TMC 4671 Motor Driver Has Noise Sound Report

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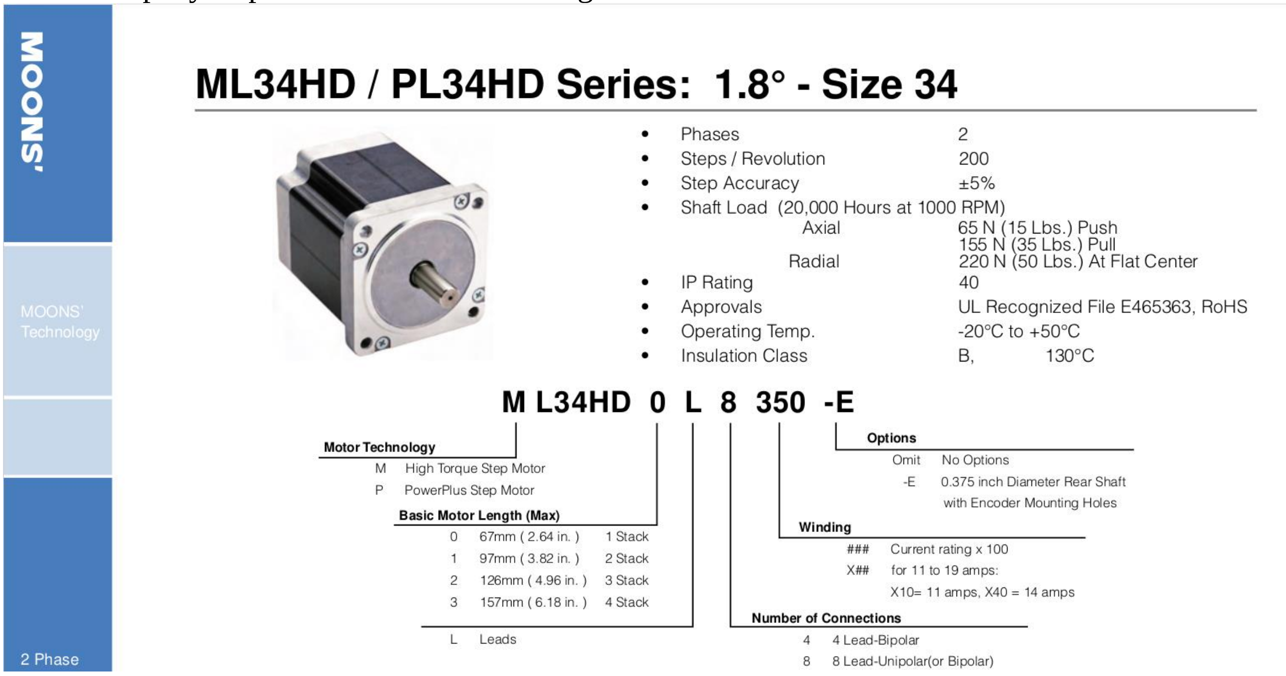
1 Project Introduction

Our company operates in the field of research and production of ventilators, especially the production of high-frequency ventilators. Currently, the product is almost complete, but there is currently a problem related to the use of a stepping motor driver to create oscillation. We use a Moon company step motor with the following code PL34HD0L4700.



The motor will convert the circular motion into a linear motion of the piston, thereby creating an oscillating air flow into the patient's lungs.
The problem we encounter is that the motor makes a lot of noise when operating, which is very unacceptable for our products.
I have also configured the driver to reduce noise, but when the noise is reduced, the motor's movement does not follow the desired sinusoidal motion. I will present the details below.

2 Issue Description

- Please see the video attached:

./more_noise_sound/IMG_3084.mov
./less_noise_sound/IMG_3085.mov

- We tuned the FOC23 follow the data sheet:

Y_PID_FLUX	=	PID_FLUX_P	×	ERROR_FLUX/256
Y_PID_FLUX_RATE	=	PID_FLUX_I	×	ERROR_FLUX/65536/(32µs)
Y_PID_TORQUE	=	PID_FLUX_P	×	ERROR_TORQUE/256
Y_PID_TORQUE_RATE	=	PID_TORQUE_I	×	ERROR_TORQUE/65536/(32µs)
Y_PID_VELOCITY	=	PID_VELOCITY_P	×	ERROR_VELOCITY/256
Y_PID_VELOCITY_RATE	=	PID_VELOCITY_I	×	ERROR_VELOCITY/65536/(256µs)

Y_PID_POSITION	=	PID_POSITION_P	×	ERROR_POSITION/65536
Y_PID_POSITION_RATE	=	PID_POSITION_I	×	ERROR_POSITION/65536/(256µs)

Table 22: Scalings and Change Rate Timings of PID Controllers (Classic Structure) for Currents, Velocity, and Position for Clock Frequency fCLK = 25MHz

- I realize that the bigger PID_FLUX_P, the larger noise sound occurs.

Figure 1: PID_FLUX_P is 1500 has less noise sound

Figure 2 PID_FLUX_P is 12000 has more noise sound

- However, the smaller PID_FLUX_P, the larger step error: Red curve is desired step, blue curve is encoder step.

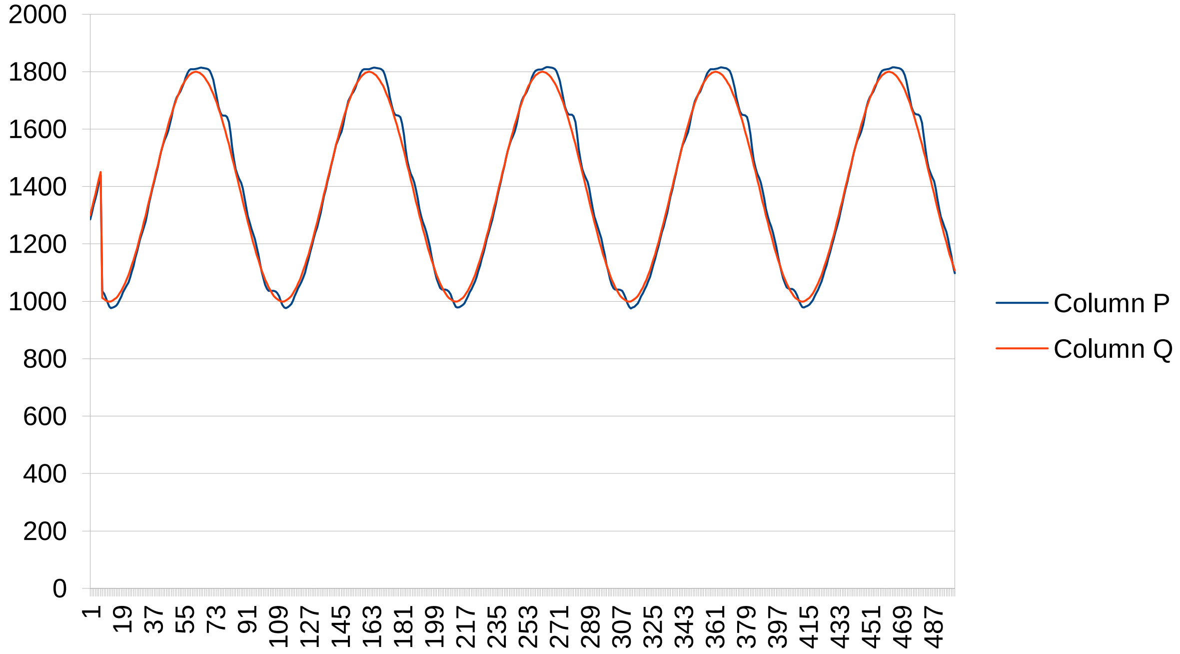


Figure 3 Encoder step does not follow desired step

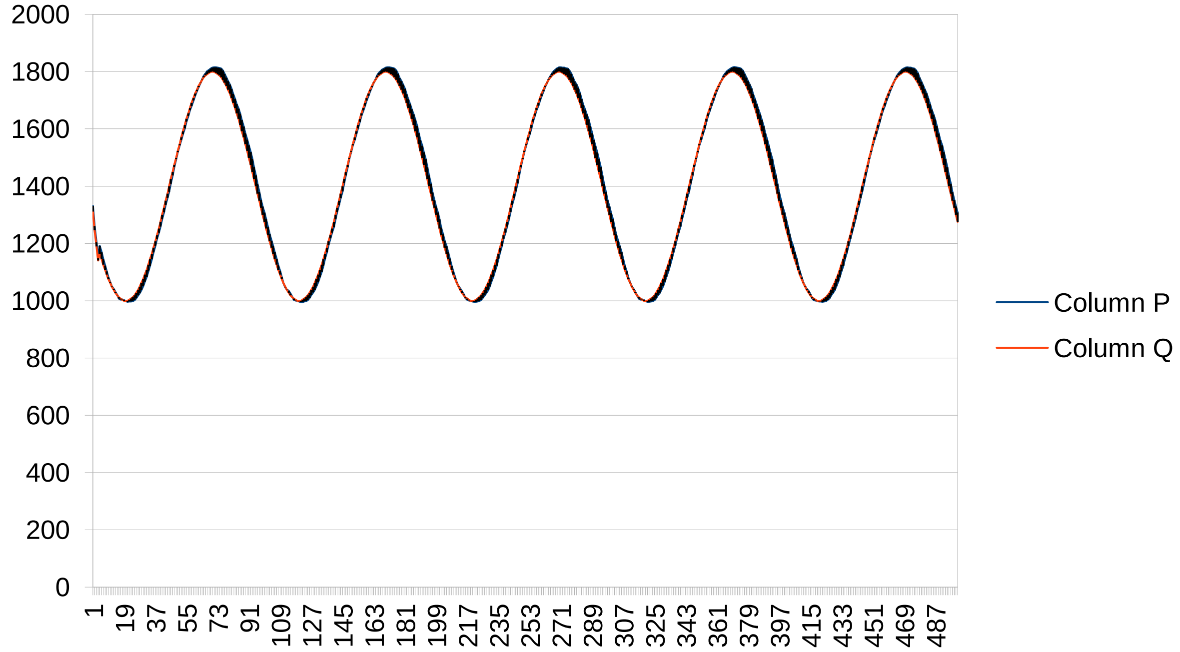
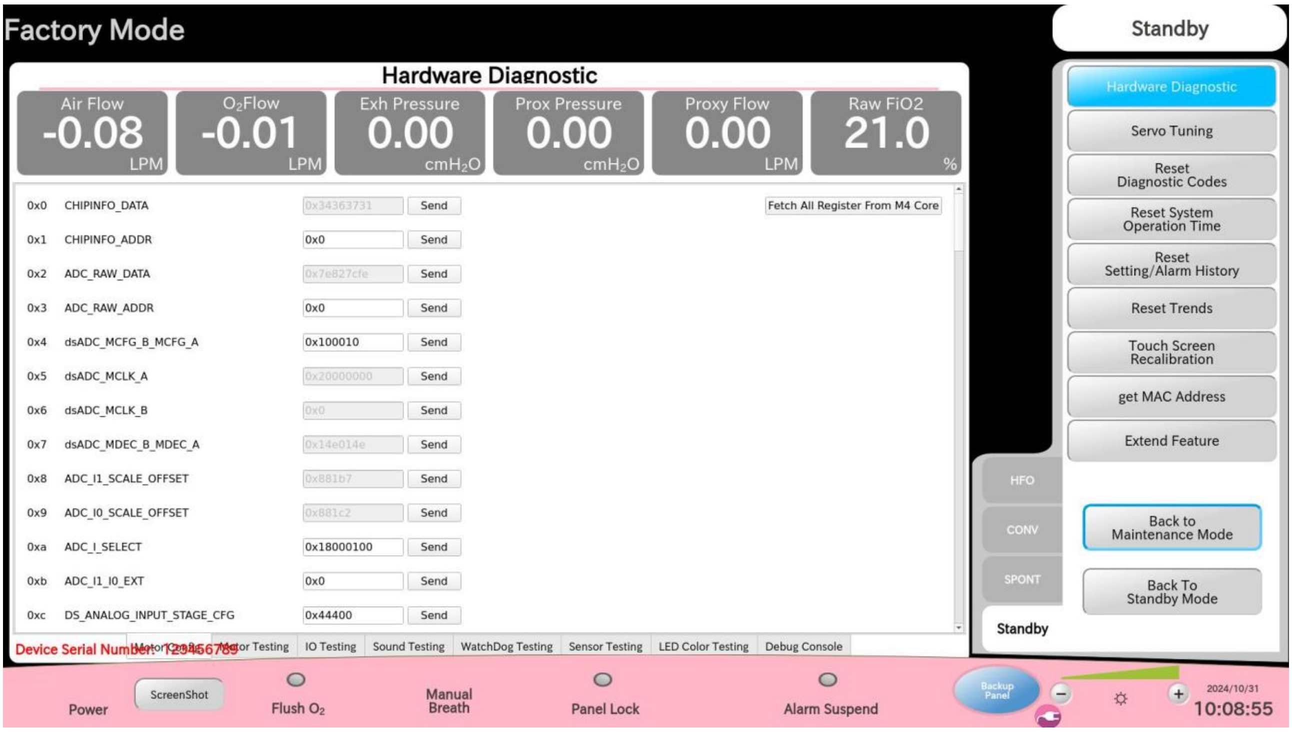
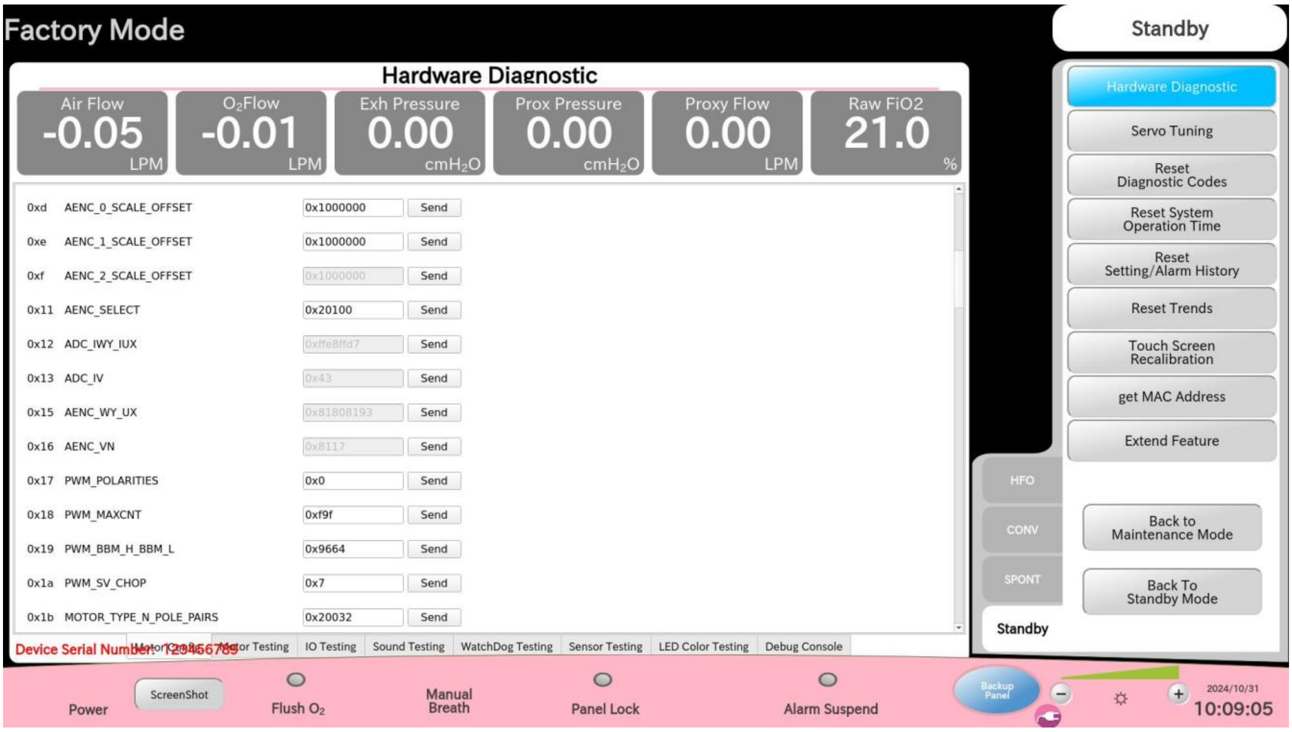


Figure 4 Encoder step follow desired step

3 TMC4671 Configuration

The TMC4671 registers is configured as below:






Factory Mode
Standby
Hardware Diagnostic
Air Flow -0.08 LPM
O2Flow -0.02 LPM
Exh Pressure 0.00 cmH2O
Prox Pressure 0.00 cmH2O
Proxy Flow 0.00 LPM
Raw FiO2 21.0 %
0x1c PHI_E_EXT 0x0 Send
0x1f OPENLOOP_MODE 0x0 Send
0x20 OPENLOOP_ACCELERATION 0x0 Send
0x21 OPENLOOP_VELOCITY_TARGET 0x0 Send
0x22 OPENLOOP_VELOCITY_ACTUAL 0x0 Send
0x23 OPENLOOP_PHI 0x0 Send
0x24 UQ_UD_EXT 0xbb8 Send
0x25 ABN_DECODER_MODE 0x1000 Send
0x26 ABN_DECODER_PPR 0xfa00 Send
0x27 ABN_DECODER_COUNT 0x1b0 Send
0x28 ABN_DECODER_COUNT_N 0x0 Send
0x29 ABN_DECODER_PHI_E_PHI_M_OFFSET 0x0 Send
0x2a ABN_DECODER_PHI_E_PHI_M 0x565401ba Send
Device Serial Number: 123456789
Motor Testing
IO Testing
Sound Testing
WatchDog Testing
Sensor Testing
LED Color Testing
Debug Console
Hardware Diagnostic
Servo Tuning
Reset Diagnostic Codes
Reset System Operation Time
Reset Setting/Alarm History
Reset Trends
Touch Screen Recalibration
get MAC Address
Extend Feature
HFO
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SPONT
Standby
Back to Maintenance Mode
Back To Standby Mode
Power
ScreenShot
Flush O2
Manual Breath
Panel Lock
Alarm Suspend
Backup Panel
2024/10/31
10:09:32


Factory Mode
Standby
Hardware Diagnostic
Air Flow -0.06 LPM
O2Flow -0.03 LPM
Exh Pressure 0.00 cmH2O
Prox Pressure 0.00 cmH2O
Proxy Flow 0.00 LPM
Raw FiO2 21.0 %
0x2c ABN_2_DECODER_MODE 0x0 Send
0x2d ABN_2_DECODER_PPR 0x10000 Send
0x2f ABN_2_DECODER_COUNT_N 0x0 Send
0x30 ABN_2_DECODER_PHI_M_OFFSET 0x0 Send
0x31 ABN_2_DECODER_PHI_M 0x0 Send
0x33 HALL_MODE 0x0 Send
0x34 HALL_POSITION_060_000 0x2aaa0000 Send
0x35 HALL_POSITION_180_120 0x80005555 Send
0x36 HALL_POSITION_300_240 0xd555aaaa Send
0x37 HALL_PHI_E_PHI_M_OFFSET 0x0 Send
0x38 HALL_DPHI_MAX 0x2aaa Send
0x39 HALL_PHI_E_INTERPOLATED_PHI_E 0x0 Send
0x3a HALL_PHI_M 0x0 Send
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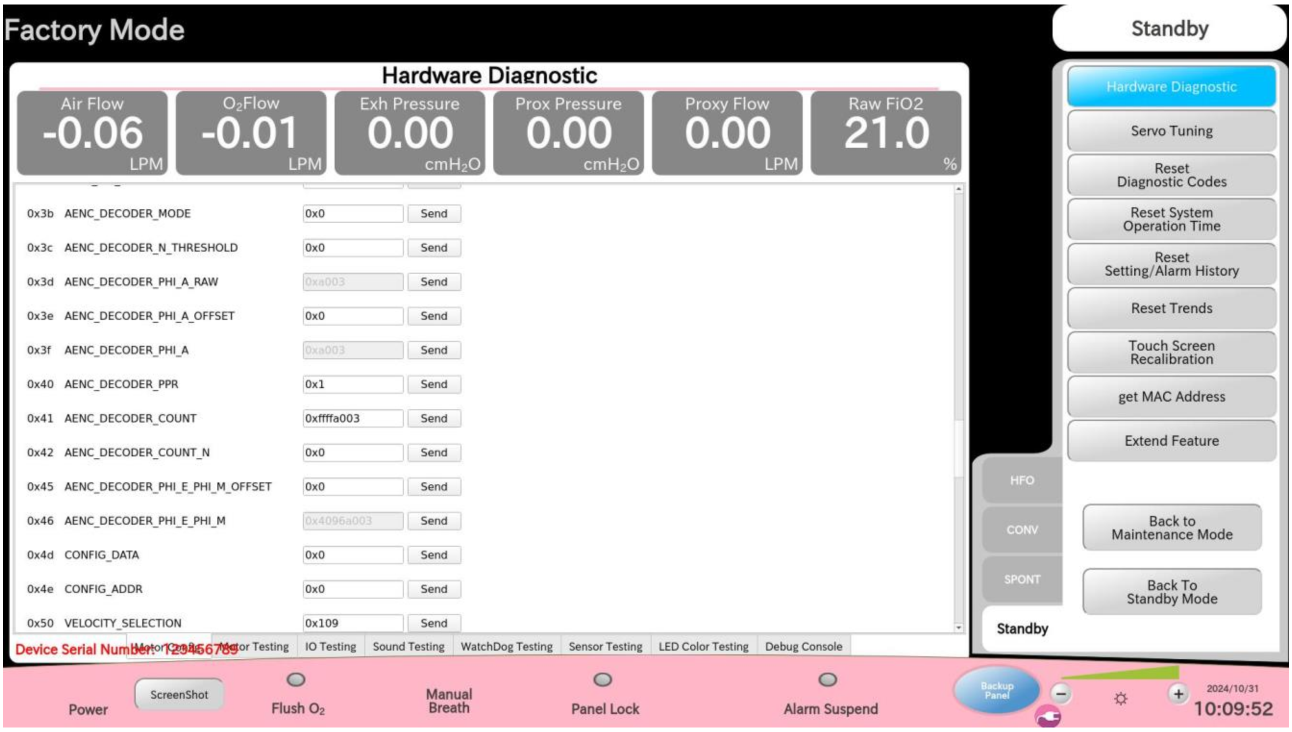
10:09:44


Factory Mode
Standby
Hardware Diagnostic
Air Flow -0.06 LPM
O2Flow -0.01 LPM
Exh Pressure 0.00 cmH2O
Prox Pressure 0.00 cmH2O
Proxy Flow 0.00 LPM
Raw FiO2 21.0 %
0x3b AENC_DECODER_MODE 0x0 Send
0x3c AENC_DECODER_N_THRESHOLD 0x0 Send
0x3d AENC_DECODER_PHI_A_RAW 0xa003 Send
0x3e AENC_DECODER_PHI_A_OFFSET 0x0 Send
0x3f AENC_DECODER_PHI_A 0xa003 Send
0x40 AENC_DECODER_PPR 0x1 Send
0x41 AENC_DECODER_COUNT 0xffffa003 Send
0x42 AENC_DECODER_COUNT_N 0x0 Send
0x45 AENC_DECODER_PHI_E_PHI_M_OFFSET 0x0 Send
0x46 AENC_DECODER_PHI_E_PHI_M 0x4096a003 Send
0x4d CONFIG_DATA 0x0 Send
0x4e CONFIG_ADDR 0x0 Send
0x50 VELOCITY_SELECTION 0x109 Send
Device Serial Number: 123456789
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2024/10/31
10:09:52


Factory Mode
Standby
Hardware Diagnostic
Air Flow -0.07 LPM
O2Flow -0.03 LPM
Exh Pressure 0.00 cmH2O
Prox Pressure 0.00 cmH2O
Proxy Flow 0.00 LPM
Raw FiO2 21.0 %
0x51 POSITION_SELECTION 0x9 Send
0x52 PHI_E_SELECTION 0x3 Send
0x53 PHI_E 0x5654 Send
0x54 PID_FLUX_P_FLUX_I 0x27107530 Send
0x56 PID_TORQUE_P_TORQUE_I 0x2ee01388 Send
0x58 PID_VELOCITY_P_VELOCITY_I 0x12c0014 Send
0x5a PID_POSITION_P_POSITION_I 0x12c0032 Send
0x5d PIDOUT_UQ_UD_LIMITS 0x7fff Send
0x5e PID_TORQUE_FLUX_LIMITS 0x1af4 Send
0x60 PID_VELOCITY_LIMIT 0x1388 Send
0x61 PID_POSITION_LIMIT_LOW 0x8ffeb940 Send
0x62 PID_POSITION_LIMIT_HIGH 0x7ffeb940 Send
0x63 MODE_RAMP_MODE_MOTION 0x80000003 Send
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10:10:10


Factory Mode
Standby
Hardware Diagnostic
Air Flow -0.08 LPM
O2Flow -0.03 LPM
Exh Pressure 0.00 cmH2O
Prox Pressure 0.00 cmH2O
Proxy Flow 0.00 LPM
Raw FiO2 21.0 %
0x64 PID_TORQUE_FLUX_TARGET 0x0 Send
0x65 PID_TORQUE_FLUX_OFFSET 0x0 Send
0x66 PID_VELOCITY_TARGET 0x0 Send
0x67 PID_VELOCITY_OFFSET 0x0 Send
0x68 PID_POSITION_TARGET 0x1ba Send
0x69 PID_TORQUE_FLUX_ACTUAL 0x2d0002 Send
0x6a PID_VELOCITY_ACTUAL 0x0 Send
0x6b PID_POSITION_ACTUAL 0x1ba Send
0x6c PID_ERROR_DATA 0x0 Send
0x6d PID_ERROR_ADDR 0x0 Send
0x6e INTERIM_DATA 0xffebffd7 Send
0x6f INTERIM_ADDR 0xa Send
0x75 ADC_VM_LIMITS 0xffffffff Send
Device Serial Number: 123456789
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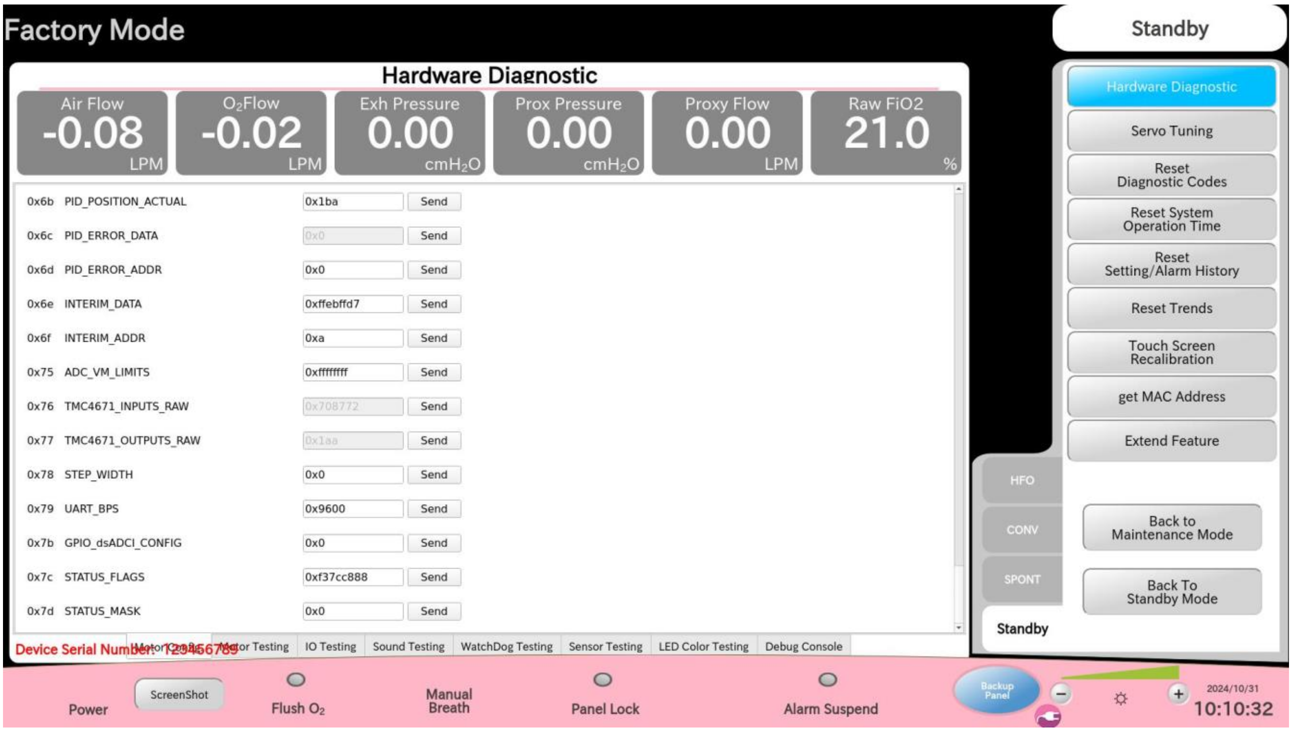
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Prox Pressure 0.00 cmH2O
Proxy Flow 0.00 LPM
Raw FiO2 21.0 %
0x6b PID_POSITION_ACTUAL 0x1ba Send
0x6c PID_ERROR_DATA 0x0 Send
0x6d PID_ERROR_ADDR 0x0 Send
0x6e INTERIM_DATA 0xffebffd7 Send
0x6f INTERIM_ADDR 0xa Send
0x75 ADC_VM_LIMITS 0xffffffff Send
0x76 TMC4671_INPUTS_RAW 0x708772 Send
0x77 TMC4671_OUTPUTS_RAW 0x1aa Send
0x78 STEP_WIDTH 0x0 Send
0x79 UART_BPS 0x9600 Send
0x7b GPIO_dsADCI_CONFIG 0x0 Send
0x7c STATUS_FLAGS 0xf37cc888 Send
0x7d STATUS_MASK 0x0 Send
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