

Figure 1. DID with 8-channel ADC mezzanine

Introduction

The Digital Input Device (“DID”) is a remote input device that is used to send data to the Overdrive Control Computer (“CC”). The DID can also communicate with the Overdrive Embedded computer on its CAN bus. DIDs can read in both analog and digital signals and connect to the CC by either RS232 serial or via CAN bus, utilizing CANopen protocol. Only one DID at a time may connect on a RS232 serial port, but many DIDs may connect at once on a CAN bus, provided there is adequate bandwidth.

DIDs have the capability of providing eight 16-bit bipolar analog inputs (+/-5V, +/-10V), sixteen 5V TTL/CMOS digital inputs, up to 8 single-ended 12-bit analog inputs (3.3V), and two single-ended quadrature encoder inputs. In special cases DIDs may be configured to read serial input from a third party device and pass that stream on to Overdrive.

The DID is shown in Fig 1, it uses a Freescale/NXP 56F8355 Digital Signal Controller.

~ The DID is static sensitive and may be damaged if its pins are touched without taking static dissipation safety precautions. ~

Dimensions: (per image above)

length (horizontal): 3.06in (77.72mm)

width (vertical): 1.31in (33.27mm)

maximum height (with ADC mezzanine): 0.50in (12.7mm)

Logic Power

Supply power for the DID can be in the range 4.3V to 16V. The device logic uses a maximum of 820 mW :

at 12V : 68 mA

9 V : 83 mA

7.2V : 97 mA

4.8V : 135 mA

This is the power into the DID's on-board DC-DC converter. The converter becomes less efficient (wastes Watts) as the input voltage gets higher.

At least 4.3V is needed by the DC-DC converter. This facilitates battery-powered applications.

Wiring

The DID logic wiring uses Molex SL contacts and crimps. Molex Part numbers are on the pin diagram at the end of this document.

CAN Bus

The DID is typically used as an input device on a CAN bus and it supports a subset of CANopen protocol, similar to CiA 406 for encoders. Multiple communications bitrates are supported via the configuration tools. Because the DID does not generate significant EMI/RFI noise, its CAN transceiver is non-isolated thus it does not have a CAN GND pin. Do not connect the CAN master 'CAN GND' to the digital GND of the DID.

ID and Flashing

Serial ID flashing

Unique IDs (between 1 and 127) must be set for multiple DIDs to connect to Overdrive on a common CAN bus.

Configuration via a serial port: Turn off all other DIDs and connect just one at a time to the CC serial port when flashing an ID.

Plug the DID into a Control Computer (“CC”) serial port and turn it on. Once a connection is established

- Select Type: “Serial DID” in the drop-down menu of the EC page
- Highlight the green connected DID
- Click the “Configure Device” button
- Click the “Assign EC ID” button

Depending on how long it takes for the DID to flash itself, it may generate communications warnings, or it may lose connection with the CC altogether. This is harmless.

To confirm that the ID assignment succeeded, turn the DID off, turn it back on, the red LED will blink the ID every 2 seconds. If it is not possible to view the LEDs, let the device connect to the CC again, click the “Assign EC ID” button to see what the new ID is, then Cancel.

DID's with IDs greater than 1 will take longer to connect to the CC on a serial port when first turned on; they also attempt to connect less frequently (this may be seen by looking at a transmitting optical fiber). This staggered connect timing helps multiple units to connect to a single CC.

CAN bus ID flashing

Shut down all other DIDs and connect just one at a time to the Control Station CAN port when performing flashing operations.

Use the “EC” section of the Overdrive Control Panel to set the ID, where a “ChipEC” settings or “ChipEC Advanced” settings menus allow setting of communications bitrate, and other settings of a DID via the CAN bus.

Note: A number marked on capacitors on the top of the DID board is a manufacturing serial number (not the ID of the device).

LEDs

The Green LED flashes at $\frac{1}{2}$ the communications rate. It signifies that the DID is communicating with something on either the serial or the CAN bus.

The Red LED blinks to indicate the device ID. It blinks like a grandfather clock: one blink means an ID of one, two blinks means an ID of two, etc. A pause of 2 seconds takes place after the unit blinks its ID. This is the ID that was flashed into the DID.

A Yellow LED is either an error indication, or, the completion of a flashing operation. It should not be illuminated under normal operating conditions.

The Blue LED flashes at $\frac{1}{2}$ the communications frequency of the peripheral serial bus, if the DID is configured to use the peripheral serial bus.

Digital Input

The DID rev1A and 1B have two sets of eight Digital Input pads labeled “DIN 1-8” and “DO 1-8”, for a total of 16 digital inputs, which are 3.3V CMOS logic but are designed to be tolerant of 5V TTL/CMOS signals.

Digital inputs are pulled high by internal pull-up resistors, so if left unconnected each bit will read a value of logical “1”. Connecting a DIN pad to PWR-COMMON asserts a logical “0”. The DID continuously sends the state of the digital inputs to the CC each Mocon frame, via telemetry packets.

Quadrature

The DID has two quadrature ports for incremental encoder input. These are normally single-ended TTL/CMOS signals, but support input voltage levels up to 15 volts. Contact tech support for details on enabling these ports.

When configured as a 'DIDCoder', the DID acts as a circuit board which counts incremental quadrature encoder pulses and sends values to a CAN master.

By default, the DID sends two TPDOs, 0x180+ID and 0x280+ID, as in the example below where node ID = 1.

```
0x181 [2] FF FF
0x281 [8] AA AA AA AA BB BB BB BB
```

0x180+ID contains the 16 Digital Inputs. Sending of this TPDO can be disabled, see 'Configuration via SDO' below.

0x280+ID contains the encoder count value. The first 4 bytes (bytes 0 - 3) are the value of encoder 1 (highlighted blue above), bytes 4-7 the value of encoder 2 (highlighted green above).

Sending of the second encoder value can be disabled.

When an index pulse is triggered, the corresponding encoder value will be reset to the preset value.

Configuration via SDO

Preset value for encoder 1	0x601 [8] 2E 10 60 01 XX XX XX XX
Index	0x6010
Sub-Index	1
Data Type	Integer32 (bytes 4-7)

(Above: node ID=1, SDO is 8 bytes, Preset value is "XX XX XX XX".)

Preset value for encoder 2	0x601 [8] 2E 10 60 02 XX XX XX XX
Index	0x6010
Sub-Index	2
Data Type	Integer32 (bytes 4-7)

Repeat NMT boot message	0x601 [5] 2F 11 60 00 XX
Index	0x6011
Sub-Index	0
Data Type	Integer8 (byte 4) 0x00 = single boot message 0x01 = repeat boot messages

Digital Input TPDO	0x601 [5] 2F 11 60 01 XX
Index	0x6011
Sub-Index	1
Data Type	Integer8 (byte 4) 0x00 = do not send TPDO 0x01 = send TPDO

Encoder TPDO	0x601 [5] 2F 11 60 02 XX
Index	0x6011
Sub-Index	2
Data Type	Integer8 (byte 4) 0x00 = send only encoder value 1 0x01 = send both encoder values 1 and 2

Index pulse	0x601 [5] 2F 11 60 03 XX
Index	0x6011
Sub-Index	3
Data Type	Integer8 (byte 4) 0x00 = ignore Index pulse 0x01 = use index pulse to reset encoder value

Index pulse polarity	0x601 [5] 2F 11 60 04 XX
Index	0x6011
Sub-Index	4
Data Type	Integer8 (byte 4) 0x00 = trigger on rising edge 0x01 = trigger on falling edge

Inputs and Telemetry

A DID performs “Telemetry”, transmitting remote measurement to the CC. DID channels can be sourced on the Overdrive Telemetry Channel page, one channel per “Telemetry Device”.

CAN bus DID Telemetry Device mapping

Telem Device	“Bit Width”	TD “Channel”	Function	Type
first	8	1	Dig Input Port	Position
second	8	2	Dig Input Port	Position
third	16	5	1st Analog	Position
fourth	16	6	2nd Analog	Position
fifth	16	7	3rd Analog	Position
sixth	16	8	4th Analog	Position
seventh	16	9	5th Analog	Position
eighth	16	10	6th Analog	Position
nineth	16	11	7th Analog	Position
tenth	16	12	8th Analog	Position
Quad 1 (option)	32	7	Encoder	Position
Quad 2 (option)	32	8	Encoder	Position

Table 1

The chart above shows how to configure telemetry patch-bays to receive two 8-bit digital input words and eight 16-bit analog inputs, which is the most common DID configuration. In this example, the sixteen digital bits arrive as two 8-bit words on the first two TD channels. If desired, one-bit values could be chosen in the patchbay to extract bits out of the first two words. Quadrature inputs are disabled by default but can be available via an alternative configuration - contact tech support.

High-resolution Analog Inputs

With a “MADC-16” mezzanine, the DID is capable of reading eight 16bit analog inputs. These are configurable in firmware for input ranges: 0-5V, +/-5V, 0-10V, +/-10V.

There is a 5VDC, 120mA Analog Reference output power source available on the MADC-16 mezzanine. This can be used for potentiometer excitation voltage. It is indicated as “REF OUT” on pads “G”, “+5” seen in Figure 2.

There are pads on the mezzanine for an external 12V supply. This power source is normally bridged to the Chip-EC logic power, but may alternatively be supplied externally by removing the wiring on the underside of the MADC-16 mezzanine, supplied during manufacturing. Use a linearly regulated supply

(not switching) for best analog signal integrity.

The MADC-16 mezzanine has on-board RC low-pass filters available for signal conditioning. By default the (2.2uf) capacitors are removed such that filters are not operative. Note that there are 100 ohm resistors in series with input signals by default, remove those if it is desirable to replace them with zero-ohm links.

Digital Inputs

There are two sets of 8 Digital Input channels, “DI1” through “DI8” and “DO1” through “DO8”. Access to these digital ports is typically 8-bit wide such that an integer between 0-255 representing one port will appear in the Telemetry Channel. Bit-wise operators are available in the Math plugin language to facilitate bit checking or extraction (See “Math Mixer User Help” document).

Low-resolution Analog Inputs

There are eight 12-bit Analog Input channels on the DID, as seen in the circuit board pictures below, though only four are available in certain modes. Power for transducers to be read by these analog inputs may come from the the analog supply provided on this connector: “3.3V”, “AGND”. Do not allow voltages higher than 3.75V into these 12 bit analog inputs or they may be damaged. Note that these 12 bit signals will be noisier than the 16 bit analogs and would require filtering, resulting in lag and even lower effective resolution. These channels are not enabled by default when there is a “MADC-16” analog input mezzanine on the board, unless the device is configured as “DID MADC w/ lowres”.

Serial DID Telemetry Device Mapping

Channel	Bit width	Type	PCB pad Name
1	32	Position	Digital “DO” port
2	32	Position	Digital “DIN” port
9	32	Position	Analog A1
10	32	Position	Analog A2
11	32	Position	Analog A3
12	32	Position	Analog A4
13	32	Position	Analog A5
14	32	Position	Analog A6
15	32	Position	Analog A7
16	32	Position	Analog A8

Table 2

When a DID is connected on a serial port, the Telemetry Device channels are as in the chart above. Note: normally a DID is connected via a CAN bus.

Two-ADC DID Telemetry Device Mapping

This configuration is for a DID is configured to utilize only its low resolution 12-bit ADC and the (16-bit) MADC mezzanine at once. Overdrive Telemetry Channel mapping information is provided below. Contact tech support for further Overdrive Telemetry Channel mapping assistance.

TC Channel	Bit width	Type	PCB pad Name
1	16	Position	Mezz AIN 1 16-bit
2	16	Position	Mezz AIN 2 16-bit
3	16	Position	Mezz AIN 3 16-bit
4	16	Position	Mezz AIN 4 16-bit
5	16	Position	Mezz AIN 5 16-bit
6	16	Position	Mezz AIN 6 16-bit
7	16	Position	Mezz AIN 7 16-bit
8	16	Position	Mezz AIN 8 16-bit
9	16	Position	Analog A1 12-bit
10	16	Position	Analog A2 12-bit
11	16	Position	Analog A3 12-bit
12	16	Position	Analog A4 12-bit
13	16	Position	Analog A5 12-bit
14	16	Position	Analog A6 12-bit
15	16	Position	Analog A7 12-bit
16	16	Position	Analog A8 12-bit

Table 3

DID MADC w/ Low-res Channels

When configured as DID MADC w/ Low-res, the device utilizes 16x digital Inputs, eight 16-bit analog inputs on the mezzanine, and for low-resolution 12-bit analog inputs. Overdrive Telemetry Channel mapping information is provided below. Contact tech support for further Overdrive Telemetry Channel mapping assistance.

TC Channel	Bit width	Type	PCB pad Name
1	8	Position	Digital "DO" port
2	8	Position	Digital "DIN" port
5	16	Position	Mezz AIN 1 16-bit
6	16	Position	Mezz AIN 2 16-bit
7	16	Position	Mezz AIN 3 16-bit
8	16	Position	Mezz AIN 4 16-bit
9	16	Position	Mezz AIN 5 16-bit
10	16	Position	Mezz AIN 6 16-bit
11	16	Position	Mezz AIN 7 16-bit
12	16	Position	Mezz AIN 8 16-bit
13	16	Position	Analog A1 12-bit
14	16	Position	Analog A2 12-bit
15	16	Position	Analog A3 12-bit
16	16	Position	Analog A4 12-bit

Table 4

CAN DID Telemetry Device Mapping

When connected to Overdrive as a CAN DID, the data can be accessed in different ways in the Telemetry Device patchbay. It can be accessed as twenty-four 8-bit channels, as six 32-bit channels, as twelve 16-bit channels, or even as 192 1-bit channels. Optionally, two additional 32-bit quadrature encoder channels are available (contact technical support to enable quadrature encoders).

DID Pin	Bits	32-bit channel	16-bit channel	8-bit channel	1-bit channel	
DI1	1	1	1	1	1	
DI2	1				2	
DI3	1				3	
DI4	1				4	
DI5	1				5	
DI6	1				6	
DI7	1				7	
DI8	1				8	
DO1	1			2	2	9
DO2	1					10
DO3	1					11
DO4	1					12
DO5	1					13
DO6	1					14
DO7	1					15
DO8	1					16
unused	16		2	3-4	17-32	
unused	32	2	3-4	5-8	33-64	
A1	16	3	5	9-10	65-80	
A2	16		6	11-12	81-96	
A3	16	4	7	13-14	97-112	
A4	16		8	15-16	113-128	
A5	16	5	9	17-18	129-144	
A6	16		10	19-20	145-160	
A7	16	6	11	21-22	161-176	
A8	16		12	23-24	177-192	
Quad 1	32	7	13-14	25-28	193-224	
Quad 2	32	8	15-16	29-32	225-256	

Table 5: The telemetry of the CAN DID

Table 4 - The telemetry of the CAN DID

Note: "DO" pins are actually inputs when the device is configured this way.

Note: The Analog Channels A1 to A8 contain 16-bit values.

Note: "channel" above refers to the field on the Telemetry Device Tab (not a Telemetry Channel).

The entries in red font above are the typical way to access the different inputs. The telemetry patch bay allows any word or bit to be extracted from the DID data individually, though the data above can also be accessed byte-wise, then parsed in the Math Mixer with bitwise operators.

Examples (patched in the Telemetry Device Tab of the GUI)

1. To access DO2, set Bits: to "1 bit" and Channel: to "10"
2. To access A1, set Bits: to "16 bit" and Channel: to "5"
3. To access DO as an 8-bit data, set Bits: to "8 bit" and Channel: to "2"
4. To access quadrature encoder 1 as a 32-bit channel, set Bits: to "32 bit", and Channel: to "7"

Advanced: Low-level CAN Mapping

	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
PDO1	Digital DO port	Digital DIN port	unused					
PDO2	Analog A1		Analog A2		Analog A3		Analog A4	
PDO3	Analog A5		Analog A6		Analog A7		Analog A8	
PDO4	Lowres Ain1		Lowres Ain2		Lowres Ain3		Lowres Ain4	

Table 6

The chart above shows CANopen PDO mapping of the data coming from the DID to the CAN master. See Telemetry Channel How-to for more details on alternate ways to configure the Telemetry Channel page.

J1939 CAN support

The J1939 protocol is an extension of the MADC-DID configuration. With J1939 mode enabled, the DID will transmit CAN packets that follow the SAE J1939 automotive standard, which uses 29-bit identifiers (as opposed to CANOpen 11-bit identifiers). With this implementation, no CANopen 'SYNC' is required, since the DID will transmit cyclically to the CAN Bus at a specified transmission rate. The maximum CAN Transmission rate for the device is 1 kHz.

J1939 PGNs used by the DID:

PGN1: 0x18FF0100 + CAN Node ID

PGN2: 0x18FF0200 + CAN Node ID

Advanced: Low-level CAN Mapping for J1939 Transmission

	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
PGN1	Analog A1		Analog A2		Analog A3		Analog A4	
PGN2	Analog A5		Analog A6		Analog A7		Analog A8	

Table 7

Note: J1939 mode allows only high-resolution analog inputs over the CAN Bus. The transmission does not contain Digital Inputs or low-resolution 12-bit analog inputs. Contact Tech Support for variations or further info.

Note: If the CAN transmission rate is set high, such as 1 kHz, the number of ADC over-samples must be reduced accordingly, as since there is a limited amount of the time before the next CAN packet transmission. Contact Tech Support for further info.

Serial Mezzanine

The Serial mezzanine (SXMezz) adds a peripheral serial port to the DID.

This port can be configured for RS-232, RS-422, or RS-485 with on-board solder jumpers. See Table 6.

It also features termination jumpers for differential signals (RS-422/RS-485), shown in table 7.

Desired interface	Jumpers				
	J2	J3	J4	J5	J6
RS-232	✓				
RS-422/RS-485 half duplex		✓		✓	✓
RS-422/RS-485 full duplex		✓	✓		

Table 8

Termination	JR	JT
	120Ω between RL and RH	✓
120Ω between TL and TH		✓

Table 9

Serial Bandwidth Utilization

A CAN DID will use different amounts of communications bandwidth depending on the configuration of the device and how many channels of data it is transmitting. The Mocon framerate determines how much time there is for CAN traffic. Below are typical Mocon framerates and their frame-periods:

<u>Mocon Frame Rate</u>	<u>Frame Period (available transmission time)</u>
60 Hz	16.66 msec
120 Hz	8.33 msec
125 Hz	8.0 msec
200 Hz	5.0 msec

DID configurations and Transmission Time (at 500KHz CAN bitrate)

Eight 16bit analogs, 16 Dig Ins :	1.00 msec
Eight 16bit analogs, 8 Dig Ins, eight 12 bit analogs:	1.50 msec
Eight 16bit analogs, 8 Dig Ins, four 2 bit analogs:	1.25 msec
Eight 16bit analogs, 16 Dig Ins, eight 12bit analogs:	1.50 msec

Whereas the Control Station's CAN bus is normally not busy, an EC's CAN bus may be full of servo drive traffic and thus a DID on that bus may compete for bandwidth. Since EC configuration will vary according to user preference, it may be necessary to put an oscilloscope on the CAN bus to determine actual bandwidth utilization.

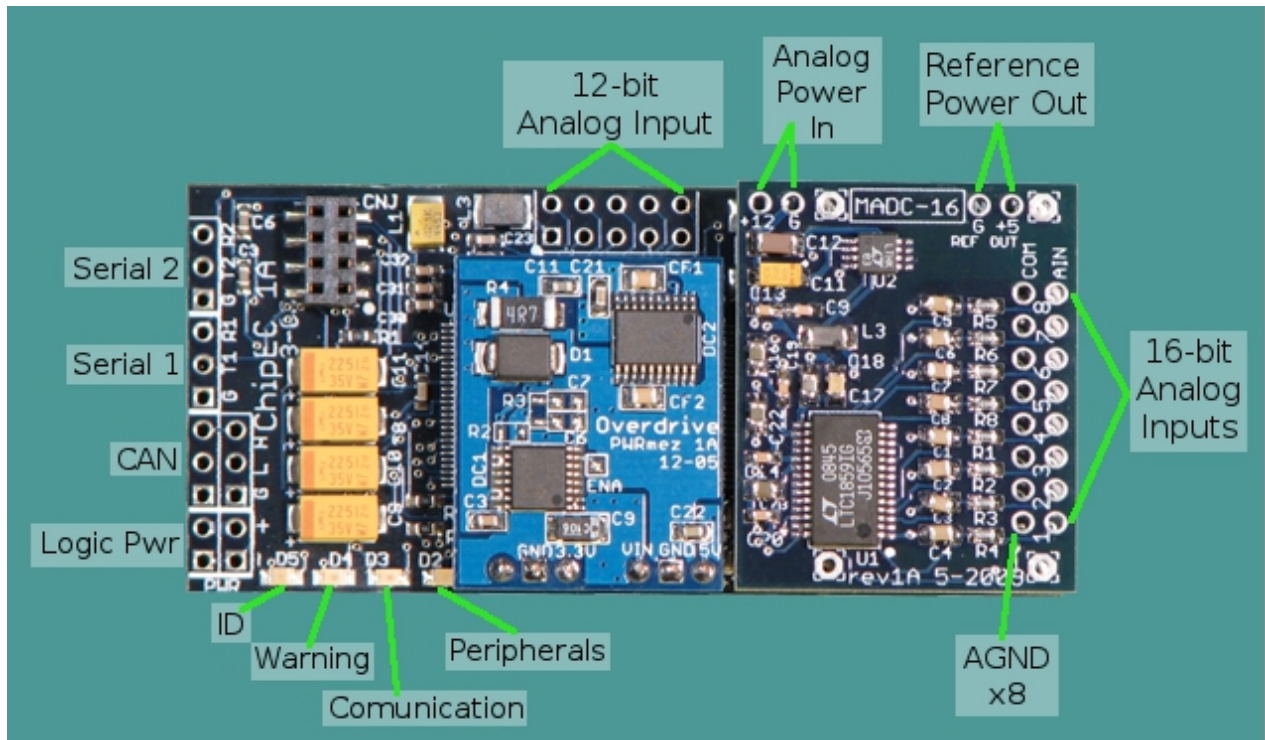


Figure 2. DID Pad & Connector Identification with MADC-16 Mezzanine

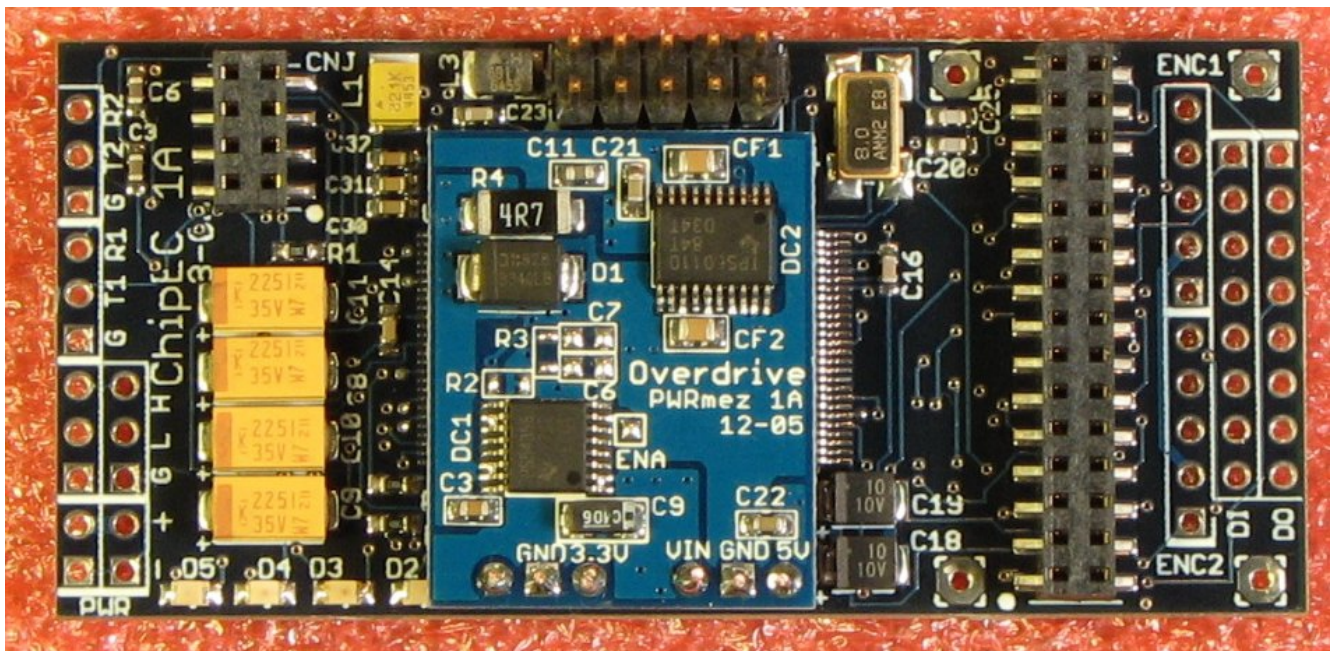


Figure 3. DID without Mezzanine Showing digital input pads and encoder pads

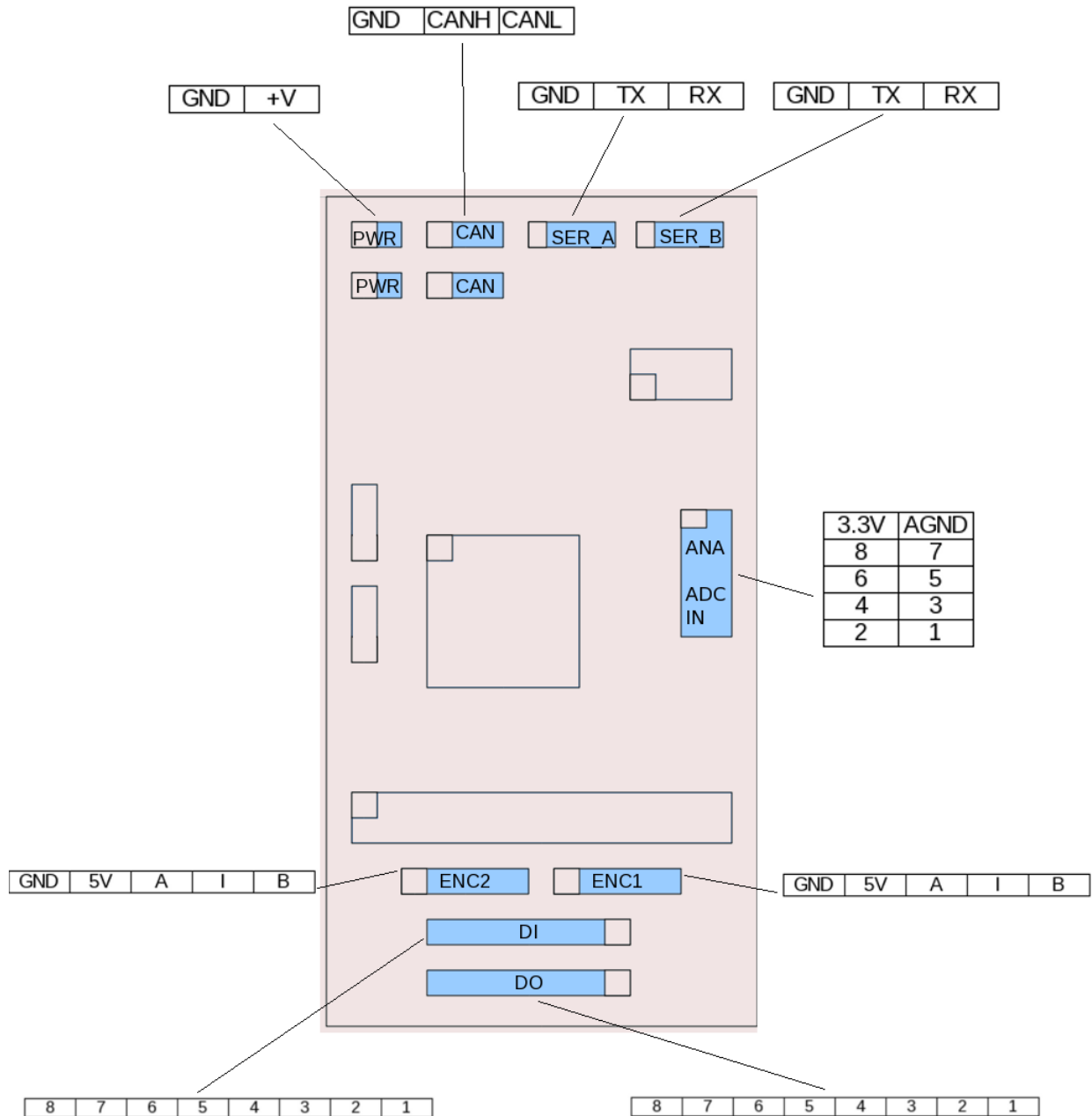
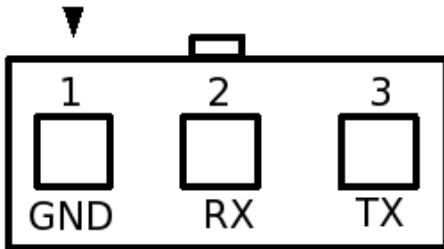


Figure 4. DID Port Pinouts
 (analog input ports are on MADC-16 mezzanine, seen in Figure 2)

~ These wired connector pin-outs are common to DID and Chip-EC devices ~

Chip-EC Pinout - rev 3 8/2005



Color Code

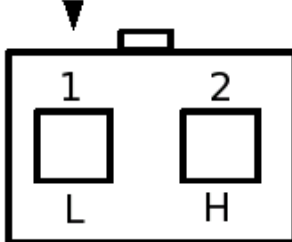
Gnd	Black
+7 to 12V	Yellow
Signal	White

Serial

Female - Front View

Female molex connector #50-57-9403
(mates with male molex #70-107-0002)
contacts: molex # 16-02-1125

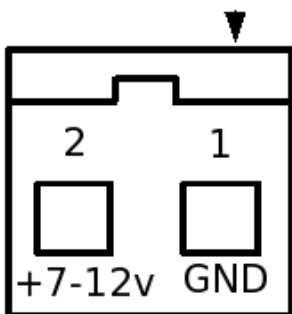
Note: Pin one indicated by arrow on top of connector



Inter-EC Bus

Female - Front View

Female molex connector #50-57-9402
(mates with male molex #70-107-0001)
contacts: molex # 16-02-1125



PWR

Male pins - Front View

Male molex connector #70-107-0001
(mates with female molex #50-57-9402)
contacts: molex 16-02-0115

Contact technical support at for further support or information

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