RX375P

INSTALLATION MANUAL

TeeJet® TECHNOLOGIES

A Subsidiary of Spraying Systems Co.®

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CHAPTER 1 INTRODUCTION

The RX375P is a smart antenna that tracks GPS and SBAS (WAAS, EGNOS, and MSAS) signals. The RX375P provides sub-meter performance with 2.0 ft (60 cm) accuracy 95% of the time. It utilizes COAST™ technology during differential outages. The RX375P is also capable of using e-Dif® and L-Dif® technology.

FEATURES

The RX375P has several features that will enhance the product's performance.

- Two RS232 serial ports
- One Tri-colored LED
- Radar-simulated pulse output
- CAN communication
- Centimeter-level accuracy using Crescent technology in a rugged, all-in-one enclosure
- RTK baselines of up to 5 km
- Supports CAN, NMEA 0183, NMEA 2000*, binary for communication with external devices
  * *To use the A101 in a NMEA 2000 network requires NMEA certification and a NMEA2000 adapter cable*
- Wide operating voltage range of 7-32 VDC, providing high transient protection for any power source
- Integrated 2D tilt sensor enables offset corrections
- 1 PPS timing output

LED

The RX375P uses one tri-colored LED:

- *Red* indicates the power is on
- *Amber* indicates a GPS lock
- *Flashing Green* indicates DGPS is being acquired
- *Green* indicates a DGPS solution

Radar-Simulated Pulse Output

The radar-simulated pulse output provides accurate ground speed. The RX375P uses pin 12 for the speed out pin. Pin 12 will output a square wave with a 50% duty cycle. The frequency of the square wave varies directly with speed. 94 Hz represents a speed of 1 meter per second, or a 28.65 pulse per foot traveled.

NOTE: Pin 12 does not have any form of isolation or surge protection. It is STRONGLY RECOMMENDED to incorporate some form of isolation circuitry into the supporting hardware if Speed Radar Pulse output is to be utilized.

CAN

The RX375P features Controller Area Network (CAN) to handle communication between CAN-based devices. The RX375P supports a selection of NMEA 2000 messages that can be broadcast on a CAN bus. The following table provides a listing of the NMEA 2000 commands that are used.

Table 1: NMEA 2000 Commands

PNG 129029	GNSSPositionData
PNG 129025	GNSSPositionRapidupdate
PNG 129026	NMEACogSogData

CHAPTER 2 INSTALLATION

PREPARATION

Before beginning the installation, thoroughly clean the mounting area.

Park the vehicle on a clean, level floor with adequate clearance to work around.

Do not attempt to loosen or attach any fittings while the engine is running.

Photos and illustrations may vary form the actual components provided. This may be due to different installation options, operation modes or production models.

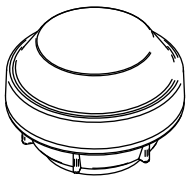
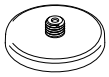
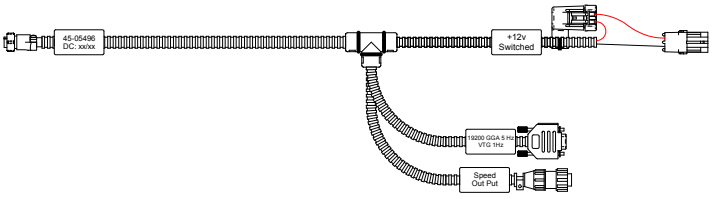
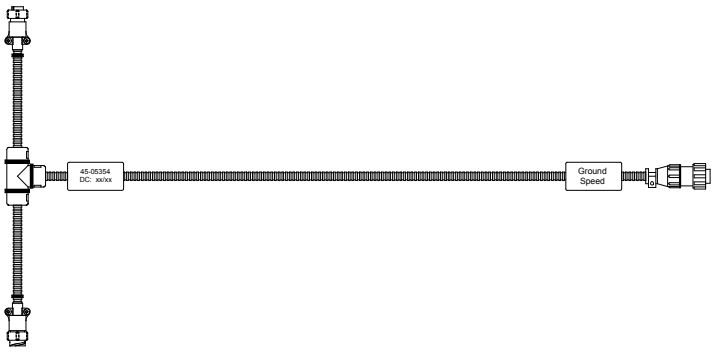
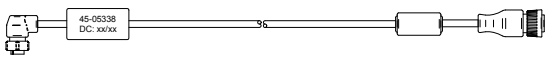
Always try to use original parts. Built to the highest standards of safety and reliability, TeeJet Technologies parts are to be used for this system as others might jeopardize the safety and function of the system. TeeJet is not responsible for any redesign or adaptations of the RX375P. Any changes to the RX375P voids the company warranty.

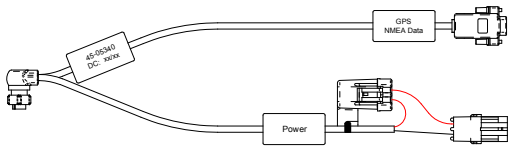
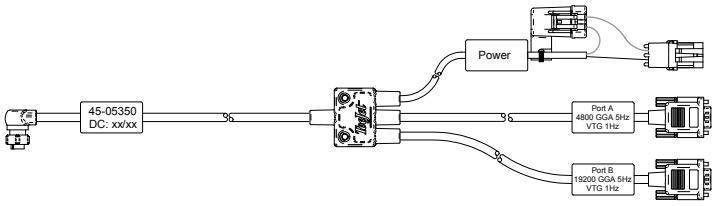
COMPONENTS

Unpack the installation kit and identify the required parts for your installation.

Item	Part Number	Description	Quantity
A	78-50203	Receiver, RX375P, SBAS	1
B		Magnet Mount Adapter, RX375P	1
C		Magnet, RX375P	1
D*	45-05496	Cable, RX370P DB9, Speed, Power	1
D*	45-05495	Cable, RX370P Speed Only	1
	45-05338	Cable, GPS Data w/12 position Deutsch	1
D*	45-05340	Cable, Deutsch to DB9	1
D*	45-05350	Cable, Com 1 & 2 with Power In	1

** Depends on which cable was ordered with the receiver.*

Item	Part #	Description	Illustration
A	78-50203	Receiver, RX375P, SBAS	
B		Magnet Mount Adapter, RX375P	
C		Magnet, RX375P	
D*	45-05496	Cable, RX370P DB9, Speed, Power	
D*	45-05495	Cable, RX370P Speed Only	
	45-05338	Cable, GPS Data w/12 position Deutsch	

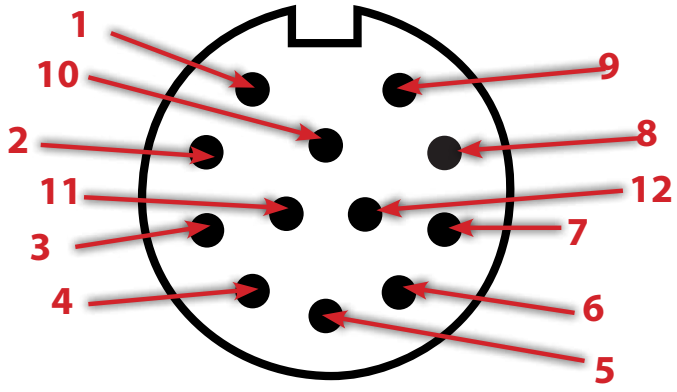
Item	Part #	Description	Illustration
D*	45-05340	Cable, Deutsch to DB9	
D*	45-05350	Cable, Com 1 & 2 with Power In	

** Depends on which cable was ordered with the receiver*

CABLES

The following figure provides a front view of the Deutsch connector receptacle's numbering.

Figure 1: Deutsch Connector Receptacle Numbering



The following table provides the Deutsch connector's pin-outs.

Table 2: Deutsch Connector's Pin-Outs

Pin-Out	Function	Pin-Out	Function
1	Manual mark in	7	One PPS
2	TxB	8	RxA
3	RxB	9	CAN Low
4	CAN High	10	Power in (12V)
5	Signal Ground	11	Power Ground
6	TxA	12	Speed Out

The RX375P is preset to the following settings:

Port A 4800 Baud, GGA 1 Hz, VTG 1 Hz

Port B 19200 Baud, GGA 5 Hz, VTG 1 Hz

Cable Interface

The cable options include:

- DB9 Serial
- Speed
- CAN
- Power

Additional extension cables may be purchased, as necessary, for other installations. This allows the RX375P to be quickly and easily moved from one installation to another. If an extension cable is damaged in the field, it can be replaced without returning the complete RX375P system.

Extension Power/Data Cable

The RX375P system is quickly installed with one of the various extension cables. When choosing a route for the RX375P extension cable:

- Avoid running cables in areas of excessive heat
- Keep cables away from corrosive chemicals
- Do not run the extension cable through door or window jams
- Keep cables away from rotating machinery
- Do not bend excessively or crimp the cables
- Avoid placing tension on the cables
- Remove unwanted slack from the extension cable at the receiver end
- Secure along the cable route using plastic ties or wraps

WARNING! Cables improperly installed near machinery can be dangerous.

MOUNTING

RX375P Placement

Placement of the RX375P is crucial to the system's operation. The GPS engine inside the RX375P computes a position based upon measurements from each satellite to the internal GPS antenna unit. Mount the RX375P to the identified point of interest. When choosing a location, make certain there is an unobstructed view of the sky available to the smart antenna. This will ensure that the GPS satellites are not masked by obstructions, which can potentially reduce system performance.

To place the RX375P:

1. Mount the RX375P on, or as close to the center of the point of measurement.
2. Position the RX375P as high as possible.

The following illustration provides an example of the ideal location for vehicle placement.

Figure 2: RX375P Vehicle Placement

Routing and Securing the Cables

Consider the following when routing cables:

- Power/data cable must reach an appropriate power source
- Power/data cable may connect to a data storage device, computer, or other device that accepts GPS data
- Do not run cables in areas of excessive heat
- Do not expose cables to corrosive chemicals
- Do not crimp or excessively bend cables
- Do not place tension on cables
- Coil up excess cable in the cab of the vehicle or near the antenna
- Secure along the cable route using plastic tie wraps as necessary
- Do not run cables near high voltage or strong RF noise and transmitter sources

WARNING! Improperly installed cables near machinery may cause injury or death.

Mounting options

The RX375P can be mounted in several ways: Magnetic Mount, Surface Mount or Pole Mount.

Magnetic Mount

The magnetic mount can be screwed into the bottom of the RX375P and mounts to metal surfaces. A metal disc and foam adhesive are included with each magnetic mount. Use the foam adhesive to bond the metal disc to the desired mounting location if there are no metal surfaces.

To use the metal disc and foam adhesive:

1. Clean and dry the mounting surface on the vehicle.
2. Remove the backing from one side of the foam adhesive and press the metal plate onto the mounting surface on the vehicle.
3. Remove the backing from the other side of the foam adhesive.
4. Press the metal plate onto the mounting surface of the vehicle.
5. Apply firm pressure to ensure good adhesion.
6. Place the RX375P on top of the metal disc.

Surface Mount

As an alternative to the magnetic mount, the antenna is easily attached to the surface with four machine screws (no. 8-32, not included).

To surface mount the antenna:

1. Use the templates located in Appendix C of this document, or photocopy the bottom of the antenna and use it as a template to plan the mounting hole locations

   WARNING! Make sure the printout of the template or the photocopy is scaled ONE TO ONE with the mounting holes on the bottom of the antenna!

2. Mark the mounting hole centers as necessary on the mounting surface.

   NOTE: If using a photocopy of the receiver bottom, punch the holes in the copy and use the back of the copy when marking from the outside of the cab.

3. Place the antenna over the marks to ensure that the planned hole centers agree with the true hole centers. Adjust as necessary.
4. Use a center punch on the hole centers in order to guide the drill bit.
5. Drill the mounting holes with a 9 mm bit appropriate for the surface mount.
6. Place the antenna over the mounting holes and insert the mounting screws through the bottom of the mounting surface and into the antenna.

   WARNING! Install the antenna only hand-tight. Damage resulting from overtightening the antenna is not covered by warranty.

Pole Mount

The center thread of the antenna is 5/8 in (15.875 mm) for compatibility with a survey pole (not included).

POWERING THE RX375P

Connect the RX375P to a TeeJet Technologies guidance system or a 12 volt DC source with a power connector. Refer to Appendix D for illustrations. Choosing the appropriate connector will depend on specific installation requirements.

NOTE: It is recommended that a weather-tight connection and connector be used if the connection will be located outside.

WARNING! Be careful not to provide a voltage higher than the input range. This will damage the antenna.

The RX375P accepts an input voltage between 7 and 32 VDC via the cable. For best performance, the supplied power should be continuous and clean.

WARNING! Do not apply a voltage higher than 32 VDC. This will damage the receiver and void the warranty.

The RX375P features reverse polarity protection to prevent excessive damage if the power leads are accidentally reversed. With the application of power, the RX375P will automatically proceed through an internal start-up sequence. However, it will be ready to communicate immediately.

NOTE: The initial start-up can take from 5 to 15 minutes depending upon location.

NOTE: The RX375P can take up to five (5) minutes for a full ionospheric map to be received from SBAS. Optimum accuracy will be obtained once the RX375P is processing corrected positions using complete ionospheric information.

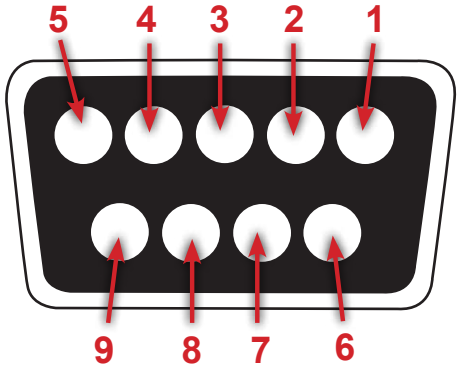
EXTERNAL DEVICE CONNECTIONS

The serial ports of the RX375P operate at the RS-232C interface level to communicate with external data loggers, navigation systems, and other devices. The serial ports are accessible via the extension cable that features a DB9 female data connector. The serial ports are also used for firmware updates.

NOTE: For successful communication, the baud rate of the RX375P serial port must be set to match that of the devices to which they are connected.

The following figure illustrates the numbering for the extension cable's DB9 socket connector (female). The associated numbering for the plug connector (male) is a mirror reflection of the scheme illustrated.

Figure 3: DB9 Socket Numbering



NOTE: Other pins on the serial ports may be active depending on the optional cable selection.

Table 3: Extension Cable Pin-Out, DB9

Pin Number	Function
2	Transmit RX375P NMEA 0183, binary and RTCM
3	Receive RX375P NMEA 0183, binary and RTCM input
5	Signal Ground

Factory Parameters

Table 4: DGPS Options

Application	
Application 1	SBAS (WAAS, EGNOS, etc.)
Application 2	e-Dif (unsubscribed)

Table 5: Serial Port Settings

Serial Port	Baud Rate	Data Bits	Parity	Stop Bits	Interface Level
Serial Port A and B	4800*	8	None	1	R2-232C
	9600	8	None	1	R2-232C
	19200**	8	None	1	R2-232C
	38400	8	None	1	R2-232C
	57600	8	None	1	R2-232C
	115200	8	None	1	R2-232C

**Serial Port A default setting*

***Serial Port B default setting*

Table 6: GPS Message Output Options

GPS Message	Update Rate	Elavation Mask
GPS Binary	From 1 Hz to 20 Hz	5°
NMEA 0183	From 1 Hz to 20 Hz	5°
NMEA 2000 (CAN)	From 1 Hz to 20 Hz	5°

The CAN port will automatically output the NMEA 2000 messages.

Custom Configuration

All aspects of the RX375P may be configured through the serial port with the use of GPS commands. The user can configure the following items:

- Selecting one of the two on-board applications
- Selecting the baud rate
- Choosing which NMEA 0183 data message to output on the dual serial ports and the update rate of each message

NOTE: The changes made to the RX375P will not be saved to memory for subsequent power-up unless a save command is issued.

NOTE: Contact your local TeeJet Technologies dealer for information regarding the use of GPS commands to customize configuration.

Environmental Considerations

The RX375P is designed to withstand various outdoor environments. However, there are specific environmental limits that should be met when using the RX375P. Refer to Appendix B for additional information.

CHAPTER 3 GPS OVERVIEW

For operator convenience, both the GPS and differential correction of the RX375P are pre-configured. The receiver will work out of the box, and for most applications, little user setup is required. When powered for the first time, the RX375P will perform a “cold start” which involves acquiring the available GPS satellites in view and the SBAS differential service.

GPS OPERATION

The GPS engine is always operating, regardless of the DGPS mode of operation. The following sections describe the general operation of the RX375P’s internal GPS engine.

Automatic Tracking

The GPS engine within the RX375P automatically searches for GPS satellites, acquires the signals, and manages the navigation information required for positioning and tracking. This is a hands-free mode of operation.

Receiver Performance

The RX375P works by finding four or more GPS satellites in the visible sky and uses the information those satellites provide to compute an appropriate position (typically within 7-10 ft (2-3 m).) Since there is some error in the GPS data calculations, the RX375P also tracks a differential correction. The RX375P uses these corrections to improve its position to less than 3 ft (1 m).

There are two main aspects of GPS receiver performance:

- Positioning
- Satellite acquisition quality

GPS is essentially a timing system. When the RX375P is properly positioned on the vehicle, the satellites transmit coded information to the antenna in a specific frequency that allows the receiver to calculate a range to each satellite. The ranges are calculated by timing how long it takes for the GPS signal to reach the GPS antenna.

The GPS receiver uses a complex algorithm incorporating satellite locations and ranges to each satellite to calculate the geographic location. Reception of any four or more of these signals allows a GPS receiver to compute 3-dimensional coordinates.

DIFFERENTIAL OPERATION

The Radio Technical Commission of Marine services (RTCM) has a differential service intended for correction services. This includes the Space Based Augmentation Systems (SBAS), such as the Wide Area Augmentation System (WAAS) and the European Geo-stationary Navigation Overlay System (EGNOS). The RX375P is compatible with each of these differential services in addition to e-Dif.

SBAS

The SBAS enabled RX375P operates automatically anywhere within the coverage areas of WAAS, EGNOS, or other SBAS programs.

The Basics

WAAS is a free services of the FAA that allows regular GPS positions to be improved to a DGPS level of accuracy. Tests using an RX375P have shown better than 3 ft (1 m) accuracy. WAAS is available everywhere in the United States, including Alaska, Hawaii, and Puerto Rico. It can also be picked up in some of the border areas of Mexico and Canada. There are no subscription charges incurred when using WAAS. EGNOS is a similar service that is available in Europe and Western Russia.

Automatic SBAS Tracking

The RX375P will automatically scan and track the satellite signals. This automatic tracking allows the operator to focus on other aspects of differential operation without the need to tune the receiver. The RX375P features two-channel SBAS tracking that provides an enhanced ability to maintain a lock on a SBAS satellite when more than one satellite is in view. This redundant tracking approach results in more consistent tracking of an SBAS signal when in an area where signal blockage of a satellite is possible.

e-Dif

An RX375P that is equipped with e-Dif capabilities can operate anywhere in the world where normal GPS signals can be viewed. e-Dif can be used anywhere on the globe where a GPS lock can be achieved. e-Dif was developed for customers who are not able to receive other types of differential signals due to location or budget. e-Dif requires a subscription. Once the e-Dif capable RX375P computes a differential correction, the user can operate for unlimited time and provide good relative accuracy. Alternatively, the operator can regularly update e-Dif to maintain absolute accuracy (typically less than 3 ft (1 m) over 40 minutes).

APPENDIX A - TROUBLESHOOTING

The following table provides a checklist to troubleshoot common problems and their solutions for the RX375P.

Table 7: Troubleshooting

Problem	Possible Solution
Receiver fails to power	• Verify polarity of power leads • Check integrity of power cable connections • Check power input voltage (7 - 32 VDC) • Check current restrictions imposed by power source (maximum is 250 mA)
No data from RX375P	• Check receiver power status (LED) • Check integrity and connectivity of power and data cable connections • The volume of data requested to be output by the RX375P could be higher than what the current baud rate supports. Try using 19,200 or higher as the baud rate for all devices.
No GPS lock	• Check integrity of cable connections • Verify RX375P's unobstructed view of the sky
No SBAS lock	• Check integrity of cable connections • Verify RX375P's unobstructed view of the sky • Check SBAS visibility map

APPENDIX B - SPECIFICATIONS

The following tables provide the power, mechanical, communication, environmental and DGPS specifications for the RX375P.

Table 8: Power Specifications

Item	Specification
Input Voltage	7-32 VDC with reverse polarity operation
Power Consumption	< 3 W @ 12 VDC (typical)
Current Consumption	134 mA 12 VDC (typical)
Power Isolation	No
Reverse Polarity Protection	Yes
Antenna Voltage	Internal antenna

Table 9: Mechanical Specifications

Item	Specification
Dimensions	104.0 H x 145.0 D (mm) 4.09 H x 5.71 D (in)
Weight	1.37 lb (558 g)
Status Indicators (LED)	Power, GPS Lock
Power/Data Connector	12-pin male (metal)
Antenna Mounting	1-14 UNS-2A female, 5/8-11 UNC-2B adapter, and mag-mount available

Table 10: Communication Specifications

Item	Specification
Serial	2 full duplex RS232, CAN
Baud Rates	4800-115200
Data I/O Protocol	NMEA 0183, NMEA 2000*, Hemisphere GPS binary **To use the A101 in a NMEA 2000 network requires NMEA certification and a NMEA2000 adapter cable*
Correction I/O Protocol	Hemisphere GPS proprietary, RTCM v2.3 (DGPS), RTCM v3 (RTK), CMR (RTK), CMR+ (RTK)[3]
Timing Output	1 PPS CMOS, active high, rising edge sync, 10 kΩ, 10 pF load
Event Marker Output	CMOS, active low, falling edge sync, 10kΩ, 10 pF load

Table 11: Environmental Specifications

Item	Specification
Operating Temperature	-40° C to +70° C (-40° F to +158° F)
Storage Temperature	-40° C to +85° C (-40° F to +185° F)
Humidity	95% non-condensing
Enclosure	IP67
Shock and Vibration	Mechanical Shock: EP455 Section 5.14.1 Operational Vibration: EP455 Section 5.15.1 Random
EMC	CE (ISO 14982 Emissions and Immunity), FCC Part 15, Subpart B, CISPR 22

Table 12: Sensor Specification

Item	Specification
Receiver Type	L1 GPS
Channels	12 L1CA GPS, 12 L1P GPS, 3 SBAS or 3 additional L1CA GPS
GPS Sensitivity	-142 dBm
SBAS Tracking	3-channel, parallel tracking
Update Rate	10 Hz standard, 20 Hz optional (with subscription)
Pitch/roll Accuracy	1° using tilt sensor
Timing (1PPS) Accuracy:	20 ns
Cold Start	< 60 s typical (no almanac or RTC)
Warm Start	< 30 s typical (almanac and RTC)
Hot Start	< 10 s typical (almanac, RTC, and position)
Maximum speed	1,850 kph (999 kts)
Maximum altitude	18,288 m (60,000 ft)

Table 13: Horizontal Accuracy

Item	Specification	
	RMS (67%)	2DRMS (95%)
RTK[1,2]	10 mm+1 ppm	20 mm+2 ppm
SBAS (WAAS)[1]	0.3 m	0.6 m
Autonomous, no SA[1]	1.2 m	2.5 m

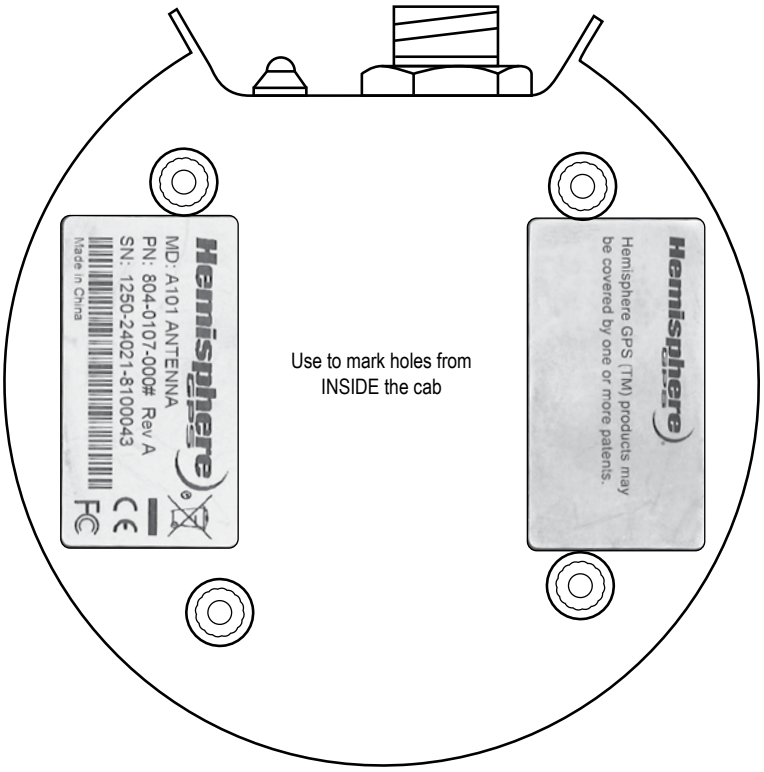
[1] Depends on multipath environment, number of satellites in view, satellite geometry and ionospheric activity

[2] Depends also on baseline length

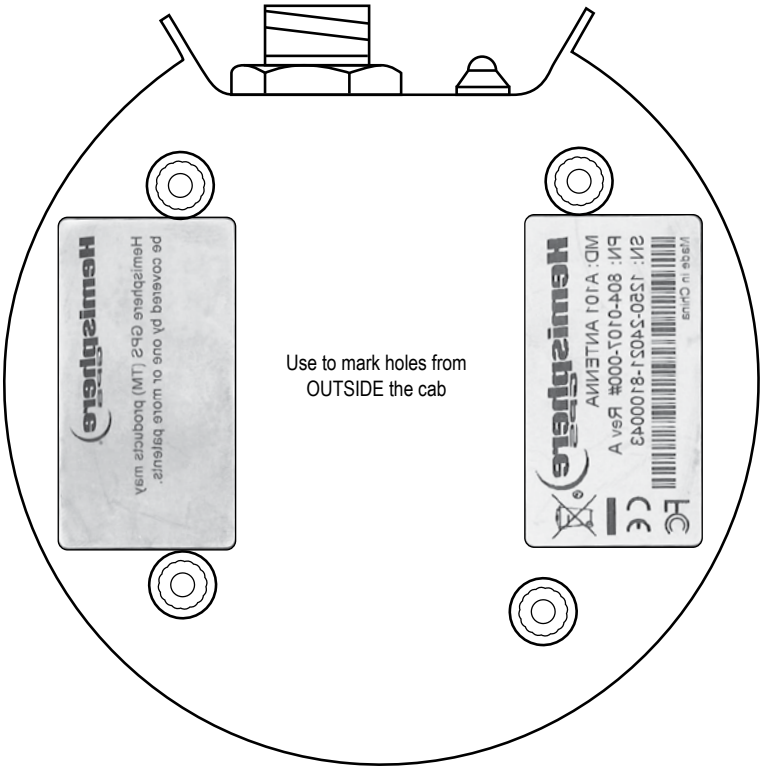
[3] Receive only, does not transmit this format

APPENDIX C - SURFACE MOUNT TEMPLATE

The following templates should be used to plan for the location of the mounting holes when surface mounting the RX375P.



WARNING!
Print this page at 100%



APPENDIX D - ILLUSTRATIONS

Table 14: CenterLine with SmartPad II with RX375P System Configuration

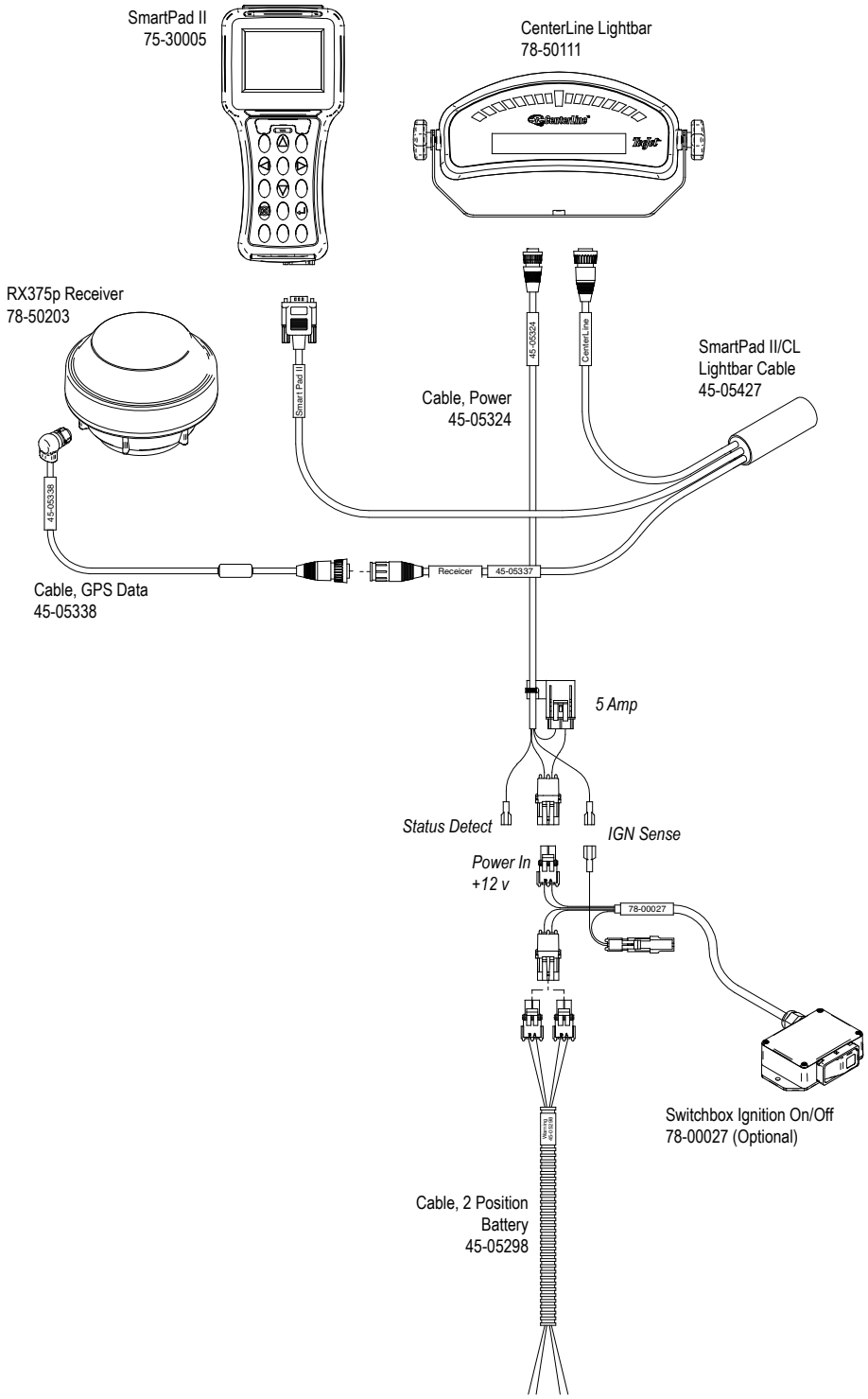


Figure 4: Standard CenterLine System Configuration with RX375P

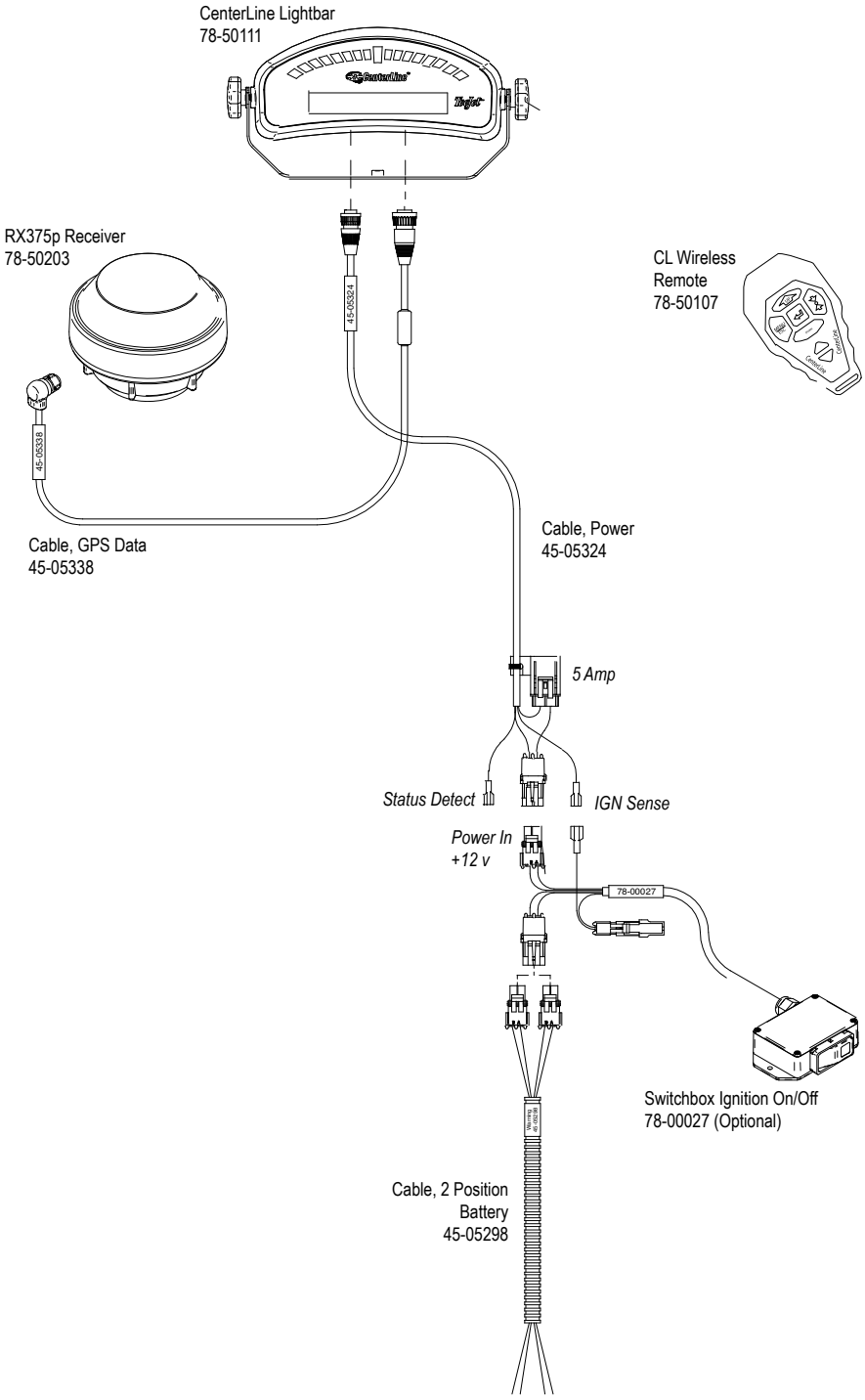
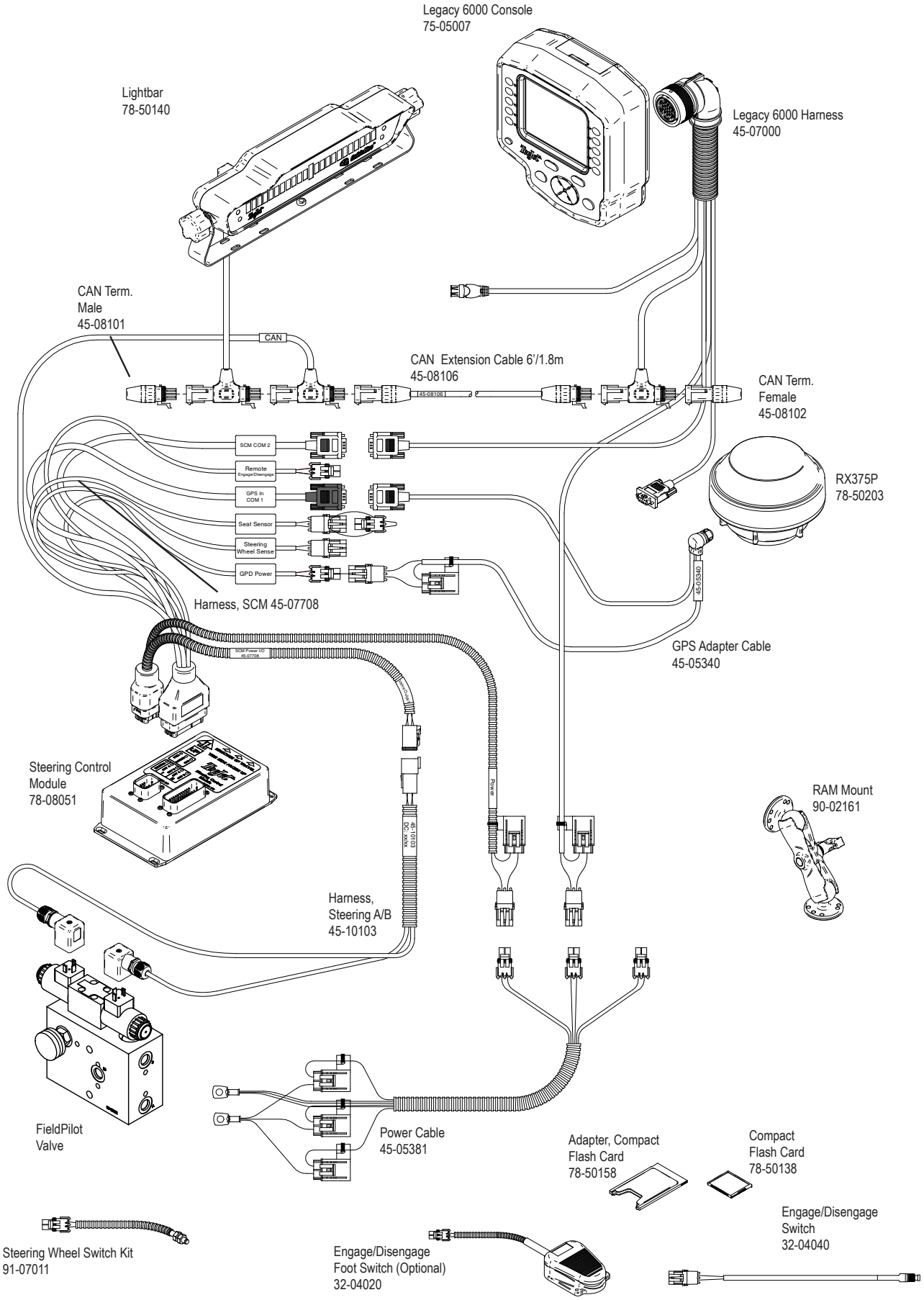


Figure 5: FieldPilot Assisted Steering with RX375P System Configuration



RX375P

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TeeJet® TECHNOLOGIES

1801 Business Park Drive
Springfield, Illinois 62703 USA
Tel: (800) 643-8324 • Fax: (800) 230-6211
www.teejet.com

A Subsidiary of *Spraying Systems Co.*®

98-05327-ENUS R0 English-US