ServoCenter 3.1 Chip

User's Manual
&
Programming Guide

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1 Introduction

The ServoCenter Chip is a microcontroller that allows any serial communications-capable device to control standard hobby servo motors. The chip provides easy control of the seek position and seek speed of each of up to sixteen connected servos independently and simultaneously. This independent control scheme allows one servo to be moving to a position slowly, while another is moving to a different position quickly, while yet another is moving to another position at a medium speed.

The ServoCenter Chip also offers advanced control features such as absolute & relative control command sets, raw & scaled positional modes, a simple yet reliable command protocol, and on-board settings storage.

The ability to independently control both position and speed, combined with the controller's flexible and extensible feature set make the ServoCenter Chip especially useful for servo control applications such as robotics, animatronics, motion control, automation, retail displays, and other areas where independent or coordinated fluid servo motion is necessary or desirable.

Up to 16 motors can be connected to each ServoCenter Chip, and with proper support circuitry, up to 16 ServoCenter Chips can be "daisy-chained" together, thus allowing for a total of 256 RC servos to be controlled independently and simultaneously from one serial device.

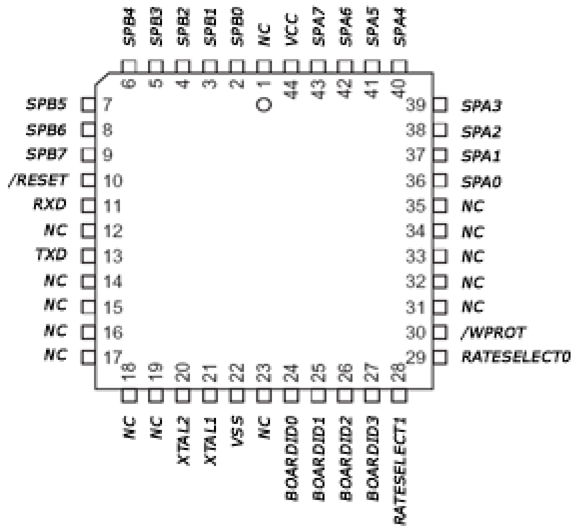
2 Features

- Standard RS-232 or TTL serial control at 9600,14400,19200, or 38400 bps.
- Control position and speed of all connected servos simultaneously.
- Scaled motion commands allow maximum, minimum, and startup position-setting, making complex motion programming easier.
- Absolute and relative position commands allow for greater programming flexibility.
- Configuration information saved even when the power is off.
- Control up to 16 RC servos per chip.
- Daisy-chain up to 16 chips to control up to 256 servos from one serial controller.
- Simple yet robust serial protocol makes programming simple.
- Downloadable example code can get you started quickly.
- Example programs available for VC6, VB6, QBASIC, Turbo C, and GCC/LINUX.

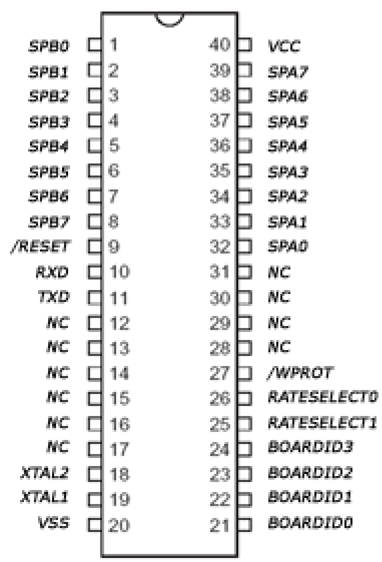
3 Chip Overview

3.1 Chip Package Diagrams

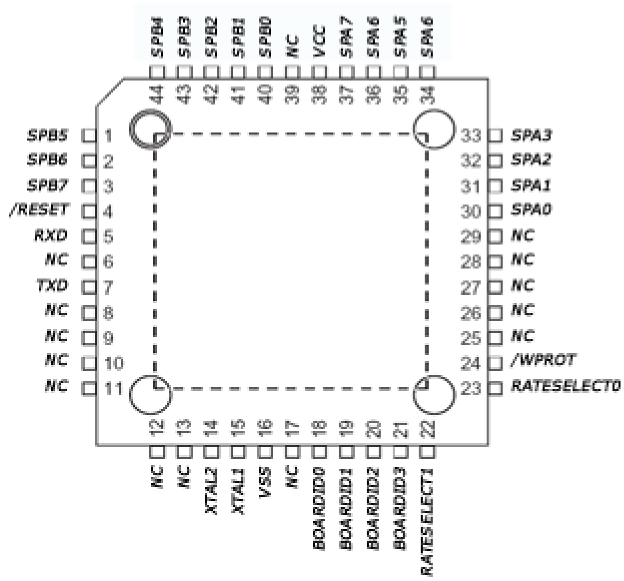
3.1.1 PLCC



3.1.2 DIP



3.1.3 TQFP



3.2 Pin Descriptions

All of the Servo Control and Configuration pins are internally tied high through 20-50K pull-up resistors. The /RESET pin is internally tied high through a 30-60K pull-up resistor. When used in the charts below, logic levels 1 and 0 correspond to V_{DD} and V_{SS}, respectively.

- **SPA0-7** : These pins should be connected to the signal pin of servos 0-7.
- **SPB0-7** : These pins should be connected to the signal pin of servos 8-15.
- **/RESET** : This pin will reset the ServoCenter Chip when it is pulled low. Use of a reset circuit will prevent unwanted chip-resetting during power source fluctuation, but such a circuit is not necessary for the operation of the chip.
- **RXD & TXD**: The RXD and TXD pins can be used for serial communication between the ServoCenter Chip and another device. This communication should follow the ServoCenter Protocol.
- **V_{DD}** : V_{DD} should be connected to a voltage in the range 2.7V-5.5V. +5V is the nominal voltage.
- **V_{SS}** : V_{SS} should be connected to the circuit's ground path.

- **BOARDID0-BOARDID3** : These 4 pins determine the Chip ID. See the chart below:

BOARDID0	BOARDID1	BOARDID2	BOARDID3	Chip ID
1	1	1	1	0
0	1	1	1	1
1	0	1	1	2
0	0	1	1	3
1	1	0	1	4
0	1	0	1	5
1	0	0	1	6
0	0	0	1	7
1	1	1	0	8
0	1	1	0	9
1	0	1	0	10
0	0	1	0	11
1	1	0	0	12
0	1	0	0	13
1	0	0	0	14
0	0	0	0	15

- **RATESELECT0-RATESELECT1** : These two pins determine the Data Rate for serial communication. See the chart below:

RATESELECT0	RATESELECT1	Data Rate
1	1	9600 bps
0	1	14400 bps
1	0	19200 bps
0	0	38400 bps

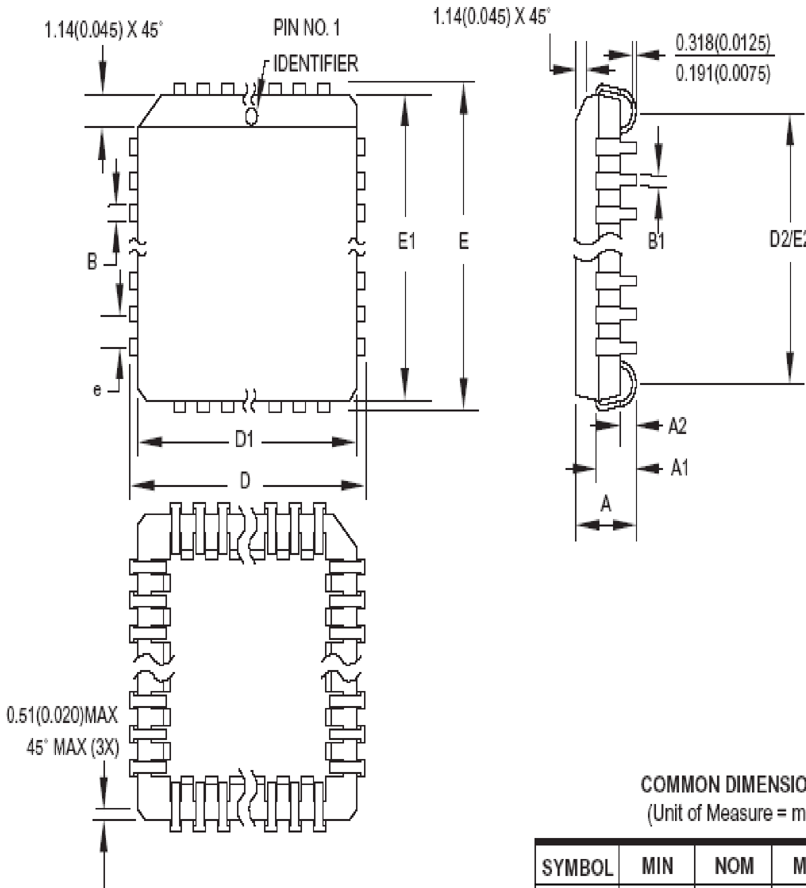
- **/WPROT** : This is the Write-Protection Pin. To enable Write Protection, tie WPROT to V_{SS}.

- **XTAL1-XTAL2** : For the ServoCenter 3.1 Chip to operate correctly, it must be interfaced to an 8 MHz clock signal. This can be accomplished by either attaching an oscillator to XTAL1 and leaving XTAL2 hanging, or by tying a crystal between XTAL1 and XTAL2.

4 Specifications

4.1 Physical

4.1.1 PLCC:

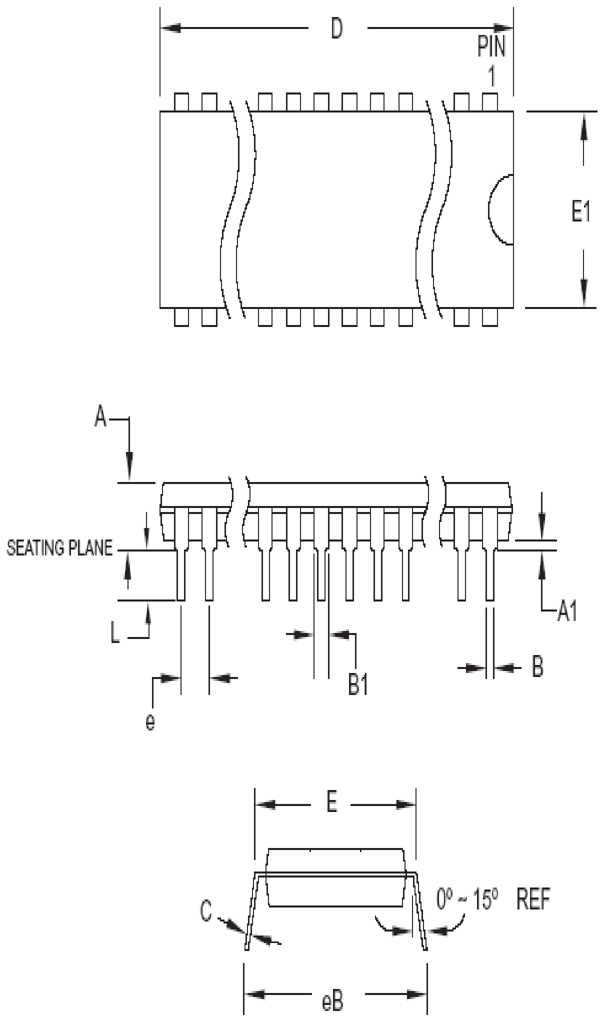


COMMON DIMENSIONS
(Unit of Measure = mm)

SYMBOL	MIN	NOM	MAX	NOTE
A	4.191	–	4.572	
A1	2.286	–	3.048	
A2	0.508	–	–	
D	17.399	–	17.653	
D1	16.510	–	16.662	Note 2
E	17.399	–	17.653	
E1	16.510	–	16.662	Note 2
D2/E2	14.986	–	16.002	
B	0.660	–	0.813	
B1	0.330	–	0.533	
e	1.270 TYP			

Notes:
1. This package conforms to JEDEC reference MS-018, Variation AC.
2. Dimensions D1 and E1 do not include mold protrusion. Allowable protrusion is .010"(0.254 mm) per side. Dimension D1 and E1 include mold mismatch and are measured at the extreme material condition at the upper or lower parting line.
3. Lead coplanarity is 0.004" (0.102 mm) maximum.

4.1.2 PDIP:

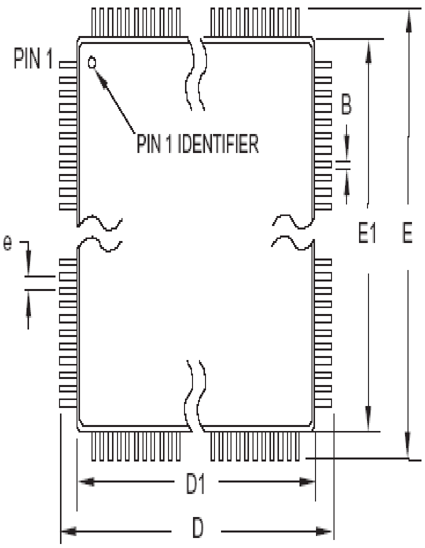


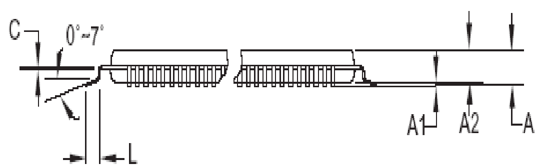
Notes: 1. This package conforms to JEDEC reference MS-011, Variation AC.
2. Dimensions D and E1 do not include mold Flash or Protrusion.
Mold Flash or Protrusion shall not exceed 0.25 mm (0.010").

COMMON DIMENSIONS
(Unit of Measure = mm)

SYMBOL	MIN	NOM	MAX	NOTE
A	–	–	4.826	
A1	0.381	–	–	
D	52.070	–	52.578	Note 2
E	15.240	–	15.875	
E1	13.462	–	13.970	Note 2
B	0.356	–	0.559	
B1	1.041	–	1.651	
L	3.048	–	3.556	
C	0.203	–	0.381	
eB	15.494	–	17.526	
e	2.540 TYP			

4.1.3 TQFP:





COMMON DIMENSIONS
(Unit of Measure = mm)

SYMBOL	MIN	NOM	MAX	NOTE
A	–	–	1.20	
A1	0.05	–	0.15	
A2	0.95	1.00	1.05	
D	11.75	12.00	12.25	
D1	9.90	10.00	10.10	Note 2
E	11.75	12.00	12.25	
E1	9.90	10.00	10.10	Note 2
B	0.30	–	0.45	
C	0.09	–	0.20	
L	0.45	–	0.75	
e	0.80 TYP			

Notes:
1. This package conforms to JEDEC reference MS-026, Variation ACB.
2. Dimensions D1 and E1 do not include mold protrusion. Allowable protrusion is 0.25 mm per side. Dimensions D1 and E1 are maximum plastic body size dimensions including mold mismatch.
3. Lead coplanarity is 0.10 mm maximum.

4.2 Electrical

4.2.1 Absolute Maximum Ratings*

Operating Temperature	-55˚C to +125˚C
Storage Temperature	-65˚C to +150˚C
Voltage on any pin except /RESET with respect to Ground	-0.5V to V_{DD} +0.5V
Voltage on /RESET with respect to Ground	-0.5V to +13.0V
Maximum Operating Voltage	6.0V
DC Current per I/O pin	40.0 mA
DC Current V_{DD} and GND pins	200.0 mA

*Notice: Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the ServoCenter Chip. This is a stress rating only and functional operation of the chip at these or other conditions beyond those indicated here is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

4.2.2 DC Characteristics

T_A = -40˚C to 85˚C, V_{DD} = 2.7V to 5.5V (Unless Otherwise Noted)

Symbol	Parameter	Condition	Min	Max	Units
V_{DD}	Supply Voltage		2.7	5.5	V
V_{IL}	Input Low Voltage		-0.5	0.2 V_{DD} (1)	V
V_{IH}	Input High Voltage	Except /RESET Pin	0.6 V_{DD} (2)	V_{DD}+ 0.5	V
V_{IH1}	Input High Voltage	/RESET Pin	0.9 V_{DD} (2)	V_{DD} + 0.5	V
V_{OL}	Output Low Voltage	I_{OL} = 20mA, V_{DD} = 5V I_{OL} = 10mA, V_{DD} = 3V		0.7 0.5	V
V_{OH}	Output High Voltage	I_{OH} = -20mA, V_{DD} = 5V I_{OL} = -10mA, V_{DD} = 3V	4.2 2.2		V
I_{IL}	Input Leakage Current	V_{DD} = 5.5V, pin low (absolute value)		1	µA
I_{IH}	Input Leakage Current	V_{DD} = 5.5V, pin high (absolute value)		1	µA
R_{RST}	Reset Pull-up Resistor		30	60	kΩ
R_{PU}	I/O Pin Pull-up Resistor		20	50	kΩ
I_{DD}	Power Supply Current	V_{DD} = 5V		12	mA

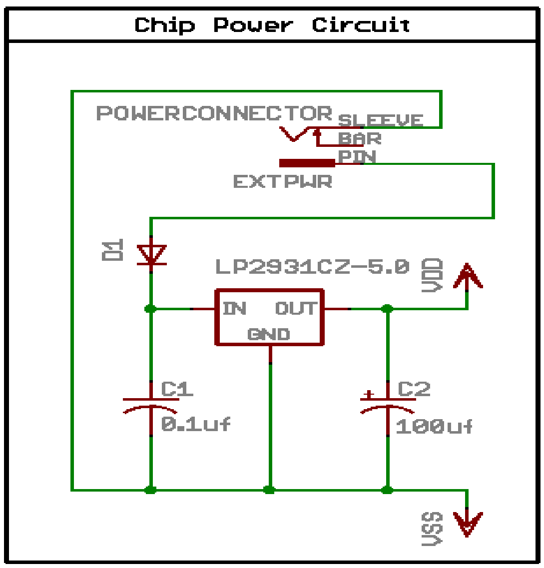
Notes: 1. "Max" means the highest value where the pin is guaranteed to be read as low.
2. "Min" means the lowest value where the pin is guaranteed to be read as high.

5 ServoCenter 3.1 Chip Example Support Circuitry

5.1 Power Supply

Chip V_{DD} should be in the range 2.7-5.5V.

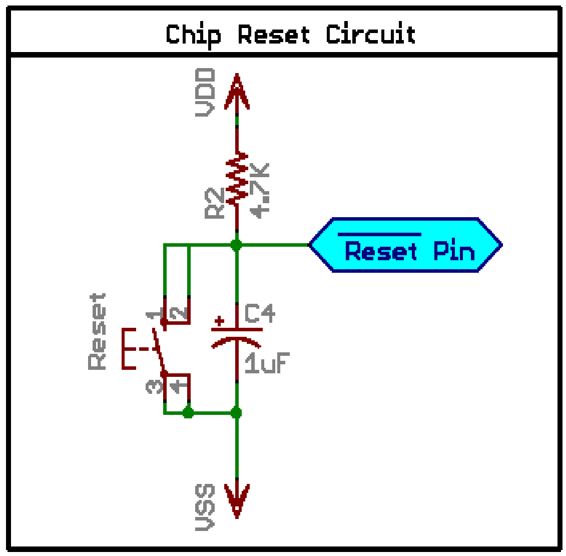
One way to achieve this voltage is through the use of a voltage regulator such as the LP2931CZ-5.0. EXTPWR should be at least 5V, and not greater than the maximum rating of the voltage regulator (30V for the LP2931CZ-5.0).



Power Supply Pins		
Package	**VDD Pin**	**VSS Pin**
PDIP	40	20
TQFP	38	16
PLCC	44	22

5.2 Reset Circuit

The ServoCenter Chip has an active-low /RESET input pin. Pulling this /RESET pin low will cause the ServoCenter Chip to reset.



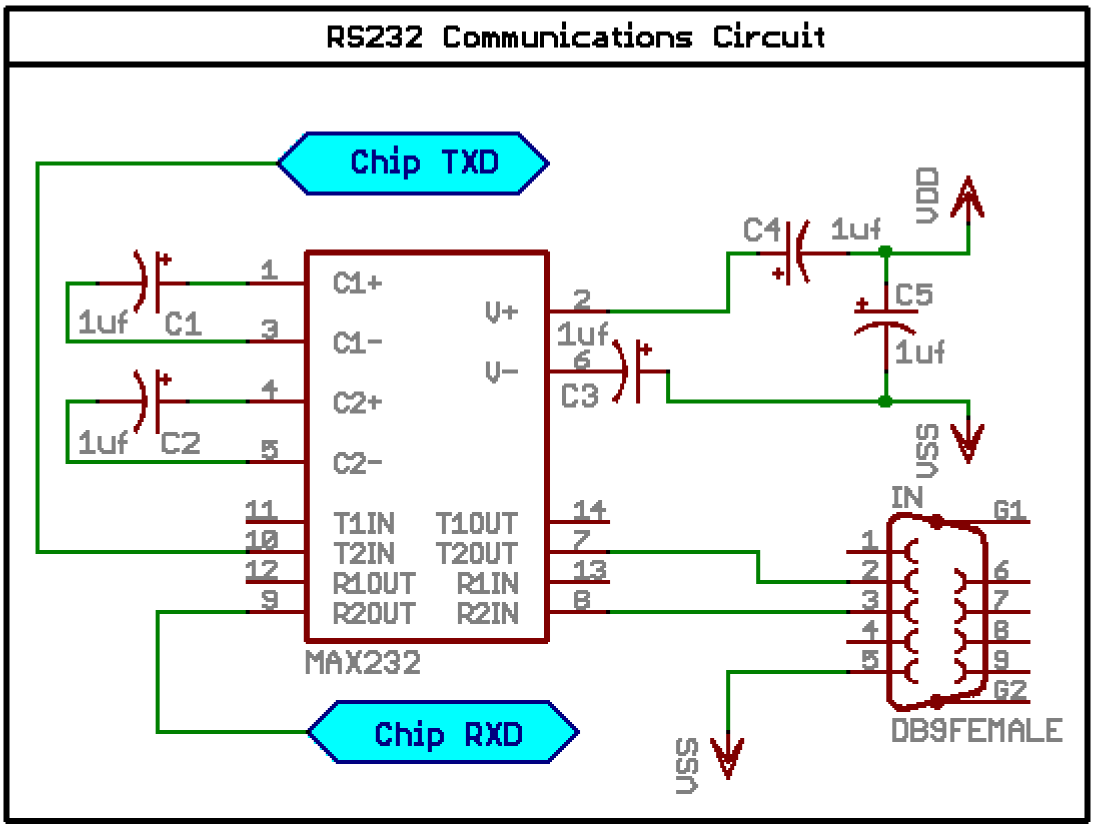
/RESET Pin	
Package	**/RESET Pin**
PDIP	9
TQFP	4
PLCC	10

5.3 Serial Communications

The ServoCenter Chip has an onboard UART, which makes it very easy to implement serial communication. The example circuits below are for RS-232 and TTL level communication.

5.3.1 RS-232 Serial Communications

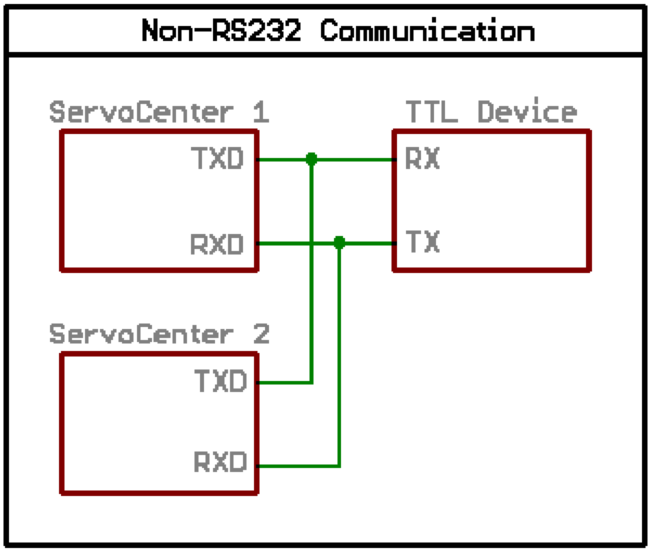
The ServoCenter Chip can communicate with RS-232 capable devices via a level shifter and appropriate support circuitry. The MAX232 in the example circuit shifts the 12V RS-232 logic signals down to the 5V logic signals used by the ServoCenter Chip, and shifts ServoCenter Chip logic signals up to RS-232 logic signals. For more information about the MAX232, consult its data sheet.



Serial Communication Pins		
Package	**TXD Pin**	**RXD Pin**
PDIP	11	10
TQFP	7	5
PLCC	11	13

5.3.2 TTL Serial Communications

The ServoCenter Chip can communicate with serial controller devices at TTL signal levels. This can be accomplished by simply connecting the RXD and TXD pins of the ServoCenter chip to the TX and RX pins of the controlling device. Multiple ServoCenter Chips can receive commands from the same controller device by simply chaining the TX and RX lines together, as shown here.



Serial Communication Pins		
Package	**TXD Pin**	**RXD Pin**
PDIP	11	10
TQFP	7	5
PLCC	11	13

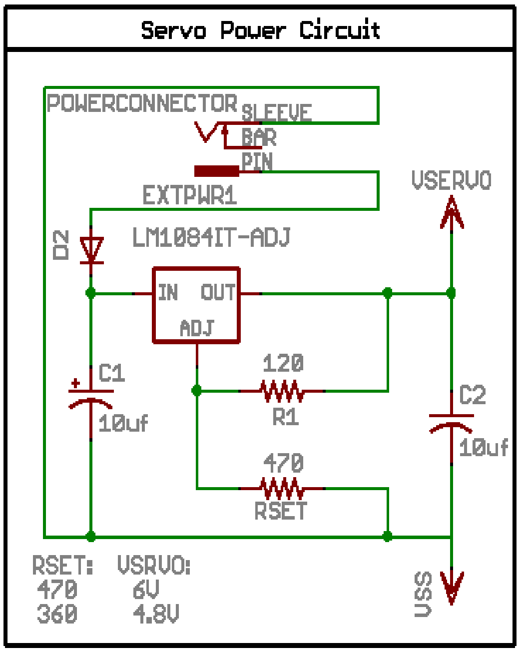
5.4 Powering The Servos

In addition to providing power to the ServoCenter Chip itself, the servos being controlled need must be powered. The servos can be powered by a battery or ant other regulated power source of sufficient amperage capability.

Servos will exhibit higher speed and torque at higher voltages. Most servos will list the operating characteristics at 4.8V and 6V in their documentation.

The LM1084IT-ADJ is an example of an adjustable voltage regulator that can be used to accommodate a variety of voltage requirements.

Note that a voltage regulator is not necessary if batteries or a regulated power supply is being used.



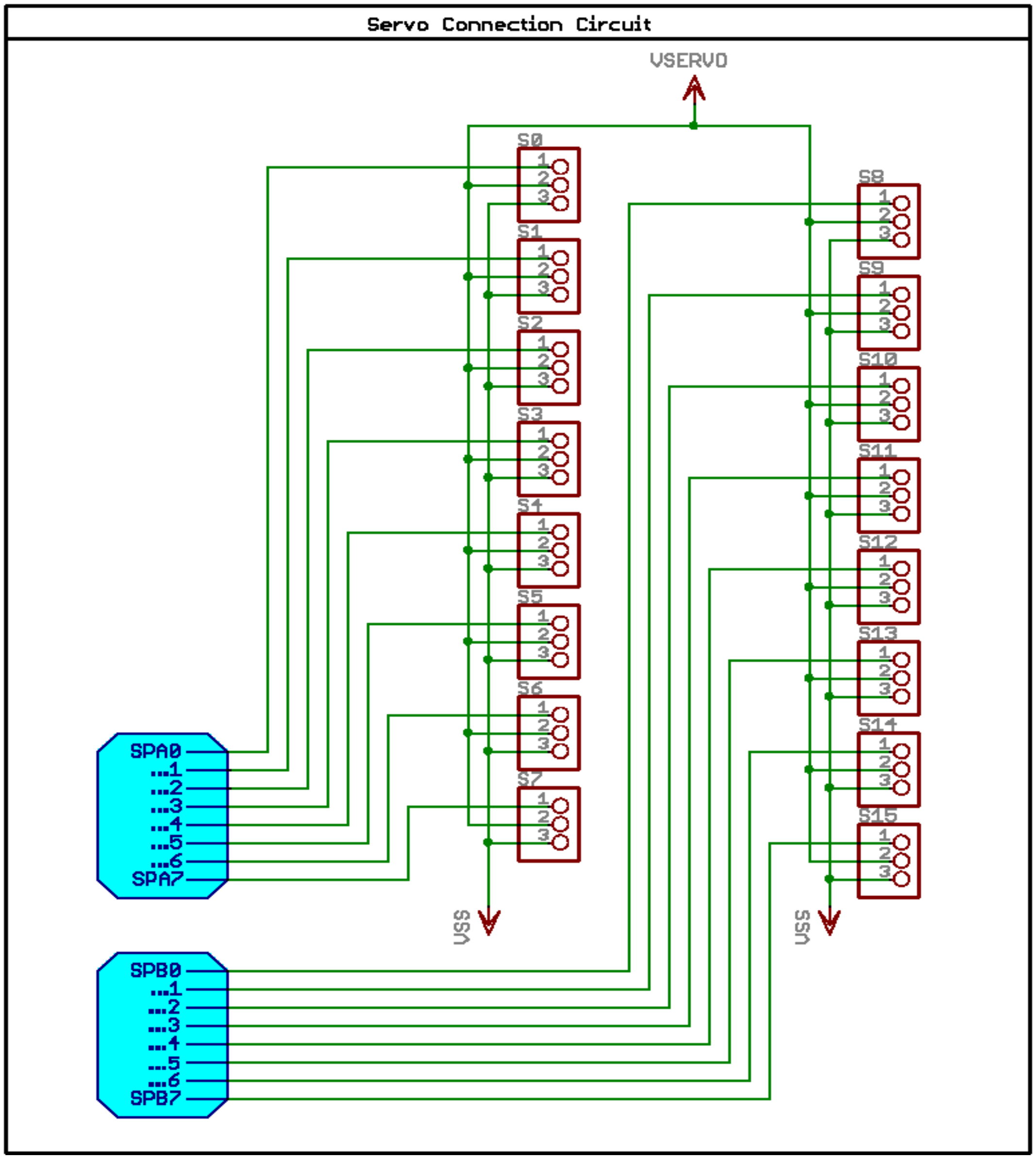
In the LM1084IT circuit shown, R1 should be around 100Ω to maintain an appropriate amount of feedback current. The resistance of R2 should be changed to modify the output voltage of the regulator. The Servo Supply Voltage of the LM1084IT-ADJ can be determined by using the formula:

VSERVO = 1.25 * (1 + (R2 / R1))

R2	VServo
360Ω	4.8V
470Ω	6V

5.4 Connecting The Servos

Servo Ports A & B provide the control signals for up to 16 servos. If using separate power supplies for VSERVO and VDD, remember to tie the grounds together.



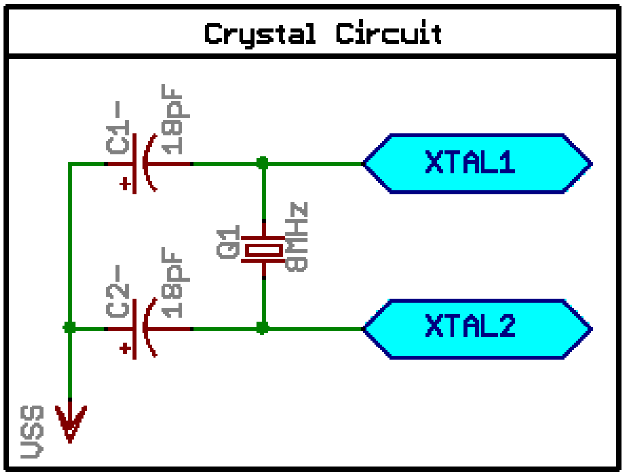
Servo Control Pins		
Package	**SPA Pins**	**SPB Pins**
PDIP	32-39	1-8
TQFP	30-37	40-44, 1-3
PLCC	36-43	2-9

5.5 Clock Signals

The ServoCenter 3.1 Chip requires an 8 MHz clock signal for timing purposes. The two circuits below are examples of how to generate this clock signal.

5.5.1 Using a Crystal as a Clock Source

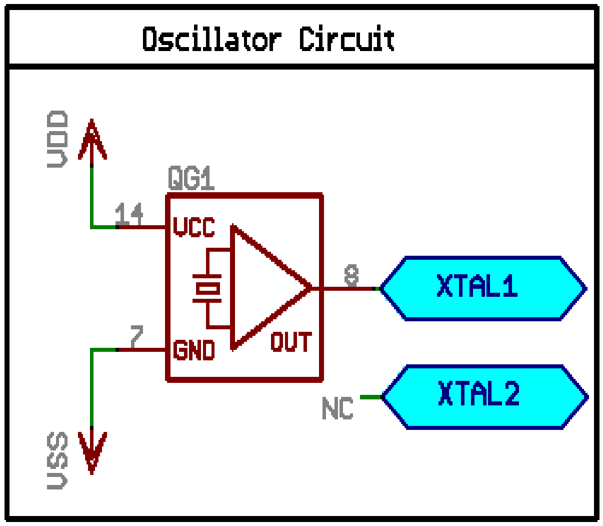
In the following example, an 8 MHz crystal is used as a clock source for the ServoCenter Chip.



Clock Input Pins		
Package	**XTAL1 Pin**	**XTAL2 Pin**
PDIP	19	18
TQFP	15	14
PLCC	21	20

5.5.1 Using an Oscillator as a Clock Source

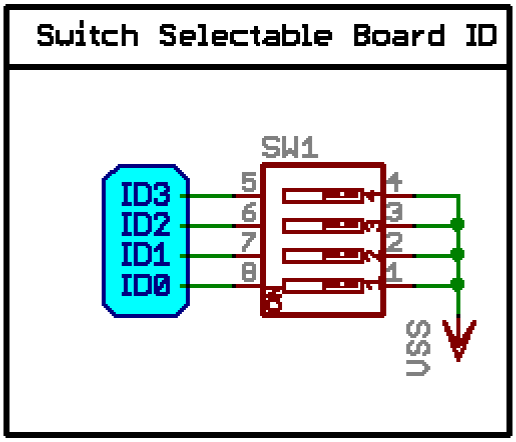
In the following example, an 8 MHz oscillator is used as the clock source for the ServoCenter Chip.



Clock Input Pins		
Package	**XTAL1 Pin**	**XTAL2 Pin**
PDIP	19	18
TQFP	15	14
PLCC	21	20

5.6 Setting the Board ID

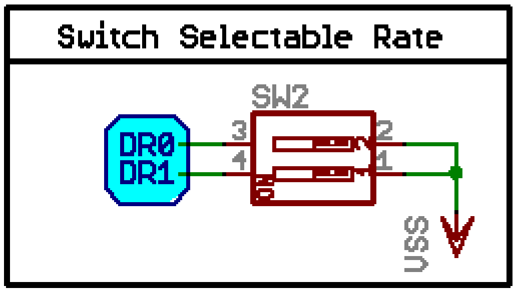
The following circuit shows how to interface a DIP switch to the BOARDID (ID = BOARDID) pins. The use of a DIP switch allows the BOARDID to be easily configured (See Section 2.2 for more information).



Board ID Pins	
Package	**BOARDID0-BOARDID1 Pins**
PDIP	21-24
TQFP	18-21
PLCC	24-27

5.7 Setting the Baud Rate

The above circuit shows how to interface a DIP switch to the RATESELECT (DR = RATESELECT) pins. The use of a DIP switch allows the data rate to be easily configured (See Section 2.2 for more information).



Rate Select Pins		
Package	**RATESELECT0 Pin**	**RATESELECT1 Pin**
PDIP	26	25
TQFP	23	22
PLCC	29	28

6 Programming the ServoCenter 3.1 Chip

6.1 ServoCenter 3.1 Protocol

6.1.1 Protocol Overview

The ServoCenter 3.1 controller receives messages from the controlling system in the form of sequences of serial communication bytes called packets. Each byte is serial encoded using 8N1 serial encoding (8 data bits, no parity, and 1 stop bit). The packet size can range from three to six bytes in length, depending upon the nature of the command being sent to the controller. Each packet consists of an initial **“start of packet”** byte (which includes a board ID specifier), followed by a **“command value”** specifier byte, followed by zero to three “**command data”** bytes, and terminated by a packet “**checksum value**” byte.

The ServoCenter 3.1 controller buffers the incoming command stream and will only take an action once the entire packet has been received and the checksum has been verified as correct. Incomplete packets, packets with inappropriate chip IDs, and packets with incorrect checksums will be ignored. This allows the controlling system to send command data at leisure without loss of function. The command buffer will, however, be cleared whenever the ServoCenter controller is either reset or powered off/on.

Most ServoCenter commands return no result data. Certain commands, however, are designed to return status information about the current settings and positions of connected servos. It is important to note that although many ServoCenter 3.1 chips can be connected and controlled simultaneously by a single controller, only one of the connected boards may be configured to send data back to the controlling system. The transmit/receive functionality is determined by the Chip Communications Circuit.

6.1.2 Packet Overview

Each packet is from 3 to 6 bytes in length and is formatted as follows:

240(0xF0) + Chip ID	First Byte – **Start of Packet**. Calculated by adding 240 to the desired chip ID.
Command ID	Second Byte – **Command Value.** Selected from one of the possible control commands.
Command Data	**Command Data/ Command Parameters**. Varies from zero to three bytes depending upon the command specified in the second byte position. See the table below for specific command data format and specification.
Command Data	
Command Data	
Checksum Value	Last Byte – **Packet Checksum**. See the checksum description below for specific calculation information.

Typical ServoCenter 3.1 Command Packet

6.1.3 Start of Packet Byte

Each command packet starts with a specific type of byte called the "Start of Packet" byte. The "**Start of Packet**" byte serves two purposes: to signify the start of a command packet and to identify the chip ID of the intended recipient. This byte's value is calculated by adding 240 (0xf0 hex) to the chip ID of the chip to which you are sending the command message. Thus a byte value of 240(0xf0 hex) would be used to send a message to the chip with ID 0, 241(0xf1) for chip ID 1, 242(0xf2) for chip ID 2, etc.

6.1.4 Command Set

Command Summary

The table below summarizes the ServoCenter 3.1 command set.

Description	Command	Data Length	Data Descriptions
QuickMove	0 (x00)	2	SvNum(0~15), SvPosition(0~200)
Scaled QuickMove	1 (0x01)	2	SvNum(0~15), %SvPosition(0~100%)
Servo Enable	2 (0x02)	1	SvNum(0~15)
Servo Disable	3 (0x03)	1	SvNum(0~15)
Set Min	4 (0x04)	2	SvNum(0~15), SvPosition(0~200)
Set Max	5 (0x05)	2	SvNum(0~15), SvPosition(0~200)
Set Start	6 (0x06)	2	SvNum(0~15), SvPosition(0~200)
Set Max Speed	7 (0x07)	2	SvNum(0~15), SvMaxSpeed(1~200) in centi-secs / 60°
Set Min to Current	8 (0x08)	1	SvNum(0~15)
Set Max to Current	9 (0x09)	1	SvNum(0~15)
Set Start To Current	10 (0x0a)	1	SvNum(0~15)
Get Current Position	11 (0x0b)	1	SvNum(0~15)
Get Min Position	12 (0x0c)	1	SvNum(0~15)
Get Max Position	13 (0x0d)	1	SvNum(0~15)
Get Start Position	14 (0x0e)	1	SvNum(0~15)
Get Max Speed	15 (0x0f)	1	SvNum(0~15)
Move Raw	16 (0x10)	3	SvNum(0~15), SvPosition(0~200), SvSpeed(1~100)
Move Raw CW	17 (0x11)	3	SvNum(0~15), ΔSvPosition(0~200), SvSpeed(1~100)
Move Raw CCW	18 (0x12)	3	SvNum(0~15), ΔSvPosition(0~200), SvSpeed(1~100)
Move Scaled	19 (0x13)	3	SvNum(0~15), %SvPosition(0~100), SvSpeed(1~100)
Move Scaled CW	20 (0x14)	3	SvNum(0~15), Δ%SvPosition(0~100), SvSpeed(1~100)
Move Scaled CCW	21 (0x15)	3	SvNum(0~15), Δ%SvPosition(0~100), SvSpeed(1~100)
Set Pulse Width Min	22 (0x16)	1	PwValue(1 – 239) in 10us units.
Set Pulse Width Max	23 (0x17)	1	PwValue(1 – 239) in 10us units.
Servo Reverse	24 (0x18)	1	SvNum(0~15)
Servo Normal	25 (0x19)	1	SvNum(0~15)
Show Settings	235 (0xeb)	0	None.
Commit Settings	236 (0xec)	0	None.
Load Factory Settings	237 (0xed)	0	None.
Reset as Startup	238 (0xee)	0	None.
Display Version	239 (0xef)	0	None.

Command Details

In the tables below you'll find a description of each of the ServoCenter commands and a brief explanation of how and where each command would be used.

Function:	QuickMove
Command Value:	0 (0x00)
Data Bytes:	2
Data Format:	SvNum(0~15), SvPosition(0~200)
Description:	The QuickMove command provides a method of instantly moving a single servo (specified by SvNum) to a specified raw position (specified by SvPosition). This function is useful when it is desired to move a servo to a position as fast as possible. With QuickMove no servo position interpolation is performed and the control signal for that specified servo is immediately modified when the command is issued.

Function:	Servo Enable
Command Value:	2 (0x02)
Data Bytes:	1
Data Format:	SvNum(0~15)
Description:	The Servo Enable command provides a method of enabling a servo(specified by SvNum). This function is used to enabled a servo channel that has been previously disabled. With the control signal enabled the servo will actively hold its position. Enabled servos will draw significantly more power than disabled servos.

Function:	Servo Disable
Command Value:	3 (0x03)
Data Bytes:	1
Data Format:	SvNum(0~15)
Description:	The Servo Disable command provides a method of disabling a servo(specified by SvNum). This function is used to remove the control signal for a servo channel. With the control signal disabled the servo will not actively hold its position. This can be useful for disabling a servo without having to physically disconnect it from the chip. A disabled servo can generally be moved by hand and will draw significantly less power than an enabled servo.

Function:	Set Minimum
Command Value:	4 (0x04)
Data Bytes:	2
Data Format:	SvNum(0~15), SvPosition(0~200)
Description:	The Set Minimum command sets the minimum raw servo position set-point(specified by SvPosition) of the specified servo (specified by SvNum). This minimum position is used in all scaled movement modes of operation. Setting the minimum position above the start position will cause the start position to be set equal to the minimum. Setting the minimum position above the maximum will cause the maximum position to be set equal to the minimum.

Function:	Set Maximum
Command Value:	5 (0x05)
Data Bytes:	2
Data Format:	SvNum(0~15), SvPosition(0~200)
Description:	The Set Maximum command sets the maximum raw servo position set-point(specified by SvPosition) of the specified servo (specified by SvNum). This maximum position is used in all scaled movement modes of operation. Setting the maximum position below the start position will cause the start position to be set equal to the maximum. Setting the maximum position below the minimum will cause the minimum position to be set equal to the maximum.

Function:	Set Start
Command Value:	6 (0x06)
Data Bytes:	2
Data Format:	SvNum(0~15), SvPosition(0~200)
Description:	The Set Start command sets the starting raw servo position set-point(specified by SvPosition) of the specified servo (specified by SvNum). The start position is the position that the servo will assume when the system is powered-up or reset. The start position is capped and cannot be set greater than the max or less than the min.

Function:	Set Maximum Speed
Command Value:	7 (0x07)
Data Bytes:	2
Data Format:	SvNum(0~15), SvMaxSpeed(1~200)
Description:	The Set Maximum Speed command sets the maximum speed (as specified by SvMaxSpeed and measured in centi-seconds per 60° of travel) that is allowed for a particular servo channel (specified by SvNum). This maximum speed is used to calculate all speed related seek commands. Different servos have different rated travel speeds depending upon the manufacturer, model, and power supply voltage. These speeds are generally rated in seconds per 60° of travel so the programmer will have to convert the rated speed (in seconds) to centi-seconds by multiplying by 100. The ServoCenter 3.1 controller allows the maximum allowable travel speed to be set independently for each of the 16 servo channels.

Function:	Set Minimum to Current
Command Value:	8 (0x08)
Data Bytes:	1
Data Format:	SvNum(0~15)
Description:	The Set Minimum to Current command sets the minimum raw servo position set-point to the current raw position of the servo of the specified servo (specified by SvNum). This minimum position is used in all scaled movement modes of operation. Setting the minimum position above the start position will cause the start position to be set equal to the minimum. Setting the minimum position above the maximum will cause the maximum position to be set equal to the minimum.

Function:	Set Maximum to Current
Command Value:	9 (0x09)
Data Bytes:	1
Data Format:	SvNum(0~15)
Description:	The Set Maximum to Current command sets the maximum raw servo position set-point to the current raw position of the specified servo (specified by SvNum). This maximum position is used in all scaled movement modes of operation. Setting the maximum position below the start position will cause the start position to be set equal to the maximum. Setting the maximum position below the minimum will cause the minimum position to be set equal to the maximum.

Function:	Set Start to Current
Command Value:	10 (0x0a)
Data Bytes:	1
Data Format:	SvNum(0~15)
Description:	The Set Start to Current command sets the startup raw servo position set-point to the current raw position of the specified servo (specified by SvNum). The start position is the position that the servo will assume when the system is powered-up or reset. The start position is capped and cannot be set greater than the maximum or less than the minimum.

Function:	Get Current Position
Command Value:	11 (0x0b)
Data Bytes:	1
Data Format:	SvNum(0~15)
Description:	The Get Current Position command causes the ServoCenter board to transmit a one byte message corresponding to the raw servo position of a particular servo (specified by SvNum). The ability of the board to send these responses is partially dependent upon the jumper settings of jumper block JP1 (see section 3.4.1 of the user's manual for details).

Function:	Get Min Position
Command Value:	12 (0x0c)
Data Bytes:	1
Data Format:	SvNum(0~15)
Description:	The Get Min Position command causes the ServoCenter board to transmit a one byte message corresponding to the currently set minimum servo position of a particular servo (specified by SvNum). The ability of the chip to send these responses is partially dependent upon the wiring of the communications circuitry.

Function:	Get Max Position
Command Value:	13 (0x0d)
Data Bytes:	1
Data Format:	SvNum(0~15)
Description:	The Get Max Position command causes the ServoCenter board to transmit a one byte message corresponding to the currently set maximum servo position of a particular servo (specified by SvNum). The ability of the chip to send these responses is partially dependent upon the wiring of the communications circuitry

Function:	Get Start Position
Command Value:	14 (0x0e)
Data Bytes:	1
Data Format:	SvNum(0~15)
Description:	The Get Start Position command causes the ServoCenter board to transmit a one byte message corresponding to the currently set starting servo position of a particular servo (specified by SvNum). The ability of the chip to send these responses is partially dependent upon the wiring of the communications circuitry

Function:	Get Max Speed
Command Value:	15 (0x0f)
Data Bytes:	1
Data Format:	SvNum(0~15)
Description:	The Get Max Speed command causes the ServoCenter board to transmit a one byte message corresponding to the currently set maximum speed setting of a particular servo channel (specified by SvNum). The ability of the chip to send these responses is partially dependent upon the wiring of the communications circuitry

Function:	Move Raw
Command Value:	16 (0x10)
Data Bytes:	3
Data Format:	SvNum(0~15), SvPosition(0~200), SvSpeed(1~100)
Description:	The Move Raw command is used to move a servo's position at a specified speed. The move raw command moves a servo (specified by SvNum) to a raw position (specified by SvPosition) at a particular speed (specified by SvSpeed). Raw movement modes do not use the set minimum and maximum points to determine the servo's position. The specified speed is calculated as a percentage of the preset maximum servo speed for the specified servo channel. Thus, a speed of 50 is half as fast as a speed of 100, a speed of 1 is $1/100^{th}$ as fast as a speed of 100, etc.

Function:	Move Raw CW (Clockwise)
Command Value:	17 (0x11)
Data Bytes:	3
Data Format:	SvNum(0~15), ΔSvPosition(0~200), SvSpeed(1~100)
Description:	The Move Raw CW command is used to move a servo's position clockwise by a certain amount at a specified speed. The move raw clockwise command moves a servo (specified by SvNum) clockwise by a certain number of units (specified by ΔSvPosition) at a particular speed (specified by SvSpeed).

Function:	Move Raw CCW (Counter-Clockwise)
Command Value:	18 (0x12)
Data Bytes:	3
Data Format:	SvNum(0~15), ΔSvPosition(0~200), SvSpeed(1~100)
Description:	The Move Raw CCW command is used to move a servo's position counter-clockwise by a certain amount at a specified speed. The move raw counter-clockwise command moves a servo (specified by SvNum) clockwise by a certain number of units (specified by ΔSvPosition) at a particular speed (specified by SvSpeed).

Function:	Move Scaled
Command Value:	19 (0x13)
Data Bytes:	3
Data Format:	SvNum(0~15), %SvPosition(0~100), SvSpeed(1~100)
Description:	The Move Scaled command is used to move a servo's position at a specified speed. The move scaled command moves a servo (specified by SvNum) to a scaled position (specified by SvPosition) at a particular speed (specified by SvSpeed). Scaled movement modes use the set minimum and maximum points to determine the servo's position. The scaled position value can be thought of as a percentage of the range from the minimum to the maximum. Thus 0 is the minimum, 100 is the maximum, and 50 is the midpoint between the set minimum and maximum. The specified speed is calculated as a percentage of the preset maximum servo speed for the specified servo channel. Thus, a speed of 50 is half as fast as a speed of 100, a speed of 1 is 1/100th as fast as a speed of 100, etc.

Function:	Move Scaled CW (Clockwise)
Command Value:	20 (0x14)
Data Bytes:	3
Data Format:	SvNum(0~15), Δ%SvPosition(0~100), SvSpeed(1~100)
Description:	The Move Scaled CW command is used to move a servo's position clockwise at a specified speed. The move scaled clockwise command moves a servo (specified by SvNum) clockwise by a certain percentage (specified by Δ%SvPosition) at a particular speed (specified by SvSpeed). The percentage indicated by the %SvPosition byte is based upon a percentage of the distance between the minimum position and the maximum position. Thus a distance of 10 units would move the servo clockwise by a distance of 1/10th of the entire scaled travel range, a distance of 1 unit would move the servo by 1/100th of the entire scaled travel range, etc.

Function:	Move Scaled CCW (Counter-Clockwise)
Command Value:	21 (0x15)
Data Bytes:	3
Data Format:	SvNum(0~15), Δ%SvPosition(0~100), SvSpeed(1~100)
Description:	The Move Scaled CCW command is used to move a servo's position counter-clockwise at a specified speed. The move scaled counter-clockwise command moves a servo (specified by SvNum) counter-clockwise by a certain percentage (specified by Δ%SvPosition) at a particular speed (specified by SvSpeed). The percentage indicated by the %SvPosition byte is based upon a percentage of the distance between the minimum position and the maximum position. Thus a distance of 10 units would move the servo clockwise by a distance of 1/10th of the entire scaled travel range, a distance of 1 unit would move the servo by 1/100th of the entire scaled travel range, etc.

Function:	Set Pulse Width Min
Command Value:	22 (0x16)
Data Bytes:	1
Data Format:	PwValue (1-239)
Description:	The Set Pulse Width Minimum command lets the user specify the minimum value of the range of control pulses that are produced by the ServoCenter 3.1 chip for all raw position modes. This minimum value is applied globally to all servo channels of the chip. Since some servos have slightly different control pulse width ranges this value may have to be tweaked to get a full servo motion range out of all raw position modes. The PwValue is measured in 10 microsecond units thus allowing the chip to produce any range of pulses in the range from 10 to 2390 microseconds.

Function:	Set Pulse Width Max
Command Value:	23 (0x17)
Data Bytes:	1
Data Format:	PwValue (1-239)
Description:	The Set Pulse Width Maximum command lets the user specify the maximum value of the range of control pulses that are produced by the ServoCenter 3.1 chip for all raw position modes. This maximum value is applied globally to all servo channels of the chip. Since some servos have slightly different control pulse width ranges this value may have to be tweaked to get a full servo motion range out of all raw position modes. The PwValue is measured in 10 microsecond units thus allowing the chip to produce any range of pulses in the range from 10 to 2390 microseconds.

Function:	Servo Invert
Command Value:	24 (0x18)
Data Bytes:	1
Data Format:	SvNum(0~15)
Description:	The Servo Invert command causes the servo channel specified by the first data byte (SvNum) to have its positions seek in an inverted manner. This means that a raw position value of zero is the servo's extreme counter-clockwise rotational position and 200 is the extreme clockwise position. This function can be useful for dealing with paired servos or with servos that are mounted in such a way that an inverted positional system is more natural.

Function:	Servo Normal (UnInvert)
Command Value:	25 (0x19)
Data Bytes:	1
Data Format:	SvNum(0~15)
Description:	The Servo Normal command causes the servo channel specified by the first data byte (SvNum) to have its positions seek in the normal, non-inverted, manner. This means that a raw position value of zero is the servo's extreme clockwise rotational position and 200 is the extreme counter-clockwise position.

Function:	Show Settings
Command Value:	235 (0xeb)
Data Bytes:	0
Data Format:	None.
Description:	The Show Settings command causes the chip to transmit a table of the current settings for all channels. The format of the returned data is a human-readable table composed of ASCII characters. This fuction is useful when troubleshooting a chip's settings or simply verifying current settings. The ability of the chip to transmit these settings is partially dependent upon the wiring of the communications circuitry

Function:	Commit Settings
Command Value:	236 (0xec)
Data Bytes:	0
Data Format:	None.
Description:	The Commit Settings command causes the chip to save the current settings into the EEPROM storage. Once the board's settings are stored in the EEPROM settings of the ServoCenter 3.1 they will be restored every time the chip is either reset or powered up. This allows the configuration to be saved thus avoiding a configuration process every time the chip is reset. Note: the EEPROM storage of the ServoCenter 3.1 chip has a limited lifetime of rewritability (about 100,000 rewrites) so avoid writing a programmatic loop that continuously commits the settings of the chip. The current rewrite count can be viewed by using the “Show Settings” command. A user can prevent chip settings from being written by connecting the WProt pin to GND.

Function:	Load Factory Settings
Command Value:	237 (0xed)
Data Bytes:	0
Data Format:	None.
Description:	The Load Factory Settings command causes all of the chip's settings to revert to the state that they were in when shipped as new. This command only loads the settings and doesn't commit the settings to the EEPROM of the chip. To restore the settings and save these settings, the user should perform a “Commit Settings” command following the “Load Factory Settings” command.

Function:	Reset as Startup
Command Value:	238 (0xee)
Data Bytes:	0
Data Format:	None.
Description:	The Reset as Startup command causes the chip to perform a software reset of the control software. This command is functionally equivalent to resetting or cycling the power of the chip. All EEPROM settings are loaded and all servo channels are modified according to these stored settings.

Function:	Display Version
Command Value:	239 (0xef)
Data Bytes:	0
Data Format:	None.
Description:	The Display Version command simply displays the version of the firmware embedded within your ServoCenter 3.1 chip. This can be useful for allowing software to query the chip's version to ensure interoperability between this and other/future YEI products.

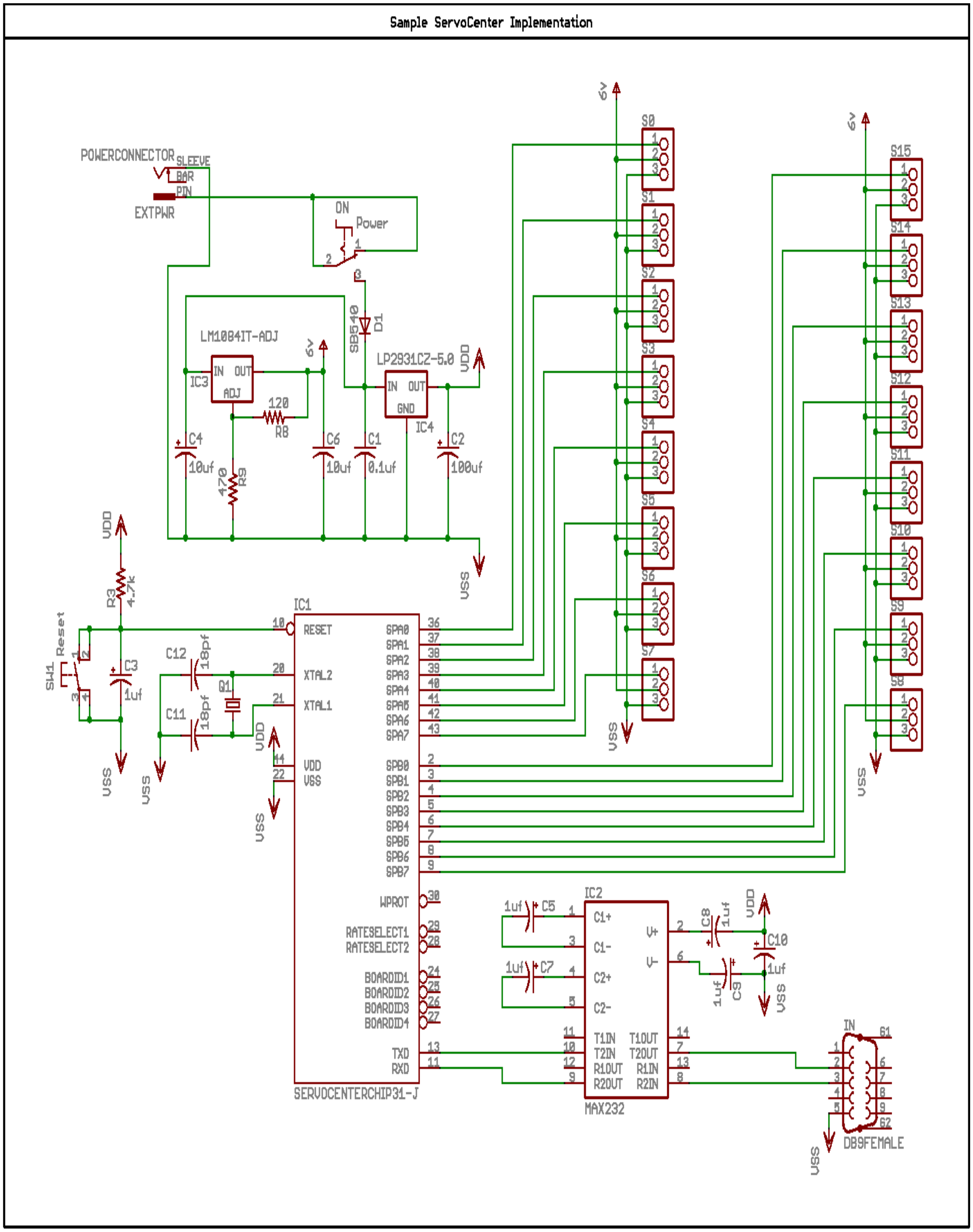
6.1.5 The Checksum Value

The checksum is computed as an arithmetic summation of all of the characters in the packet (except the checksum value itself) modulus 239 plus one. This gives a resulting checksum in the range 1 to 239. The checksum will be ignored if a 0 byte value is passed in the checksum position of the packet.

The purpose of the checksum is to minimize the chances of the ServoCenter 3.1 chip receiving and acting upon corrupted or erroneous control messages. In most instances the checksum should be used to enhance the reliability and robustness of the control system, but, as noted above, a zero value can be placed in the checksum byte position to ignore the checksum calculation.

This placing of a 0 value in the checksum position can free the sender from having to worry about calculating the actual checksum. This is useful in situations where simplicity of implementation is necessary and reliable communication is not a requirement.

7 ServoCenter 3.1 Chip Sample Schematic



Note: The pin numbers used in this schematic correspond to those of the PLCC package.