UNIDEX™ XI AND UNIDEX IV PROGRAMMABLE ACCEL/DECEL USER'S MANUAL

(OPTION 3)

REV. 0-2.L

AUGUST, 1987

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LIST OF ILLUSTRATIONS

DISCLAIMER

The information contained in this manual is subject to change due to improvements in design.

Though this document has been checked for inaccuracies, Aerotech does not assume responsibility for any errors contained herein.

CHAPER 1: PROGRAMMABLE ACCELERATION/DECELERATION

This option increases the performance of the motion control system by providing the ability to achieve higher motor speeds. The ramp time (the time to attain programmed feedrate) is programmable from 50 milliseconds to 9999 milliseconds. The acceleration/ deceleration profile may be set up to be linear or parabolic. Also programmable is the individual start/ stop feedrate for each axis. (The start/stop setting is used as a default speed for very short moves where accel/decel can not be used.)

Once the user has set (Set Up mode) the desired ramp time, start/stop feedrate and the profile for acceleration/deceleration, the values are stored in the battery backed up memory. The system default values for these parameters are:

ACCEL/DECEL RAMP TIME:	**250 MILLISECONDS**
START/STOP FEEDRATE:	**500 STEPS/SECOND**
ACCEL/DECEL PROFILE:	**LINEAR**

These parameters are modal. That is, they stay in effect in both the programmed (indexed) and immediate modes of Unidex XI or IV. However, Unidex XI or IV can be programmed (in the indexing mode) to change the accel/decel ramp time during program execution. (Start/stop feedrate and accel/decel profile can only be changed in the Set Up mode.) If the accel/decel ramp time is changed during program control, the last value set becomes the new modal accel/decel parameter.

Before proceeding with the discussion of the accel/decel option, it is assumed that the user is familiar with either the Unidex XI or Unidex IV Operator's Manual.

SECTION 1-1 REQUIRED HARDWARE

The option board OP4 with the accel/decel circuit components is required to be installed to exercise this option.

CHAPTER 2: PROGRAMMING

SECTION 2-1 MANUAL PROGRAMMING OF RAMP TIME

To program the parameters related to acceleration and deceleration, bring up the fifth screen of the main menu:

```
* * * * * * * * * * * * * * * * * * * * * *
*   1.  DIG. OUT          3.  COMM ENAB     *
*   2.  ACL/DCL           4.  PRINT         *
* * * * * * * * * * * * * * * * * * * * * *
```

Press key #2 to see:

```
* * * * * * * * * * * * * * * * * * * * * *
*   1.  ACCEL/DECEL RAMP TIME               *
*   2.  START/STOP SPEED ENTRY              *
* * * * * * * * * * * * * * * * * * * * * *
```

Press key #1 to select ramp time programming:

```
* * * * * * * * * * * * * * * * * * * * * *
*     ENTER ACL/DCL RAMP TIME               *
*              0250     msec                *
* * * * * * * * * * * * * * * * * * * * * *
```

The screen shows the current active value of ramp time.

The required ramp time may now be programmed. This value may be from 50 to 9999. Any value below 50 will be entered in the system as zero and this will turn acceleration and deceleration OFF. After entering the ramp time, press "ENTER" to store the ramp time information.

User memory (battery back up) will be updated as a result of manually programming the ramp time.

SECTION 2-2 MANUAL PROGRAMMING OF START/STOP FEEDRATE

The start/stop speed entry is similar to Run speed entry. Press key #2 to select start/stop speed programming.

```
* * * * * * * * * * * * * * * * * * * * * *
*    SS-Spd  X  0000500   step/s            *
*    SS-Spd  Y  0000500   step/s            *
* * * * * * * * * * * * * * * * * * * * * *
```

Feedrate values from 1 to 500000 units/sec may be entered here (in this case, 0 to 500000 steps/sec). Start/stop speed is the speed the axis defaults to when a programmed move is too short to implement acceleration and deceleration. If the time for the move is less than 32.768 milliseconds, acceleration/deceleration is turned off for the move and the move is executed at the start/stop feedrate.

SECTION 2-3 ACCELERATION/DECELERATION PROFILE SET UP

The accel/decel profile is set up as linear or parabolic using the Set Up screens (see section 2-2, item K of the Unidex XI or Unidex IV Operator's Manual). The Set Up screen, immediately after the Digital Input/output screen, shows:

```
* * * * * * * * * * * * * * * * * * * * * *
*    Programmable Accel/Decel               *
*      Profile   :  LINEAR                  *
* * * * * * * * * * * * * * * * * * * * * *
```

Press +/- to change the set up to PARABOLIC. Press SELECT repeatedly until the system goes back to the main menu screens.

SECTION 2-4 RAMP TIME PROGRAMMING IN A USER PROGRAM

The seventh EDIT screen (section 3-7, Item C, of the Unidex XI or Unidex IV Operator's Manual) allows acceleration/deceleration ramp time programming.

```
* * * * * * * * * * * * * * * * * * * * * *
*    1.  COR RND      3.  ACL / DCL         *
*    2.  PROG DEL     4.  DIG. OUT          *
* * * * * * * * * * * * * * * * * * * * * *
```

Press key #3 for:

```
* * * * * * * * * * * * * * * * * * * * * *
*      ENTER ACL/DCL RAMP TIME              *
*              0000     msec                *
* * * * * * * * * * * * * * * * * * * * * *
```

Now enter the required value and press ENTER to enter the block in memory. The accel/decel block, if called up again, will show the most recently entered ramp time.

To turn off acceleration/deceleration, program 0 milliseconds.

The motion command for entering the ramp time when downloading a program via a communication port (i.e., RS-232C or IEEE-488) is:

AD nnnn *

where "nnnn" is the ramp time in milliseconds. (See section 5-2, Item Z of the "UNIDEX XI AND UNIDEX IV RS-232C USER'S MANUAL" or section 5-2, Item Z of the "UNIDEX XI AND UNIDEX IV IEEE-488 USER'S MANUAL".)

The ramp time may be programmed as many times as required within a program. At the end of program execution, the value of the ramp time will remain as the last programmed value. If programmed manually before running a program, this value will be effective at the start of the program. The last ramp-time block executed from a program becomes modal to the system, but is NOT retained in the battery backed up user memory.

SECTION 2-5 CONDITIONS UNDER WHICH ACCEL/DECEL IS NOT IMPLEMENTED

The conditions under which accel/decel is not implemented are:

1. Ramp time programmed is less than 50 mSec.
2. Feedrate for the move is less than 16 units/second.
3. Total time for the move is less than 32.768 mSecs.
4. Option board is not installed.
5. System is not factory set for Programmable accel/decel option for a given axis.

CHAPTER 3: OPERATION

SECTION 3-1 ACCELERATION/DECELERATION IN OPERATION

Acceleration and deceleration velocity profiles in Unidex XI and Unidex IV are achieved by updating the clock rate from the indexer at fixed intervals, pre-computed from the programmed ramp time. The minimum clock-rate-update interval is 1 mSec. and the maximum number of updates is 250. If the ramp time programmed is 250 mSecs., the controller increments the clock rate from 0 to the programmed feedrate in 250 steps of a 1 mSec interval. For ramp times less than 250 mSecs. but greater than 125 mSecs., the number of updates is 125 and the interval is accordingly computed. For ramp times between 125 and 50 mSecs., the number of updates is 50. The following table illustrates this:

RAMP TIME	NUMBER OF UPDATES	UPDATE INTERVAL (mS)
5000	250	20.0
400	250	1.6
200	125	1.6
80	50	1.6
30	NO ACCEL/DECEL	

In LINEAR accel/decel mode, the clock-rate is updated linearly. In PARABOLIC mode, the clock-rate-update is a parabolic function of time. In the following description, N stands for the number of updates computed from the programmed ramp time as explained above, Fn represents feedrate at interval number n and Fp represents programmed feedrate.

The feedrate as a function of an update interval number during acceleration is shown below.

LINEAR

$$Fn = (Fp/N) * n \qquad n < N$$

$$Fn = Fp \qquad n >= N$$

3-1

PARABOLIC

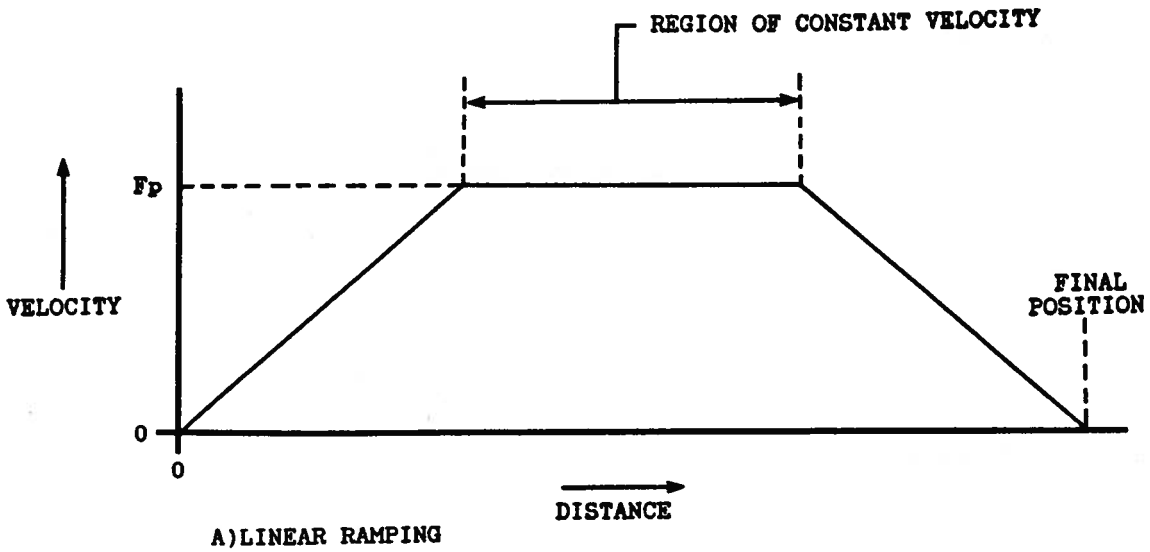
$$Fn = (Fp/N) * [N - (n-N) /N] \qquad n < N$$

$$Fn = Fp \qquad n >= N$$

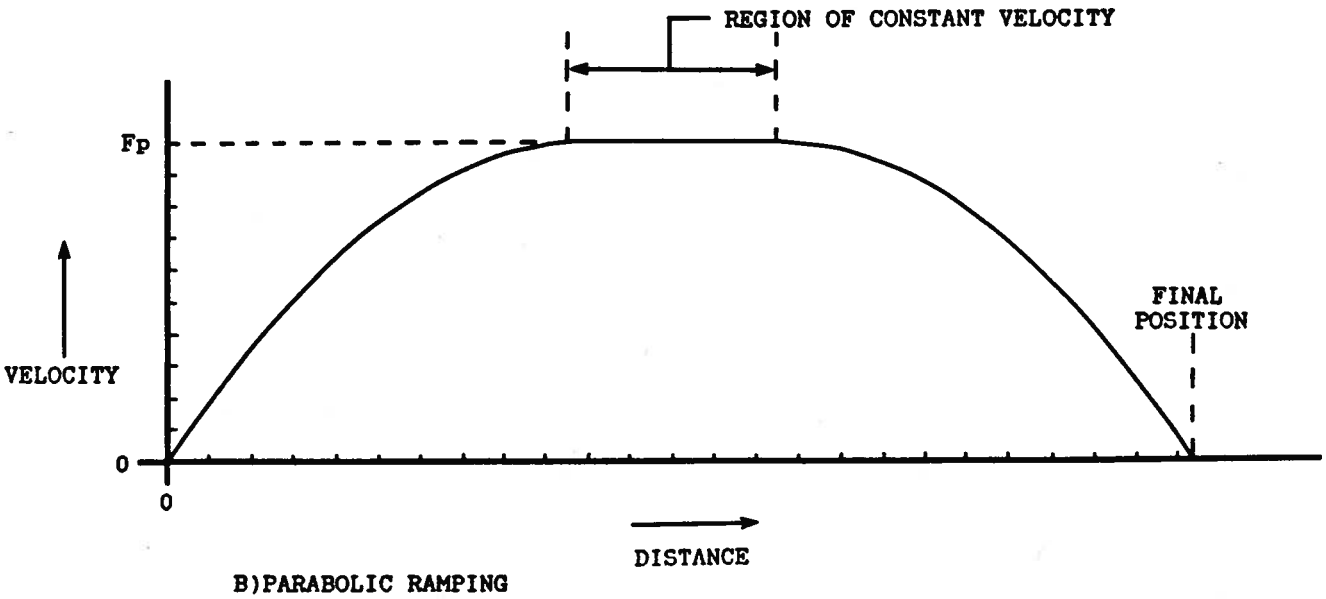
3-2

In the linear accel/decel mode, when the programmed move is longer than the ramp time, a trapezoidal velocity profile is achieved. When the move is shorter, (but greater than 32.768 mSec.), a triangular velocity profile results and the axis does not attain the programmed feedrate. Parabolic profile is truncated when the programmed move is not long enough to attain programmed feedrate.

Figure 3-1 and figure 3-2 illustrate some examples of linear and parabolic ramping in both full and truncated profiling modes.

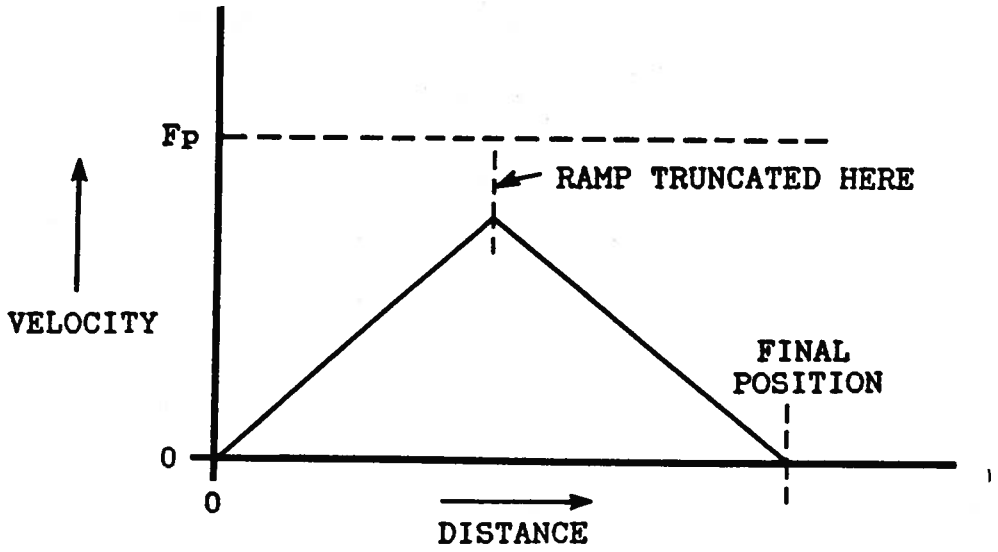


A)LINEAR RAMPING

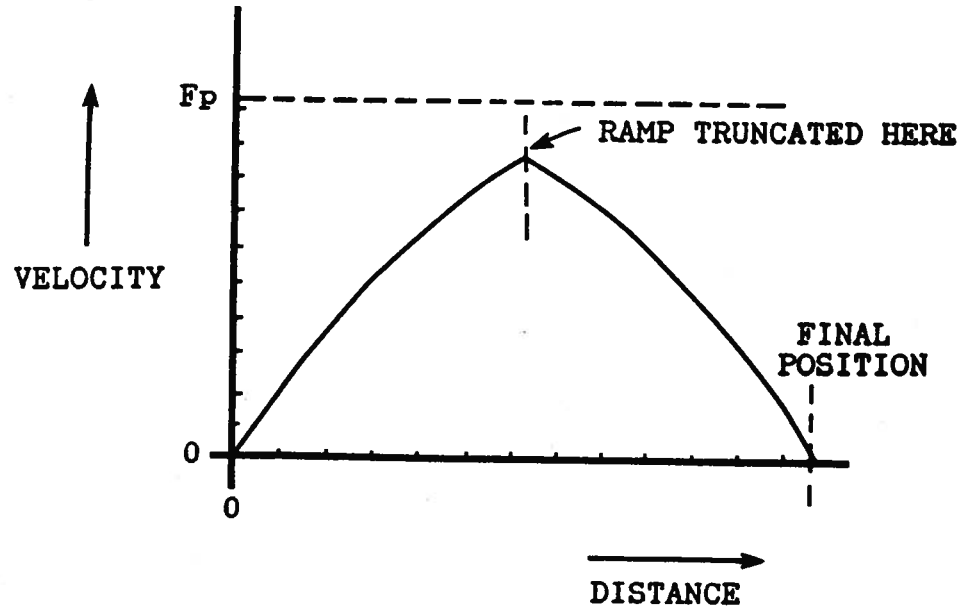


B)PARABOLIC RAMPING

FIGURE 3-1: FULL RAMP PROFILES FOR LINEAR AND PARABOLIC RAMPING



A) LINEAR RAMPING



B)PARABOLIC RAMPING

FIGURE 3-2: TRUNCATED RAMP PROFILES FOR LINEAR AND PARABOLIC RAMPING

SECTION 3-2 RAMPING LIMITATIONS

The system hardware imposes certain restrictions on the performance of the programmable accel/decel. The maximum axis feedrate with accel/decel is 125000 units/sec. The period resolution of the clock pulses from the indexer is 8 microseconds. To compensate for this, the number of update intervals (ramp time) is modified. Example:

PROGRAMMED FEEDRATE	:	50000 UNITS/SEC.
REQUIRED SYSTEM CLOCK PERIOD	:	20 uSec (reciprocal of feedrate)
NUMBER OF UPDATES (N)	:	250
THE CLOSEST FEEDRATE OF WHICH THE SYSTEM IS CAPABLE	:	16 uSec or 62500 units/sec
MODIFIED NUMBER OF UPDATES (N):		250 * 16/20 = 200
MODIFIED RAMP TIME	:	RAMP TIME * 16/20
FEEDRATE AT END OF ACCEL	:	62500 * 16/20 = 50000 units/sec

Computations for ramp time modification of a parabolic ramp is done based on the computation for an equivalent linear accel/decel ramp shown above. In the parabolic mode, with a similar computation done above, the parabolic ramp profile becomes "clipped" at the top. Also, the feedrate attained at the end of acceleration is higher than the programmed feedrate.

For the above example, the modified number of update intervals is 200.

When decelerating at the end of a move, the feedrate levels off at the programmed start-stop value in order to mask any nonlinearities of the system. The user may set up his system for the optimum performance.

For an equivalent parabolic ramp with the same programmed feedrate shown in the previous example:

FEEDRATE ATTAINED (FN)

= (62500/250) * [250 - ((200-250)^2/250)]

= 62500/250 * 240

= 60000 steps/sec.

SECTION 3-3 OTHER LIMITATIONS

Accel/decel control in Unidex XI and IV is implemented with individual hardware VCO (voltage control oscillator) circuitry. Hardware VCOs are used because of the need for feeding back electronic damping control signals from the Aerotech stepping translators when the Unidex XI and Unidex IV is used to control stepping motor systems. Since these VCOs are analog drivers, and operate asynchronously with respect to the indexing circuitry of Unidex XI and Unidex IV, user calculated vector motion for any two sets of axes may yield inaccuracies in the trajectory between two given points.

In other words, a calculated vectorial move between two given points of an X/Y plane using accel/decel may produce a slight curvature on the line connecting the two points. For this reason, it is recommended that the accel/decel mode not be used in those cases where precise vectorial motion is required.

This limitation is not considered a flaw in Unidex XI or Unidex IV performance since the basic design criteria for both Unidex XI and Unidex IV is four axis point to point motion.

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Warranty and Field Service Policy

Aerotech, Inc. warrants its products to be free from defects caused by faulty materials or poor workmanship for a period of one year from date of shipment from Aerotech. Seller's liability is limited to replacing, repairing or issuing credit, at its option, for any products which are returned by the original purchaser during the one-year period. Seller makes no warranty that its products are fit for the use or purpose to which they may be put by the buyer, whether or not such use or purpose has been disclosed to seller in specifications or drawings previously or subsequently provided seller, and whether or not seller's products are specifically designed and/or manufactured by seller for buyer's use or purpose. Aerotech's liability on any claim for loss or damage arising out of the sale, resale or use of any of its products shall in no event exceed the selling price of the unit.

Returning Goods Procedure
Claims for incorrect or defective materials must be filed within thirty (30) days from delivery at buyer's place of business. No units or systems may be returned, in or out of warranty, without first obtaining approval from the seller, and no claim will be allowed nor credit given for units or systems returned without such approval.

Returned Goods Warranty Determination
If possible, after approval from Aerotech, the defective unit or system is to be returned to the factory with statement of problem and transportation prepaid (no c.o.d. or collect freight shipments will be accepted). After Aerotech's in-plant examination, warranty or out-of-warranty status will be determined. If upon Aerotech's examination of such unit or system, warrantied defects exist, then the unit or system will be repaired at no charge and shipped, prepaid, back to the buyer. If an out-of-warranty situation exists, the buyer shall be notified of the repair cost immediately. At such time, the buyer must issue a purchase order to cover the cost of the repair or authorize the unit or system to be shipped back as is, at the buyer's expense.

On-Site Warranty Repair
If the system or unit cannot be made functional by telephone assistance or by sending and having customer install replacement parts, and cannot be returned to the Aerotech factory for repair, and if it is determined that the problem could be warranty-related, then the following policy applies:

Aerotech will provide an on-site field service representative in a reasonable amount of time, provided that the customer issues a bona-fide purchase order to Aerotech covering all transportation and subsistence costs. For warranty repairs, customer will not be charged for cost of labor and material.

If during the on-site repair it is determined the problem is not warranty related, then the terms and conditions stated in the following "On-Site Non-Warranty Repair" section apply.

On-Site Non-Warranty Repair
If system or unit cannot be made functional by no-charge telephone assistance or purchased replacement parts cannot be returned to the Aerotech factory for repair, then the following field service policy applies:

Aerotech will provide an on-site field service representative in a reasonable amount of time, provided that the customer issues a bona-fide purchase order to Aerotech covering all transportation and subsistence costs and the prevailing cost per hour including travel time necessary to complete the repair.

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