ISC629ER

2-Channel Isolated DC Servo Motor Interface Board

User's Manual

BDM-610020059 Rev. D

RTD Embedded Technologies, Inc.
AS9100 and ISO 9001 Certified

RTD Embedded Technologies, Inc.
103 Innovation Boulevard
State College, PA 16803 USA
Telephone: 814-234-8087
Fax: 814-234-5218

www.rtd.com

sales@rtd.com
techsupport@rtd.com

Revision History

Rev A	Initial Release
Rev B	New Board release and removal of RTD Finland
Rev C	Fixed TOC and removed erroneous temperature specification
Rev D	New Manual format. Added IDAN information. Corrected Jumper descriptions.

Advanced Analog I/O, Advanced Digital I/O, aAIO, aDIO, a2DIO, Autonomous SmartCal, "Catch the Express", cpuModule, dspFramework, dspModule, expressMate, ExpressPlatform, HiDANplus, "MIL Value for COTS prices", multiPort, PlatformBus, and PC/104EZ are trademarks, and "Accessing the Analog World", dataModule, IDAN, HiDAN, RTD, and the RTD logo are registered trademarks of RTD Embedded Technologies, Inc (formerly Real Time Devices, Inc.). PS/2 is a trademark of International Business Machines Inc. PCI, PCI Express, and PCIe are trademarks of PCI-SIG. PC/104, PC/104-Plus, PCI-104, PCIe/104, PCI/104-Express and 104 are trademarks of the PC/104 Embedded Consortium. All other trademarks appearing in this document are the property of their respective owners.

Failure to follow the instructions found in this manual may result in damage to the product described in this manual, or other components of the system. The procedure set forth in this manual shall only be performed by persons qualified to service electronic equipment. Contents and specifications within this manual are given without warranty, and are subject to change without notice. RTD Embedded Technologies, Inc. shall not be liable for errors or omissions in this manual, or for any loss, damage, or injury in connection with the use of this manual.

Copyright © 2014 by RTD Embedded Technologies, Inc. All rights reserved.

Table of Contents

1 Introduction **7**

1.1 Product Overview 7

1.2 Board Features 7

1.3 Ordering Information 7

1.4 Contact Information 8
1.4.1 Sales Support 8
1.4.2 Technical Support 8

2 Specifications **9**

2.1 Operating Conditions 9

2.2 Electrical Characteristics 9

3 Board Connection **10**

3.1 Board Handling Precautions 10

3.2 Physical Characteristics 10

3.3 Connectors and Jumpers 10
3.3.1 External I/O Connectors 11
CN4: Motor Interface Connectors 11
J14: Timer Counter Connector 11
J5 & J6 Incremental Encoder Connectors 12
JP4: General Purpose Digital I/O Connector 12
J4: Motor Control Port Connector 13
3.3.2 Bus Connectors 13
3.3.3 Jumpers 13
Digital I/O Pull Up/Pull Down Jumpers (Factory setting: 2-3) 15

3.4 Steps for Installing 16

4 IDAN Connections **17**

4.1 Module Handling Precautions 17

4.2 Physical Characteristics 17

4.3 Connectors 18
4.3.1 External I/O Connectors 18
Motor Control 1 & 2 18
Digital I/O 18
4.3.2 Bus Connectors 19

4.4 Steps for Installing 20

5 Functional Description **21**

5.1 Block Diagram 21

5.2 The LM629 Servo Controller 22

5.3 H-Bridges for Motion Control 22

5.4 Incremental encoder inputs 22

5.5 Motor control port 23

5.6 8255 Based Digital I/O 23

5.7 8254 Timer/Counter 23

6 Board Operation and Programming **24**

6.1 Defining the Memory Map 24
BA+0 Servo chip channel #1 1-8 (Read/Write) 24
BA+1 Servo chip channel #2 1-8 (Read/Write) 24
BA+2 Board control register 1-4 (Read/Write) 24

BA+3 Reserved for factory testing purposes 25
BA+4 PPI Port A 1-8 (Read/Write) 25
BA+5 PPI Port B 1-8 (Read/Write) 25
BA+6 PPI Port C 1-8 (Read/Write) 25
BA+7 PPI Control byte 1-8 (Read/Write) 25
BA+8 8254 Counter 1 1-8 (Read/Write) 25
BA+9 8254 Counter 2 1-8 (Read/Write) 25
BA+A 8254 Counter 3 1-8 (Read/Write) 25
BA+B 8254 Control 1-8 (Read/Write) 26

6.2 LM629 Instruction set 27

7 Troubleshooting 28

8 Additional Information 29

8.1 PC/104 Specifications 29

9 Limited Warranty 30

Table of Figures

Figure 1: Board Connections 10
Figure 2: Motor Interface Terminal Block 11
Figure 3: Incremental encoder terminal-blocks 12
Figure 4: Base address jumpers (JP3) set for 300H 14
Figure 5: Interrupt jumpers 14
Figure 6: Timer/counter jumpers 15
Figure 7: Example 104™Stack 16
Figure 8: IDAN Connector Locations 17
Figure 9: Example IDAN System 20
Figure 10: ISC629 Block Diagram 21
Figure 11: Typical motor control scheme 22
Figure 12:8255 Control byte bit definitions 26

Table of Tables

Table 1: Ordering Options 7
Table 2: Operating Conditions 9
Table 3: Electrical Characteristics 9
Table 4: Digital I/O Connector 12
Table 5:Motor Control Port pin-out 13
Table 6: Factory Configured Jumper Settings 13
Table 7: Base Address Jumper Settings (JP3) 14
Table 8:Motor Control Connector 18
Table 9: P2 and P3 Pin Assignments 18
Table 10: ISC629 I/O Map 24
Table 11:LM629 Instruction Set 27

1 Introduction

1.1 Product Overview

The ISC629ER Embedded DC servo motor controller board provides a compact single board solution for demanding motor control applications. Motion control tasks are performed by two LM629 motion control chips. These motion controllers interface to onboard MOSFET power bridges that drive motors up to 60V with a maximum current of 10A. For more information on the capabilities of the motion control features of the ISC629ER please refer to the component specific datasheets of the LM629 chip. If you choose to use an external/remote power stage to drive your motor you may use the motor drive port of the ISC629ER. In this port are available both the PWM/DIR as well as H-bridge left/right half control signals for both channels. Also included is a power output of +5V or alternatively +12V to supply remote electronics or drivers.

You may use +5V or +12V supply incremental encoders to provide the feedback from the motors. Special buffering and protection on these inputs is used to meet the requirements of standard EN61000-4-4 for the encoder inputs. This will make sure your board works reliably in the noisy environments of industrial and automotive applications.

24 TTL level digital I/O are available onboard. These I/O are located to the right side of the board on a 50-pin header. This header has the standard pinout of RTD digital I/O boards.

1.2 Board Features

- Two independent Servo Motor controller channels
- Onboard Isolated full H-bridges with 10A drive capability
    - 3000V of isolation
- Direct motor interfaces using onboard terminal blocks
- 2 Independent LM629 PWM-output servo motor controllers
- 2 Protected and filtered incremental encoder inputs (selectable pull-up/dn)
- 24 user accessible, programmable TTL-level digital I/O (8255 compatible)
- 3 16-bit timer counter channels (8254 compatible)
- +5V only operation
- Supports direct drive of +12V motors from onboard power supply
- PC/104 compliant

1.3 Ordering Information

The ISC629 is available with the following options:

Table 1: Ordering Options

Part Number	Description
ISC629ER	PC/104 Isolated Two-Channel DC Servo Motor Controller
IDAN-ISC629HR-62D	PC/104 Isolated Two-Channel DC servo Motor Controller IDAN Peripheral Module

The Intelligent Data Acquisition Node (IDAN®) building block can be used in just about any combination with other IDAN building blocks to create a simple but rugged 104™ stack. This module can also be incorporated in a custom-built RTD HiDAN® or HiDANplus High Reliability Intelligent Data Acquisition Node. Contact RTD sales for more information on our high reliability systems.

1.4 Contact Information

1.4.1 Sales Support

For sales inquiries, you can contact RTD Embedded Technologies sales via the following methods:

Phone: 1-814-234-8087 Monday through Friday, 8:00am to 5:00pm (EST).
E-Mail: sales@rtd.com

1.4.2 Technical Support

If you are having problems with you system, please try the steps in the Troubleshooting section of this manual on page 28.

For help with this product, or any other product made by RTD, you can contact RTD Embedded Technologies technical support via the following methods:

Phone: 1-814-234-8087 Monday through Friday, 8:00am to 5:00pm (EST).
E-Mail: techsupport@rtd.com

2 Specifications

2.1 Operating Conditions

Table 2: Operating Conditions

Symbol	Parameter	Test Condition	Min	Max	Unit
V_{cc5}	5V Supply Voltage		4.75	5.25	V
T_a	Operating Temperature	ISC629ER	0	+70	C
T_a	Operating Temperature	IDAN-ISC629HR-62D	-40	+85	C
T_s	Storage Temperature		-55	+125	C
RH	Relative Humidity	Non-Condensing	0	90%	%
MTBF	Mean Time Before Failure	Telcordia Issue 2 30°C, Ground benign, controlled		TBD	Hours

2.2 Electrical Characteristics

Table 3: Electrical Characteristics

Symbol	Parameter	Test Condition	Min	Max	Unit
P	Power Consumption	V_{cc5} = 5.0V	2.0		W
LM629 Servo Controllers					
	Clock Frequency			4	MHz
H-Bridge					
	Voltage Range			60	V_{DC}
	Current	With supplied heat sink		10	A
	Peak Current			25	A
8255 Digital I/O					
	Drive Current		-2	+2	mA
	Pull-up/Pull-down		10k		Ω

3 Board Connection

3.1 Board Handling Precautions

To prevent damage due to Electrostatic Discharge (ESD), keep your board in its antistatic bag until you are ready to install it into your system. When removing it from the bag, hold the board at the edges, and do not touch the components or connectors. Handle the board in an antistatic environment, and use a grounded workbench for testing and handling of your hardware.

3.2 Physical Characteristics

- Weight: Approximately 55 g (0.12 lbs.)
- Dimensions: 90.17 mm L x 95.89 mm W (3.550 in L x 3.775 in W)

3.3 Connectors and Jumpers

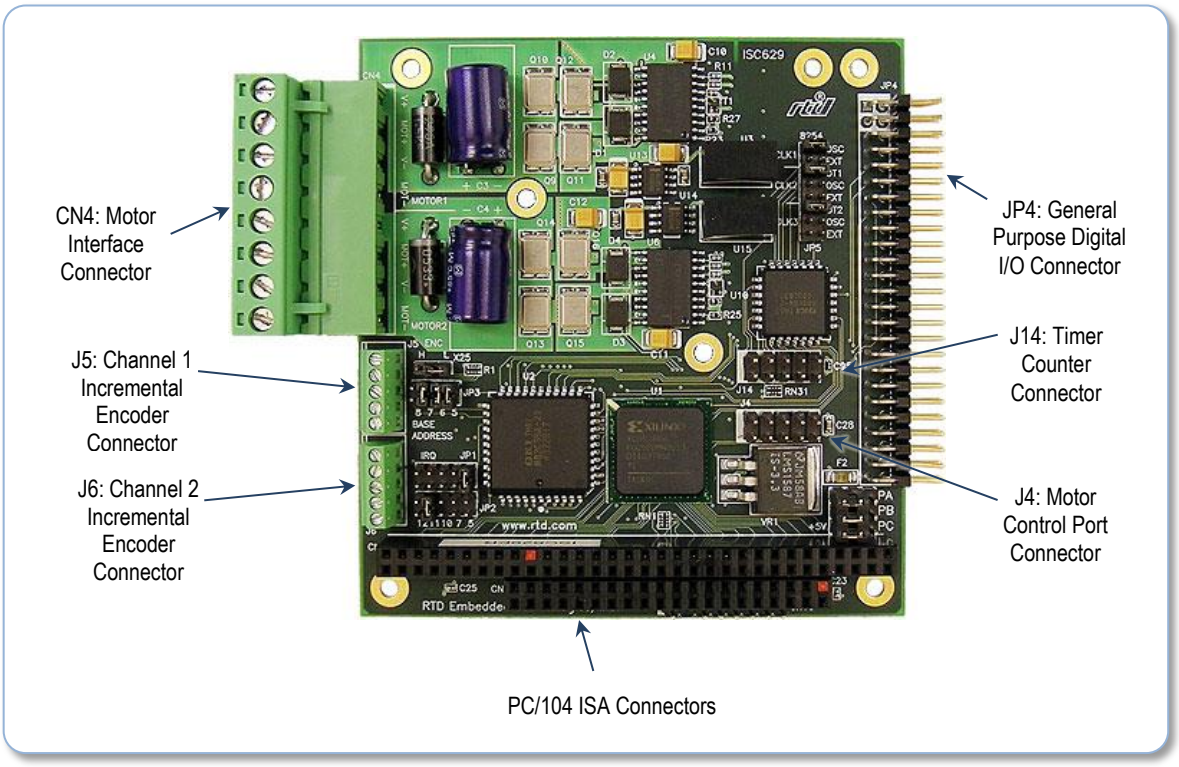


Figure 1: Board Connections

3.3.1 EXTERNAL I/O CONNECTORS

There are two 4-position terminal blocks on the left side of the module to directly interfacing to DC motors. The incremental encoders connect to the ISC629 using small screw terminal blocks. The general-purpose 50-pin digital I/O interface connector is located on the right hand side of the board. The 10-pin counter/timer I/O port header is located near the base address jumper block.

CN4: Motor Interface Connectors

The figure 3-1 below illustrates the logical connection of the DC-servo motors to the ISC629. The Motor + should be connected to the DC motor + terminal for correct loop operation. Connect Motor - to the negative terminal of the motor. Note that the maximum supply voltage is 60V. It is very important that the nominal motor voltage is not exceeded.

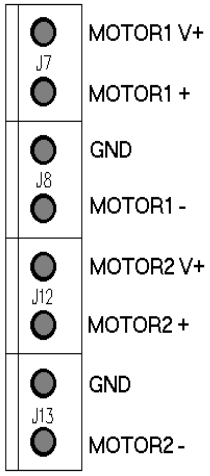


Figure 2: Motor Interface Terminal Block

J14: Timer Counter Connector

Connector J14 carries the external clock, gate and output signals of the three timer/counters. The pinout of this connector (top view) is shown below:

2	4	6	8	10
E_GATE1	E_CLK2	TC2	E_GATE3	GND
E_CLK1	TC1	E_GATE2	E_CLK3	TC3
1	3	5	7	9

Signal definitions:

E_CLK1	External clock signal counter1 (10K pull-down)
E_GATE1	External gate counter1 (10K pull-up)
TC1	Output of timer counter1
E_CLK2	External clock signal counter2 (10K pull-down)
E_GATE2	External gate counter2 (10K pull-up)
TC2	Output of timer counter2
E_CLK3	External clock signal counter3 (10K pull-down)
E_GATE3	External gate counter3 (10K pull-up)
TC3	Output of timer counter3

J5 & J6 Incremental Encoder Connectors

The figure 3-2 below illustrates the screw terminal blocks used to connect the incremental encoders of the DC-servo motors to the ISC629. J5 is the connector for Channel #1 and J6 for Channel #2. The +5V is supplied by the PC/104-bus. Both of these outputs are independently fused with 2A fuses located under the terminal blocks.

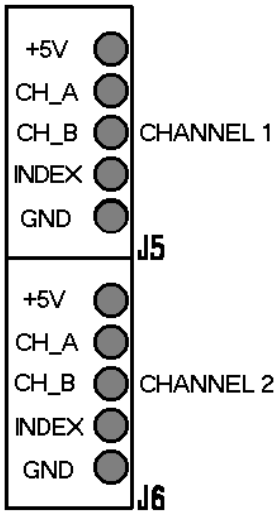


Figure 3: Incremental encoder terminal-blocks

JP4: General Purpose Digital I/O Connector

The table below illustrates the pinout of the 50-pin header connector that is used for general-purpose digital I/O. +5V is available in pin 49.

Table 4: Digital I/O Connector

PIN number	Signal Description	PIN Number	Signal Description
1	PC0	2	N.C
3	PC1	4	GND
5	PC2	6	GND
7	PC3	8	GND
9	PC4	10	GND
11	PC5	12	GND
13	PC6	14	GND
15	PC7	16	GND
17	PB0	18	GND
19	PB1	20	GND
21	PB2	22	GND
23	PB3	24	GND
25	PB4	26	GND
27	PB5	28	GND
29	PB6	30	GND
31	PB7	32	GND
33	PA0	34	GND
35	PA1	36	GND
37	PA2	38	GND
39	PA3	40	GND
41	PA4	42	GND
43	PA5	44	GND
45	PA6	46	GND
47	PA7	48	GND
49	+5V (Fused 2A)	50	GND

J4: Motor Control Port Connector

The tables below show the connector layout of the ESC629 motor control port J4. This connector is located towards the top of the board. It is a non-isolated port that can be used for external H-bridges.

Table 5:Motor Control Port pin-out

Pin #	Pin Name	Signal Description
1	+5V	Positive supply
2	GND	System ground
3	SIGN_1 (TTL)	Channel 1 Sign signal from LM629 chip (TTL)
4	MAGN_1(TTL)	Channel 1 PWM output signal from LM629 chip (TTL)
5	SIGN_2 (TTL)	Channel 2 Sign signal from LM629 chip (TTL)
6	MAGN_2 (TTL)	Channel 2 PWM output signal from LM629 chip (TTL)
7	DIR1+ (TTL)	Channel 1 direction + (TTL) DIR1+ > DIR1- FORWARD
8	DIR1- (TTL)	Channel 1 direction - (TTL) DIR1+ < DIR1- FORWARD
9	DIR2+ (TTL)	Channel 2 direction + (TTL) DIR2+ > DIR2- FORWARD
10	DIR2- (TTL)	Channel 2 direction - (TTL) DIR2+ < DIR2- FORWARD

The pin-out of this connector (top view) is shown below:

9	7	5	3	1
DIR2+	DIR1+	Sign_2	Sign_1	V+
DIR2-	DIR1-	Mag_2	Mag_1	GND
10	8	6	4	2

3.3.2 BUS CONNECTORS

PC/104 ISA Connectors

The PC/104 connectors carry the signals of the PC/104-Plus ISA bus. Refer to *PC/104-Plus Specification Revision 1.0* for the pinout of this connector. This is a pass-through connector. The DM7820HR connects to the power and ground pins only, and does not use any of the signals.

3.3.3 JUMPERS

Table 6 below illustrates the factory jumper setting for the ISC629. Figure 1 on page 10 shows the board layout of the ISC629 and the locations of the jumpers. The following paragraphs explain how to change the factory jumper settings to suit your specific application.

On all jumpers, pin 1 is designated by a thick white silkscreen line, and a square pad on the PCB.

Table 6: Factory Configured Jumper Settings

Jumper Name	Description	Number of Jumpers	Factory Setting
ADDR	Base Addresses	4	300H
TIMER	8254 clock settings	8	OSC, OT1,OT2
IRQ #1	Host interrupt Ch#1	5	5
IRQ #2	Host interrupt Ch#2	5	11

Base Address jumpers JP3 (Factory setting: 300h)

The most common cause of failure when you are first setting up your module is address contention. Some of your computer´s I/O-space is already occupied by other internal I/O devices or expansion boards. When the board attempts to use its own reserved I/O addresses (which are being already used by another peripheral device), erratic performance may occur and the data read from the board may be corrupted.

To avoid this problem make sure you set up the base address first using the four jumpers marked "BASE". It allows you to choose from 16 different I/O addresses in your computer's I/O map. Should the factory installed setting of 300h be unusable for your system configuration, you may change this setting to another using the options illustrated in Table 2-2 (overleaf). The table shows the switch settings and their corresponding values in hexadecimal values. Ensure that you verify the correct location of the base address jumpers. When the jumper is removed it corresponds to a logical "1", connecting the jumper to a "0".

Table 7: Base Address Jumper Settings (JP3)

BASE ADDRESS (HEX)	A5 A6 A7 A8
200	0 0 0 0
220	1 0 0 0
240	0 1 0 0
260	1 1 0 0
280	0 0 1 0
2A0	1 0 1 0
2C0	0 1 1 0
2E0	1 1 1 0
300	0 0 0 1
320	1 0 0 1
340	0 1 0 1
360	1 1 0 1
380	0 0 1 1
3A0	1 0 1 1
3C0	0 1 1 1
3E0	1 1 1 1

1 = JUMPER OFF **0 = JUMPER CLOSED**

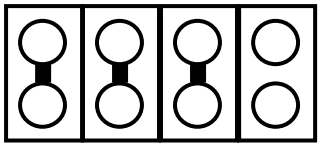


Figure 4: Base address jumpers (JP3) set for 300H

Interrupt Channels JP1 & JP2 (Factory setting: IRQ5 / IRQ11)

The jumpers shown in Figure 2-3 below, lets you connect the LM629 servo controller interrupt outputs to one of the interrupt channels available on the host XT/AT bus. If your board has no AT extension, interrupts 10-15 are not available. Both servo controllers must use different interrupts and therefore two headers are available. IRQ JP1 marks the Channel 1 interrupt and JP2 marks the interrupt for Channel 2.

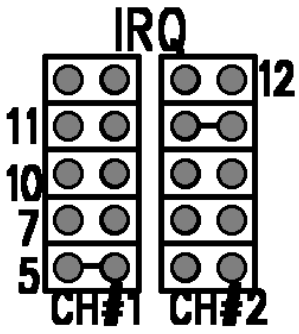


Figure 5: Interrupt jumpers

NOTE: The ISC629 does not support interrupt sharing. This is sometimes regarded as a part of the PC/104 special features. After extensive software and hardware tests we have found that error-free performance cannot be guaranteed when sharing interrupts.

Timer/counter settings JP5 (Factory settings: OSC, OT1 and OT2)

The clock sources of the onboard 8254 timer/counter chips can be selected with the left section of the jumper block shown in figure 2-4 below.

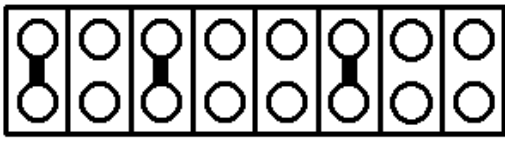


Figure 6: Timer/counter jumpers

The definitions are shown below, from left to right:

```
Clock 1 source  OSC (Onboard 4MHz oscillator)
                EXT (External source)
Clock 2 source  OT1 (Output of timer 1)
                OSC (Onboard 4MHz oscillator)
                EXT (External source)
Clock 3 source  OT2 (Output of timer 2)
                OSC (Onboard 4MHz oscillator)
                EXT (External source)
```

Digital I/O Pull Up/Pull Down Jumpers (Factory setting: 2-3)

All digital I/O lines are controlled by a jumper to determine pull up or pull down. If 1-2 is selected on the jumper it is a 10K ohm pull up, and if 2-3 is selected it is a pull down. The 24 digital I/O lines are configured as follows.

Jumper "X10" – I/O00 to I/O07
Jumper "X11" – I/O08 to I/O15
Jumper "X13" – I/O16 to I/O23

3.4 Steps for Installing

1. Always work at an ESD protected workstation, and wear a grounded wrist-strap.
2. Turn off power to the PC/104 system or stack.
3. Select and install stand-offs to properly position the module on the stack.
4. Remove the module from its anti-static bag.
5. Check that pins of the bus connector are properly positioned.
6. Check the stacking order; make sure all of the busses used by the peripheral cards are connected to the cpuModule.
7. Hold the module by its edges and orient it so the bus connector pins line up with the matching connector on the stack.
8. Gently and evenly press the module onto the PC/104 stack.
9. If any boards are to be stacked above this module, install them.
10. Attach any necessary cables to the PC/104 stack.
11. Re-connect the power cord and apply power to the stack.
12. Boot the system and verify that all of the hardware is working properly.

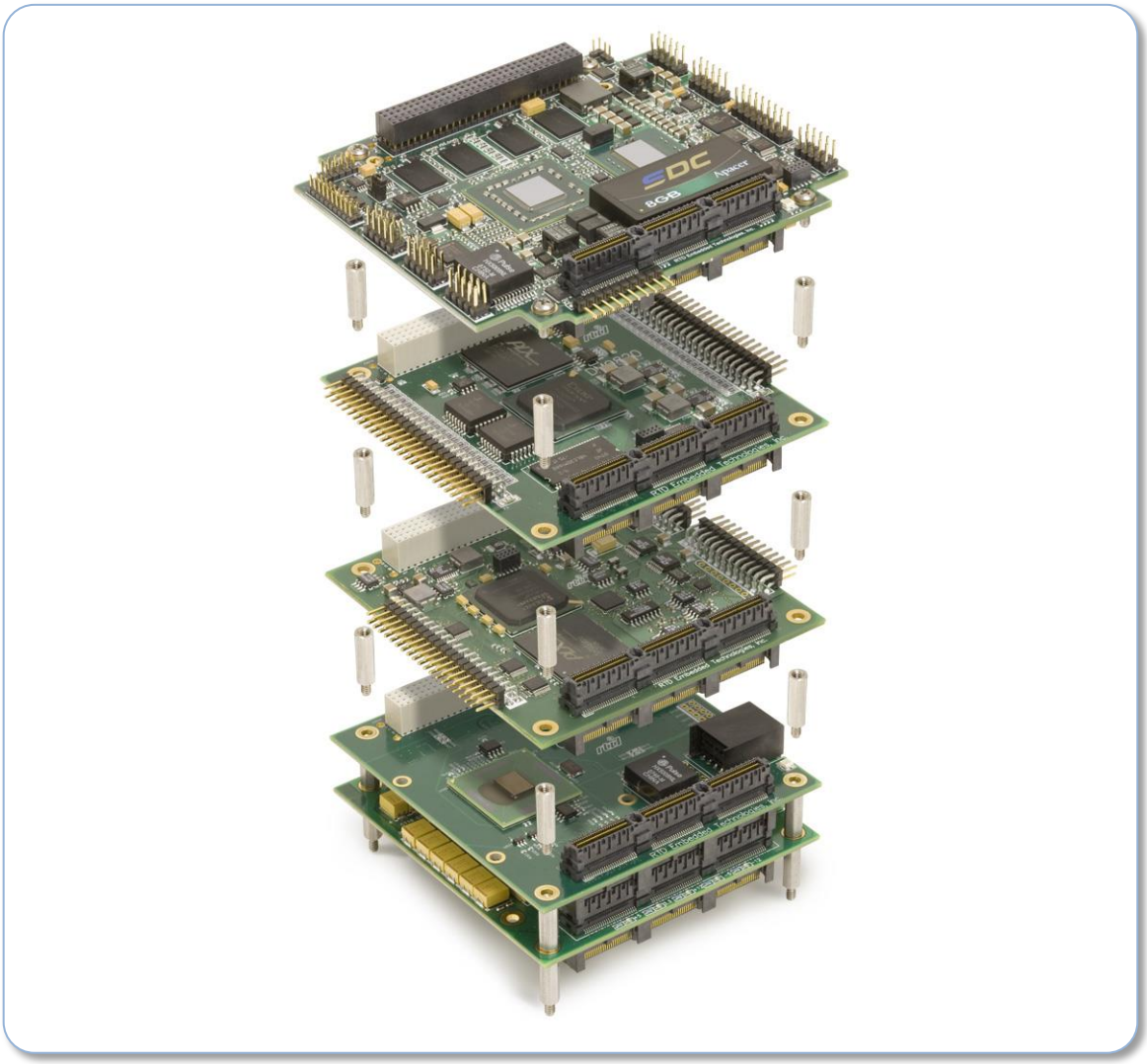


Figure 7: Example 104™ Stack

4 IDAN Connections

4.1 Module Handling Precautions

To prevent damage due to Electrostatic Discharge (ESD), keep your module in its antistatic bag until you are ready to install it into your system. When removing it from the bag, hold the module by the aluminum enclosure, and do not touch the components or connectors. Handle the module in an antistatic environment, and use a grounded workbench for testing and handling of your hardware.

4.2 Physical Characteristics

- Weight: Approximately 0.57 Kg (1.25 lbs.)
- Dimensions: 152 mm L x 130 mm W x 34 mm H (5.983 in L x 5.117 in W x 1.339 in H)

Figure 8: IDAN Connector Locations

4.3 Connectors

4.3.1 External I/O Connectors

Motor Control 1 & 2

Connector Part #: ITT Cannon DBMM9W4S, DM53744-7 **Mating Connector:** ITT Cannon DBMM9W4P, DM53745-7

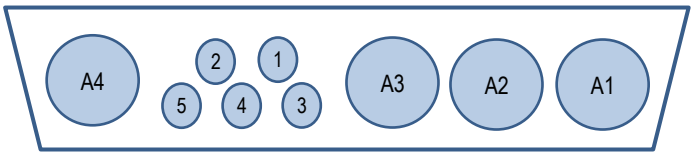


Table 8:Motor Control Connector

IDAN Pin #	Signal	Motor 1 Connector Pin	Motor 2 Connector Pin
A1	Motor Supply V+	CN4.1	CN4.5
A2	Motor +	CN4.2	CN4.6
A3	Motor -	CN4.3	CN4.7
A4	Motor Supply V-	CN4.4	CN4.8
1	Incremental Encoder +5VDC	J5.1	J6.1
2	Incremental Encoder A	J5.2	J6.2
3	Incremental Encoder B	J5.3	J6.3
4	Incremental Encoder Index	J5.4	J6.4
4	Incremental Encoder GND	J5.5	J6.5

Digital I/O

Connector Part #: VALCONN **Mating Connector:** VALCONN HDB-62P

Table 9: P2 and P3 Pin Assignments

IDAN Pin				Board
Row 1	Row 2	Row 3	Signal	Pin
1			PC0	J3.1
	22		RESERVED	J3.2
		43	PC1	J3.3
2			DIGITAL GND	J3.4
	23		PC2	J3.5
		44	DIGITAL GND	J3.6
3			PC3	J3.7
	24		DIGITAL GND	J3.8
		45	PC4	J3.9
4			DIGITAL GND	J3.10
	25		PC5	J3.11
		46	DIGITAL GND	J3.12
5			PC6	J3.13
	26		DIGITAL GND	J3.14
		47	PC7	J3.15
6			DIGITAL GND	J3.16
	27		PB0	J3.17
		48	DIGITAL GND	J3.18
7			PB1	J3.19

Table 9: P2 and P3 Pin Assignments

IDAN Pin			Signal	Board Pin
Row 1	Row 2	Row 3		
	28		DIGITAL GND	J3.20
		49	PB2	J3.21
8			DIGITAL GND	J3.22
	29		PB3	J3.23
		50	DIGITAL GND	J3.24
9			PB4	J3.25
	30		DIGITAL GND	J3.26
		51	PB5	J3.27
10			DIGITAL GND	J3.28
	31		PB6	J3.29
		52	DIGITAL GND	J3.30
11			PB7	J3.31
	32		DIGITAL GND	J3.32
		53	PA0	J3.33
12			DIGITAL GND	J3.34
	33		PA1	J3.35
		54	DIGITAL GND	J3.36
13			PA2	J3.37
	34		DIGITAL GND	J3.38
		55	PA3	J3.39
14			DIGITAL GND	J3.40
	35		PA4	J3.41
		56	DIGITAL GND	J3.42
15			PA5	J3.43
	36		DIGITAL GND	J3.44
		57	PA6	J3.45
16			DIGITAL GND	J3.46
	37		PA7	J3.47
		58	DIGITAL GND	J3.48
17			+5 VOLTS	J3.49
	38		DIGITAL GND	J3.50
		59	E_CLK1	J14.1
18			E_GATE1	J14.2
	39		TC1	J14.3
		60	E_CLK2	J14.4
19			E_GATE2	J14.5
	40		TC2	J14.6
		61	E_CLK3	J14.7
20			E_GATE3	J14.8
	41		TC3	J14.9
		62	GND	J14.10
21			N/C	
	42		N/C	

4.3.2 BUS CONNECTORS

PC/104 ISA Connectors

The PC/104 connectors carry the signals of the PC/104-Plus ISA bus. Refer to *PC/104-Plus Specification Revision 1.0* for the pinout of this connector.

4.4 Steps for Installing

1. Always work at an ESD protected workstation, and wear a grounded wrist-strap.
2. Turn off power to the IDAN system.
3. Remove the module from its anti-static bag.
4. Check that pins of the bus connector are properly positioned.
5. Check the stacking order; make sure all of the busses used by the peripheral cards are connected to the cpuModule.
6. Hold the module by its edges and orient it so the bus connector pins line up with the matching connector on the stack.
7. Gently and evenly press the module onto the IDAN system.
8. If any boards are to be stacked above this module, install them.
9. Finish assembling the IDAN stack by installing screws of an appropriate length.
10. Attach any necessary cables to the IDAN system.
11. Re-connect the power cord and apply power to the stack.
12. Boot the system and verify that all of the hardware is working properly.

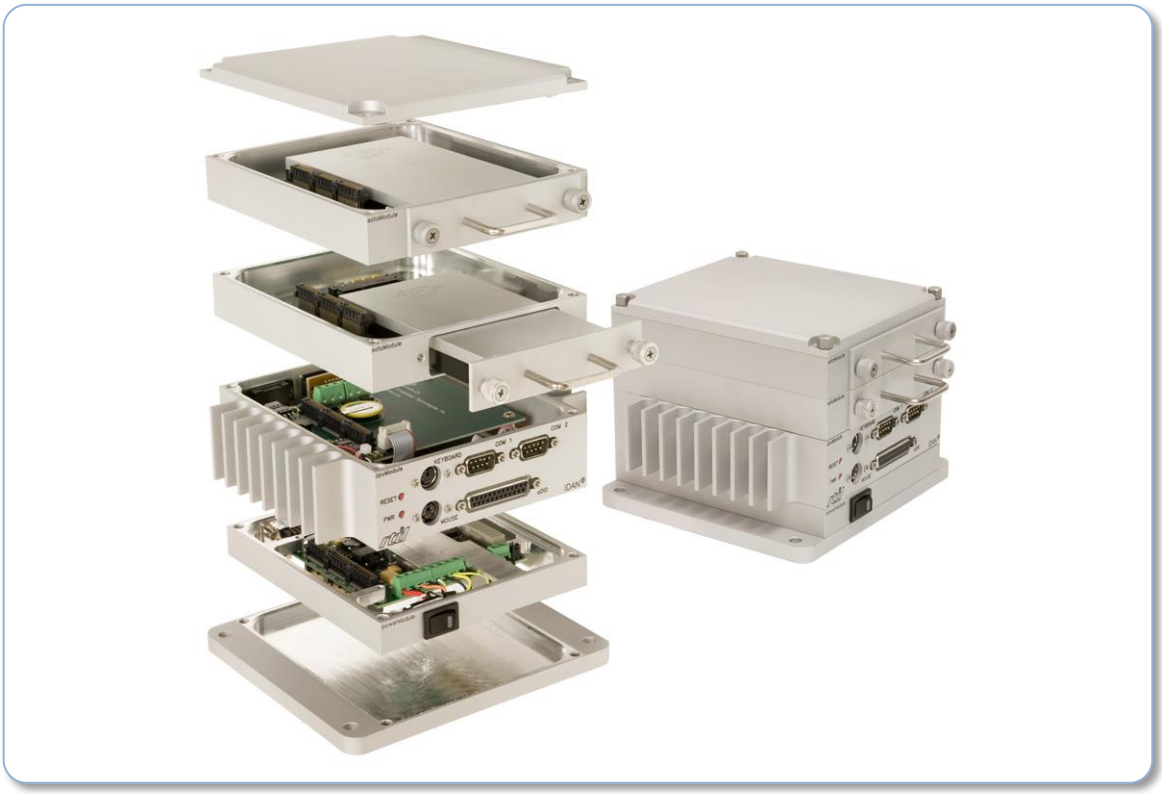


Figure 9: Example IDAN System

5 Functional Description

This chapter describes in detail the major features of the ISC629:

- The LM629 Servo controller chips
- H-bridges for motor control
- Incremental encoder inputs
- Motor control port
- 8255 based digital I/O
- 8245 counter/timers
- Interrupts

5.1 Block Diagram

The Figure below shows the functional block diagram of the ISC629. The various parts of the block diagram are discussed in the following sections.

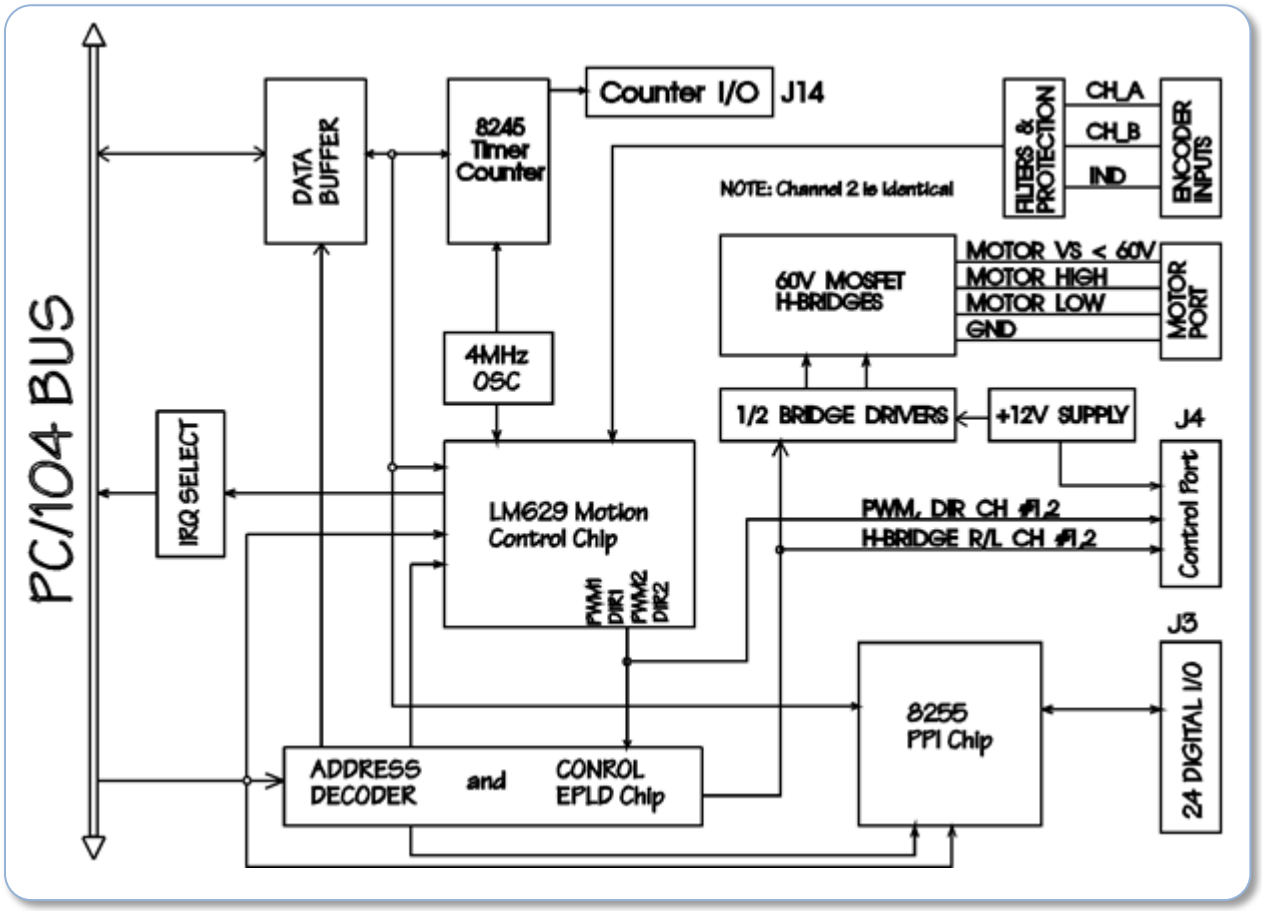


Figure 10: ISC629 Block Diagram

5.2 The LM629 Servo Controller

The LM629 chips are dedicated motion control processors designated for use with a variety of applications using DC Servo motors. These parts perform the complete real-time computational tasks of complex digital motion control. Included in the chips are three following blocks: 1) a 32-bit command position sequencer, 2) a 32-bit position feedback processor and 3) a 16-bit programmable PID filter. Figure 4-2 below illustrates the setup for a LM629 based motor control system. The clock frequency of the controllers is 4MHz. This must be taken into account in all timing calculations. (8MHz ISC629 boards are also available upon special request)

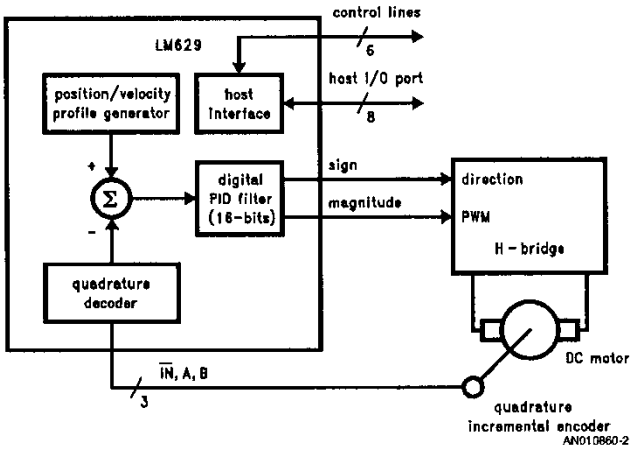


Figure 11: Typical motor control scheme

Main features of the LM629 include:

- 32-bit position, velocity and acceleration registers
- Programmable PID filter with 16-bit coefficients
- Programmable derivative sampling interval
- 8-bit and sign PWM output
- Internal trapezoidal velocity profile generator
- Velocity, target position, and filter parameters may be changed during motion
- Position and velocity modes of operations
- Real-time programmable interrupts
- Quadrature encoder feedback with index pulse

5.3 H-Bridges for Motion Control

The ISC629 features two independent H-bridges that are used to drive the motors. The H-bridges are implemented using 4 high performance N-channel MOSFETs. These MOSFETs are configured in two full bridges. Each of the two bridges consists of high side and low-side MOSFETs. Special full bridge driver chips are used to drive the MOSFET bridges. These drivers can tolerate negative voltage transients as well as voltages up to 600V. The propagation delay for the high and low side is also matched to ensure precise control of the bridge. The maximum peak current of the H-bridge is 25A, 10A continuous with a voltage of 60V.

The on-board H-Bridges are isolated from the system ground, with a maximum isolation voltage of 3000V.

5.4 Incremental encoder inputs

The feedback from DC-servo motors is usually implemented using TTL level incremental encoders. The ISC629 has terminal blocks onboard for direct connection to feedback encoders. The incremental encoders are powered from the board +5V. This output is protected against over voltages with a special transient absorber diode.

Encoder inputs CH_A, CH_B and INDEX are protected against positive and negative voltage transients. The encoder inputs are fed into a Schmidt trigger buffer that ensures reliable operation even under noisy environments. Input signals are inverted in this stage. This must be taken into account when making sensor channel connections. The input impedance of the encoder inputs lines are 4,7K.

A header (X25) on the board allows you to select either a pull-up or pull-down configuration to suit the encoder output circuitry. Factory default is pull-down mode. The illustration below shows the selection jumper set for 4,7K pull-down on the encoder inputs

5.5 Motor control port

The header J4 carries all the necessary signals required to interface to an external power stage. Available in this connector are power, 8-bit PWM and sign, as well as direct 1/2- bridge control signals. The power in this connector is selected to be either +12V or +5V. The selection is made using the solder blob B1 located on the solder side of the board next to the 50-pin connector. This output is protected with a 2A fuse.

5.6 8255 Based Digital I/O

The 8255 programmable peripheral interface (PPI) is used for digital I/O functions. This high performance TTL/CMOS compatible chip has 24 digital I/O lines divided into two groups of 12 lines each. All the 24 digital I/O lines are pulled down with 10K Ohm resistor.

Group A: Port A (8) lines and Port C upper (4) lines
Group B: Port B (8) lines and Port C lower (4) lines

Port A, Port B and Port C are available in the 50 pin expansion connector. These Ports can be utilized using any of the three operating modes as described below:

Mode 0: Basic I/O, this lets you use simple input/output functions for a port. Data is written to or read from the specified port
Mode 1: Strobed input/output. Lets you transfer data I/O from port A in conjunction with strobed or handshake signals.
Mode 2: Strobed bi-directional input/output lets you communicate with an external device through the port A. Handshaking is similar to mode 1.

Available Port direction definitions: Port A and B are defined to be Inputs or Outputs as ports, the lower bits in Port C, 0-3 and 4-7 may be set as Inputs or Outputs in groups.

All of these modes are discussed in detail in the 8255 data sheet available from Intel.

5.7 8254 Timer/Counter

An 8254 programmable interval timer provides three 16-bit, 4MHz timer / counters to support a wide range of timing and counting functions. All of the timer/counters TC1 to TC3 can be cascaded. The timers have different options for clock sources as well as gate signals available at header connector J14 on the board.

Each Timer/Counter has two inputs, CLK in and GATE in, and one output TC. They can be programmed as binary or BCD down counters by writing the appropriate data to the command word. The command word also lets you set up the different modes of operation. The six programmable modes are:

Mode 0 Event Counter (Interrupt on Terminal Count)
Mode 1 Hardware-Retriggerable one-shot
Mode 2 Rate Generator
Mode 3 Square Wave Mode
Mode 4 Software-Triggered Strobe
Mode 5 Hardware Triggered Strobe (Retriggerable)

All of these modes are discussed in detail in the 8254 data sheet available from Intel.

6 Board Operation and Programming

This chapter shows you how to program and use your ISC629.

Included are a complete detailed description of the memory map and a detailed discussion of programming operations to aid you in programming. The full functionality of the LM629 is described in the attached data sheet reprint from National Semiconductor.

6.1 Defining the Memory Map

The I/O map of the ISC629 is shown in Table 5-1 below. As shown, the module occupies two addresses. The Base Address (designated as BA) can be set using the jumpers as described in Chapter 2 (Board settings). The following sections describe the register contents of each address used in the I/O map.

Table 10: ISC629 I/O Map

Register Description	Read Function	Write Function	Address in HEX
Servo chip #1	Reads from chip	Writes to chip	BA+0
Servo chip #2	Reads from chip	Writes to chip	BA+1
Board control register	Read control bits	Write control bits	BA+2
Reserved	Reserved	Reserved	BA+3
PPI Port A	Read digital inputs	Write digital outputs	BA+4
PPI Port B	Read digital inputs	Write digital outputs	BA+5
PPI Port C	Read digital inputs	Write digital outputs	BA+6
PPI Control	Reserved	Write to control byte	BA+7
8254 TC Counter1	Read Counter1	Write Counter1	BA+8
8254 TC Counter2	Read Counter2	Write Counter2	BA+9
8254 TC Counter3	Read Counter3	Write Counter3	BA+A
8254 Control	Reserved	Program counter mode	BA+B

BA = Base Address (300h factory default)

BA+0 Servo chip channel #1 1-8 (Read/Write)

This is the address through which all communication is performed to the servo controller chip for channel #1. Data and commands are selected by one bit in the board control register, bit 3 (BA+2).

BA+1 Servo chip channel #2 1-8 (Read/Write)

This is the address through which all communication is performed. Data and commands are selected by one bit in the board control register, bit 3 (BA+2).

BA+2 Board control register 1-4 (Read/Write)

The board control register is used to configure the operation of the ISC629 board. The bit definitions are listed below:

Bit 0 (0 after reset) /EN_RST, this bit is used to block the host reset from resetting the servo control chips. In some cases it may be desirable to inhibit a host reset for example from a watchdog timer to abort a trajectory.

0 -> Enables host reset to reset servo chips
1 -> Disables host reset from resetting servo chips

Bit 1 (0 after reset) reserved for factory testing only
Bit 2 (0 after reset) reserved for factory testing only
Bit 3 (1 after reset) PS, this bit is important for all access to the LM629 chips.
With the PS bit you may select whether you are addressing the chip with commands or data. This bit must be set before access to the chip is performed to ensure correct interpretation of the data written to the addresses BA+1 and BA+2. See the software disk for more examples on the usage of this bit.

0 -> DATA
1 - > COMMAND

NOTE: When reading back this bit is inverted (1 -> DATA, 0 -> COMMAND)

BA+3 Reserved for factory testing purposes

BA+4 PPI Port A 1-8 (Read/Write)

This port is used to access the 8255 Port A bits. Instructions on how to access port A is described in greater detail in the software that is included in the shipment. For an exhaustive explanation of the operation of the 8255 PPI chip please consult the data sheet available from Intel or NEC.

BA+5 PPI Port B 1-8 (Read/Write)

This port is used to access the 8255 Port B bits. Instructions on how to access port A is described in greater detail in the software that is included in the shipment. For an exhaustive explanation of the operation of the 8255 PPI chip please consult the data sheet available from Intel or NEC

BA+6 PPI Port C 1-8 (Read/Write)

This port is used to access the 8255 Port C bits. Instructions on how to access port A is described in greater detail in the software that is included in the shipment. For an exhaustive explanation of the operation of the 8255 PPI chip please consult the data sheet available from Intel or NEC

BA+7 PPI Control byte 1-8 (Read/Write)

This port is used to access the 8255 control byte. The functionality of these bits is described briefly in the following page in figure 5-1.

BA+8 8254 Counter 1 1-8 (Read/Write)

This port is used to access the 8254 Counter 1 bits. For an exhaustive explanation of the operation of the 8254 timer chip please consult the data sheet available from Intel or NEC.

BA+9 8254 Counter 2 1-8 (Read/Write)

This port is used to access the 8254 Counter 2 bits. For an exhaustive explanation of the operation of the 8254 timer chip please consult the data sheet available from Intel or NEC.

BA+A 8254 Counter 3 1-8 (Read/Write)

This port is used to access the 8254 Counter 3 bits. For an exhaustive explanation of the operation of the 8254 timer chip please consult the data sheet available from Intel or NEC.

BA+B 8254 Control 1-8 (Read/Write)

This port is used to access the 8254 control byte. The functionality of these bits is described in the data sheet available from Intel or NEC.

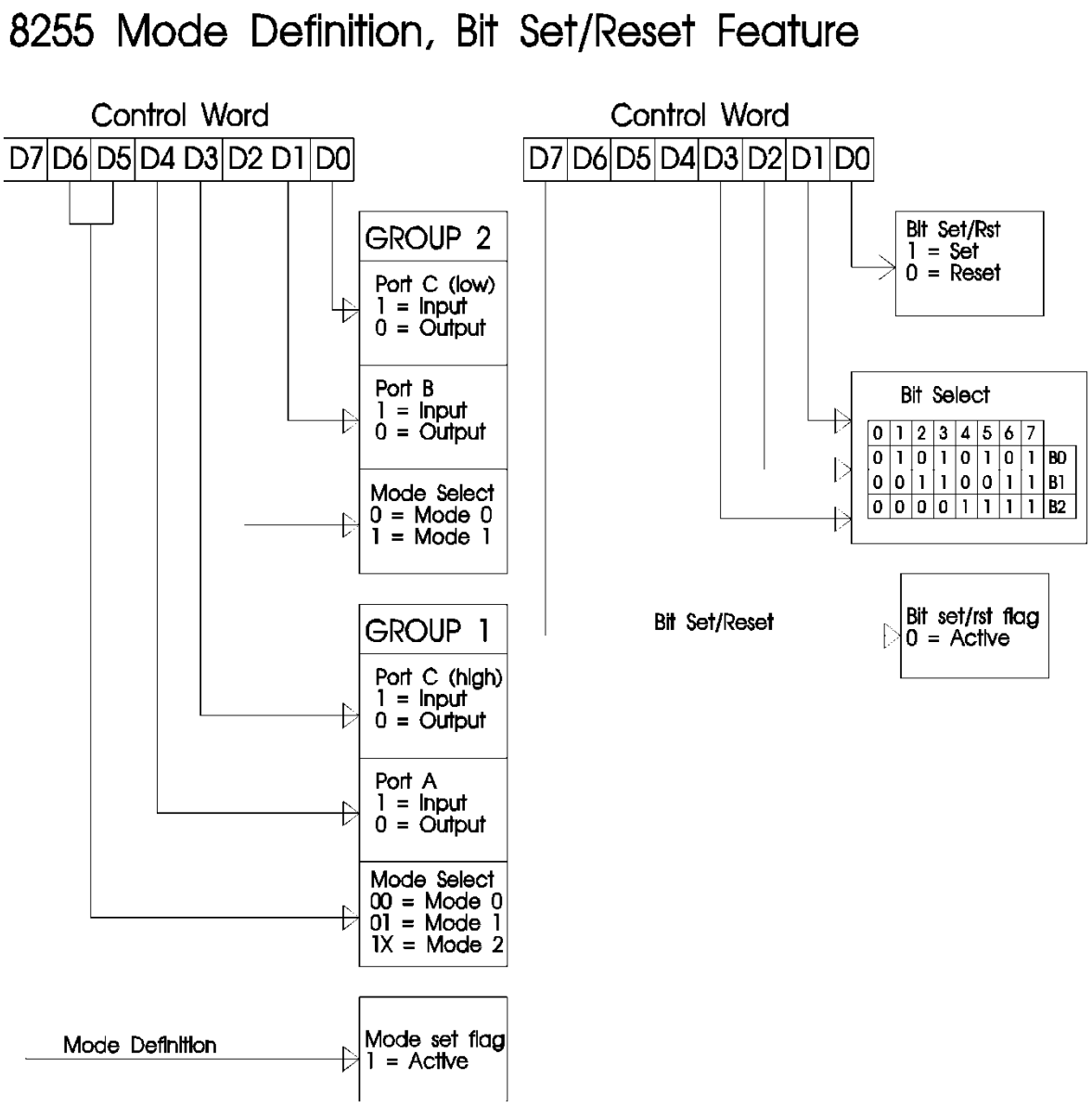


Figure 12:8255 Control byte bit definitions

6.2 LM629 Instruction set

A complete list of instructions accepted by the LM629 chip is described below in table 5-2.

Table 11:LM629 Instruction Set

Instruction	Type	Description	HEX
RESET	Initialize	Reset LM629	00
DFH	-"-	Define Home	02
SIP	-"-	Set Index Position	03
LPEI	Interrupt	Interrupt on Error	1B
LPES	Interrupt	Stop on Error	1A
SBPA	Interrupt	Set Breakpoint , Absolute	20
SBPR	Interrupt	Set Breakpoint , Relative	21
MSKI	Interrupt	Mask Interrupts	1C
RSTI	Interrupt	Reset Interrupts	1D
LFIL	Filter	Load Filter Parameters	1E
UDF	Filter	Update Filter	04
LTRJ	Trajectory	Load Trajectory	1F
STT	Trajectory	Start Motion	01
RDSTAT	Report	Read Status Byte	None
RDSIGS	Report	Read Signals Register	0C
RDIP	Report	Read Index Position	09
RDDP	Report	Read Desired Position	08
RDRP	Report	Read Desired Position	0A
RDDV	Report	Read Desired Velocity	07
RDRV	Report	Read Real Velocity	0B
RDSUM	Report	Read Integration Sum	0D

These instructions are loaded to the LM629 chip while the PS-bit is in "COMMAND" mode. See previous sections for more details. The board status register can be read at all times, remember to set the PS-bit in "DATA" mode when reading this register.

AN-639, AN-706 Application note and **LM628/LM629 Datasheet** walk you through all the important functions required to solve most motion control problems. This application note is included on your software disk and it can be downloaded from www.national.com. The diagnostic program "diag629.exe" has the same functions described in flow charts in AN-639 as C-functions. This diagnostics program shows you how to correctly use them together.

7 Troubleshooting

If you are having problems with your system, please try the following initial steps:

- **Simplify the System** – Remove modules one at a time from your system to see if there is a specific module that is causing a problem. Perform you troubleshooting with the least number of modules in the system possible.

- **Swap Components** – Try replacing parts in the system one at a time with similar parts to determine if a part is faulty or if a type of part is configured incorrectly.

If problems persist, or you have questions about configuring this product, contact RTD Embedded Technologies via the following methods:

Phone: +1-814-234-8087
E-Mail: techsupport@rtd.com

Be sure to check the RTD web site (http://www.rtd.com) frequently for product updates, including newer versions of the board manual and application software.

8 Additional Information

8.1 PC/104 Specifications

A copy of the latest PC/104 specifications can be found on the webpage for the PC/104 Embedded Consortium:

www.pc104.org

9 Limited Warranty

RTD Embedded Technologies, Inc. warrants the hardware and software products it manufactures and produces to be free from defects in materials and workmanship for one year following the date of shipment from RTD Embedded Technologies, Inc. This warranty is limited to the original purchaser of product and is not transferable.

During the one year warranty period, RTD Embedded Technologies will repair or replace, at its option, any defective products or parts at no additional charge, provided that the product is returned, shipping prepaid, to RTD Embedded Technologies. All replaced parts and products become the property of RTD Embedded Technologies. Before returning any product for repair, customers are required to contact the factory for a Return Material Authorization (RMA) number.

This limited warranty does not extend to any products which have been damaged as a result of accident, misuse, abuse (such as: use of incorrect input voltages, improper or insufficient ventilation, failure to follow the operating instructions that are provided by RTD Embedded Technologies, “acts of God” or other contingencies beyond the control of RTD Embedded Technologies), or as a result of service or modification by anyone other than RTD Embedded Technologies. Except as expressly set forth above, no other warranties are expressed or implied, including, but not limited to, any implied warranties of merchantability and fitness for a particular purpose, and RTD Embedded Technologies expressly disclaims all warranties not stated herein. All implied warranties, including implied warranties for merchantability and fitness for a particular purpose, are limited to the duration of this warranty. In the event the product is not free from defects as warranted above, the purchaser's sole remedy shall be repair or replacement as provided above. Under no circumstances will RTD Embedded Technologies be liable to the purchaser or any user for any damages, including any incidental or consequential damages, expenses, lost profits, lost savings, or other damages arising out of the use or inability to use the product.

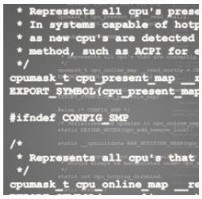
Some states do not allow the exclusion or limitation of incidental or consequential damages for consumer products, and some states do not allow limitations on how long an implied warranty lasts, so the above limitations or exclusions may not apply to you.

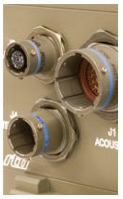
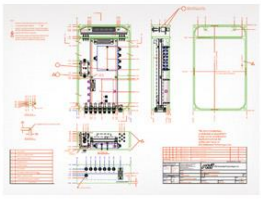
This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

RTD Embedded Technologies, Inc.
103 Innovation Boulevard
State College, PA 16803 USA
Telephone: 814-234-8087
Fax: 814-234-5218

www.rtd.com

sales@rtd.com
techsupport@rtd.com



Copyright 2014 by RTD Embedded Technologies, Inc. All rights reserved.