Transputer Link DAC Card   # User Guide

Transputer Link DAC
version 1.1 (Jun-1994)
Made in Australia
by Dave Keenan,
Smalltalk Computing

Link Speed Jumper (J11)

20 Mbit/s Link speed
(standard setting)

10 Mbit/s Link speed
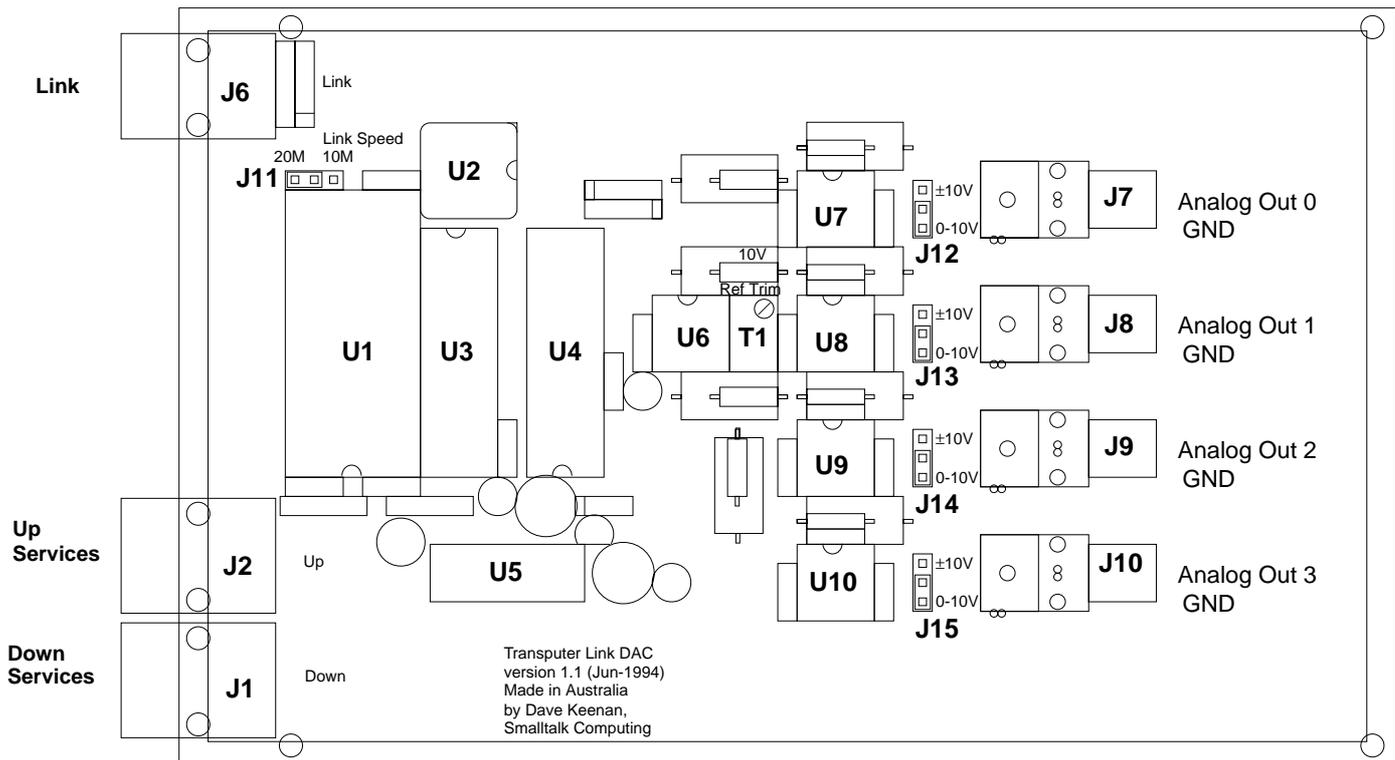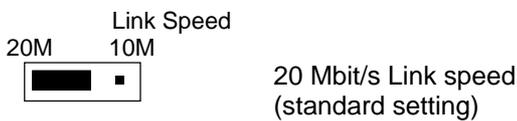
Output Range Jumpers (J12, J13, J14, J15)

Bipolar output range
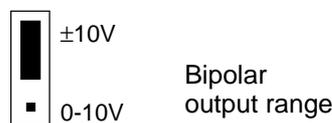
Digital input	Analog output
0	-10V
2048	0V
4095	9.995V

Unipolar output range (with greater accuracy)
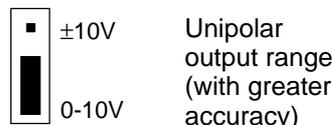
Digital input	Analog output
0	0V
2048	5V
4095	9.998V

Maximum Output Sample Rate

The maximum output sample rate is 120k samples per second or 8µs per sample (on all 4 channels simultaneously). This corresponds to the maximum rate that data can be received when the Transputer Link is set to the highest speed of 20Mbit/s.

Maximum Load on Analog Outputs

An output which is set to **Bipolar** can source or sink a maximum of **10mA** and therefore can drive a load of **1k**Ω minimum impedance .

An output which is set to Unipolar can only source a maximum of **2mA** and therefore can drive a load of **5k**Ω minimum impedance.

The circuit can be modified to allow unipolar outputs also to drive down to a 1kΩ load at the expense of accuracy (contact Smalltalk Computing).

Resolution and Accuracy

Each output has a resolution of 12 bits or 4096 counts. With the reference set to 10.00V this corresponds to approximately 2.441mV per count for unipolar outputs or 4.883mV per count for bipolar outputs.

The output function is guaranteed monotonic with a maximum nonlinearity of ±1 count.

The maximum total error is ±3 counts for unipolar outputs and ±7 counts for bipolar outputs. Greater accuracy is available if required (contact Smalltalk Computing).

These accuracy figures assume that the reference voltage is correctly calibrated. See right.

Calibration (T1)

There is a single adjustment to calibrate the reference voltage for all outputs in both unipolar and bipolar modes. Its range includes 10.00V and 10.24V. The standard setting is 10.00V. 10.24V is useful for ease of generating exact decimal voltages (2.5mV per count unipolar or 5mV per count bipolar). This adjustment can be made using a small screwdriver in the 25-turn trimmer (T1) in the middle of the card.

Calibration is performed with all channels set to the maximum count (4095), outputs set to the desired mode(s) (unipolar or bipolar), and an accurate meter connected in turn to each output to be used. Adjust the trimmer to minimise the error over all outputs. Note that the maximum output voltage is 4095/4096 of the reference voltage in unipolar mode or 4094/4096 in bipolar mode, as follows.

Reference Voltage	Output for max. count (4095)	
	unipolar	bipolar
10.00	9.9976	9.9951
10.24	10.2375	10.2350

For bipolar outputs you may, if you wish, set the count to zero and adjust for the negative of the desired reference voltage, -10.00V or -10.24V, instead.

Link Cables

6 wide 4 conductor modular plug

4 wire modular cable

Maximum length 3m@20Mb/s
6m@10Mb/s

Note the plug orientations

Link   **J6**

+5V
Link In
GND
GND
Link Out
+5V
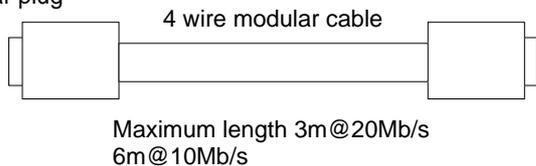
Only these four wires are used in standard Link cables
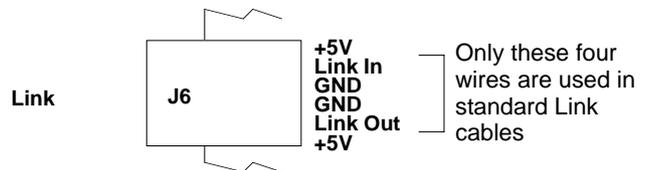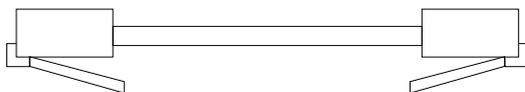
Additional hardware may be available for transmitting links over larger distances. Contact Smalltalk Computing.

Services Cables

8 wide 8 conductor modular plug

Two lengths of 4 wire modular cable

Maximum length for power 300mm
Maximum length for other signals 12m

Note the plug orientations

Up or Down Services   **J1, J2**

+5V
+5V
GND
GND
GND
notError
notReset
notAnalyse
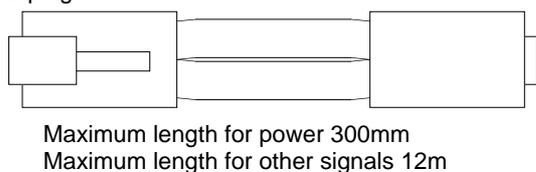
Services cables use two sets of four wires
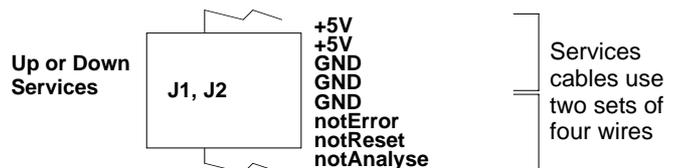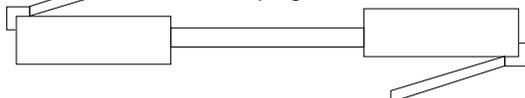
Alternative services cable

Power only

Control only
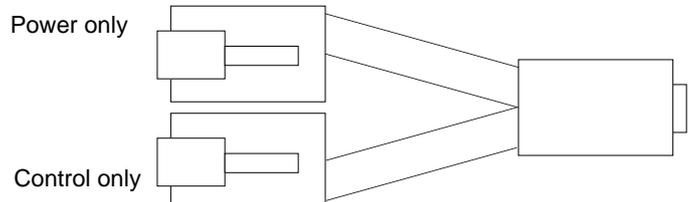
How to Control the DAC Card from a Transputer

Hardware Setup

Ensure that both the transputer card and the serial card are set to communicate at the same link speed (usually 20Mbit/s). Refer to the transputer card user guide for the correct setting of its Link Speeds. See above for the correct setting of the DAC card's Link Speed jumper (J11).

Choose which analog outputs will be bipolar and which unipolar (J12-J15).

Run a services cable from Down Services of the transputer card to the Up Services socket on the DAC card (the services socket second from the card edge). Of course services do not need to come directly from the transputer card. They may be daisy-chained thru other devices first.

Run a link cable from a spare Link of the transputer card to the Link socket on the DAC card.

Connect the Analog output screw terminals (or optional RCA audio sockets) to the analog inputs of the device to be driven. Check the impedance of these inputs to ensure that no bipolar output will be driving less than 1kΩ and no unipolar output will be driving less than 5kΩ.

It may be useful to connect a voltmeter, CRO or audio monitor to the analog outputs for testing.

As standard, the voltage reference is calibrated to 10.00V. It can be adjusted to 10.24V. See above for calibration information.

Communication Protocol

The hardware must be set up correctly as described in the previous section.

The analog outputs are undefined on power up but usually correspond to a zero count. Analog outputs are not affected by system resets, they retain any previous value.

After a system reset, the DAC card is ready to receive the least significant byte for Channel 0 on its link input. Any process attempting to *read* from the DAC card at this stage will block.

The standard mode of operation simply requires 8 bytes to be written to the link in the following order.

Chan. 0 Least significant byte
Chan. 0 Most significant byte (4 most sig. bits ignored)
Chan. 1 Least significant byte
Chan. 1 Most significant byte (4 most sig. bits ignored)
Chan. 2 Least significant byte
Chan. 2 Most significant byte (4 most sig. bits ignored)
Chan. 3 Least significant byte
Chan. 3 Most significant byte (4 most sig. bits ignored)

When the 8th byte is received, all of the outputs are updated simultaneously and the DAC card is again ready to receive the least significant byte for Channel 0.

The alternative mode of operation is only of use if the maximum sample rate is required when link communication is slow, and all four channels are not required.

We must still send the bytes in the same order, beginning with Channel 0 LSB, but we need not send all 8 bytes. When we have sent the bytes we want , we *read* a byte from the DAC card. This causes the outputs to be updated and the DAC card is again ready to receive the least significant byte for Channel 0.

For example, to change only channels 0 and 1 we can write 4 bytes and then read one. To change only channel 0 we can write 2 bytes then read one. To change only the least significant byte of channel 0 we can write one byte then read one.

To be able to read a byte without blocking, at least one byte must have been written since the last byte was read (and since a reset). The value of the byte returned will usually be of no interest, however it will be the same as the last byte written and so may be used to perform a loopback test to confirm correct link operation.

For waveform generation you would normally use a timer-wait between each group of bytes, to obtain the desired output sample rate. For the greatest timing accuracy at high sample rates you may need to specifically time the sending of the 8th byte (or the *read* if fewer than 8 bytes) since it is this which causes the outputs to update.