



RT Box ControlCard Interface

User Manual February 2024

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RT Box ControlCard Interface

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Introduction

The PLECS RT Box is a powerful real-time simulator based on a Xilinx Zynq system on a chip (SOC). With its digital and analog I/O signals, the RT Box is well-equipped for hardware-in-the-loop (HIL) testing as well as rapid control prototyping (RCP).

If employed for HIL testing, the RT Box typically emulates the power stage of a power electronic system. The power stage could be a simple DC/DC converter, an AC drive system or a complex multi-level inverter system. The device under test (DUT) is the control hardware connected to the RT Box. In such a setup, the complete controller can be tested without the real power stage.

To simplify the connection of external hardware and to provide convenient access to the RT Box inputs and outputs, Plexim offers a set of RT Box accessories.

The **RT Box ControlCard Interface** described in this document has two controlCARD slots which facilitate a simple connection of the RT Box with the 100-pin and 180-pin controlCARD modules from Texas Instruments (TI). It enables users to test control algorithms implemented on TI C2000 MCUs without developing their own interface hardware. The pinout of the ControlCard Interface board has been optimized for the following development kits:

- HSEC180 based controlCARDS (28003x, 28004x, 2837x, 2838x, 28002x, 280013x, 28P65x)
- DIMM100 based controlCARDS (2806x, 2833x)

The ControlCard Interface can also be used with other controlCARD boards not listed above, provided that the board physically aligns and connects with the header pins. Users will need to create their own pin assignment table, similar to the ones shown in Section 3.

Interface Board Overview

The interface board provides a 100-pin socket for the older 100-pin control-CARDS, as well as a 180-pin socket for the newer modules. Fig. 2.1 shows the top view of the ControlCard interface board.

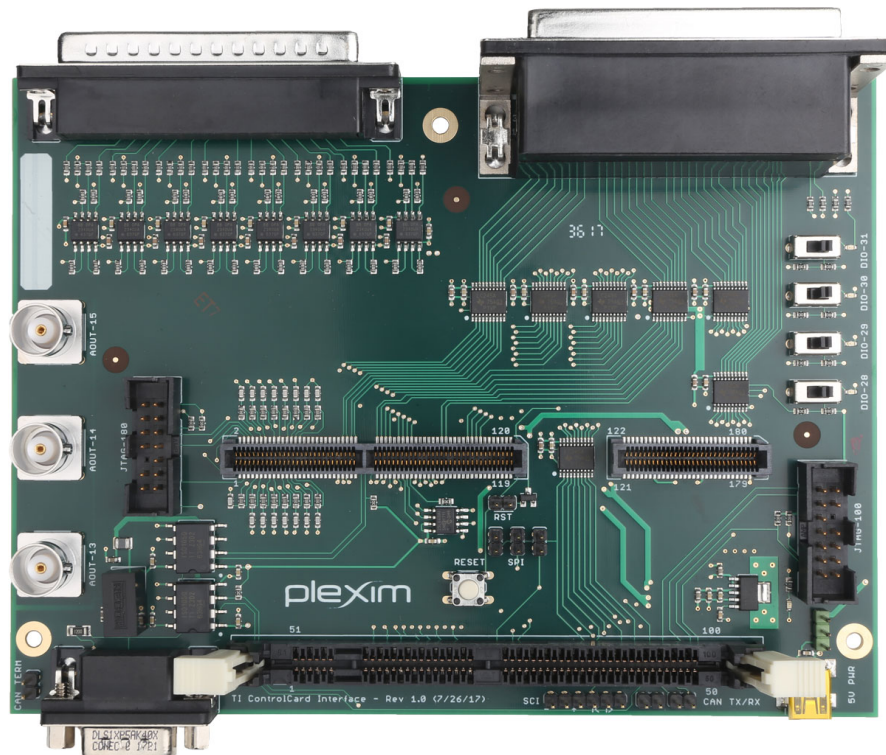


Figure 2.1: RT Box ControlCard Interface Board

Fig. 2.2 shows the top view of the board with a F28388D controlCARD attached.

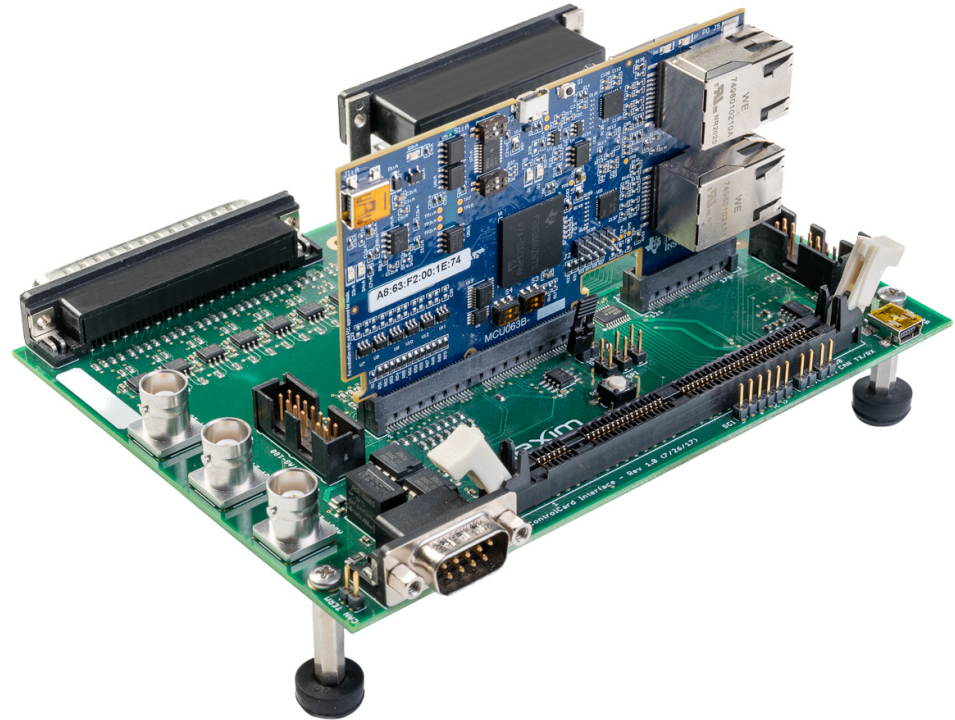


Figure 2.2: RT Box ControlCard Interface with F28388D controlCARD

All output signals from the RT Box are buffered to prevent overvoltage and ensure the safety of the MCU. Local opamps are used to offer a low-impedance source for the MCU's ADC inputs. To facilitate status communication with the RT Box, the board incorporates four sliding switches and four LEDs labeled DIO-28–31. The board provides BNC connectors to access three RT Box analog outputs, specifically AOUT-13–15.

The MCUs can be connected to external JTAG adapters via two 14-pin headers labeled JTAG-100 and JTAG-180. Additionally, each controlCARD is connected to an isolated CAN driver, enabling communication between the controlCARDS and external equipment. The board is also equipped with a 64 kbit Serial Electrically Erasable PROM that can be used for user-specific purposes.

For compatibility with older 100-pin controlCARDS that lack a serial interface, there is a 6-pin unshrouded connector labeled SCI for FTDI cable communication.

ControlCard Socket Pins

The pin assignments in Tables 2.1 and 2.2 display either the RT Box signals, or the controlCARD interface header connections/ functions (CC header) for the 100-pin and 180-pin controlCARD sockets. NC denotes no connection.

A more detailed table, including the available processor functions at each pin for the supported controlCARDS, can be found in the Appendix.

Onboard Voltage Supply

The ControlCard interface board can be powered in two ways, by selecting the appropriate jumper terminals on the bottom right corner of the board:

- To supply power directly from the RT Box, position the jumper onto the terminals towards the JTAG-100 connector.
- Or connect an external power source to the USB connector labeled 5V PWR and position the jumper onto the terminals towards the USB connector. This allows the board to be used without the RT Box.

The interface board contains a linear voltage regulator that steps down the externally supplied or RT Box-supplied 5 V to 3.3 V required by the controlCARD. A green LED on the lower right section of the board indicates power supply to the board.

RT Box	100-pin		RT Box
NC	1	51	NC
NC	2	52	NC
NC	3	53	NC
NC	4	54	NC
NC	5	55	NC
NC	6	56	NC
AO-14	7	57	AO-15
GND	8	58	GND
AO-12	9	59	AO-13
GND	10	60	GND
AO-10	11	61	AO-11
GND	12	62	GND
AO-8	13	63	AO-9
GND	14	64	GND
AO-6	15	65	AO-7
NC	16	66	NC
AO-4	17	67	AO-5
NC	18	68	NC
AO-2	19	69	AO-3
NC	20	70	NC
AO-0	21	71	AO-1
NC	22	72	NC
DI-17	23	73	DI-16
DI-19	24	74	DI-18
DI-21	25	75	DI-20

RT Box / CC header	100-pin		RT Box / CC header
DI-23	26	76	DI-22
GND	27	77	+5 V
DI-25	28	78	DI-24
DI-27	29	79	DI-26
DI-29	30	80	DI-28
NC	31	81	NC
NC	32	82	+5 V
NC	33	83	DO 0
NC	34	84	DO-5
DO-6	35	85	DO-7
DO-4	36	86	NC
GND	37	87	+5 V
NC	38	88	NC
NC	39	89	NC
DO-2	40	90	DO-3
NC	41	91	DO-1
NC	42	92	+5 V
SCI_RX (Tab. 2.7)	43	93	SCI_TX
CAN_RX (Tab. 2.4)	44	94	CAN_TX
DI-31	45	95	DI-30
NC	46	96	+5 V
GND	47	97	JTAG_TDI
JTAG_TCK (Tab. 2.5)	48	98	JTAG_TDO
JTAG_TMS	49	99	JTAG_TRST
JTAG_EMU1	50	100	JTAG_EMU0

Table 2.1: 100-pin controlCARD socket

RT Box / CC header	180-pin		RT Box / CC header
JTAG_EMU1 (Tab. 2.6)	1	2	JTAG_EMU0
JTAG_TMS	3	4	JTAG_TRST
JTAG_TCK	5	6	JTAG_TDO
GND	7	8	JTAG_TDI
AO-15	9	10	GND
AO-13	11	12	AO-14
NC	13	14	AO-12
AO-11	15	16	NC
AO-9	17	18	AO-10
GND	19	20	AO-8
AO-7	21	22	GND
AO-5	23	24	AO-6
AO-3	25	26	AO-4
AO-1	27	28	AO-2
NC	29	30	AO-0
NC	31...34		NC
GND	35	36	NC
NC	37	38	GND
NC	39...44		NC
NC	45	46	GND
GND	47	48	+5 V
DI-0	49	50	DI-4
DI-1	51	52	DI-5
DI-2	53	54	DI-6
DI-3	55	56	DI-7
DI-8	57	58	DI-12
DI-9	59	60	DI-13
DI-10	61	62	DO-11
DI-11	63	64	DO-12

RT Box / CC header	180-pin		RT Box / CC header
GND	65	66	NC
SPI_SIMO (Tab. 2.8)	67	68	DO-13
SPI_SOMI	69	70	DO-14
SPI_CLK	71	72	DO-27
SPI_STE	73	74	DO-26
DO-25	75	76	NC
DO-24	77	78	NC
DO-23	79	80	CAN_RX (Tab. 2.3)
DO-22	81	82	CAN_TX
GND	83	84	+5 V
NC	85	86	NC
NC	87	88	DI-14
DO-21	89	90	DI-15
DO-20	91	92	NC
NC	93...96		NC
GND	97	98	+5 V
NC	99	100	DO-19
NC	101	102	DO-18
NC	103	104	DO-17
NC	105	106	DO-16
NC	107...110		NC
GND	111	112	+5 V
NC	113...118		NC
NC	119	120	RESET (DO-15)
NC	121...134		NC
GND	135	136	NC
NC	137...156		NC
GND	157	158	+5 V
NC	159...178		NC
GND	179	180	+5 V

Table 2.2: 180-pin controlCARD socket

Analog Output

All 16 analog outputs from the RT Box are routed to both the 100-pin and 180-pin controlCARD slots. It is possible to operate two cards simultaneously, although the user must be aware that the sampling of one MCU could affect the measurements of the other. If both control card slots are populated, the analog signals must be shared by the controlCARDS. Three analog output channels (AOUT-13–15) are also accessible at the BNC connectors.

All 16 analog output signals are passed through a rail-to-rail CMOS operational amplifier signal conditioning circuit, as shown in Figure 2.3. This circuit scales the voltages to 0 V and 3.3 V and protects the inputs of the MCU from damage due to over-voltage. It introduces a gain of 4.42/6.8 (or 0.65) between the analog output pins of the RT Box and the analog input pins of the controlCARD.

In addition, each analog channel routed to the 180-pin controlCARD socket is buffered with a 2200 pF capacitor connected to ground. This configuration lowers the source impedance of the channel, allowing the sample and hold capacitor of the MCU to charge quickly. A small resistance of 56 Ω is also included in series to stabilize the driving opamp circuit.

The 100-pin controlCARD socket is excluded from this step and receives analog output signals directly after signal conditioning. This is because the resistors and capacitors used in the buffering circuit are already populated on the 100-pin controlCARDS.

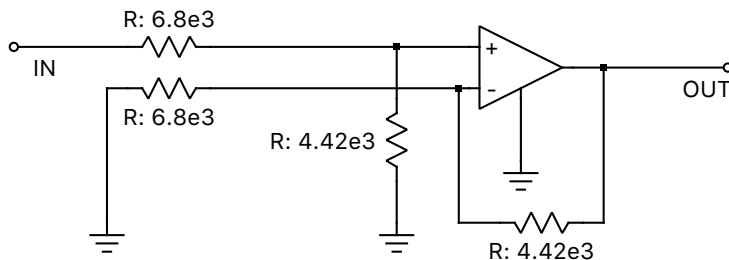


Figure 2.3: Analog output signal conditioning circuit

Digital I/O

Digital inputs DI-0–15 from the RT Box are connected to the 180-pin controlCARD socket, while DI-16–31 are connected to the 100-pin controlCARD socket.

Additionally, the four sliding switches labeled DIO-28–31 on the board allow the configuration of digital inputs DI-28–31.

For digital outputs, DO-0–7 are connected to the 100-pin controlCARD socket, while DO-11–14 and DO-16–27 are connected to the 180-pin controlCARD socket. The four LEDs labeled DIO-28–31 in the upper right section of the board correspond to DO-28–31.

To safeguard the MCU inputs from voltages exceeding 3.3 V, all digital input and output signals pass through bus transceivers.

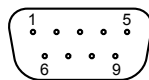
DO-15 is specifically connected to the MCU reset pin of the 180-pin controlCARD via the RST jumper. When the jumper is set, a low-level output at DO-15 will reset the MCU. It is advised not to set this jumper unless you intend to utilize this functionality. Alternatively, the MCU can be reset using the push button labeled RESET.

CAN Communication

CAN communication is facilitated by two electrically isolated CAN transceivers, which are accessible via a 9-pin DSUB connector located in the bottom left corner of the board. This enables communication between the controlCARDS when they are populated together, as well as with external equipment.

Table 2.3 provides the pin assignments of the 9-pin DSUB connector in relation to the 100-pin and 180-pin controlCARD boards.

CAN Connector



9-pin male DSUB (front view)

Note The CAN_LO and CAN_HI signals on pins 2 and 7, respectively, of the 9-pin DSUB connector can be terminated with a 120 Ω resistor by using the jumper labeled CAN TERM, located in the bottom left corner of the board.

In addition, there are two CAN TX/RX jumpers positioned on the bottom right of the board. These jumpers allow for connecting the CAN TX/RX signals of the 100-pin controlCARD to the digital I/O of the RT Box, as shown in Table 2.4.

100-pin	CAN signal		9-pin DSUB	CAN signal		180-pin
		NC	1	NC		
94	TX	CAN_LO	2	CAN_LO	TX	82
		GND	3	GND		
		NC	4	NC		
		NC	5	NC		
		GND	6	GND		
44	RX	CAN_HI	7	CAN_HI	RX	80
		NC	8	NC		
		NC	9	NC		

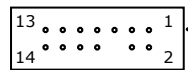
Table 2.3: CAN pin assignment

CAN TX/RX jumper location	Function	100-pin	RT Box
Left	CAN_TX	94	DO-0
Right	CAN_RX	44	DI-29

Table 2.4: CAN TX/RX jumpers

JTAG Headers

JTAG Connector



14-pin male header (front view)

Table 2.5 provides the pin assignments of the JTAG header labeled JTAG-100 for the 100-pin controlCARD, while Table 2.6 outlines the pin assignments of the JTAG header labeled JTAG-180 for the 180-pin controlCARD.

100-pin	Function	JTAG-100		Function	100-pin
49	TMS	1	2	$\overline{\text{TRST}}$	99
97	TDI	3	4	GND	
	+3.3 V	5	6	NC	
98	TDO	7	8	GND	
48	TCK	9	10	GND	
		11	12	GND	
100	EMU0	13	14	EMU1	50

Table 2.5: JTAG-100 pin assignment

180-pin	Function	JTAG-180		Function	180-pin
3	TMS	1	2	$\overline{\text{TRST}}$	4
8	TDI	3	4	GND	
	+3.3 V	5	6	NC	
6	TDO	7	8	GND	
5	TCK	9	10	GND	
		11	12	GND	
2	EMU0	13	14	EMU1	1

Table 2.6: JTAG-180 pin assignment

SCI Communication

Table 2.7 lists the pin assignments of the 6-pin unshrouded connector labeled SCI, for communication with the older 100-pin control cards.

SCI	Function	100-pin
1	GND -	
2	NC	
3	VCC +	
4	TX <	43
5	RX >	93
6	NC	

Table 2.7: SCI pin assignment

SPI Communication

There are three jumpers on the board, labeled SPI, that enable the connection between the SPI signals of the 180-pin controlCARD and the digital I/O of the RT Box, as shown in Table 2.8.

SPI jumper location	Function	180-pin	RT Box
Left	SPI_SOMI	69	DO-7
Middle	SPI_CLK	71	DI-16
Right	SPI_SIMO	67	DI-17

Table 2.8: SPI jumpers

In addition, the SPI signals of the 180-pin controlCARD are also connected to a 64 kbit Serial Electrically Erasable PROM on the board, that can be used for user-specific purposes.

Connectors

The following table contains the part numbers of the connectors used on the ControlCard interface board. For dimensions of the front panel of the RT Box, refer to the RT Box manual.

Manufacturer	Part Number	Function
Samtec	HSEC8-160-01-SM-DV-A	120-pin socket of 180-pin controlCARD
Samtec	HSEC8-130-01-SM-DV-A	60-pin socket of 180-pin controlCARD
TI	TMDSDIM100CON5PK	100-pin controlCARD socket
Conec	DLS1XP5AK40X	9-pin DSUB CAN connector
TE	5104338-2	14-pin JTAG connectors
3M	961106-6404-AR	6-pin SCI connector
3M	961102-6404-AR	2-pin jumpers (RST, SPI, CAN TX/RX, CAN TERM)
3M	961103-6404-AR	3-pin jumper switch for selecting 5V PWR
Radiall	R141426161	BNC connector to access analog outs 13-15
Assmann	A-DS 37 A/KG-T4S	37-pin DSUB to connect to RT Box Analog Out
Assmann	ASUB-277-37TP25	37-pin DSUB stacked to connect to RT Box Digital I/O

Table 2.9: Connectors on the ControlCard Interface

Appendix

The tables on the next pages provide more detailed information on the connectivity of the 180-pin and 100-pin controlCARD sockets. For each TI C2000 controlCARD, the RT Box I/O is shown beside the controlCARD socket pins and the processor peripherals available at those pins. Note that not all peripherals are listed. Refer to the datasheet of the MCU board for a complete list of available peripherals. NC denotes no connection.

TI F280039C controlCARD Pin Map

MCU Function	RT Box	180-pin		RT Box	MCU Function
JTAG (see Tab. 2.6)	NC	1 ... 8		NC	JTAG (see Tab. 2.6)
ADC-A0, B15, C15, DAC-A	AO-15	9	10	GND	
ADC-A1, B7, DAC-B	AO-13	11	12	AO-14	ADC-B3, VDAC
	NC	13	14	AO-12	ADC-B2, C6
ADC-A2, B6, C9	AO-11	15	16	NC	
ADC-A4, B8	AO-9	17	18	AO-10	ADC-B12, C2
	GND	19	20	AO-8	ADC-B4, C8
ADC-A5	AO-7	21	22	GND	
ADC-A6	AO-5	23	24	AO-6	ADC-B11
ADC-A10, B1, C10	AO-3	25	26	AO-4	ADC-B5
ADC-A11, B10, C0	AO-1	27	28	AO-2	ADC-C1
GND	NC	29	30	AO-0	ADC-A8
	NC	31 ... 48		NC	
PWM1A, GPIO-00	DI-0	49	50	DI-4	PWM3A, GPIO-04
PWM1B, GPIO-01	DI-1	51	52	DI-5	PWM3B, GPIO-05
PWM2A, GPIO-02	DI-2	53	54	DI-6	PWM4A, GPIO-06
PWM2B, GPIO-03	DI-3	55	56	DI-7	PWM4B, GPIO-07
PWM5A, GPIO-08	DI-8	57	58	DI-12	PWM7A, GPIO-12
PWM5B, GPIO-09	DI-9	59	60	DI-13	PWM7B, GPIO-13
PWM6A, GPIO-10	DI-10	61	62	DO-11	GPIO-14
PWM6B, GPIO-11	DI-11	63	64	DO-12	GPIO-15
	GND	65	66	NC	
SPIA_SIMO, GPIO-16	See Tab. 2.8	67	68	DO-13	QEP1A, GPIO-20

MCU Function	RT Box	180-pin		RT Box	MCU Function
SPIA_SOMI, GPIO-17		69	70	DO-14	QEP1B, GPIO-21
SPIA_CLK, GPIO-18	See Tab. 2.8	71	72	DO-27	QEP1S, GPIO-22
SPIA_STEn, GPIO-19	NC	73	74	DO-26	QEP1I, GPIO-23
SPIB_SIMO, GPIO-24	DO-25	75	76	NC	SCIA_RX, GPIO-28
SPIB_SOMI, GPIO-25	DO-24	77	78	NC	SCIA_TX, GPIO-29
SPIB_CLK, GPIO-26	DO-23	79	80	NC	CANRXA, GPIO-30 (see Tab. 2.3)
SPIB_STEn, GPIO-27	DO-22	81	82	NC	CANTXA, GPIO-31 (see Tab. 2.3)
	GND	83	84	+5 V	
	NC	85	86	NC	
	NC	87	88	DI-14	TDO, GPIO-37
GPIO-40	DO-21	89	90	DI-15	TDI, GPIO-35
GPIO-41	DO-20	91	92	NC	
	NC	93...96		NC	
	GND	97	98	+5 V	
	NC	99	100	DO-19	QEP2A, GPIO-54
	NC	101	102	DO-18	QEP2B, GPIO-55
	NC	103	104	DO-17	QEP2S, GPIO-56
	NC	105	106	DO-16	QEP2I, GPIO-57
	NC	107...118		NC	
VDDIO	NC	119	120	DO-15	XRSn
	NC	121...180		NC	

Table 3.1: TI F280039C controlCARD pin map

TI F280049C controlCARD Pin Map

MCU Function	RT Box	180-pin		RT Box	MCU Function
JTAG (see Tab. 2.6)	NC	1 ... 8		NC	JTAG (see Tab. 2.6)
ADC-A0, B15, C15, DAC-A	AO-15	9	10	GND	
ADC-A1, DAC-B	AO-13	11	12	AO-14	ADC-B0
	NC	13	14	AO-12	ADC-B1, A10, C10, PGA-7
ADC-A2, B6, PGA-1	AO-11	15	16	NC	
ADC-A3	AO-9	17	18	AO-10	ADC-B2, C6, PGA-3
	GND	19	20	AO-8	ADC-B3, VDAC
ADC-A4, B8, PGA-2	AO-7	21	22	GND	
ADC-A5	AO-5	23	24	AO-6	ADC-B4, C8, C3, PGA-4
ADC-A6, PGA-5	AO-3	25	26	AO-4	ADC-C0
ADC-A9	AO-1	27	28	AO-2	ADC-C1
	NC	29	30	AO-0	ADC-C2
	NC	31 ... 48		NC	
PWM1A, GPIO-00	DI-0	49	50	DI-4	PWM3A, GPIO-04
PWM1B, GPIO-01	DI-1	51	52	DI-5	PWM3B, GPIO-05
PWM2A, GPIO-02	DI-2	53	54	DI-6	PWM4A, GPIO-06
PWM2B, GPIO-03	DI-3	55	56	DI-7	PWM4B, GPIO-07
PWM7A, GPIO-12	DI-8	57	58	DI-12	PWM5A, GPIO-37
PWM7B, GPIO-13	DI-9	59	60	DI-13	PWM6A, GPIO-35
PWM8A, GPIO-14	DI-10	61	62	DO-11	GPIO-39
PWM8B, GPIO-15	DI-11	63	64	DO-12	GPIO-23
	GND	65	66	NC	
SPIA_SIMO, GPIO-16	See Tab. 2.8	67	68	DO-13	QEP1A, GPIO-40

MCU Function	RT Box	180-pin		RT Box	MCU Function
SPIA_SOMI, GPIO-17		69	70	DO-14	QEP1B, GPIO-57
SPIA_CLK, GPIO-09	See Tab. 2.8	71	72	DO-27	QEP1S, GPIO-22
SPIA_STEn, GPIO-11	NC	73	74	DO-26	QEP1I, GPIO-31
SPIB_SIMO, GPIO-24	DO-25	75	76	NC	SCIA_RX, GPIO-28
SPIB_SOMI, GPIO-25	DO-24	77	78	NC	SCIA_TX, GPIO-29
SPIB_CLK, GPIO-26	DO-23	79	80	NC	CANRXA, GPIO-30 (see Tab. 2.3)
SPIB_STEn, GPIO-27	DO-22	81	82	NC	CANTXA, GPIO-32 (see Tab. 2.3)
	GND	83	84	+5 V	
	NC	85	86	NC	
	NC	87	88	DI-14	NC
GPIO-18	DO-21	89	90	DI-15	NC
NC	DO-20	91	92	NC	
	NC	93...96		NC	
	GND	97	98	+5 V	+5 V
	NC	99	100	DO-19	QEP2A, GPIO-24
	NC	101	102	DO-18	QEP2B, GPIO-25
	NC	103	104	DO-17	NC
	NC	105	106	DO-16	NC
	NC	107...118		NC	
	NC	119	120	DO-15	XRSn
	NC	121...180		NC	

Table 3.2: TI F280049C controlCARD pin map

TI F28379D controlCARD Pin Map

MCU Function	RT Box	180-pin		RT Box	MCU Function
JTAG (see Tab. 2.6)	NC	1 ... 8		NC	JTAG (see Tab. 2.6)
ADC-A0, DAC-A	AO-15	9	10	GND	
ADC-A1, DAC-B	AO-13	11	12	AO-14	ADC-B0
	NC	13	14	AO-12	ADC-B1
ADC-A2	AO-11	15	16	NC	
ADC-A3	AO-9	17	18	AO-10	ADC-B2
	GND	19	20	AO-8	ADC-B3
ADC-A4	AO-7	21	22	GND	
ADC-A5	AO-5	23	24	AO-6	ADC-B4
ADCIN14	AO-3	25	26	AO-4	ADC-B5
ADCIN15	AO-1	27	28	AO-2	ADC-D0
	NC	29	30	AO-0	ADC-D1
	NC	31 ... 48		NC	
PWM1A, GPIO-00	DI-0	49	50	DI-4	PWM3A, GPIO-04
PWM1B, GPIO-01	DI-1	51	52	DI-5	PWM3B, GPIO-05
PWM2A, GPIO-02	DI-2	53	54	DI-6	PWM4A, GPIO-06
PWM2B, GPIO-03	DI-3	55	56	DI-7	PWM4B, GPIO-07
PWM5A, GPIO-08	DI-8	57	58	DI-12	PWM7A, GPIO-12
PWM5B, GPIO-09	DI-9	59	60	DI-13	PWM7B, GPIO-13
PWM6A, GPIO-10	DI-10	61	62	DO-11	GPIO-14
PWM6B, GPIO-11	DI-11	63	64	DO-12	GPIO-15
	GND	65	66	NC	
SPIA_SIMO, GPIO-16	See Tab. 2.8	67	68	DO-13	QEP1A, GPIO-20

MCU Function	RT Box	180-pin		RT Box	MCU Function
SPIA_SOMI, GPIO-17		69	70	DO-14	QEP1B, GPIO-21
SPIA_CLK, GPIO-18	See Tab. 2.8	71	72	DO-27	QEP1S, GPIO-22
SPIA_STEn, GPIO-19	NC	73	74	DO-26	QEP1I, GPIO-23
SPIB_SIMO, GPIO-24	DO-25	75	76	NC	SCIA_RX, GPIO-28
SPIB_SOMI, GPIO-25	DO-24	77	78	NC	SCIA_TX, GPIO-29
SPIB_CLK, GPIO-26	DO-23	79	80	NC	CANRXA, GPIO-30 (see Tab. 2.3)
SPIB_STEn, GPIO-27	DO-22	81	82	NC	CANTXA, GPIO-31 (see Tab. 2.3)
	GND	83	84	+5 V	+5 V
	NC	85	86	NC	
	NC	87	88	DI-14	GPIO-39
GPIO-40	DO-21	89	90	DI-15	GPIO-44
GPIO-41	DO-20	91	92	NC	
	NC	93...96		NC	
	GND	97	98	+5 V	+5 V
	NC	99	100	DO-19	QEP2A, GPIO-54
	NC	101	102	DO-18	QEP2B, GPIO-55
	NC	103	104	DO-17	QEP2S, GPIO-56
	NC	105	106	DO-16	QEP2I, GPIO-57
	NC	107...118		NC	
	NC	119	120	DO-15	XRSn
	NC	121...180		NC	

Table 3.3: TI 28379D controlCARD pin map

TI F28388D controlCARD Pin Map

MCU Function	RT Box	180-pin		RT Box	MCU Function
JTAG (see Tab. 2.6)	NC	1 ... 8		NC	JTAG (see Tab. 2.6)
ADC-A0, DAC-A	AO-15	9	10	GND	
ADC-A1, DAC-B	AO-13	11	12	AO-14	ADC-B0
	NC	13	14	AO-12	ADC-B1
ADC-A2	AO-11	15	16	NC	
ADC-A3	AO-9	17	18	AO-10	ADC-B2
	GND	19	20	AO-8	ADC-B3
ADC-A4	AO-7	21	22	GND	
ADC-A5	AO-5	23	24	AO-6	ADC-B4
ADCIN14	AO-3	25	26	AO-4	ADC-B5
ADCIN15	AO-1	27	28	AO-2	ADC-D0
	NC	29	30	AO-0	ADC-D1
	NC	31 ... 48		NC	
PWM1A, GPIO-00	DI-0	49	50	DI-4	PWM3A, GPIO-04
PWM1B, GPIO-01	DI-1	51	52	DI-5	PWM3B, GPIO-05
PWM2A, GPIO-02	DI-2	53	54	DI-6	PWM4A, GPIO-06
PWM2B, GPIO-03	DI-3	55	56	DI-7	PWM4B, GPIO-07
PWM5A, GPIO-08	DI-8	57	58	DI-12	PWM7A, GPIO-12
PWM5B, GPIO-09	DI-9	59	60	DI-13	PWM7B, GPIO-13
PWM6A, GPIO-10	DI-10	61	62	DO-11	GPIO-14
PWM6B, GPIO-11	DI-11	63	64	DO-12	GPIO-15
	GND	65	66	NC	
SPIA_SIMO, GPIO-16	See Tab. 2.8	67	68	DO-13	QEP1A, GPIO-20

MCU Function	RT Box	180-pin		RT Box	MCU Function
SPIA_SOMI, GPIO-17		69	70	DO-14	QEP1B, GPIO-21
SPIA_CLK, GPIO-18	See Tab. 2.8	71	72	DO-27	QEP1S, GPIO-22
SPIA_STEn, GPIO-19	NC	73	74	DO-26	QEP1I, GPIO-23
SPIB_SIMO, GPIO-24	DO-25	75	76	NC	SCIA_RX, GPIO-28
SPIB_SOMI, GPIO-25	DO-24	77	78	NC	SCIA_TX, GPIO-29
SPIB_CLK, GPIO-26	DO-23	79	80	NC	CANRXA, GPIO-30 (see Tab. 2.3)
SPIB_STEn, GPIO-27	DO-22	81	82	NC	CANTXA, GPIO-31 (see Tab. 2.3)
	GND	83	84	+5 V	
	NC	85	86	NC	
	NC	87	88	DI-14	GPIO-39
GPIO-40	DO-21	89	90	DI-15	GPIO-125
GPIO-41	DO-20	91	92	NC	
	NC	93...96		NC	
	GND	97	98	+5 V	
	NC	99	100	DO-19	QEP2A, GPIO-54
	NC	101	102	DO-18	QEP2B, GPIO-55
	NC	103	104	DO-17	QEP2S, GPIO-56
	NC	105	106	DO-16	QEP2I, GPIO-57
	NC	107...118		NC	
	NC	119	120	DO-15	XRSn
	NC	121...180		NC	

Table 3.4: TI 28388D controlCARD pin map

TI F280025C controlCARD Pin Map

MCU Function	RT Box	180-pin		RT Box	MCU Function
JTAG (see Tab. 2.6)	NC	1 ... 8		NC	JTAG (see Tab. 2.6)
ADC-A0, C15	AO-15	9	10	GND	
ADC-A1	AO-13	11	12	AO-14	ADC-A11, C0
	NC	13	14	AO-12	ADC-A12, C1
ADC-A2, C9	AO-11	15	16	NC	
ADC-A3, C5, VDAC	AO-9	17	18	AO-10	ADC-C4, A14
	GND	19	20	AO-8	ADC-C6
ADC-A4, C14	AO-7	21	22	GND	
ADC-A5, C2	AO-5	23	24	AO-6	ADC-A15, C7
ADC-A6	AO-3	25	26	AO-4	ADC-C8, A9
ADC-A7, C3	AO-1	27	28	AO-2	ADC-A10, C10
	NC	29	30	AO-0	ADC-A8, C11
	NC	31 ... 48		NC	
PWM1A, GPIO-00	DI-0	49	50	DI-4	PWM3A, GPIO-04
PWM1B, GPIO-01	DI-1	51	52	DI-5	PWM3B, GPIO-05
PWM2A, GPIO-02	DI-2	53	54	DI-6	PWM4A, GPIO-06
PWM2B, GPIO-03	DI-3	55	56	DI-7	PWM4B, GPIO-07
PWM5A, GPIO-08	DI-8	57	58	DI-12	PWM7A, GPIO-12
PWM5B, GPIO-09	DI-9	59	60	DI-13	PWM7B, GPIO-13
PWM6A, GPIO-10	DI-10	61	62	DO-11	PWM8A, GPIO-14
PWM6B, GPIO-11	DI-11	63	64	DO-12	PWM8B, GPIO-15
	GND	65	66	NC	
SPIA_SIMO, GPIO-16	See Tab. 2.8	67	68	DO-13	QEP1A, GPIO-40

MCU Function	RT Box	180-pin		RT Box	MCU Function
SPIA_SOMI, GPIO-17		69	70	DO-14	QEP1B, GPIO-41
SPIA_CLK, GPIO-18	See Tab. 2.8	71	72	DO-27	QEP1S, GPIO-22
SPIA_STEn, GPIO-19	NC	73	74	DO-26	QEP1I, GPIO-23
SPIB_SIMO, GPIO-24	DO-25	75	76	NC	SCIA_RX, GPIO-28
SPIB_SOMI, GPIO-25	DO-24	77	78	NC	SCIA_TX, GPIO-29
SPIB_CLK, GPIO-26	DO-23	79	80	NC	CANRXA, GPIO-30 (see Tab. 2.3)
SPIB_STEn, GPIO-27	DO-22	81	82	NC	CANTXA, GPIO-31 (see Tab. 2.3)
	GND	83	84	+5 V	
	NC	85	86	NC	
	NC	87	88	DI-14	TDO, GPIO-37
GPIO-39	DO-21	89	90	DI-15	TDI, GPIO-35
NC	DO-20	91	92	NC	
	NC	93...96		NC	
	GND	97	98	+5 V	
	NC	99	100	DO-19	QEP2A, GPIO-24
	NC	101	102	DO-18	QEP2B, GPIO-25
	NC	103	104	DO-17	QEP2I, GPIO-27
	NC	105	106	DO-16	QEP2S, GPIO-26
	NC	107...118		NC	
	NC	119	120	DO-15	XRSn
	NC	121...180		NC	

Table 3.5: TI F280025C controlCARD pin map

TI F2800137 controlCARD Pin Map

MCU Function	RT Box	180-pin		RT Box	MCU Function
JTAG (see Tab. 2.6)	NC	1 ... 8		NC	JTAG (see Tab. 2.6)
ADC-A0, C15, DAC-A	AO-15	9	10	GND	
ADC-A1	AO-13	11	12	AO-14	ADC-C0, A11
	NC	13	14	AO-12	ADC-C1, A12
ADC-A2, C9, GPIO-224	AO-11	15	16	NC	
ADC-A3, C5, GPIO-242	AO-9	17	18	AO-10	ADC-C4, A14
	GND	19	20	AO-8	ADC-C6, GPIO-226
ADC-A4, C14	AO-7	21	22	GND	
ADC-A5, C2	AO-5	23	24	AO-6	ADC-C7, A15
ADC-A6, GPIO-228	AO-3	25	26	AO-4	ADC-C8, A9, GPIO-227
ADC-A7, C3	AO-1	27	28	AO-2	ADC-C10, A10, GPIO-230
	NC	29	30	AO-0	ADC-C11, A8
	NC	31 ... 48		NC	
PWM1A, GPIO-00	DI-0	49	50	DI-4	PWM3A, GPIO-04
PWM1B, GPIO-01	DI-1	51	52	DI-5	PWM3B, GPIO-05
PWM2A, GPIO-02	DI-2	53	54	DI-6	PWM4A, GPIO-06
PWM2B, GPIO-03	DI-3	55	56	DI-7	PWM4B, GPIO-07
PWM5A, GPIO-08	DI-8	57	58	DI-12	PWM6A, GPIO-18
PWM5B, GPIO-09	DI-9	59	60	DI-13	PWM6B, GPIO-19
PWM7A, GPIO-12	DI-10	61	62	DO-11	GPIO-40
PWM7B, GPIO-13	DI-11	63	64	DO-12	GPIO-41
	GND	65	66	NC	
SPIA_SIMO, GPIO-16	See Tab. 2.8	67	68	DO-13	QEP1A, GPIO-20

MCU Function	RT Box	180-pin		RT Box	MCU Function
SPIA_SOMI, GPIO-17		69	70	DO-14	QEP1B, GPIO-21
SPIA_CLK, GPIO-10	See Tab. 2.8	71	72	DO-27	QEP1S, GPIO-22
SPIA_STEn, GPIO-11	NC	73	74	DO-26	QEP1I, GPIO-23
GPIO-24	DO-25	75	76	NC	SCIA_RX, GPIO-28
GPIO-39	DO-24	77	78	NC	SCIA_TX, GPIO-29
NC	DO-23	79	80	NC	CANRXA, GPIO-35 (see Tab. 2.3)
NC	DO-22	81	82	NC	CANTXA, GPIO-37 (see Tab. 2.3)
	GND	83	84	+5 V	
	NC	85	86	NC	
	NC	87	88	DI-14	NC
GPIO-40	DO-21	89	90	DI-15	NC
GPIO-41	DO-20	91	92	NC	
	NC	93...96		NC	
	GND	97	98	+5 V	
	NC	99	100	DO-19	NC
	NC	101	102	DO-18	NC
	NC	103	104	DO-17	NC
	NC	105	106	DO-16	NC
	NC	107...118		NC	
	NC	119	120	DO-15	XRSn
	NC	121...180		NC	

Table 3.6: TI F2800137 controlCARD pin map

TI F28069 controlCARD Pin Map

MCU Function	RT Box	100-pin		RT Box	MCU Function
	NC	1-6	51-56	NC	
ADCIN-B0	AO-14	7	57	AO-15	ADCIN-A0
	GND	8	58	GND	
ADCIN-B1	AO-12	9	59	AO-13	ADCIN-A1
	GND	10	60	GND	
ADCIN-B2	AO-10	11	61	AO-11	ADCIN-A2
	GND	12	62	GND	
ADCIN-B3	AO-8	13	63	AO-9	ADCIN-A3
	GND	14	64	GND	
ADCIN-B4	AO-6	15	65	AO-7	ADCIN-A4
	NC	16	66	NC	
ADCIN-B5	AO-4	17	67	AO-5	ADCIN-A5
	NC	18	68	NC	
ADCIN-B6	AO-2	19	69	AO-3	ADCIN-A6
	NC	20	70	NC	
ADCIN-B7	AO-0	21	71	AO-1	ADCIN-A7
	NC	22	72	NC	
GPIO-00, PWM1A	DI-17	23	73	DI-16	GPIO-01, PWM1B
GPIO-02, PWM2A	DI-19	24	74	DI-18	GPIO-03, PWM2B, SPIA_SOMI
GPIO-04, PWM3A	DI-21	25	75	DI-20	GPIO-05, PWM3B, SPIA_SIMO, ECAP1
GPIO-06, PWM4A	DI-23	26	76	DI-22	GPIO-07, PWM4B, SCIRXA, ECAP2

MCU Function	RT Box	100-pin		RT Box	MCU Function
	GND	27	77	+5 V	
GPIO-08, PWM5A	DI-25	28	78	DI-24	GPIO-09, PWM5B, SCITXB, ECAP3
GPIO-10, PWM6A	DI-27	29	79	DI-26	GPIO-11, PWM6B, SCIRXB, ECAP1
GPIO-40, PWM7A, SCITXB	DI-29	30	80	DI-28	GPIO-41, PWM7B, SCIRXB
	NC	31	81	NC	
	NC	32	82	+5 V	
	NC	33	83	DO-0	GPIO-13, TZ-2, SPIB_SOMI
	NC	34	84	DO-5	GPIO-14, TZ-3, SPIB_CLK, SCITXB
GPIO-24, ECAP1, QEP2A, SPIB_SIMO	DO-6	35	85	DO-7	GPIO-25, ECAP2, QEP2B, SPIB_SOMI
GPIO-26, ECAP3, QEP2I, SPIB_CLK	DO-4	36	86	NC	
	GND	37	87	+5 V	
	NC	38	88	NC	
	NC	39	89	NC	
GPIO-20, QEP1A	DO-2	40	90	DO-3	GPIO-21, QEP1B
	NC	41	91	DO-1	GPIO-23, QEP1I, SCIRXB
	NC	42	92	+5 V	
GPIO-28 , SCIRXA (see Tab. 2.7)	NC	43	93	NC	GPIO-29, SCITXA (see Tab. 2.7)
GPIO-30, CANRXA (see Tab. 2.3)	See Tab. 2.4	44	94	See Tab. 2.4	GPIO-31, CANTXA (see Tab. 2.3)
GPIO-32	DI-31	45	95	DI-30	GPIO-33
JTAG (see Tab. 2.5)	NC	46-50	96-100	NC	JTAG (see Tab. 2.5)

MCU Function	RT Box	100-pin	RT Box	MCU Function
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Table 3.7: TI F28069 controlCARD pin map

TI F28335 controlCARD Pin Map

MCU Function	RT Box	100-pin		RT Box	MCU Function
	NC	1-6	51-56	NC	
ADCIN-B0	AO-14	7	57	AO-15	ADCIN-A0
	GND	8	58	GND	
ADCIN-B1	AO-12	9	59	AO-13	ADCIN-A1
	GND	10	60	GND	
ADCIN-B2	AO-10	11	61	AO-11	ADCIN-A2
	GND	12	62	GND	
ADCIN-B3	AO-8	13	63	AO-9	ADCIN-A3
	GND	14	64	GND	
ADCIN-B4	AO-6	15	65	AO-7	ADCIN-A4
	NC	16	66	NC	
ADCIN-B5	AO-4	17	67	AO-5	ADCIN-A5
	NC	18	68	NC	
ADCIN-B6	AO-2	19	69	AO-3	ADCIN-A6
	NC	20	70	NC	
ADCIN-B7	AO-0	21	71	AO-1	ADCIN-A7
	NC	22	72	NC	
GPIO-00, PWM1A	DI-17	23	73	DI-16	GPIO-01, PWM1B
GPIO-02, PWM2A	DI-19	24	74	DI-18	GPIO-03, PWM2B
GPIO-04, PWM3A	DI-21	25	75	DI-20	GPIO-05, PWM3B, ECAP1
GPIO-06, PWM4A	DI-23	26	76	DI-22	GPIO-07, PWM4B, ECAP2
	GND	27	77	+5 V	
GPIO-08, PWM5A, CAN-TXB	DI-25	28	78	DI-24	GPIO-09, PWM5B, SCITXB, ECAP3

MCU Function	RT Box	100-pin		RT Box	MCU Function
GPIO-10, PWM6A, CAN-RXB	DI-27	29	79	DI-26	GPIO-11, PWM6B, SCIRXB, ECAP4
GPIO-48, ECAP5	DI-29	30	80	DI-28	GPIO-49, ECAP6
	NC	31	81	NC	
	NC	32	82	+5 V	
	NC	33	83	DO-0	GPIO-13, TZ-2, CANRXB
	NC	34	84	DO-5	GPIO-14, TZ-3, SCITXB
GPIO-24, ECAP1, QEP2A	DO-6	35	85	DO-7	GPIO-25, ECAP2, QEP2B
GPIO-26, ECAP3, QEP2I	DO-4	36	86	NC	
	GND	37	87	+5 V	
	NC	38	88	NC	
	NC	39	89	NC	
GPIO-20, QEP1A, CANTXB	DO-2	40	90	DO-3	GPIO-21, QEP1B, CANRXB
	NC	41	91	DO-1	GPIO-23, QEP1I, SCIRXB
	NC	42	92	+5 V	
GPIO-28 , SCIRXA (see Tab. 2.7)	NC	43	93	NC	GPIO-29, SCITXA (see Tab. 2.7)
GPIO-30, CANRXA (see Tab. 2.3)	See Tab. 2.4	44	94	See Tab. 2.4	GPIO-31, CANTXA (see Tab. 2.3)
GPIO-32	DI-31	45	95	DI-30	GPIO-33
JTAG (see Tab. 2.5)	NC	46-50	96-100	NC	JTAG (see Tab. 2.5)

Table 3.8: TI F28335 controlCARD pin map

TI F28P650DK9 controlCARD Pin Map

MCU Function	RT Box	180-pin		RT Box	MCU Function
JTAG (see Tab. 2.6)	NC	1 ... 8		NC	JTAG (see Tab. 2.6)
ADC-A0, DAC-A	AO-15	9	10	GND	
ADC-A1	AO-13	11	12	AO-14	ADC-B0
	NC	13	14	AO-12	ADC-B1, DAC-C
ADC-A2	AO-11	15	16	NC	
ADC-A3	AO-9	17	18	AO-10	ADC-B2
	GND	19	20	AO-8	ADC-B3
ADC-A4	AO-7	21	22	GND	
ADC-A5	AO-5	23	24	AO-6	ADC-B4, GPIO-215
ADC-A14, B14, C14	AO-3	25	26	AO-4	ADC-B5, GPIO-216
ADC-A15, B15, C15	AO-1	27	28	AO-2	ADC-C6, GPIO-203
	NC	29	30	AO-0	ADC-C4, GPIO-205
	NC	31 ... 48		NC	
PWM1A, GPIO-00	DI-0	49	50	DI-4	PWM3A, GPIO-04
PWM1B, GPIO-01	DI-1	51	52	DI-5	PWM3B, GPIO-05
PWM2A, GPIO-02	DI-2	53	54	DI-6	PWM4A, GPIO-06
PWM2B, GPIO-03	DI-3	55	56	DI-7	PWM4B, GPIO-07
PWM5A, GPIO-08	DI-8	57	58	DI-12	PWM7A, GPIO-12
PWM5B, GPIO-09	DI-9	59	60	DI-13	PWM7B, GPIO-13
PWM6A, GPIO-10	DI-10	61	62	DO-11	PWM8A, GPIO-14
PWM6B, GPIO-11	DI-11	63	64	DO-12	PWM8B, GPIO-15
	GND	65	66	NC	
SPIA_PICO, GPIO-16	See Tab. 2.8	67	68	DO-13	EQEP1A, GPIO-20

MCU Function	RT Box	180-pin		RT Box	MCU Function
SPIA_POCI, GPIO-17		69	70	DO-14	EQEP1B, GPIO-21
SPIA_CLK, GPIO-18	See Tab. 2.8	71	72	DO-27	EQEP1S, GPIO-22
SPIA_CS, GPIO-35	NC	73	74	DO-26	EQEP1I, GPIO-23
EQEP2A, GPIO-24	DO-25	75	76	NC	
EQEP2B, GPIO-25	DO-24	77	78	NC	
NC	DO-23	79	80	NC	
NC	DO-22	81	82	NC	
	GND	83	84	+5 V	
	NC	85	86	NC	
	NC	87	88	DI-14	GPIO-39
MCANB_RX, GPIO-40	DO-21	89	90	DI-15	GPIO-125
MCANB_TX, GPIO-41	DO-20	91	92	NC	
	NC	93...96		NC	
	GND	97	98	+5 V	
	NC	99	100	DO-19	SPIA_PICO, GPIO-54
	NC	101	102	DO-18	SPIA_POCI, GPIO-55
	NC	103	104	DO-17	SPIA_CLK, GPIO-56
	NC	105	106	DO-16	SPIA_CS, GPIO-57
	NC	107...118		NC	
	NC	119	120	DO-15	XRSn
	NC	121...180		NC	

Table 3.9: TI F28P650DK9 controlCARD pin map

