Interface Control Document – Electrical
Reaction Wheel with 4 V Power
Sinclair Interplanetary
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1. Scope

This document describes the electrical interface for the Sinclair Interplanetary reaction wheels with 4 V nominal power bus. For it to be relevant to your reaction wheels, your part number must be:

RW-x.xx-4-ASYNC-x-1-x

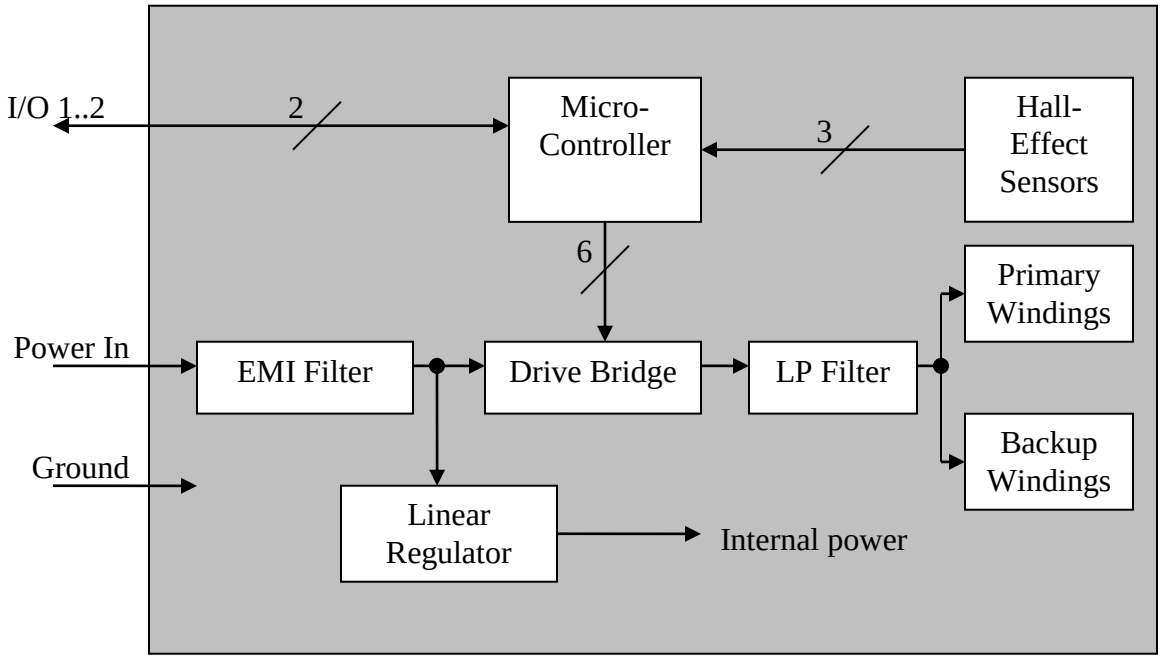
Or

RW-x.xx-4-I2C-x-1-x

For additional interface definitions see:

- The mechanical ICD for your particular size of wheel
- The NSP packet protocol
- The software ICD for your particular software load

2. Block Diagram



3. Principle of Operation

The motor is a three-phase brushless design with redundant windings. Unregulated spacecraft power passes through the front-end EMI filter and into the drive bridge. Here it is chopped by a 350 kHz PWM waveform. The LP (low pass) filter smoothes the PWM, leaving only the DC drive components that pass on to the motor. Backup windings are wired in parallel with the primary.

Three Hall-effect sensors detect the position of the rotor magnets. This data is processed by a microcontroller where it is used for commutation and for speed estimation. The microcontroller controls the three current-mode half-bridges allowing it to set the motor torque.

Two I/O signals from the microcontroller are carried on the electrical connector. The command and telemetry interface is implemented using these signals. The details of this interface depend on which onboard software load the customer has requested.

4. Connector

The connector is a Harwin Datamate M80-8420442. This is a 4-pin single row plug with retention latches.

Mating Connector Part Number	Comments
M80-8450445 (Digikey 952-1184-ND)	Receptacle connector takes wires 24-28 AWG. Special crimp tooling required.
M80-8400401	Through-hole connector with SnPb termination, suitable for flex circuit.

Care must be taken when demating the connector as the retention latches are delicate. If they are treated well they will positively retain a mating connector without any need for staking.

If customer access to crimp tooling is problematic, Sinclair Interplanetary can pre-terminate wires or prepare harnesses on a special order basis.

5. Connector Saver

Reaction wheels are provided with connector savers to protect the flight connectors from unnecessary mate/demate cycles during testing. These savers are fabricated from short lengths of Teflon wire and Harwin Datamate crimp plug and socket connectors. The connector saver should be removed prior to final integration with the spacecraft.

6. Pinout

The connector has the following pin assignments:

Pin	Type	Signal
1	Digital I/O	IO/2
2	Power	Power In
3	Digital I/O	I/O1

4	Power	Ground

7. Grounding

The default factory option is RF multipoint grounding, whereby the chassis is connected to the internal electronics ground via 4 x 10 nF capacitors (50 V rated), and one 1 MΩ resistor. Upon request, wheels can be furnished with complete isolation between chassis and electronics. Alternatively, wheels can be supplied with low-impedance DC connection between chassis and electronics.

8. Signals

8.1. Ground

Ground is the reference used for all other signals.

8.2. Power In

Absolute Maximum Voltage	0 to +7.0 V (see note)
Operating Voltage	+3.5 V to +6.0 V
Fault Protection	6 V TVS

The Power In signal provides power to the all of the wheel circuits. It is intended to be compliant with busses that are regulated from either a single cell Li-ion battery or two triple-junction GaAs solar cells.

A transient voltage suppressor (TVS) is included for fault protection. This part is rated for a standoff voltage of 6 V, and at this voltage it does not impact the circuit. At 6.67 V it may begin to conduct up to 10 mA. At a maximum voltage of 10.3 V it conducts a clamping current of 58.3 A. It will also conduct if a negative voltage is applied to the Power In signal.

High (or negative) voltages must not be applied for long durations from low impedance sources or the TVS will overheat and become damaged. It is intended to absorb capacitive discharges, load dumps, and other short-lived phenomena. A power of 600 W may be applied for no longer than 1 msec.

8.3. I/O[1..2]

Absolute Maximum Voltage	-0.5 to 5.5 V
Input Low Voltage	0.9 V max
Input High Voltage	2.1 V min
Output Low Voltage	0.7 V max, 3 mA external load
Output High Voltage	2.3 V min, 3 mA external load
Pull-up	120 kΩ nominal to +3.0V
ESD Protection	5.6 V Zener
Power-off impedance	High

The use of the I/O signals is dependent on the software running in the wheel. They may be configured as digital inputs or open-drain or push-pull outputs.

I/O1 and I/O2 may be driven above the internal +3.0 V rail, though they must always respect the absolute maximum limits.

9. Connections

The connections made to the I/O pins depend on the communication option specified in the part number:

Part Number	Communications
RW-x.xx-4-ASYNC-x-x-x	Asynch Serial with NSP
RW-x.xx-4-I2C-x-x-x	I2C with NSP

Signals are assigned to I/O pins as follows:

Signal	ASYNC	I2C
I/O1	Transmit	SDA
I/O2	Receive	SCL

Using the Asynch Serial and I2C options a number of devices may share a common data bus, and each requires a unique address to identify it. However, the small 4-pin connector does not allow any additional signals for addressing. Instead, each wheel has an NSP address programmed into it in the factory. The user must take care not to put two wheels with the same NSP address on the same bus.

The asynchronous option configures the UART in the following way. Note that the wheel's master oscillator is not crystal driven and so there can be some variation in actual baud rates.

Data Bits per Byte	8
Parity	None
Stop Bits	1
Nominal Baud Rate	57600 bps
Actual Output Rate	56338 bps to 58685 bps
Permissible Input Rate	56000 bps to 59000 bps

Using the I2C option, connections SDA and SCL are open-drain digital lines. The internal pull-up device will be turned on for each line, but this pull-up is weak. It is recommended that the user install an additional pull-up resistor to ensure fast transitions.