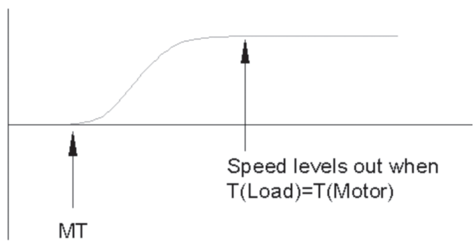
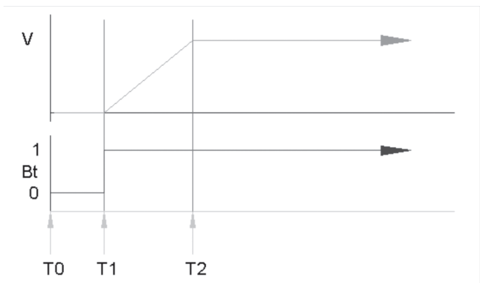
Torque Mode:



Open loop directional control of power to the motor windings. In this mode the motor has knowledge of encoder position but does not use it for motion. The motor will increase speed until its commanded torque equalizes with load torque. If load torque decreases, shaft speed will increase. If load torque increases, shaft speed will decrease. In a static condition, force applied will be proportional to commanded torque.

Velocity Mode:



Closed loop speed control based on position over time, not frequency. This means that from the initial command to begin motion, the controller keeps track of what the actual position should be.

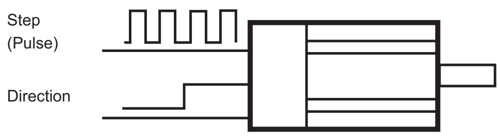
If load momentarily increases beyond the limits of the motor, shaft speed will be slightly reduced. If the load decreases back to within the capabilities of the motor, the shaft speed will increase beyond commanded speed in order to catch up to where it should have been had a constant velocity been maintained.

Position Mode:

Closed Loop control based on encoder feedback. All position mode moves are classified as either relative or absolute mode. Relative Mode means the motor is commanded to move a set distance in either direction relative to where the shaft is at the time.

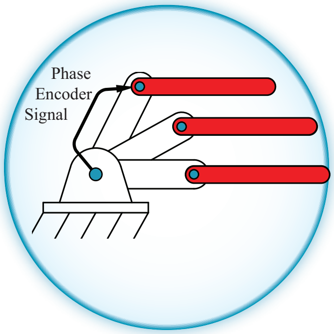
Absolute Mode means the motor is commanded to move to a specific location regardless of initial position.

Mode Step (Step and Direction Input):



The motor will follow a standard step and direction input signal. A ratio of internal encoder counts to incoming pulses may be used. The step input can also be used as a high speed counter.

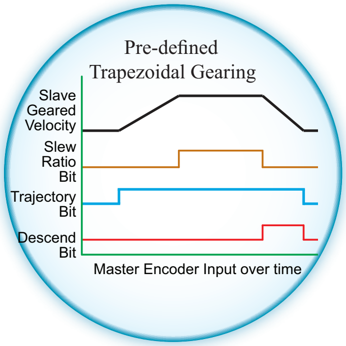
Phase Adjust Mode



Enables applications such as product tracking where moves must be applied over a target in motion, automatically stabilizes pan & tilt applications, or allows arm end effectors to remain parallel to base while the mid arm section moves.

Phased Origin stays referenced to base allowing commanded moves to be DYNAMICALLY independent of the phase axis.

Expanded Electronic Gearing Functionality

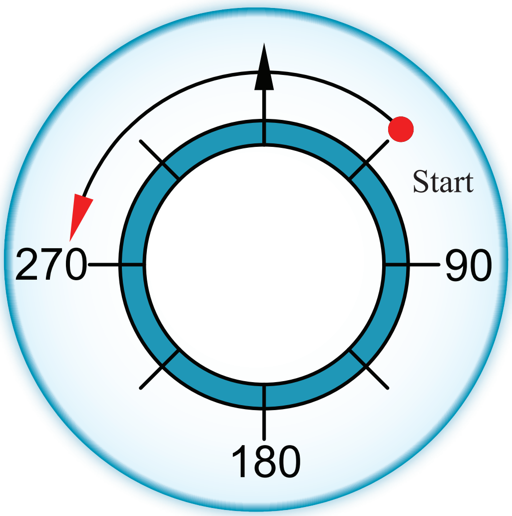


Now includes separate Ascend, Slew and Descend pre-defined distances that may be defined off of either master or slave encoder values for enhancing applications such as high speed winders.

With an array of status bits available, all portions of the move may be used for I/O triggering. Automatic transitions in and out are ideal for high speed labeling applications.

Modulo Count Mode

Modulo Count Mode allows the user to define maximum position counter rollover. Normally the shaft position counter can run anywhere from zero to +/- 2^{31}. This means the motor counter will continuously increase in the positive direction and when it hits its maximum, it will instantly go negative and begin counting down to zero. With Modulo Count Mode, the user can alternately set up a counter that will increase up to a given value and then roll directly over to zero and start counting up again. The count will never go negative, it will always be 0<=modulo value<= (Modulo Limit-1). This mode is especially useful in rotary pan or azimuth controls for targeting systems, radar, and Camera bases. Combined with the Combitronic™ interface, multi Camera surveillance systems may more easily pass off subject tracking from one pan & tilt to the next.




```
PML= 360 (Position Modulo Limit) maintain counts
between 0 and 359

PMT= 270 (Position Modulo Target) take shortest
path to Target Position.
```

DE/Dt: Rate of Change of Following Error Limit (Dervative Error Limit)

DEL (Derivative Error Limit) provides the safest fast-means to fault a motor on sudden changes in load or detection of human interference.

The purpose of this Limit is to act as a look ahead on following error. Instead of just triggering on a raw following error of how far behind in a move the motor may be, the processor is looking at how fast that following error changes.

DE/Dt refers to the dynamic rate of change of following error. This results in an instant release of energy and safer operation and less chance of damage to equipment or injury to machine operators. Under normal servo control following error limits, if the load collides against an object, the motor will not fault until the following error limit is reached. As a result, current and torque applied will increase until that condition is met. By adding an additional derivative limit on following error, the servo will fault out within microseconds of contact with the object.

Example:

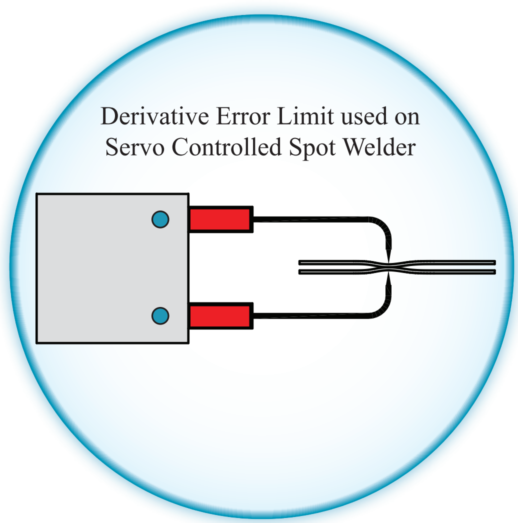
```
DEL=VT 'Set limit to commanded speed
```

If DE/Dt equals commanded velocity, then the motor just hit a hard stop. Normally, the motor would have to continue applying torque until the normal following error is exceeded. However, if DEL (DE/Dt limit) is set to target velocity (VT), then the controller would error out immediately upon hitting a hard stop without any wind-up whatsoever.

Derivative Error Limit

(Rate of change of following error limit)

This feature quickly detects jams for safer operation and less chance of damage to equipment or injury to machine operators.

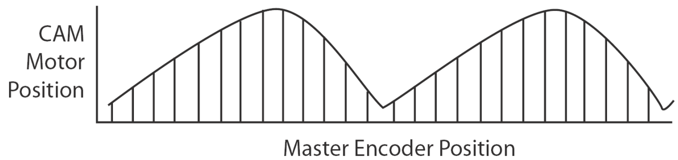



```
Jaw stops immediately upon making contact with
metal for minimal product deflection and maximum
balance to each side.
```

Cam Mode with Advanced Capabilities

Cam Mode

Electronic Camming is similar to mechanical Cams in that for a given master rotating device, a slave device tracks the speed and moves through a fixed profile of positions. In Electronic Camming, the profile is a look-up table of data stored in the slave motor.



Cam data can run from CPU RAM or Flash. Extra CAM data may be stored in EEPROM as well. CAM Mode data may be run using either Fixed Master segment length or variable master segment length.

- RAM storage: 1 CAM table
  - 52 fixed length data points, 35 variable length data points
- Flash storage: 9 CAM tables
  - 750 fixed length data points, 500 variable length data points
- EEPROM: Up to 8000 points total may be stored and moved to flash or RAM.

Powerful & Advanced Capabilities

- Multiple profile tables may be stored & called upon when required
- Dynamic tables can be created in real time for cases where amplitude or frequency and even actual specific points may need to be changed on the fly
- The master signal may be either an external encoder input from another motor, or it may be from an internal virtual axis encoder signal

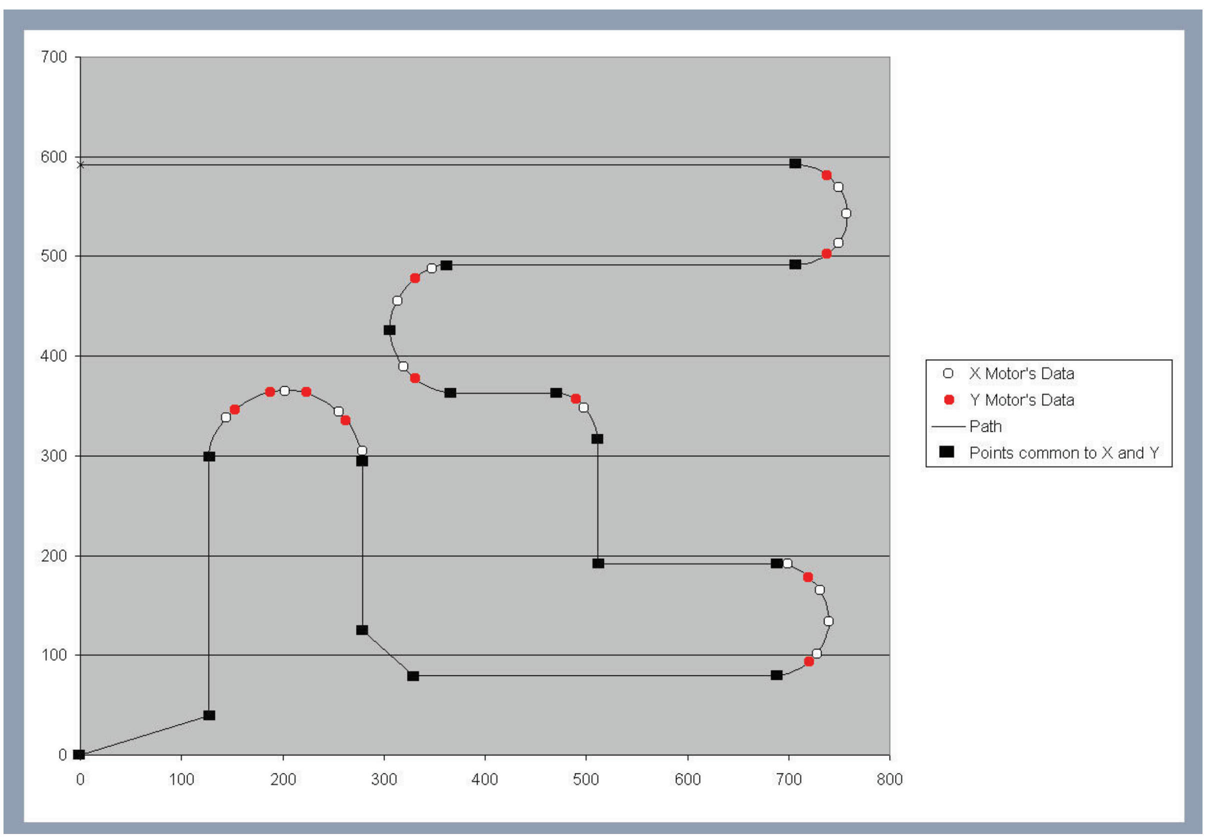
Use Cam Table to Control Entire Machine Process

Data is in the form of slave positions and master position deviations. Table data may be fixed Master position deviation where only slave data is stored or may be variable segment master data and slave data combined. In addition, each Cam data point has an additional 8 points of control data. This control data may used to define interrupt Status Bits for controlling I/O or move events, as well as defining a given point as linear, or curvilinear spline points.

All Cam tables may be run as standard linear interpolation or a modified spline algorithm. When running in Spline Mode, the data points may be greatly reduced. The sample diagram (Fig. 1) shows an X Y plot of Cam tables running on two motors. While the original data was over 700 points, the final data was around 30 points in each motor.

Fig. 1

In Spline Mode, only 30 data points in each SmartMotor™ were required to control the entire path of motion.



Cam Mode may be used for complete stand-alone coordinated motion

Fig. 2

The example data for motor 1 is shown below

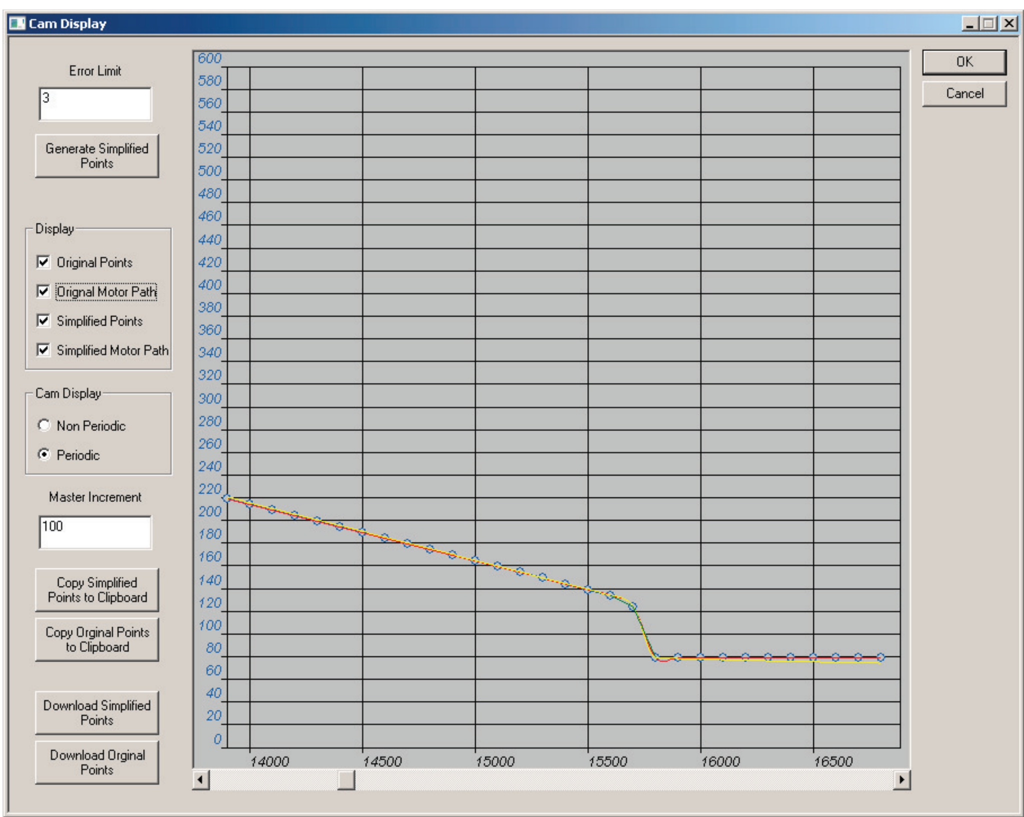
CTE(1)	CTW(511,29900)
CTA(30,0)	CTW(509,32600)
CTW(0,0)	CTW(498,33100)
CTW(126,2600)	CTW(456,34000)
CTW(130,8200)	CTW(334,36500)
CTW(156,9100)	CTW(312,37200)
CTW(253,11200)	CTW(306,37900)
CTW(273,11900)	CTW(323,38700)
CTW(279,12500)	CTW(372,39800)
CTW(279,15700)	CTW(740,47200)
CTW(329,15800)	CTW(756,47800)
CTW(717,23600)	CTW(756,48400)
CTW(737,24300)	CTW(743,48900)
CTW(739,24800)	CTW(687,50100)
CTW(727,25400)	CTW(0,63900)
CTW(699,26100)	CTW(0,75600)

Flexible Approach

- Cam Table data may be directly imported from a tab delimited text file of spread sheet
- Imported data in SMI can be writted into a program, copied to the clipboard or directly written (live) into a motor
- Import funtion allows for optimizing data points for cubic spline interpolation

Fig. 3

Below is the Cam Display window in SMI you see when importing data. Clicking the "Copy Simplified Points to Clipboard" button on the bottom left side of the Cam Display window in SMI results in Fig. 2 above.



Introducing COMBITRONIC™ Communications

High Speed Transparent Communications over CAN bus

Animatics Corporation 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, however, Combitronic has no master or slave.

An array of 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
```

New Stand Alone Linear Interpolation:

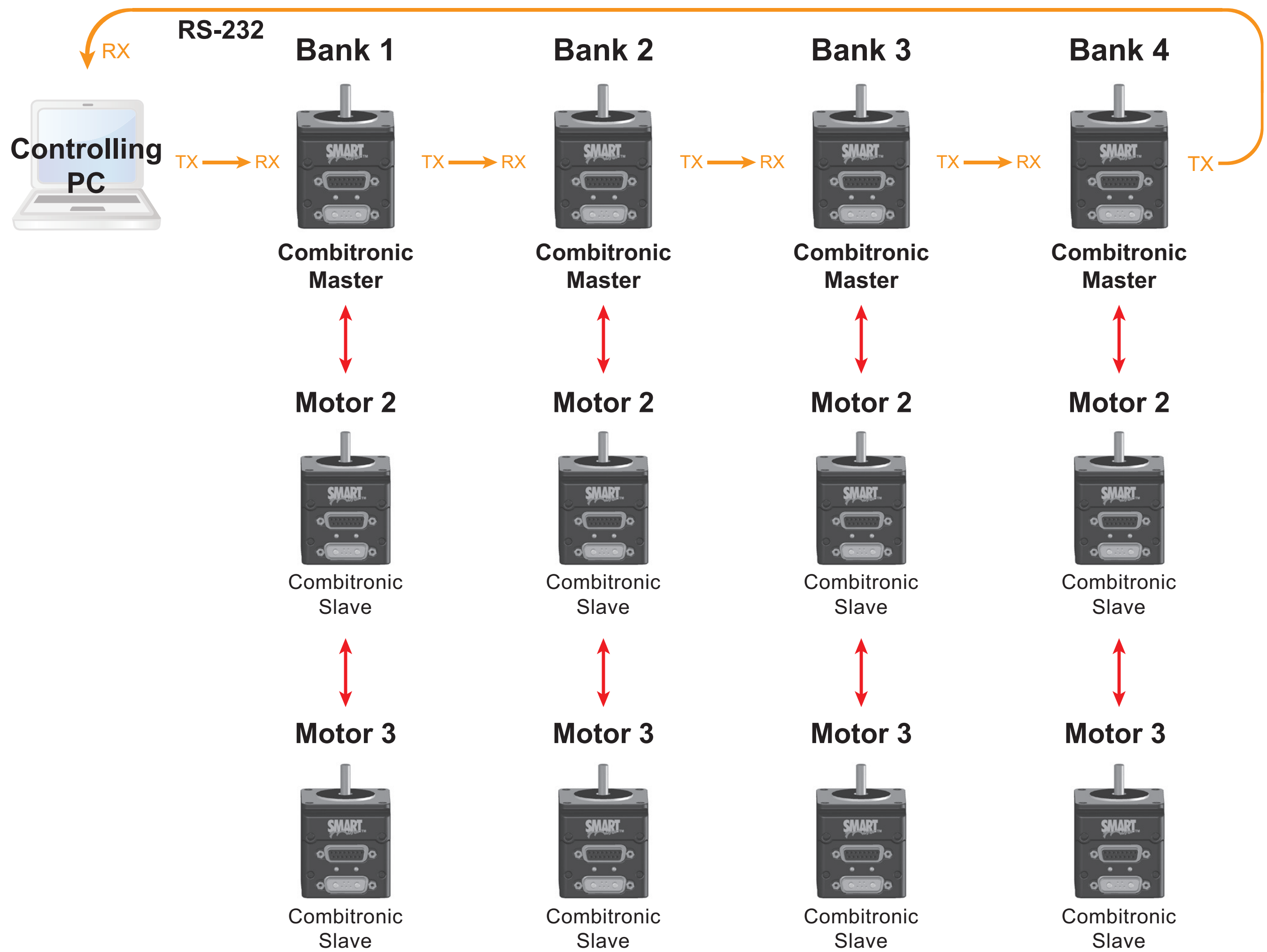
```
'Assign commanded positions for x, y, and
z
x=123000
y=20000
z=8000
'Use variables to define motor addresses
VTS=100000           'set path velocity
ATS=1000             'set path acceleration
DTS=100              'set path deceleration
PTS(x;1,y;2,z;3)     'set 3-axis synchronized
                      target position
GS                   'Go, 3 axis synchronized
                      linear interpolation

TSWAIT               'Wait until 3 axis move
                      is complete
```

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*