STX/eDriveXD (flip booklet for MAX)

Your Calibration Guide: Setup and Execution

Calibration Overview

The largely-automated calibration process has some initial setup requirements—adding and setting up your vehicle, see 1 and 2 following. The actual calibration steps are listed in 3 (a-g) and each step has short, summary information about it. Other, non-calibration steering-related activities are listed on page 3.

1. Adding your vehicle (page 4).

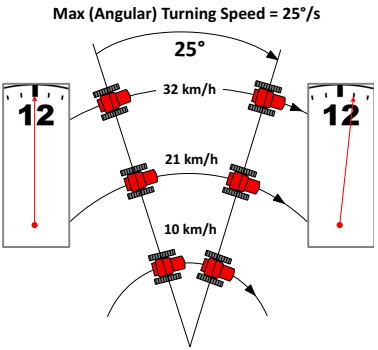
   a. Name your vehicle.
   b. Set vehicle color.

2. Setting up your vehicle.

   a. Vehicle (e.g. standard tractor, sprayer, combine) and valve type (hydraulic - relay valve; electric - ESi/VSi - page 4). The combination determines the number and type of calibration steps - see “Calibration Matrix” on page 8.
   b. Dimensions - Required: wheelbase; antenna height; antenna pivot (page 4).
   c. Dimensions - Optional: Antenna offset (L/R); front hitch length; rear hitch length (page 5).

3. Calibrating your eDriveXD (there are four or five calibrations, numbered 1/4 to 4/4 or 1/5 to 5/5 - see “Calibration Matrix” on page 8).

   a. ECU Orientation (where logo/connector ‘point’ - page 9).
   b. Maximum Turning Speed - (angular turning speed in degrees per second). You set how tightly autosteering is to turn you at your current speed; whatever your current ‘traveling’ speed, an autosteered turn’s angular speed (°/s) will never exceed this setting - page 10.



   c. Minimum Radius (turning circle - page 11).
   d. Steering Ratio (page 12).
   e. Lock to Lock (both ways measured - page 13). In simple terms, it is the electric (ESi/VSi) equivalent of f. Steering Speed.
   f. Steering Speed (left to right only measured - page 14). In simple terms, it is the hydraulic equivalent of e. Lock to Lock. Both e and f relate to the steering’s reaction to crosstrack errors while engaged - pages 14 and 15.
   g. Mounting Bias (‘roll & pitch’ - compensates for ECU mounting tolerances - page 16).

Other (non-calibration) steering-performance related activities are:

1. User preferences:

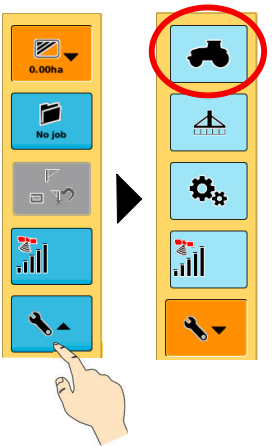
   a. Sensitivity (reaction to crosstrack variations - page 18).
   b. Attack (line acquisition 'urgency' - page 18).
   c. Smoothing (contour adjustments - page 18).

2. Service:

   a. Maximum Lateral Acceleration ('Cornering Speed' - page 19).
   b. Steer Test (ensures left/right commands make left/right turns - page 19).

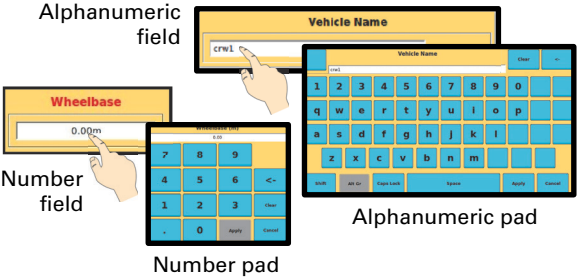
Basics 1: Accessing the Vehicle Screen Button

The vehicle screen button (tractor icon) is one of the screen buttons displayed in two alternate panels on the left of the screen. The vehicle button is not in the default panel (left in graphic at right) so press the setup button (the wrench) to switch to the second, alternate panel (right set in the graphic). For more information, see "STX Display" in your STX User Guide.



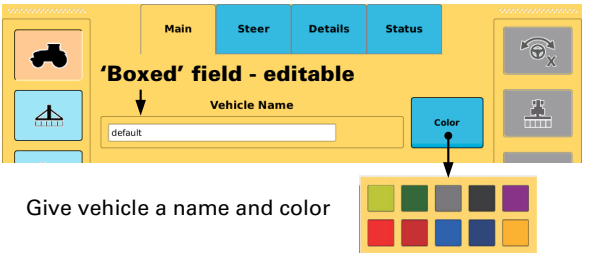
Basics 2: Entering Data in Screen Fields

You can enter/edit data only in fields that have a gray rectangle around them (see **Vehicle Name** field at right). Fields with no rectangle are read-only fields. To enter data in an editable field, press within the field itself. Depending on the type of data applicable to the field you will be presented with the appropriate data entry pad. For letter/number fields you get an alphanumeric pad; for number only fields you get a number pad.



Adding a Vehicle

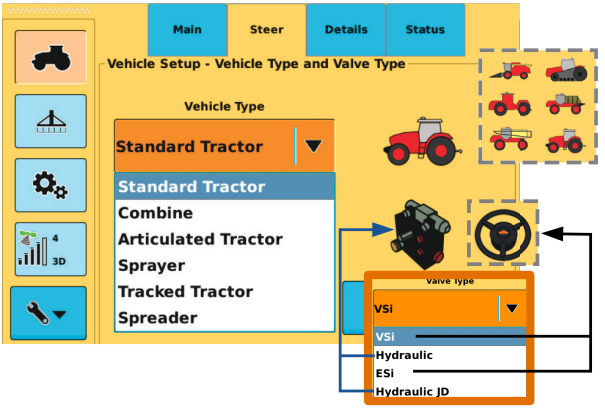
- Vehicles are identified by name and color.
- Vehicles remain in STX's memory even if you move the terminal to another vehicle.



Give vehicle a name and color

Setting Vehicle and Valve Type

- Select a vehicle type then select a valve type.
- The vehicle and valve icons reflect your selection.
- After you change the vehicle or valve type, STX *may* prompt you to restart (power cycle) the ECU for the changes to take effect.



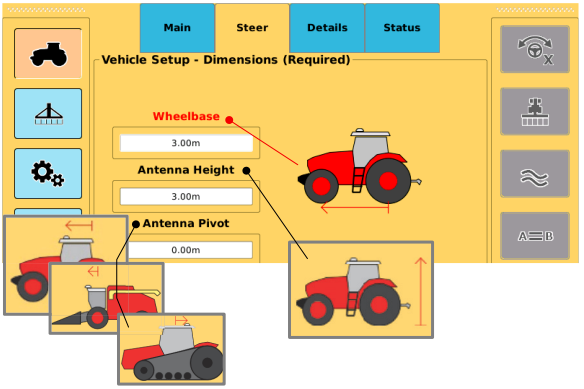
Setting Required Vehicle Dimensions

The required dimensions (there are *optional* dimensions, see "Setting Other Vehicle Dimensions (Optional)" on page 5) are:

Wheelbase: The distance between front and rear axle centers.

Antenna height: Vertical distance from ground to bottom of antenna.

Antenna pivot: Horizontal distance of antenna's center in front of or behind vehicle's pivot point. The pivot point varies with vehicle type so where to measure from is indicated on the icon for

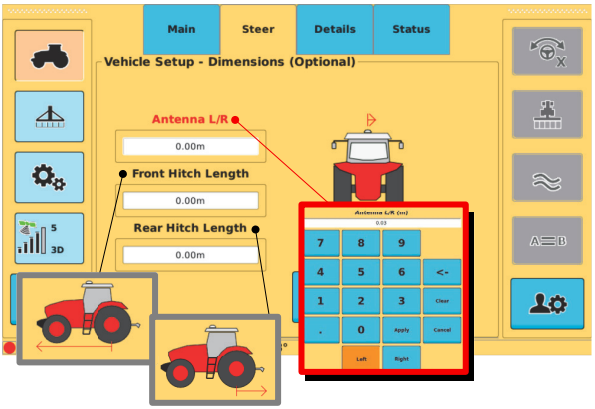


each vehicle type (see examples for standard tractor, combine, and tracked tractor at bottom of previous page).

Note: Measure the antenna pivot as accurately as practical, as this measurement has some impact on the accuracy of vehicle guidance and is the reference point from which the implement offset is calculated. Unlike the antenna left/right offset, there is really no field method to verify or improve the antenna pivot measurement.

Setting Other Vehicle Dimensions (Optional)

Optional dimensions are:



Antenna L/R: 'Antenna offset'—the perpendicular distance between the fore/aft centerline of the vehicle and the center of the antenna. Unless you have a noticeably large offset, you can complete calibration with the default 0.00. (If you do have a noticeably large offset, you can enter a 'provisional' measured value.) If necessary, after calibration, you can measure the offset in the field (there are two methods) and adjust the offset as necessary. See your STX User Guide for more information on antenna offset.

Front Hitch Length: Horizontal distance between the vehicle's pivot point and the front hitch (manual measurement).

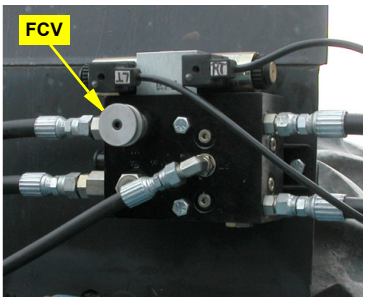
Rear Hitch Length: Horizontal distance between the vehicle's pivot point and the rear hitch (manual measurement).

Flow Control - Presetting and Adjusting

The steering speed calibration (lock to lock time) depends on the presetting and possible subsequent adjustment of the flow control valve (FCV).

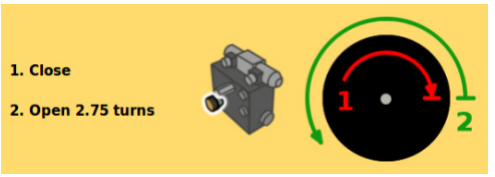
By presetting the FCV before running the calibration process you can ensure the steering speed will be either in the recommended range or close to the recommended range. If the measured steering speed is out of range, screen messages will identify the adjustment required.

You preset the flow control valve by closing it fully (clockwise) then opening it (counterclockwise) a specified number of turns.



Flow control valve on a typically mounted block (the valve knob may vary in appearance)

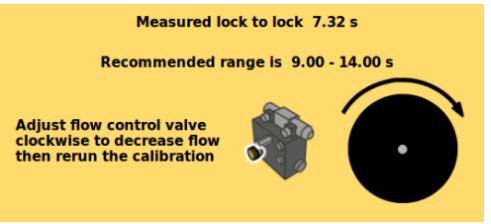
The screen message will tell you how far to open the valve for your make/model. See at right and sections 5a and 5b on pages 14 and 15.



Flow control valve preset for articulated vehicles (open 2.75 turns)

Steering Speed Adjustment - Flow Control Valve

If the calibration result is out of range, a screen message will advise you to adjust the flow control valve - see at right. Note that the screen message reports measured lock to lock, recommended range, and adjustment required.

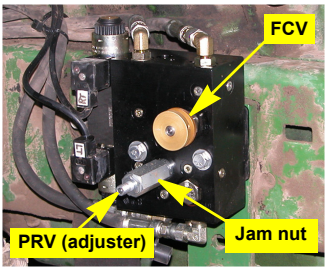


Post-calibration flow control valve adjustment (decrease flow)

Note: John Deere 4000 and 8000 models have a pressure reduction valve (PRV) as well as a flow control valve - for information on PRV adjustment for these models, see "Steering Speed Adjustment - JD 4/8K only" following.

Steering Speed Adjustment - JD 4/8K only

For John Deere 4000 and 8000 series vehicles (4/8K) you do not need to preset the pressure reduction valve (PRV) but you may need to adjust it before making adjustments to the preset FCV.

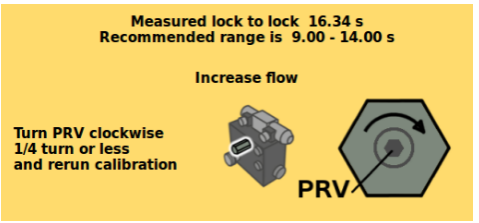


If the out-of-range value is small, the screen message will advise you to adjust the flow control valve as described above.

For bigger out-of-range results, the screen message will advise you to adjust the pressure reducing valve. Note that the screen message reports measured lock to lock, recommended range, and the adjustment required.

To adjust the PRV:

1. Loosen the long jam nut within which the PRV adjuster is situated.
2. Adjust the PRV 1/4 turn (or less).
3. Retighten the jam nut.
4. Rerun the calibration.



Post-calibration pressure reduction valve adjustment (increase flow in the example) - JD 4/8K only

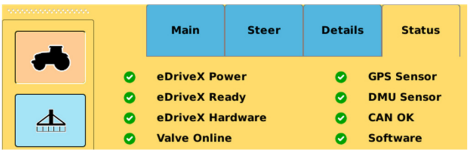
5. Repeat if the same message appears (see note following).

Note: After PRV adjustment has sufficiently reduced the out-of-range amount, you may need to make fine tuning adjustments to the flow control valve—the screen message will advise you.

Before Calibrating a Vehicle

Before and during calibration ensure that:

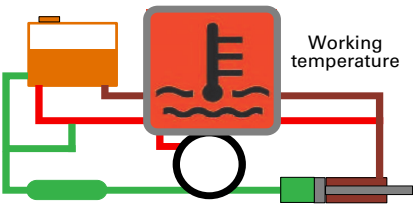
- You have enough open area in which to drive your vehicle throughout the calibration process - see "Calibration Ground Area Requirement" on page 8.
- GPS antenna/sensor is located in its final position and initialized.
- You use the GPS source the vehicle will use in operations. For example, if you plan to use RTK in the field you must use RTK during calibration.
- All the items at the top of the Status screen are green (see at right).



- You have preset the flow control valve (see "Flow Control - Presetting and Adjusting" on page 5).
- Your vehicle's hydraulic oil is at working temperature - see "Hydraulic Oil Temperature and Calibration" following.
- You maintain an engine speed of at least 1500 rev/min - see "Engine Speed and Calibration" below.

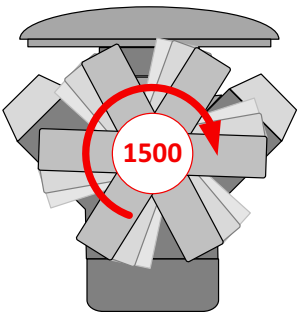
Hydraulic Oil Temperature and Calibration

Ensure your vehicle's hydraulic oil is at working temperature before you start calibrating your eDXD. Steering performance depends in part upon 'normal' flow of hydraulic oil so it needs to be at working temperature.



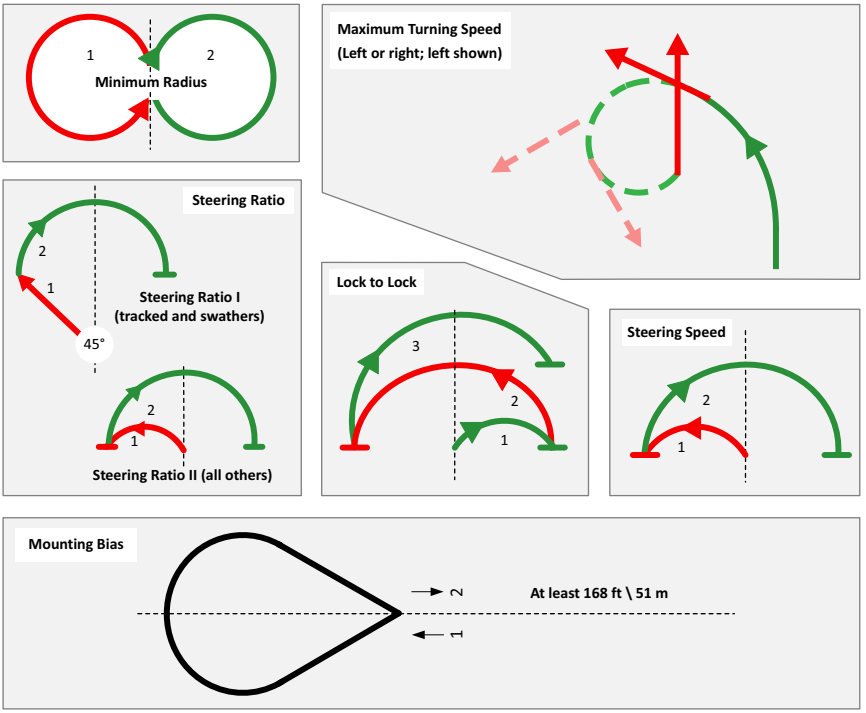
Engine Speed and Calibration

Some calibration steps should be carried out at full hydraulic pressure. Because some hydraulic systems need higher engine speeds than others to achieve full hydraulic pressure, it is recommended that you execute moving calibration steps with a minimum engine speed of 1500 rev/min.



Calibration Ground Area Requirement

You need enough open space to execute each calibration maneuver. The graphic below shows simplified representations of the calibration maneuvers and the area required for each of the six moving calibration steps. Note that there are two **Steering Ratio** maneuvers - (I) tracked vehicles and swathers and (II) all other vehicles.



Calibration Matrix

'Valve'	Std Tractor	Artic'ted Tractor	Combine	Sprayer	Track Tractor	Spreader	Swather
Hydraulic	■	■	■	■	N/A	■	N/A
Hydraulic JD (4/8K)	■	■	N/A	N/A	N/A	N/A	N/A
ESi/VSi	▲	▲	▲	▲	●	▲	●

■
ECU Orientation (1/4)
Minimum Radius (2/4)
Steering Speed (3/4)
Mounting Bias (4/4)

▲
ECU Orientation (1/5)
Minimum Radius (2/5)
Steering Ratio (3/5)
Lock to Lock (4/5)
Mounting Bias (5/5)

●
ECU Orientation (1/5)
Max Turning Speed (2/5)
Steering Ratio (3/5)
Lock to Lock (4/5)
Mounting Bias (5/5)

Executing the Calibration Process

Much of the calibration process is automated—you need only respond to screen prompts. On the following pages, in the summary activity boxes for 2. Maximum Turning Speed, 3. Minimum Radius, 4. Steering Ratio, 5. Lock to Lock, 6. (a and b) Steering Speed, and 7. Mounting Bias, **brown** indicates what you do, **blue** indicates what the system does (see example at right). For those steps (2-7) also, the information is displayed in four sections: A. Navigation and Screen Title; B. Calibration Maneuver (what happens, where the vehicle goes during the calibration); C. Activity Summary (the main steps in the calibration - color coded as explained above); D. Screen Sequence, the main screens in sequence with captioned notes.

What you do

What the system does

Set (and maintain) speed
Turn and hold full left lock
Left measurement
Turn and hold full right lock
Right measurement
Calibration complete

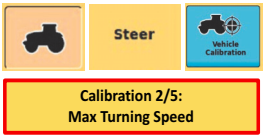
With all the pre-calibration setup complete, press the **Vehicle Calibration** button (Vehicle > Steer).

1. ECU Orientation (graphics 1-8 show all the possible combinations)

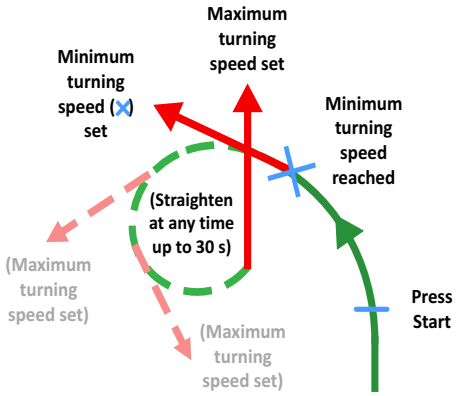
2. Maximum Turning Speed (Swather/Track Tractors Only)

This is a wholly manual steering calibration—there is no autosteering involved. At a speed within the specified range, steer the vehicle left or right progressively tightening the turn until you reach your 'comfort level on turns' (you are setting the maximum angular speed of your turns). The system requires a minimum turn speed and will (i) time out after 30 seconds if you do not achieve it, or (ii) advise you onscreen that you have achieved it. When advised "Minimum turn speed reached", you can either straighten from the turn to end the calibration (with that minimum turning speed set) or continue, tightening the turn, to store a higher value. After reaching the minimum turn speed, for up to 30 seconds you can end the calibration by straightening your current turn. After 30 seconds, the maximum turn speed recorded is stored and the calibration ended (that is, without you ending it by straightening the turn).

A. Navigation and Screen Title



B. Calibration Maneuver
(Left or right turn; left shown)



C. Activity Summary

Drive straight, set (and maintain) speed

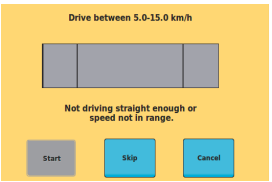
Turn left or right, progressively tightening the turn

Screen advises minimum storable turning speed reached

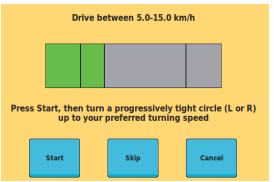
Straighten the turn (ending the calibration) *or* continue tightening the turn, straightening at any time to end the calibration

At straightening or 30 s, maximum turning speed recorded and stored: calibration complete

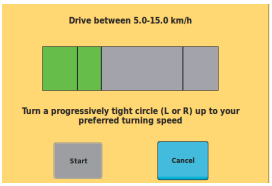
D. Screen Sequence



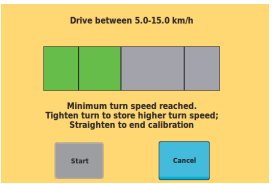
1. Not driving straight, speed not in range, Start button not active.



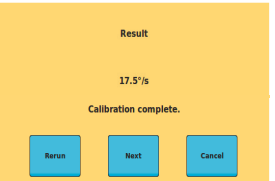
2. Speed good, press Start. Make progressively tighter left or right turn.



3. Maintain or tighten turn.



4. Minimum storable turning speed reached; straighten or continue tightening turn.

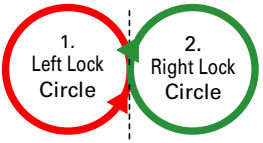


5. Maximum turning speed recorded and stored.

3. Minimum (Turning) Radius

A. Navigation and Screen Title

B. Calibration Maneuver (what happens)



C. Activity Summary

Set (and maintain) speed

Turn and hold full left lock

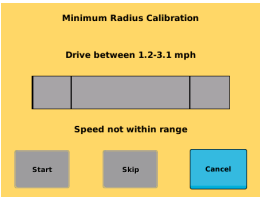
Left measurement

Turn and hold full right lock

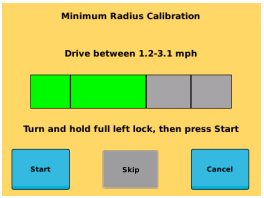
Right measurement

Calibration complete

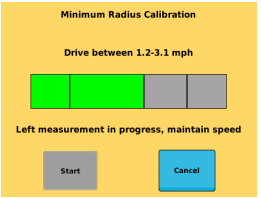
D. Screen Sequence



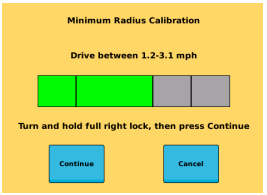
1. Speed not in range - Start button not active



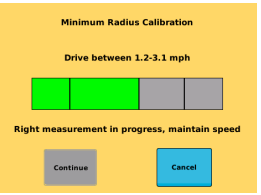
2. Speed good. Turn and hold full left lock, press Start.



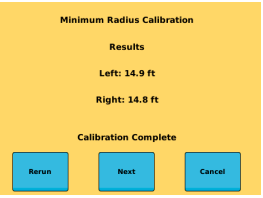
3. Left measurement in progress - maintain speed.



4. Turn and hold full right lock. Press Continue.



5. Right measurement in progress - maintain speed.



6. Results
Calibration complete
Rerun - Next - Cancel

4. Steering Ratio (ESi/VSi)

A. Navigation and Screen Title

C. Activity Summary

Set (and maintain) speed

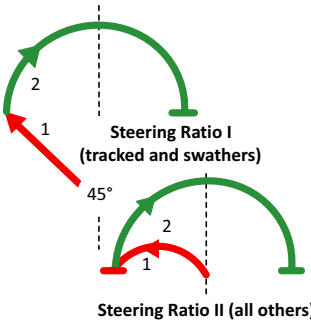
Steer left 45° or to left lock

Press OK

Wheel spins rapidly clockwise - vehicle turns full lock right

Calibration complete

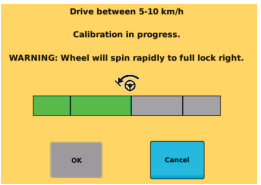
B. Calibration Maneuver (what happens)



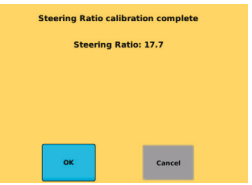
D. Screen Sequence

1. No speed - can't start (Left lock start, 45° start for tracked and swathers).

2. Speed set - steer to left lock or left 45°. Release wheel, press OK.



3. In progress - wheel spins rapidly to right lock.



4. Calibration complete - steering ratio stored.

5. Lock to Lock ('L2L' ESi/VSi)

A. Navigation and Screen Title

C. Activity Summary

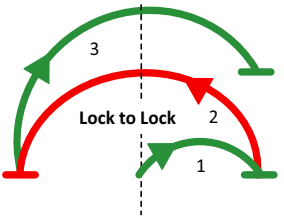
Set (and maintain) speed, steer straight, release wheel

Press OK

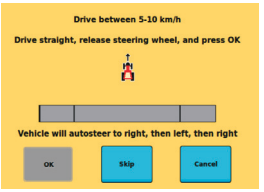
Vehicle turns to right lock then to full left lock then to full right lock

Calibration complete

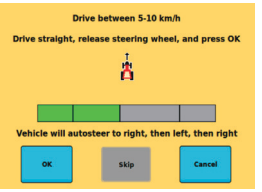
B. Calibration Maneuver (what happens)



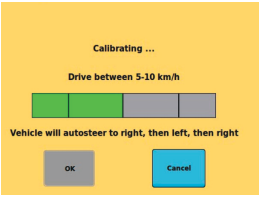
D. Screen Sequence



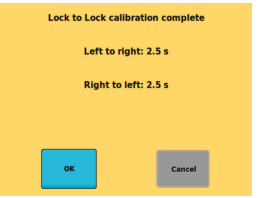
1. No speed - can't start.



2. Speed good - steer straight release wheel, press OK.



3. Vehicle steers to right lock then to left lock (R2L) then to right lock (L2R).



4. Calibration complete lock to lock times stored.

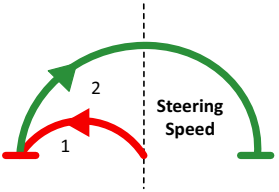
6a. Steering Speed ('L2L' hydraulic - non-JD 4000/8000s)

Once you press Start in this calibration step, all steering is by the system—that is, the vehicle is auto-steered left, then right. After you preset the flow control valve, steer in a straight line at the required speed and press Start, the system executes all the steering required. If you need to make adjustments and re-run the calibration, you can of course manually steer your vehicle to a new location if space to maneuver is required.

As stated above, you need to have preset the flow control valve before running this calibration step. The system will determine, from the calibration results, if adjustment is required and advise accordingly. See "Steering Speed Adjustment - Flow Control Valve" on page 6.

A. Navigation and Screen Title

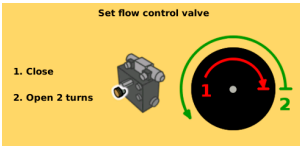
B. Calibration Maneuver (what happens)



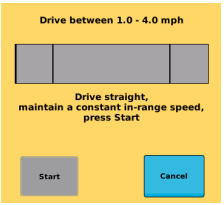
C. Activity Summary

Preset flow control valve
Set (and maintain) speed
Drive straight
Press Start
Steers left then right ('Measuring')
Result
Adjust or continue

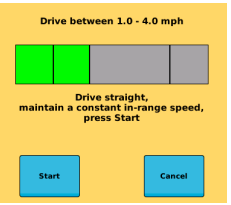
D. Screen Sequence



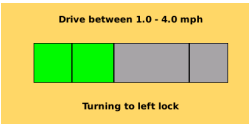
Preset flow control valve.



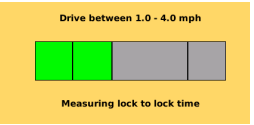
No speed - can't start.



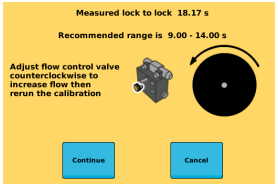
Speed good - can start.



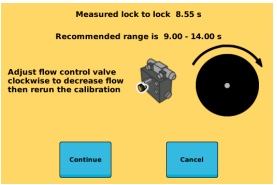
Turning to left lock.



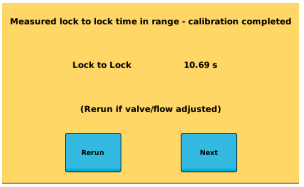
Turning to right lock - measuring lock to lock time.



Too slow - increase flow.



Too fast - decrease flow.



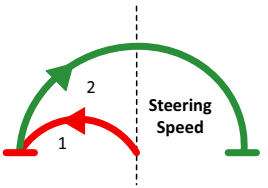
In range - no adjustment required.

6b Steering Speed (‘L2L’ hydraulic - JD 4000/8000s)

(See first paragraph of 6a). For JD 4000 and 8000 models, you preset the flow control valve just as for all other makes/models. But, depending on the calibration result, you may need to adjust the pressure reducing valve (PRV) instead of (or as well as) the flow control valve. The system will determine, from the calibration results, which valve requires adjustment - that is, for ‘big’ and ‘small’ out-of-range values, the PRV and FCV respectively. See “Steering Speed Adjustment - JD 4/8K only” on page 6.

A. Navigation and Screen Title

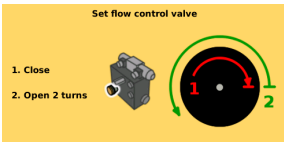
B. Calibration Maneuver (what happens)



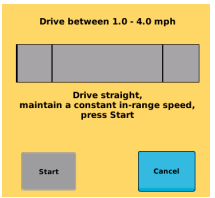
C. Activity Summary – JD 4/8Ks

Preset flow control valve
Set (and maintain) speed
Drive straight
Press Start
Steers left then right (‘Measuring’)
Result
Adjust PRV or FCV
or continue

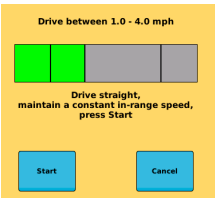
D. Screen Sequence – JD 4/8Ks



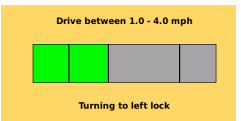
Preset flow control valve.



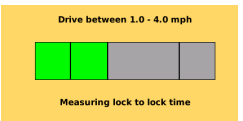
No speed - can’t start.



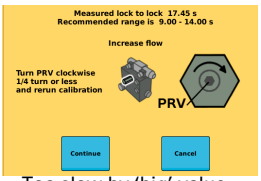
Speed good - can start.



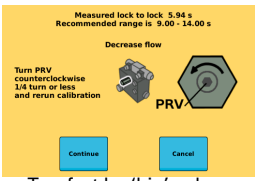
Turning to left lock.



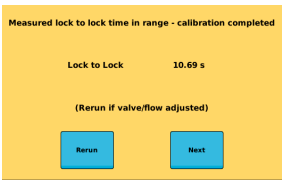
Turning to right lock - measuring lock to lock time.



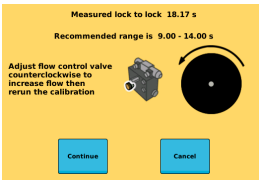
Too slow by ‘big’ value - increase pressure.



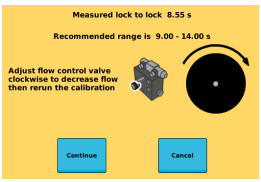
Too fast by ‘big’ value - decrease pressure.



In range - no adjustment required.



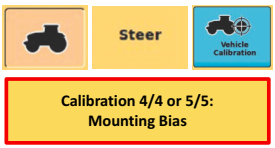
Too slow by ‘small’ value - increase flow.



Too fast by ‘small’ value - decrease flow.

7. Mounting Bias (Roll and Pitch)

A. Navigation and Screen Title



B. Calibration Maneuver (what happens)

See next page

C. Activity Summary

Set (and maintain) speed

Start

Calibration line set, Pass 1 calibration

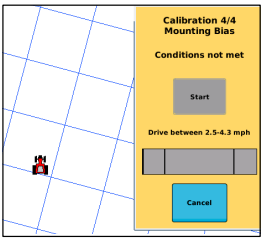
Turn around. In 'Engage Zone', engage auto-steer

Line acquired, Pass 2 data collected

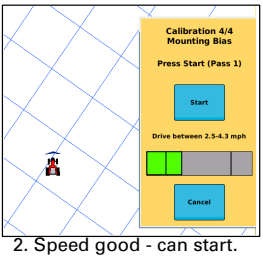
Calibration complete

(or repeat if instructed)

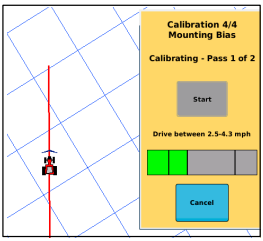
D. Screen Sequence



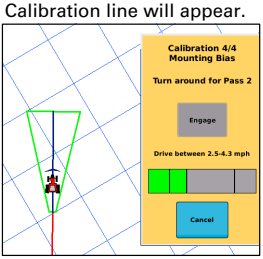
1. No speed - can't start.



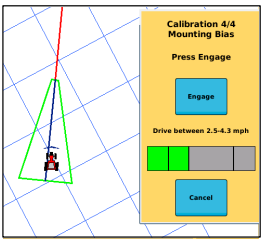
2. Speed good - can start. Calibration line will appear.



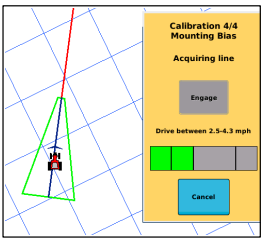
3. Pass 1 on calibration line.



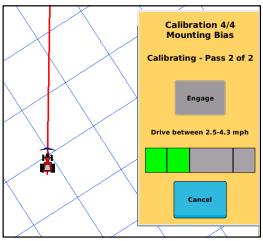
4. Pass 1 ends - 'engage zone' appears - turn around.



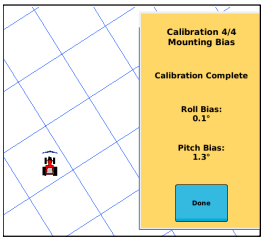
5. In engage zone after turn engage for line acquisition.



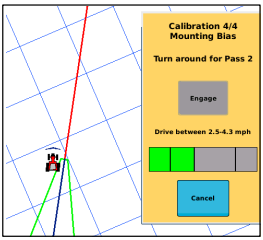
6. Autosteering engaged - line acquisition in progress.



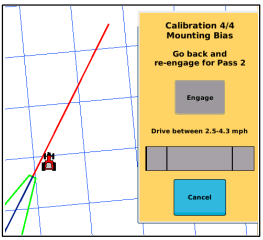
7. Line acquired - Pass 2 begins.



8. Pass 2 good, calibration complete.



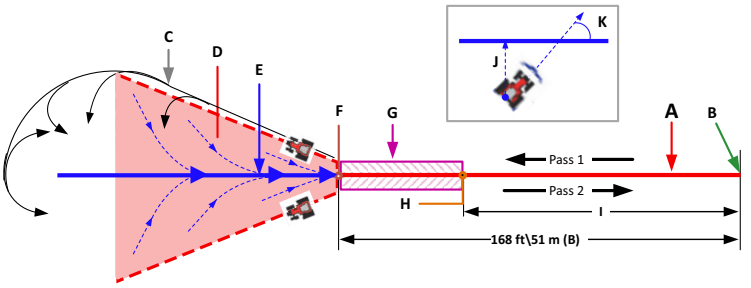
9. No engagement, **Pass 2 fails**. Turn back, re-enter engage zone, Engage for line acquisition.



10. Engagement but no line acquisition, **Pass 2 fails.** Turn back into engage zone, engage sooner and acquire line.

Pass 2 fails (9) if autosteering is not engaged, speed goes out of range, or autosteering manually overridden. Pass 2 fails (10) if autosteering does not acquire line in time.

Mounting Bias Calibration Maneuver



A	The preset fixed-length calibration line. Data is logged (collected) on two passes on this line. The line appears when you start the calibration process.
B	Initial start of line A. When you press Start, line A appears and the vehicle travels along it collecting data (Pass 1). (Note: F is the end of line A on Pass 1, the start of line A on Pass 2.)
C	The turn around. A manual turn as required/preferred (keyhole, 'K' turn, either direction). An on-screen instruction tells you when to turn (when you get to the end of A).
D	The 'Engagement Zone'. After your turn, you are in the engagement zone if the system calculates that at your current crosstrack and heading*, under autosteering, you can acquire ('get on') extension line E before point F (but see G). When you are in the engagement zone, the steering engage button is blue (from gray) indicating that autosteering is available/ready. You press that button to engage autosteering to begin auto-steered line acquisition. * Assumes you maintain the 'in-range' calibration speed you set.
E	The calibration line extension. Line acquisition can be anywhere on this line or on the calibration line itself (provided it [line acquisition] is before the data-collection cut-off point H).
F	The calibration line end point (for Pass 1) and begin point (for Pass 2). If, after your turn, you are on line before F (that is, somewhere on E), data logging begins at F. If line acquisition occurs on the calibration line itself, data logging begins provided the line acquisition is within the data-logging start zone G. The data-logging 'on line' conditions are crosstrack <= 50 cm, heading error <= 5° (see J and K).
G	The data-logging start zone. Data logging begins: • At F if you are on line before F • Within G if you get on line in this zone (G is a kind of buffer zone allowing for settled line acquisition between F and H.)
H	Cut-off point for the data-logging start. If you are not on line by H there is not enough of line A left to collect the required data from. The calibration line is still OK, you just need to turn, and then turn back in time to acquire either the extension line or the calibration line itself before H: that is, restart at C.
I	Minimum data collection distance (30 m).
J	Crosstrack—the perpendicular distance from vehicle to target line (measured from the center of the vehicle's rear axle).
K	Heading 'error' (heading difference vehicle/line).

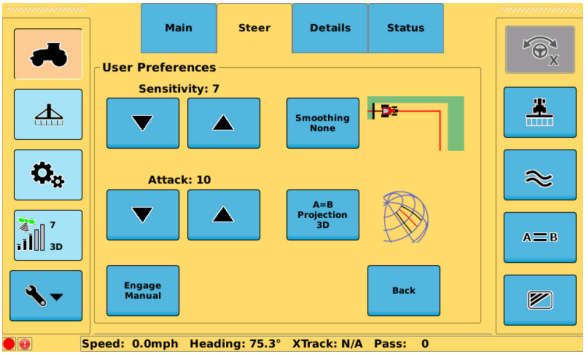
Repeating a Calibration Step

To repeat a calibration step, restart the calibration sequence (press **Vehicle Calibration**) then:

- Reset ECU orientation or press **Next**
- Recalibrate Maximum Turning Speed or press **Skip**
- Recalibrate minimum radius or press **Skip**
- Recalibrate steering speed or press **Skip**
- Rerun mounting bias or press **Skip** (the mounting bias Skip button is the Cancel button when you first execute calibration)

Setting User Preferences

Non-calibration related, steering-behavior related settings are sensitivity, attack and smoothing.



Sensitivity: How aggressively steering works to eliminate crosstrack variations as they occur while on a guidance line. For more information on sensitivity see your STX User Guide.

Attack: 'Angle of attack' or 'Acquisition aggression'. How the steering works towards line acquisition. The shortest distance between you and a target guidance line is the perpendicular distance. An impractical 90° approach angle would be the maximum, most aggressive, angle of attack. The actual range is 1-10 (default 5) providing line acquisition aggression between very slow (but with no or minimal overshoot) and fast with higher overshoot potential.

Smoothing: Smoothing determines the amount of smoothing of contours and is applied to the current contour. It is based on the smoothing setting that was active during the preceding pass. The options are:

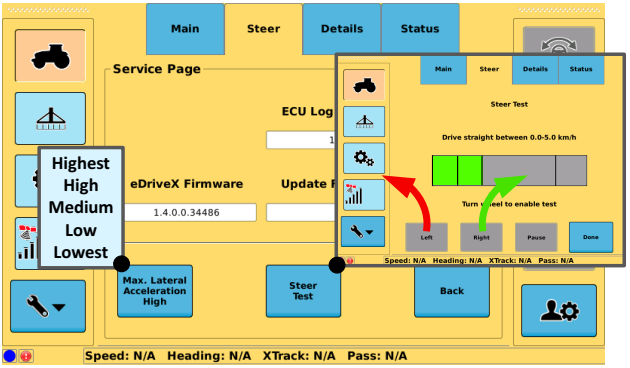
- None (default) - STX tries to follow every contour, even if the contour has a very tight curvature, but may disengage on very tight turns.
- Low - minimum smoothing is applied.
- Medium - medium smoothing is applied.
- High - STX generates optimized control paths for high-speed operation, where the minimum curvature for each turn is large. It is not suitable for tight-turn operations as unwanted coverage gaps may occur.

For example, you may need to adjust smoothing if a vehicle/implement combination does not allow turning within a tight radius. In addition, a very sharp curvature may not be desired during high-speed operation.

Steering-Related Service Items

Steering (behavior) related items in the service page are “Max(imum) Lateral Acceleration” and “Steer Test”.

Maximum Lateral Acceleration (MLA): This can be non-technically likened to ‘cornering speed’ particularly when it relates to the calculation of eTurns (eDXC only). For vehicles guided by eDXD, MLA contributes to the ‘aggressiveness’ of line acquisition (which is mostly controlled by attack - see “Attack:” on page 18) and curvature control during contour guidance.



There are five settings: Highest (fastest/tightest turns), High, Medium, Low, and Lowest (slowest/widest turns). At the highest setting, for example, line acquisition will be most aggressive; at the lowest setting, noticeably less aggressive. The effect of MLA is particularly apparent during contour guidance and swather operations. You will need to determine the best setting for your particular operation.

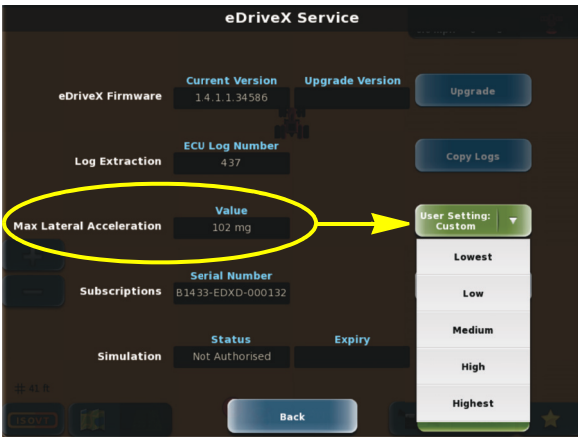
Steer Test: This test simply establishes that left and right commands to the auto-steering system result in the vehicle turning to the left and right respectively. A steer test would have been completed at the commissioning of the steering system but the facility to repeat the test at any time is provided. See figure above, right inset.

Steering-Related Service Items

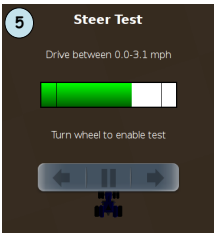
Steering (behavior) related items in the service page are “Max(imum) Lateral Acceleration” and “Steer Test”.

Maximum Lateral Acceleration (MLA): This can be non-technically likened to ‘cornering speed’ particularly when it relates to the calculation of eTurns (eDXC only). For vehicles guided by eDXD, MLA contributes to the ‘aggressiveness’ of line acquisition (which is mostly controlled by attack - see “Attack:” on page 20) and curvature control during contour guidance.

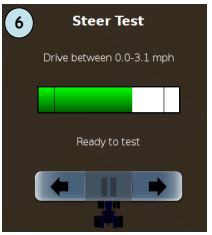
There are five settings: Highest (fastest/tightest turns), High, Medium, Low, and Lowest (slowest/widest turns). At the highest setting, for example, line acquisition will be most aggressive; at the lowest setting, noticeably less aggressive. The effect of MLA is particularly apparent during contour guidance and swather operations. You will need to determine the best setting for your particular operation.



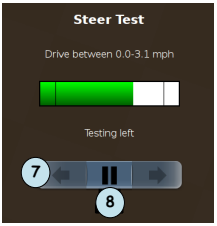
Steer Test: This test simply establishes that left and right commands to the autosteering system result in the vehicle turning to the left and right respectively. A steer test would have been completed at the commissioning of the steering system but the facility to repeat the test at any time is provided.



Set speed and turn wheel to enable test

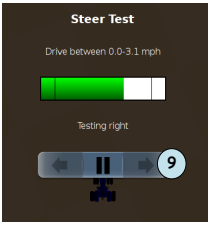


Ready to test



Press left arrow. Steers left?

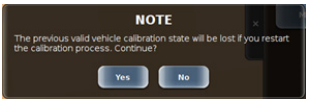
Pause (8)



Press right arrow. Steers right?

Repeating a Calibration Step

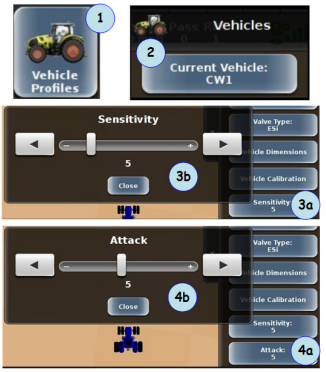
Once you have successfully completed the calibration process, provided no calibration-related changes are made (vehicle, valve, required dimensions), you can go back to the Vehicle Calibration panel and rerun any of the moving steps. However, because of dependencies, rerunning a moving step will require subsequent steps to be rerun.



The on-screen note that a valid calibration will be lost if you *restart* the calibration process is displayed because a change to the ECU orientation constitutes a restart; if you change the ECU orientation all the previous calibration data will be lost and the whole calibration process will have to be rerun. If you don't *change* the ECU orientation, you can rerun any moving calibration, then rerun only the calibrations that come after the one you reran.

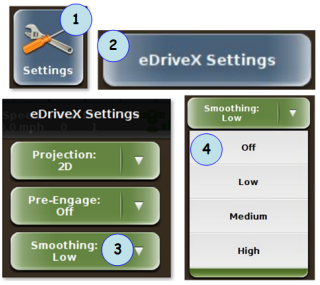
Setting User Preferences

Non-calibration related, steering-behavior related settings are sensitivity, attack and smoothing.



Sensitivity: How aggressively steering works to eliminate crosstrack variations as they occur while on a guidance line. For more information on sensitivity see your MAX User Guide.

Attack: 'Angle of attack' or 'Acquisition aggression'. How the steering works towards line acquisition. The shortest distance between you and a target guidance line is the perpendicular distance. An impractical 90° approach angle would be the maximum, most aggressive, angle of attack. The actual range is 1-10 (default 5) providing line acquisition aggression between very slow (but with no or minimal overshoot) and fast with higher overshoot potential.

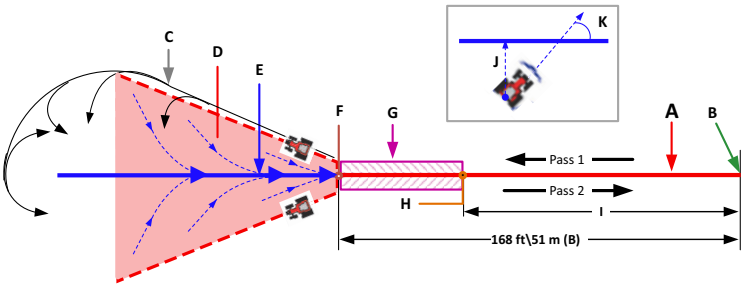


Smoothing: Smoothing determines the amount of smoothing of contours and is applied to the current contour. It is based on the smoothing setting that was active during the preceding pass. The options are:

- None (default) - tries to follow every contour, even if the contour has a very tight curvature, but may disengage on very tight turns.
- Low - minimum smoothing is applied.
- Medium - medium smoothing is applied.
- High - generates optimized control paths for high-speed operation, where the minimum curvature for each turn is large. It is not suitable for tight-turn operations as unwanted coverage gaps may occur.

For example, you may need to adjust smoothing if a vehicle/implement combination does not allow turning within a tight radius. In addition, a very sharp curvature may not be desired during high-speed operation.

Mounting Bias Calibration Maneuver



A	The preset fixed-length calibration line. Data is logged (collected) on two passes on this line. The line appears when you start the calibration process.
B	Initial start of line A. When you press Start, line A appears and the vehicle travels along it collecting data (Pass 1). (Note: F is the end of line A on Pass 1, the start of line A on Pass 2.)
C	The turn around. A manual turn as required/preferred (keyhole, 'K' turn, either direction). An on-screen instruction tells you when to turn (when you get to the end of A).
D	The 'Engagement Zone'. After your turn, you are in the engagement zone if the system calculates that at your current crosstrack and heading*, under autosteering, you can acquire ('get on') extension line E before point F (but see G). When you are in the engagement zone, the Engage button is blue (from gray) indicating that autosteering is available/ready. You press Engage to engage autosteering to begin auto-steered line acquisition. * Assumes you maintain the 'in-range' calibration speed you set.
E	The calibration line extension. Line acquisition can be anywhere on this line or on the calibration line itself (provided it [line acquisition] is before the data-collection cut-off point H).
F	The calibration line end point (for Pass 1) and begin point (for Pass 2). If, after your turn, you are on line before F (that is, somewhere on E), data logging begins at F. If line acquisition occurs on the calibration line itself, data logging begins provided the line acquisition is within the data-logging start zone G. The data-logging 'on line' conditions are crosstrack <= 50 cm, heading error <= 5° (see J and K).
G	The data-logging start zone. Data logging begins: • At F if you are on line before F • Within G if you get on line in this zone (G is a kind of buffer zone allowing for settled line acquisition between F and H.)
H	Cut-off point for the data-logging start. If you are not on line by H there is not enough of line A left to collect the required data from. The calibration line is still OK, you just need to turn, and then turn back in time to acquire either the extension line or the calibration line itself before H: that is, restart at C.
I	Minimum data collection distance (30 m).
J	Crosstrack—the perpendicular distance from vehicle to target line (measured from the center of the vehicle's rear axle).
K	Heading 'error' (heading difference vehicle/line).

7. Mounting Bias (Roll and Pitch)

A. Navigation and Screen Title

B. Calibration Maneuver (see next page)

C. Activity Summary

Set (and maintain) speed

Start

Calibration line set, Pass 1 calibration

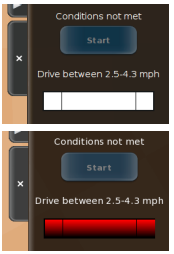
Turn around. In 'Engage Zone', engage auto-steer

Line acquired, Pass 2 data collected

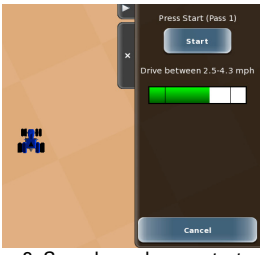
Calibration complete

(or repeat if instructed)

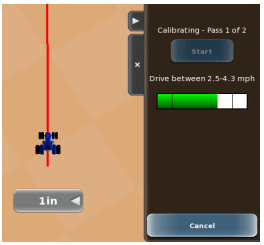
D. Screen Sequence



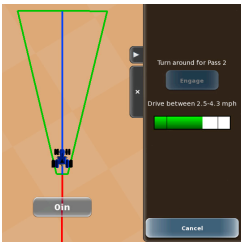
1. Too slow/too fast Start button not active.



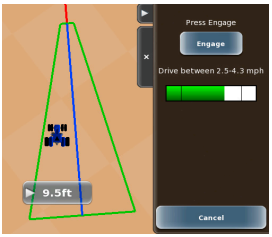
2. Speed good - can start. Calibration line will appear.



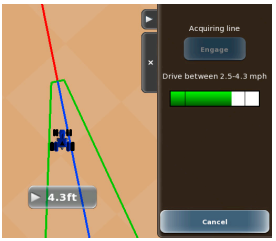
3. Pass 1 on calibration line.



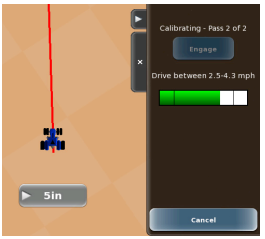
4. Pass 1 ends - 'engage zone' appears - turn around.



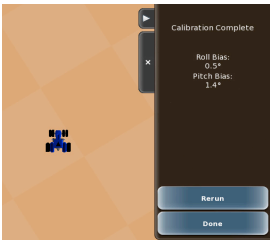
5. In engage zone after turn engage for line acquisition.



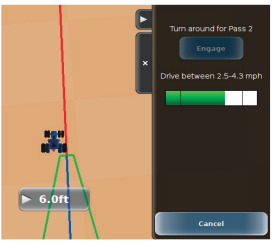
6. Autosteering engaged - line acquisition in progress.



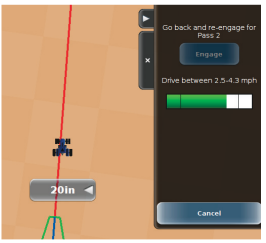
7. Line acquired - Pass 2 begins.



8. Pass 2 good, calibration complete.



9. No engagement, **Pass 2 fails**. Turn back, re-enter engage zone, Engage for line acquisition.



10. Engagement but no line acquisition, **Pass 2 fails.** Turn back into engage zone, engage sooner and acquire line.

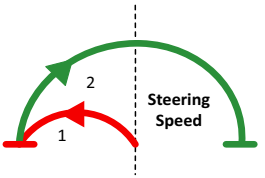
Pass 2 fails (9) if autosteering is not engaged, speed goes out of range, or autosteering manually overridden. Pass 2 fails (10) if autosteering does not acquire line in time.

6b. Steering (Lock to Lock) Speed (JD 4000/8000s)

(See first paragraph of 5a). For JD 4000 and 8000 models, you preset the flow control valve just as for all other makes/models. But, depending on the calibration result, you may need to adjust the pressure reducing valve (PRV) instead of (or as well as) the flow control valve. The system will determine, from the calibration results, which valve requires adjustment - that is, for 'big' and 'small' out-of-range values, the PRV and FCV respectively. See "Steering Speed Adjustment - JD 4/8K only" on page 8.

A. Navigation and Screen Title

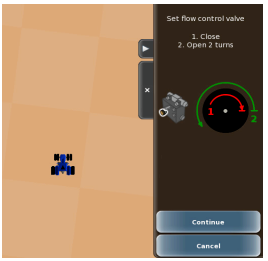
B. Calibration Maneuver (what happens)



C. Activity Summary – JD 4/8Ks

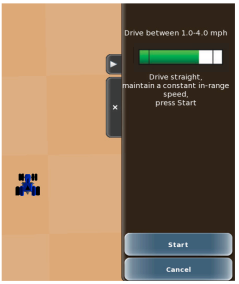
Preset flow control valve
Set (and maintain) speed
Drive straight
Press Start
Steers left then right ('Measuring')
Result
Adjust PRV or FCV or continue

D. Screen Sequence – JD 4/8Ks



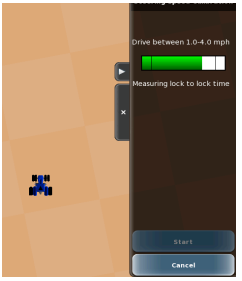
1. Preset flow control valve

2. Too slow/too fast
Start button not active



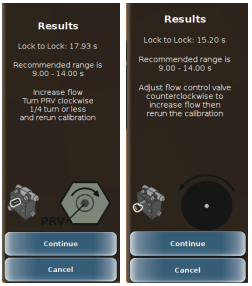
3. Speed good - can start

4. Turning to left lock



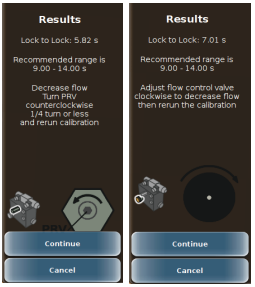
5. Turning to right lock - measuring lock to lock time

6
Too slow, adjust PRV or FCV as advised



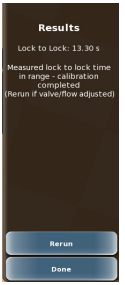
Adjust PRV | Adjust FCV

7
Too fast, adjust PRV or FCV as advised



Adjust PRV | Adjust FCV

8
In range, OK



No adjustment

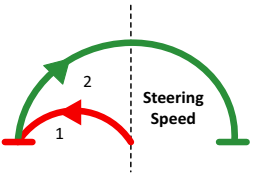
6a. Steering (Lock to Lock) Speed (non-JD 4000/8000s)

Once you press Start in this calibration step, all steering is by the system—that is, the vehicle is auto-steered left, then right. After you preset the flow control valve, steer in a straight line at the required speed and press Start, the system executes all the steering required. If you need to make adjustments and re-run the calibration, you can of course manually steer your vehicle to a new location if space to manuever is required.

As stated above, you need to have preset the flow control valve before running this calibration step. The system will determine, from the calibration results, if adjustment is required and advise accordingly. See “Steering Speed Adjustment - Flow Control Valve” on page 7.

A. Navigation and Screen Title

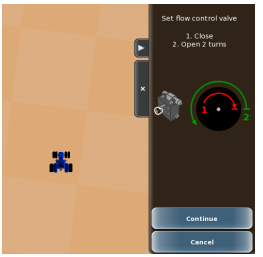
B. Calibration Maneuver (what happens)



C. Activity Summary

Preset flow control valve
Set (and maintain) speed
Drive straight
Press Start
Steers left then right (‘Measuring’)
Result
Adjust or continue

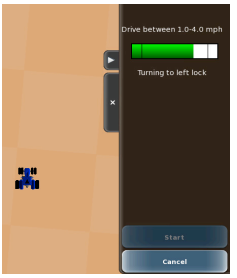
D. Screen Sequence



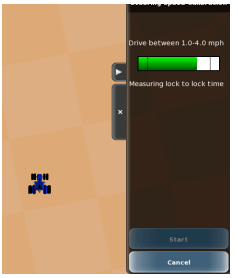
1.Preset flow control valve

2. Too slow/too fast
Start button not active

3. Speed good - can start



4. Turning to left lock

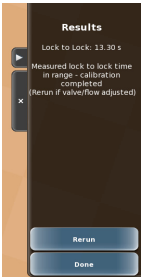


5. Turning to right lock - measuring lock to lock time

6
Too slow: increase flow

7
Too fast: decrease flow

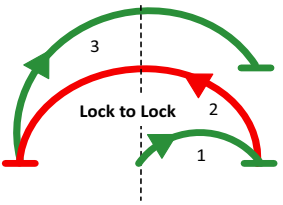
8
In range, no adjustment required



5. Lock to Lock ('L2L' ESi/VSi)

A. Navigation and Screen Title

B. Calibration Maneuver (what happens)



C. Activity Summary

Set (and maintain) speed, steer straight, release wheel

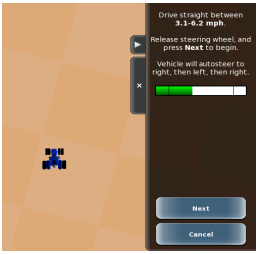
Press Next

Vehicle turns to right lock then to full left lock then to full right lock

Calibration complete

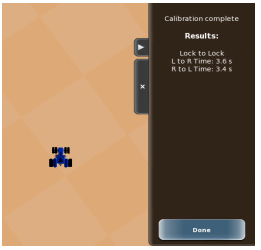
D. Screen Sequence

1. Speed not in range - Next button not active.



2. Speed good - steer straight release wheel, press Next.

3. Vehicle steers to right lock then to left lock (R2L) then to right lock (L2R).

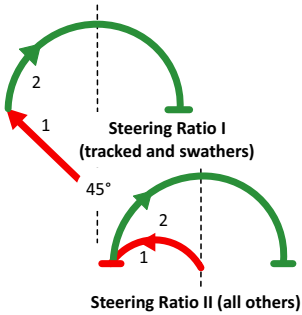


4. Calibration complete lock to lock times stored.

4. Steering Ratio (ESi/VSi)

A. Navigation and Screen Title

B. Calibration Maneuver (what happens)



C. Activity Summary

Set (and maintain) speed

Steer left 45° or to left lock

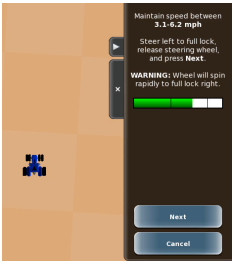
Press Next

Wheel spins rapidly clockwise - vehicle turns full lock right

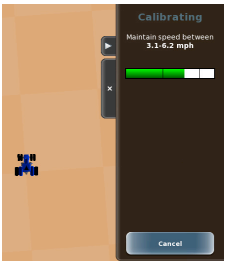
Calibration complete

D. Screen Sequence

1. Speed not in range (too slow/too fast) - Next button not active. (Left lock start, else 45° start for tracked/swathers)



2. Speed set - steer to left lock or left 45°. Release wheel.



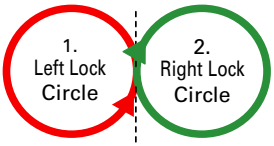
3. In progress - wheel spins rapidly to right lock.

4. Calibration complete - steering ratio stored.

3. Minimum (Turning) Radius

A. Navigation and Screen Title

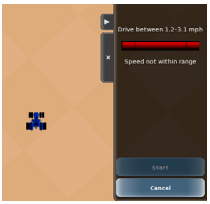
B. Calibration Maneuver (what happens)



C. Activity Summary

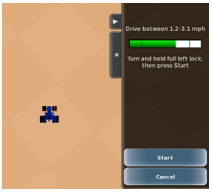
Set (and maintain) speed
Turn and hold full left lock
Left measurement
Turn and hold full right lock
Right measurement
Calibration complete

D. Screen Sequence



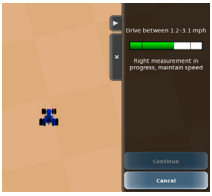
1. Speed not in range (too slow/too fast) Start button not active.

2. Speed good. Turn and hold full left lock, press Start.



3. Left measurement in progress - maintain speed.

4. Turn and hold full right lock. Press Continue.



5. Right measurement in progress - maintain speed.

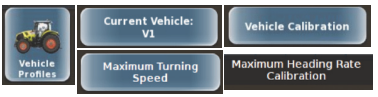
6. Results Calibration complete Rerun - Done

7. Error: Recorded L/R radius difference exceeds tolerance - rerun

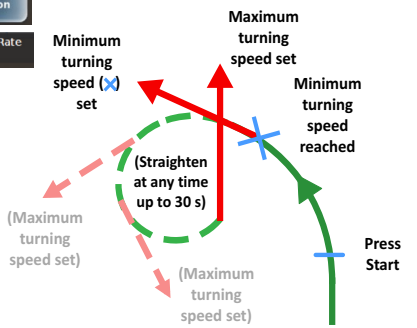
2. Maximum Turning Speed (Swather/Track Tractors Only)

This is a wholly manual steering calibration—there is no autosteering involved. At a speed within the specified range, steer the vehicle left or right progressively tightening the turn until you reach your 'comfort level on turns' (you are setting the maximum angular speed of your turns). The system requires a minimum turn speed and will (i) time out after 30 seconds if you do not achieve it, or (ii) advise you onscreen that you have achieved it. When advised "Minimum turn speed reached", you can either straighten from the turn to end the calibration (with that minimum turning speed set) or continue, tightening the turn, to store a higher value. After reaching the minimum turn speed, for up to 30 seconds you can end the calibration by straightening your current turn. After 30 seconds, the maximum turn speed recorded is stored and the calibration ended (that is, without you ending it by straightening the turn).

A. Navigation and Screen Title



B. Calibration Maneuver
(Left or right turn; left shown)



C. Activity Summary

Drive straight, set (and maintain) speed

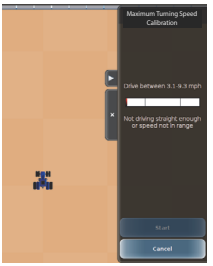
Turn left or right, progressively tightening the turn

Screen advises minimum storable turning speed reached

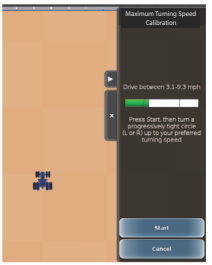
Straighten the turn (ending the calibration)
or
continue tightening the turn, straightening at any time to end the calibration

At straightening or 30 s, maximum turning speed recorded and stored: calibration complete

D. Screen Sequence



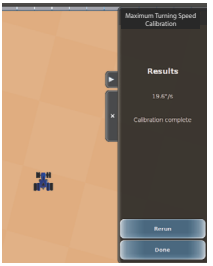
1. Not driving straight, speed not in range, Start button not active.



2. Speed good, press Start. Make progressively tighter left or right turn.

3. Maintain or tighten turn.

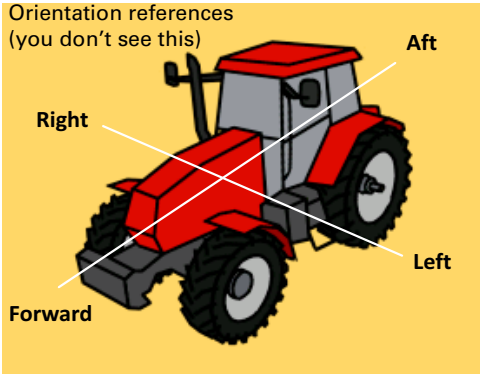
4. Minimum storable turning speed reached; straighten or continue tightening turn.



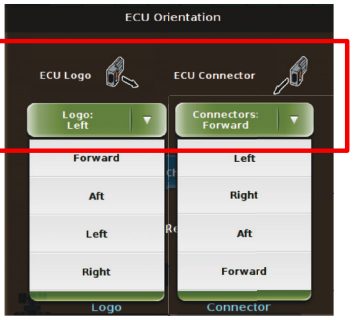
5. Maximum turning speed recorded and stored.

1. ECU Orientation

Set logo and connector position



Below, arrows indicate left and forward
(this does not change - it's a fixed example)



The drop-down lists
(you see one at a time)

Valid Combinations

Logo	Connector
Left	Forward
Left	Aft
Right	Forward
Right	Aft
Forward	Left
Forward	Right
Aft	Left
Aft	Right

Example Invalid Combination (Right/Left)

Calibration Matrix

'Valve'	Std Tractor	Artic'ted Tractor	Combine	Sprayer	Track Tractor	Spreader	Swather
Hydraulic	■	■	■	■	N/A	■	N/A
Hydraulic JD (4/8K)	■	■	N/A	N/A	N/A	N/A	N/A
ESi/VSi	▲	▲	▲	▲	●	▲	●

■ **ECU Orientation (1/4)**
Minimum Radius (2/4)
Steering Speed (3/4)
Mounting Bias (4/4)

▲ **ECU Orientation (1/5)**
Minimum Radius (2/5)
Steering Ratio (3/5)
Lock to Lock (4/5)
Mounting Bias (5/5)

● **ECU Orientation (1/5)**
Max Turning Speed (2/5)
Steering Ratio (3/5)
Lock to Lock (4/5)
Mounting Bias (5/5)

Executing the Calibration Process

Much of the calibration process is automated—you need only respond to screen prompts. On the following pages, in the summary boxes for 2. Maximum Turning Speed, 3. Minimum Radius, 4. Steering Ratio, 5. Lock to Lock, 6. (a and b) Steering Speed, and 7. Mounting Bias, **brown** indicates what you do, **blue** indicates what the system does (see example at right). For those steps (2-7) also, the information is displayed in four sections: A. Navigation and Screen Title; B. Calibration Maneuver (what happens, where the vehicle goes during the calibration—manually or auto-steered); C. Activity Summary (the main steps in the calibration—color coded as explained above); D. Screen Sequence, the main screens in sequence with captioned notes.

What you do

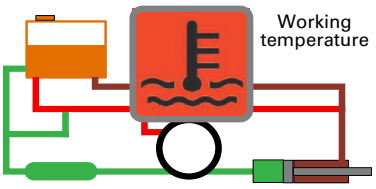
What the system does

Set (and maintain) speed
Turn and hold full left lock
Left measurement
Turn and hold full right lock
Right measurement
Calibration complete

With all the pre-calibration setup complete, press the **Vehicle Calibration** button on the New Vehicle Profile panel.

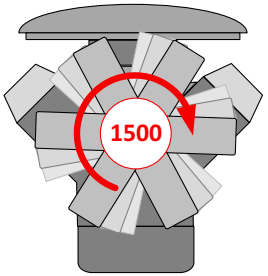
Hydraulic Oil Temperature and Calibration

Ensure your vehicle's hydraulic oil is at working temperature before you start calibrating your eDXD. Steering performance depends in part upon 'normal' flow of hydraulic oil so it needs to be at working temperature.



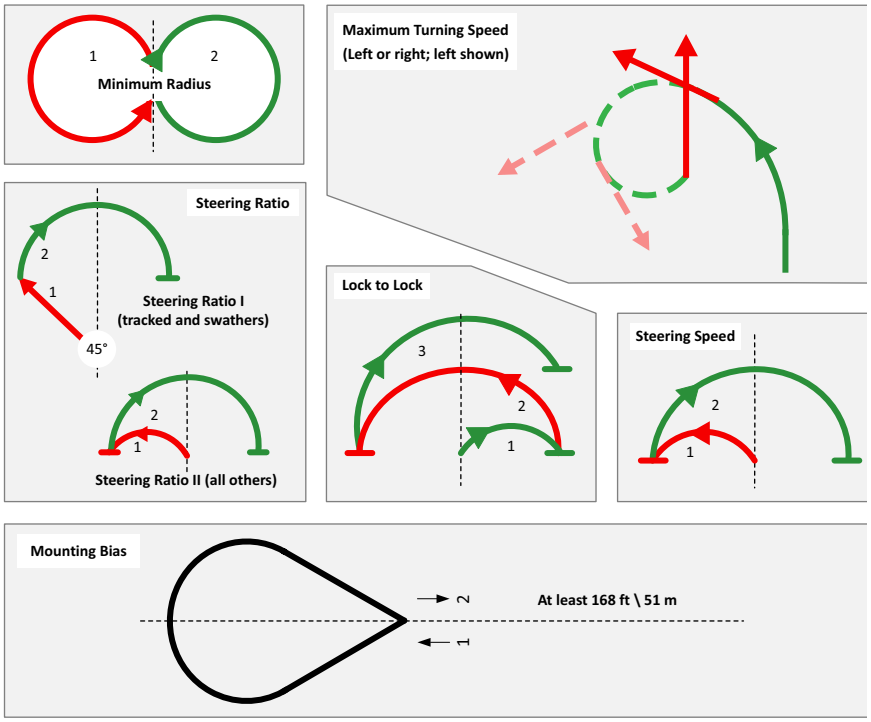
Engine Speed and Calibration

Some calibration steps should be carried out at full hydraulic pressure. Because some hydraulic systems need higher engine speeds than others to achieve full hydraulic pressure, it is recommended that you execute moving calibration steps with a minimum engine speed of 1500 rev/min.

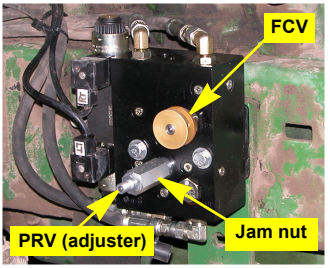


Calibration Ground Area Requirement

You need enough open space to execute each calibration maneuver. The graphic below shows simplified representations of the maneuvers and the area required for each of the six moving calibration steps. Note that there are two **Steering Ratio** maneuvers - (I) tracked vehicles and swathers, and (II) all other vehicles.



Steering Speed Adjustment - JD 4/8K only



For John Deere 4000 and 8000 series vehicles (4/8K) you do not need to preset the pressure reduction valve (PRV) but you may need to adjust it before making adjustments to the preset FCV.

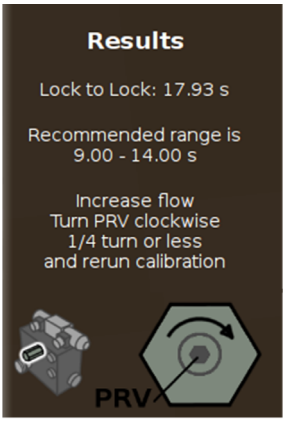
If the out-of-range value is small, the screen message will advise you to adjust the flow control valve as described above.

For bigger out-of-range results, the screen message will advise you to adjust the pressure reducing valve. Note that the screen message reports measured lock to lock, recommended range, and the adjustment required.

To adjust the PRV:

1. Loosen the long jam nut within which the PRV adjuster is situated.
2. Adjust the PRV 1/4 turn (or less).
3. Retighten the jam nut.
4. Rerun the calibration.
5. Repeat if the same message appears (see note following).

Note: After PRV adjustment has sufficiently reduced the out-of-range amount, you may need to make fine tuning adjustments to the flow control valve—the screen message will advise you.

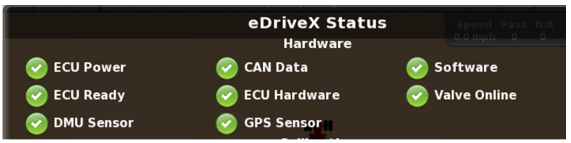


JD 4/8K post-calibration PRV adjustment (increase flow in the example)

Before Calibrating a Vehicle

Before and during calibration ensure that:

- You have enough open area in which to drive your vehicle throughout the calibration process - see “Calibration Ground Area Requirement” on page 9.
- GPS antenna/sensor is located in its final position and initialized.
- You use the GPS source the vehicle will use in operations. For example, if you plan to use RTK in the field you must use RTK during calibration.
- All the items at the top of the eDriveX Status screen are green (see at right - the navigation path is Diagnostics > eDriveXD > Status).



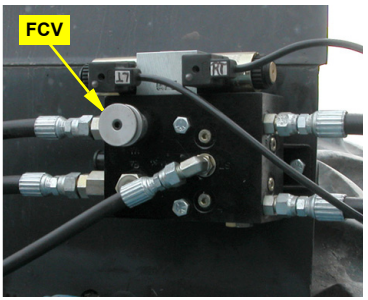
- You have preset the flow control valve (see “Flow Control - Presetting and Adjusting” on page 7).
- Your vehicle’s hydraulic oil is at working temperature - see “Hydraulic Oil Temperature and Calibration” on page 9.
- You maintain an engine speed of at least 1500 rev/min - see “Engine Speed and Calibration” on page 9.

Flow Control - Presetting and Adjusting

The steering speed calibration (lock to lock time) depends on the presetting and possible subsequent adjustment of the flow control valve (FCV).

By presetting the FCV before running the calibration process you can ensure the steering speed will be either in the recommended range or close to the recommended range. If the measured steering speed is out of range, screen messages will identify the adjustment required.

You preset the flow control valve by closing it fully (clockwise) then opening it (counterclockwise) a specified number of turns.



Flow control valve on a typically mounted block (the valve knob may vary in appearance)

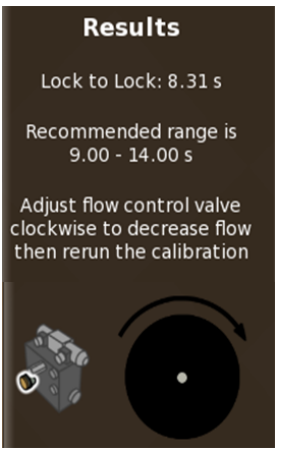
The screen message will tell you how far to open the valve for your make/model. See at right and sections 6a and 6b on pages 16 and 17.

Flow control valve preset for standard tractor (open 2 turns)

Steering Speed Adjustment - Flow Control Valve

If the calibration result is out of range, a screen message will advise you to adjust the flow control valve - see at right. Note that the screen message reports measured lock to lock, recommended range, and adjustment required.

Note: John Deere 4000 and 8000 models have a pressure reduction valve (PRV) as well as a flow control valve - for information on PRV adjustment for these models, see "Steering Speed Adjustment - JD 4/8K only" following.

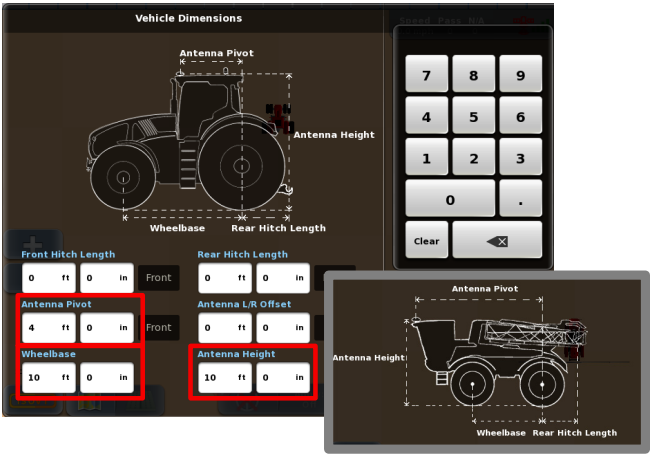


Post-calibration flow control valve adjustment (decrease flow)

Wheelbase: The distance between front and rear axle centers.

Antenna height: Vertical distance from ground to bottom of antenna.

Antenna pivot: Horizontal distance of antenna's center in front of or behind vehicle's pivot point. The pivot point varies with vehicle type so where to measure from is indicated on the icon for each vehicle type (see examples for standard tractor and sprayer above).

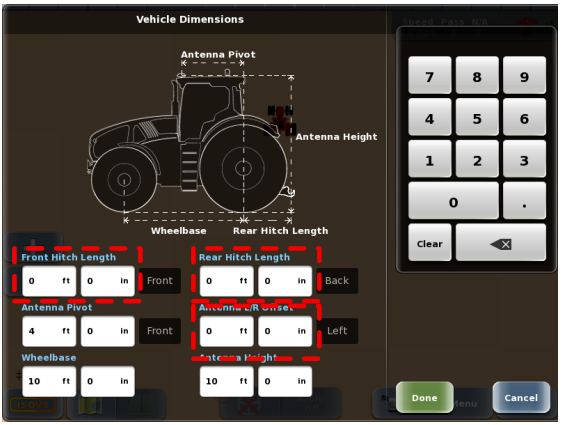


Note: Measure the antenna pivot as accurately as practical, as this measurement has some impact on the accuracy of vehicle guidance and is the reference point from which the implement offset is calculated. Unlike the antenna left/right offset, there is really no field method to verify or improve the antenna pivot measurement.

Setting Other Vehicle Dimensions (Optional)

Optional dimensions are:

Antenna L/R: 'Antenna offset'—the perpendicular distance between the fore/aft centerline of the vehicle and the center of the antenna. Unless you have a noticeably large offset, you can complete calibration with the default 0.00. (If you do have a noticeably large offset, you can enter a 'provisional' measured value.) If necessary, after calibration, you can measure the offset in the field (there are two methods) and adjust the offset as necessary. See your MAX User Guide for more information on antenna offset.

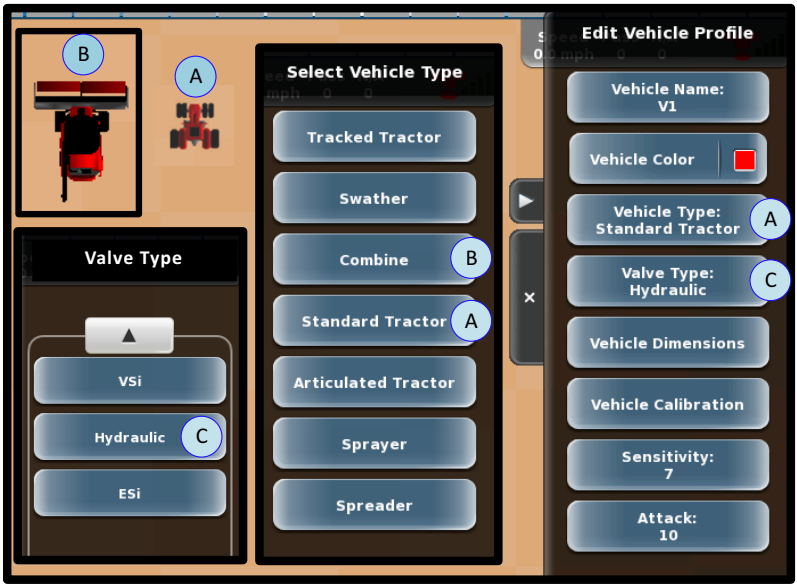


Front Hitch Length: Horizontal distance between the vehicle's pivot point and the front hitch (manual measurement).

Rear Hitch Length: Horizontal distance between the vehicle's pivot point and the rear hitch (manual measurement).

Setting Vehicle and Valve Type

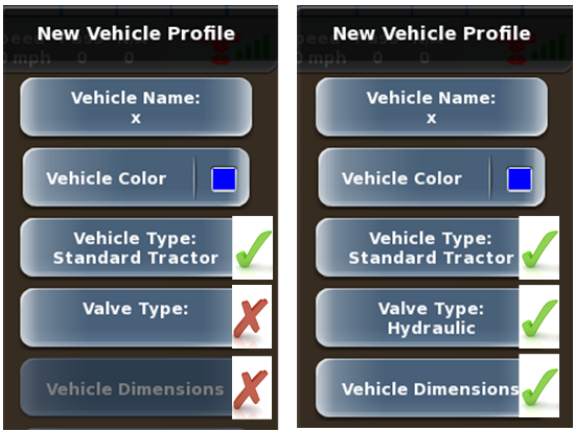
Select a vehicle type (**A**); the icons change for each selection - a standard tractor and a combine are shown at **A** and **B** (inset). Select a valve type (**C**).



After you change the vehicle or valve type, MAX *may* prompt you to restart (power cycle) the ECU for the changes to take effect.

Setting Required Vehicle Dimensions

- You can set vehicle dimensions only when a vehicle type and valve type have been selected (see at right). You set the value and, where applicable, the position.
- The vehicle icons change for each vehicle type and show you where each dimension applies; icons for a standard tractor (main picture) and a sprayer (inset) are shown below.



The required dimensions (there are *optional* dimensions, see “Setting Other Vehicle Dimensions (Optional)” on page 6) are:

Basics 2: Entering Data in Screen Fields

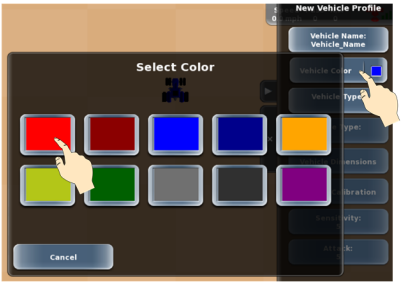
To enter data in an editable field, press the item's button (e.g. Vehicle Name) or in the item's data field (e.g. Antenna L/R Offset). Depending on the type of data applicable to the field you will be presented with the appropriate data entry pad. For letter/number fields you get an alphanumeric pad; for number only fields you get a number pad.

Alphanumeric pad (entering vehicle name)

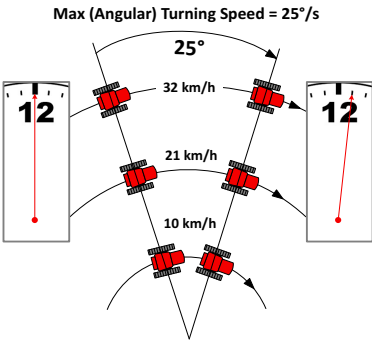
Number pad (entering wheelbase)

Adding a Vehicle

- Vehicles are identified by name (see "Basics 2: Entering Data in Screen Fields" above for adding a vehicle name) and color.
- Vehicles remain in MAX's memory even if you move the terminal to another vehicle.



b. Maximum Turning Speed - (angular turning speed in degrees per second). You set how tightly autosteering is to turn you at your current speed; whatever your current 'traveling' speed, an autosteered turn's angular speed (°/s) will never exceed this setting - page 12.



c. Minimum Radius (turning circle - page 13).

d. Steering Ratio (page 14).

e. Lock to Lock (both ways measured - page 15). In simple terms, it is the electric (ESi/VSi) equivalent of f. Steering Speed.

f. Steering Speed (left to right only measured - page 16). In simple terms, it is the hydraulic equivalent of e. Lock to Lock. Both e and f relate to the steering's reaction to crosstrack errors while engaged - pages 16 and 17.

g. Mounting Bias ('roll & pitch' - compensates for ECU mounting tolerances - page 18).

Other (non-calibration) steering-performance related activities are (D-G from page 1):

1. User preferences:
   a. Sensitivity (reaction to crosstrack variations - **D** and page 20).
   b. Attack (line acquisition 'urgency' - **D** and page 20).
   c. Smoothing (contour adjustments - **E** and page 20).
2. Service:
   a. Maximum Lateral Acceleration ('Cornering Speed' - **F** and page 21).
   b. Steer Test (ensures left/right commands make left/right turns - **G** and page 21).

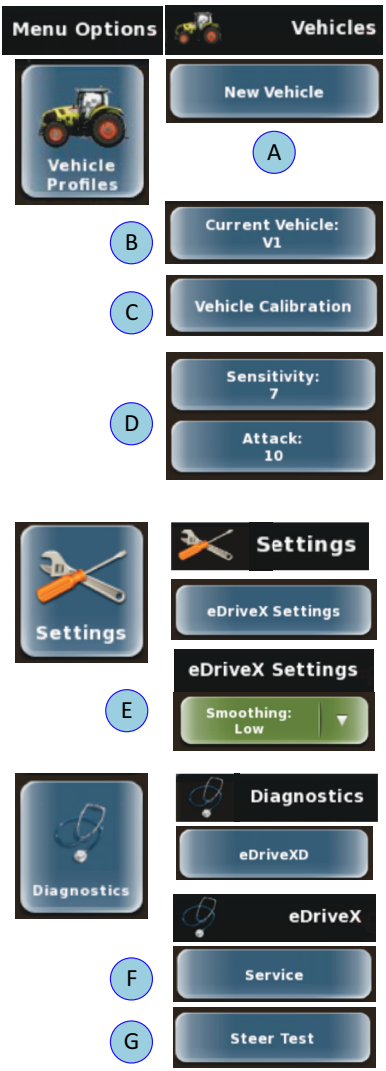
Basics 1: Accessing Setup and Calibration Screens

The setup and calibration screens you will need to visit are accessed from the Menu Options panel (see at right) displayed when MAX has started. You access Menu Options by pressing Menu at the bottom right of the screen after you have responded to the initial 'Warning' screen and Start Up Menu - see Starting Outback MAX in your Outback MAX User Guide. You will use menu options Vehicle Profiles, Diagnostics, and Settings. For more information, see "Panels" in Chapter 1 of your Outback MAX User Guide.

Calibration Overview

The largely-automated calibration process has some initial setup requirements—see 1 and 2 following. The actual calibration steps are listed in 3 (a-g, pages 2 and 3) and each step has short, summary information about it. Other, non-calibration steering-related activities are listed after 3.

1. Adding your vehicle (**A** at right and page 4).
   a. Name your vehicle.
   b. Set vehicle color.
2. Setting up your vehicle (**B**).
   a. Vehicle (e.g. standard tractor, sprayer, combine) and valve type (hydraulic - relay valve; electric - VSi/ESi - page 5). The combination determines the number and type of calibration steps - see “Calibration Matrix” on page 10.
   b. Dimensions - Required: wheelbase; antenna height; antenna pivot (page 5).
   c. Dimensions - Optional: Antenna offset (L/R); front hitch length; rear hitch length (page 6).
3. Calibrating your eDriveXD (**C**) - there are four or five calibrations, numbered 1/4 to 4/4 or 1/5 to 5/5.
   a. ECU Orientation (where logo/ connector ‘point’ - page 11).



MAX/eDriveXD (flip booklet for STX)

Your Calibration Guide: Setup and Execution