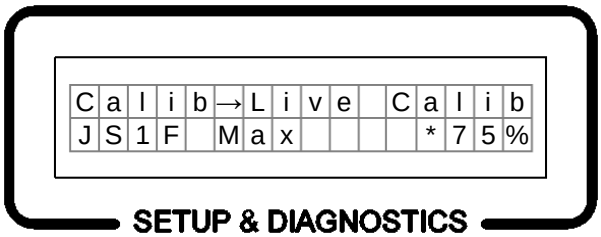
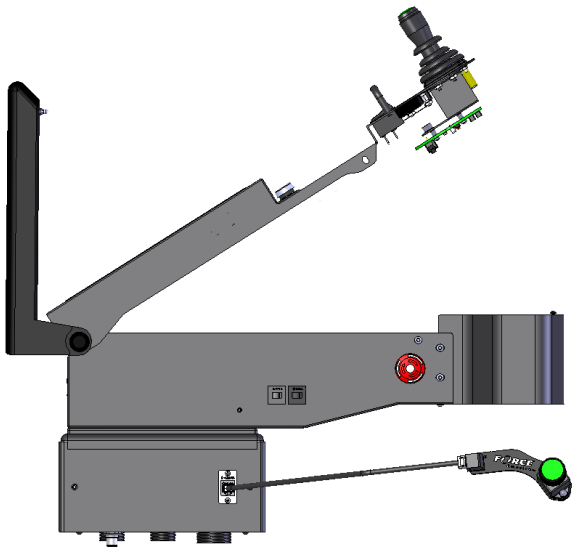
9-Axis Proportional Joystick Control System with CAN Bus

Calibration Manual





Firmware Version
2.1

FORCE America INC.

Table of Contents

First Use Guide

The first time you configure your 9-Axis system, you will need to complete the following steps:

Calibration Menu

To Enter the Calibration Menu

Use a standard, non-crossover Ethernet cable to connect a 94069A001 ThumbCal into the Ethernet port on the side of the arm or switch base.

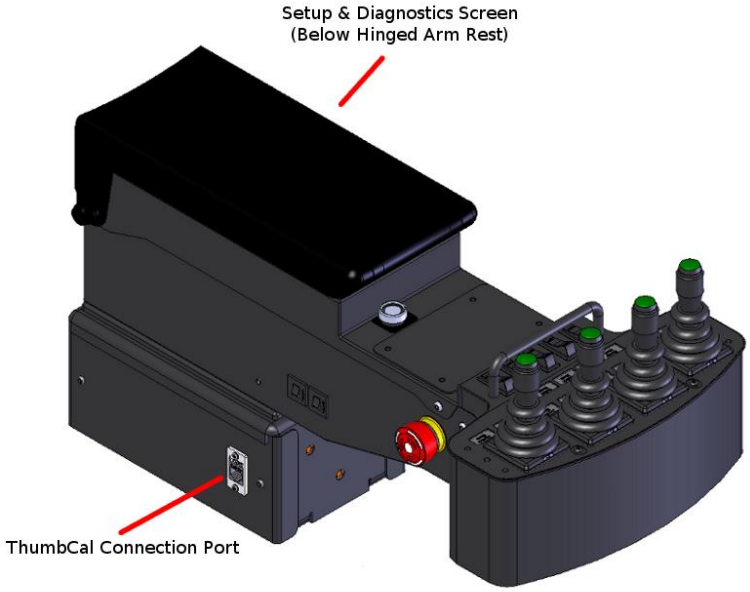


Figure 1: 9-Axis Arm

The Calibration Menu will appear on the Setup & Diagnostics screen. On a standard fit vehicle, the Setup & Diagnostics screen is located underneath the hinged arm rest. On a retrofitted vehicle, it is located on the circuit board inside the arm assembly. See Hardware Locations on page 4.

For more information on hardware pinouts and connections, refer to the schematics in the 9-Axis Binder.

If you see the message “Replug for Calib” appear on your screen, as shown in Figure 2, the system has started or restarted while the ThumbCal device was plugged in. Simply disconnect and reconnect the ThumbCal device to the system in order to enter the Calibration Menu.

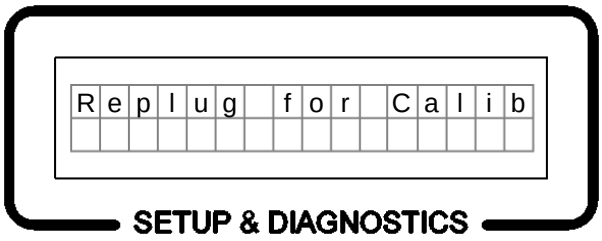


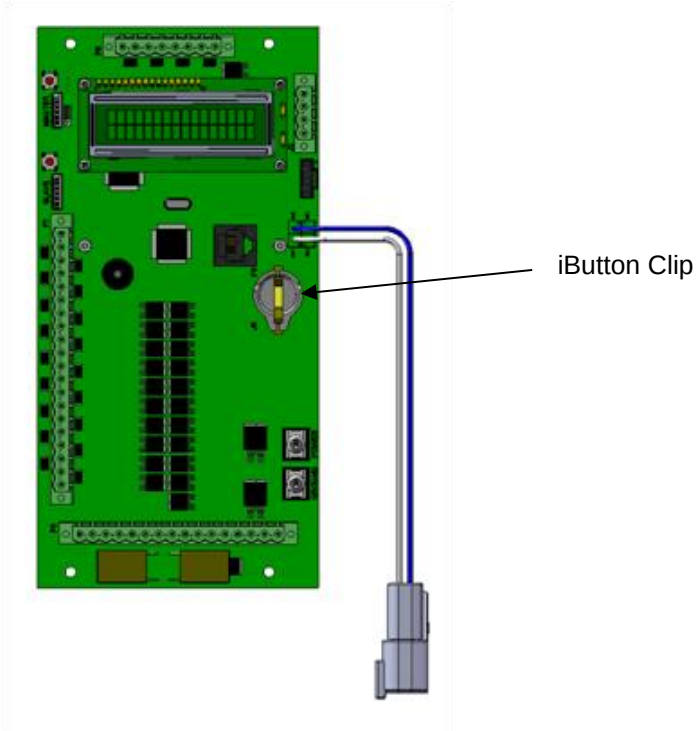
Figure 2: Replug for Calib Screen

ThumbCal Connection Port

Connect the 94069A001 ThumbCal to the ThumbCal Connection Port using the included cable to open the Calibration Menu. The Calibration Menu will appear on the Setup & Diagnostics screen.

iButton

The iButton is a small, circular data storage device similar to a watch battery. The 9-Axis System stores all of its calibration settings on the iButton. The iButton is attached to the iButton Clip on the circuit board.



If you receive a Calibration Error or an iButton Communication Error (see Error Conditions & Troubleshooting on page 18), you may need to replace your iButton. Order a replacement iButton from your local FORCE America Representative.

To replace an iButton:

STEP 1: Power down the 9-Axis System and disconnect it from power.

STEP 2: Lift up the gold tab on the iButton Clip and gently slide the iButton out towards the Setup & Diagnostics Screen.

STEP 3: Gently slide the replacement iButton into the iButton Clip.

STEP 4: Reconnect the 9-Axis System to power and power it back up.

STEP 5: Enter the Calibration Menu.

STEP 6: Reconfigure and save your calibration settings to the new iButton.

Hardware Locations

On a standard fit vehicle, the Setup & Diagnostics screen is located underneath the hinged arm rest. The ThumbCal Connection Port is located on the side of the arm assembly. The iButton is located on the circuit board inside the arm assembly.

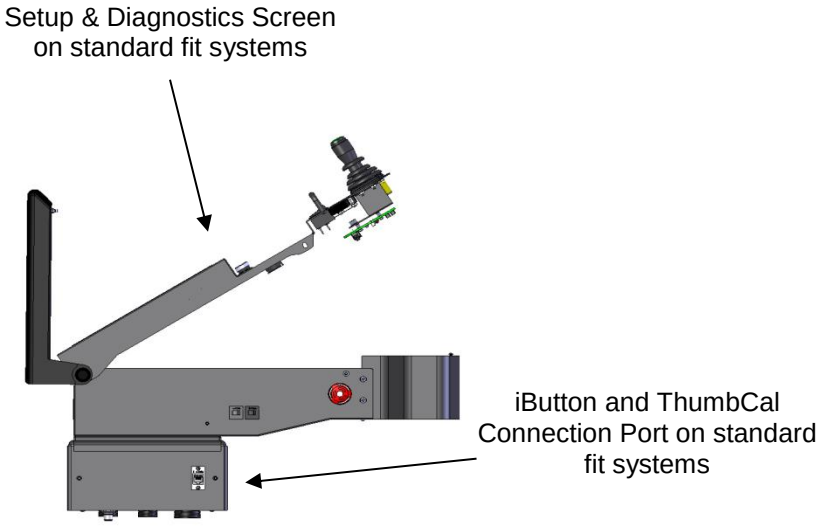


Figure 3: Standard Fit 9-Axis System

On a retrofitted vehicle, the Setup & Diagnostics screen, iButton, and ThumbCal Connection Port are located on the circuit board either inside the arm assembly or at the front of the switch base.

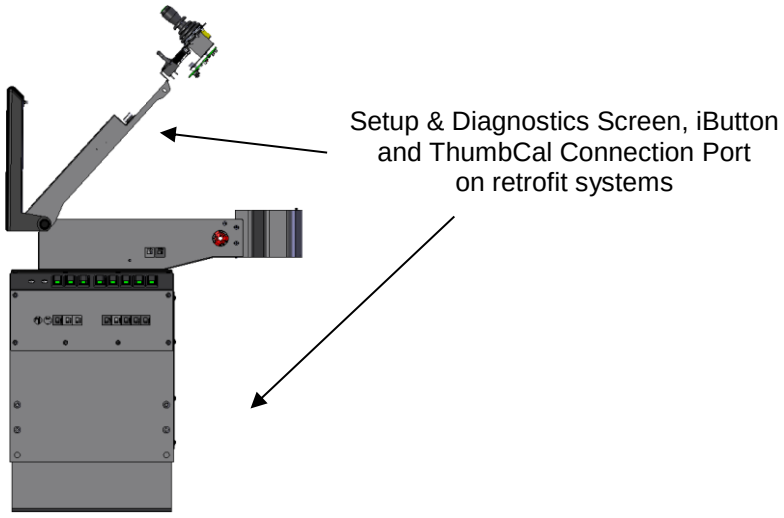


Figure 4: Retrofit 9-Axis System

Calibration Menu Navigation

The Calibration Menu uses its “Never Lost Lite” menu system to ensure that navigating through the settings is quick and easy. “Never Lost Lite” uses both lines of the LCD. The top line of the LCD holds the Trackback Line and the bottom line holds the Menu Items, as shown in Figure 5.

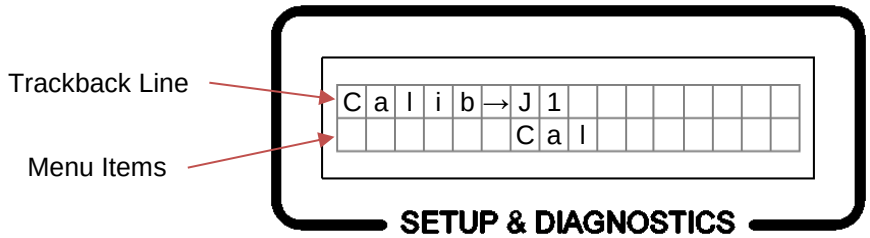


Figure 5: The Layout of the Calibration Menu

Trackback Line
The Trackback Line shows your current location in the Calibration Menu. It will always list the submenus you traveled through to see your current screen. The submenu you are currently viewing will always be the furthest to the right in the Trackback. For example, in Figure 5, the user is editing the settings in the CALIB→J1 menu.

Menu Items Line
The Menu Items Line always displays your currently selected item, whether it’s a submenu, the name of a setting, or its value.

When you enter a submenu, its name will move from the Menu Item line to the Trackback line. For example, Figure 6 will transition to Figure 7 when you enter the Live Calib submenu.

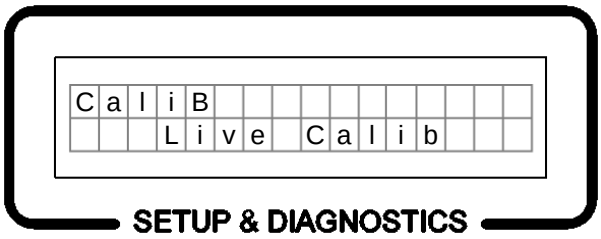


Figure 6: Main Calib Menu

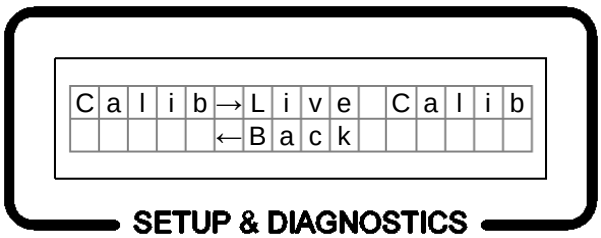


Figure 7: Live Calib Submenu

Menu Movement
All actions within the Calibration Menu are done using the ThumbCal (PN 94069A001). The ThumbCal is meant to be held in your left hand with the green encoder facing towards you.

The table below lists the functions of the ThumbCal when in the Calibration Menu. Not all actions are available at all locations within the menu.

	Action	**Function**
	Twist Counter-Clockwise	Scroll to previous menu item or submenu. Decrease a numeric value.
	Twist Clockwise	Scroll to next menu item or submenu. Increase a numeric value.
	Push	Enter submenu. Edit menu item. Confirm value. Return to previous menu.

Changing a Value
When changing a value in Calibration, the current set value will always be highlighted with an asterisk (*). In Figure 8, 20% is set as the Min.

The ←BACK menu item will always return you to a previous submenu in the Calibration Menu. When editing a numeric value, such as Joystick 1's Forward Min Output Percentage (Figure 8), the ←BACK menu item will appear when you are viewing the current set value.

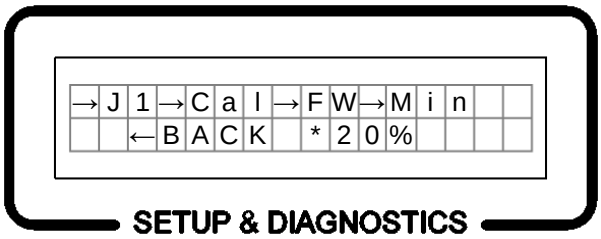


Figure 8: Joystick Forward Min Set at 20%

When you increase the numeric value but have not set it, the asterisk will disappear, as shown in Figure 9.

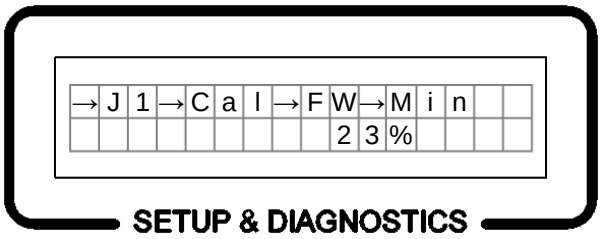


Figure 9: Joystick Forward Min Increased to 23%, Not Set

Select the value that is desired by pressing the pushbutton. An asterisk will appear next to the value indicating it is the new set value. See Figure 10.

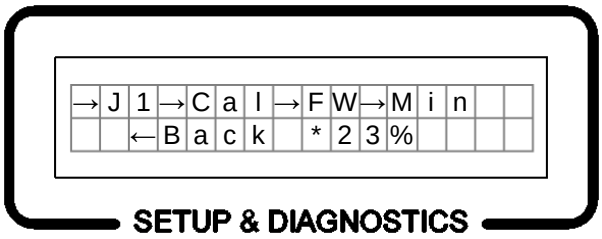


Figure 10: Joystick Forward Min Increased to 23%, Set

Once a numeric value is set using the ThumbCal's pushbutton, the ←BACK menu will reappear and you can return to the previous submenu.

When editing a selectable value, such as Joystick 1's Pushbutton Output, the ←BACK menu item is always located at the end of the selectable options. See Figure 11.

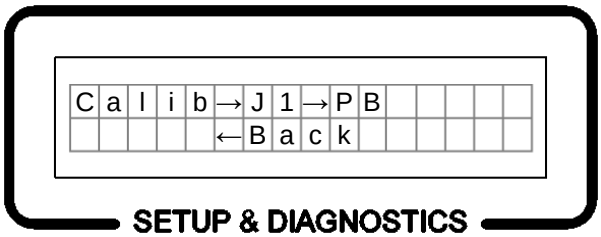


Figure 11: Joystick 1 Pushbutton Output Menu

Descriptions of Calibration Values

This section will describe each calibration value in the Calibration Menu in detail.

WARNING

Calibration Settings are not automatically saved when they are changed. Exiting the Calibration Menu without using Save Calib will discard all changed calibration settings.

Make sure to use Save Calib to save your settings.

Live Calib

Live Calibration is a new feature for dynamically calibrating (or nulling) an output's minimum and maximum duty cycles. This guarantees maximum joystick precision when running outputs.

Live Calib allows you to calibrate all of your joystick outputs from one menu location. Each direction on a joystick (forward, back, left, and right) can be individually calibrated.

In Live Calib, all of the joystick functions are active so you can immediately see how your calibrations affect vehicle performance.

When you enter Live Calib, you should see the following screen:

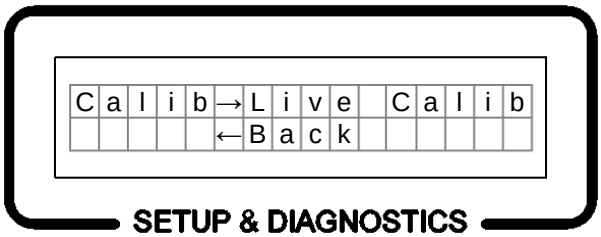


Figure 12: Live Calib

When you move a joystick slightly off-center, the system will allow you to change the minimum output duty cycle for the output associated with the movement direction. The Min output duty cycle can be adjusted between 0% and 90%. The default value is 20%.

When you move a joystick over 50% off-center, the system will allow you to change the maximum output duty cycle for the output associated with the movement direction. The Max output duty cycle can be adjusted between 10% and 100%. The default value is 75%.

Live Calib will automatically adjust the Min and the Max up or down so that they are at least 10% apart. For example, assume the Min is set at 20% and the Max is set at 75%. Increasing the Min to 90% will automatically increase the Max to 100%. Decreasing the Max to 10% will automatically decrease the Min to 0%.

Rotating the ThumbCal's encoder clockwise will increase the output duty cycle. The new value will be set immediately.

Rotating the ThumbCal's encoder counter-clockwise will decrease the output duty cycle. The new value will be set immediately.

Press the ThumbCal's pushbutton at any time to return to the Calibration Menu.

Live Calib Error Conditions
If a joystick is off-center when you enter Live Calib, the Setup & Diagnostics screen will display:

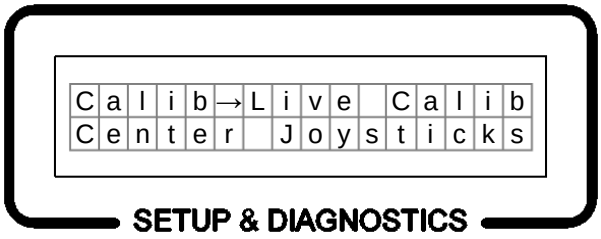


Figure 13: Live Calib - Joystick Off Center Error Upon Entry

When this error occurs, the joystick functions will no longer operate and the min and max settings cannot be calibrated until all joysticks have been centered for 3 seconds.

If multiple joysticks are moved off-center at the same time, the Setup & Diagnostics screen will display:

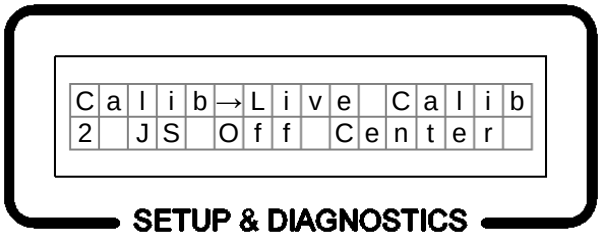


Figure 14: Live Calib - Multiple Joysticks Off Center Error

When this error occurs, the joystick functions will no longer operate and the min and max settings cannot be changed until only one joystick is off center.

To Live Calib a joystick's MIN value:

STEP 1: Move a single joystick slightly off-center in the direction you want to calibrate. For example, to calibrate the MIN for the JS1F output, move Joystick 1 forward slightly.

STEP 2: The Setup & Diagnostics screen will display:

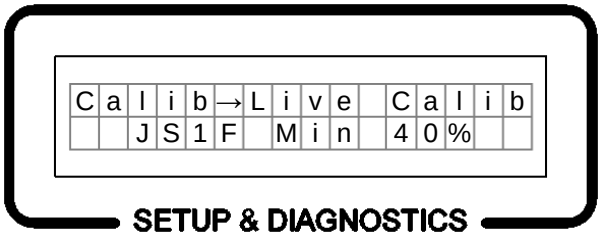


Figure 15: Live Calibrating Joystick 1 Forward Min

STEP 3: While holding the joystick in place, scroll the ThumbCal clockwise or counter-clockwise to increase or decrease the MIN value. For maximum precision, set the Min so that the output runs at the slowest rate possible without stopping.

STEP 4: When the calibrated value is reached, return Joystick 1 to the center position. The value will be automatically set.

STEP 5: When finished, return to the Main Calibration Menu and save the calibration settings using Save Calib.

To Live Calib a joystick's MAX value:

STEP 7: Move a single joystick off-center to its maximum range in the direction you want to calibrate. For example, to calibrate the MAX for the JS1F output, move Joystick 1 to its maximum forward range.

STEP 8: The Setup & Diagnostics screen will display:

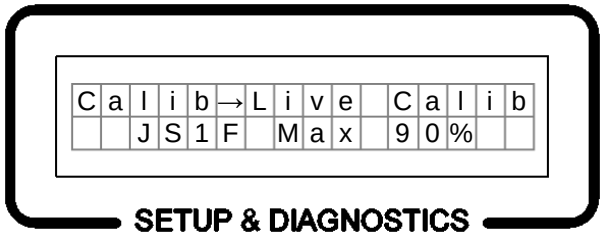


Figure 16: Live Calibrating Joystick 1 Forward Max

STEP 9: While holding the joystick in place, scroll the ThumbCal clockwise or counter-clockwise to increase or decrease the MIN value. For maximum precision, set the Max so that the output runs at its maximum speed at full joystick travel.

STEP 10: When the calibrated value is reached, return Joystick 1 to the center position. The value will be automatically set.

STEP 11: When finished, return to the Main Calibration Menu and save the calibration settings using Save Calib.

J1

The J1 menu allows you to configure settings for Joystick 1. These settings include minimum and maximum duty cycle settings, pushbutton settings, and float settings.

Cal

The Cal menu contains settings for adjusting the minimum and maximum values on Joystick 1 outputs. The Min and Max settings are defined per movement.

FW

The FW menu contains the Min and Max settings for Joystick 1 forward movement. If Joystick 1 does not have a forward/backward axis, this menu will not be visible.

Min

The Min menu item allows you to change the minimum output duty cycle in percent for the JS1F output. The Min output duty cycle can be adjusted between 0% and 90% output. The default value is 20%.

If JS1F was calibrated using Live Calib, this value will match the value set in Live Calib.

If the minimum value is set above the maximum value, the maximum will shift to be at least 10% above the minimum.

Max

The Max menu item allows you to change the maximum output duty cycle in percent for the JS1F output. The Max output duty cycle can be adjusted between 10% and 100% output. The default value is 75%.

If JS1F was calibrated using Live Calib, this value will match the value set in Live Calib.

If the maximum value is set below the minimum value, the minimum will shift to be at least 10% below the maximum.

BK

The BK menu contains the Min and Max settings for Joystick 1's backward movement. If Joystick 1 does not have a forward/backward axis, this menu will not be visible.

Min

The Min menu item allows you to change the minimum output duty cycle in percent for the JS1B output. The Min output duty cycle can be adjusted between 0% and 90% output. The default value is 20%.

If JS1B was calibrated using Live Calib, this value will match the value set in Live Calib.

If the minimum value is set above the maximum value, the maximum will shift to be at least 10% above the minimum.

Max

The Max menu item allows you to change the maximum output duty cycle in percent for the JS1B output. The Max output duty cycle can be adjusted between 10% and 100% output. The default value is 75%.

If JS1B was calibrated using Live Calib, this value will match the value set in Live Calib.

If the maximum value is set below the minimum value, the minimum will shift to be at least 10% below the maximum.

LT

The LT menu contains the Min and Max settings for Joystick 1's left movement. If Joystick 1 does not have a left/right axis, this menu will not be visible.

Min

The Min menu item allows you to change the minimum output duty cycle in percent for the JS1L output. The Min output duty cycle can be adjusted between 0% and 90% output. The default value is 20%.

If JS1L was calibrated using Live Calib, this value will match the value set in Live Calib.

If the minimum value is set above the maximum value, the maximum will shift to be at least 10% above the minimum.

Max

The Max menu item allows you to change the maximum output duty cycle in percent for the JS1L output. The Max output duty cycle can be adjusted between 10% and 100% output. The default value is 75%.

If JS1L was calibrated using Live Calib, this value will match the value set in Live Calib.

If the maximum value is set below the minimum value, the minimum will shift to be at least 10% below the maximum.

RT

The RT menu contains the Min and Max settings for Joystick 1's right movement. If Joystick 1 does not have a left/right axis, this menu will not be visible.

Min

The Min menu item allows you to change the minimum output duty cycle in percent for the JS1R output. The Min output duty cycle can be adjusted between 0% and 90% output. The default value is 20%.

If JS1R was calibrated using Live Calib, this value will match the value set in Live Calib.

If the minimum value is set above the maximum value, the maximum will shift to be at least 10% above the minimum.

Max

The Max menu item allows you to change the maximum output duty cycle in percent for the JS1R output. The Max output duty cycle can be adjusted between 10% and 100% output. The default value is 75%.

If JS1R was calibrated using Live Calib, this value will match the value set in Live Calib.

If the maximum value is set below the minimum value, the minimum will shift to be at least 10% below the maximum.

PB
The PB menu item allows you to set the output or function that runs when Joystick 1's pushbutton is pressed. If Joystick 1 does not have a pushbutton, this menu will not be visible.

The available options are Disabled, Interlock, Blast, Standby, Vibrator, Gen1, and Gen2. The default value is Disabled.

Disabled	The pushbutton shall do nothing.
Interlock	The pushbutton shall activate the joystick so movement runs a function. The joystick function will only operate if the pushbutton is pressed.
Blast	The pushbutton shall activate the Blast output on an attached spreader control, if equipped.
Standby	The pushbutton shall activate the Standby output on an attached spreader control, if equipped.
Vibrator	The pushbutton shall activate the Vibrator output on an attached spreader control, if equipped.
Gen1	The pushbutton shall activate the Generic 1 output.
Gen2	The pushbutton shall activate the Generic 2 output.

LockTime
The LockTime menu item allows you to set the interlock timeout for all joysticks that have their pushbutton configured as Interlock.

If LockTime is set to zero, releasing the joystick's pushbutton will immediately deactivate the interlock (momentary interlock). Otherwise, the interlock will remain active until the joystick has been in the center position for the number of seconds equal to LockTime.

The available options are from 0 to 90 seconds. The default value is 0 seconds.

Flt
The Flt menu contains settings for Joystick 1's float. These settings include float type, switch, axis, secondary output, and delay settings.

Type
The Type menu item allows you to set the type of float that is associated with Joystick 1.

The available options are Single-Acting, Dual-Acting, or None. The default value is None. If the type is set to None, the Swch, Axis, Flt #, and Del menus will not appear.

Users with Power Float and Blade Saver should set Type to Dual-Acting.

Swch
The Swch menu item allows you to choose whether or not the float is always on or controlled by an external switch. If a switch is not installed, the float is considered always on.

Refer to your order documentation to determine if your vehicle has a float enable switch, and if so, which input it is connected to. Set **Flt #** to this input.

The available options are Yes and No. The default value is No.

Axis
The axis menu item allows you to choose which direction of Joystick 1 activates the float. The axis opposite of this value shall automatically be set to deactivate the float.

The available options are FW, BK, LT, and RT. The default value is FW.

Flt #
The Flt # menu item allows you to choose which external output runs when the float is activated and which external input turns the float on and off when a switch is enabled. The Flt # menu item will only be visible if the Type menu item is set to Dual Acting or the Swch menu item is set to Yes.

The available options are None, Float 1, Float 2, Float 3, and Float 4. These directly correspond to the Float 1, Float 2, Float 3, and Float 4 pins on the 94065A001 Driver Board's float connector. The default value is None.

Del
The Del menu item allows you to set an optional 3 second delay in activating the float. When this is set to Yes, the driver must hold the joystick in the appropriate direction for at least 3 seconds before the float is activated.

The available options are Yes and No. The default value is No.

A2D Counts
The A2D Counts menu item provides diagnostic tools used to show the current Analog to Digital Counts coming from Joystick 1 into the 94066A001 Transmitter Board.

This menu and its submenus are meant to be used with the help and support of a FORCE America Representative.

FW / BK
The FW / BK menu item shows the A2D Counts for the forward/backward axis of the joystick. Pressing the ThumbCal's pushbutton will return you to the A2D Counts menu.

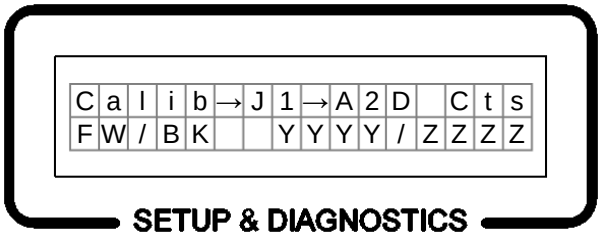


Figure 17: FW / BK A2D Counts

YYYY shows the counts coming from Joystick 1's forward/backward non-inverting input.

ZZZZ shows the counts coming from Joystick 1's forward/backward inverting input.

LT / RT
The LT / RT menu item shows the A2D Counts for the left/right axis of the joystick. Pressing the ThumbCal's pushbutton will return you to the A2D Counts menu.

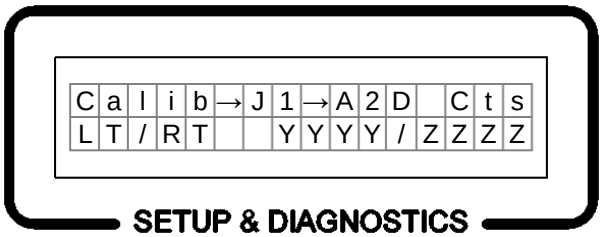


Figure 18: LT / RT A2D Counts

YYYY shows the counts coming from Joystick 1's left/right non-inverting input.

ZZZZ shows the counts coming from Joystick 1's left/right inverting input.

J2, J3, J4, J5
The J2, J3, J4, and J5 menus allow you to configure settings for Joysticks 2, 3, 4, and 5. These settings are identical to the Joystick 1 settings, beginning on page 11.

Freq Setup
The Frequency Setup menu item allows you to select the frequency at which to run the valve outputs. This frequency will vary depending on the brand and type of valve being used. See your valve manufacturer's documentation for the recommended operating frequency.

The available options are 50 Hz and 125Hz. The default value is 50 Hz.

Ver
The versions submenu allows you to see the current revision of firmware on the Driver Board's master processor, slave processor, and the Transmitter Board's processor. The versions submenu also allows you to see the hardware revision and serial numbers for the Driver Board and the Transmitter Board.

Master
The Master menu item shows the version number of the firmware on the driver board's master processor.

Slave
The Slave menu item shows the version number of the firmware on the driver board's slave processor.

TransM
The TransM menu item shows the version number of the firmware on the MPJC transmitter board's processor.

Driver HW
The Driver HW menu item shows the revision number of the driver board PCB.

TransM HW
The TransM HW menu item shows the revision number of the MPJC transmitter board PCB.

Driver SN
The Driver SN menu item shows the serial number of the driver board.

TransM SN
The TransM SN menu item shows the serial number of the MPJC transmitter board.

Error Log
The Error Log allows you to see how many times a specific error has occurred since startup. It records up to 99 instances of each error condition. The Error Log is cleared when the system is powered off.

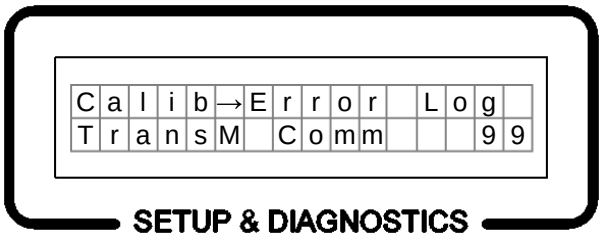


Figure 19: Error Log showing 99 Transmitter Communication Errors

All of the system-wide errors are displayed first:
- TransM Comm
- Slave Comm
- ESTOP
- Overvoltage
- Undervoltage
- Calibration
- iButton
- LCD Comm
- ESTOP Wiring

For more information on error conditions, see *Troubleshooting and Error Codes* on page 18.

All of the valve, float, and joystick-specific errors are categorized on a per-joystick basis. Beneath the J1, J2, J3, J4, and J5 menus are the following error logs:
- JS*N* Valve
- JS*N* Float
- JS*N* Output
- JS*N* Integ
- JS*N* Hi Range
- JS*N* Lo Range
- JS*N* Norm
- JS*N* Center
- JS*N* Stuck PB

OEM
The OEM menu contains system-wide hardware configuration settings that are only available to FORCE America Representatives.

Restore Defaults
The Restore Defaults menu item changes all calibration menu items except the OEM settings back to their factory-supplied defaults. This can be useful when a valve needs to be recalibrated and you need to start from a known value. Upon restoring defaults, you will be returned to the Calibration Menu.

Using the Restore Defaults menu item does not save the restored defaults to the iButton. Make sure you save your calibration settings using Save Calib in order for the restored defaults to take effect.

Save Calib
The Save Calib menu item saves all changed menu item values to the iButton storage device. Upon saving, you will be returned to the Calibration Menu.

WARNING

Removing the ThumbCal from the system without using Save Calib will discard all changed calibration settings.

To Exit the Calibration Menu

Exit the Calibration Menu by disconnecting the 94069A001 ThumbCal from the Ethernet port on the arm base.

WARNING

Exiting the Calibration Menu without using Save Calib will discard all changed calibration settings.

Errors in Calibration

Only critical, system-wide errors can occur in Calibration:

- Transmitter Communication Error
- Slave PIC Communication Error
- Emergency Stop Warning
- Power Overvoltage Error
- Power Undervoltage Error
- LCD Communication Error
- Invalid ESTOP Wiring Error
- Calibration Error
- iButton Communication Error

When one of these errors occurs, you will be exited from Calibration and any changes you made that were not saved will be erased.

For more information and solutions for each error condition, see Error Conditions & Troubleshooting on page 18.

Error Conditions & Troubleshooting

If an error occurs during system operation, use the following table to determine the cause and solution. A “long” beep is a tone that lasts for 2 seconds, followed by 2 seconds of silence. A short beep is a tone that lasts for ½ second, followed by ½ second of silence.

Number of Beeps	Possible Cause	Solution
Solid	CAN Communication between the driver board and transmitter board has been lost.	Verify the integrity of the CAN cable connecting the 94065A001 driver board to the 94066A001 transmitter board.
	CAN Communication between the driver board master processor and the slave processor has been lost.	Verify the integrity of the 94065A001 driver board.
1 Long	The Emergency STOP (ESTOP) switch has been activated.	Twist the ESTOP switch to deactivate the Emergency Stop.
1 Short	The 9-Axis system is receiving too much voltage.	Verify the integrity of the vehicle’s electrical system.
	The 9-Axis system is receiving too little voltage.	Verify the integrity of the vehicle’s electrical system.
3 Short	The 9-Axis system has corrupted calibration settings.	Verify the integrity of the iButton and iButton interface on the 94065A001 driver board.
	The 9-Axis system cannot communicate with the calibration settings iButton.	
5 Short	A short or an open circuit has been detected on the joystick output that is blinking.	Verify the integrity of the outputs and wiring.
	A short or an open circuit has been detected on the pushbutton output that is blinking.	Verify the integrity of the outputs and wiring.
7 Short	The joystick that is blinking is operating outside of its acceptable range.	Contact a FORCE America Representative for a replacement joystick.
9 Short	The joystick was detected off-center at startup.	Verify that the joystick is not off-center.
	The joystick’s pushbutton was detected pressed on startup.	Verify that the joystick’s pushbutton is not pressed.
11 Short	The 9-Axis system cannot communicate with the Setup & Diagnostics screen.	Verify the integrity of the 94065A001 driver board.
13 Short	The Emergency Stop Switch is miswired and will not function properly.	Verify the wiring of the Emergency Stop Switch.

Number of Beeps	Possible Cause	Solution
15 Short	Communication with the joystick backlighting board has been lost.	Verify the connection between the joystick backlighting board and the joystick input board.

FORCE America Contact Information

Should you encounter problems with your 9-Axis System that are not documented in this Calibration Manual or the *9-Axis Proportional Joystick Control System with CAN Bus Operation Manual (M0105)*, please contact your local FORCE America Sales Representative for assistance.

For company and product information, please contact FORCE America at:

Phone: 1-888-99FORCE (1-888-993-6723)
Website: http://www.forceamerica.com
E-mail: info@forceamerica.com

Document No: M0106-C
Released: 08/31/2015