

Refer to the T800, T4000 and T6000e printers *Administrators Manual* for full details on loading media, loading ribbons, media calibration and other printer adjustments to set up the printer for proper operation.

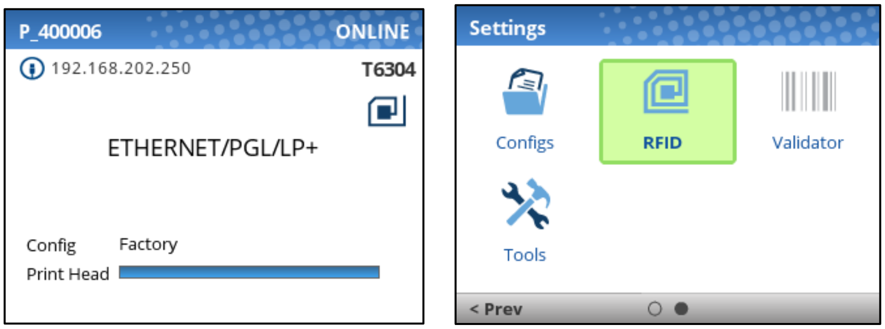
RFID > Control

Software can automatically detect an installed RFID encoder when the printer is powered up. The state of the RFID feature can be observed from the ONLINE screen as shown in

Figure 1 below:

- The ONLINE screen will show the “enabled” RFID symbol under the model number when the RFID encoder is installed AND enabled via the menu *RFID* > *Control* > *RFID Active*.
- The ONLINE screen will show the “disabled” RFID symbol under the model number when the RFID encoder is installed and disabled via the menu *RFID* > *Control* > *RFID Active*.
- If the RFID encoder is not installed, then no RFID symbol will be present on the ONLINE screen and the RFID icon shown in the Settings menu section in
- Figure 1 is gray in color and cannot be selected.

Figure 1 RFID Icon



P_400006 ONLINE

192.168.202.250 T6304

ETHERNET/PGL/LP+

Config Factory

Print Head

Once the RFID is installed, the RFID icon in the Settings menu can be selected and the RFID configured. However, it may not be enabled by default:

- If the printer is powered up with the menu *Configs* > *Control* > *Power-Up Config* set to Factory, the *RFID* > *Control* > *RFID Active* will be set to “Enable” automatically.
- If the printer is powered up with *Configs* > *Control* > *Power-Up Config* to something other than Factory, the *RFID* > *Control* > *RFID Active* could be set to “Disable”.

To enable the RFID feature, change the menu *RFID* > *Control* > *RFID Active* to “Enable” and save the configuration as described in the printer’s *Administrator’s Manual*.

Media > Media Handling

Before you can print, you must decide which media handling mode to use:

- **Continuous**. When the print job ends the trailing edge of the last label printed remains at the TOF position under the printhead (not aligned at the Tear Bar).
- **Tear-Off Strip**. When the print job is complete the printer will place the trailing edge of the last printed label printed at the tear bar for easy removal. When a new print job is sent, the leading edge of the last label will be pulled back to the TOF position under the printhead.
- **Cut**. When the optional media cutter is installed, the printer automatically cuts media after each label is printed or can cut the media after a specified number of labels have been printed using the Active IGP Emulation cut command.
- **Peel-Off**. This option is not available on RFID printers using the external antenna (T4000, T6000e). Peel mode can be used on the T800 printers when this option is installed. Refer to the T800 *Administrator’s Manual* for set-up instructions for this option.

Sensors > Control

After the Media Handling mode is selected, load the media and select the mode of media length sensing to be used:

- **Mark**. Mark is the preferred format for inter-label sensing with RFID media, as the embedded inlay/antenna within the label can sometimes be falsely sensed. Select Mark sensing when a black mark exists on the underside of the RFID label liner. The menu defaults to Mark when RFID is enabled.
- **Gap**. Select Gap sensing when a liner gap exists between die cut RFID labels.

IMPORTANT: After the desired sensing mode is selected, perform the media Auto-Calibrate routine before proceeding to the RFID calibration procedure. Refer to the printer’s *Administrator’s Manual* for additional information.

3 *RFID Calibration*

Antenna System

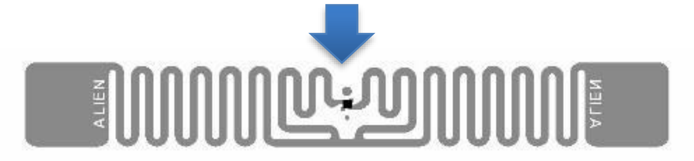
The T800, T4000, and T6000e printers have RFID antenna coupler designs that support a wide variety of standard tags and on-metal tags. The T800 has an internal antenna coupler affixed to the media guard that can be adjusted horizontally into seven different detent positions. The antenna is mounted below (back-side) of the media working well with standard tags but may not be suited for use with some on-metal tags.

The T4000 and T6000e (4" and 6" printers) have a fixed position antenna coupler mounted at the exit of the printer (as part of the tear or cutter options) that requires no adjustment. The antenna is mounted above the exiting media (top-side) and can program standard tags and on-metal tags.

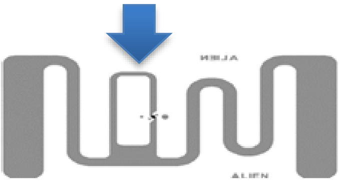
The T6000e 4" printer has both internal (adjustable) and external (fixed position) RFID antenna couplers.

T800 - Selecting the Internal (Adjustable) Antenna Coupler Position

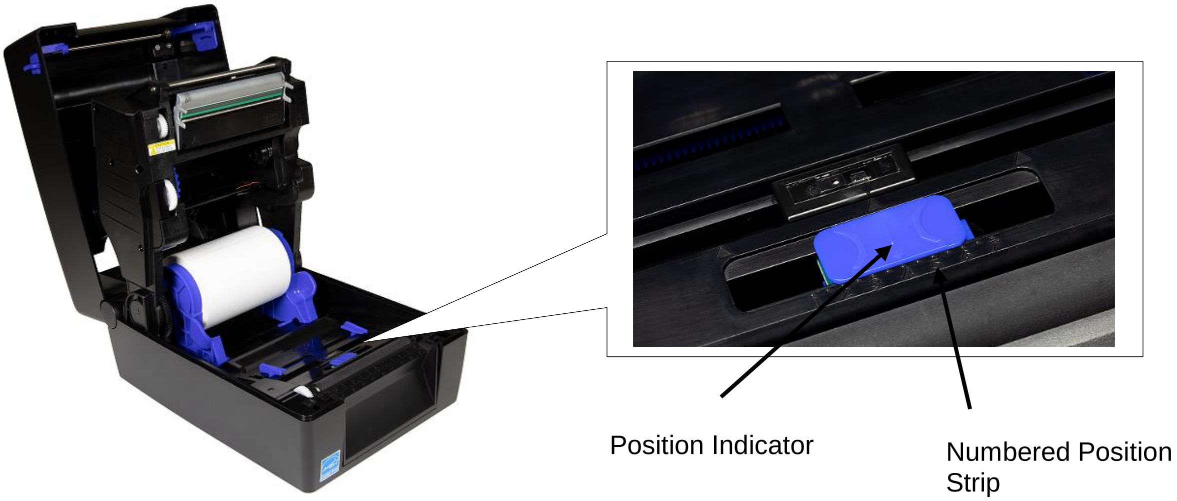
1) Visually inspect the label, locating the antenna loop within the tag to determine the best position for the antenna. In most cases, the antenna loop will be directly above or below the chip



The loop may be off to one side of the chip in some tags:

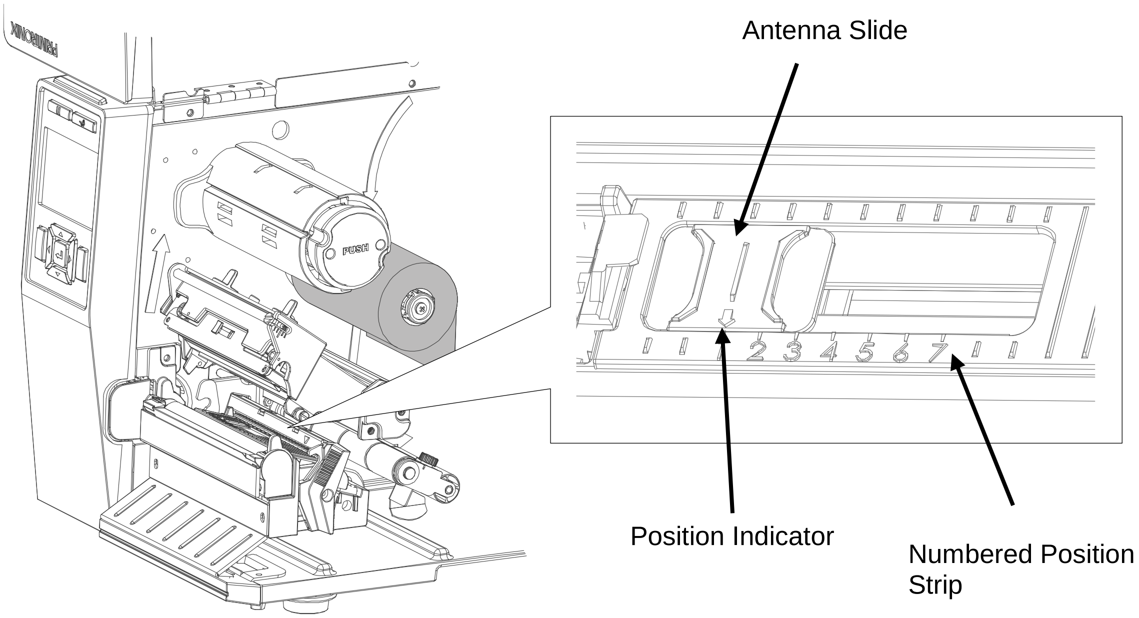


2) Open the pivoting cover to access the antenna slide. Move the slide so that the position indicator aligns with the loop in the tag.



T6000e 4” - Selecting the Internal Antenna Coupler Position

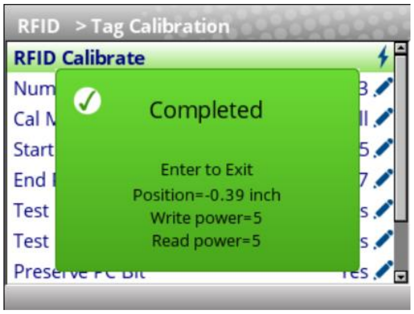
1) Rotate the deck lock lever clockwise to open the pivoting deck to access the antenna slide. Move the slide so that the position indicator aligns with the loop in the tag.



RFID Calibration Procedure

There are a few steps to do the RFID calibration:

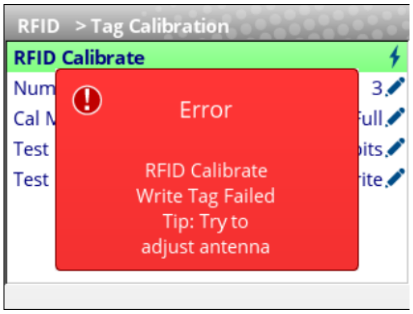
1) The first step is to perform the Media Gap/Mark Calibration routine before beginning the RFID calibration procedure. It is necessary to have the label length set properly or the results of the RFID calibration will not be optimal. Refer to Label Calibration in the printer’s *Administrator’s Manual* for complete instructions.
2) For printers with the internal, adjustable RFID antenna, verify the antenna is set at the position of the center of the RFID chip or antenna loop on the tag.
3) For printers with the external, fixed position RFID antenna, no separate adjustment is needed.
4) Select RFID menu > Tag Calibration > RFID Calibrate and press the Enter key to execute the calibration routine.
5) Depending on the tag type and tag length, the calibration may take several minutes. At the end of calibration either a Green or Red window pops up. A green window signifies successful calibration.


RFID > Tag Calibration

RFID Calibrate

✓ Completed

Enter to Exit
Position=-0.39 inch
Write power=5
Read power=5


RFID > Tag Calibration

RFID Calibrate

Error

RFID Calibrate
Write Tag Failed
Tip: Try to
adjust antenna

6) If the calibration fails, you will see a red screen. Press the Pause or Enter key to clear the failure notice. In most cases when this error occurs, it is necessary to re-position the antenna slide. In some cases it may be due to an incompatibility between the tag and the reader.

7) Restart the RFID calibration procedure.

8) After calibration is complete, press the Enter key to continue.

9) When going next online, choose the option to save your settings into your configuration so that the RFID calibration values will be preserved.

The RFID printers can encode tags before, during or after printing the label. During the RFID calibration sequence, the printer will determine which operation order will work best with the labels installed.

If Encode During Print is selected, depending on the amount of data to be encoded on the tag, there can be a slight pause during encoding, which may distort or cause a break in the printing on the label. If this occurs, this setting can be manually changed to either Encode Before or Encode After Print, if desired (see *RFID Menu > Calibration Param > Operation Order* in the Smart Label Operation section of this manual for more details).

4 *Smart Label Operation*

Overview

This chapter describes the function of the RFID encoder module. The RFID encoder is designed to be transparent to the printer operation. It provides the capability of programming smart labels (with embedded RFID tags) while printing the label format.

There are several ways to program RFID tags in smart labels:

- Incorporate RFID commands into new or existing Printronix PGL® programs.
- Incorporate RFID commands into new or existing ZPL™ programs. By selecting the Printronix ZGL emulation you can seamlessly upgrade from Zebra™ printers.
- Incorporate RFID commands into new or existing SATO® printer language programs. By selecting the Printronix STGL emulation you can seamlessly upgrade from SATO printers.
- There are commercial label making software packages available that support the creation and programming of RFID tags that are compatible with all Printronix Auto ID RFID printers.

Refer to the appropriate Programmers Reference Manual for each printer language for a complete list of supported RFID commands and instructions. Programmers Reference Manuals are available from our website at https://usca.tscprinters.com/en/downloads

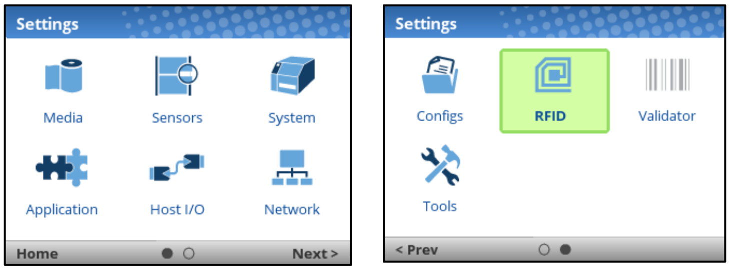
Supported RAIN Class 1 (UHF Class 1 Gen2) Tag Types

The Printronix Auto ID RFID Label and Verification Test Lab is continually testing new tags as they come on the market. For tag type information and specifications, go to https://usca.tscprinters.com/en/printronix-auto-id-enterprise-printers.

RFID Menu Overview

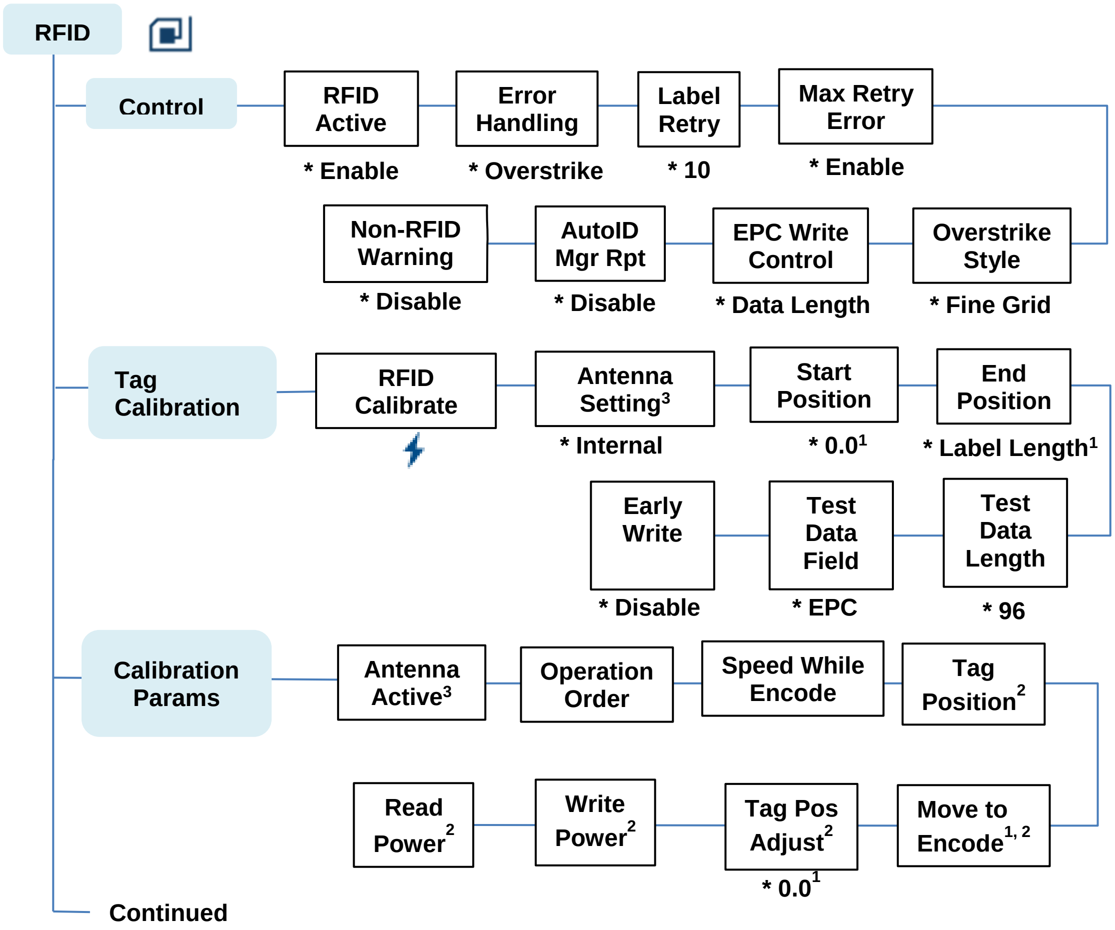
The RFID section is found by selecting the RFID icon from the second page of the Settings menu as shown here.

RFID Icon Location



The RFID menu is structured into six submenus described below:

RFID Control, Tag Calibration, Calibration Params Submenus

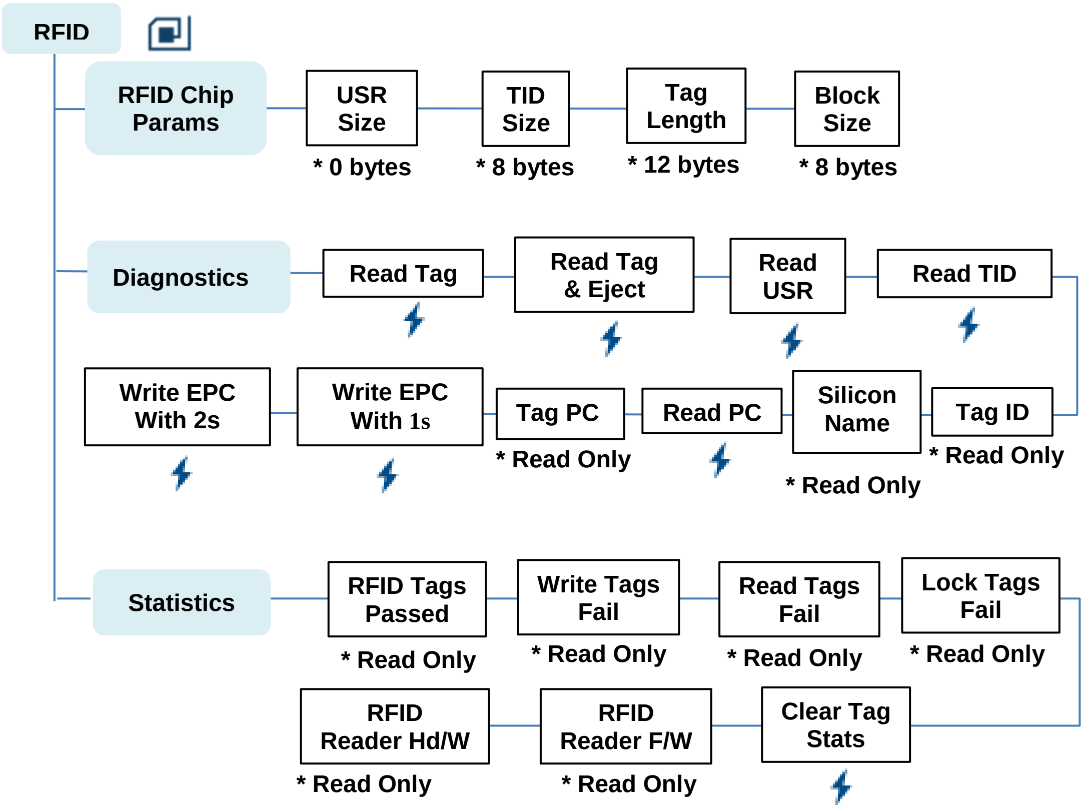


[1] Inches or Millimeters, depending on *SYSTEM* > *Control* > *Media Units*.

[2] Value determined by tag installed

[3] Antenna Setting and Antenna Active for T6000e only

RFID Chip Params, Diagnostics, Statistics Submenus



- The **RFID Chip Params** submenu is used to configure the system when support of custom RFID tags is required. Those menus are described below.
- The **Diagnostics** submenu is used to run test procedures to help determine the accuracy and troubleshoot the RFID system. Those menus are described starting on page 27.
- The **Statistics** submenu is general read-only and used to gather and report statistics on how the RFID system is reporting on print jobs sent to the printer. Those items are described starting on page 34.

Configuring the RFID

Configuring the RFID is done by selecting the RFID icon within the Settings section. The RFID comes equipped with a default setting for each configuration option, and it works without having to change any of these options. However, in some cases it is necessary to adjust these options, which are described below.

IMPORTANT **If you are unable to select the RFID icon or the icon is grey, then the RFID is not properly installed. Refer to Section "Printronix Customer Support Center" for help on how to solve this problem.**

IMPORTANT **If you make any changes to the default configuration menu items, you will be prompted to save the configuration. Use the UP and DOWN Arrow Keys to unlock the control panel. See "Auto Save Configuration" in the *Administrator's Manual*.**

Enabling and Disabling

Software can automatically detect an installed RFID when the printer is powered up. If the printer is powered up with *Configs* > *Control* > *Power-Up Config* set to “Factory”, the RFID icon can be selected and *RFID* > *Control* > *RFID Active* is set to “Enable”.

If Power-Up Config. is not set to Factory, the RFID icon can be selected, but *RFID* > *Control* > *RFID Active* could be set to “Disable”. Set this menu to “Enable” and save the configuration as described in the *Administrator’s Manual*. In the same manner, the RFID can be disabled.

Control Submenu

A number of RFID options which define specific parameters for certain print jobs can be set from the RFID > Control submenu. Menus within this submenu are common for all models.

RFID Active

RFID > Control > RFID Active	
Software can automatically detect an installed RFID reader when the printer is powered up. If the printer is powered up with *Configs* > *Control* > *Power-Up Config* set to “Factory”, the RFID icon can be selected and this option is set to “Enable”. If *Power-Up Config* is not set to Factory, the RFID icon can be selected, but this option could be set to “Disable”.	
Disable	The RFID function is disabled and not active.
Enable	The RFID function is enabled and active.
Factory Default	Depends on *Configs* > *Control* > *Power-Up Config* setting. See above.

Error Handling

RFID > Control > Error Handling	
If an RFID tag within a smart label is deemed unacceptable after the defined number of retries, this menu item selects the error handling mode.	
Overstrike	Each failed label prints with the Overstrike pattern and the form retries on a new label until the Label Retry count is exhausted. Whether or not an error message will display or the failed label will reprint depends upon the *Max Retry Error* setting.
None	No specific action is taken when a tag fails to be programmed.
Stop	The printer will halt and display the error message “RFID Error: Check Media.” The label is discarded and reprinting of the label (if desired) must be initiated from the host. When the error is cleared, the label with the failed tag moves forward until the next label is in position to be printed.
Factory Default	Overstrike

Label Retry

RFID > Control > Label Retry	
This menu item selects the number of label retries that the RFID encoder will attempt before declaring a fault. This may indicate a problem with the RFID encoder, the coupler assembly, the printer setup, or the label stock.	
Minimum	1
Maximum	10
Factory Default	10
IMPORTANT	Label Retry only applies when the *Error Handling* mode is set to Overstrike.

Max Retry Error

RFID > Control > Max Retry Error	
This menu item determines if errors are declared when the *Label Retry* count is exceeded.	
Disable	Errors are not declared and the print content for the current label is discarded.
Enable	Errors are declared when the tag cannot be programmed within the *Label Retry* count.
Factory Default	Enable

Auto Retry

RFID > Control > Auto Retry	
This menu item selects the number of automatic (internal) retries that the printer will attempt on the same tag before taking action per the menu *Error Handling*. T800 menu only.	
Minimum	1
Maximum	9
Factory Default	2

Overstrike Style

RFID > Control > Overstrike Style	
This menu item selects the style of the overstrike: Refer to the table below when printing the error on the label.	
Grey	Print a shade of grey on the label.
Checkerboard	A pattern of small squares prints when it overstrikes.
Fine Grid	A grid pattern prints when it overstrikes.
Error Type Msg	An error message prints that indicates which error occurred according to the table below.
Factory Default	Fine Grid
IMPORTANT	**If you are using a validator, set the RFID Overstrike Style different than *VALIDATOR > Control > Overstrike Style*. This will help you differentiate errors.**

Error Type Messages

Error Message	Explanation
The *x* in the error messages represents a number code that identifies the area in the printer software or RFID encoder where the failure occurred.	
Tag R/W Err *x* Check media	The printer software attempted to write to or read from the RFID tag, but the RFID encoder indicated that the tag could not be written to or read from.
Tag Comm Err *x* Check cable	The printer software temporarily lost communication with the RFID encoder, or communication between the printer software and the RFID encoder was not synchronized and had to be forced.
Precheck Fail *x* Check media	This failure occurs only when the *Precheck Tags* is enabled. It indicates that the RFID tag was automatically failed since it did not contain the correct pre-programmed quality code.

Overstrike Distances

When Error Handling >Overstrike is selected the amount of the label that is overstruck to indicate an error may be different for the T4000 and T6000e model printers using the external antenna or if the Peel option is installed. The number of labels overstruck can also vary depending on the operation order selected (encode before print, encode while print, encode after print).

T800

There is generally no limit to the length of the overstrike distance on the T800 printer using the internal antenna and encode before print or encode during print operation orders. However, if the tag position within a long label is at the end of the label, the length of the overstrike will be limited to 1-1/2” from the trail edge of the label.

T4000

For T4000 printers shipped from the factory with the RFID option installed, the overstrike distance is a maximum of 6” (152.4mm). This means for labels longer than 6”, the portion of the label beyond 6” from the trail edge will not be overstruck.

For T4000 printers that have a field installed RFID option or if the Peel option is installed the overstrike distance is limited to 1” (25.4mm) from the trail edge of the label.

T6000e

For T6000e printers shipped from the factory with the RFID option installed, there is generally no limit to the length of the overstrike distance on the T6000e printer using the internal antenna and encode before print or encode during print operation orders. However, if the tag position within a long label is at the end of the label, the length of the overstrike will be limited to 6” from the trail edge of the label.

For T6000e printers shipped from the factory with the RFID option installed and using the external antenna, the overstrike distance is a maximum of 6” (152.4mm). This means for labels longer than 6”, the portion of the label beyond 6” from the trail edge will not be overstruck.

For T6000e printers that have a field installed RFID option or if the Peel option is installed the overstrike distance is limited to 1” (25.4mm) from the trail edge of the label.

T4000 and T6000e using External Antenna

When running short pitch tags (tags less than 0.8”), printers using the external antenna will overstrike up to the number of tags that fit into the distance between the antenna and the print line, when encoding during print, or encoding after print operation orders are selected.

EPC Write Ctrl

RFID > Control > EPC Write Ctrl	
This option controls how the printer encodes the RFID tag EPC field.	
Data Length	Only the amount of data provided in the application is encoded.
Full EPC Length	The maximum EPC length for the particular tag type in use is written to the tag (padded with zeroes if necessary).
Factory Default	Data Length

AutoID Mgr Rpt

RFID > Control > AutoID Mgr Rpt	
This menu item enables AutoID and label information to be sent out the network port. This information can be used by an RFID tag data and labels manager program.	
Disable	No data is sent out the network port.
Enable	Data is sent out the network port.
Factory Default	Disable

Non-RFID Warning

RFID > Control > Non-RFID Warning	
This menu item enables a warning to appear if the printer receives a print job that does not contain any RFID commands when RFID media is installed in the printer.	
Disable	No warnings will be produced when data is received.
Enable	Warnings will be produced when the condition is met.
Factory Default	Disable

Tag Calibration Submenu

This submenu is used to do RFID calibration. The user must do the tag calibration when installing a new tag in the printer. RFID calibration operation determines the RFID chip type, the optimum write/read power levels, programming position, and length of the EPC/User field.

NOTE: The Tag Calibration menus for the early production T800 are different from the T4000 and T6000e printers. The model number affected will be included in the menus below. Please be sure to follow the correct listing.

RFID Calibrate

RFID > Tag Calibration > RFID Calibrate	
The executable item performs RFID calibration (Common to all models)	
IMPORTANT	**This item should be executed when changing the RFID tag type.** **The calibration process will set a number of RFID menus in the printer configuration, and after RFID calibration is complete, the configuration should be stored to preserve the results of the calibration in that configuration.**

Antenna Setting

RFID > Tag Calibration> Antenna Setting (T6000e 4" Only)	
This menu determines which antenna will be used for RFID encoding during the RFID calibration. After RFID calibration, an update will be applied to > RFID Calibration Params > Antenna Active (T6000e 4" model only)	
External	RFID jobs and diagnostics will use the slit-antenna located at the exit of the printer.
Internal	RFID jobs and diagnostics will use the adjustable, sliding antenna located behind the print head.
Factory Default	Internal
IMPORTANT	The internal RFID antenna should be manually adjusted every time new RFID labels are used in the printer. Slide the antenna so the chip within the label is aligned with the center if the antenna. The external antenna cannot be adjusted.

Start Position / End Position

These submenus are for use when running longer tags. See explanation for use in section 7 RFID Inlay Position/Longer Pitch Tags. No changes to these settings are needed under normal operation.

Start Position

RFID > Tag Calibration > Start Position	
The menu item determines the RFID calibration start location on the tag. This value can be left at the default value. (T4000 and T6000e models only)	
Minimum	0.0*
Maximum	Label Length as determined by Media Calibration*
Factory Default	0.0*
	*Inches or Millimeters, depending on SYSTEM > Control > Media Units.

End Position

RFID > Tag Calibration > End Position	
The menu item determines the RFID calibration end location on the tag. This value can be left at the default value. See additional information about this selection in section below. (T4000 and T6000e models only)	
Minimum	0.0*
Maximum	Label Length as determined by Media Calibration*
Factory Default	Label Length as determined by Media Calibration*
	*Inches or Millimeters, depending on SYSTEM > Control > Media Units.

Test Data Length

RFID > Tag Calibration > Test Data Length	
The menu item determines the size of the test data that will be used to perform the RFID Calibration. This menu can be increased to improve the accuracy of the RFID Calibration, but it should not be increased to a value greater than the maximum data length that the current Tag Type can support. (Common to all models)	
Minimum	16
Maximum	256
Factory Default	96

Test Data Field

RFID > Tag Calibration > Test Data Field
The menu item determines the field that will be used to perform the RFID Calibration. Not all tag types support all of the various types of RFID fields. (Common to all models)
EPC
USR
ACS
KIL
Factory Default: EPC

Early Write

RFID > Tag Calibration > Early Write
The menu item enables the RFID calibration to calculate an appropriate distance for attempting Early Writing during printing. Early Writing may increase overall throughput speed in certain cases but should not be used if the label sensed distance is less than 2.0 inches (Common to all models)
Disable
Enable
Factory Default: Disable

Calibration Params Submenu

Settings saved on the printer to optimize RFID encoding.

NOTE: Calibration Parameters menus for the T800 are different from the T4000 and T6000e printers. The model numbers affected will be included in the menus below. Please be sure to follow the correct listing.

Antenna Active

RFID > Calibration Params > Antenna Active (T6000e Only)	
This menu determines which Antenna will be used to encode RFID tags during host jobs. This menu can only be read and is updated after every RFID Calibration. (T6000e 4” model only)	
External	RFID jobs and diagnostics will use the slit-antenna located at the printer exit.
Internal	RFID jobs and diagnostics will use the adjustable, sliding antenna located behind the print head.
Factory Default	Internal
IMPORTANT	**This menu is a Read-Only menu. It cannot be manually adjusted by the user. This value can be changed using RFID > Tag Calibration > Antenna Setting, then performing a RFID Calibration. Antenna Active will contain the value of Antenna Setting used during the most recently saved or loaded RFID calibration.**

Operation Order

RFID > Calibration Params > Operation Order	
This menu determines when the RFID encoding operations will be performed relative to any printing operations on RFID tags during host jobs. This menu will be updated automatically after every RFID Calibration. (Common to all models)	
Encode Before Print	When processing RFID jobs, the printer will attempt the RFID operations before the print operations for each label. Mode used with the internal antenna coupler.
Encode After Print	When processing RFID jobs, the printer will attempt the RFID operations after the print operations for each label. Mode used with the external antenna coupler.
Encode During Print	When processing RFID jobs, the printer will initiate the print operations, then perform the RFID operations when the label reaches the encoding position. After the encoding operations have been completed, the printing operations will resume.
Factory Default	Encode During Print (may change after RFID calibration routine)
IMPORTANT	**Some types of jobs and operations will only be compatible with “Encode Before Print”. When**

	such operations are received, the printer will proceed with "Encode Before Print" and ignore the value of the "Operation Order" menu. The menu will NOT be changed after the operations are processed, and the printer will adhere to the menu again once compatible operations are received. **If Encode During Print is selected, depending on the amount of data to be encoded on the tag, there can be a slight pause during encoding, which may distort or cause a break in the printing on the label. If this occurs, this setting can be manually changed to either Encode Before or Encode After Print.**

Speed While Encode

RFID > Calibration Params > Speed While Encode	
This menu determines how fast the media will move during RFID operations. Substantial RFID operations on one tag may cause the media to stop moving during the encode process (Common to all models). **The units display in inches or millimeters, depending on *SYSTEM > Control > Media Units*.**	
Minimum	1 inch per second
Maximum	6 inches per second
Factory Default	6 inches per second

Tag Position

RFID > Calibration Params > Tag Position	
This menu determines how far the RFID tag encoding position of the currently installed tag should be offset from Top of Form (Common to all models)	
Minimum	-1.0 inches
Maximum	12.0 inches
Factory Default	0.0 inches (Top of Form)
IMPORTANT	**The units display in inches or millimeters, depending on *SYSTEM > Control > Media Units*.** **This value will be set when RFID calibration is executed. Normally, this value should be left at the value chosen by RFID calibration because this was determined to be the optimal programming position.**

Move To Encode

RFID > Calibration Params > Move To Encode

This menu item displays the distance required in additional movements during RFID encoding. This menu is set automatically based on the RFID Calibration results and the value of *RFID > Calibration Params > Operation Order*, and cannot be changed manually.	
Minimum	-1.0 inches
Maximum	Label Length as determined by Media Calibration
Factory Default	0.0 inches
IMPORTANT	**The units display in inches or millimeters, depending on *SYSTEM > Control > Media Units*.**

Tag Pos Adjust

RFID > Calibration Params > Tag Pos Adjust	
This menu item selects the amount of movement the printer will perform to move beyond the RFID programming position (*RFID > Calibration Params > Tag Position)* during RFID operations. Modifications to this menu can impact the accuracy of RFID operations, and users are recommended to keep this value set to zero.	
Minimum	-3.0 inches
Maximum	3.0 inches
Factory Default	0.0 inches

Write Power

RFID > Calibration Params > Write Power	
This menu item selects the write power level to be used in the RFID encoder. 1 is the lowest power level setting on all models, while the highest is 7 for T800, 30 for the T4000 and T6000e. Normally, this value is set automatically by the RFID calibration process and should not be changed.	
Minimum	1
Maximum	25 (T6000) / 7 (T800) / 30 (T4000 and T6000e)
Factory Default	Depends on the type of RFID encoder installed.

Read Power

RFID > Calibration Params > Read Power	
This menu item selects the read power level to be used in the RFID encoder. 1 is the lowest power level setting on all models, while the highest is 7 for T800, 30 for the T4000 and T6000e. Normally, this value is set automatically by the RFID calibration process and should not be changed.	
Minimum	1
Maximum	25 (T6000) / 7 (T800) / 30 (T4000 and T6000e)
Factory Default	Depends on the type of RFID encoder installed.

RFID Chip Params

A number of RFID options which define specific parameters for custom RFID tags can be set from the *RFID > RFID Chip Params* submenu. These menus are common for all models.

USR Size

RFID > RFID Chip Params > USR Size	
This menu item selects the size in bytes of the USR block within the RFID tag memory. Normally, this value is set automatically by the RFID calibration process and should not be changed.	
Minimum	0
Maximum	928
Factory Default	0
IMPORTANT	**This value will be hidden if Higgs3 or Higgs 9 tags are detected, and the Adjusted USR Len menu will be unhidden instead.**

Adjusted USR Len

RFID > RFID Chip Params > Adjusted USR Len	
Higgs 3 and Higgs 9 tags differ from other RFID tags in that its memory bank size is not fixed. To accommodate EPC lengths longer than 96 bits, Higgs 3 and Higgs 9 borrow memory from the USR bank. This display-only menu indicates the size in bits of the USR block within the RFID tag memory.	
Minimum	64 / 288
Maximum	512 / 688
Factory Default	512 / 688
IMPORTANT	**This menu will only be shown if a Higgs 3 or Higgs 9 tag is detected. Otherwise, it will be hidden.** **When an EPC length is selected by the user, the value in this USR length menu will change automatically per the Higgs 3 EPC/USR Lengths and PC Values table below. The USR length in this menu must be set to a value that is equal to or longer than all USR value lengths to be written by the application. If the value displayed in this menu is too short in length, the Adjusted EPC Len menu must be reduced so that this menu value will increase.**

TID Size

RFID > RFID Chip Params > TID Size	
This menu item indicates the size of the memory block within the RFID tag memory that contains the Tag ID. Normally, this value is set automatically by the RFID calibration process and should not be changed.	
Minimum	0
Maximum	32
Factory Default	8

Tag Length

RFID > RFID Chip Params > Tag Length	
This menu item selects the number of bytes in the EPC block within the RFID tag memory. Normally, this value is set automatically by the RFID calibration process and should not be changed.	
Minimum	8
Maximum	64
Factory Default	12
IMPORTANT	**This value will be hidden if Higgs3 or Higgs 9 tags are detected, and the Adjusted EPC Len menu will be unhidden instead.**

Adjusted EPC Len

RFID > RFID Chip Params > Adjusted EPC Len	
Higgs 3 and Higgs 9 tags differ from other RFID tags in that its memory bank size is not fixed. To accommodate EPC lengths longer than 96 bits, Higgs 3 and Higgs 9 borrow memory from the USR bank. This menu item selects the number of bits dedicated to the EPC block within the RFID tag memory.	
Minimum	96
Maximum	496
Factory Default	96
IMPORTANT	**This menu will only be shown if a Higgs 3 or Higgs 9 tag is detected. Otherwise, it will be hidden.** **When an EPC length is selected by the user in this menu, the USR length will change automatically according to the EPC, USR, and PC value tables. The EPC length in this menu must be set to a value that is equal to or longer than all EPC value lengths to be written by the application.** **Since the PC value indicates the length of the EPC in the Higgs 3 and Higgs 9, the PC value must be**

	programmed when programming the EPC (if the EPC value has changed from its factory state). The PC value to be programmed for each of the supported EPC lengths is shown in the table below.

Higgs 3 EPC/USR Lengths and PC Values

EPC Length	USR Length	PC Value
96	512	0x3000
112	448	0x3800
128	448	0x4000
144	448	0x4800
160	448	0x5000
176	384	0x5800
192	384	0x6000
208	384	0x6800
224	384	0x7000
240	320	0x7800
256	320	0x8000
272	320	0x8800
288	320	0x9000
304	256	0x9800
320	256	0xA000
336	256	0xA800
352	256	0xB000
368	192	0xB800
384	192	0xC000
400	192	0xC800
416	192	0xD000
432	128	0xD800
448	128	0xE000
464	128	0xE800
480	128	0xF000

Higgs 9 EPC/USR Lengths and PC Values

EPC Length	USR Length	PC Value
96	688	0x3000
112	624	0x3800
128	624	0x4000
144	624	0x4800
160	624	0x5000
176	560	0x5800
192	560	0x6000
208	560	0x6800
224	560	0x7000
240	496	0x7800
256	496	0x8000
272	496	0x8800
288	496	0x9000
304	432	0x9800
320	432	0xA000
336	432	0xA800
352	432	0xB000
368	368	0xB800
384	368	0xC000
400	368	0xC800
416	368	0xD000
432	304	0xD800
448	304	0xE000
464	304	0xE800
480	304	0xF000
496	240	0xF800

Block Size

RFID > RFID Chip Params > Block Size	
This menu item selects the maximum number of bytes written to the USR block within the RFID tag memory at one time. Normally, this value is set automatically by the RFID calibration process and should not be changed.	
Minimum	0
Maximum	32
Factory Default	8

RSV SP Min

RFID > RFID Chip Params > RSV SP Min	
This menu item indicates the lower limit of address values for special memory in the Reserved bank of the currently installed RFID tags. Address values between and including the Min and Max may be used in RFID Write and Read commands.	
IMPORTANT	**This value will be hidden if the currently installed tags do not have special RSV memory.**

RSV SP Max

RFID > RFID Chip Params > RSV SP Max	
This menu item indicates the upper limit of address values for special memory in the Reserved bank of the currently installed RFID tags. Address values between and including the Min and Max may be used in RFID Write and Read commands.	
IMPORTANT	**This value will be hidden if the currently installed tags do not have special RSV memory.**

EPC SP Min

RFID > RFID Chip Params > EPC SP Min	
This menu item indicates the lower limit of address values for special memory in the EPC bank of the currently installed RFID tags. Address values between and including the Min and Max may be used in RFID Write and Read commands.	
IMPORTANT	**This value will be hidden if the currently installed tags do not have special EPC memory.**

EPC SP Max

RFID > RFID Chip Params > EPC SP Max	
This menu item indicates the upper limit of address values for special memory in the EPC bank of the currently installed RFID tags. Address values between and including the Min and Max may be used in RFID Write and Read commands.	
IMPORTANT	**This value will be hidden if the currently installed tags do not have special EPC memory.**

TID SP Min

RFID > RFID Chip Params > TID SP Min	
This menu item indicates the lower limit of address values for special memory in the TID bank of the currently installed RFID tags. Address values between and including the Min and Max may be used in RFID Write and Read commands.	
IMPORTANT	**This value will be hidden if the currently installed tags do not have special TID memory.**

TID SP Max

RFID > RFID Chip Params > TID SP Max	
This menu item indicates the upper limit of address values for special memory in the TID bank of the currently installed RFID tags. Address values between and including the Min and Max may be used in RFID Write and Read commands.	
IMPORTANT	**This value will be hidden if the currently installed tags do not have special TID memory.**

USR SP Min

RFID > RFID Chip Params > USR SP Min	
This menu item indicates the lower limit of address values for special memory in the USR bank of the currently installed RFID tags. Address values between and including the Min and Max may be used in RFID Write and Read commands.	
IMPORTANT	**This value will be hidden if the currently installed tags do not have special USR memory.**

USR SP Max

RFID > RFID Chip Params > USR SP Max	
This menu item indicates the upper limit of address values for special memory in the USR bank of the currently installed RFID tags. Address values between and including the Min and Max may be used in RFID Write and Read commands.	
IMPORTANT	**This value will be hidden if the currently installed tags do not have special USR memory.**

Diagnostics Submenu

The following items are in the *RFID > Diagnostics* section and used to check correct behavior with the RFID system or the tags being used. The printer does not move the tag to proper position before performing read/write. To perform diagnostics with RFID tag, you need to manually position the tag at the reader's antenna. This is a quick way to find out the tag type or data in the RFID memory bank. These menus are common for all models.

Read Tag

RFID > Diagnostics > Read Tag
This executable menu reads the tag in range of the internal RFID coupler

<table>
<tr><td colspan="2">and reports the tag data to the debug port and momentarily displays it on the control panel’s LCD. It is primarily intended for development verification by checking that the system is working.</td></tr>
<tr><td>IMPORTANT</td><td><b>This menu item does not position the RFID tag over the coupler. Make sure to position the tag over the coupler to receive an accurate reading.</b></td></tr>
</table>

Read Tag & Eject

<table>
<tr><th colspan="2">RFID > Diagnostics > Read Tag & Eject</th></tr>
<tr><td colspan="2">This executable menu works exactly the same as <i>Read Tag</i> executable, except that after the printer reads the tag, it feeds the label to the next top-of-form.</td></tr>
<tr><td>IMPORTANT</td><td><b>This menu item does not position the RFID tag over the coupler. Make sure to position the tag over the coupler to receive an accurate reading.</b></td></tr>
</table>

Read USR

<table>
<tr><th colspan="2">RFID > Diagnostics > Read Tag</th></tr>
<tr><td colspan="2">This executable menu reads the User Memory bank of the tag in range of the internal RFID coupler and reports the data to the debug port and momentarily displays it on the control panel’s LCD. It is primarily intended for development verification by checking that the system is working.</td></tr>
<tr><td>IMPORTANT</td><td><b>This menu item does not position the RFID tag over the coupler. Make sure to position the tag over the coupler to receive an accurate reading.</b></td></tr>
</table>

Read TID

<table>
<tr><th colspan="2">RFID > Diagnostics > Read TID</th></tr>
<tr><td colspan="2">This executable menu reads the TID (Tag ID) from the tag in range of the internal RFID coupler and displays the value read in the <i>Tag ID</i> menu.</td></tr>
<tr><td>IMPORTANT</td><td><b>This menu item does not position the RFID tag over the coupler. Make sure to position the tag over the coupler to receive an accurate reading.</b></td></tr>
</table>

Tag ID

<table>
<tr><th>RFID > Diagnostics > Tag ID</th></tr>
<tr><td>This menu item displays the first TID (Tag ID) read since power-up, or if using the <i>Read TID</i> menu, the most recently read TID. If no tag is in range of the internal RFID coupler, “Unknown” displays.</td></tr>
</table>

Silicon Name

RFID > Diagnostics > Silicon Name
This menu item displays the name of the tag type that was most recently read and recognized by the printer.

Read PC

RFID > Diagnostics > Read PC	
This executable menu reads the PC (Protocol Control) field from an RFID tag in range of the internal RFID coupler and displays the value read in the *Tag PC* menu.	
IMPORTANT	**This menu item does not position the RFID tag over the coupler. Make sure to position the tag over the coupler to receive an accurate reading.**

Tag PC

RFID > Diagnostics > Tag PC
This menu item displays the last PC (Protocol Control) field read from an RFID tag. If no tag is in range of the internal RFID coupler, “Unknown” displays.

Write EPC with 1s

RFID > Diagnostics > Write EPC with 1s	
This executable menu writes all ones to the tag in range of the internal RFID coupler. It is primarily intended for development verification by checking that the system is working.	
IMPORTANT	**This menu item does not position the RFID tag over the coupler. Make sure to position the tag over the coupler to receive an accurate writing.**

Write EPC with 2s

RFID > Diagnostics > Write EPC with 2s	
This executable menu writes all twos to the tag in range of the internal RFID coupler. It is primarily intended for development verification by checking that the system is working.	
IMPORTANT	**This menu item does not position the RFID tag over the coupler. Make sure to position the tag over the coupler to receive an accurate writing.**

Statistics Submenu

The following items are in the *RFID > Statistics* section and used to store statistics about the RFID system activities. The statistics can be reset by executing the menu ***Clear Tag Stats*** operation within this section.

Reporting Statistics

After any completed print job, you can request a report from the printer which describes the RFID statistics since the printer was turned on, or since the last time the *RFID > Statistics > Clear Tag Stats* was executed.

Requesting an RFID/ODV Report

This procedure prints a summarized RFID report. (This report also includes Validator data if the printer has a Validator installed.)

1. Press the PAUSE key to take the printer OFFLINE.
2. If necessary, press the UP+DOWN ARROW keys at the same time to unlock the front panel.
3. Edit the menu *Tools* > *Print Tests* > *Run Tests*.
4. Find the printer test named “Valid. Report” and press the ENTER key.
5. Lock the panel again using the UP+DOWN ARROW keys.
6. Press PAUSE again to put the printer ONLINE.

RFID Tags Passed

RFID > Statistics > RFID Tags Passed
This menu item displays the number of tags with successful RFID operations since the last *Clear Tag Stat* operation.

Write Tags Fail

RFID > Statistics > Write Tags Fail
This menu item displays the number of failed RFID write tags since the last *Clear Tag Stat* operation.

Read Tags Fail

RFID > Statistics > Read Tags Fail
This menu item displays the number of failed RFID read tags since the last *Clear Tag Stat* operation.

Lock Tags Fail

RFID > Statistics > Lock Tags Fail
This menu item displays the number of failed RFID lock tags since the last *Clear Tag Stat* operation.

Clear Tag Stat

RFID > Statistics > Clear Tag Stat
This executable menu item clears the Count menu items in this submenu.

Resetting RFID Data

The RFID statistics are kept since the last time the *RFID > Statistics > Clear Tag Stats* was executed. For example, you print a large batch of labels reading and writing RFID tags and then print an RFID/ODV report. Then you print/encode another batch of labels and print another report. The report will contain information on both batch jobs. However, if you reset the RFID data between batch jobs, the second report will only contain information on the second batch job.

To reset RFID Data, execute the menu *RFID > Statistics > Clear Tag Stats*.

RFID Reader F/W

RFID > Statistics > RFID Reader F/W
Shows the RFID firmware version installed in the encoder.

RFID Reader Hd/W

RFID > Statistics > RFID Reader Hd/W
Shows the RFID Hardware version installed in the encoder. Not available on T800.

Checking Firmware Revision

For troubleshooting purposes, you may need to reference the RFID firmware revision number. This can be found in two different places within the Settings section:

- RFID > Statistics > RFID Reader F/W.
- TOOLS > About > RFID Reader F/W.

5 *RFID Commands*

This section will cover different emulations that support RFID within the Printronix RFID thermal products. For a full listing of supported commands, please refer to the *Programmers Reference Manuals* available on our website at https://usca.tscprinters.com/en/downloads:

- Incorporate RFID commands into new or existing Printronix PGL® programs.
- Incorporate RFID commands into new or existing ZPL™ programs. By selecting the Printronix ZGL emulation you can seamlessly upgrade from Zebra™ printers.
- Incorporate RFID commands into new or existing SATO® printer language programs. By selecting the Printronix STGL emulation you can seamlessly upgrade from SATO printers. PGL RFID Commands.

IMPORTANT **With all examples make sure *MEDIA > Image > Label Length* matches the physical length of the installed media.**

RFWTAG

Purpose The RFWTAG command is used to program an RFID tag (embedded in a smart label) using structured data format. The data structure of an RFID tag can consist of one or more bit fields. Each bit field specifies its own field length, the data format, the field type plus additional options if the type is incremental, and finally the field value.

Mode CREATE

Format RFWTAG[;LOCKn*[;format]*][;SECUREn[;*format*]];*size*[;offset][*;mem* bank][;*mask*]

(Bit Field) +

STOP

RFWTAG Specifies the RFWTAG command, enter **RFWTAG;**

LOCK*n[;format]*

PERMALOCK*n[;format]*

Optional parameter to lock the data block to prevent it from being overwritten. By default, the data are not locked initially. n is the passcode. The acceptable values for n are 1 to FFFFFFFF in hex, a 4 bytes data. When the LOCKn option is used to lock any memory bank, which at the same time is programmed with the write data, the same passcode will be written on ACS memory bank. The ACS memory bank will also be locked if ACS is not locked at the time of the operation. If ACS is already locked at the time of the operation, the passcode needs to match the current content of ACS so that the memory bank lock takes effect. The passcode (n) can also be in dynamic format. For dynamic format, enter LOCK<DFn>, where DFn is the dynamic field defined in EXECUTE mode. Both LOCK and PERMALOCK share the same syntax. The “RSV” mem bank is not allowed for LOCK or PERMALOCK. For differences in functionality, see Comment 11. Cannot be used together with SECURE*n[;format]* in the same command instance.

format is the optional parameter to specify the format for the passcode data. Enter B for binary, D for decimal, S for ASCII, and H for hexadecimal. The default is decimal if format is not specified.

SECURE*n[;format]*

Optional parameter to include a passcode with the RFID Write operation. A passcode must be included to perform Write operations to specific portions of memory that may only be accessed when the tag is in the Secured State. n is the passcode. The acceptable values for n are 1 to FFFFFFFF in hex, a 4 bytes data. The passcode (n) can also be in dynamic format. For dynamic format, enter SECURE<DFn>, where DFn is the dynamic field defined in EXECUTE mode. format is the optional parameter to specify the format for the passcode data. Enter B for binary, D for decimal, S for ASCII, and H for hexadecimal. The default is decimal if format is not specified. Cannot be used together with LOCK*n[;format]* in the same command instance.

format is the optional parameter to specify the format for the passcode data. Enter B for binary, D for decimal, S for ASCII, and H for hexadecimal. The default is decimal if *format* is not specified.

size A decimal number specifying the overall bit length of the memory bank that will be written starting at the *offset* position (not necessarily the total bank size). Regardless of the overall bank size, any given write segment cannot exceed 256 bytes (2048 bits). The entire size of a bank can be written by entering “FULL” instead of a number. Data will be padded if the full size is not specified in (Bit Field). Only use “FULL” for banks up to 2048 bits.

offset This optional parameter of starting position to do the write relative to the start of the mem bank. The position is a word value (16 bits).

mem bank Specifies which tag logical memory area that this command will be applied. If omitted, it defaults to the EPC memory area. Other areas include Identification, User Data, Access area and Kill area. Enter one of the following values:

‘EPC’ – EPC bank, default start block “2” **‘TID’** – Tag identification bank (currently N/A)

‘USR’ – User bank

‘ACS’ – 4 bytes access code area

‘KIL’ – 4 bytes kill code area

‘PC’ – 2 bytes PC code area (Gen 2 tags only)

‘RSV’ – Reserved field

mask The PC mask can be used to specify certain bits to be honored in the *Bit Field*, and others omitted. The mask must be 2 bytes long and specified in Hex format. The mask is only allowed when *mem bank* is “PC”. If no mask is specified, a default mask with all bits set will be used and will cause the PC data from the *Bit Field* to be written as is. A mask specified with no bits set will result in an error. The first 5 bits of the mask (the PC length bits) can be omitted as a whole. Otherwise, if the length bits of the mask interfere with the length bits of the *Bit Field*, an error will result

Bit Field A line description of a bit field and must have one of the following syntax formats:

1. For non-incremental data (both static and dynamic):

   length;[**DF***n*;]*format*;(D)*datafield*(D)

2. For incremental fixed data:

   length;**I**;*format*;**STEP**[*idir*]*step*;[**RPT***n*;][**RST***n*;](D)*startdata*(D)

3. For dynamic incremental data:

   length;**IDF***n*;*format*;

length A decimal number specifying the bit length of a field within a tag. The maximum length for each DFn field or static field of NON-HEX format is 64 bits. For hexadecimal format, the bit length can be up to the maximum bit length specified for the corresponding memory bank.

DF*n* Optional parameter to indicate this field has dynamic data. Replace *n* with a number ranging from 1 to 512 to identify the field number of this particular field. If this option is used, *datafield* is ignored, and dynamic data must be entered via the DF command in the EXECUTE mode.

IDF*n* Enter **IDF** to indicate this field is a bit field with dynamical assignment of increment (or decrement) data. The *step* and *startdata* parameters will be supplied by the IDF command in the EXECUTE mode. Replace *n* with a number ranging from 1 to 512 to identify the field number of this bit field. Dynamically enter the *step* and *startdata* parameters using the IDF command in the EXECUTE mode.

1. The same field number cannot be used in both DFn and IDFn.
2. If a field is defined as IDFn, it must be referenced as IDFn later for consistency. The same applies for DFn.
3. If <IDFn> syntax is used for merging data into AFn or BFn, neither DFn, AFn, or BFn will be incremented. The increment only takes place in the ~DFn command where the STEP is specified.

format A letter specifying the format of the data field.
B – binary, **D** – decimal, **S** – string, **H** – hexadecimal

(D) Delimiter designating the start and end of static data for this bit field. Replace (D) with any printable character, except the SFCC and the slash character (/).

datafield The static data of this static field. It is a mandatory parameter of bit field with static data.

I Identifies this field is an incremental bit field.

STEP Specifies that the incremental data field will use the step method. Enter **STEP;**. The STEP option replaces the STEPMASK option that is used in Alpha and Barcode.

idir Enter a plus sign (+) or leave the field blank to increment (default). Enter a minus sign (–) to decrement.

step A decimal number specifies the amount to increment/decrement each time the form is executed. The increment is at bit level and will automatically wrap based on the field size.

RPT*n* The optional incremental repeat count parameters to specify the number of times a particular field value is repeated before it is incremented. The default repeat count parameter *n* is 1, which will increment the field value each time it prints. The repeat count can range from 1 to 65535.

RST*n* The optional incremental reset count parameter to specify the number of times an incremented field is printed before it is reset to the starting value. By default, there is no reset count. The reset count parameter *n* can range from 1 to 65535.

startdata Defines the value of the field or the starting value of the incremented field. If the field is dynamic, the value will be specified later in the EXECUTE mode. The data must be specified within a pair of delimiters (D). The delimiter (D) cannot be a “/” or SFCC character since the “/” will comment out the rest of the line and SFCC is reserved for PGL commands. If “R” or “S” is used as delimiters, the data pattern must not comprise of the keywords in the incrementing options. Since the delimiters could be different from one value to another, proper care must be taken to avoid one of the letters mentioned above.

Comments

1. The RFWTAG command cannot be mixed with RFWRITE in the same form.
2. Each field structure must be specified in a single line and in the order it appears in the RFID tag from MSB bits to LSB bits (left to right). The sum of all the field lengths must match the size of the tag.
3. The host data are read in as ASCII characters. They would be converted to binary representation for the base field on the field format. Therefore, if the converted value is larger than the maximum value that a field can hold, an error will be reported. If the data value is smaller than the specified field length, on the other hand, the field will be padded to the left with zero bits.
4. Unlike the Alpha and Barcode command which use STEPMASK for incremental data, RFWTAG uses the STEP which will increment or decrement at bit level.
5. 432 IGP dots in the ~CREATE line specifies a 6 inch label. 6 inches = 432 (IGP dots)/72 (dpi)

   Use 144 for 2 inch labels and 288 for 4 inch labels.

6. ACS and KIL are similar to other memory banks. ACS contains the passcode which is used for LOCK and UNLOCK operations. KIL contains the killcode which is used to kill a tag. The user can write to or read from KIL memory bank, but the functionality of killing a tag is not currently applicable. Also, once ACS and KIL are locked, both cannot be written to or read from. For other memory banks, EPC, USR, and TID, once locked, they can be read from but not written to.
7. There are two ways to program the ACS memory area. One is to write to the ACS memory area directly with RFWTAG. The other is to use the LOCK option while writing to other memory banks. If ACS is not previously locked, then LOCK option will lock the memory bank and also write the passcode to ACS and lock ACS. When write to ACS with RFWTAG, ACS is not automatically locked. To lock ACS, use LOCKn with RFWTAG, where the passcode (n) should be the same as the write data to ASC.
8. There is only one passcode, the content of ACS memory bank, for each tag. The same passcode is used to lock or unlock any memory bank in that tag.
9. For LOCKn and UNLOCKn, the passcode (n) (which includes the dynamic format <DFn>) does not accept incremental data. This also applies to the ACS and KIL memory banks. The write data to the ACS and KIL memory banks do not accept incremental data because the ACS memory bank contains passcodes for LOCK and UNLOCK operations, and the KIL memory bank contains a killcode to kill a tag. Incremental data do not apply to passcodes or killcodes.
10. When LOCK<DFn> and UNLOCK<DFn> are used in the same form with the same dynamic data (the passcode), the dynamic format <DFn> needs to be a different dynamic number for LOCK and UNLOCK since it is designed with a unique dynamic number that can be linked to only one object type. In this case, LOCK is linked to RFWTAG object and UNLOCK is linked to RFRTAG object. Although both options use the same passcode, the dynamic format needs to be in a different dynamic number in the same form.
11. Both LOCK and PERMALOCK requires the user to enter the password. Once the tag is permanently locked with the PERMALOCK command, it cannot be unlocked again; the tag can only be read from and never be written to once it is permanently locked. On the other hand, after the tag is locked with the LOCK command, it can be unlocked again with the same password.
12. For PERMALOCK (ex, EPC), the password must match the current content of ACS bank for PERMALOCK to work. If the current content of ACS bank is null (0x0) which could be the case for the brand new tag, the password for PERMALOCK EPC will be 0x0. If you use a different password for PERMALOCK, you need to write (RFWTAG) the new content (password) to ACS first, and then use this new password to PERMALOCK EPC.
13. For LOCK (ex, EPC), the password may be different from the current content of ACS. When a new password is used to lock EPC where ACS is not locked, this new password is written to ACS and locks ACS at the same time while locking EPC. For new tags where ACS is not locked and has all null data, you can lock EPC with a new password directly without writing to ACS first.

Example 1

The following example programs an SGTIN–64 value into the RFID tag that is embedded in a 4x6 smart label. Assume that the SGTIN–64 value is provided as a single number.

```
~CREATE;SGTIN-64;432
RFWTAG;64
64;H;*87D0034567ABCDEF*     /EPC number
STOP
END
~EXECUTE;SGTIN-64;1
~NORMAL
```

Example 2

Same as Example 1, except the EPC number is broken into its component parts. Assume that the SGTIN–64 value has the Header = 2d, Filter Value = 5d, EPC Manager Index = 15383d, Object Class = 703710d or 0xABCDE, and the Serial Number = 0123456d.

```
~CREATE;SGTIN-64;432
RFWTAG;64
2;B;*10*             /Header
3;D;*5*              /Filter Value
14;D;*15383*         /EPC Manager Index
20;H;*ABCDE*         /Object Class
25;D;*0000123456*    /Serial Number
STOP
END
~EXECUTE;SGTIN-64;1
~NORMAL
```

Example 3

Same as Example 2, except it uses a dynamic method. This example also shows how to program another RFID tag without redefining the data structure of the SGTIN–64.

```
~CREATE;SGTIN-64;432
RFWTAG;64
2;DF1;B              /Header
3;DF2;D              /Filter Value
14;DF3;D             /EPC Manager Index
20;DF4;H             /Object Class
25;DF5;D             /Serial Number
STOP
ALPHA
AF1;18;10;5;3;3
STOP
END
~EXECUTE;SGTIN-64
~DF1;*10*            /Header
~DF2;*5*             /Filter Value
~DF3;*15383*         /EPC Manager Index
~DF4;*ABCDE*         /Object Class
~DF5;*0000123456*    /Serial Number
~AF1;<DF5>           /Print serial number on label
~NORMAL
```

```
~EXECUTE;SGTIN-64
 ~DF1;*10*             /Header
~DF2;*5*               /Filter Value
~DF3;*15383*           /EPC Manager Index
~DF4;*ABCDE*           /Object Class
~DF5;*0000123456*      /Serial Number
~AF1;<DF5>             /Print serial number on label
~NORMAL
```

Example 4

This example shows the EPC Write and Read with the alphanumeric format.

```
~NORMAL
~CREATE;TEST1;X
RFWTAG;128;EPC
64;S;*12811111*
64;S;*11111128*
STOP
RFRTAG;128;EPC
64;DF1;S
64;DF2;S
STOP
VERIFY;DF1;S;*EPC = *;*\r\n*
VERIFY;DF2;S;*EPC = *;*\r\n*
END
~EXECUTE;TEST1
~NORMAL
```

Example 5

This example shows how to program a roll of 1500 smart labels with SGTIN–64 values, where the Header = 2d, Filter Value = 5d, EPC Manager Index = 15383d, Object Class = 703710d or 0xABCDE, and the Serial Number starting from 0000000 to 0001499d.

```
~CREATE;SGTIN-64;432
RFWTAG;64
2;B;*10*               /Header
3;D;*5*                /Filter Value
14;D;*15383*           /EPC Manager Index
20;H;*ABCDE*           /Object Class
25;I;D;STEP1;*0*       /Serial Number
STOP
END
~EXECUTE;SGTIN-64;ICNT1500
~NORMAL
```

Example 6

This example shows how to program a 96 bit RFID tag. A SGTIN–96 format is used and the EPC number is broken into its component parts. Assume that the SGTIN–96 value has the Header = 48, Filter Value = 5d, EPC Manager Index = 123456d, Object Class = 777777d or 0xBDE31, and the Serial Number = 123456d.

96 bit tags must be broken up as in Examples 2, 3, and 4, and no field can be more than 64 bits in length if the format is binary or decimal. There is no restriction on the bit length if the format is hexadecimal.

```
~CREATE;SGTIN-96;432
RFWTAG;96
8;B;*00110000*       /Header
3;D;*5*              /Filter Value
3;D;*6*              /Partition
20;D;*123456*        /EPC Manager Index
24;D;*777777*        /Object Class
38;D;*123456*        /Serial Number
STOP
END
~EXECUTE;SGTIN-96;1
~NORMAL
```

Example 7

This example shows memory bank usage, where multiple RFWTAG and RFRTAG can be used.

```
~CREATE;SGTIN;216
SCALE;DOT;203;203
RFWTAG;96;EPC
96;IDF1;H
STOP
RFRTAG;96;EPC
96;DF3;H
STOP
RFWTAG;256;USR
256;IDF2;H
STOP
RFRTAG;256;USR
256;DF4;H
STOP

ALPHA
IAF1;24;POINT;90;60;16;6
IAF2;64;POINT;130;60;16;4
STOP

BARCODE
C3/9;X1;IBF1;64;170;60
PDF
STOP

VERIFY;DF1;H;*EPC W= *;*\r\n*
VERIFY;DF3;H;*EPC R= *;*\r\n*
VERIFY;DF2;H;*USR W= *;*\r\n*
VERIFY;DF4;H;*USR    R= *;*\r\n*

END
~EXECUTE;SGTIN;ICNT4
~IDF1;STEP+1;*313233343536373839414243*
~IDF2;STEP+1;*3132333435363738394142434445464748494A
4B4C4D4E4F*
~IAF1;<DF3>
~IAF2;<DF4>
```

```
 ~IBF1;<DF3>
 ~NORMAL
```

Example 8

This example shows the LOCK and UNLOCK options used with RFWTAG and RFRTAG.

```
~NORMAL
~CREATE;TEST1;X
RFRTAG;UNLOCK12345678;H;96;EPC
96;DF1;H
STOP
RFWTAG;LOCK12345678;H;96;EPC
96;H;*960101010101010101010196*
STOP
END
~EXECUTE;TEST1
 ~NORMAL
```

Example 9

This example shows memory bank usage with LOCK and UNLOCK option, where multiple RFWTAG and RFRTAG can be used, and the passcode for lock and unlock can be in dynamic format.

```
~CREATE;SGTIN;432
SCALE;DOT;203;203
RFWTAG;LOCK<DF6>;D;96;EPC
96;DF1;H
STOP
RFRTAG;UNLOCK<DF7>;D;96;EPC
96;DF2;H
STOP
RFWTAG;LOCKA1B2C3;H;32;KIL
32;DF3;H
STOP
RFRTAG;UNLOCKA1B2C3;H;32;KIL
32;DF4;H
STOP
RFWTAG;LOCK<DF8>;H;32;ACS
32;DF6;D
STOP
RFRTAG;UNLOCK<DF9>;H;32;ACS
32;DF10;H
STOP
ALPHA
AF1;24;POINT;400;60;16;6
AF2;8;POINT;600;60;16;6
AF3;6;POINT;800;60;16;6
AF4;8;POINT;1000;60;16;6
STOP
VERIFY;DF1;H;*DF1 = *;*\r\n*
VERIFY;DF2;H;*DF2 = *;*\r\n*
VERIFY;DF4;H;*DF4 = *;*\r\n*
VERIFY;DF6;H;*DF6 = *;*\r\n*
VERIFY;DF7;H;*DF7 = *;*\r\n*
```

```
VERIFY;DF8;H;*DF8 = *;*\r\n*
VERIFY;DF9;H;*DF9 = *;*\r\n*
VERIFY;DF10;H;*DF10 = *;*\r\n*
END
~EXECUTE;SGTIN;FCNT3
~DF1;*313233343536373839414243*
~DF3;*44454647*
~DF6;*10597059*
~DF7;*10597059*
~DF8;*A1B2C3*
~DF9;*A1B2C3*
~AF1;<DF2>
~AF2;<DF6>
~AF3;<DF8>
~AF4;<DF10>
~NORMAL
```

Example 10

This example shows the usage of RFWTAG with PC field which needs to be followed immediately by RFWTAG with EPC field. There is not restriction for RFRTAG with PC filed.

```
~NORMAL
~CREATE;TEST1;432
RFWTAG;16;PC
16;H;*3000*
STOP
RFWTAG;96;EPC
96;H;*313233343536373839414243*
STOP
RFWTAG;256;USR
256;H;*3132333435363738394142434445464748494A4B*
STOP
RFRTAG;16;PC
16;DF1;H
STOP
RFRTAG;96;EPC
96;DF2;H
STOP
VERIFY;DF1;H;*DF1 = *;*\r\n*
VERIFY;DF2;H;*DF2 = *;*\r\n*
END
~EXECUTE;TEST1
~NORMAL
```

Example 11

This example shows the usage of PERMALOCK.

```
~NORMAL
~CREATE;RFID;432
ALPHA
IAF1;24;POINT;4;5;10;10
STOP
```

```
RFWTAG;32;ACS
32;H;*ABC*
STOP
RFWTAG;PERMALOCKABC;H;96;EPC
96;IDF1;H
STOP
RFRTAG;96;EPC
96;DF2;H
STOP
VERIFY;DF2;H;* *
END

~EXECUTE;RFID;ICNT5
IDF1;STEP+1;*222222222222222222220011*
IAF1;<DF2>
~NORMAL
```

Example 12

This example shows the access of 240 bits EPC and 512 bits USR.

```
~CREATE;TEST;X;NOMOTION
RFWTAG;LOCK0C0D0E0F;H;240;EPC
240;I;H;STEP+1;*0102030405060708091011121314
151617181920212223242526272829 30*
STOP
RFWTAG;LOCK0C0D0E0F;H;512;USR
512;I;H;STEP+1;*0102030405060708091011121314
15161718192021222324252627282930313233343 5
3637383940414243444546474849505152535455 56
5758596061626364*
STOP
RFWTAG;LOCK0C0D0E0F;H;32;KIL
32;H;*08090A0B*
STOP
RFRTAG;UNLOCK0C0D0E0F;H;32;ACS
32;DF31;H
STOP
VERIFY;DF31;H;*#ACS=*;“\r\n”
RFRTAG;UNLOCK0C0D0E0F;H;32;KIL
32;DF22;H
STOP
VERIFY;DF22;H;*KIL=*;“\r\n”
RFRTAG;UNLOCK0C0D0E0F;H;240;EPC
240;DF1;H
STOP
VERIFY;DF1;H;*EPC=*;*\r\n
RFRTAG;UNLOCK0C0D0E0F;H;512;USR
512;DF7;H
STOP
VERIFY;DF7;H;*USR=*;*\r\n*
END
~EXECUTE;TEST;10
~NORMAL
```

Example 13

This example shows the EPC and PC Write with the PC mask.

```
~NORMAL
~CREATE;TEST1;X
RFWTAG;16;PC;3044
16;H;*30FF*
STOP
RFWTAG;96;EPC
96;H;*961111111111111111111196*
STOP
RFRTAG;16;PC
16;DF1;H
STOP
VERIFY;DF1;H;*PC = [ *;* ] \r\n*
END
~EXECUTE;TEST1
~NORMAL
```

Example 14

This example shows the offset option used with RFWTAG and RFRTAG.

```
~NORMAL
~CREATE;TEST1;X
RFWTAG;32;4;USR
32;H;*32000032*
STOP
RFRTAG;32;4;USR
32;DF1;H
STOP
VERIFY;DF1;H;*USR = *;*\r\n*
END
~EXECUTE;TEST1
~NORMAL
```

Example 15

This example shows the “FULL” size option used with RFWTAG.

```
~NORMAL
~CREATE;TEST1;X
RFWTAG;FULL;EPC
48;H;*961111111111*
48;H;*111111111196*
STOP
END
~EXECUTE;TEST1
~NORMAL
```

Example 16

This example shows a Secured-State write with the SECURE syntax of the RFWTAG command. The passcode is 32000032h, and the memory written is the USR field at address 168d.

```
~NORMAL
~CREATE;TEST1;X
RFWTAG;SECURE32000032;H;16;168;USR
16;H;*1010*
STOP
END
~EXECUTE;TEST1
~NORMAL
```

RFRTAG

Purpose To read the content of an RFID tag (embedded in a smart label) into a dynamic field. This command cannot be mixed with the RFREAD command.

Mode CREATE

Format RFRTAG[;UNLOCKn*[;format]*][;SECUREn[;*format*]];*size*[;offset][*;mem bank*][;KEY1 *AES Key Value*]

(Bit Field)+

STOP

RFRTAG Specifies the RFRTAG command, enter **RFRTAG;**

size A decimal number specifying the overall bit length of the RFID tag memory bank that will be read starting at the *offset* position (not necessarily the total bank size). Regardless of the overall bank size, any given read segment cannot exceed 256 bytes (2048 bits).

offset This optional parameter of starting position to do the read relative to the start of the mem bank. The position is a word value (16 bits).

UNLOCK*n[;format]*

PERMAUNLOCK*n[;format]*

Optional parameter to unlock the data block so it can be overwritten later. n is the passcode. The acceptable values for n are 1 to FFFFFFFF in hex, a 4 bytes data. The value of n should be the same passcode used for the LOCK option to unlock the protected data block. When the UNLOCKn or PERMAUNLOCKn option is used to unlock any memory bank, which at the same time is programmed to read the tag, the operation will unlock ACS memory area. The passcode (n) can also be in dynamic format. For dynamic format, enter LOCK<DFn>, where DFn is the dynamic field defined in EXECUTE mode. Cannot be used together with SECURE*n[;format]* in the same command instance.

format is the optional parameter to specify the format for the passcode data. Enter B for binary, D for decimal, S for alphanumeric, and H for hexadecimal. The default is decimal if *format* is not specified.

SECUREn[;format]

Optional parameter to include a passcode with the RFID Read operation.

A passcode must be included to perform Read operations to specific portions of memory that may only be accessed when the tag is in the Secured State. n is the passcode. The acceptable values for n are 1 to FFFFFFFF in hex, a 4 bytes data. The passcode (n) can also be in dynamic format. For dynamic format, enter SECURE<DFn>, where DFn is the dynamic field defined in EXECUTE mode. format is the optional parameter to specify the format for the passcode data. Enter B for binary, D for decimal, S for ASCII, and H for hexadecimal. The default is decimal if format is not specified. Cannot be used together with UNLOCKn[;format] in the same command instance.

format is the optional parameter to specify the format for the passcode data. Enter B for binary, D for decimal, S for ASCII, and H for hexadecimal. The default is decimal if format is not specified.

mem bank Specifies which tag logical memory area that this command will be applied. If omitted, it defaults to the EPC memory area. Other areas include Identification, User Data, Access area, and Kill area. Enter one of the following values:

'EPC' – EPC field, default start block "2", PC dependent

'EPCRAW' **–** EPC field, default start block "2", PC independent

'TID' – Tag identification field

'USR' – User field

'ACS' – 4 bytes access code area

'KIL' – 4 bytes kill code area

'PC' – 2 bytes PC code area (Gen 2 tags only)

KEY1 AES KEY Value

Enter KEY1 for Authentication or Encrypt/Decrypt followed by a space and then the 16-byte AES Key Value, containing exactly 32 Hex Characters (0-9, A-F) in left-right order Byte 0 .. Byte 15.

Bit Field A line description of a bit field; must have one of the syntax formats:

length;**DF***n***;***format*

length A decimal number specifying the bit length of a field within a tag. The maximum length is 64 bits for binary or decimal format. For hexadecimal format, the bit length can be up to the maximum bit length specified for the corresponding memory bank.

DF*n* Indicate dynamic data field to store the read result. Replace *n* with a number ranging from 1 to 512 to identify the field number of this field.

format A letter specifying the representation format of the field data.

B – binary, **D** – decimal, **S** - string
H – hexadecimal

1. Multiple RFRTAG commands are allowed in the same form but the same DFn field cannot be defined multiple times.
2. The DF field length is restricted to 64 bits for binary or decimal format and must be a multiple of 8 bits. The sum of all field lengths must be equal to the tag size.
3. The first field always start at the MSB bit. The bit length of a field dictates the start bit of the next field, etc. As a result, DF fields will not overlap each other.
4. RFRTAG does not allow incremental fields (with the "I" prefix).
5. 432 IGP dots in the ~CREATE line specifies a 6 inch label. 6 inches = 432 (IGP dots)/72 (dpi)

   Use 144 for 2 inch labels and 288 for 4 inch labels.

Example 1

Same as **Example 5** of RFWTAG, except the increment is dynamic and the result is merged into Alpha to print on the smart label.

```
~CREATE;SGTIN-64;432
RFWTAG;64
2;B;*10*               /Header
3;D;*5*                /Filter Value
14;D;*15383*           /EPC Manager Index
20;D;*123456*          /Object Class
25;IDF1;H              /Serial Number STOP
RFRTAG;64
64;DF2;H;
STOP
ALPHA
IAF1;16;3;12;0;0
STOP
END
~EXECUTE;SGTIN-64;ICNT1500
~IDF1;STEP+1;*0*
~IAF1;<DF2>

~NORMAL
```

Comments

1. The <IDF1> usage does not increment the DF1 field. It merges the DF1 content into the AF1 field, keeping the same representation previously defined for IDF1.
2. The use of IAF1 is to print alpha on every label. If AF1 is used instead, only the first label is printed. The AF1 field is not incremented either since it is using the result from the DF1 merge.

Example 2

This example performs Permaunlock on the EPC and ACS fields using the hex passcode: 12345678.

```
~NORMAL
~CREATE;TEST1;X
RFRTAG;PERMAUNLOCK12345678;H;64;EPC
64;DF1;H
STOP
VERIFY;DF1;H;*EPC = *;*\r\n*
RFRTAG;PERMAUNLOCK12345678;H;32;ACS
```

```
32;DF1;H
STOP
VERIFY;DF1;H;*ACS = *;*\r\n*
END
~EXECUTE;TEST1
~NORMAL
```

Example 3

This example performs a Secured-State read from the Reserved Field. The passcode is 32000032h.

```
~NORMAL

~CREATE;TEST1;X

RFRTAG;SECURE32000032;H;16;52;RSV

16;DF1;H

STOP

VERIFY;DF1;H;*RSV = [ *;* ] \r\n*

END

~EXECUTE;TEST1
~NORMAL
```

RFWGS1

Purpose The RFWGS1 command is used to program an RFID tag. This command will write data into the EPC memory bank according to the memory portions that are specified.

Mode CREATE

Format RFWGS1;LEN;Data

ATT;Data

EPC;Data

STOP

RFWGS1 The command identifier; enter **RFWGS1**.

LEN;Data This optional parameter identifies the data that will be written to the PC length bits located in the EPC bank at bit addresses 10h to 14h. The Data must be in hex format, or enter “FULL” to set the max amount of length bits supported by the tag installed.

ATT;Data This optional parameter identifies the data that will be written to the Attribute bits located in the EPC bank at bit addresses 18h to 1Fh. The Data must be in hex format.

EPC;Data This optional parameter identifies the data that will be written to the EPC bank starting from bit address 20h. The Data must be in hex format.

Comments

1. Any portion of data can be omitted. Omitted portions of the PC will not be overwritten and the existing values will be preserved.
2. The T-Bit of the PC data (bit address 17h) is always written to zero with the RFWGS1 command.

Example 1

This example performs a 12 byte RFID Write operation in the EPC field starting from bit address 20h..

```
~NORMAL
~CREATE;TEST1;X
RFWGS1;EPC;961111111111111111111196
STOP
END
~EXECUTE;TEST1
~NORMAL
```

Example 2

This example performs RFID write operations for the PC length field, Attribute bits, and EPC data field.

```
~NORMAL
~CREATE;TEST1;X
RFWGS1;LEN;40
ATT;11
EPC;12800000000000000000000000000128
STOP
END
~EXECUTE;TEST1
~NORMAL
```

Example 3

This example performs RFID write operations for the PC length bits and the EPC data field. The length bits are written to the max size allowed on the installed tag.

```
~NORMAL
~CREATE;TEST1;X
RFWGS1;LEN;FULL
EPC;961111111111111111111196
STOP
END
~EXECUTE;TEST1
~NORMAL
```

RFWISO

Purpose The RFWISO command is used to program an RFID tag. This command will write data into the EPC memory bank according to the memory portions that are specified.

Mode CREATE

Format RFWISO;LEN;Data

AFI;Data

UII;Data

STOP

RFWGS1 The command identifier; enter **RFWISO**.

LEN;Data This optional parameter identifies the data that will be written to the PC length bits located in the EPC bank at bit addresses 10h to 14h. The Data must be in hex format, or enter “FULL” to set the max amount of length bits supported by the tag installed.

AFI;Data This optional parameter identifies the data that will be written to the AFI bits located in the EPC bank at bit addresses 18h to 1Fh. The Data must be in hex format.

UII;Data This optional parameter identifies the data that will be written to the EPC bank starting from bit address 20$_h$. The Data must be in hex format.

Comments

1. Any portion of data can be omitted. Omitted portions of the PC will not be overwritten and the existing values will be preserved.
2. The T-Bit of the PC data (bit address 17h) is always written to one with the RFWISO command.

Example 1

This example performs RFID write operations for the PC length field, AFI bits, and UII data field.

```
~NORMAL
~CREATE;TEST1;X
RFWISO;LEN;40
AFI;11
UII;12800000000000000000000000000128
STOP
END
~EXECUTE;TEST1
~NORMAL
```

VERIFY

Purpose Request the printer to send to the host the ASCII representation of a dynamic field. The dynamic field could be one of AFn, BFn, or DFn, but cannot be RFn.

The Verify command is supported only on Thermal printers.

Mode CREATE

Format VERIFY**;field;***format***;**(D)*ASCIIheader*(D);(D)*ASCIITrailer*(D)

VERIFY The command to verify data of a dynamic field, enter VERIFY;

field The dynamic field AFn, BFn, or DFn that contains the data to be sent to the host.

format A letter specifying the format of the outgoing data to be sent to the host.

B – binary, **D** – decimal, **H** – hexadecimal, **S** – string

Based on the incoming format of the data field, a format conversion may be performed if the outgoing format is not the same. The AFn and BFn format is always S type. The DFn format could be either B, D, or H. Due to the possible conversion the outgoing data stream could be longer than the incoming one. The maximum length for the outgoing data is 512 bytes. If the format request will result in a data stream exceeding the maximum length, an error would be reported.

ASCIIheader A mandatory parameter to specify an ASCII string of characters, which is followed by the RFID data, to be sent by the printer to the host.

ASCIItrailer An optional parameter to specify an ASCII string of characters, which will follow the RFID data, to be sent by the printer to the host.

(D) Delimiter designating the start and end of a character string. Replace (D) with any printable character, except the SFCC and the slash character (/). The string could be empty, i.e. there are not headers preceding the field data.

1. The DFn field must be defined previously in the CREATE mode before it can be specified in the VERIFY command otherwise it will be considered as a syntax error and the VERIFY command will abort.
2. All RFID Read/Write commands are executed first in the order they appear in CREATE mode, followed by Alpha and Barcode commands, and finally VERIFY commands. The VERIFY commands are always executed last although they may appear before other commands in the CREATE mode. The reason for this is to make sure the data are sent back to the host only if other commands are completed and the form is not aborted.
3. If the data comes from a DFn field, the DFn format is the original format before any conversion. If the VERIFY command specifies a different format, the data would then be converted to the new format. If the data comes from an AFn or BFn, the original format is S format.
4. Below is the possible syntax for header and trailer string,

```
1, VERIFY;DF2;H;*Head = *               //Header only
2, VERIFY;DF2;H;*Head = *; *Tail*       //Header & trailer
3, VERIFY;DF2;H;**;*Tail*               //Trailer only
4, VERIFY;DF2;H;*Head = *;**            //Header only
```

To insert the CR/LF character, add “\r” and “\n” as CR/LF characters, such as

```
VERIFY;DF2;H;*Head=*; *Tail\r\n*        //“Head=<tag data>Tail<CR><LF>”
```

If the user wants to display “\r” or “\n” as normal text character, do the following:

```
VERIFY;DF2;H;*Header\\r\\n*    //this will display “Header\r\n” on the screen, where
                               double back slash “\\” (0x5C 0x5C) will be replaced with
```

one back slash ‘\’ (0x5C).

The characters \r and \n can be inserted anywhere in the header string and trailer string.

To summarize,

\r –> 0x0D	//CR
\n –> 0x0A	//LF
\\ –> \	//one back slash

Example 1

This example requests the printer to send to the host the content of the RFID tag, in hexadecimal format, both before and after the RFWTAG command writes data to the tag. Also, the label is not moved.

```
~CREATE;VERIFY;432;NOMOTION
RFRTAG;64
64;DF1;H
STOP
VERIFY;DF1;H;*TagBefore=*
RFWTAG; 64
2;B;*01*
6;D;*29*
24;H;*466958*
17;H;*ABC*
15;D;*1234*
STOP
RFRTAG;64
64;DF2;H
STOP
VERIFY;DF2;H;*TagAfter=*
END
~EXECUTE;VERIFY;1
~NORMAL
TagBefore=A5A500005D055E04              <== Whatever data inside the tag before
TagAfter=5D466958055E04D2               <== Should match with RFWTAG command
```

Example 2

This example reads a roll of 1500 pre-programmed smart labels.

```
~CREATE;READONLY;432
RFRTAG;64
64;DF1;H
STOP
VERIFY;DF1;H;**
END
~EXECUTE;READONLY;1500
~NORMAL

A5A500005D055E04                        <== Data from first tag
   …                                    <== Data from 1498 tags in middle
A5A50000000550D4                        <== Data from last tag
```

Example 3

This example requests the printer to program a roll of 2000 smart labels using the RFWTAG command with incremental field. Then, it sends the actual data from each of the 2000 tags to the host.

```
~CREATE;SIMPLE;432;NOMOTION
RFWTAG;64
2;B;*01*
6;D;*29*
24;H;*466958*
17;H;*ABC*
15;I;D;STEP+1;*0000*
STOP
RFRTAG; 64
64;DF1;H
STOP
VERIFY;DF1;H;*Data=*
END
~EXECUTE;SIMPLE;ICNT2000
~NORMAL

Data=5D466958055E0000                    <== Should be the newly programmed data.
Data=5D466958055E0001
   ….
Data=5D466958055E07CE
Data=5D466958055E07CF                    <== Should be the last programmed data
```

RFLOCK

Purpose Perform different types of RFID lock operations on available RFID data fields.

Mode CREATE

Format RFLOCK**;type***[***;***field list][***;***BlockStart***;***BlockQuantity]*

Format;Passcode

STOP

RFLOCK The command to lock or unlock RFID data fields, enter RFLOCK;

type The type of lock command Legal options are *LOCK*, *PERMALOCK*, *PERMABLOCK*, *PERMACHIP, UNLOCK, PERMAUNLOCK* (Lock, Permalock, Block Permalock, Full Chip Permalock, Unlock, Permaunlock). If “Type” is *PERMACHIP*, all other parameters, including “Format” and “Passcode”, are ignored and should be left blank.

field list Identify the desired field(s) for the lock request. Legal options are *EPC*, *USR*, *ACS*, *KIL*. Multiple fields may be listed in any order, separated by commas (e.g. ACS,KIL,EPC). Any fields not listed will not be affected by this command. “Field List” does not apply to *PERMABLOCK* or *PERMACHIP* and should be left blank for these types.

BlockStart;BlockQuantity The USR field is the only field that can be affected by Block Permalock. Use “BlockStart” to specify the first “block” to be permalocked. The size of one block is silicon-specific and determined by the chip manufacturer. The legal minimum is zero, and the maximum depends on the tag size. Use “BlockQuantity” to specify the number of blocks to be permalocked. The legal minimum is one, and the maximum depends on the tag size. If “Type” is PERMABLOCK and “BlockStart;BlockQuantity” is omitted, an error will be reported.

Format
The format in which the passcode will be defined. Legal options are *B* for binary, *D* for decimal, *S* for alphanumeric, and *H* for hexadecimal. Ignored when “Type” is *PERMACHIP*.

Passcode
The value of the passcode for the lock operations. The size for the passcode is 32 bits. The passcode must be non-zero when “Type” is *LOCK* or *UNLOCK*. The passcode can also be in dynamic format; for dynamic format, enter <DFn>, where DFn is the dynamic field defined in EXECUTE mode. Ignored if “Type” is *PERMACHIP*.

Example 1

This example performs a 12 byte RFID Write operation in the EPC field and RFID Lock operations in the EPC, USR, ACS, and KIL fields using the hexadecimal Passcode: 12345678.

```
~NORMAL
~CREATE;TEST1;X
RFWTAG;96;EPC
96;H;*961111111111111111111196*
STOP
RFLOCK;LOCK;EPC,USR,ACS,KIL
H;12345678
STOP
END
~EXECUTE;TEST1
~NORMAL
```

Example 2

This example performs a 12 byte RFID Write operation in the USR field and a RFID Block Permalock operation that permalocks blocks 0, 1, and 2 of the USR field using the binary Passcode: 10010001101000101011001111000.

```
~NORMAL
~CREATE;TEST1;X
RFWTAG;96;USR
96;H;*961111111111111111111196*
STOP
RFLOCK;PERMABLOCK;0;3
B; 10010001101000101011001111000
STOP
END
~EXECUTE;TEST1
~NORMAL
```

Example 3

This example performs a 12 byte RFID Write operation in the EPC field and a Full Chip Permalock.

```
~NORMAL
```

```
~CREATE;TEST1;X
RFWTAG;96;EPC
96;H;*963333333333333333333396*
STOP
RFLOCK;PERMACHIP
STOP
END
~EXECUTE;TEST1
~NORMAL
```

Example 4

This example performs a RFID Permaunlock operation in the EPC and ACS fields using the hexadecimal Passcode: 12345678.

```
~NORMAL
~CREATE;TEST1;X
RFLOCK;PERMAUNLOCK;EPC,ACS
H;12345678
STOP
END
~EXECUTE;TEST1
~NORMAL
```

RFSERL

Purpose Insert serialization data obtained from reading RFID fields into other RFID Write operations and print commands. Serialization data is saved into separate fields identified by an index number and can be used inside static data fields. Serialization fields can have a predefined length and “source” RFID field, or a custom field can be made with a user-specified length and “source” RFID field. Serialization data is inserted using the SO character, which can be configured using a printer menu: **Settings > Application > PGL Setup > Select SO Char**.

Mode CREATE

Format RFSERL;n;Field;StartBit;Length

RFSERL The command identifier; enter **RFSERL**.

n Parameter to indicate field-serialization data. Replace “n” with a hex number between 0x01 and 0xFF to identify the number of this field. A value between 0x01 and 0x0F indicates a predefined serialization option, and a value larger than 0x0F indicates a custom serialization option. If a predefined serialization option is used, the other parameters “Field”, “StartBit”, and “Length” should not be used and will result in a syntax error.

Predefined Serialization Options (n | n < 0x10)

“01” - Form 96 bits of data using the most significant 58 bits of the EPC field from start block “2” and the least significant 38 bits of the first 96 bits of the TID field. The data from the “01” option must be used in hexadecimal format.

(96 bits) = (58 bit EPC) … (38 bit TID)

“02” – create 5 bytes of data according to the Impinj Serialization formula for the currently installed chip type. Impinj Serialization formulas define 38-bit formats for serialization data obtained from the TID field and can vary for different types of Impinj chip types. The data from the “02” option must be used in hexadecimal format. (40 bits) = (2 bit 00) + (38 bit formula)

“03”- create 12 bytes of data according to the Impinj Serialization formula for the currently installed chip type. Impinj serialization formulas define 96-bit formats for serialization data obtained from the TID field and can vary for different types of Impinj chip types. The data from the “03” option must be used in hexadecimal format (96 bits) = (96 bit formula)

Define Custom Serialization Option (n | n > 0x0F)

Field
The RFID field that will be read to supply the field-serialization data. The legal options are EPC, USR, ACS, KIL, TID, PC.

StartBit
Indicate the first bit to save into the field-serialization data from the RFID field specified by “Field”. The minimum is zero, and the maximum depends on the tag type, but cannot be larger than 2048. If non-zero, the value must be a multiple of 8.

Length
Indicate how many bits beyond the “StartBit” to save into the field serialization data. The value must be a multiple of 8, and the maximum depends on the tag type, but cannot be larger than 2048.

Example 1

Field-Serialization data can be inserted into the static data used in other RFID Write operations. Use the shift-out character ***SO*** defined by **Settings > Application > PGL Setup > Select SO Char** to indicate usage of the field-serialization, then insert “n”, where n is the index of the field-serialization data.

```
~NORMAL
~CREATE;TEST1;X
RFSERL;FS10;TID;64;32
RFWTAG;96;USR
96;H;*96222222SO1022222296*
STOP
END
~EXECUTE;TEST1
~NORMAL
```

Example 2

Field-Serialization data can be inserted into the static data used in print commands. Use the shift-out character ***SO*** defined by **Settings > Application > PGL Setup > Select SO Char** to indicate usage of the field-serialization, then insert “n”, where n is the index of the field-serialization data.

```
~NORMAL
~CREATE;TEST1;X
RFSERL;FS50;EPC;0;64
ALPHA
2;5;0;0;*1234SO505678*
STOP
END
~EXECUTE;TEST1
~NORMAL
```

Example 3

Field-Serialization data can be inserted into the data used in dynamic format <DFn> fields. Use the shift-out character ***SO*** defined by **Settings > Application > PGL Setup > Select SO Char** to indicate usage of the field-serialization, then insert “n”, where n is the index of the field-serialization data.

```
~NORMAL
~CREATE;TEST1;X
RFSERL;FS01
RFWTAG;96;USR
96;DF1;H
STOP
END
~EXECUTE;TEST1
~DF1;*SO01*
~NORMAL
```

RFCRYPT

Purpose Perform certain RFID Security commands that make use of RFID Untraceable and Authenticate capabilities or that write AES encryption keys.

Mode CREATE

Format RFCRYPT;KEYn*;AES Key Value*[;STORE][;AUTH][*;Private List*]

CAUTION!: The RFCRYPT commands will only work on special RFID tags that support Gen2v2 security capabilities. The RFCRYPT implementation is fully compatible with Ucode DNA security tags. Other security tags might not be fully compatible.

RFCRYPT The command identifier; enter **RFCRYPT**.

KEYn Enter either KEY0 for Authentication only or KEY1 for Authentication or Encrypt/Decrypt. This is a mandatory field.

AES Key Value This is a 16-byte Key Value associated with the first parameter KEY0 or KEY1. This is a mandatory field and must contain 32 Hex Characters (0-9, A-F) in left-right order Byte 0 .. Byte 15.

STORE Optional parameter to store an AES Key within the tag.

CAUTION!: On many tag types, each AES Key only be stored a single time. Once an

AES Key has been written to the tag and locked in, that key can never again be changed. The STORE option should only be used on a fresh tag that has never yet had that particular AES key stored.

AUTH Optional parameter to confirm that a tag with a stored encryption key is authentic. If this parameter is included in the command and the tag does not contain the AES Key Value given in the command, the tag will be failed. This command is useful in cases where the AES key is already stored in the tag and the user wants to confirm that the tag is authentic (contains the correct AES key).

Private List Optional parameter to either make all memory fields in the tag public or to identify a list of desired memory field(s) to be made private. Private memory fields can no longer be read by normal read command; they can only be read by special read commands with a KEY1 option and the correct AES Key Value specified. If a field which has been made private is later attempted to be read without an AES Key with the wrong AES key value, the operation will fail and no data will be returned.

Legal options are EPC n, USR, TID, CLR.

The CLR selection will reset all banks to public and should not be mixed with other fields.

If the CLR selection is not used, multiple fields may be listed in any order, separated by commas (e.g. USR,TID,EPC n). When USR or TID are listed, the entire fields will be made private and will not be readable without the proper AES Key Value. The EPC field has a special functionality where it can be made either fully private, partially private, or fully public. The n value following EPC indicates the starting block of the area of the EPC to be made private. For example, “EPC 2” would leave the first two words (four bytes) of the EPC bank public and make the remaining bytes of the EPC field private.

CAUTION!: Although it is AES keys that are used to read fields that have been made private, this functionality also requires a non-zero ACS password to be stored in the tag. Any print job that makes one or more fields private must also provide an ACS field value.

CAUTION!: Any print job that makes fields private will automatically lock the ACS field to prevent that value from being read as it could compromise the security for that value to be exposed.

Example 1

Write out AES encryption key, write out the EPC bank memory, and make the EPC bank partially public and partially private

On a fresh tag which has never had the AES Key1 stored, write the value 0x0123456789ABCDEF0123456789ABCDEF to AES Key1, write 28 bytes to the EPC bank, and make all but the first 32 bits of the EPC bank private. Note that this job writes a non-zero value to the ACS as all jobs that make fields public must.

```
~NORMAL
~CREATE;TEST1;X
RFWTAG;32;ACS
32;H;*12345678*
STOP
RFWTAG;224;EPC
224;H;*123456789ABCDEF0112233445566778899AABBCCDDEEFF1020304050*
STOP
RFCRYPT;KEY1;0123456789ABCDEF0123456789ABCDEF;STORE;EPC 2
RFRTAG;224;EPC;KEY1 0123456789ABCDEF0123456789ABCDEF
224;DF2;H
STOP
VERIFY;DF2;H;*EPC = *;*\r\n*
END
~EXECUTE;TEST1

~NORMAL
```

Example 2

Read 28 bytes out of a private EPC bank by providing a known AES encryption key that was previously stored on the tag.

```
~NORMAL
~CREATE;TEST1;X
RFRTAG;224;EPC;KEY1 0123456789ABCDEF0123456789ABCDEF
224;DF2;H
STOP
VERIFY;DF2;H;*EPC = *;*\r\n*
END
~EXECUTE;TEST1

~NORMAL
```

Example 3

Confirm that a tag is authentic by providing a known AES encryption key that was previously stored on the tag.

The tag is authenticated with KEY1 and the AES encryption key previously stored in the tag was 0x0123456789ABCDEF0123456789ABCDEF. If this example job was sent to a tag with no encryption key or the wrong encryption key stored in it, the tag would be failed.

```
~NORMAL
~CREATE;TEST1;X
RFCRYPT;KEY1;0123456789ABCDEF0123456789ABCDEF;AUTH
END
~EXECUTE;TEST1

~NORMAL
```

Example 4

Make all the banks on a tag public by supplying a known AES encryption key and a known ACS password.

Unlock the ACS bank with the known password, and then make all banks on the tag public using the known AES encryption key in AES Key1.

```
~NORMAL
~CREATE;TEST1;X
RFRTAG;UNLOCK12345678;H;32;ACS
32;DF1;H
STOP
RFCRYPT;KEY1;0123456789ABCDEF0123456789ABCDEF;CLR
END
~EXECUTE;TEST1
~NORMAL
```

ZGL RFID Commands

Read Tag ^RT

Purpose This command allows data from the RFID tag (embedded in the smart label) to merge into any previously defined dynamic data field. It is equivalent to the Field Number command (^FN) except that the data come from the RFID tag.

Format ^RT *x*, *start*, *length*, *hex*, *retries*, *motion*, *reserved*

^RT Read Tag command.

x Specified Field Number (value assigned to the field). The default is 0. The acceptable value range is 0 to 9999.

start Location where data will be read from the RFID tag. The ZGL only supports Alien Technology Class 1a tags, which have only one 8–byte or 12–byte block.

Therefore, *start* will be set to 0, regardless of the specified value.

length The number of blocks to be read from the RFID tag. The ZGL only supports Alien Technology Class 1a tags, which have only one 8–byte or 12–byte block.

Therefore, *length* will be set to 1, regardless of the specified value.

hex This flag indicates whether the data, after being read from the RFID tag, should be translated into hexadecimal format. The default is 0, meaning the data will not be translated. The other acceptable value is 1, meaning the data will be translated into hexadecimal format.

retries The number of automatic attempts to read data from the tag if previous reads failed. The ZGL absorbs the number and uses the value on the control panel's LCD.

motion Set this flag to 1 to read data from the tag without moving the label. The printer may adjust the label position while it reads data from the tag, but this adjustment will reverse before any subsequent normal label movement. Even if this flag is set to 1, other commands (i.e., alpha or barcode) may move the label.

reserved This is a reserved flag. The ZGL absorbs this number.

Comments This command is only executed by the demand for data from any dynamic field. The ZGL absorbs this command if there are no demands for the data

Write Tag ^WT

Purpose This command programs data into an RFID tag (embedded in the smart label).

Format ^WT *start*, *retries*, *motion*, *protect*, *data format, reserved*

^WT Write Tag command.

start Starting block location where data will be programmed into the RFID tag. The ZGL only supports Alien Technology Class 1a tags, which have only one 8–byte or 12–byte block. Therefore, *start* will be set to 0, regardless of the specified value.

retries The number of automatic attempts to write data into the tag if previous writes failed. The ZGL absorbs the number and uses the value on the control panel's LCD.

motion Set this flag to 1 to program data into the tag without moving the label. The printer may adjust the label position while it writes data into the tag, but this adjustment will reverse before any subsequent normal label movement. Even if this flag is set to 1, other commands (i.e., alpha or barcode) may move the label.

protect This flag indicates whether the data should be protected from being overwritten later. The default is 0, meaning the data are not protected. Other acceptable values are 1 to 255, meaning the data are protected using this number as the LOCK password.

Data format 0 (ASCII) or 1 (hex). The default is 0.

reserved This is a reserved flag. The ZGL absorbs this number.

Write or Read Format ^RF

Purpose This command allows you to write or read to an RFID tag.

Format ^RF*a*,*b*,*c*,*d*,*e*

^RF Write or Read RFID command.

a Specifies the read or write option. The default is W.
W = write to the tag
L = write with LOCK
R = read the tag
P = read password (Gen 2 tags only; used when c is set to K or A).

b Specifies the data format. The default is H.

A = ASCII

H = Hex

E = EPC format.

c Specifies the starting block number. The default is 2 for the EPC field and 0 for other fields. Acceptable range is 0 to n-1, where n is the size of the field in words.

This parameter can be set to ‘P’ to request a data write in the Access or Kill field (parameter *a* must be ‘W’).

EX: ^RFW,H,P^FD11111111,22222222^FS

Or, specifies which password to read (Gen 2 tags only; used when *a* is set to ‘P’).
K = kill password
A = access password

d Specifies the number of blocks to read. This option is valid only for the read operation. Since there are currently only 8–byte or 12–byte blocks, the number of blocks to be read can only be 1.

e Specifies the memory bank to write to or read from. The default is E.
E = EPC
0 = Reserved
1 = EPC
2 = TID (only for read)
3 = USER

Example

```
^XA
^RS8,,100,1,E,,,6^FS
^FO0,0,0
^RFW,H,2,12,1^FDaaaaaaaaaaaabbbbbbbbbbbb^FS // Write 12 bytes to the EPC field
^RFW,H,P^FD12345678^FS // Write the ACS data in Hex format (0x12345678)
^PQ5
^XZ
```

Calibrate Transponder ^HR

Purpose This command initiates an RFID transponder calibration for a specific RFID label and returns the results to the host computer.

Format ^HR*a,b*

^HR Calibrate RFID command.

a The start string to appear before the returned result. The default is “start”. The acceptable value is any string less than 65 characters.

b The end string to appear after the returned result. The default is “end”. The acceptable value is any string less than 65 characters.

Define EPC Data Structure ^RB

Purpose This command defines the structure of EPC data, which can be read from or written to an RFID transponder.

Format ^ RB*p0*,*p1*,*p2*...,*p15*

^RB EPC Data command.

n Total bit size of the field. The default is 96. The acceptable value range is 1 to *n*, where n is the total bit size of the tag.

p1..p15 Specifies each partition size. These must add up to the total bit size. The default is 1. The acceptable value range is 1 to 64 bits for each partition.

Enable RFID Motion ^RM

Purpose This command enables or disables RFID paper motion. Be default, labels automatically print at the end of the format. This command allows you to inhibit the label from moving.

Format ^RM*a*

^RM Enable RFID Motion command.

a The default is Y. The acceptable values are Y (Yes, move the label) or N (No, do not move the label).

Specify RFID Retries for a Block ^RR

Purpose This command specifies the number of times that the printer attempts to read from or write to a particular block of a single RFID tag. The number will reflect in the *RFID > Control > Auto Retry* menu.

Format ^RR*a*

^RR Specify RFID Retries command.

a The default is 2. The acceptable value range is 1 to 9.

RFID Setup ^RS

Purpose This command sets up parameters including tag type, read/write position of the transponder, and error handling.

Format ^RS*a*,*b*,*c*,*d*,*e*,*f*,*g*,*h*

^RS RFID Setup command.

a Selects the tag type. The acceptable values range is 0 to 5. (This option is currently not supported.).

b Sets the read/write position of the transponder in the vertical (Y axis) in dot rows from the top of the label. Set to 0 if the transponder is already in the effective area without moving the media. The default value is label length minus 1 mm. The acceptable value range is 0 to label length.

c Sets the length of the void printout in dot rows. The acceptable value range is 0 to label length. (This option is currently not supported.)

d Sets the number of retries that will be attempted in case of read/write failure. The number will reflect in the Label Retry menu.

e Error handling. Enter N for no action. Enter P to place the printer in Pause mode.

Enter E to place the printer in Error mode. (This option is currently not supported.)

f Signals on applicator. Enter S to single signal. Enter D for double signal. (This option is currently not supported.)

g Certify tag with a pre-read. (This option is currently not supported.)

h Sets the print speed at which “VOID” will be printed across the label. (This option is currently not supported.)

RFID Chip Serialization ^RU

Purpose This command performs a Read of TID and EPC data. The data will be available for other RFID or print operations, and can be used in several different formats. The data can be included in other operations using the RU Special character. 4 formats are supported with the RU command: #S (TID in decimal format), #H (TID in Hexadecimal format), #F (EPC and TID data in Hexadecimal format), #Q (EPC data in hexadecimal format).

Format ^RU*a,b*

^RU Specify RFID Chip Serialization command.

a Specify a prefix for the TID data. The prefix is to be defined in binary format. The prefix must be 38 bits or less.

b Specify the RU Special Character. If this parameter is not defined, the default is the ‘#’ character. Cannot use Command character, Control character, or Delimiter character.

Example

```
^XA
^RU
^RFW,H,0,2,3^FD11#H22^FS
^RFR,H,0,12,3^FN1^FS
^HV1,24,USR = [ , ] ^FS
^PQ3
^XZ
```

Example

```
^XA
^RS8,,90,2,E
^PW 1200
^RU
^FO90,100^A0N,30,30^FD11#S22#S33^FS
^FO90,200^A0N,30,30^FH^FDPRINTRONIX AUTO ID RFID Testing^FS
^FO90,300^A0N,30,30^FH^FD4 x 0.3 inch 300 DPI^FS
^PQ1
^XZ
```

Lock / Unlock RFID Tag Memory ^RL

Purpose This command locks, unlocks, permalocks, and block-permalocks RFID data.

The ^RL command is compatible with two different formats:

- ^RLM – Lock or Unlock the memory banks specified in the command. Memory banks can be locked, unlocked, or permalocked. Open / permanent unlock is not supported as this time.

- ^RLB – Permalock blocks of the User memory bank.

WARNING: With Gen 2 tags you can lock a tag's memory bank with an access password, or define a kill password that can permanently disable a tag

Format ^RLM,*a*,*b*,*c*,*d*

^RLM Lock, unlock or permalock memory banks on the RFID tag. Locked memory banks will not allow subsequent writes to those banks. The password required for locking and unlocking must be provided using a different command. For example, ^RF.

a Kill password operation.

U = Unlock the kill password

L = Lock the kill password

O = permanently unlock (Open) the kill password. Not supported at this time.

P = permanently lock (Permalock) the kill password

b Access password operation.

U = Unlock the access password

L = Lock the access password

O = permanently unlock (Open) the access password. Not supported at this time.

P = permanently lock (Permalock) the access password

c EPC memory bank operation.

U = Unlock the EPC memory bank

L = Lock the EPC memory bank

O = permanently unlock (Open) the EPC memory bank. Not supported at this time.

P = permanently lock (Permalock) the EPC memory bank

d User memory bank operation.

U = Unlock the User memory bank

L = Lock the User memory bank

O = permanently unlock (Open) the User memory bank. Not supported at this time.

P = permanently lock (Permalock) the User memory bank

IMPORTANT Tags that have been permalocked cannot be unlocked or rewritten.

Example

```
^XA
^RS8,,100,1,E,,,6^FS
^FO0,0,0
^RFW,H,2,12,1^FDaaaaaaaaaaaabbbbbbbbbbbb^FS
^RFW,H,P^FD12345678^FS
```

```
^RLM,,,L,
^PQ5
^XZ
```

Example

```
^XA
^RS8,,100,1,E,,,6^FS
^FO0,0,0
^RFS,H,P^FD12345678^FS
^RLM,,,U,
^RFW,H,2,12,1^FDCCCCCCCCCCCCDDDDDDDDDDDD^FS
^PQ5
^XZ
```

Format ^RLB*a*,*b*

^RLB Permalock sections of the User memory bank on the RFID tag. The section size for each tag is defined by the tag manufacturer.

a Specify the starting section of memory to lock.

b Specify the number of sections to lock.

IMPORTANT Tags that have been permalocked cannot be unlocked or rewritten.

Example

```
^XA
^RS8,,100,1,E,,,6^FS
^FO0,0,0
^RFW,H,0,12,3^FD11111111111111222222222222^FS
^RLB,0,2^FS
^PQ1
^XZ
```

Tag Password ^RZ

Purpose This command defines the password for the tag during writing.

WARNING: With Gen 2 tags you can lock a tag's memory bank with an access password, or define a kill password that can permanently disable a tag

Format ^RZ*a*,*b*,*c*

^RZ Set RFID Tag Password command.

b Sets a password. Gen 2 tags use a 32–bit password and they specify the memory bank and lock style. Other tags use 8 bits and they ignore the memory bank and lock style. To read the password, see section Write or Read Format ^RF. The default is 00. The acceptable value range is 00 to FF (hexadecimal).

b Specifies the memory bank (Gen 2 tags only). There is no default value.

K = kill password
A = access password

E = EPC
T = tag identifier (TID)
U = user

c Specifies the lock style (Gen 2 tags only). There is no default value.

U or O = unlocked
L = locked
P = permalocked
W = write value (used only when *b* is set to K)

IMPORTANT Tags that have been permalocked cannot be unlocked or rewritten.

Example

```
^XA
^RZA1B2C3D4,K,W             //Write “A1B2C3D4” to set the kill password.
^RZ1234ABCD,K,L             //Use password “1234ABCD” to lock the kill memory bank
^XZ
^XA
^RZ1234ABCD,A,U             //Unlock the access memory bank.
^RZ1234ABCD,K,U             //Unlock the kill memory bank.
^FO50,550^A0N,50^FN1^FS
^FN1^RFP,H,K^FS             //Read from the kill memory bank.
^FO50,650^A0N,50^FN2^FS
^FN2^RFP,H,A^FS             //Read from the access memory bank.
^HV1,16,KIL=^FS
^HV2,16,ACS=^FS
^XZ
```

Host Verification ^HV

IMPORTANT This command requires setting up the *SYSTEM* > *Printer Mgmt* > *Ret. Status Port* menu up correctly. See the *Administrator’s Manual* for more details.

Purpose This command sends back the data in a ^FN (Field Number) field to the host.

Format ^HV*a*,*b*,*c*,*d*

^HV Host Verification command.

a Specified Field Number. The default is 0. The acceptable value range is 0 to 9999.

b Number of characters to be returned. The default is 64. The acceptable value range is 0 to 256).

c Header text (in uppercase ASCII characters). The default is None. The acceptable value range is 0 to 256 characters.

d Termination text (in uppercase ASCII characters). The default is None. The acceptable value range is 0 to 256 characters.

Example

```
^XA
^WT0^FDHELLOTAG^FS
^RT3,0,1,1^FS
^FO100,100^A0N,60^FN3^FS
^HV3,16,TAGNO = ^FS
^XZ
```

Response from Printer

```
TAGNO = 48454C4C4F544147
```

EPC Programming Examples

IMPORTANT **With all examples make sure *MEDIA* > *Image* >*Label Length* matches the physical length of the installed media.**

Example 1

This programming example programs data into an RFID tag and prints that data onto a smart label.

```
^XA                                    //Begin ZPL form.
^WT0^FH^FD_87_D0_03_45_67_AB_CD_EF^FS  //Write tag data “87D0034567ABCDEF” in hex
^RT1,0,1,1^FS                          //Read Tag into element 1, 8–byte (16 chars hex)
^FO100,100^A0N,60^FN1^FS               //Print data in element 1.
^XZ                                    //End and print label.
```

Example 2

Same as Example 1, except an alternative ZGL syntax that does not require underscores between the hex characters is used.

```
^XA                                    //Begin ZPL form.
^WT0,,,,1FDN^FD87D0034567ABCDEF^FS     //Write Tag “87D0034567ABCDEF” (hex format)
^RT1,0,1,1^FS                          //Read Tag into element 1, 8–byte (16 chars hex)
^FO100,100^A0N,60^FN1^FS               //Print data in element 1.
^XZ                                    //End and print label.
```

Example 3

This example uses the ^RF command to write and read the tag.

```
^XA                                    //Begin ZPL form.
^RFW,H,0^FD31323334^FS                 //Write tag data 31323334 in hex.
^FO100,100^A0N,60,60^FN1^FS            //Print tag data in FN1.
^FN1^RFR,H,0^FS                        //Read tag data and store into FN1.
^XZ                                    //End and print label.
```

Example 4

This example uses the ^RF command to write and read the tag with EPC format.

```
^XA
^RMY
^RB64,16,16,16,16
^RZ01^RR3^RFW,E^FD12594,13108,13622,14136^FS
```

```
^FO50,150^A0N,50^FN0^FS
^FN0^RR4^RFR,E^FS
^XZ
```

Example 5

Writes EPC data “112233445566778899001122” to the tag in hexadecimal format

Locks the tag’s EPC data with the password “1234ABCD”

Renders the tag’s access password unreadable

```
^XA
^RFW,H^FD112233445566778899001122^FS
^RZ1234ABCD,E,L^FS
^RZ1234ABCD,A,L^FS
^XZ
```

Example 6

Unlocks EPC data “112233445566778899001122” using the password “1234ABCD”

Writes EPC data “newdata” to the tag in ASCII format

Locks the tag’s new EPC data

Since the access password and its lock state are not changed, the access password remains unreadable

```
^XA
^RZ1234ABCD,E,U^FS
^RFW,A^FDnewdata^FS
^RZ1234ABCD,E,L^FS
^XZ
```

Example 7

This example shows the access of 240 bits EPC and 512 bits USR.

```
^XA
^RZ31323334,K,W
^RZ1234ABCD,K,L
^RFW,H,1,30,1^FD0102030405060708091011121314
151617181920212223242526272829 30^FS
^RFR,H,1,30,1^FN0^FS^HV0,128,#EPC240:^FS
^RZ1234ABCD,E,L
^RFW,H,0,64,3^FD010203040506070809101112131415161718192021222324252627282930 31
323334353637383940414243444546474849505152535455565758596061626364^FS
^RFR,H,0,64,3^FN1^FS^HV1,128,#USR512:^FS
^RZ1234ABCD,U,L
^XZ
^XA
^RZ1234ABCD,A,U
^RZ1234ABCD,K,U
^RZ1234ABCD,U,U
^RZ1234ABCD,E,U
^FN2^RFP,H,A^FS
^FN3^RFP,H,K^FS
^HV2,16,#ACS=^FS
^HV3,16,#KIL=^FS
```

```
^XZ
```

STGL RFID Commands

RFID Write

Purpose This command specifies data to be written into RFID tags.

Format <ESC>RK 1,a,b,D16,c..c

^HV Host Verification command.

a RFID tag Error Ignore. 0 = Disable (default when value is omitted), 1 = Enabled, 2 to 9 = Auto retry on tag error.

IMPORTANT **This “a” parameter is ignored for STGL. The error handling for all RFID commands on all supported emulations is set according to the menus on the front panel. Using the RFID menu, the user can set the error handling, number of retries, and tag type.**

b Write Protector Designation. Valid range is 0 to 1. 0 = Fixed (default).

D Write Protector Designation. Valid range is 0 to 1. 0 = Fixed (default).

16 or 24 Specification of Writing Data Size. Valid data size is 16 or 24 characters.

c..c EPC data (fixed at 16 characters). Valid range is 0 to 9 or A to F only.

Example

```
<ESC>RK1,0,0,D16,ABCDEF1234567543
```

RFID Write(IP0), RFID Read(IP1)

Refer to your SATO programmer’s reference manual for a description of the RFID command syntax for IP0 and IP1.

PTX SETUP Commands

The PTX SETUP commands are a superset of commands which allow the printer to perform several tasks by parsing commands either stored in flash or sent to the printer by the host. Commands range from re-routing debug statements to downloading complete printer configurations. See the *Administrator’s Manual* for a full description of all the commands available. Those specific to RFID are shown in Table 1.

Concepts to Note

1. PTX_SETUP commands are not emulation specific. They work regardless of how *Applications > Control > Active IGP Emul* is setup.

2. The PTX_SETUP command set is case sensitive; all PTX_SETUP commands are in uppercase characters only.

3. The white space separating commands may be any number of spaces and tabs. This allows a PTX_SETUP file to be formatted for easier readability.

4. Any unknown command will terminate the PTX_SETUP processing. The offending command will be the first line of printed text.

Each emulation has modes in which the PTX_SETUP commands could get missed. It is highly recommended that all PTX_SETUP commands be placed between print jobs, rather than attempting to embed them within jobs.

PTX_SETUP commands have the following format:

```
(SFCC)PTX_SETUP
Command-Sub Command; Value
PTX_END
```

For example, if the SFCC assigned to PTX_SETUP is the default value of the exclamation mark (!, hex 21), and you want to change the EPC Length for a Higgs-3 RFID tag to 256, use the following command sequence:

```
!PTX_SETUP RFID;EPC_LENGTH;256 PTX_END
```

Table 1 PTX-SETUP Commands for RFID

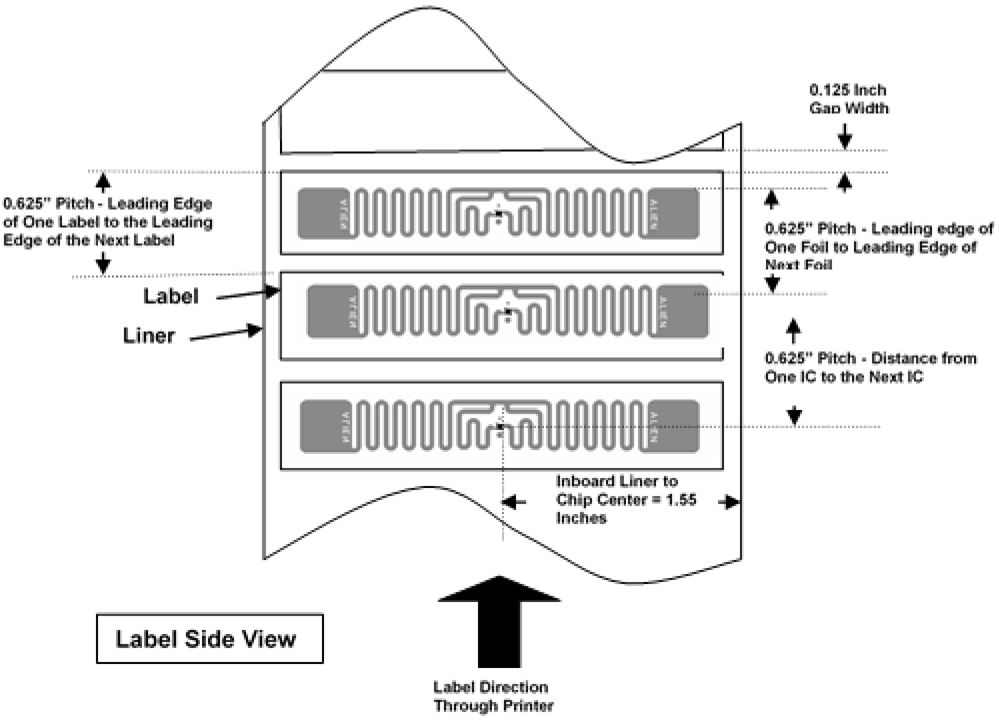
Command	Sub-Command	Parameter	Description
RFID	OVERSTRIKE_REPORT	0	When set to 0 (OFF), an RFID overstrike occurs then it is not reported to the host.
		1	When set to 1 (ON), an RFID overstrike occurs then it is reported to the host.
	STATISTICS_REPORT	0	When set to 0 (OFF), RFID statistics are not reported to the host.
		1	When set to 1 (ON) RFID overstrikes are reported to the host when an alert is processed.
	STATISTICS_CLEAR	None	When this command is processed the RFID statistics are cleared.
	EPC_LENGTH	EPC field length	Specifies the EPC Length for RFID tag types that have a variable length EPC field (e.g. higgs-3). EPC field length can be one of (96, 112, 128, 144, 160, 176, 192, 208, 224, 240, 256) **NOTE:** When the EPC length is selected with the command, the USR field is automatically set to the corresponding size as defined by the EPC Global Class-1 Generation -2 UHF RFID Specification. When the EPC length is selected with the command, the PC field must be programmed with the correct value as defined by the EPC Global Class-1 Generation-2 UHF RFID Specification.

6 RFID Inlay Pitch

Pitch is defined as the distance from one point on an inlay to the same point on the next inlay. The reference point can be any point on the inlay: leading (or trailing) edge of the antenna (often described as the foil), leading (or trailing) edge of the antenna substrate, or the distance between ICs.

On-Pitch RFID Labels

Use the RFID Inlay Reference Figure 6 for a clearer understanding of the various points that can be used to determine pitch. The figure shows the minimum distance our printers can work with between inlays from 0.5 to 0.625”. The reason for this is to prevent the printer’s coupler from talking to two or more tags at once. Any closer together and the coupler in the printer would be broadcasting to the tag in back or in front at the same time.


0.125 Inch Gap Width
0.625” Pitch - Leading Edge of One Label to the Leading Edge of the Next Label
0.625” Pitch - Leading edge of One Foil to Leading Edge of Next Foil
Label
Liner
0.625” Pitch - Distance from One IC to the Next IC
Inboard Liner to Chip Center = 1.55 Inches
Label Side View
Label Direction Through Printer

On-Pitch Label Configuration Using
Alien 9730 Squiglette Inlay

Label Size

Printronix Auto ID RFID printers are compatible with the latest chips (IC's) and inlays from the major suppliers in the RFID industry. The printers are equipped with an *Auto-Calibration* feature for easy setup eliminating the need to specify exact inlay placement or RFID power settings. The calibration routine has been tested with most major inlays embedded in typical label sizes and will work with many other inlays as well. Here are a few things to consider for optimum performance.

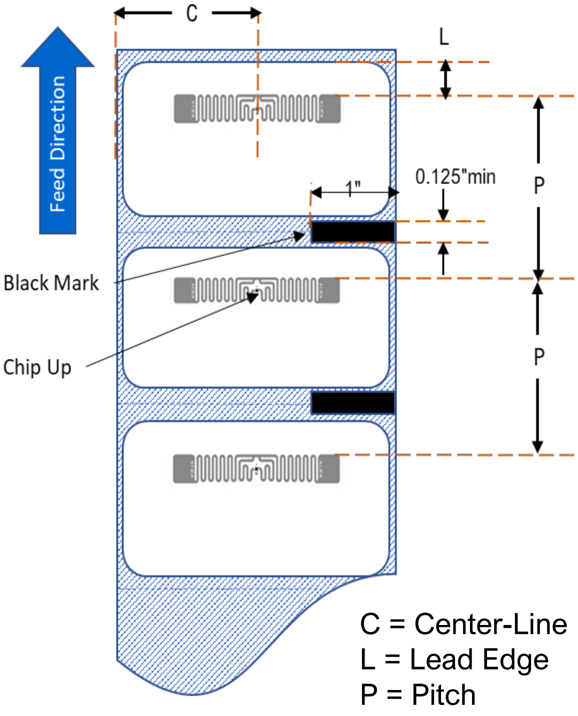
Referring to the diagram at right:

Inlays should be centered horizontally across the media (dimension "C"). Consistent, tag-to-tag placement of the inlays is more important than how close to center the inlays are actually placed.

The pitch (overall distance from inlay to inlay) is shown as dimension "P".

The inlay should be set back from the lead edge of the media (dimension "L") a constant distance tag to tag.

Always test RFID media on your printer before purchasing large quantities of media



C = Center-Line
L = Lead Edge
P = Pitch

Website Support

Printronix RFID printers support a number of RFID protocols and coupler configurations.

For a complete list of Certified RFID Smart Labels available from Printronix, go to https://usca.tscprinters.com/en/printronix-auto-id-enterprise-printers.

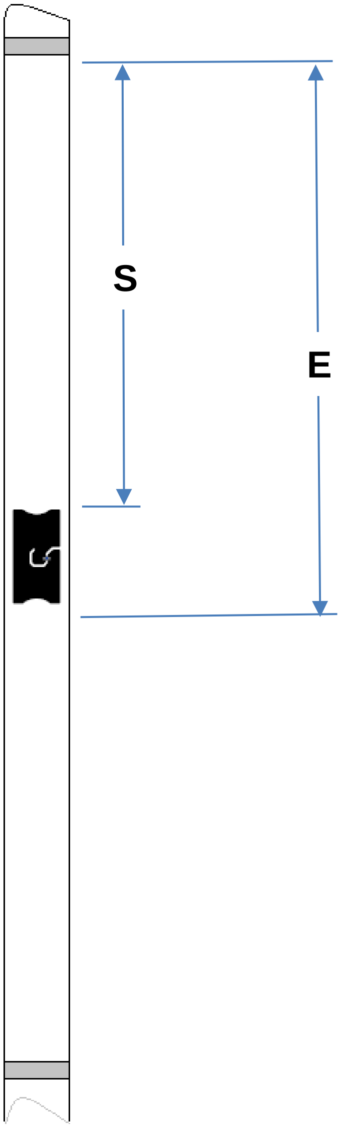
Disclaimer:

The guidelines and suggestions for developing converted RFID labels, are provided by Printronix Auto ID on an "as is" basis and without warranty, expressed or implied. Printronix Auto ID disclaims any implied warranty of merchantability or fitness for a particular purpose. Printronix Auto ID will not be liable under any circumstances for any damages or losses related in any way to use of these guidelines, specifications or other information, including damages which may be incurred as a result of labels not working properly in a specific application. All specifications are subject to change without notice. Testing of the converted labels in the printer is strongly recommended prior to production quantities

Longer Pitch Tags

When running long tags, such as airline baggage tags or tags where the RFID inlay pitch is greater than 2 inches, you can adjust the Start and End Position for the RFID calibration routine to significantly reduce the time it takes. Menus for adjusting these dimensions are located in the Tag Calibration submenu.

Refer to the diagram below for explanation of these features.



S – Start Position
Using a scale or tape measure, measure the distance from top of form (TOF) to the upper-most edge of the inlay within the label. Enter this value using the Start Position menu.

E – End Position
Measure the distance from top of form (TOF) to the lower-most edge of the inlay within the label. Enter this value using the End Position menu.

When running RFID Calibration, using these settings will significantly speed up the label calibration routine. The calibration tests will be concentrated between the Start and End Position dimensions instead of over the full length of the tag.

A *Errors and Troubleshooting*

Error Messages

The RFID encoder can detect a number of errors. When one of these errors occurs, the RFID encoder alerts the printer to perform the currently selected error action and display the appropriate error message on the control panel's LCD (see Table 2).

Table 2 RFID Error Messages

Displayed Message	Solution/Explanation
RFID Comm Err Check Cable	RFID error: communication cannot be established between the printer and the RFID encoder. 1. Press **PAUSE** to clear the message. 2. Disable the *Control* > *RFID Active* menu. 3. See "Troubleshooting" on page 82.
RFID FW ERR: Version Mismatch	The RFID encoder firmware version is not capable of operating with the printer software. 1. Press **PAUSE** to clear the message. 2. Download the program file to the printer again.
RFID LOCK CMD: Not supported!	A lock command was executed on a tag which does not support locking. Most Gen 2 tags support locking. 1. Press **PAUSE** to clear the message. 2. Remove the lock command from the application.
RFID MAX RETRY Check System	The menu *Control* > *Error Handling* is set to *Overstrike*, and the Label Retry count has been exhausted. 1. Press **PAUSE** to clear the message. 2. See "Troubleshooting" on page 82.

Displayed Message	Solution/Explanation
RFID TAG ERR: Read-Only Tag	A write was attempted on a read-only tag. 1. Press **PAUSE** to clear the message. 2. See "Troubleshooting" on page 82.
ODV COMM ERR See Manual	Communication error between printer and online data validator (ODV). 1. Cycle power. 2. If the problem persists, contact your authorized customer service representative.
RFID TAG FAILED Check Media	The menu *Control* > *Error Handling* is set to *Stop*, and the RFID encoder could not read the RFID tag. 1. Press **PAUSE** to clear the message. 2. See "Troubleshooting" on page 82.
RFID UNLOCK CMD: Not Supported!	An unlock command was executed on a tag which does not support locking. 1. Press **PAUSE** to clear the message. 2. Remove the unlock command from the application.
RFID ACS FIELD: Not Supported!	The ACS field was accessed on a tag which does not support the ACS field. 1. Press **PAUSE** to clear the message. 2. Remove references to ACS field from the application.
RFID KIL FIELD: Not Supported!	The KIL field was accessed on a tag which does not support the KIL field. 1. Press **PAUSE** to clear the message. 2. Remove references to KIL field from the application.
RFID PC FIELD: Not Supported!	The PC field was accessed on a tag which does not support the PC field. 1. Press **PAUSE** to clear the message. 2. Remove references to PC field from the application.

Troubleshooting

If you are having problems with the RFID system, consult Table 3 for a list of symptoms and possible solutions.

Table 3 Troubleshooting the RFID System

Symptom	Solution
No communication between the printer and the RFID encoder	1. Make sure the reader is enabled via *Control* > *RFID Active* menu. 2. Use the *Diagnostics* > *Read Tag* feature (page 32) to read and display the current RFID tag content. 3. If the problem persists, your RFID encoder may be disconnected or defective. Contact your authorized service representative.
Tag failed	1. The label could be misaligned. Perform the *Sensors* > *Control* > *Auto Calibrate* procedure to ensure the label is at top-of-form. For more information, refer to the Administrator's Manual. 2. Make sure the media are smart labels with RFID tags located in the correct position. 3. The RFID tag could be defective. Try another tag. 4. Make sure the application does not send too few or too many digits to the RFID tag.
Inconsistent results	Make sure the media is loaded correctly. For more information, refer to the Administrator's Manual.
The RFID encoder works, but it does not meet expectations	Make sure that both *Control* > *Error Handling* and *Control* > *Label Retry* are set to desired values.
The RFID icon is greyed out in the Settings section: ▣	The printer did not detect the RFID encoder at power-up. Your RFID encoder may be disconnected or defective. Contact your authorized service representative.

B *Contact Information*

TSC | Printronix Customer Support Center

IMPORTANT **Please have the following information available prior to calling the Printronix Customer Support Center:**

- Model number
- Serial number (located on the back of the printer)
- Installed options (i.e., interface and host type if applicable to the problem)
- Configuration printout: Refer to the *Administrator's Manual.*
- Is the problem with a new install or an existing printer?
- Description of the problem (be specific)
- Good and bad pictures that clearly show the problem (faxing or emailing of these pictures may be required)

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Printronix Auto ID Support: https://usca.tscprinters.com/en/technical-support

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Visit the TSC | Printronix Auto ID web site at https://usca.tscprinters.com/en/printronix-auto-id-enterprise-printers