DATASHEET

Celera MOTION
A Novanta Company

Aura Series Datasheet

Exported on: 06/25/2021

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1 General Information

1.1 Revision History

Revision	Release Date	Changes
1.0	Jan 26 2021	
1.1		Storage temperature. BiSS daisy-chain.
1.2	May 28 2021	Electrical Interface update. Communications added.
1.3	Jun 23 2021	Changed Function naming on Electrical Interface page to be consistent with schematic.

1.2 Disclaimers and limitations of liability

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2 Overview

Aura employs a short wavelength LED for precise absolute position decoding. An incremental scale track and advanced sensor produce pure sinewave signals enabling high resolution interpolation with run-speeds up to 83,721 rpm. High repeatability and accuracy satisfy the most demanding applications.

The small, low power consumption SMT package integrates easily into an OEM PCB. Generous alignment tolerances facilitate installation. Built-in scale eccentricity compensation improves production efficiency and eliminates the cost of dual averaging encoders.

High speed BiSS-C delivers the minimal latency required for high bandwidth control loops. SSI, SPI and AqB interfaces complete the comprehensive connectivity options. AqB provides the flexibility to operate incrementally after initial absolute position is determined. AqB also enables interface redundancy when safety is an issue.

SmartPrecision lll is intuitive software for calibration, alignment and status monitoring. Encoder data can be sampled and recorded in a CSV file. To simplify installation, Celera Motion also provides hubs with pre-mounted encoder scales. For fast prototyping, a compact, easy-connect Evaluation Board is available in limited quantities (consult your sales representative). Note that the Evaluation Board accessory is in the beta stage of release.

2.1 Benefits

- True absolute position - no wake-and-wiggle
- Small, low power SMT package
- High resolution and accuracy
- High run-speed
- Wide alignment tolerances
- Eccentricity compensation
- Low communications latency
- Comprehensive connectivity

3 Specifications

System Data		
Scale Sizes (OD)	18.0 mm	33.0 mm
Resolution	18-22 bits	18-22 bits
Accuracy	±0.01 °	±0.01 °
Alignment Tolerances TAN, RAD, Z	± 0.10, ± 0.40, ± 0.50 mm	± 0.20, ± 0.40, ± 0.50 mm
Max. Speed	83,721 rpm	41,983 rpm
Repeatability	1 LSB	1 LSB
Jitter (Position Noise)	< 1 LSB	< 1 LSB
Jitter Averaging Sample Size*	19 bits = 4, 20 bits = 12, 21 bits = 45, 22 bits = 287	

*Jitter is specified as <1 LSB at 18 bits resolution. At 22 bits (x16) resolution, jitter would be < 4th LSB at that resolution. Position sample averaging in the drive/controller can be used to eliminate jitter at higher resolutions. The recommended number of samples depends on the resolution. In noisy environments it may be necessary to increase the sample size.

Alignment tolerances assume a concentric scale and precise chip placement using fiducial guides. See Installation for further details. If eccentricity error and chip placement error are present, Radial and Tangential tolerances must be adjusted. As an example, for 33 mm scale:

Eccentricity Error = 0.02 mm, Chip Placement Error = 0.06 mm (typical without fiducial-guided placement)
Radial Tolerance = ± (0.40 - 0.02 - 0.06) = ± 0.32 Tangential Tolerance = ± (0.20 - 0.02 - 0.06) = ± 0.12

Electrical Data	
VAA Supply Voltage	4.5 VDC to 5.5 VDC
VDDIO Supply Voltage	2.5 VDC to 5.5 VDC
Supply Current	45 mA
Input Voltage Thresholds	Low: 30% VDDIO, High: 70% VDDIO

Electrical Data	
Output Voltage Thresholds	Low: 10% VDDIO, High: 90% VDDIO
BiSS Max. Clock Rate	20 MHz
BiSS Latency	< 5 µsec
SPI Max. Clock Rate	12 MHz
SPI Latency	< 5 µsec
SSI Max. Clock Rate	10 MHz
SSI Latency	< 30 µsec
AB Min. Edge Separation	37.5 nsec
Mechanical Data	
Size	9.0 x 7.0 x 1.2 mm
Fly Height	1.75 mm
Weight	1.5 g
Environmental Data	
Operating Temperature	-20°C to 85°C
Storage Temperature	-40°C to 110°C
Soldering Peak Temperature	245°C < 20 sec, convection reflow
Moisture Sensitivity Level	5a
Contamination Immunity*	Tolerant to fingerprints from clean hands
Humidity	10-85 % RH Non-Condensing

* See Handling and Installation for guidelines on minimizing contamination

Reliability Data	
MTBF	> 77,000 hours (@ 55°C operating temperature)

4 Storage, Handling, Installation

Aura is a precision electronic instrument. It has been designed to function in a wide range of applications and environments. To take full advantage of the encoder design, allow easy access to the sensor for service and/or replacement. For optimal performance and reliability:

- DO follow standard ESD precautions while handling the sensor.
- DO allow proper clearance for sensor head alignment.
- DO follow setup and alignment instructions for the encoder system.
- DO, where possible, install the scales in an inverted or vertical position to minimize accumulation of dust.
- DO NOT store sensors in an uncontrolled environment.
- DO NOT electrically overstress the sensor (power supply ripple/noise).
- DO NOT intentionally "hot swap" the sensor if the device is energized.
- **DO NOT hand solder**. Hand soldering can cause damage to the device.

4.1 Safety Considerations

Depending on the mode of operation, Aura can emit a highly concentrated visible blue light which can be hazardous to the human eye. Products that incorporate this device should follow the safety precautions given in IEC 60825-1 and IEC 62471.

4.2 Chip Handling Considerations

Follow Electrostatic Discharge (ESD) precautions at all times. Prior to reflow soldering, pay particular attention to preventing ESD damage as the damage threshold is 500 V.

The optical window is tolerant to clean fingerprints but avoid contact wherever possible.

4.3 Scale Handling Considerations

Gloved handling is not required but is recommended. If gloves are not used, hands should be clean and contact with scale tracks avoided.

4.4 Moisture Sensitivity Level

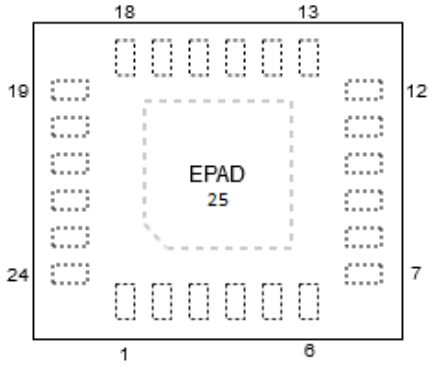
Aura is an MSL 5a component and must go through a bake out procedure prior to being soldered in place. Please refer to IPC/JEDEC J-STD-033 for appropriate MSL 5a bake conditions.

4.5 Surface Sensitivity

When handling Aura, do not allow the pickup device to touch anywhere in the Keep Out Zone - LED surface and glass windows. Scratches or 'digs' in the Keep Out Zone can affect the encoder performance.

5 Electrical Interface

5.1 Pinout



Through Chip View

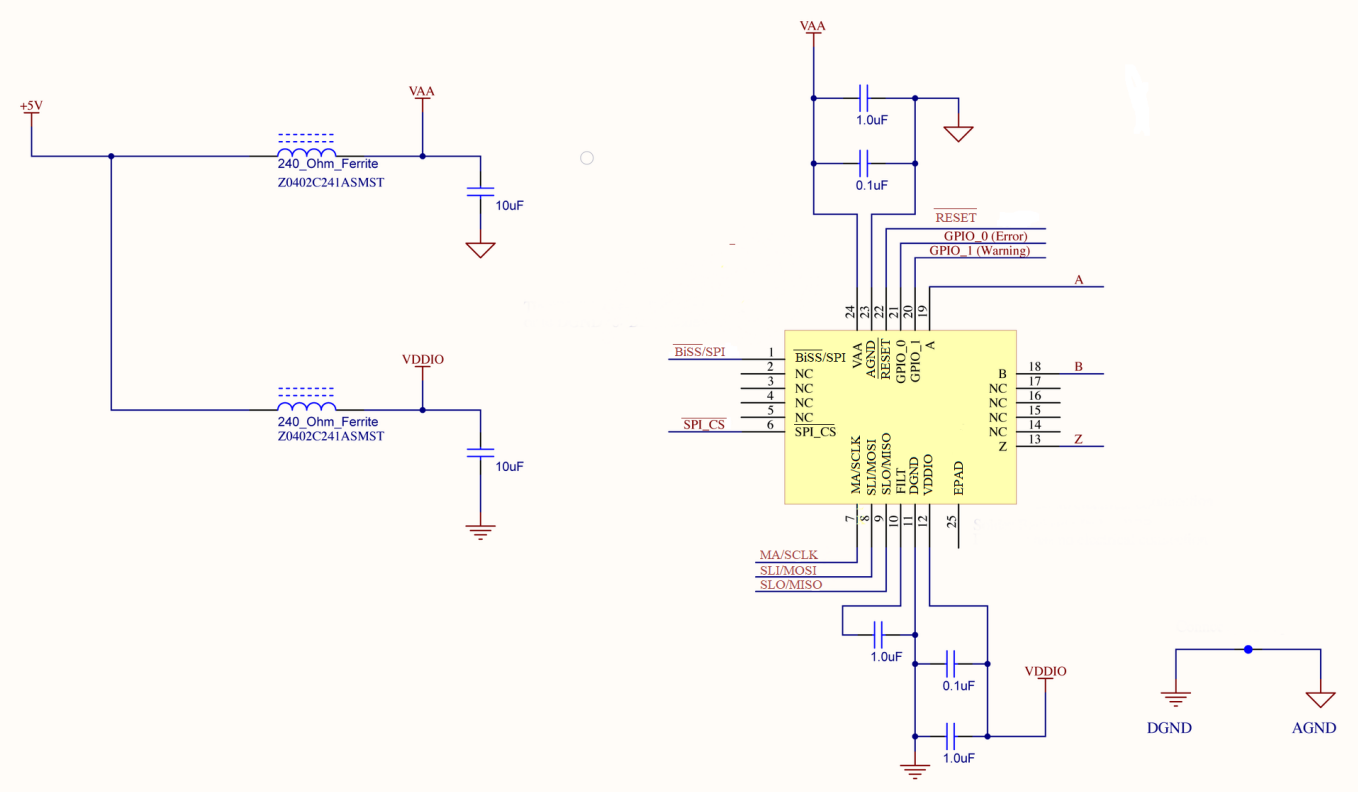
Pin	Function	Pin	Function
1	$\overline{\text{BiSS}}$/SPI[1]	14	NC
2	NC	15	NC
3	NC	16	NC
4	NC	17	NC
5	NC	18	B
6	$\overline{\text{SPI\_CS}}$[2]	19	A
7	MA/SCLK	20	GPIO_1 (Warning)
8	SLI/MOSI	21	GPIO_0 (Error)
9	SLO/MISO	22	$\overline{\text{RESET}}$[4]
10	FILT[3]	23	AGND
11	DGND	24	VAA
12	VDDIO	25	EPAD
13	Z		

5.1.1 Notes:

1. BiSS mode = pin pulled low, SPI mode = pin pulled high
2. Chip is selected = pin pulled low
3. Decoupling capacitor pin - see Recommended Supporting Circuitry
4. Reset = pin pulled low, Active = pin pulled high

5.2 Recommended Supporting Circuitry

- Note separation of VAA and VDDIO via ferrites
- Connect DGND and AGND at star point close to chip
- BiSS Mode: connect Pin 1 (BiSS/SPI) to DGND
- SPI Mode: connect Pin 1 (BiSS/SPI) to VDDIO
- Solder EPAD to PCB Pad - for heat dissipation only, **make no electrical connection**



5.3 SmartPrecision III Connectivity

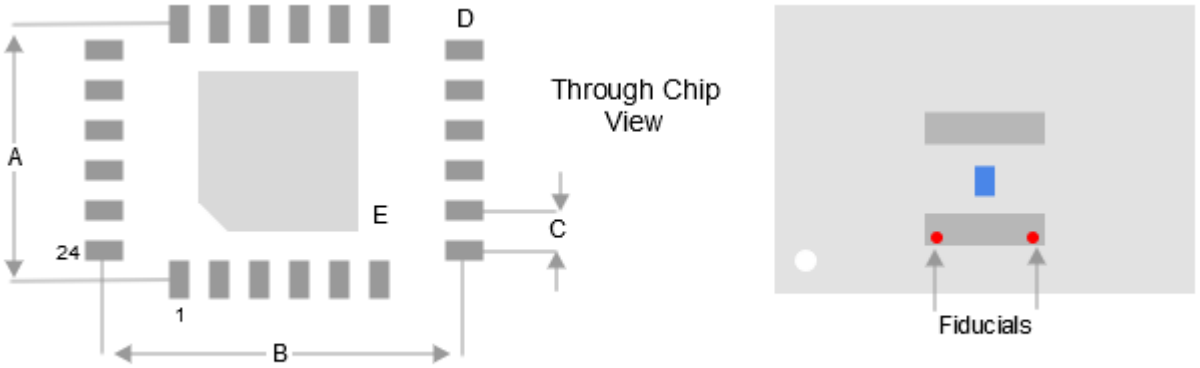
SmartPrecision III requires access to Aura BiSS interface via BiSS/USB converter. See SmartPrecison III.

6 Installation

6.1 Scale Installation

Where possible, install the scales in an inverted or vertical position to minimize accumulation of dust. Ensure scale is free of contamination. If contamination is present, follow cleaning guidelines: Cleaning Optics[1]

6.2 Recommended PCB Footprint



Parameter	Description	Dimensions
A	Y Distance Pads	5.80 mm
B	X Distance Pads	7.80 mm
C	Step Size Pads	1.00 mm
D	Pads Size (L x W)	0.70 mm x 0.35 mm
E	EPAD Size (L x W)	3.70 x 3.70 mm

- All dimension tolerances are ± 0.02 mm
- EPAD is centered in Y (A) and X (B)

6.3 Chip Installation and Alignment Guidelines

6.3.1 Note

- Please refer to Interface Drawings ID-00414 (18 mm scale) and ID-00415 (33 mm scale)
- Please refer to Specifications (Mechanical) for alignment tolerances

1 https://www.celeramotion.com/microe/support/technical-papers/cleaning-encoder-optics/

- Z alignment is defined by the distance from the scale to the chip mounting surface of the Customer PCB
- Radial and Tangential alignments are defined by the locations of the Aura **chip fiducials** relative to the scale centerlines. Do not use pad centerlines as an alignment reference

6.3.2 Recommended Steps

- Define precision benching edges on the Customer PCB
- Precisely place the chip relative to the benching edges by aligning the chip fiducials with fiducials or other references on the Customer PCB during the SMT process
- Ensure the chip window is clean. If contamination is present, follow cleaning guidelines: Cleaning Optics[2]
- Employ the Customer PCB benching edges to accurately position the chip relative to the scale

Note that Radial and Tangential alignment tolerances must be adjusted if fiducial guided placement is not employed and the chip is merely allowed to settle on the pads.

6.4 Confirming Alignment

Execute the following procedure to ensure that alignment is within tolerance.

6.4.1 Note:

- To reboot encoder, cycle power or Disconnect/Connect in SmartPrecision III (if encoder power is supplied exclusively via BiSS/USB adapter)
- Record position using an external controller or SmartPrecision III
- Ensure scale is stationary relative to readhead during read/reboot/read cycles

6.4.2 Procedure

1. Position scale zero marker approximately under Aura LED
2. Apply power to encoder
3. Record position
4. Position should be approximately zero. Pass: continue. Fail: realign encoder and start over.
5. Reboot encoder
6. Record position again
7. The position difference before/after reboot should be within the jitter range. If the alignment is out of tolerance there will be a significant change in position. Pass: continue. Fail: realign encoder and start over.
8. Move counterclockwise to ~90° position
9. Record position
10. Reboot encoder
11. Record position again
12. The position difference before/after reboot should be within the jitter range. If the alignment is out of tolerance there will be a significant change in position. Pass: continue. Fail: realign encoder and start over.
13. Move back to zero position (approximately is sufficient)
14. Reboot encoder
15. Move counterclockwise to ~180° position
16. Record position
17. Reboot encoder
18. Record position again

2 https://www.celeramotion.com/microe/support/technical-papers/cleaning-encoder-optics/

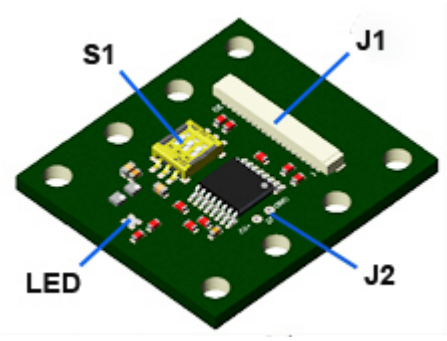
19. The position difference before/after reboot should be within the jitter range. If the alignment is out of tolerance there will be a significant change in position. Pass: continue. Fail: realign encoder and start over.
20. Move back to zero position (approximately is sufficient)
21. Reboot encoder
22. Move counterclockwise to ~270° position
23. Record position
24. Reboot encoder
25. Record position again
26. The position difference before/after reboot should be within the jitter range. If the alignment is out of tolerance there will be a significant change in position. Pass: procedure complete, encoder aligned correctly. Fail: realign encoder and start over.

7 Evaluation Board

7.1 Overview

The Evaluation Board can be used to mount, test, and evaluate the performance of the Aura chip.

NOTE: The Evaluation Board is in the beta stage of release.



- 27.1 x 24.2 x 4.1 mm
- I/O support for BiSS, SPI, ABZ, and SSI
- User selectable BiSS/SPI
- User selectable single-ended or differential SPI
- Precision benching edges for ease of installation
- Error/Warning LED
- BiSS-USB cable

7.2 Mounting

Please refer to Interface Drawing for the relevant scale.

Be sure to observe the datums A, B, and C shown in the figures when installing the evaluation board. The mechanical attachment of the evaluation board into your assembly should not intrude beyond the areas designated as “Mounting Pad”.

Where possible, install the scales in an inverted or vertical position to minimize accumulation of dust. Ensure scale and sensor glass are free of contamination. If contamination is present, follow cleaning guidelines: Cleaning Optics[3]

3 https://www.celeramotion.com/microe/support/technical-papers/cleaning-encoder-optics/

7.3 Electrical Interface

7.3.1 J1 (JST SM20B-XSRS-ETB)

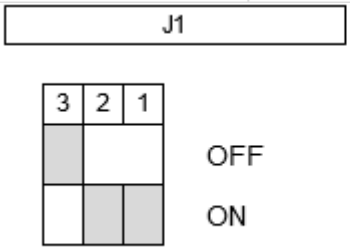
Pin	Function	Pin	Function
1	SCLK/MA+	11	SPI_CS-
2	SCLK/MA-	12	5 V
3	GND	13	A+
4	MISO/SLO+	14	A-
5	MISO/SLO-	15	GND
6	GND	16	B+
7	MOSI/SLI+	17	B-
8	MOSI/SLI-	18	GND
9	5 V	19	Z+
10	SPI_CS+	20	Z-

7.3.2 J2 (Solder)

For connection of external 5V.

7.4 Hardware Configuration Switch S1

Position	On	Off
1	USB 5V (J1)	External 5V (J2)
2	Differential SCLK, MISO, MOSI, CS	Single Ended SCLK, MISO, MOSI, CS
3	SPI	BiSS



Switch settings for SmartPrecision III
(USB 5V)

7.5 Status LED

The LED is three-color driven by GPIO pins mapped to error and warning status bits.

Error	Warning	LED Color
No	No	Green
Yes	No	Red
No	Yes	Yellow
Yes	Yes	Red

See SmartPrecision III for details on errors and warnings.

8 SmartPrecision III

8.1 Overview

- Misalignment compensation
- Gain, Offset and Phase calibration
- Angle Plot and Strip Plot viewer
- Data save capabilities for characterization and analysis
- Eccentricity compensation

8.2 Prerequisites

1. Win10 (64 bit) PC
2. BiSS-USB converter and cable: IC Haus, https://www.ichaus.de/MB5U
3. MB5U Driver-6.2_libusb1.0.21 installed on PC
4. Aura Carrier Board mounted to scale
5. Cable from Carrier Board to BiSS-USB converter
6. **Aura must be in BiSS or SSI mode**

Ensure that the USB 2.0 computer output can supply the standard 500 mA. If a suitable USB port is not available, external 5V must be provided.

For rapid prototyping, consult your sales representative for an Evaluation Board and BiSS-USB cable. Ensure that the switch settings are as described in Evaluation Board.

8.3 Quick Start

CONVENTION: **Connect** - click Connect *button* **[Settings]** - click Settings *tab*

1. Connect Carrier Board or Evaluation Board to MB5U adapter and MB5U adapter to PC
2. Download SmartPrecision III installer from Get Software[4]
3. Run installer and launch SmartPrecision III application
4. Three windows should be visible: Setup Tool, Strip Plot, Angle Plot
5. **Connect** (Setup Tool window)
6. **Start Polling** (Setup Tool window)
7. Move scale relative to sensor and observe position (degrees and raw counts) in Angle Plot
8. Rotate through 360° and ensure there are no faults or warnings

8.4 Aura Status

[Encoder Status] displays similar status (Position, Error, Warning) to Angle Plot with the addition of:

- Chip ID - an identifier useful when recording a CSV file
- Eccentricity - measured eccentricity (10 µm resolution) after Eccentricity Calibration

See chart below for Error/Warning descriptions and corrective action.

4 **https://go.celeramotion.com/SmartPrecisionIII**

Error/Warning	Description	Solution
Warning	Not Ready	Wait until startup complete
Warning	Under-Temperature	Check ambient temperature
Warning	Over-Temperature	Check ambient temperature
Error	No Scale	Install on scale and verify in alignment tolerance
Error	Detector Saturated	Eliminate strong ambient light
Error	Low Voltage	Increase supply voltage, check current rating
Error	Initialization Timeout	Faulty unit, return to factory
Error	EEPROM Failure	Faulty unit, return to factory

8.5 SmartPrecision lll Settings

[Settings]

- Set communication port
- Define windows launched at startup
- Window Launch Now functions
- Set Angle Plot persistence (default 2000). To see the effect of lower persistence (say 100): close Angle Plot, set to 200, launch Angle Plot
- Reset defaults for parameters, startup display and window sizes

8.6 Configuration

[Configuration]

At startup Smart Precision lll reads the the Aura configuration. Four parameters can be changed:

- **Scale ID** - From the factory, Aura is configured for a specific scale. The configured chip has a specific part number. It is possible to use a different scale by reconfiguring the Scale ID. The Scale ID can be found on the Scale Drawing. Note that changing the Scale ID effectively changes the chip part number. *Reconfiguring the Scale ID must be approved by Celera Motion. **Failure to do so will void the warranty.***
- **Resolution** - The resolution can be reduced to shorten latency if the configured resolution is higher than required. Note that Position Noise is specified as <1 LSB at the preconfigured resolution. If the resolution is increased to 22 bits (x4), the Position Noise would be < 4th LSB at that resolution.
- **Counts per Revolution** - The resolution of the ABZ incremental output can be changed up to a maximum of the programmed resolution. Note that a "count" is defined as a transition on A or B.
- **BiSS/SSI Communications** - Aura is preconfigured for BiSS communication. SmartPrecision lll communicates with Aura via BiSS. If Aura is reconfigured to SSI, the chip will remain in BiSS mode until power is cycled.

Stop Polling (if polling is active) to access the following Configuration function buttons:

Read Encoder - read Aura chip configuration

Save File - save configuration as .acf file

Load File - load previously saved configuration file

Write Encoder - store configuration in Aura EEPROM

8.7 Set Position to Zero

To define the current position as zero absolute position:

1. **Stop Polling** (if polling is active)
2. **Zero Position**

Note that the Angle Plot indicator is set to the 3 o'clock position.

8.8 Record Data in CSV File

8.8.1 Configure CSV File Content

[CSV Fields]

To select a field for CSV recording:

1. Click field in Available Fields
2. **>>Add**

To deselect a field:

1. Click field in Selected Fields
2. **<<Remove**

The selected fields will be placed in columns in the CSV file in the order seen in Selected Fields. To change the order click a field then **Move Up** or **Move Down**.

The number of samples taken can be defined in Record Count. The sampling rate is 60 Hz so a Record Count of 3600 would yield 1 minute of data sampling and recording. Note that setting Record Count to zero will disable the CSV record buttons.

8.8.2 Create a CSV File and Record

1. **New CSV File**
2. Define file name, location, **Save**
3. **Record CSV** and observe Record Count
4. **Close CSV** File when count complete

Note that its is possible to pause the recording - **Pause CSV**. **Record CSV** will resume and another recording of Record Count length will be appended. Similarly another recording can be appended to a completed recording before the file is closed (repeat Step 3 above).

8.9 Strip Plot Configuration

[Strip Plot Fields]

To select a field for display:

1. Click field in Available Fields
2. **>>Add**

To remove a field from the plot:

1. Click field in Selected Fields
2. **<<Remove**

The strip plot has two Y-axes on the left/right sides of the plot. This makes it possible to assign fields with similar value ranges to a specific axis. For example, Sine (+1 to -1) and ErrorState (0 to 1) could be assigned to the left axis and AngleDegrees (0 to 360) assigned to the right axis. Check the field in Selected Fields to assign to the left axis. Note that that when a field is removed from Selected Fields, the axis assignment is retained.

To configure Y-axes:

1. **Set Y-axis Ranges**
2. Set min/max values
3. Set display interval
4. **OK**

9 Calibration

Calibration requires the scale to be rotated at a constant speed. 300 rpm is recommended to minimize the time of the calibration routine. Velocity variations can compromise eccentricity calibration accuracy. A slotless motor is recommended with a high resolution feedback device and high bandwidth servo. Bearings should be high quality with minimal runout.

9.1 Calibration - Incremental & Absolute Tracks

A code on the absolute track defines each scale period on the incremental track. Misalignment can compromise the accuracy of the absolute position reading. Calibration compensates for this potential error.

The incremental track generates sine and cosine signals which are subsequently interpolated. The fidelity of the signals is critical to encoder accuracy. Ideal signals are: undistorted, equal in magnitude or gain, without DC offset, 90° shifted in phase. The geometry of the encoder yields signals of low distortion. Misalignment and small internal circuit variances can cause gain imbalances (**G**), offsets (**O**) and phase (**P**) errors. The GOP calibration procedure compensates for these effects, improving encoder accuracy.

1. **Stop Polling** (if polling active)
2. Rotate scale at 300 rpm
3. **Calibrate**
4. **Yes**

9.2 Calibration - Eccentricity

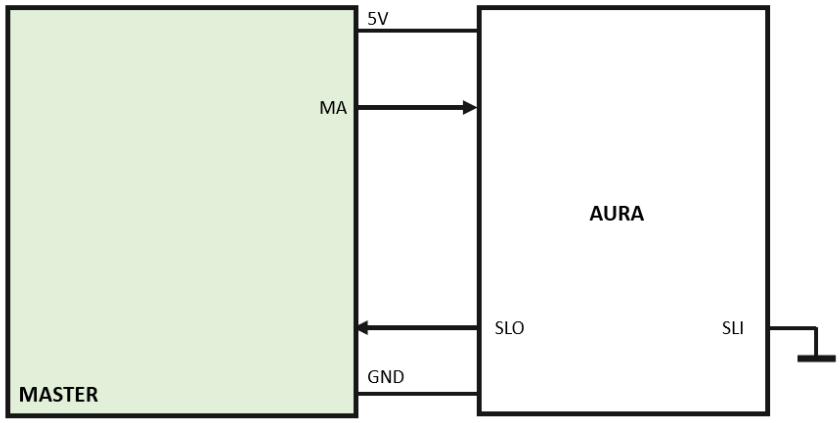
Scale mounting eccentricity and bearing runout are typically the most significant contributors to overall accuracy. The effects of scale eccentricity and repeatable bearing runout can be significantly reduced by eccentricity calibration. The procedure is an optional final calibration step. The entire procedure is repeated here for convenience.

1. **Stop Polling** (if polling active)
2. Rotate scale at 300 rpm
3. **Calibrate**
4. **Yes**
5. **Yes**

10 Communications

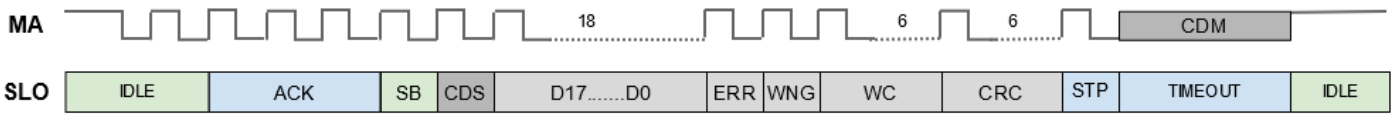
10.1 BiSS-C

10.1.1 Single Slave Operation



Aura employs a bidirectional implementation of BiSS. BiSS can incorporate a channel embedded in the operational frame for control, configuration and status. This method is initiated by the state of the master clock (CDM - Control Data Master) at the end of a data frame. The response (CDS - Control Data Slave) is embedded in subsequent frames one bit per frame. This technique is used for Aura configuration but not in operational mode.

The protocol sequence is outlined below. Note that CDS and CDM are included for completeness.

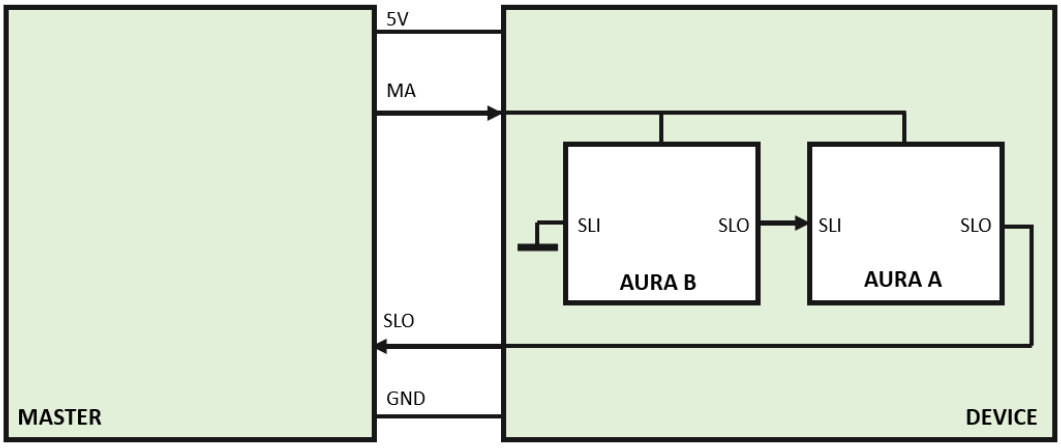


Note: green=1, blue=0, grey=0/1

1. Master initiates communication, clock active
2. ACK Acknowledge [0] - slave responds on second rising clock edge, begins to compile data
3. SB Start [1] - slave is ready to transmit data after three clocks
4. CDS Control Data Slave - one bit of data packet transferred over multiple cycles in response to CDM
5. Data - 18 bits
6. ERR Error [0 if error]
7. WNG Warning [0 if warning]
8. WC Working Counter- initialized to 0, counts each frame from 1 to 63 skipping the 0 when wrapping
9. CDC Cyclic Redundancy Check - 6 bits
10. STP Stop [0] + Timeout [0]
11. During Stop and Timeout, Master can transmit CDM (Control Data Master) by bringing MA high or low - note the slave interprets the clock state as a single control/data bit
12. MA & SLO [1] - idle, slave ready

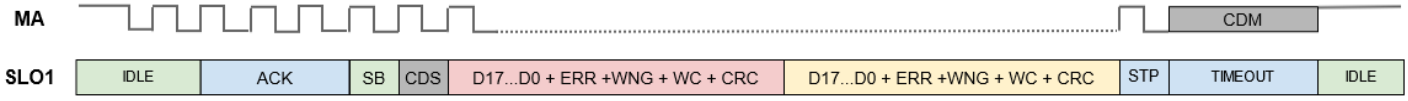
When interfacing to an Ingenia drive, set the following parameters in MotionLab3. Note that the frame size does not include ACK, Start, CDS, Stop.
Protocol: BiSS-C
Frame type: RAW
Frame size: 32
Position bits: 18
Single turn bits: 18
Position start: 14

10.1.2 Daisy-Chained Slave Operation



Up to eight (8) slaves can be connected in a daisy-chained configuration. Data is captured at exactly the same time on each slave. The first slave, Aura A, clocks out its data packet first while buffering the data packet from Aura B. Aura A then clocks out the buffered packet from Aura B. Note that the last slave, Aura B, must have its SLI input tied to zero.

Aura configuration is performed in single-slave mode for each slave. The slaves can then be connected in a daisy-chain. The protocol sequence is outlined below. Note that CDS and CDM are included for completeness.

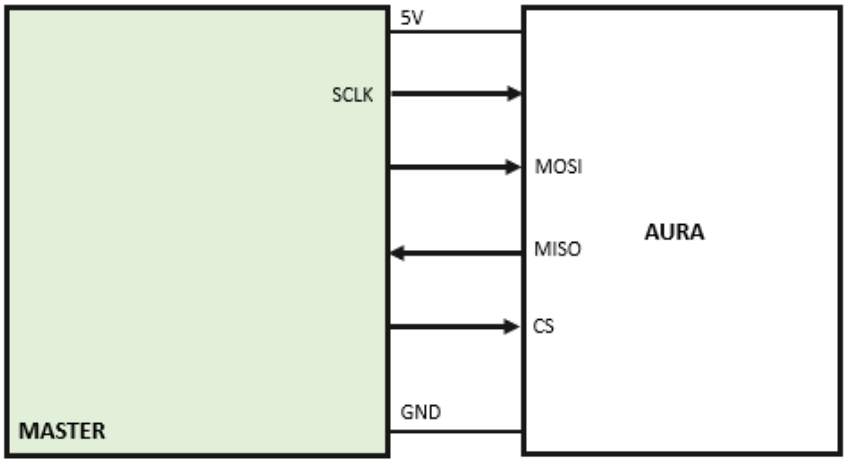


Note: green=1, blue=0, grey=0/1, pink=data packet Aura A, yellow=data packet Aura B

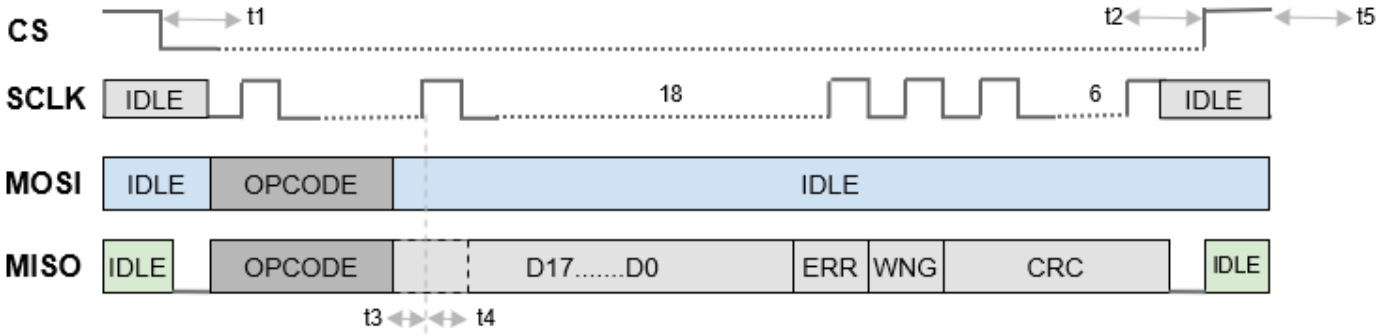
1. Master initiates communication, clock active
2. ACK Acknowledge [0] - Aura A responds on the second rising edge of MA clock. Aura A and B are latched simultaneously
3. SB Start [1] - Aura A is ready to transmit data after three clocks
4. CDS Control Data Slave - one bit of data packet from the addressed slave transferred over multiple cycles
5. Data A - 18 bits
6. ERR Error A [0 if error]
7. WNG Warning A [0 if warning]
8. WC Working Counter A- initialized to 0, counts each frame from 1 to 63 skipping the 0 when wrapping
9. CDC Cyclic Redundancy Check A - 6 bits

10. Data B - 18 bits
11. ERR Error B [0 if error]
12. WNG Warning B [0 if warning]
13. WC Working Counter B- initialized to 0, counts each frame from 1 to 63 skipping the 0 when wrapping
14. CDC Cyclic Redundancy Check B - 6 bits
15. STP Stop [0] + Timeout [0]
16. During Stop and Timeout, Master can transmit CDM (Control Data Master) by bringing MA high or low - note the slave interprets the clock state as a single control/data bit
17. MA & SLO A - idle, slave ready

10.2 SPI



- One operating mode - Read Position
- Clock Mode idle state defined by Master: Mode 0 - normally low, Mode 3 - normally high
- MISO should be pulled up or down (pullup assumed in timing diagram)



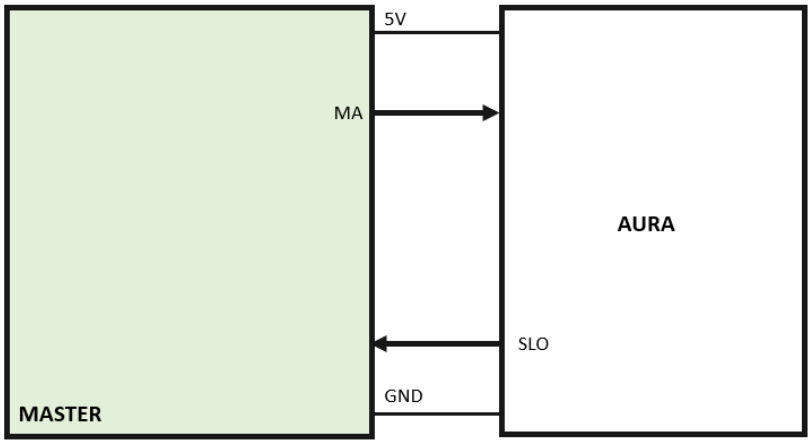
Note: green=1, blue=0, grey=0/1

1. Master initiates communication - CS active low
2. Master sends Opcode (0xA6) via MOSI which slave echoes on MISO
3. Data - 18 bits
4. ERR Error [0 if error]
5. WNG Warning [0 if warning]
6. CDC Cyclic Redundancy Check - 6 bits

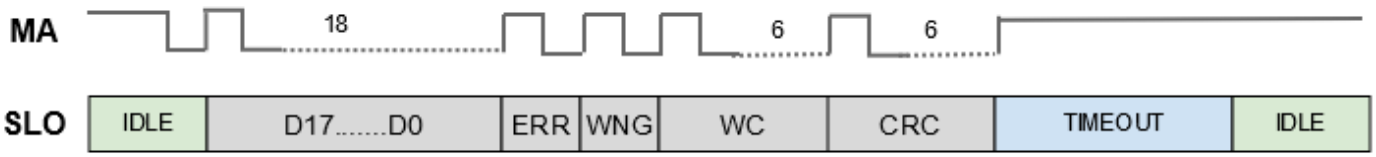
7. Master terminates communication - CS inactive high

Parameter	Description	Min Value
t1	CS low to MA clock rising edge setup time	42 nsec
t2	Last MA clock rising edge to CS high hold time	42 nsec
t3	Data setup time	15 nsec
t4	Data hold time	5 nsec
t5	Dwell time between cycles	200 nsec

10.3 SSI



- Unidirectional - position data only, no register access
- Pure binary data
- Fixed timeout



Note: green=1, blue=0, grey=0/1

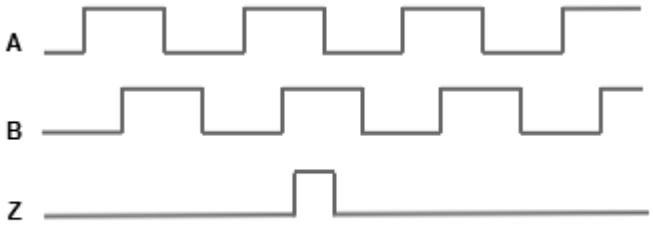
1. Master initiates communication, clock active
2. Data - 18 bits
3. ERR Error [0 if error]

4. WNG Warning [0 if warning]
5. WC Working Counter- initialized to 0, counts each frame from 1 to 63 skipping the 0 when wrapping
6. CDC Cyclic Redundancy Check - 6 bits
7. MA [1], SLO [0] fixed timeout (16 - 24 µsec)
8. SLO [1] - idle, slave ready

When interfacing to an Ingenia drive, set the following parameters in MotionLab 3.
Protocol: SSI
Frame type: RAW
Frame size: 32
Position bits: 18
Single turn bits: 18
Position start: 14

10.4 ABZ Incremental

- AB = 11, Z = 0 during startup, until position found
- Index active at zero absolute position, A and B both high
- Zero AB hysteresis after a change in direction



11 Ordering Information

NOTE: The Aura chip is configured for a specific scale. Be sure to specify the correct chip/scale pair.

11.1 Aura Chip

Part Number	Use With Scale Size
AUR-R-B-0002-WP	18 mm
AUR-R-B-0003-WP	33 mm

11.2 Rotary Glass Scale

Part Number	Inner Diameter	Outer Diameter	Use With Chip
AUR-R-G-0002	7.0 mm	18.0 mm	AUR-R-B-0002-WP
AUR-R-G-0003	21.0 mm	33.0 mm	AUR-R-B-0003-WP

NOTE: Consult your sales representative for Evaluation Board availability