Introducing COMBITRONIC™ Communications

High Speed Transparent Communications over CAN bus

Moog Animatics has introduced a significant advancement in integrated motor technology. Combitronic™ is a protocol that operates over a standard "CAN" (Controller Area Network) interface. It may coexist with either CANopen or DeviceNet protocols at the same time. Unlike these common protocols however, Combitronic™ requires no single dedicated master to operate. Each integrated servo connected to the same network communicates on an equal footing, sharing all information, and therefore, sharing all processing resources. Combitronic communications operate over a standard "CAN" interface, the same basic hardware used in most automobiles as well as in familiar industrial networks such as CANopen and DeviceNet. Unlike these common control networks, Combitronic has no master or slave.

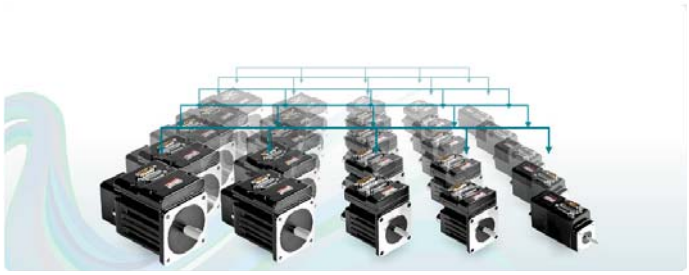
An array of Moog Animatics SmartMotor servos become one giant parallel-processing system when equipped with the Combitronic™ interface. This powerful technological advancement provides the joint benefits of centralized and distributed control while eliminating their respective historical drawbacks, opening up the possibility to either:

- Elimate PLCs from machine designs
  or
- Enhancing the performance of existing PLCs by unburdening it from specific tasks

The optional Combitronic™ technology allows any motor's program to read from, write to, or control any other motor simply by tagging a local variable or command with the other motor's CAN address. All SmartMotor™ units become one multi-tasking, data-sharing system without writing a single line of communications code or requiring detailed knowledge of the CAN protocol. The only prerequisite is to have matched baud rates and unique addresses.

Up to 120 SmartMotor servos may be addressed on a single array using Combitronic technology.

Combitronic Protocol Features:



- 120 axis node count
- 1MHz Bandwidth
- No Master required
- No scan list or node list set up required
- All Nodes have full read/write access to all other nodes

For example, SmartMotor servos use a single letter command to start a motion profile, so a line of code to start a motion profile would look like this:

G	Issue Go in local motor
G:2	Issue Go to Motor 2
G:0	Issue Global Go to all motors on the network
x=PA:5	Assign Motor 5 Actual position to the variable "x"

Additionally, comparisons or live polling and value comparisons may be made across the bus:

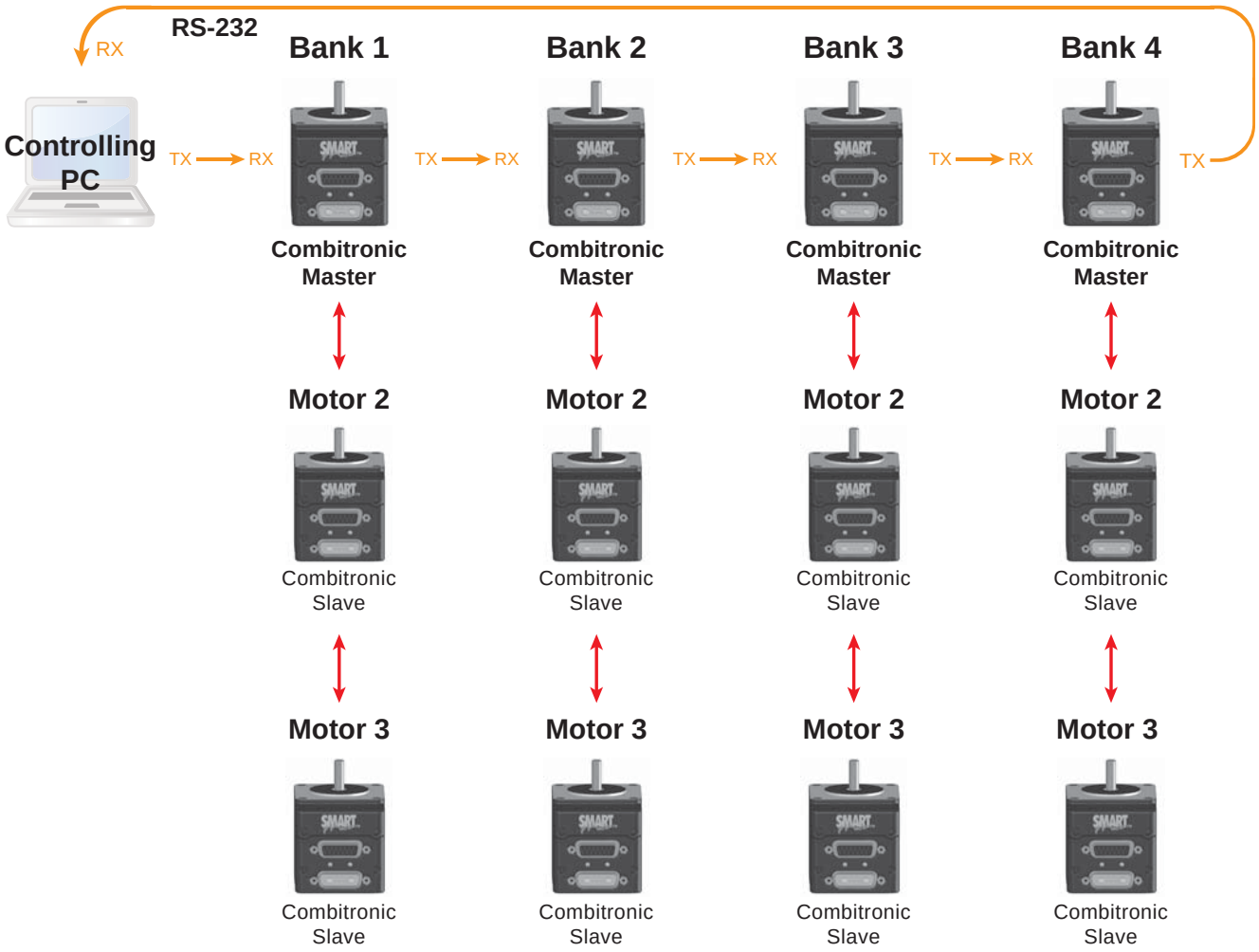
```
IF PA:3>PA:5      If motor 3 position exceeds motor 5
                  position
        S:2       Stop motor 3
ENDIF

WHILE IN (4) : 2==0 LOOP Wait for Input 4 of motor 2
                  to go high
```

Combitronic™ with RS 232 Interface

In the event that a PC or HMI is desired to control a large number of SmartMotors, but RS232 is desired to save the cost of direct CANbus interfacing to the network, any SmartMotor may be used as master access via RS232 to all Combitronic motors on its network. The following demonstrate 12 motors in a network where 4 SmartMotors are in a serial daisy chain over RS232. Each of those 4 may have up to 119 motors on its Combitronic network.

The controlling PC may freely access and control all motors via a single standard RS232 serial port.



Example of RS232 commands form Host PC using SMI software for above system layout:

2PT:3=1234	*Motor 2 sets target position of Motor 3 in its group to 1234*
3PT:0=0	*Motor 3 sets target position of all motors in its group to zero*
4PT=345	*Just Motor 4 gets its own target position set to 345*
0G	*Motor 1, 2, 3, and 4 get Go command*
0G:0	*All motors on RS232 and all network Combitronic motors receive Go command*

Linear Interpolation

New Stand Alone Linear Interpolation Utilizing COMBITRONIC™ Protocol and our New Class 5 SmartMotor:

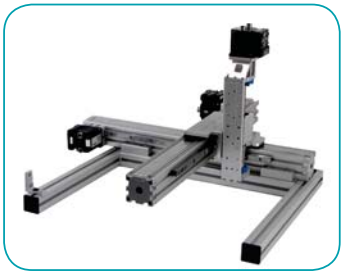
Moog Animatics has broken down the barrier between multiple integrated motors and introduced a simple command structure that allows any one SmartMotor to command linear interpolated paths across multiple motors at once. The new synchronized motion command set opens the door to direct control without the need for any centralized processor. The user may command path velocity, acceleration, deceleration and target points in 3 cartesian dimensions.

Dual Axis Example (Absolute Move)

```
a=1 b=2          'Motor addresses, x and y
x=123000         'X Axis Target Position
y=20000          'Y Axis Target Position
VTS=100000       'set path velocity
ATS=1000         'set path acceleration
DTS=100          'set path deceleration
PTS(x;a,y;b)     'set 2-axis synchronized target position
GS               'Go, 2-axis linear interpolation
TSWAIT           'Wait until 2 axis move is complete
```

Dual Axis Example (Relative Move Syntax)

```
PTRS(x;a,y;b)  'set 2-axis synchronized Relative Target position
```

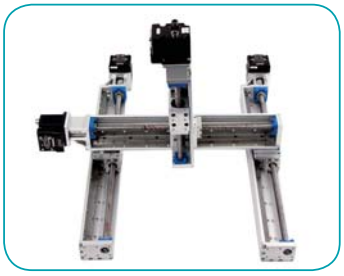


Three Axis XYZ Example

```
a=1 b=2 c=3        'Motor addresses, x, y and z
x=123000           'X Axis Target Position
y=20000            'Y Axis Target Position
z=8000             'Z Axis Target Position
PTS(x;a,y;b, z;c)  'set 3-axis synchronized target position
GS                 'Go, 3-axis linear interpolation
TSWAIT             'Wait until 3 axis move is complete
```

Four Axis X1, X2, Y, Z Example

```
a=1 b=2 c=3      'Motor addresses, x, y and z
u=4              'Motor address, x slave (parallel X axis)
x=123000         'X Axis Target Position
y=20000          'Y Axis Target Position
z=8000           'Z Axis Target Position
PTS(x;a;u,y;b,z;c) 'set 4-axis including x slave
GS               'Go, 3-axis +slave X axis
TSWAIT           'Wait until all axis move is complete
```



Synchronized commands allow up to 3 pairs of motors for X, Y and Z for large parallel axis gantry systems with 2 motors per axis:

```
PTS(x;a;u,y;b;v,z;c;z) 'set 6-axis including x slave, y slave, z slave
GS                      'Go, 3-axis primaries x, y, z, + slaves: u, v, and w
TSWAIT                  'Wait until all axis move is complete
```

Supplemental Axis syntax allows for additional motors above and beyond that will start and stop and the exact same time as the main motors: These motors could be rotary axis, pumps, etc….

```
PTS(x;a,y;b,z;c)      'set 3-axis X, Y, Z
PTSS(j,q)             'set supplemental axis q to j absolute position
PRTSS(k,r)            'set supplemental axis r,  k relative distance
GS                    'Go, all 5 motors
TSWAIT                'Wait until all moves are complete
```

Now With CAN Bus through D-Sub Connector

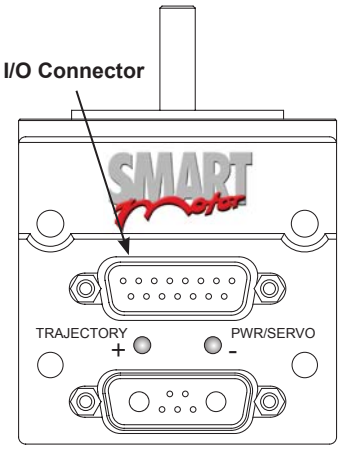
- Get your SmartMotor with CAN & brake
- More compact design decreases required space in machine
- Low cost OEM means of connecting CAN through the DB15 connector

SmartMotor Part Numbers Compatible with New –CDS Option

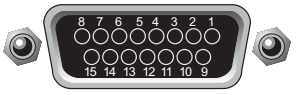
- SM23165D-CDS
- SM23165DT-CDS
- SM23165D-BRK-CDS
- SM23165DT-BRK-CDS
- SM23165D-CDS-AD1
- SM23165DT-CDS-AD1
- SM23165D-DE-CDS
- SM23165DT-DE-CDS
- SM23165D-DEBRK-CDS
- SM23165DT-DEBRK-CDS
- SM23165D-DE-CDS-AD1
- SM23165DT-DE-CDS-AD1

The part numbers listed above can also have the following options: sealed –S or –S3, F1 or F2 flats, or reduced shaft length –SL.

PIN	I/O CONNECTOR (5VTTL I/O)	Specifications:	
1	I/O – 0 General Purpose or Enc. A or Step Input	25mAmp Sink or Source 10Bit 0-5VDC A/D	1.5MHz max as Enc or Step input
2	I/O – 1 General Purpose or Enc. B or Dir. Input	25mAmp Sink or Source 10Bit 0-5VDC A/D	1.5MHz max as Enc or Dir. Input
3	I/O – 2 Positive Over Travel or GP	25mAmp Sink or Source 10Bit 0-5VDC A/D	
4	I/O – 3 Negative Over Travel or GP	25mAmp Sink or Source 10Bit 0-5VDC A/D	
5	I/O – 4 General Purpose or RS485 A Channel(1)	25mAmp Sink or Source 10Bit 0-5VDC A/D	115.2KBaud Max
6	I/O – 5 General Purpose or RS485 B Channel(1)	25mAmp Sink or Source 10Bit 0-5VDC A/D	115.2KBaud Max
7	I/O – 6 General Purpose or “G” command	25mAmp Sink or Source 10Bit 0-5VDC A/D	Redundant connection on Main Power Connector
8	Phase A Encoder Output		
9	Phase B Encoder Output		
10	CAN-Low	1MBaud (max, non-isolated)	115.2KBaud Max
11	CAN-Hi	1MBaud (max, non-isolated)	115.2KBaud Max
12	+5VDC Out	50mAmps Max (total)	
13	SIG Ground		
14	Ground		
15	Main Power: +20-48VDC	if -DE option, control power separate from main power	



DB-15 D-sub Connector



WARNING: Proper bus biasing and termination must be incorporated into system wiring to ensure quality communications over any industrial bus. Failure to do so could result in loss of communications. Please consult the associated bus standard organizations for details.

Moog Animatics is releasing a new option to their popular NEMA 23 frame SmartMotors, the SM23165D-CDS and SM23165DT-CDS.

This motor option allows users to employ CAN communications through the D-sub connector on the top of the motor instead of through the 5-pin connector on the back of the motor. This change allows for the integrated brake option to be used with CAN, opening the door to numerous applications requiring SmartMotor on their vertical axis.

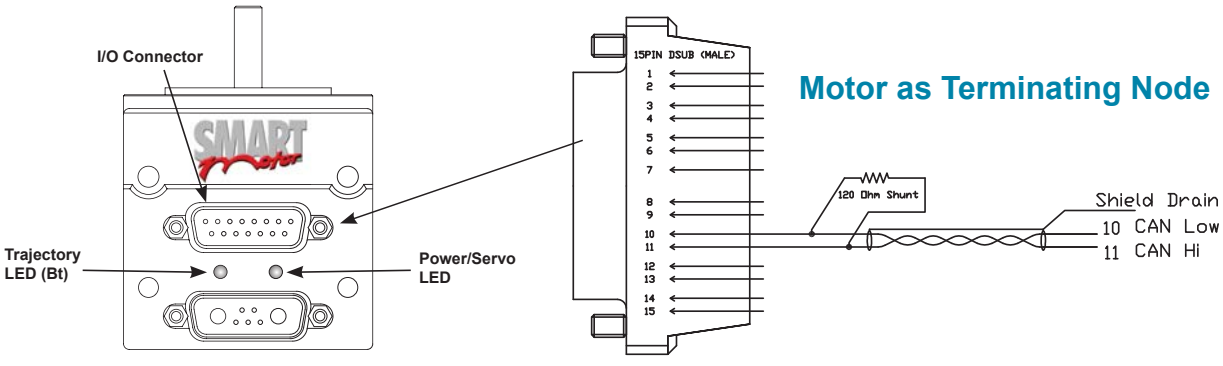
SmartMotor products from Moog Animatics are advanced motion controllers with an integrated servo motor, drive and encoder inside one package. Each SmartMotor is able to be a slave or a master with the ability to link over 100 SmartMotors together over one CANbus.

Note: 24V CAN bus power connection is not required at the motor. DeviceNet bus power monitor and fault are over ridden and bypassed.

LED Indications are as standard Class 5 D-style SmartMotors with added indications for CANbus condition.

Condition	**Indication**
Bt=0, CAN bus OK,	Trajectory LED = OFF
Bt=1, CAN bus OK,	Trajectory LED = GREEN
Bt=0, CAN bus fault	Trajectory LED = Red flashing
Bt=1, CAN bus fault	Trajectory LED = Red/Green alternating

Bt refers to Busy Trajectory Status Bit. When the motor is actively pursuing a trajectory, the Bt bit will be set to 1.



3 Motor Example with Required Terminating Node at each end.
Note: Bus must be multi-drop as shown, NOT star network!