

# **Installation Guide**

## **SaviTag ST-654**

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**Version 1.0**



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Documentation for SaviTag ST-654, version 1.0

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Savi Technology, Inc.  
615 Tasman Drive  
Sunnyvale, CA 94089-1707

Phone: 1-408-743-8000  
Facsimile: 1-408-543-8650  
[www.savi.com](http://www.savi.com)

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# Contents

## 1 Introduction

Features .....	5
SaviTag ST-654 Description .....	6
Specifications .....	6
Model Description .....	9
Contacting Customer Support .....	9

## 2 Installing SaviTag ST-654

Required Tools and Materials .....	11
Commissioning SaviTag ST-654 with SaviTag Write Cable STA-1030 .....	11
Commissioning SaviTag ST-654 with SDSA-654-01 and Savi Docking Station .....	13
Replacing the Battery .....	14
Tag Placement .....	15
Mounting SaviTag ST-654 .....	17
Mounting SaviTag ST-654 Using Pressure Sensitive Tape ...	18
Mounting SaviTag ST-654 Using Rivets .....	27
Mounting SaviTag ST-654 Without a Mounting Sleeve .....	28

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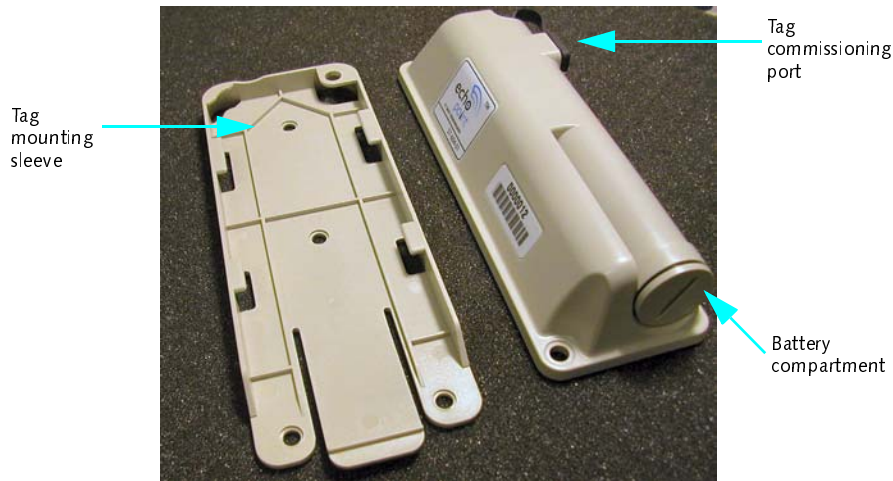
# Introduction

SaviTag™ ST-654 is a high performance active RFID tag suited for applications including shipping containers, vehicles, and other large asset tracking equipment. Available with 128K or 240K of programmable memory, SaviTag ST-654 supports a broad range of applications in multiple system configurations. Fully compatible with fixed and handheld Savi® readers, these tags feature up to 300 feet (91.44 meters) of omnidirectional line-of-sight range. Battery life, using lithium cells, is typically five years. SaviTag ST-654 is also certified as safe for operation with live ordnance.

## Features

- ◆ 433 MHz, active RFID technology with up to 300-foot (91.44) range for monitor, wake-up, and RF write/read
- ◆ 123 KHz receiver for slot level, chokepoint tag wake-up and short range commissioning
- ◆ Small form factor design ideally suited for shipping containers, vehicles, and other large assets
- ◆ Rugged, weatherproof design
- ◆ Fast 28 Kbps data rate powered by a lithium battery
- ◆ Battery is easily replaced by hand using a coin or a screwdriver
- ◆ Built-in firmware database allows readers to rapidly search for specific information saved on the tag

## SaviTag ST-654 Description



## Specifications

Specification	Description
Physical characteristics	<p>Length: 6 .25 inches (16 cm)</p> <p>Width: 2.13 inches (5.4 cm)</p> <p>Height: 1.13 inches (2.9 cm)</p> <p>Weight: 3.8 oz. (108 g)</p> <p>Color: Federal Standard 595 #34094 Bronze Green</p>
Environment	<p>Temperature: -26°F to +158°F (-32°C to +70°C) operating; -40°F to +158°F (-40°C to 70°C) storage</p> <p>Humidity: 100% non-condensing</p> <p>Salt fog: MIL-STD-810E Method 509.3</p> <p>Low pressure (altitude): MIL-STD-810E Method 500.3</p>

Specification	Description
RF receiver/transmitter	<p><b>Ultra High Frequency transceiver:</b></p> <p><b>Frequency:</b> 433.92 MHz</p> <p><b>Modulation:</b> FSK, deviation +/- 50 KHz</p> <p><b>Data rate:</b> 27.8 Kbps</p> <p><b>Data coding:</b> Manchester</p> <p><b>Communication range (unobstructed):</b> Typical range is 300 feet (91.44 meters) line-of-sight when mounted onto a container and communicating with a Savi Fixed Reader SR-650-101 or SaviReader 410R. Typical range is 200 feet (61 meters) line-of-sight when mounted onto a container and communicating with a Savi Mobile Reader SMR-650P-110 or SMR-650P-111</p> <p><b>Maximum transmit power:</b> 0.6 mW</p> <p><b>Air protocol:</b> EBCS Commands (20-bit tag identification supported) and Savi EchoPoint Air Protocol 2.1 (32-bit tag identification supported)</p>
LF receiver	<p><b>Low Frequency receiver (downlink)</b></p> <p><b>Frequency:</b> 123 KHz</p> <p><b>Modulation:</b> ASK On-Off Keying</p> <p><b>Data rate:</b> Average 1.6 Kbps, 50% duty cycle</p> <p><b>Data coding:</b> Pulse Width Modulation</p> <p><b>Communication range:</b> Up to 4 feet (1.22 meters) with Savi Mobile Reader SMR-650P-110 or SMR-650P-111</p> <p>Up to 12 feet (3.66 meters) with Savi Signpost (model SP-65x-xxx)</p> <p><b>Air protocol:</b> Savi EchoPoint Air Protocol 1.1</p>
Network	<p><b>Wireless:</b> RF read/write capable</p> <p><b>Wired:</b> Serial read/write capable (via SaviTag Write Cable STA-1030 or Savi Docking Station Adapter SDSA-654-01)</p>
Memory	Onboard non-volatile memory 128K
Antenna	<b>Internal UHF:</b> Omni loop antenna
Shock and vibration	<p><b>Shock:</b> MIL-STD-810E Method 514.4, Category 10</p> <p><b>Vibration:</b> MIL-STD-810E Method 514.4, Category 10</p>
Protection type	Sealed to IP54

Specification	Description
Power	<p><b>Battery type:</b> 3.6 volt primary lithium (Li-SOCl<sub>2</sub>), user replaceable</p> <p><b>Battery life:</b> Approximately 5 years depending on usage</p> <p><b>Power management:</b> UHF sleep mode prevents unwanted collections, enabled/disabled by LF link</p> <p><b>Diagnostics:</b> Reports low tag battery status by beeping three times</p>
Regulatory approvals	<p><b>Radiated emission (intentional):</b> U.S. emission standards as contained in FCC Part 15 and European Community emission standards as contained in EN 300 220 (433 MHz)</p> <p><b>Electromagnetic immunity:</b> ESD compliance Exposed to 8 kV air discharge or 4 kV contact discharge in accordance with EN 301 489-1</p> <p><b>Radiated emission (unintentional):</b> U.S. emissions standards as contained in FCC Part 15 and European Community emission standards as contained in EN 301 489-1</p> <p><b>Ordnance Safety:</b> HERO PENDING unit will meet 4-inch (10.16 cm) minimum safe separation distance requirement</p> <p><b>Markings:</b> Savi logo, product model and serial number, EMC compliance (FCC/EN), and Ordnance/HERO</p>
Indicators	<p><b>Beeper:</b> Audible beeper for tag location. Ability to hear tag at approximately 100 feet (30.48 meters) with nominal background noise (similar to ST-410)</p>
Mounting	<p>Mounting kit includes spare tag mounting sleeve, pressure sensitive tape, rivets, and tie-wrap. Magnetic mount STA-1035 must be ordered separately</p> <ul style="list-style-type: none"> <li>◆ Tag mounting sleeve included with pre-installed pressure sensitive tape. <ul style="list-style-type: none"> <li>Length: 6.5 inches (16.51 cm)</li> <li>Width: 2.5 inches (6.35 cm)</li> <li>Weight: 1.0 oz. (28.35 g)</li> <li>Color: Federal Standard 595 #34094 Bronze Green</li> </ul> </li> <li>◆ Tag housing has through-holes for rivet mount</li> </ul>
Software	<p>Savi SmartChain® Site Manager, Retriever, or Savi SmartChain® Client Tools 4.0</p>
Accessories	<p>Spare A size batteries; part number BAT-1125</p>



## **Model Description**

Part number: ST-654-001

Description: SaviTag ST-654-001

Onboard memory: 128K Serial EEPROM – User memory

## **Contacting Customer Support**

If you cannot find the information you need in this guide, contact Savi Customer Support.

- ◆ Call 1-888-994-SAVI (North America only) or 1-408-743-8888 between 9 a.m. and 5 p.m. Pacific time.
- ◆ Send email to [help@savi.com](mailto:help@savi.com).
- ◆ Check [www.savi.com/support](http://www.savi.com/support) for information.

When you contact Savi Customer Support by telephone or email, have the following information available:

- ◆ Contact information (company name, your name, email, and phone number)
- ◆ Problem description
- ◆ Product type and location
- ◆ Serial number or license information



# Installing SaviTag ST-654

## Required Tools and Materials

Before you begin installation of SaviTag ST-654, make sure you have the following materials available:

- ◆ SaviTag ST-654
- ◆ SaviTag Write Cable STA-1030
- ◆ Savi SmartChain Client Tools 4.0 or TAV Tools 3.6x or later
- ◆ One 3.6V lithium battery, size A (provided)
- ◆ A coin or screwdriver
- ◆ Tag mounting sleeve
- ◆ Two rivets or pressure sensitive tape (provided) and a handheld rivet gun
- ◆ One tie-wrap (provided)

## Commissioning SaviTag ST-654 with SaviTag Write Cable STA-1030

ST-654 tags are shipped from the factory with the battery installed in the reverse direction to preserve battery life. Before you attempt to commission SaviTag ST-654, make sure the battery is properly installed. See “Replacing the Battery” on page 14.

You can commission SaviTag ST-654 using SaviTag Write Cable STA-1030, which you can purchase separately.

1. Connect SaviTag Write Cable STA-1030 to an available serial port on the host computer.
2. Locate the tag commissioning port on the SaviTag ST-654.



3. Unplug the rubber cap covering the port.



4. Insert SaviTag Write Cable STA-1030, with the LED up, into the ST-654 tag commissioning port. Start the tag commissioning application. The LED is lit when the application writes data to the tag.



## Commissioning SaviTag ST-654 with SDSA-654-01 and Savi Docking Station

You can commission SaviTag ST-654 using the SDSA-654-01 and docking station (model SDS-2002 shown, which you can purchase separately).

1. With the Savi EchoPoint label right-side up, insert the adapter into the docking station until the adapter stops. The adapter has a magnetic contact that adheres to the Savi Docking Station SDS-2002 when fully inserted.



2. Unplug the rubber cap covering the write port on the tag and ensure that the Savi EchoPoint label on the tag is upside down. Note the lit Contact LED on the docking station. The tag is ready for commissioning.



3. Start the tag commissioning application. When the tag commissioning application writes data to the tag, the Data LED is lit.



## Replacing the Battery

SaviTag ST-654 is equipped with non-volatile memory. Stored data is not lost when you replace the battery.

1. Using a coin or screwdriver, turn the battery cover counterclockwise.

When removing the battery cover, hold on to it to avoid dropping it.



2. Remove the discharged battery from its compartment.

**Warning:** The lithium battery can be harmful to the environment. Follow current procedures for safely disposing of lithium batteries.

3. Install an A 3.6V lithium battery, matching the negative (-) and positive (+) terminals to the symbols shown on the ST-654 housing. The tag will not work if you install the battery in the wrong direction (reversed).



The tag beeps twice if you install a fully charged battery. The tag beeps three times if you install a battery with low charge; replace it with a charged battery. When removing and replacing a charged battery, you may need to wait a few seconds after replacing the battery to hear the confirmation beep.

4. Replace the battery cover using a coin or screwdriver. With the coin placed in the battery cover groove, push the cover in. Turn the battery cover counterclockwise 1/4 to 1/2 of a turn to properly seat the cover. Turn the battery cover clockwise until it fits flush with the tag case. Be careful not to overtighten.



Make sure the battery cover is completely closed and that it is not cross-threaded.

5. Dispose of the used battery according to local safety requirements.

## Tag Placement

Savi Technology recommends that you mount SaviTag ST-654 on a flat surface, with the tag's longitudinal axis aligned vertically. For optimal radio communication, place SaviTag ST-654 as high as possible, safe from impact (for example, between the ribs of an ISO-type shipping container), and away from obstructions on the asset.

When SaviTag ST-654 is mounted in its optimal position:

- ◆ It is mounted at no less than a 6-foot (1.8 meters) elevation.
- ◆ The tag's longitudinal axis is aligned vertically. See "Applying the Tag" on page 23 for a mounting example.

SaviTag ST-654 will achieve a 300-foot (91.44 meters) read range to SR-410 and SR-650 fixed readers. To achieve the most consistent communications with SaviTag ST-654, the fixed readers must be mounted:

- ◆ To have an unobstructed line of sight to the tag
- ◆ At 20 feet (6 meters) or higher
- ◆ With the reader dome pointed downward

Recommended mounting locations for an M3 Container Roll-in/out Platform (CROP) and other mobile assets are shown in the following pictures.

*Figure 2-1 Primary and alternate CROP locations for SaviTag ST-654*



Primary CROP location



Alternate CROP location



*Figure 2-2 Examples of tag mounting locations on mobile assets*



## **Mounting SaviTag ST-654**

You can choose among several mounting methods for SaviTag ST-654, including using pressure sensitive tape, rivets, or a plastic mounting sleeve. Whichever mounting method you select, the goal is to prevent accidental loss of the tag by sudden impact, vibration, or shock during transport. The fastener you choose often depends on the material from which the asset or container is constructed and your personal preference.

SaviTag ST-654 includes these recommended mounting fasteners:

- ◆ Rivets
- ◆ Pressure sensitive tape (PST)
- ◆ Magnetic mount STA-1035 (must be ordered separately)

You can also use the following alternative fastening methods:

- ◆ Velcro, 3M SJ3550 Dual Lock Reclosable Fastener, 1 inch (2.5 cm) wide
- ◆ Tie-wraps
- ◆ Twine
- ◆ Screws

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**Caution:** Use these and other alternative methods at your own risk:

## **Mounting SaviTag ST-654 Using Pressure Sensitive Tape**

If it is not possible or practical to use screws or rivets, you can use pressure sensitive tape (PST) to attach a SaviTag ST-654. The only brand of PST that Savi Technology recommends for mounting SaviTags is 3M Corporation's Automotive Acrylic Plus Attachment Tape.

For ease of installation, during manufacturing Savi installs this PST on the back of the plastic mounting sleeve. PST mounting kits are also available for separate purchase.

*Figure 2-3 SaviTag ST-654 factory installed PST*



Once a mounting sleeve is fastened to an asset, you can leave it on the asset even after SaviTag ST-654 is removed so it is available for future use with other compatible SaviTags. Prior to re-use, visually inspect the PST-mounted sleeve to make sure it is attached securely. If necessary, reinstall the sleeve using new PST.

### **PST Reliability and Durability**

3M Corporation has conducted extensive environmental testing on their Automotive Acrylic Plus Attachment Tape. In addition, Savi has conducted its own independent environmental tests of PST using SaviTag ST-410 as a test platform. The U.S. Army (Tobyhanna Army Depot) has also tested PST for use on surfaces treated with Chemical Agent Resistant Coating (CARC). All these tests confirm that PST is an appropriate choice for mounting SaviTags.

- ◆ Savi Technology successfully conducted the following tests upon samples of 3M PST:
  - ❖ Extreme temperature (–40° to +70° Celsius)
  - ❖ Step test (200 pounds applied in shear)
  - ❖ Shock (140g or 120 lbs.)
  - ❖ Vibration (MIL-STD-810E)
  - ❖ Salt fog (MIL-STD-810E)
  - ❖ Corrosive liquids
  - ❖ Peel test (50 pounds of peel force)Savi's tests confirm the excellent adhesion integrity and reliability of 3M PST.
- ◆ 3M Corporation conducted a longevity test of PST. They found no significant degradation in the performance of PST even after five years of service on a test vehicle. As long as the surface is prepared properly, PST will work reliably for five years or longer. See “Preparing the Surface for PST Application” on page 19.
- ◆ 3M Corporation compared the peel strength of a new roll of PST versus a roll that had been aged 21 months. In all cases, the aged roll matched performance of the new roll in tests conducted over a 72-hour period.

### **Preparing the Surface for PST Application**

PST is suitable for almost any smooth, flat surface made of metal or plastic. Metal surfaces may be coated with most paints, including Chemical Agent Resistant Coating (CARC). It is, however, extremely important that you follow proper surface preparation to enable optimal adhesion.

PST is not intended for attachment to wooden surfaces because of the surface roughness of wood, and the wicking of rain or spray through wood fiber. Screws are the preferred mounting method for wooden surfaces.

PST surface preparation is a simple, but critical process. The surface cleaning procedure on page 21 demonstrates how to clean a shipping container that has greasy residue and dirt on the intended mounting surface as shown in Figure 2-4.

*Figure 2-4 Dirty, greasy mount location*



This demonstration was performed at about 50 degrees Fahrenheit on a mounting surface covered with moisture and condensation. The optimum mounting surface temperature for PST application is 60 degrees Fahrenheit or above. At this temperature full adhesion strength will be achieved within a few hours. But 3M has successfully applied PST to exposed surfaces at temperatures as low as 40 degrees Fahrenheit. Even at these lower temperatures, tags can be installed immediately after PST application; full adhesion strength will be achieved within 24 hours.

Make sure you have the following cleaning materials available:

- ◆ General purpose cleaner. Any commercial cleaner with a degreaser; for example Formula 409® Cleaner, Ajax® All-Purpose Cleaner, or Simple Green® All-Purpose Industrial Degreaser
- ◆ Rags or paper towels
- ◆ Scrub brush, bucket, and mild soap and water solution if needed

To clean the surface:

1. Determine where the mounting sleeve or SaviTag ST-654 is to be attached to the shipping container or asset. Be sure that the surface to which the tapes will be applied is flat.
2. Spray a liberal amount of general purpose cleaner onto the mounting surface.
3. Using rags or paper towels, clean the mounting surface so it is free of dirt, rust, and loose paint flakes.



4. If the surface is heavily soiled, use a mild soap and water solution to scrub the surface clean.



5. Ensure that the mounting surface is free from moisture and condensation.



### Applying the Tag

1. Return to the location where the mounting sleeve or tag is to be attached to the shipping container or asset.
2. Obtain a mounting sleeve with PST installed and carefully remove the red protective film covering. Avoid touching the PST adhesive. You can also apply PST directly to the back of a tag that is to be mounted without a sleeve.
3. Position the sleeve, making sure the retaining clip is pointed up. Make sure there is at least 4 inches (10 cm) of vertical clearance above the ST-654 sleeve to allow the ST-654 tag to be inserted. Be sure that the surface to which you will apply the tape is flat, and that the sleeve or tag can move freely to compress the tape in the next step.



4. When the sleeve or tag is straight, press it into place. Apply pressure to the tape strips by pushing firmly against the tag or inside surface of the sleeve. To assure a good bond, apply as much finger pressure as possible and work fingers up and down the area over the tape strips.



5. If applicable, insert the tag into the sleeve and insert a wire loop or nylon tie-wrap through the two retaining ears. No tape curing time is required prior to installing the tag.





The mounting sleeve is equipped with a tie-wrap groove to ensure that SaviTag ST-654 is securely fastened.



6. To prevent the tag from dislodging from the tag mounting sleeve as a result of sudden impact or extreme shocks, insert the supplied tie-wrap through the sleeve.



When you are done, the mounted tag looks like this.



### Removing Pressure Sensitive Tape-Mounted Sleeves or Tags

Savi recommends that you leave the mounting sleeve attached to the shipping container or asset for later reuse, but if it is necessary to remove the sleeve or tag:

1. Lift one end of the mounting sleeve or RFID tag with a putty knife or chisel and separate the tape.



2. Remove the tape on the sleeve, tag, or mounting surface by rubbing with dry thumbs.



3. Use a scouring pad with a mild soap and water solution to remove any remaining adhesive.

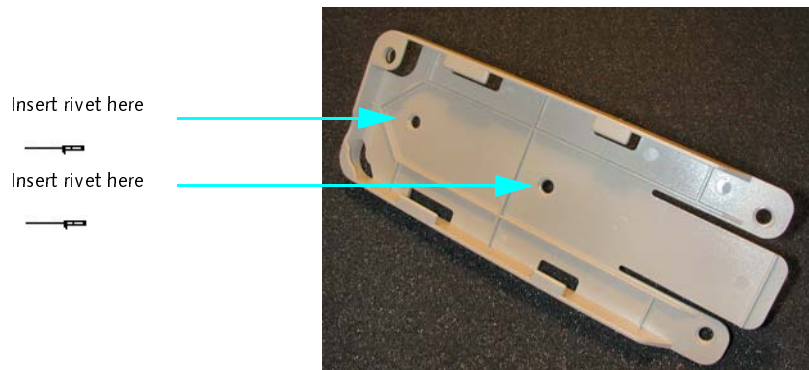


## Mounting SaviTag ST-654 Using Rivets

**Note:** If you want to mount SaviTag ST-654 using rivets, consider removing the PST as outlined in “Removing Pressure Sensitive Tape-Mounted Sleeves or Tags” on page 26.

1. Determine where the mounting sleeve or SaviTag ST-654 is to be attached to the shipping container or asset. Make sure there is at least 4 inches (10 cm) of vertical clearance above SaviTag ST-654 mounting sleeve to allow the tag to be inserted.
2. Using a marker, mark on the shipping container or asset the location of the rivet holes on the tag mounting sleeve.
3. On the shipping container, drill holes at the locations you marked in step 2.
4. Return to the location where the mounting sleeve or tag is to be attached to the shipping container or asset. Align the rivet holes on the tag mounting sleeve with the rivet holes you made in step 3.
5. Push the head of the rivets through the tag mounting sleeve.

*Figure 2-5 Insert rivets*

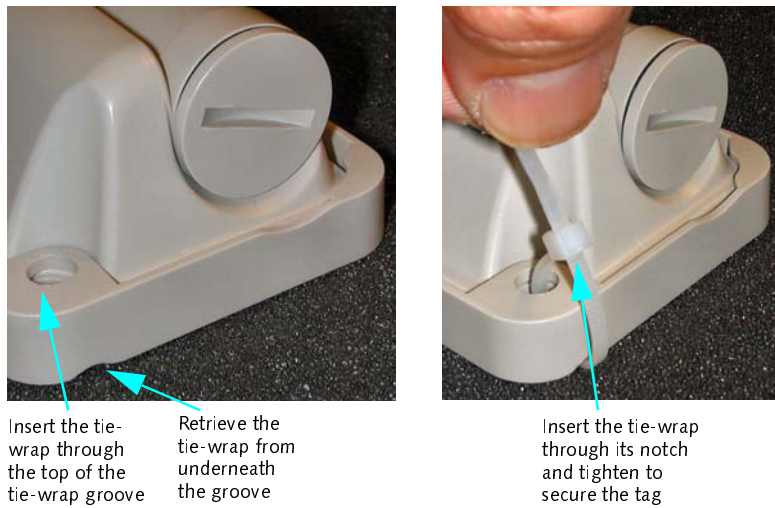


6. Use the handheld rivet gun to clip the nail of the rivet and secure the tag mounting sleeve to the shipping container or asset. Avoid fastening the rivets too tightly so as not to damage the mounting sleeve.

7. To prevent the tag from dislodging from the tag mounting sleeve as a result of sudden impact or extreme shocks, insert the supplied tie-wrap through the sleeve.

The mounting sleeve is equipped with a tie-wrap groove to ensure that SaviTag ST-654 is securely fastened.

*Figure 2-6 Use the tie-wrap to secure the tag*



## **Mounting SaviTag ST-654 Without a Mounting Sleeve**

You can mount SaviTag ST-654 without a plastic mounting sleeve using some or all of the fasteners listed on page 17. You will need to provide your own rivets or screws.

*Figure 2-7 SaviTag ST-654 mounting holes*

