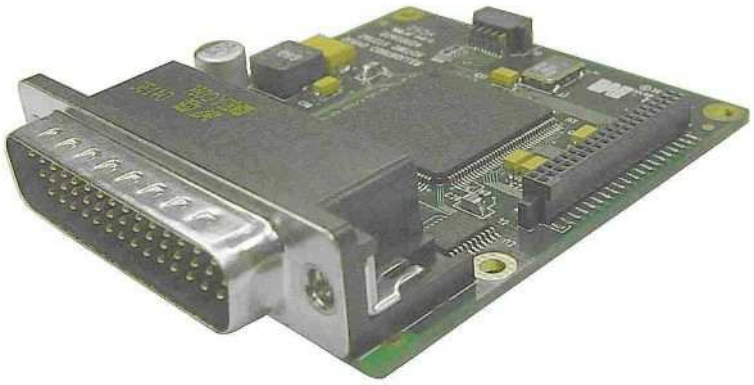
Servo Switch/Controller
Users Manual

February 2, 2007



MICROBOTICS, INC.
28 RESEARCH DRIVE, SUITE G
HAMPTON, VIRGINIA 23666
TEL 757-865-7728
FAX 757-865-7565
Innovative System Integration and Control

1. Overview

The Microbotics Servo Switch/Controller (SSC) is a highly configurable, multiplexing switch for servo command signals. It allows the dynamic selection of several sources of pulse signals for servos. Pulse sources include asynchronous serial communication packets from a control computer, pulse signals from a conventional RC receiver or other servo pulse generator, and user definable constant signals. Sources are selected based on a signal at a pulse input channel, allowing a standard RC receiver channel to be used as the switch source. The SSC is designed to drive a wide range of servos. It is capable of producing pulse signals with high times of 0 to 30 ms at periods of 1 to 30 ms, making it suitable for industrial, duty cycle based servos as well as conventional RC servos.

1.1. Features

- Small size and weight: 2.25 x 2.43 inches (57 x 62 mm), 34 grams.
- 24 pulse signal channels with up to 16 of them definable as pulse inputs.
- 6 auxiliary digital channels that can be assigned for general I/O, timer (e.g. RPM), or pulse signal operation.
- Switch between five servo command sources
- Map any source to output for any command channel condition
- Serial messages that report switch status, including the current state of the sources
- All serial messages can be configured for polling or continuous output up to 50Hz

1.2. Typical Applications

- Unmanned vehicle development
- RC pilot/operator training
- RC link redundancy
- Vehicle operation
- Payload control

2. Operation

The SSC maps several sources of pulse command information to pulse output channels based on the contents of a switch table (Figure 1). On startup, the SSC loads the switch table, along with all of the other configuration settings, from non-volatile configuration memory. The table has a row for each pulse output channel, and a column for each possible command state of the switch. Each cell of the table indicates the pulse source to use for the corresponding channel (row) and the current command state (column).

Command state can be one of four values: 0 ms, 1 ms, 1.5 ms, and 2 ms. These correspond to a pulse received on pulse input (PIN) 1, which is always the command channel. A 1 ms pulse received repetitiously on PIN 1 will cause the 1 ms command state to become active. The same is true for the 1.5 ms and 2 ms command states. The 0 ms command state becomes active if no pulse has been received within 32 ms.

These rules for the command channel correspond to conventional RC receivers which produce pulses with high times of 1 to 2 ms with a nominal period of 20 ms. The 1.5 ms and 0 ms values are special indicators. Many radio/receiver pairs will allow failsafe values to be set in the event of lost-link between the transmitter and receiver. In this case, the receiver should be set so that lost-link results in a 1.5 ms pulse signal on the command channel so that the SSC can handle the lost-link as a special condition. The 0 ms value represents the case of no signal (or invalid signal) on the command channel. This is intended to indicate receiver failure so that the switch can respond that condition.

Given a current command state, each pulse output multiplexer is provided with a pulse source selection from the switch table. Five source selections are currently supported in the SSC:

- Last, which holds the last pulse value
- Serial, which uses the corresponding element of the serial command array as the pulse source
- Const, which uses the corresponding element of the constants command array as the pulse source
- PIN, which allows the use of any of the pulse inputs as a source
- PINv, same as PIN, but mirrors the PIN source about 1.5 ms.

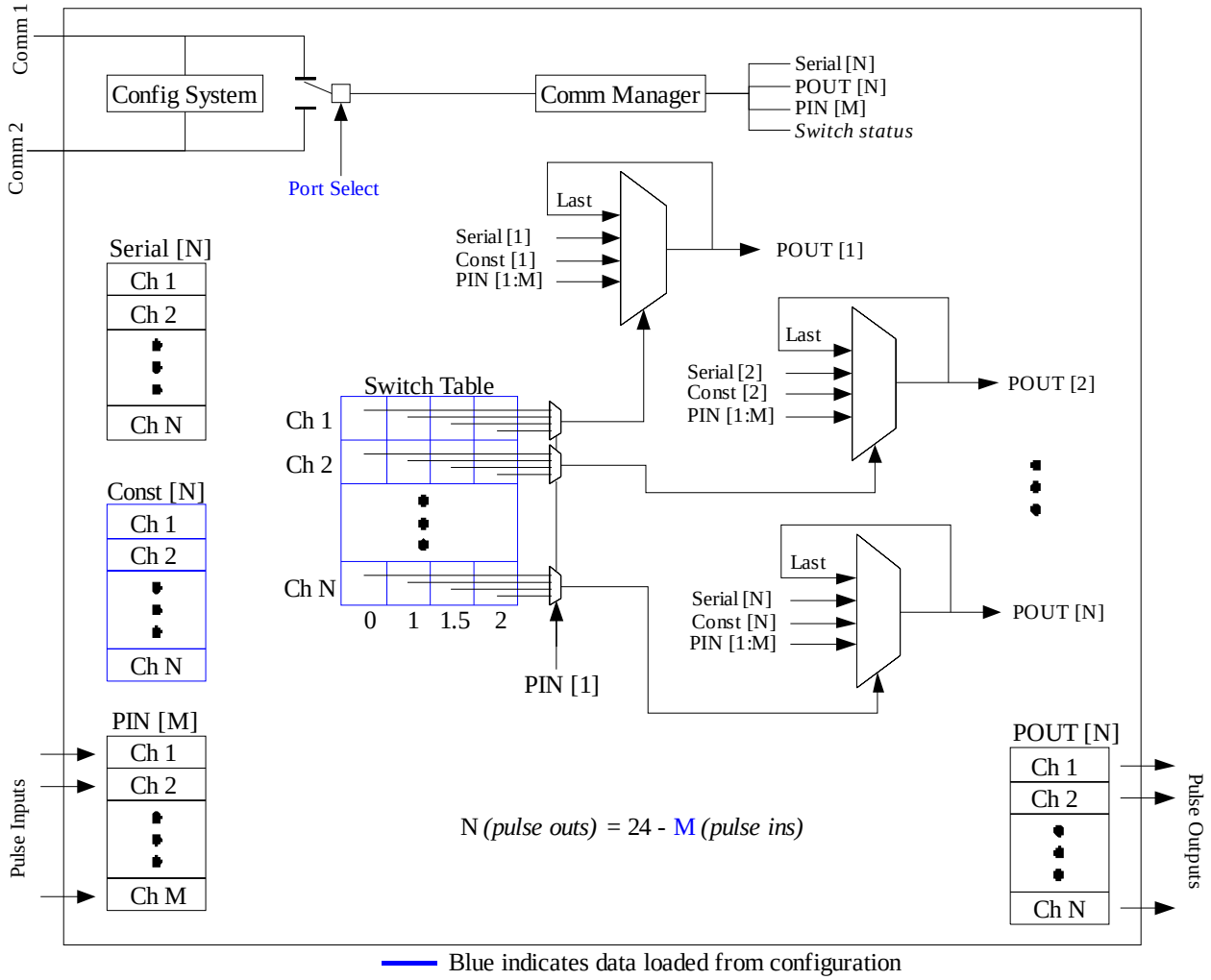


Figure 1. SSC Operation Diagram

Configuration information, which determines the details of switch operation, is stored in non-volatile memory on the SSC. This includes the selected operational asynchronous serial port, the constants array used as a pulse source, the pulse period for each channel, and the command source switch table.

Either of the SSC serial ports may be used to configure the switch. One of the ports must be selected for use during operation for communication with the user. The selected port, referred to as the operational port, allows the user to command values for the serial pulse source. It also provides messages to the user that report the state of the various command sources and the status of the switch. Switch status includes information such as the current state of the command pulse channel and, as a result, which of the five sources is being used to drive each servo. Complete details are provided in the Software Interface section of this document.

3. Configuration

The SSC has a configuration mode that can be entered within 5 seconds of power-on reset. The user can enter this configuration mode by issuing the string 'ssconfig', without the quotes, to either of the SSC serial ports using a terminal emulator such as HyperTerminal, which is included with Microsoft Windows. Once the string is received by the switch (before the configuration lockout period of 5 seconds expires), the SSC main menu will be presented.

```
MAIN MENU
  1) I/O Setup
  2) Switch Table
  3) Message Rates
  4) Primary Comm
  5) Config Lockout

  C) Config ...
  X) Exit

Select:
```

When this menu appears, the SSC is in a dedicated configuration mode. In configuration mode, all servo switch and control operations are suspended. In the following subsections, each of the main menu selections will be described in detail. The following characteristics apply to all elements of the configuration mode.

- Menu selections do not require pressing <enter>
- Menu selections are not case sensitive
- At all submenus, the number 0 (zero) returns user to the previous menu
- At any menu, the letter R can be used to refresh the display.
- The examples shown below are from a switch that has 12 pulse channels assigned as inputs.
- If more than 16 pulse output channels exist, all configuration items cannot be displayed on a single screen in submenus that have a row for each channel. Instead, a menu option 'M' is provided to switch between the first 16 channels and the remaining channels.
- Pages within the menu system are separated by the following ANSI sequences to clear the screen and move the cursor to the screen home position:
  <ESC>[2J (clears the screen)
  <ESC>[1;1H (moves to screen home)
  Note that <ESC> represents the single ASCII character with value 0x27.
- **Any changes to configuration should be saved at the main menu before exiting the menu system. Unsaved changes are not preserved across resets.**
- When the menu system is terminated by selecting 'X' at the main menu, the switch will reset.

3.1. Config Submenu

The Config submenu provides access to configuration storage and retrieval operations. Selections are provided that deal with the operation of the non-volatile configuration memory along with selections that facilitate saving configuration information external to the switch. When the Config Submenu is invoked from the main menu by pressing 'C', the following subment appears.

```
  S) Save to NV Memory
  L) Reload from NV Memory
  E) Erase NV Memory

  D) Dump Config Image (ASCII Hex)
  I) Receive Config Image (ASCII Hex)

Select:
```

Selections S, L, and E deal with the non-volatile configuration memory of the SSC. Configuration settings may be saved to non-volatile memory by pressing S. Configuration data may be reloaded from non-volatile memory by pressing L, reverting any changes made since the last save operation. And, the non-volatile memory may be erased by pressing E. When non-volatile memory is erased, the switch will require the user to enter configuration mode on the next reset. The SSC will never start switch operations if the configuration data is invalid or missing. Configuration will be filled with sensible defaults upon entry to configuration mode in this case.

Selections D and I allow for storing configuration data external to the switch and restoring that data from the external source. This is accomplished using an ASCII representation of the binary configuration data as stored in SSC memory.

If the 'D' selection is made, a block like the one below will be displayed.

```
---------- Start Of Image ----------
01000C0100007E000203041002030411020304100203041002030410020304100203041002030410
020304100203041102030410020304100203041002030410020304100203041002030410020304100
020304100000AC120203048002030480020304800000007300000000000BF88044C04B0
0514057805DC064006A40708076C07D003E8044C05DC05DC05DC05DC05DC05DC00800F5C
000000003239413 94E204E204E204E204E204E204E204E204E204E204E204E204E204E20
4E204E204E204E204E204E204E204E204E20000000000000000000000000005050505
0500C87C

----------  End Of Image  ----------
```

The user can save this block of data (using cut-and-paste or log-to-file in the terminal emulator) as valid configuration data. The section between the start and end lines contain the valid configuration data.

The 'I' menu option prompts the user to supply the block of configuration data as saved with the 'D' option. When the SSC displays the prompt string:

```
---------- Waiting For Image ----------
```

the user can paste the saved configuration block into the terminal emulator. The switch will report success or failure for the configuration load and provide instructions for continuing. Configuration data loaded in this way must be saved from the configuration submenu to be preserved across reset.

3.2. I/O Setup

The I/O Setup submenu provides options that describe how the I/O lines of the switch are configured. The top section of the submenu (A,B) addresses the switch channel assignments and a user defined configuration ID. The lower section of the submenu (1-6) assigns a variety of functions to the 6 auxiliary channels. Text in brackets in the menu indicate the current setting for the menu item.

```
I/O SETUP
  A) Pulse Input Channels [12]
  B) User Config ID     [126]

  1) Aux 1 Assign [Dig In   ]
  2) Aux 2 Assign [Timer In  (1us,+,+)]
  3) Aux 3 Assign [PulAcc In (-)]
  4) Aux 4 Assign [Dig Out   (-)]
  5) Aux 5 Assign [Pulse Out (2us,f,+)]
  6) Aux 6 Assign [Dig In   ]

  0) Previous Menu

Select:
```

3.2.1. Switch Pulse Input Assignment

The servo switch section of the SSC consists of 24 channels. Up to 16 of the 24 may be defined as pulse inputs. Channels in the switch section not assigned as pulse inputs will be pulse outputs. The first pulse input, PIN 1, is used as the switch command source, and must always be present.

3.2.2. User Configuration ID

The user configuration ID is not used by the SSC internally. It is provided so that the user can assign numbers to uniquely identify different configurations. The configuration ID can be retrieved at runtime by querying the System Configuration message (Message ID 15). Valid range of the configuration ID is 0 to 255.

The remaining menu items assign functions to the auxiliary channels. Selecting one of these items presents a menu that assigns a function to the auxiliary channel

```
1) Digital In
2) Timer In
3) Pulse Accum In
4) Digital Out
5) Pulse Out

Select:
```

3.2.3. Auxiliary Channel Function Assignment

Subsequent submenus specify any related attributes. In the I/O Setup submenu, attributes for each function are shown in parenthesis following the function name. (Note that '+' means high or rising edge, and '-' means low or falling edge.) Available functions include digital input, timer input, pulse accumulator input, digital output, and pulse output. Each of these functions is described in the following subsections. Channels defined as inputs are represented in the Auxiliary Inputs message (Message ID 14). Channels defined as outputs are commanded using the Auxiliary Outputs message (Message ID 21).

3.2.3.1. Digital Input

An auxiliary channel defined as a digital input senses the voltage level on the associated pin. The Auxiliary Inputs message (Message ID 14) reports the value of each auxiliary pin in its dig_in field, where a bit is assigned to each channel. The pin state of all channels are reported in this field, whether or not they are defined as digital inputs.

3.2.3.2. Timer Input

Timer inputs measure pulse events on the associated pin using a 14 bit timer, providing capability for RPM measurement and pulse time measurement. Attributes for the timer function include start edge, stop edge, and time base. The Auxiliary Inputs message (Message ID 14) reports the measurements made by all channels defined as timers.

The type of measurement made by the timer depends on the definitions of the start and stop edges, which can be either rising or falling edges. For example, a timer with start and stop edges set to rising and falling, respectively, would measure the duration of a high pulse. Likewise, a timer with start and stop edges set to falling and rising, respectively, would measure the duration of a low pulse. If both edges are set to the same value, the timer will measure the period of a signal (e.g., RPM).

Time base is the amount of time represented by each tick of the timer counter. It may be set to one of eight values: 1, 2, 4, 8, 16, 32, 64, and 128 microseconds. For example, a timer measurement of 1000 counts using a time base of 16 microseconds represents a measured time of 16000 microseconds.

Often, the timer input function will be used to measure the frequency of a signal. The following table depicts the maximum frequency and minimum frequency that can be measured for each of the available time base values. Minimum frequency corresponds to the point of timer over-range. Maximum frequency corresponds to 100 timer counts for 1% accuracy.

Timer Measurement Range

Time Base (us)	Min Freq. (Hz)	Max Freq. (Hz)	Min RPM	Max RPM
1	61.04	10000.00	3662.11	600000.00
2	30.52	5000.00	1831.05	300000.00
4	15.26	2500.00	915.53	150000.00
8	7.63	1250.00	457.76	75000.00
16	3.81	625.00	228.88	37500.00
32	1.91	312.50	114.44	18750.00
64	0.95	156.25	57.22	9375.00
128	0.48	78.13	28.61	4687.50

The timer measurement is updated when the stop edge occurs. As a result, the minimum measurement frequency shown above is equivalent to the lowest update speed of the timer value. This is significant when the timer measurement is to be used in a control loop. If, for example, the control loop requires a new sample at 10Hz, then a time base of 4us or lower must be chosen. A time base of 128 can measure RPM values lower than 30, but as RPM approaches the minimum limit of measurement, the samples will only be updated once every 2 seconds. If 4us is chosen as the time base, then the over-range flag will be set for the timer value whenever the RPM drops below approximately 915.

3.2.3.3. Pulse Accumulator Input

Pulse accumulator inputs measure the number of edge events that occur on the associated pin over a period of time. As implemented in the SSC, the pulse accumulators indicate the number of received pulses since the last Auxiliary Inputs message (Message ID 14) was generated. The only attribute for this function is the edge (rising or falling) on which to increment the count. If the 14 bit counter overflows before the accumulator is reset upon message 14, the over-range flag will be set.

3.2.3.4. Digital Output

An auxiliary channel defined as a digital output drives the associated pin to the level commanded by the user using the Auxiliary Outputs message (Message ID 21). Any channel defined as a digital output will be set by the dig_out field of this message if the most significant bit of the dig_out bit is set. Channels not assigned as digital outputs are not affected by their corresponding bits in this field.

The digital output function has a single attribute: the initial level of the pin. When the switch is powered on, all channels are inputs that are weakly pulled up. When an auxiliary digital output channel is switched to output during initialization, it is set to the selected initial state.

3.2.3.5. Pulse Output

Pulse outputs generate pulses on the associated pin. Attributes for the pulse output include whether the pulse is high or low, single shot or continuous, and selected time base. The time base for pulse output may be 1, 2, 4, 8, 16, 32, 64, or 128 microseconds. The pulse time and period values are commanded using the Auxiliary Output message (Message ID 21), and are in units of the selected time base. If the pulse output is configured for single shot operation, the period is ignored and a pulse is generated whenever an Auxiliary Output message updates the pulse output channel high time.

3.3. Switch Table

The Switch Table menu item allows configuration of the main switch table used to decide the SSC output given the values of the various input sources and the state of the command channel. Assignment of the constants array and the pulse output period are also done under this menu item so that a clear picture of switch operation is provided with a single view. A typical switch table is shown here:

```
   SWITCH TABLE
    Ch    0ms     1ms    1.5ms    2ms       Const  Period
   ----  ******  ------  ------  ------     -----  ------
1)   1   CONST   SERIAL  LAST    PIN  1      1500   20000
2)   2   CONST   SERIAL  LAST    PIN  2      1500   20000
3)   3   CONST   SERIAL  LAST    PIN  3      1500   20000
4)   4   CONST   SERIAL  LAST    PIN  7      1500   20000
5)   5   CONST   SERIAL  LAST    PIN  5      1500   20000
6)   6   CONST   SERIAL  LAST    PINv 6      1500   20000
7)   7   CONST   SERIAL  LAST    PIN  1      1500   20000
8)   8   CONST   SERIAL  LAST    PIN  8      1500   20000
9)   9   CONST   SERIAL  LAST    PIN  9      1500   20000
A)  10   CONST   SERIAL  LAST    PIN 10      1500   20000
B)  11   CONST   SERIAL  LAST    PIN 11      1500   20000
C)  12   CONST   SERIAL  LAST    PIN 12      1500   20000

X) Set All in Row
Y) Set All in Column

N) Select Next Column
0) Previous Menu

Select:
```

Only one of the switch table columns may be active for configuration at any time. The active column is indicated by asterisks in the column header. Menu selection 'N' sequences through the switch table columns to allow configuration of all the information on this display.

The switch table settings can be changed as individual elements or as entire columns or rows. To change an individual element, make the column active by pressing 'N' and then select the corresponding table row. A menu or prompt will be displayed that allows selection or entry for the table element. Often it is convenient to set an entire row or column to a single source before changing individual elements. The 'X' and 'Y' menu items are provided to facilitate this.

When the constants column is selected (as indicated by the asterisks under the 'Const' column heading), the value of the constants array can be changed. Note that the values indicate pulse high time in microseconds, so that 1500 represents a 1.5 ms pulse. The valid range for a constant is 0 (no signal out to the servo) to 32000 (32 ms). Typically, the range of 1000 to 2000 is used to drive conventional RC servos.

The output pulse periods for each channel are represented by the period column of the table. As with constants, the period values are specified in microseconds. The valid range for a period is 1000 (1 ms) to 32000 (32 ms). Typically, 20000 is used to drive conventional RC servos.

Note that for the SERIAL and CONST sources, the output of servo channel *k* is completely defined by row *k* of the table. If the CONST source is specified in any command state column for channel *k*, then the constant on the row for channel *k* will be used to drive the servo. The PIN and PINv sources require that the PIN channel to be used as the source be specified.

3.4. Message Rates

The Message Rates menu item allows configuration of the serial messages to the user. The actual messages are defined in the Software Interface section of this document. Each of the messages may be configured to transmit at one of several rates between 0 and 50 Hz. Although the ability to poll messages is available at any time, it is specifically intended for use when a message transmit rate is zero.

Note that the baud rate of the SSC is fixed at 115200. **IT IS UP TO THE USER TO VERIFY THAT HIS MESSAGE OUTPUT SELECTIONS DO NOT EXCEED THE AVAILABLE BANDWIDTH OF THE SERIAL PORT**. Exceeding the bandwidth of the port will result in data delays and dropped messages.

The message rate menu and rate selection submenu are shown below.

```
      MESSAGE RATES
  1) Status Message    (msg 10) [1Hz]
  2) Source Selections (msg 11) [1Hz]
  3) Pulse Out Message (msg 12) [1Hz]
  4) Pulse In Message  (msg 13) [1Hz]
  5) Aux In Message    (msg 14) [1Hz]

  0) Previous Menu

Select:
```

```
  1) 1 Hz
  2) 2 Hz
  3) 5 Hz
  4) 10 Hz
  5) 20 Hz
  6) 25 Hz
  7) 50 Hz
  0) off
```

3.5. Primary Comm

All serial communication with the SSC occurs over the selected primary (or operational) communication port. The menu for selecting the port is:

```
      PRIMARY COMM
  1) Comm 1  [X]
  2) Comm 2  [ ]

  0) Previous Menu

Select:
```

Only one of the ports may be selected for primary communication. Selecting any of the ports causes the other ports to be unselected.

3.6. Config Lockout

As a safety feature, the configuration mode will be locked out after 5 seconds from time of power-up. The configuration lockout prevents the possibility of entering configuration mode during operation. In addition to this predefined lockout method (time delay), the option to lockout on receipt of specific serial messages is also supported. Consider the example of a flight computer communicating with the switch. It might be desirable to have the flight computer lock out SSC configuration as soon as possible after power-up. The config lockout menu follows:

```
CONFIG LOCKOUT
  1) On Rcv Msg 98  [ ]
  2) On Rcv Msg 20  [ ]

  0) Previous Menu

Select:
```

The SSC can be configured to lockout configuration upon receipt of message 98 and/or message 20. Message 98 is specifically a configuration lockout message. It has no other purpose. Message 20 is the serial command message for the servos. These lockout methods are not enabled by default because of the potential for the user to lock himself out of SSC configuration. Consider the case where the user has access to Comm 2 for doing SSC setup and has Comm 1 tied to the flight computer as the primary operational port. If the flight computer issues a lockout message that the SSC is configured to accept before the user can type 'ssconfig' at Comm 2, then the configuration mode cannot be entered. The user would first have to physically disconnect Comm 1 from the flight computer or prevent the flight computer from sending the lockout message.

4. Software Interface

4.1. Protocol Definition

Communication with the SSC occurs over the selected primary communication port using the Microbotics binary protocol, mBin. The mBin protocol is a standard binary packet format that has the following structure.

mBin Packet Frame

The checksum is a Fletcher checksum as defined in internet RFC 1145. It is computed over the bytes between the head and checksum. In other words, it includes the message ID, Count byte, and the payload bytes. The basic algorithm is as follows:

```
cksum0 = 0
cksum1 = 0
for each byte from ID to Payload_N (inclusive)
  cksum0 = cksum0 + byte
  cksum1 = cksum1 + cksum 0
```

The payload is composed of a sequence of bytes that represent values within a message. In the section that follows, the application messages will be defined using the nomenclature shown below to indicate the type of value represented in the payload.

Type	Description
U1	Unsigned, 8 bit integer
U2	Unsigned, 16 bit integer
U4	Unsigned, 32 bit integer
I1	Signed, 8 bit integer
I2	Signed, 16 bit integer
I4	Signed, 32 bit integer
B*x*	String of *x* bytes
BN	Variable length string of bytes

4.2. SSC Messages

The SCC Messages are divided into two groups: messages sent from the SSC to the Host, and messages set from the Host to the SSC. In the following message definitions, N represents the number of pulse output channels, and M represents the number of pulse input channels. These are defined by switch configuration.

4.2.1. SSC To Host

Supported output messages are:

- Status (10)
- Channel Source (11)
- Pulse Outputs (12)
- Pulse Inputs (13)
- Auxiliary Inputs (14)
- System Configuration (15)

Any of these messages may be configured to be transmitted from the SSC at one of several predefined rates from 0 to 50Hz. When a message is disabled (its output rate is set to zero), it may be polled by sending a message of the same ID to the SSC, but with no payload, so that the message count is zero.

4.2.1.1. Status Message

Message	Status				
Description	SSC status information.				
Message ID	10	**Payload Length**	2 Bytes	**Message Rate**	0, 1, 2, 5, 10, 20, 25, or 50 Hz.

Payload

Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U2		status		System Status: bits 15-7: (reserved) bits 2-1: Command Channel State 0 = signal not present 1 = 1ms 2 = 1.5ms 3 = 2ms bit 0: Config available (not locked out)

Notes:

4.2.1.2. Channel Source Message

Message	Channel Source				
Description	Current source for each output channel				
Message ID	11	**Payload Length**	N Bytes	**Message Rate**	0, 1, 2, 5, 10, 20, 25, or 50 Hz.

Payload

Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U1	1	Ch 1		Source Selected: Pulse Output 1 0 = PIN 1 = PINv (inverted) 2 = CONST 3 = SERIAL 4 = LAST
1	U1	1	Ch 2		Source Selected: Pulse Output 2
…	…	…	…	…	…
N-1	U1	1	Ch N		Source Selected: Pulse Output N

Notes:
1. Only the low nibble of the byte contains the source selection. If the source is PIN or PINv, the PIN channel is indicated in the high nibble.

4.2.1.3. Pulse Outputs Message

Message	Pulse Outputs				
Description	Current pulse values used to drive the pulse output channels.				
Message ID	12	**Payload Length**	2*N Bytes	**Message Rate**	0, 1, 2, 5, 10, 20, 25, or 50 Hz.

Payload

Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U2	1	channel 1	1e-6 sec	pulse width for channel 1
2	U2		channel 2	1e-6 sec	pulse width for channel 2
…	…	…	…	…	…
2*(N-1)	U2		channel N	1e-6 sec	pulse width for channel N

Notes:
1. If the most significant bit of a pulse value is set, the pulse signal is invalid.

4.2.1.4. Pulse Inputs Message

Message	Pulse Inputs				
Description	Current pulse values received at the pulse input channels.				
Message ID	13	**Payload Length**	2*M Bytes	**Message Rate**	0, 1, 2, 5, 10, 20, 25, or 50 Hz.

Payload

Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U2	1	channel 1	1e-6 sec	pulse width for channel 1
2	U2		channel 2	1e-6 sec	pulse width for channel 2
…	…	…	…	…	…
2*(M-1)	U2		channel M	1e-6 sec	pulse width for channel M

Notes:
1. If the most significant bit of a pulse value is set, the pulse signal is invalid.

4.2.1.5. Auxiliary Inputs Message

Message	Auxiliary Inputs				
Description	Values of the auxiliary inputs.				
Message ID	14	**Payload Length**	(see notes)	**Message Rate**	0, 1, 2, 5, 10, 20, 25, or 50 Hz.

Payload

Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U1		dig_in	bitfield	Digital inputs: bits 7-6: (reserved) bit 5: Aux channel 6 pin state (1=high) … bit 0: Aux channel 1 pin state (1=high)
1	U1	1	timer_assign	bitfield	Channel is assigned as an input timer or PA: bits 7-6: (reserved) bit 5: Aux channel 6 is a timer/PA … bit 0: Aux channel 1 is a timer/PA
2	U2	2			Timer counts for first timer assigned channel bit 15: over-range bit 14: running bits 13-0: timer/PA measurement
…	…	…	…	…	…

Notes:

1. If an auxiliary input channel is assigned as an input timer or pulse accumualtor, then the corresponding timer_assign bit is set. An unsigned short follows for each bit set in this field, starting with the lowest auxiliary channel number first. The length of the payload is 2+2*(number of bits set in timer_assign).
2. This field only exists if timer_assign is non-zero (see note 1). For timers, the measurement is the timer count in units of the timer time base as assigned during configuration. For pulse accumulators, the measurement is the number of pulses since the last time this message was generated.

4.2.1.6. System Configuration Message

Message	System Configuration				
Description	SSC configuration information.				
Message ID	15	**Payload Length**	14 Bytes	**Message Rate**	0 Hz (query only)

Payload

Byte Offset	Number Format	Notes	Name	Unit	Purpose / Comment
0	U1		ConfigID		Used specified configuration number
1	U1	1	nPINs		Number of switch pulse inputs
2	U2	2	Aux 1		Auxiliary channel 1 configuration
…	…	…	…	…	…
12	U2	2	Aux 6		Auxiliary channel 6 configuration

Notes:

1. The number of pulse outputs that are part of the switch is 24-nPINs.
2. Each auxiliary channel configuration word has the channel function encoded in the low nibble.
   bits 3-0: Channel function
   0 = Digital Input
   1 = Timer Input
   2 = Pulse Accumulator Input
   3 = Digital Output
   4 = Pulse Output

   The remaining bits of the word depend on the function selected.

   Digital Input
   no additional configuration
   Timer Input
   bit 8: start edge (1 = rising edge)
   bit 7: stop edge (1 = rising edge)
   bits 6-4: time base (defined below)
   Pulse Accumulator Input
   bit 7: pulse edge (1 = rising edge)
   bits 6-4: time base (defined below)
   Digital Output
   bit 4: initial state (1 = high)
   Pulse Output
   bit 8: mode (1 = one shot (pulse on message 21), 0 = free running)
   bit 7: polarity (1 = low pulses, 0 = high pulses)
   bits 6-4: time base (defined below)

   Time base indicates the amount of time specified by the least significant bit of the timer value.
   0 = 1 microseconds
   1 = 2 microseconds
   2 = 4 microseconds
   3 = 8 microseconds
   4 = 16 microseconds
   5 = 32 microseconds
   6 = 64 microseconds
   7 = 128 microseconds

4.2.2. Host To SSC

Three messages are supported from the host to SSC.

- Pulse Command (20)
- Auxiliary Outputs (21)
- Lockout Now (98)

4.2.2.1. Pulse Command Message

Message	Pulse Command				
Description	Commanded pulse values for the serial source.				
Message ID	20	**Payload Length**	2*N Bytes	**Message Rate**	

Payload

Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U2	1	channel 1	1e-6 sec	pulse width for channel 1
2	U2		channel 2	1e-6 sec	pulse width for channel 2
…	…	…	…	…	…
2*(N-1)	U2		channel N	1e-6 sec	pulse width for channel N

Notes:
1. Valid input range for commanded pulse signal is 0 to 32000 microseconds.

4.2.2.2. Auxiliary Outputs Message

Message	Auxiliary Outputs				
Description	Commands for the auxiliary outputs.				
Message ID	21	**Payload Length**	(see notes)	**Message Rate**	

Payload

Byte Offset	**Number Format**	**Notes**	**Name**	**Unit**	**Purpose / Comment**
0	U1	1	dig_out	bitfield	Digital outputs: bits 7: set these outputs bits 6: (reserved) bits 5: Aux channel 6 command … bits 0: Aux channel 1 command
1	U1	2	pulse_assign	bitfield	Set pulse values for the following channels: bits 7: Set period instead of pulse time. bits 6: (reserved) bits 5: Set value for aux channel 6 … bits 0: Set value for aux channel 1
2	U2	3			Pulse value for the first selected channel. bit 15: (ignored) bits 14-0: pulse / period counts
…	…	…	…	…	…

Notes:
1. The bits for any channel not assigned as a digital output will be ignored. If bit 7 is zero, then the assignment of this field to the digital outputs will not occur.
2. If a pulse output is set for one-shot operation, it will be triggered only the channel bit of this character is set and bit 7 is cleared, indicating the value is pulse time.
3. This field will only exist if pulse_assign is non-zero. The value of this unsigned short is the pulse count in units of the pulse time base as assigned during configuration.

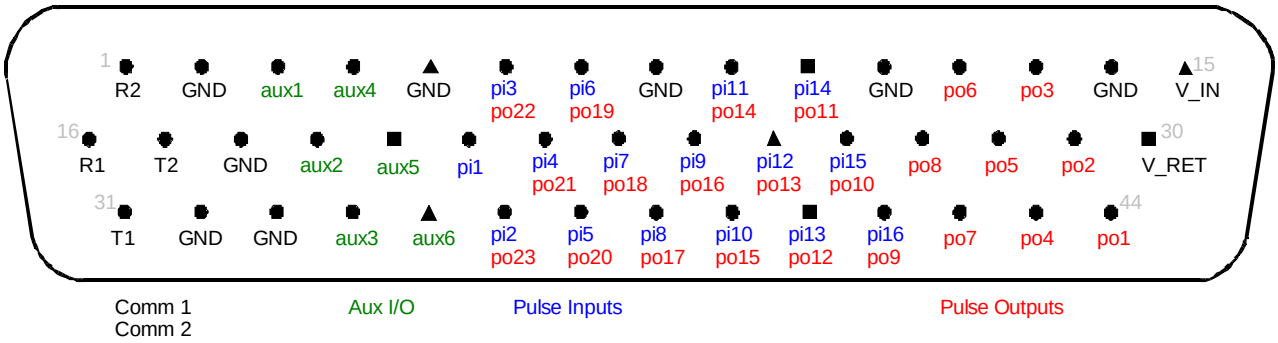
4.2.2.3. Lockout Now Message

Message	Lockout Now				
Description	Cause the configuration menu system to become unavailable.				
Message ID	98	**Payload Length**	0 Bytes	**Message Rate**	

Notes:

5. Electrical

5.1. Pinout



pins	names	direction	Signal type
15, 30	V_{IN}, V_{RET}		Power
2, 5, 8, 11, 14, 18, 32, 33	Ground		Signal Ground
16, 31 1, 17	Comm 1 Comm2	In/Out	RS-232
21	Pulse In 1	In	Digital
3, 4, 19, 20, 34, 35	Aux 1 - Aux 6	In/Out *(see configuration)*	Digital
6, 7, 9, 10, 22-26, 36-41	Pulse In 2-16 Pulse Out 9-23	In/Out *(see configuration)*	Digital
12, 13, 27-29, 42-44	Pulse Out 1-9	Out	Digital

5.2. Signal Specifications

5.2.1. Power

Power must be supplied using V_{IN} (pin 15) and V_{RET} (pin 30). Requirements are:

10 to 32 Volts DC
500 mW

NOTE: DO NOT USE THE GROUND CONNECTIONS OF THIS BOARD AS THE POWER RETURN PATH FOR SERVOS. SERVO GROUND MUST BE CONNECTED DIRECTLY TO THE POWER SUPPLY.

5.2.2. Digital Inputs

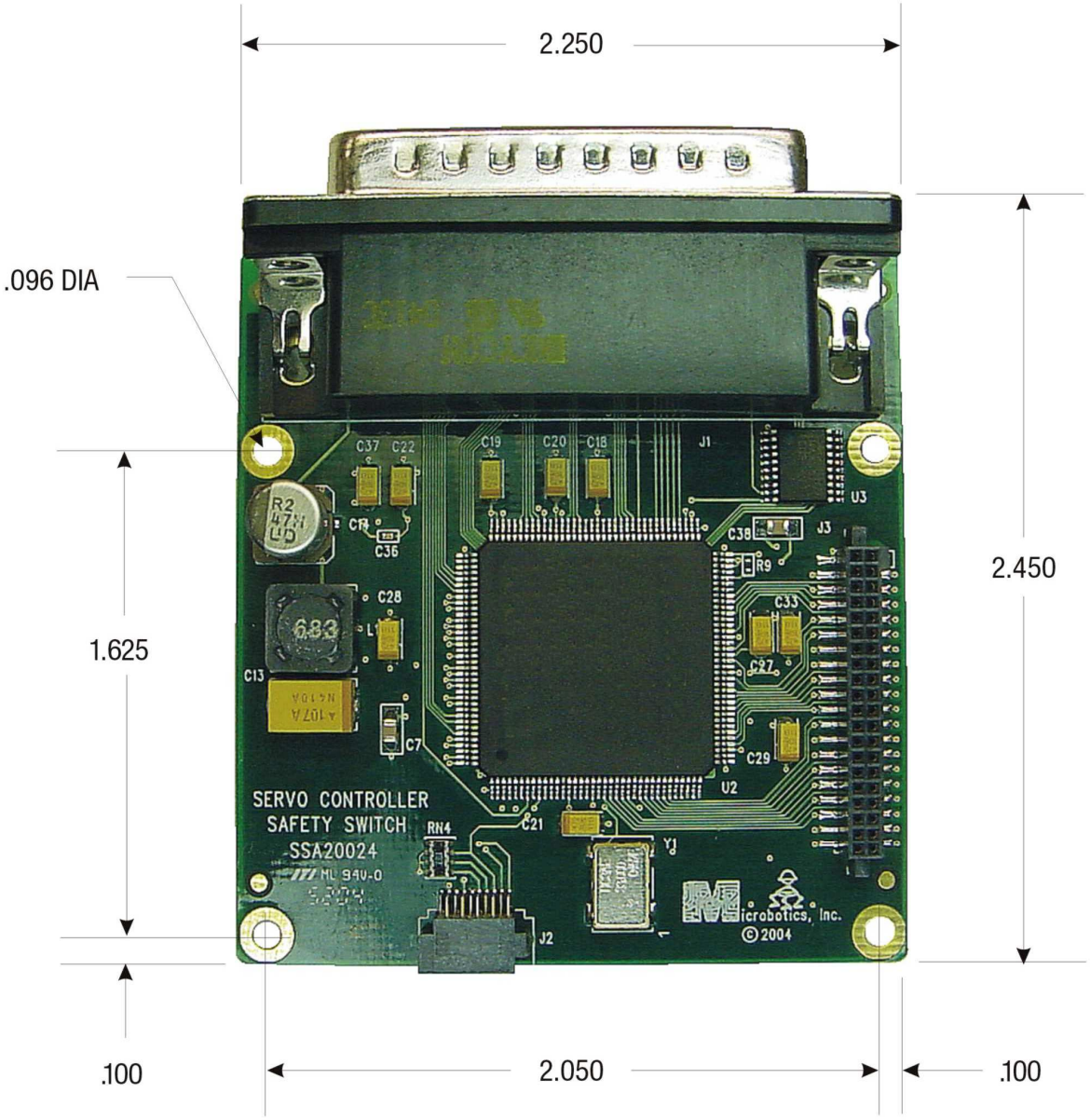
The digital inputs are TTL compatible, 5V tolerant.

Low threshold: 0.8 VDC
High threshold: 2.0 VDC

The digital outputs are 3.3V CMOS.

Low output: 0 VDC
High output: 3.3 VDC

6. Mechanical



The interface connector is a 44 pin male, high-density D-subminiature connector. The mating connector is female.

7. Ordering Information

Model:
SSA20024 Servo switch/controller