

Complete Encoder Based Servo Drive Design Platform iMOTION™ Development System

Features

- Low cost complete AC servo drive design platform
- IRMCK201 IC for complete servo control
- Simple design with IR2175 current sensing HVIC
- 230V/750W maximum output power with 600V/16A advanced Plug-N-Drive™ IGBT module
- High bandwidth torque loop response
- Flexible drive configuration (PMAC or induction motor)
- Quadrature encoder interface
- Low cost A/D interface with multiplexer
- ServoDesigner™ tool for easy operation
- RS232C/RS422 and fast SPI interface (standard)
- Parallel interface for microcontroller expansion or debug port
- Over-current and ground fault protection
- Over-voltage / Under-voltage protection
- Dynamic Braking control with brake IGBT/FWD
- Discrete I/Os (START, STOP, FAULT, FLTCLR, SYNC, IFBCAL, PWMACTIVE)
- Configuration data retention at power up/down

Product Summary

Current loop bandwidth (-3dB)	5 kHz (typ)
Speed loop bandwidth (adjustable)	400 Hz (typ)
PWM carrier frequency	70 kHz max
Hardware current loop execution time	6 μsec
Enhanced low speed regulation by 1/T algorithm	
Continuous output current	5.0 Arms (750W)
Overload output current	15 Arms
Max SPI comm. speed	6 MHz
Slave SPI configuration	
Max RS232C speed	57.6 kbps



Description

IRMCS2011 is a complete servo drive design platform for AC servo drive applications up to 750W. The system contains the latest advanced motion control IC, IRMCK201, and the ServoDesigner™ software. The complete B/Ms and schematics are provided so that the user can adapt and tailor the design per application needs. The system does not require any software code development due to unique Motion Control Engine implemented in the IRMCK201 IC. User can readily evaluate high performance servo control without spending development effort usually required in the traditional DSP or microcontroller based system. IRMCS2011 contains advanced iMOTION™ chipset such as IR2175 monolithic current sensing ICs and IRAMX16UP60A intelligent power module which enables simple and cost effective motion control design.



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1. Overview

The IRMCS2011 is a design platform for a complete servo drive system based on IRMCK201 IC. The system is based on configurable Motion Control Engine implemented by hardware logics in the IRMCK201. The system has a simple and low cost yet very flexible structure, made possible by advanced IR motion components including the IRAMX16UP60A IGBT module, and IR2175 monolithic current sensing high voltage IC. These components together with IRMCK201 IC simplify hardware construction, and perform complete servo amplifier functions. Figure 1 shows the IRMCS2011 system block diagram. Since all control logic is implemented in hardware logic as opposed to programmed software, unmatched parallel computation is achieved resulting in high bandwidth torque control.

Despite the fact that technology is based on hardware logic implementation, its design flexibility allows the user to configure different types of motors, position feedback devices, and communication protocols. The system also allows feedforward control in addition to existing PI control.

Design cycle time can be greatly shortened. Unlike a traditional DSP or microcontroller, the architecture is based on configurable register interface, and does not require any programming to complete customization for specific application needs. The user only has to configure the drive using ServoDesigner™ interactive design tool and it takes just a matter of hours instead of months and years.

Once the user become satisfied with function and performance, he can generate his own design using IRMCS2011 schematics and B/Ms.

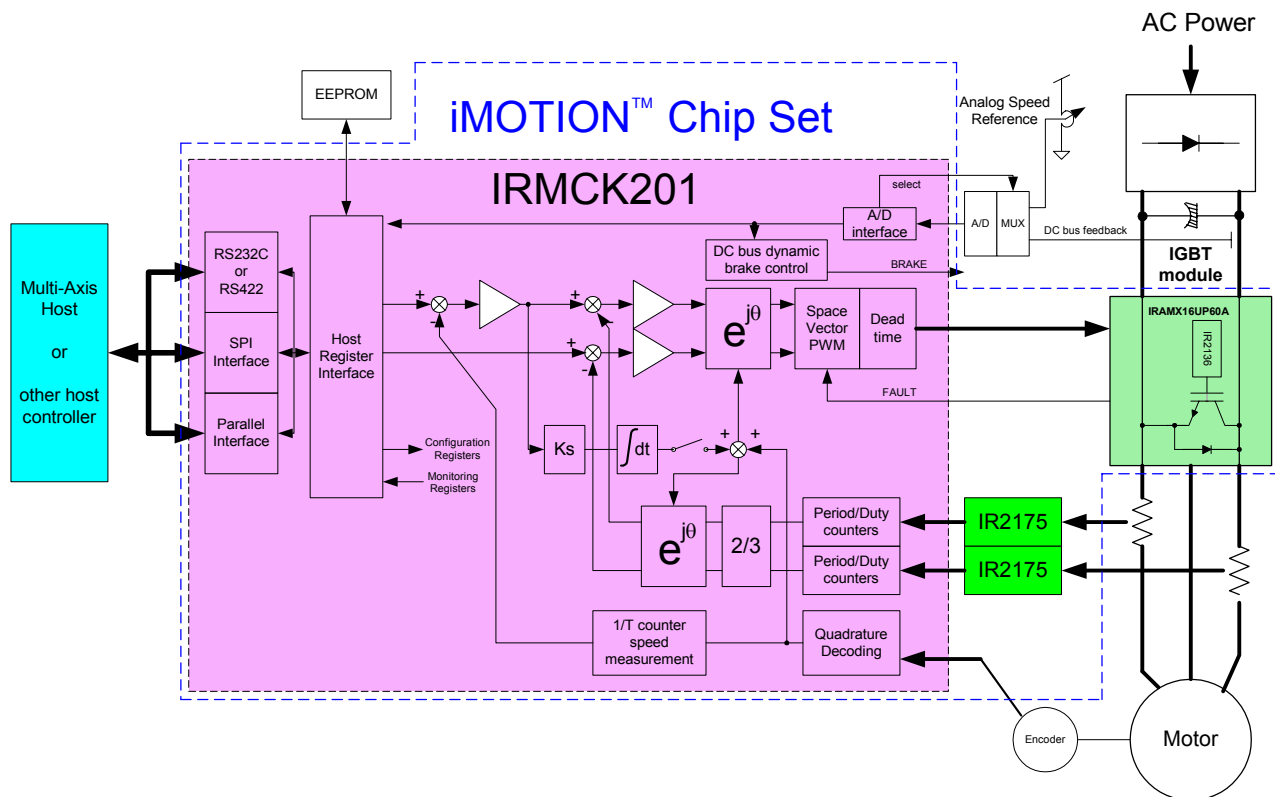


Figure 1. IRMCS2011 System Block Diagram

2. Getting Started

2.1 Safety Precautions

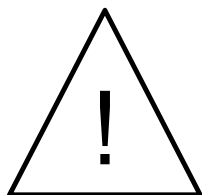
In addition to the precautions listed throughout this manual, you must read and understand the following statements regarding hazards associated with AC servo development system.



ATTENTION: Some ground potential of the IRMCS2011 system is biased to a negative DC bus voltage potential and kept high voltage potential while power is on. When measuring voltage waveform by oscilloscope, the scope ground needs to be isolated. Failure to do so may result in personal injury or death.
Darkened display LED is not an indication that capacitors have discharged to safe voltage levels.



ATTENTION: The IRMCS2011 system contains high voltage capacitors which take time to discharge after removal of main supply. Before working on drive system, ensure isolation of mains supply from line inputs [R, S, T]. Wait three minutes for capacitors to discharge to safe voltage levels. Failure to do so may result in personal injury or death.
Darkened display LED is not an indication that capacitors have discharged to safe voltage levels.



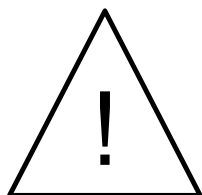
ATTENTION: Only personnel familiar with the drive and associated machinery should plan or implement the installation, start-up, and subsequent maintenance of the system. Failure to comply may result in personal injury and/or equipment damage.



ATTENTION: The surface temperatures of the drive may become hot, which may cause injury.



ATTENTION: The IRMCS2011 system contains ESD (Electrostatic Discharge) sensitive parts and assemblies. Static control precautions are required when installing, testing, servicing or repairing this assembly. Component damage may result if ESD control procedures are not followed. If you are not familiar with static control procedures, reference applicable ESD protection handbook and guideline.



ATTENTION: An incorrectly applied or installed drive can result in component damage or reduction in product life. Wiring or application errors such as undersizing the motor, supplying an incorrect or inadequate AC supply, or excessive ambient temperatures may result in system malfunction.

2.2 Unpacking and Inspecting

The IRMCS2011 system is shipped with packing materials that need to be removed prior to installation.



ATTENTION: Failure to remove all debris and packing materials, which are unnecessary for system installation, may result in overheating or abnormal operating condition.

After unpacking, check the items. The following hardware pieces are contained in the IRMCS2011 system.

- IRMCS2011 board with integrated heat sink
- Serial RS232C cable with 9-pin D-sub connectors for ServoDesigner™ development tool
- Installation CD

Before you install and start up the system, check if there is any damaged component. In that case, stop proceeding and contact our technical support.

3. Preparing the Motor

3.1 Readily Drivable Motor List

If the motor is one of the following, it can be run immediately without commissioning.

- Sanyo Denki 400W 8-pole servo motor with 2000-pulse encoder (P30B06040DXS00M),
- Sanyo Denki 750W 8-pole servo motor with 2000-pulse encoder (P30B08075DXS00M)
- Sanyo Denki 1.5kW 8-pole servo motor with 2000-pulse encoder (P20B10150DXS00M)
- Glentek 160W 4-pole servo motor with 2000-pulse encoder (GMB2010-17-E-02100005)
- Glentek 1.0kW 6-pole servo motor with 5000-pulse encoder (GMB3530-24-E-02200109)
- Glentek 1.2kW 6-pole servo motor with 5000-pulse encoder (GMB3530-37-E-02200109)
- Glentek 600W 6-pole servo motor with 5000-pulse encoder (GMB3530-48-E-02200109)
- Pacific Scientific 800W 8-pole servo motor with 2048-pulse encoder (PMB23C-00114-00)
- Reliance Electric 2HP 4-pole induction motor with 1024-pulse encoder (P14A5805)

If any other motor is used, adaptation and re-configuration is required, which can be accomplished using the ServoDesigner™ tool.

3.2 Assembling Encoder Connector

Prepare the connector assembly to the encoder cables.

- Assemble 15-pin male D-Sub connector, referring to Figure 2.
- Make sure that the encoder is a 5V type. If it is not a 5V type, proper modification is required.

For permanent magnet motors:

- Eleven pins are used: A+ (pin 2), A- (pin 3), B+ (pin 4), B- (pin 5), Z+ (pin 6), Z- (pin 7), HALL_A (pin 10), HALL_B (pin 11), HALL_C (pin 12), 5V(pin 1 or pin 9) and GND (pin 8 or pin 15).
- If hall sensors have differential output, connect only positive sides and leave negative sides open.

For induction motors:

- Only six pins are used because z-pulse is not necessary for an induction machine. The six pins are: A+ (pin 2), A- (pin 3), B+ (pin 4), B- (pin 5), 5V(pin 1 or pin 9) and GND (pin 8 or pin 15).
- Disable Z_pulse by connecting Z+ to GND and Z- to 5V.

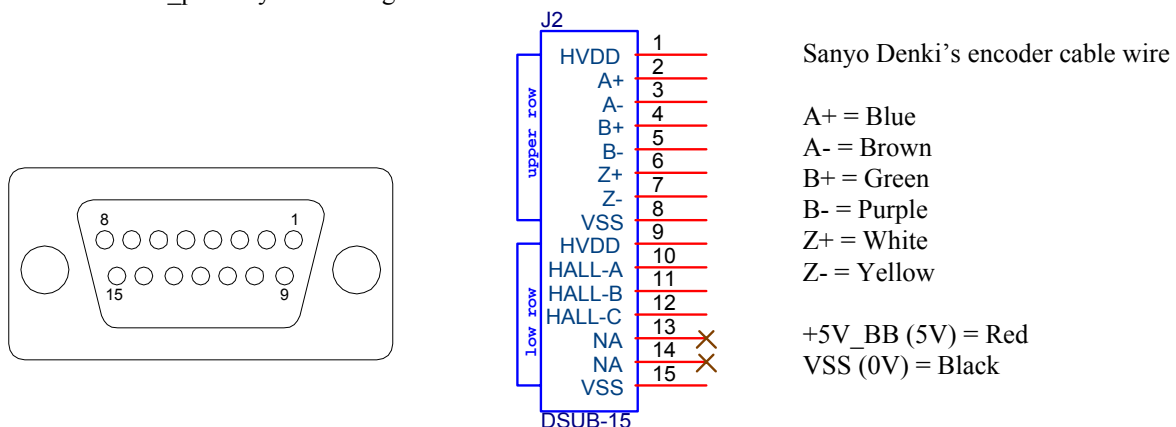


Figure 2. Encoder Interface Connector, J2

3.3 Motor Power Cable

Prepare the motor power cable, which has four wires: U, V, W and E (earth ground). Proper size and length of cable should be used.

4. Hardware Installation

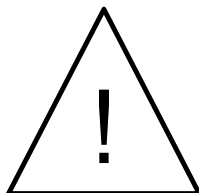
4.1 Safety Precautions



ATTENTION: Remove and lock out power from the drive before you disconnect or reconnect wires or perform service. Wait three minutes after removing power to discharge the bus voltage. Do not attempt to service the drive until bus voltage has discharged to zero. Failure to do so may result in bodily injury or death.



ATTENTION: The drive is intended to be commanded by control input that will start and stop the motor. A device that routinely disconnects then reapplies input power to the drive for the purpose of starting and stopping the motor should not be used. Failure to follow this guideline may result in damage of equipment, and/or bodily injury or death.



ATTENTION: Do not connect power factor correction capacitors to drive output terminals U, V, and W. Failure to do so may result in equipment damage or bodily injury.

4.2 Input Power Wiring

Connect AC 115V or single-phase 230V or three-phase 230V power. For single phase 100V-230V AC power, use R and T for connection. For three phase 230V power, use R/S/T for connection as shown in Figure 3. Insert a power contactor switch rated at 250V/30A in series with AC power cables.



Figure 3. Power Terminal Block, J1

If full power rating is needed, use three-phase 230V power. Otherwise output power should be de-rated. Proper size and length of cable should be used.

4.3 Motor Wiring

Connect motor power and ground wires to terminal block J1 of IRMCS2011 board as shown in Figure 4.

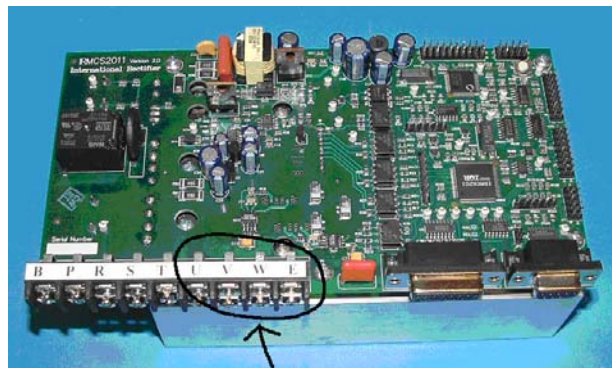


Figure 4. Motor Wiring Connection

For Sanyo Denki, Glentek or Pacific Scientific motors, the colored wires should be connected to the associated Terminal Block pins of the IRMCS2011 board as shown in Table 1.

Sanyo Denki’s motor cable wire	Glentek motor cable wire	Pacific Scientific motor cable wire	Terminal block pin
RED	RED (pin A)	BLUE	U
WHITE	BLUE (pin C)	VIOLET	V
BLACK	BLACK (pin B)	BROWN	W
GREEN/YELLOW	GREEN (pin D)	GREEN/YELLOW	E

Table 1. Motor Connections

4.4 Encoder Connection

Plug the encoder connector into J2 as shown in Figure 5. Make sure that encoder signals are connected properly. Incorrect connection of encoder signals will result in improper rotor position and/or incorrect communication. The shell of the connector is grounded to the chassis for shield termination.



Figure 5. Encoder Connector, J2

4.5 RS232 Connection

Connect the serial cable between the computer COM port and J6 as shown in Figure 6. If there is more than one COM port, please remember which one you are using. Make sure that the cable is connected properly. Incorrect connection of the serial cable will result in communication errors and/or incorrect communication. The shell of the connector is grounded to the chassis for shield termination.

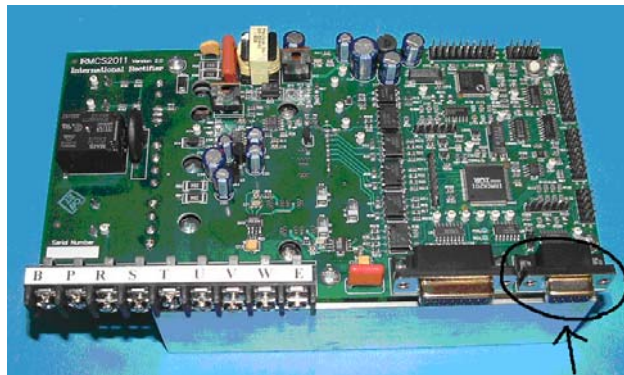


Figure 6. RS232 Connector, J6

5. Software Installation

5.1 Installing from the CD

The distributed CD contains all necessary documents and software files. Load the CD into the CD-ROM drive on your PC and double-click “IRMCS2011.exe”. It will ask you for a password, which is in the file “iMOTION Install IRMCS2011.pdf”. After you enter the password, an automated procedure will install all necessary software on your PC. The default location for the installation is “C:\Program Files\iMOTION”.

5.2 ServoDesigner Startup

You should follow the instructions in this section the first time you use ServoDesigner to verify your installation and test the reference design. These “quick start” instructions assume that you’re using one of the supported motors listed in section 3.1. If not, you’ll need to enter motor configuration parameters before you can begin testing. Refer to “ServoDesigner User’s Guide” and “IRMCK201 Application Developer’s Guide” for more information.

Step 1. RS232 Connection

ServoDesigner communicates with the IRMCS2011 using a COM port on your PC. Before you start the application, you should attach an RS232 cable to the DB9 connector on the reference platform and connect it to an available COM port on your PC.

The first time you start ServoDesigner, a Connection dialog (shown in Figure 7) appears and presents you with a list of available COM ports on your system. Select the COM port to which you have connected the RS232 cable.

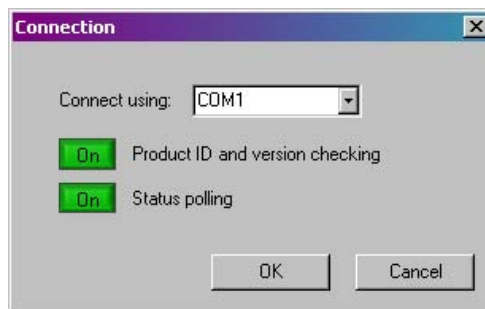


Figure 7. The Connection Dialog

The Connection dialog also allows you to enable and disable product ID and version checking and status polling. **You should have “Product ID and version checking” disabled and “Status polling” enabled!**

When you click OK in the Connection dialog, your selections are saved so they can be used next time you start the application. (The dialog won’t appear on startup again.) If you want to change your selections later on, you can access the Connection dialog through the Preferences menu.

The currently configured COM port is shown on the status bar at the bottom of ServoDesigner’s main display.

Step 2. Numeric Format

The first time you start ServoDesigner, the Numeric Display Format dialog appears, as shown in Figure 8. This dialog allows you to select either decimal or hexadecimal format for numeric display. Click the blue button to switch between hexadecimal and decimal. When you click OK, your setting is saved so it can be used next time you run ServoDesigner. (The dialog won’t appear on startup again.) If you want to change the setting later on, you can access the Numeric Display Format dialog through the Preferences menu.

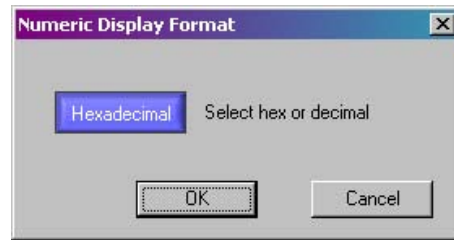


Figure 8. The Numeric Display Format Dialog

Note: Regardless of which display option you choose, you can always enter values in decimal or hexadecimal. ServoDesigner interprets a value you enter as hexadecimal if it begins with “0x” (0x222), and otherwise as decimal (222).

6. Running the System

6.1 Power-On

Apply AC 115V – AC 230V power to the system. Immediately after power-on, the red LED (surface mount LED located at the right side of the board) will lit on/off indicating the on-board DC bus has been established.

6.2 Running motor with ServoDesigner

Step 1. Opening the Configuration File

You need to open a configuration file. The configuration file contains the register, functional and monitor definitions that make up ServoDesigner’s tree view. To start, you should open one of the default files that are shipped with the release. Later, when you’ve modified the register values, function definitions and/or tunable parameters, you’ll want to save your custom configuration in another file.

A default configuration file for each supported motor is shipped with the release. The file names include the part number of your product and the part number of the motor, with the file extension “.irc”. For example, one of the configuration files for the IRMCS2011 product is named “IRMCK201-GMB2010-17-E.irc”. The files are located in the `IMOTION\ServoDesigner` directory. To open a configuration file, select Open from the File menu or click the toolbar button that shows an open folder. Browse for the file you want and click OK. An example is shown in Figure 9.

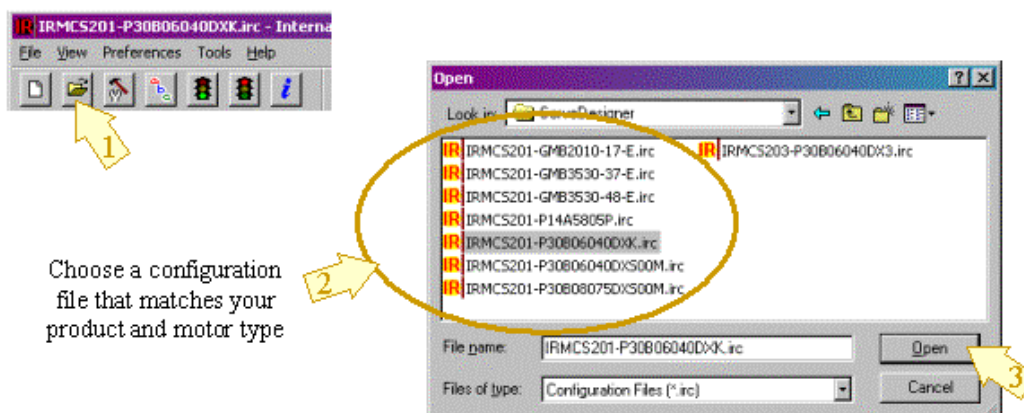


Figure 9. Open a Configuration File

Note: Configuration files are saved in text format, but you should not edit the files manually. If you need to make changes to a configuration file, open the file in ServoDesigner, make the changes as described later in this document, and then save the changes by selecting Save or Save As... from the File menu.

Step 2. Checking Communication Status

Until you open a configuration file, the COM port status at the bottom of ServoDesigner’s main display shows “Inactive”. When you open a file, ServoDesigner attempts to establish contact with the IRMCS2011 by executing a read operation. If ServoDesigner receives a reply to its request, the COM port status shows “Up.” If no reply is received, the status changes to “Down.” A “Down” status usually means the reference platform is not powered on, the RS232 cable is not connected, or the cable is connected to the wrong COM port. Figure 10 shows how communication status should appear before you continue your testing .

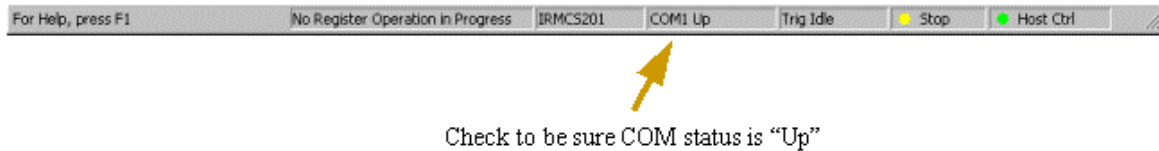


Figure 10. Communication Status Indicator

Note: If you disable status polling in the Connection dialog, ServoDesigner does not attempt to establish contact with the reference platform, and the COM port status shows "Inactive" even after you open a configuration file.

Step 3. Motor Configuration

The Configure Motor function is one of the pre-defined operations in ServoDesigner's Function Definitions section. This function initializes the host registers for normal operation. If you click the Configure Motor entry in the tree view, a list of the registers that are written when this operation is executed is displayed in the right pane of the main window. The "Value to Write" column shows the value that will be written to each register. You can click the "+" symbol to the left of the Configure Motor function to access detailed information about each of the registers.



To execute the Configure Motor function, click the Configure Motor toolbar button (the icon shows a hammer and wrench) or double-click on the Configure Motor entry in the tree view.

Once this function is executed correctly, the LED will turn to blinking green.

Step 4. Starting Angle

For induction motor operation, skip this step. This function reads the Hall A, B, C inputs and uses the motor magnet position data read from your configuration file to determine the starting position of the motor. (See "ServoDesigner User's Guide" for more information about motor configuration parameters.)



To execute the function, click the Starting Angle toolbar button (the icon shows the characters "ABC") or double-click the Starting Angle entry in the tree view.

Step 5. Running the Motor

Start Motor and Stop Motor functions are also pre-defined Function Definitions.



To start the motor, click the Start Motor toolbar button (the green traffic signal) or double-click the Start Motor entry in the tree view.



To stop the motor, click the Stop Motor toolbar button (the red traffic signal) or double-click the Stop Motor entry in the tree view.

When the motor is running, the far right hand status bar pane should show drive status "Run" with a green indicator. When the motor is stopped, the drive status should be "Stop" with a yellow indicator. If a drive fault occurs, the status changes to "Fault" with a red indicator. The status is "Inactive" (blue indicator) when the COM port status is "Down" or "Inactive."

Step 6. Reference Speed

ServoDesigner provides a special built-in function that allows you to easily control the motor's reference speed and direction. To modify the settings, see Figure 11. First, locate the Reference Speed entry in the Function Definitions section of the tree view. Right-click on the entry and select Properties. In the Properties dialog, you can enter the desired speed in RPM and the direction (forward or reverse). In the dialog, you can also specify the host register to which the speed/direction setting is written. You should not modify this setting unless you redefine the host register map.

After entering a speed and selecting forward or reverse, click OK in the dialog and then double-click the Reference Speed entry in the tree view to execute the operation. ServoDesigner calculates the appropriate value to be written the host register (based on your specified speed and direction) and performs the write operation.

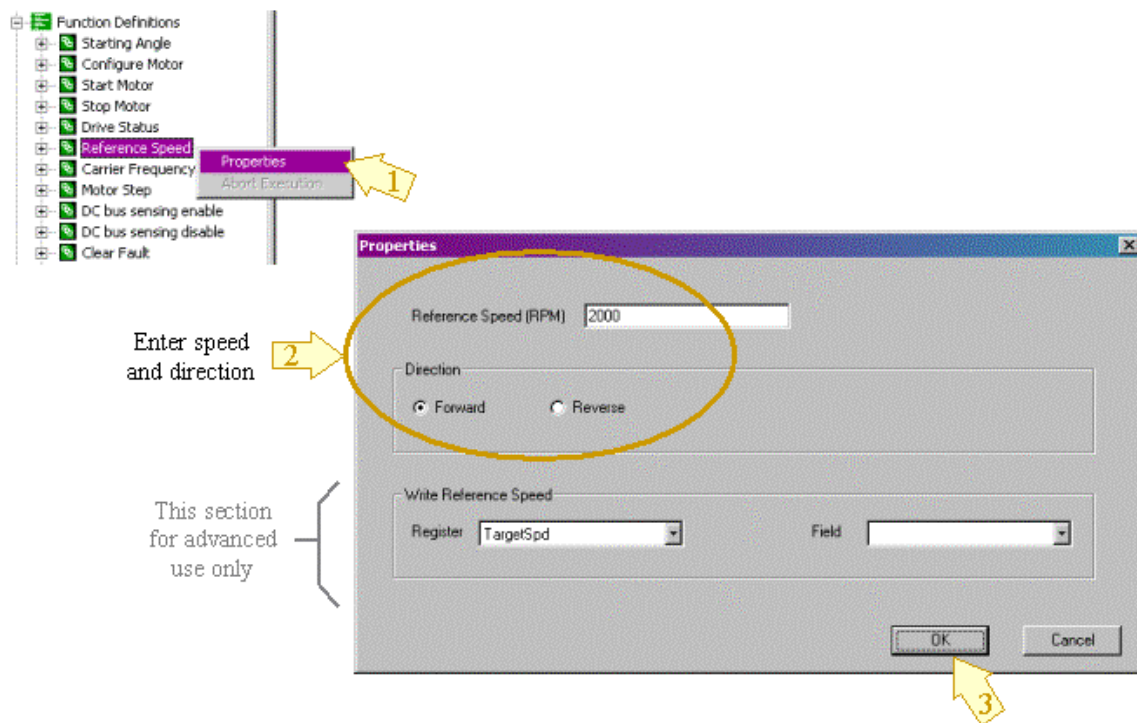



Figure 11. Setup for Reference Speed Function

Step 7. Drive Status

The Info button on the toolbar (letter “i”) executes the pre-defined Drive Status function, which reads a group of host registers associated with the function.

 To get drive status, click the Info button or double-click the Drive Status entry in the tree view. After you’ve executed the function, click on Drive Status in the tree view (if it’s not already selected). In the right pane of the main window, the values read from the Drive Status registers are shown in the Current Value column.

7. Motion Control Engine

7.1 Motion Control Engine (MCE) Based Complete Servo Control

Figure 12 shows the detailed algorithm block diagram including various parameters which can be configured through the host register interface.

Closed loop current and velocity control are implemented in the IRMCK201 IC on the IRMCS2011 board. The closed loop current control algorithm is based on a synchronously rotating frame. The velocity control is available as an outer loop control of the current control and can be disabled in order to configure torque control mode. Additional configuration allows feedforward control, selection of the position feedback devices, induction machine vector control, and selection of communication protocol.

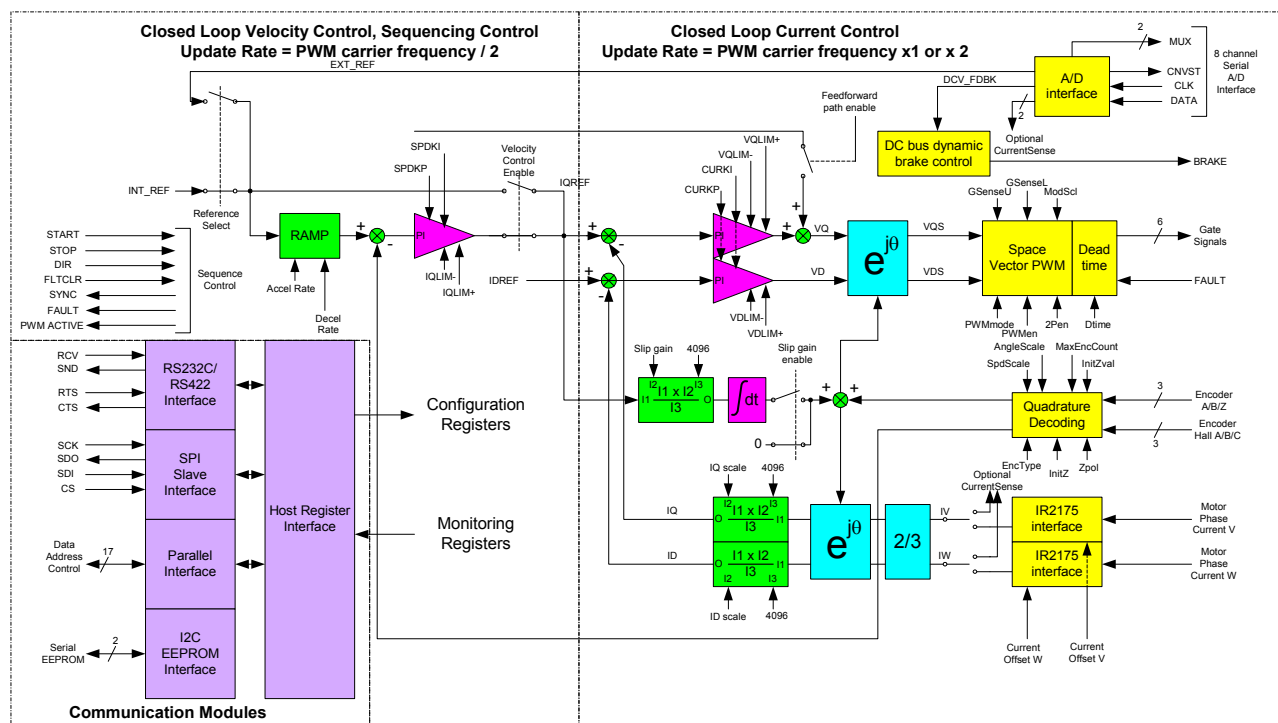


Figure 12. IRMCK201 Based Complete Servo Control



8. New Motor Adaptation

New motor can be configured by simple EXCEL spreadsheet. EXCEL spreadsheet template is provided in the shipment with the filename "IRMCx201-DriveParams.xls".

This spreadsheet facilitates configuration of parameters which need to go into each host registers inside of the IRMCK201 IC. The spreadsheet calculates current feedback/speed feedback scaling, Proportional plus Integral (PI) gains of current and speed regulators, PWM carrier frequency, deadtime, etc, based on simple motor nameplate and published data input. The output of this spreadsheet is text file containing one-to-one corresponding each registers' values. User can use the ServoDesigner™ to read this output into the associated registers.

For detailed operation, please refer to "3.1 Drive Parameter Setup" in IRMCK201 Application Developer's Guide.

Motor Selection : 1
 (Type the number here!) **P30B06040DXS00M**
 password : 201

"===== Motor Information ====="

(RPM) Rated Speed	3000rpm	
(Lq) L_phase	0.00644H	(line to line Inductance) / 2
(R_Stator) R_phase	1.4ohms/ph	(line to line Resistor) / 2
(Amps) Rated Amps	2.7Arms	
(NLC)No Load Current	0Arms	(necessary for IM)
(Jm) Inertia of Motor	2.55E-05Kg-m2	
(Kt) Torque Constant	0.533N-m/Arms	
(Ke) Voltage Constant	18.6V In-rms/krpm	voltage is line to neutral rms
Poles	8	
(PPR) Encoder PPR	2000pulse/revolution	
Wire-Saving Encoder?	TRUE(TRUE / FALSE)	

"===== Application Information ====="

"----- General -----"

Max RPM	4500rpm
(Vdc_Nom) Nominal Vdc	310Volts
(OvLoad) Max pu motor current at rated speed	3pu

"----- Speed Regulator Tuning -----"

Speed Regulator BW	200rad/sec
Positive Speed Rate limit	1000rpm/sec
Negative Speed Rate limit	1000sec to rate speed
Inertia of Load (measured)	0Kg-m2
SpdLpRate	21 SpdLoop per this # of CurLoop

"----- Current Limits -----"

Motoring Limit	200%
----------------	-------------



Regen Limit	200%
"----- Inverter Switching Frequency -----"	
(fc) Pwm carrier freq	10KHz
Dead_Time	0.5usec
" ----- Current Regulator Tuning ----- "	
(Ireg_BW) Current Reg BW	2500rad/sec

"===== Advance Information (Platform fixed) ====="

Note: Below values are fixed for IRMCS2011 platform however can be changed for other platform

(Clk) IRMCK201 clock freq	33.333MHz
DC Bus Scaling (Vdc_Scl)	8.1875cts/Volt
I_Torque (I_Trq_Rated)	4095cts for rated Amps
(Mod_Pk) - U_Alpha U_Beta max linear modulation	2355Cts

" ----- Desired Speed feedback Scaling -----"	
(Spd_Scale)	16384cts/(Max RPM)

" ----- Current Feedback Scaling -----"	
Current Shunt Resistor	10mOhm
Max H/W Current	26Apeak

"===== Commutation Information ====="

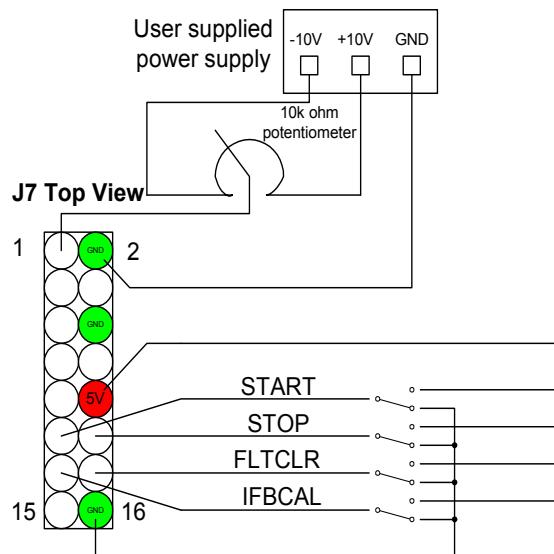
Angle of Z-pulse (based on UV line to line voltage)	272degree
Mid Angle when Hall CBA is 001	120degree
Mid Angle when Hall CBA is 010	240degree
Mid Angle when Hall CBA is 011	180degree
Mid Angle when Hall CBA is 100	0degree
Mid Angle when Hall CBA is 101	60degree
Mid Angle when Hall CBA is 110	300degree

Figure 13. EXCEL Spreadsheet Inputs

9. Appendix

9.1 External I/O

Connect External I/O Connector (J7) as needed. All inputs are 5V tolerant and high true logic.



Pin definition

- Pin 1: Analog input (+/-10V)
- Pin 2: Analog GND
- Pin 3: N/A (open)
- Pin 4: N/A (open)
- Pin 5: N/A (open)
- Pin 6: Digital GND
- Pin 7: FAULT status output (3.3V when FAULT)
- Pin 8: SYNC status output (3usec width of active low pulse at every carrier frequency period)
- Pin 9: PWMACTIVE output (3.3V when PWM active)
- Pin 10: +5V
- Pin 11: START input (high to activate)
- Pin 12: STOP input (high to activate)
- Pin 13: Ifb offset calibration input (high to activate)
- Pin 14: Fault Clear input (high to activate)
- Pin 15: N/A (open)
- Pin 16: Digital GND

Figure 14. External I/O Connector, J7

9.2 RS232C Connector

IRMCS2011 has one serial RS232C connector (J6) on the board. The connector is D-sub 9 pin standard PC female connector and directly connectable to PC serial port. As shown in Figure 15, pin 2 is send-signal and pin 3 is receive-signal, and both are 10V signal level. The baud rate is fixed at 57.6 kbps. The signal format is 8 bits, no parity, 1 stop bit.

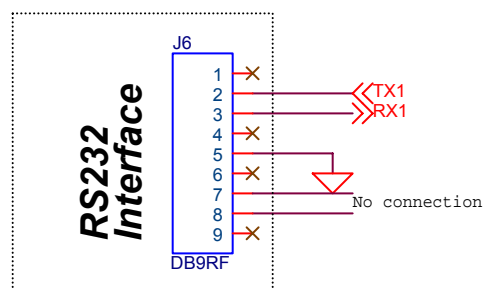


Figure 15. RS232C Connector, J6

9.3 Parallel Interface Port

IRMCS2011 provides an 8bit parallel interface port to facilitate microprocessor interface. Interface is generic and able to interface most common 8bit parallel interface such as MCS8051, some Motorola 8bit uP, MicroChip, etc. Figure 16 shows the connection diagram. The connector, J5, is a 2-by-10 header connector pins.

Each signal is 3.3V level and data bus is multiplexed. Table 2 summarizes each signal definition.

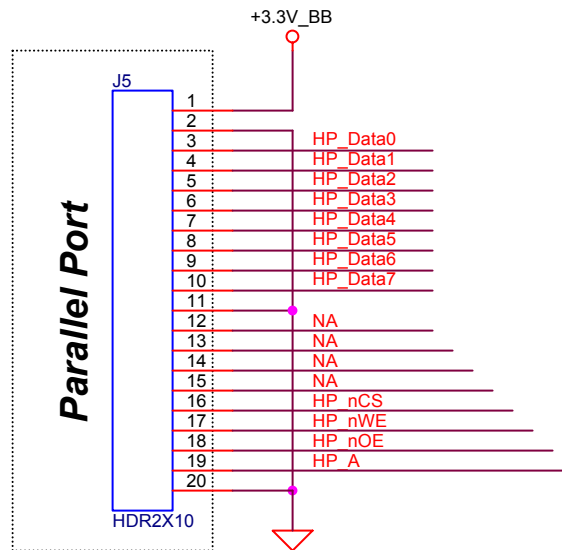


Figure 16. Parallel Interface Port, J9

Signal	I/O ¹	Description
HP_nCS	I	Active low Host Port Chip Select
HP_nOE	I	Active Low Host Port Output Enable
HP_nWE	I	Active low Host Port Write Enable
HP_A	I	Host Port Register Address. 1 = Address register, 0 = Data Register
HP_Data	I/O	Bidirectional Host Port data bus

Table 2. Microprocessor Interface Module Signal Definitions

Figure 17 and Figure 18 show detailed timing requirements for register read and write operations depending on the type of microprocessor (Intel or Motorola type). All values are in nanoseconds. The data bus output is activated by the logical combination (!nCS && !nOE && new), which allows read and write operations to be either nWe/nOE (Intel) or nCS (Motorola) driven.



Row	Name	Min	Max	Comment
1	C TsuADDR	10		HP_A to HPnCS or HP_nWE (which ever occurs last) low setup time
2	C TsuData	0		HP_D to HPnCS or HP_nWE (which ever occurs last) low setup time
3	C Tpw_nCSnWE	60		Minimum pulswidth for nCS and nWE
4	C ThData	60		Minimum data hold time from HP_nWE or HPnCS (whichever occurs last) low
5	C ThAddr			Minimum address hold time from HP_nWE or HPnCS (whichever occurs last) low
6	D Tacc	0	35	HP_nCS or HP_nOE (whichever occurs last) to Data access time
7	D ThData	0	35	HP_nCS or HP_nOE (whichever occurs last) to Data invalid/Hi-

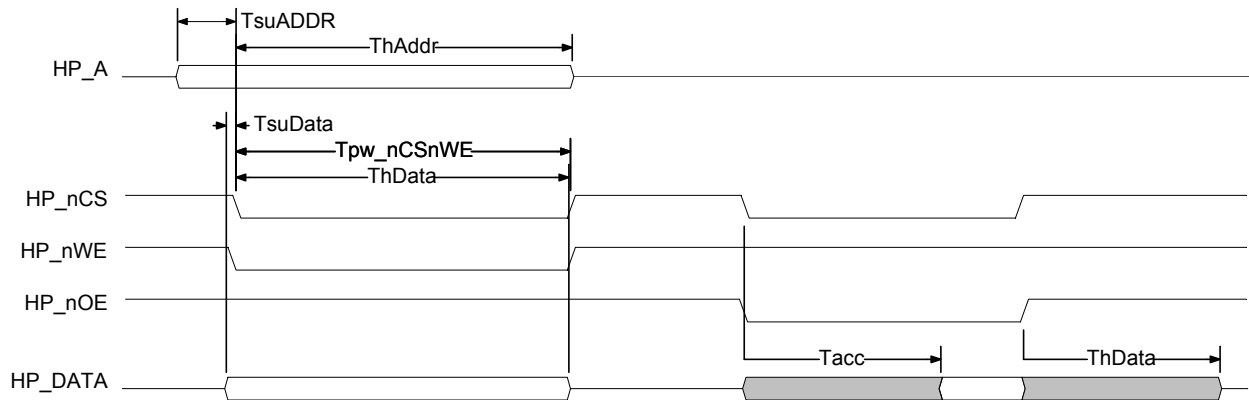


Figure 17. Register Write/Read Timing (Intel)



Row		Name	Min	Max	Comment
1	C	TsuADDR	10		HP_A to HPnCS low setup time
2	C	TsuData	0		HP_D to HPnCS low setup time
3	C	Tpw_nCSnWE	60		Minimum pulswidth for nCS
4	C	ThData	60		Minimum data hold time from HPnCS low
5	C	ThAddr			Minimum address hold time from HPnCS low
6	D	Tacc	0	35	HP_nCS to Data access time
7	D	ThData	0	35	HP_nCS to Data invalid/Hi-Z

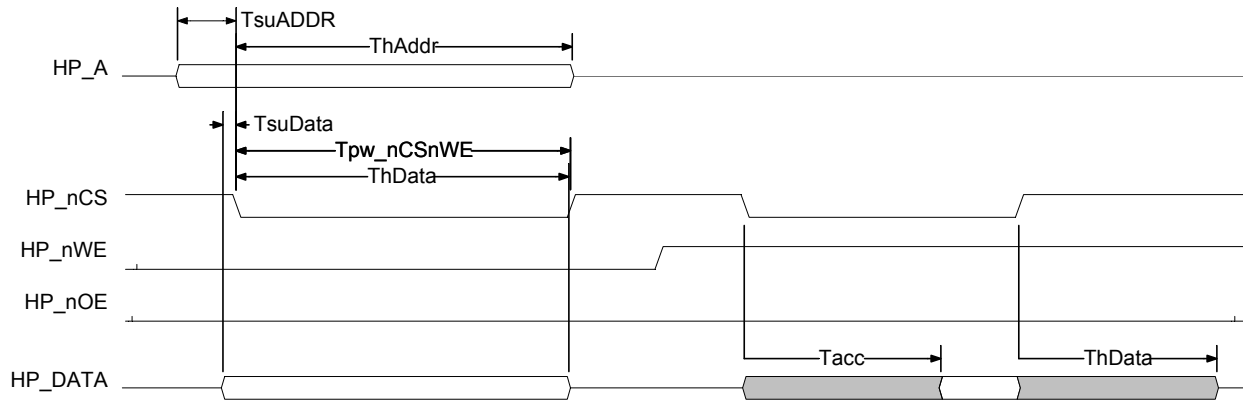


Figure 18. Register Write/Read Timing (Motorola)



10. Specifications

T_C=25°C unless specified

Parameters	Values	Conditions
Input Power		
Voltage	115V-230Vrms, -20%, +10%	TA=40°C, RthSA=1.0 °C/W
Frequency	50/60 Hz	
Input current	7A rms @nominal output	
Input line impedance	4%~8% recommended	
Output Power		
Watt	750W continuous power	Vin=230V AC, f _{PWM} =10kHz, f _O =60Hz, TA=40°C, RthSA=1.0 °C/W ZthSA limits ΔTC to 10°C during overload
Current	5.0 Arms nominal, 15 Arms Overload	
Host interface (SPI)		
SCLK,CS,MISO,MOSI, SYNC	3.3V logic level	Isolated, maximum 6MHz
Host interface (RS232C/422)		
Tx, Rx	10V	Maximum 57.6k bps, single ended, configurable for RS422 up to 1Mbps
Host interface (Parallel Port)		
HP_nCS, HP_nOE, HP_nWE, HP_A, HP_DATA[8]	3.3V	8 bit parallel interface compatible with 8051, MicroChip, other μP.
D/A		
8 bit 4 Channel	0-3.3V output	Output is buffered with 4mA drive capability
A/D		
12 bit 2 channel	±10V for reference input, 5V for DC bus input	
Discrete I/O		
Input	4 bit, START, STOP, FLTCLR, IFBCAL	5V tolerant, Isolated, Active High logic
Output	3 bit, PWMACTIVE, FAULT, SYNC	
Current feedback		
Current sensing device	IR2175, direct interface	133 MHz internal IRMCK201 clock IR2175 PWM output (130 kHz)
Resolution	10 bit (7.5 nanoseconds counting resolution)	
Latency	8.3 usec	
Protection		
Output current trip level	35A peak, ±10%	Case temperature line-to-line short, line-to-DC bus (-) short
Ground fault trip level	35A peak, ±10%	
Over-temperature trip level	110°C, ±5%	
Short circuit delay time	2.5 μsec	
DC bus voltage		
Maximum DC bus voltage	400V	Should not exceed 400V for > 30 sec VCC=15V ± 10%, VDD=5V ± 5%
Minimum DC bus voltage	120V	
Encoder Interface		
Incremental encoder	Maximum 2 MHz	All differential signals are converted to single ended signals including index pulse
Hall A/B/C initialization	Programmable wire saving/dedicated A/B/C	
Power Module		
IRAMX16UP60A 3-phase HVIC	6 IGBT/FRED + IR2136 gate driver, integrated overtemp protection	Bootstrap power supply for high side circuit
System environment		
Ambient temperature	0 to 40°C	95%RH max. (non-condensing)

Table 3. IRMCS2011 Electrical Specification



International
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