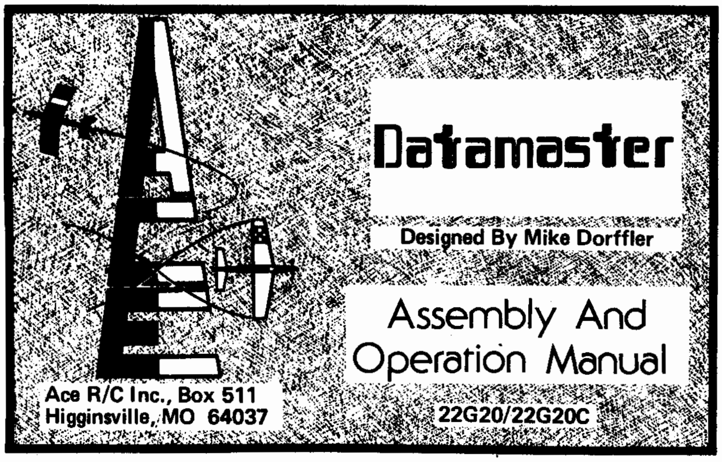
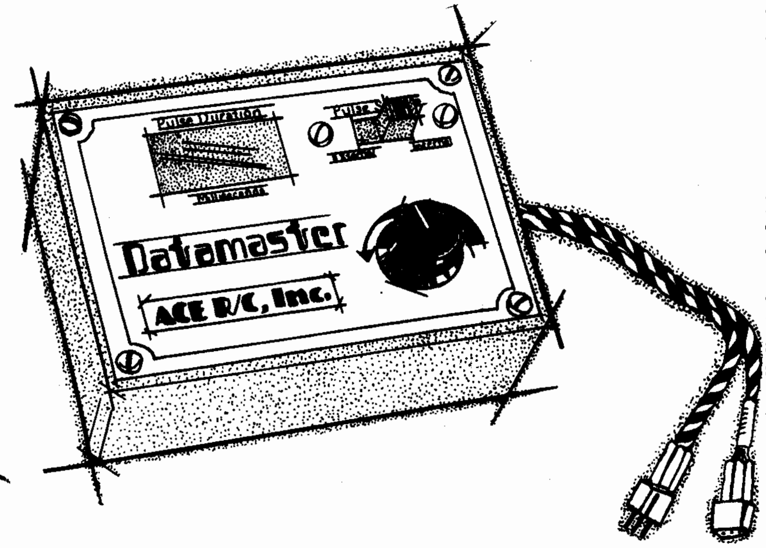




I. INTRODUCTION

Radio control has come a long way and the precision is such that servo and control surface accuracy is critical. "eye-balling" the controls is no longer good enough.

The Ace Datamaster eliminates this guess work. You can;

-Calibrate your servo to exact neutral
-Determine linearity of your servos
-Set the amount of throw on your transmitter sticks.
-Record the programmed settings of a "Super" transmitter so that these settings can be repeated in the future if they are changed for a different model.
-With an external 4.8V battery supply you can operate your servos without a transmitter and receiver. The Datamaster has a built-in pulse generator so you can adjust servos while reading pulse width in milliseconds.

The Datamaster is one of the most versatile pieces of test equipment you can get, all with "lab instrument" quality.

Note--The Datamaster is to be used with Positive Pulse systems only. Most modern systems except for pre-1982 Proline systems are Positive Pulse. If you aren't sure, check with the manufacturer of your system.

If you have obtained an assembled Datamaster, proceed to Section II. CONNECTOR WIRING and Section III. OPERATION. If you have obtained a Datamaster in kit form Skip to Section V. CONSTRUCTION and return to the Connector Wiring and Operation sections after completion.

II. CONNECTOR WIRING

( ) Obtain a male and female servo/receiver connector for the system you'll use the Datamaster with. If you are using various brands of radios, we suggest you use Dean's connectors and make up adaptor cables for the various systems.

( ) Note--Always maintain proper hookup polarity - we are interested in three connections: Red to red (+4.8V or positive), black to black (- 0V or negative), and signal to signal (odd color). If it is a four wire system, a jumper wire for the center tap (+2.4V. . .usually white) must be wired between the male and female connectors, bypassing the Datamaster. If you are not sure which wires are positive, negative and signal, consult the manufacturer of your radio.

( ) Solder the male connector that plugs into the receiver to the red, black, orange three-wire cable. Make sure polarity matches your system.

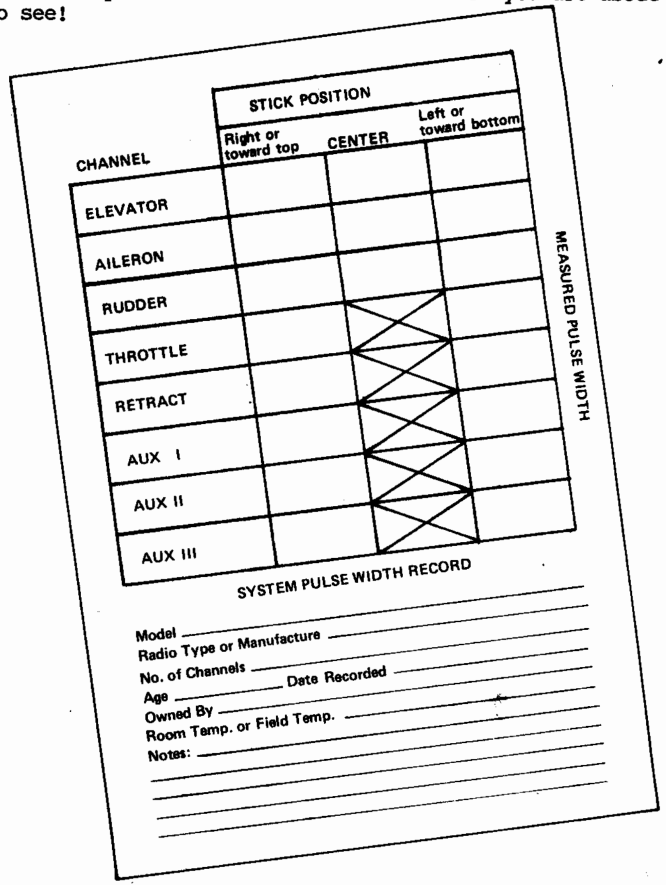
( ) Solder the female connector that plugs into the servos, to the red, black, yellow three-wire cable. Again make sure proper polarity is maintained.

NOTE-- If you are using connectors with wires already attached such as Kraft, Futaba, etc. you can either splice the connector wires to the Datamaster cables by soldering them together, or you can solder the connector wires directly to the PC board as stated in section VI. WIRING. ALWAYS make sure red is to positive, black is to negative and signal to signal (off color).

III. OPERATION

The first excercise would be to find the "neutral" pulse width that your particular radio system is using and or was designed to use. This "neutral" will appear in the display as you will soon see.

Now with the mode switch in the "External" position, carefully move all the trim levers on your transmitter to their centered positions. Don't worry about the retract switch if you have one. It's a good idea to make up a small chart like the one shown at this time because there is NO WAY you can remember all the numbers you are about to see!



CHANNEL	STICK POSITION: Right or toward top	CENTER	Left or toward bottom
ELEVATOR			
AILERON			
RUDDER		X	
THROTTLE		X	
RETRACT		X	
AUX I		X	
AUX II		X	
AUX III		X	

MEASURED PULSE WIDTH

SYSTEM PULSE WIDTH RECORD

Model ____
Radio Type or Manufacture ____
No. of Channels ____
Age ____ Date Recorded ____
Owned By ____
Room Temp. or Field Temp. ____
Notes: ____

Connect the Datamaster to the elevator channel of the receiver, turn on both transmitter and receiver battery pack. Write down the number appearing in the display in the block marked "center". Move the elevator stick on the transmitter to both extremes recording both blocks for elevator. Then the remainder of the channels can be logged the same way. Now turn off all power again.

Chances are that if your radio is U.S. made then the numbers that you wrote down in the "center" column will all be very close to 1.50. It should be noted that it's nearly impossible in final checkout at the factory to get the neutral setting for every channel to be exactly the same. So don't let this bother you. What we are trying to determine in this test is what the center pulse width for this particular radio is supposed to be, and this should become very apparent by looking at the numbers appearing in the "center" column.

With the center pulse width determined for this particular radio, move the mode switch to the "INTERNAL" position, and again apply power to the receiver. Now rotate the knob until the display matches center value determined in the exercise above.

What we have just done is to create an either-or system of command for the servos of this particular radio system. Now it's not necessary to use you transmitter when setting up your next plane. You can if you want, but what for? You have got written down what the pulse widths are for every channel so all you have to do is crank in the pulse widths with the knob, and exactly duplicate the transmitter. One word of caution, the Datamaster will have more throw in pulse width than your transmitter has so don't carelessly run your servos to their stops when using it. Up until now in our exercise for determining the throws for each channel of your transmitter we did not have a servo connected to the Datamaster. This was to avoid any confusion. One step at a time please.

So now set the transmitter aside and concentrate on the servos. With the Datamaster you can control the pulse width going to the servos in very small increments. Whether your radio is brand new or whether it has been in use for some time, you now have the ability to really examine the resolution of your servos. Do they have any dead spots? Now you can find out. If you a very demanding contest flyer now maybe you are about to find out the servos you thought were the best and have been using really aren't delivering the performance you thought they were.

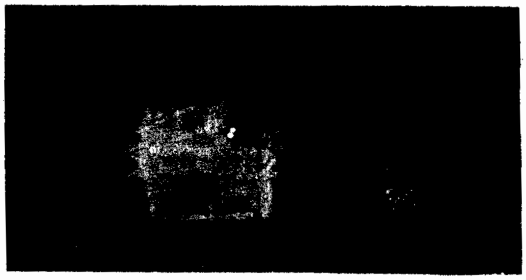
If you have been thinking about purchasing another airborne system to match your transmitter you can now REALLY match them. All you have to do is crank in the center value and adjust the servo neutral for each servo.

One extremely important use of the Datamaster is in the set-up of the new breed of Super Transmitters such as the Ace Silver Seven. Not only can you use the Datamaster in final transmitter alignment for incredible accuracy, it allows you to fully appreciate the difference and flexability that these types of transmitters have. Realize that once you have set up a "Super" transmitter to a particular airplane and have everything trimmed out and "fine tuned", you can record the settings on a chart like the example we presented (including Dual Rate settings, Slow and Snap Roll Button settings, Overall Throw, End Point settings, Reversal Switch positions, Trim Authority, etc.)

Then, all these adjustments are easily and totally repeatable when you switch from plane to plane. Without the Datamaster it would be impossible without a lot of trial and error.

Once you have spent some time using your Ace Datamaster and become familiar with its many uses you will find out how extremely useful it really is and how it can make you a better flyer through a better understanding of your radio's performance.

A useful, inexpensive aid to help in measurements is a clear, flexible plastic protractor. Simply glue it in place to an old servo arm so that the center point of the protractor lines up with the center of the hole for the screw that secures the arm onto the servo. (roughen the surfaces to be glued and use "Super" glue.) Now slip the assembly onto a servo. Use a pin stuck into an eraser or some clay for a pointer and line it up with 90 degrees on the protractor. Now you have a quick, easy, and accurate way to measure neutral, throw, resolution, etc. If you have different types of servos, simply make more protractor assemblies with the appropriate servo arms.



IV. PARTS LIST

SEMICONDUCTORS

( )	3	SS104	FND 357 Display
( )	1	SS086	74C926 IC
( )	1	SS103	CD4022 IC
( )	1	SS102	74C00 IC
( )	1	SS079	74C04 IC
( )	3	SS029	2N4400 Transistor
( )	1	SS033	2N4402 Transistor
( )	1	SS128A	IN5227 Zener Diode
( )	2	SS121	IN4446 Diode

CAPACITORS

( )	2	CD330	33pf Disc Capacitor
( )	2	CO224A	.22mf Bluecap
( )	1	CE476AL	47mf Electrolytic Capacitor
( )	1	CE106AL	10mf Electrolytic Capacitor

RESISTORS (All are 1/4 Watt)

( )	1	R4-103	10K (brown, black, orange)
( )	1	R4-104	100K (brown, black, yellow)
( )	1	R4-106	10 Meg (brown, black, blue)
( )	1	RV 156	10K Pot, Lock Washer and nut
( )	1	R4-220	22 ohm (red, red, black)
( )	1	R4-332	3.3K (orange, orange, red)
( )	1	R4-333	33K (orange, ornage, orange)
( )	1	R4-562	5.6K (green, blue, red)
( )	1	R4-750	75 ohm (violet, green, black)
( )	1	R4-822	8.2K (Grey, red, red)

HARDWARE AND MISCELLANEOUS

( )	2	HW010F	M3 x 10mm Phillips Head Bolt
( )	4	HW082A	4-40 x 1/4 Bolts
( )	1	LB060	Datamaster Faceplate
( )	1	PC141	Datamaster PC Board
( )	1	PLA 008A	Pot Knob
( )	1	PLA025	Dakaware Case
( )	1	SW001	DPDT Switch
( )	1	XT010	1 Mhz Crystal
( )	12"		Yellow, Orange Hookup Wire
( )	24"		Red, Black Hookup Wire
( )	48"		No. 22 Solder

V. CONSTRUCTION

( ) Read the "Kit Builders Hints" thoroughly.

( ) Check the parts list against the parts received. Notify Ace R/C of any shortages.

( ) Begin by installing and soldering resistor R1. Clip off the excess leads and save for the next step.

( ) Note that there are two jumpers that must be installed on the circuit board. Use the two resistor leads from the preceeding step. Carefully bend them so they lay flat and straight between the holes otherwise they could short to the pins of IC U2 when it is installed later.

( ) Install and solder the following IC's, making sure to orient them properly: U1, U2, U3, and U4.

( ) Install and solder the following resistors: R2, R6, R7, R8, and R9. Note If you will be using the Datamaster with a Kraft Sport Series radio (A series) install a 8.2K (grey, red, red) for R4 instead of the 5.6K to give the proper range for the odd neutral setting used for the Sport Series.

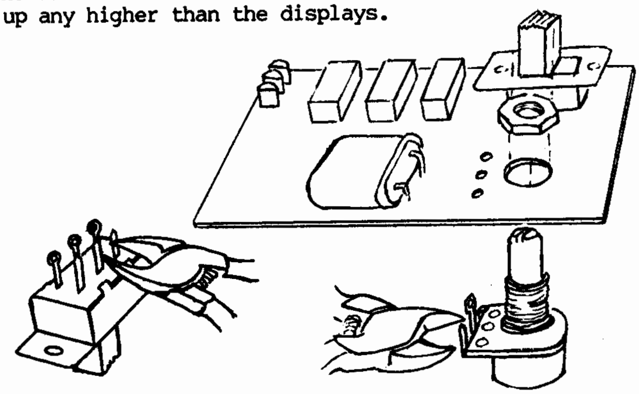
( ) Install and solder these diodes, making sure the banded ends (cathodes) are as shown, D1, D2, and D3

( ) Install and solder capacitors C1 and C2. Make sure the positive ends are positioned as shown.

( ) Install and solder C3, C4, C5 and C6.

( ) Install the three displays: DS1, DS2, and DS3. Note that the grooved edges go to the top. Watch out for solder bridges here. . . the lands are quite close.

( ) Install the four transistors Q1, Q2, Q3, and Q4. Make sure the flat sides are as shown and don't allow them to stick up any higher than the displays.



( ) Bend the crystal leads gently so they are 90 degrees to the case. Make sure they don't short out to the crystal body.

( ) Install and solder the crystal, keeping it flat on the PC board.

( ) Clip off the ends of the six switch lugs as shown. If required, remove any burrs. Install and solder, making sure it is down all the way so it is flat on the board.

( ) Carefully re-bend the three pot terminals so they point toward the end of the pot shaft and are parallel to it. Bend the small tab on the side of the pot back up against the pot body or cut it off. As with the switch, trim off the ends of the pot terminals as shown.. Note- if any of the terminals broke, a simple repair can be made with a resistor lead.

( ) Insert the threaded part of the pot from the bottom of the board. . .line up and insert the pot terminals through the appropriate holes. Use the nut provided to secure the pot to the board. Solder the three terminals.

( ) Install and solder R4 and R5.

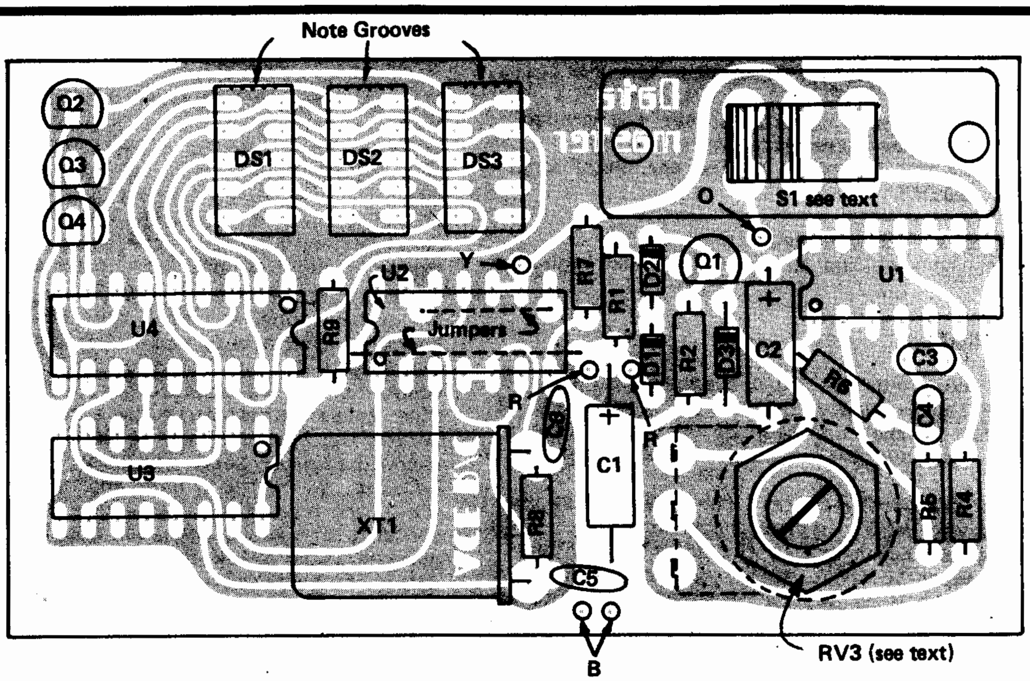
( ) Inspect the negative lead of capacitor C2. Make sure it doesn't short to either the pot nut on top of the board, or the pot body on the bottom of the board.

( ) PC board construction is complete. You will have a 8.2K resistor left over. (5.6K if this is for a Kraft Sport).

DATAMASTER OVERLAY DRAWING

Wiring:

Holes R= +4.8V (Red)
Holes B= OV (Black)
Hole O= Signal from receiver (Male Connector — Orange)
Hole Y= Signal to servo (Female Connector — Yellow)



PARTS ID LEGEND

( ) Two resistor lead jumpers
( ) C1 47mf electrolytic (note polarity)
( ) C2 10mf electrolytic (note polarity)
( ) C3 .22 mf Bluecap
( ) C4 .22 mf Bluecap
( ) C5 33 pf Disc
( ) C6 33 pf Disc

( ) D1 IN4446 (note banded end)
( ) D2 IN4446 (note banded end)
( ) D3 IN5227 (note banded end)

( ) DS1,2 & 3 FND357 Display (note groves)
( ) Q1 2N4402 (note orientation)
( ) Q2 2N4400 (note orientation)
( ) Q3 2N4400 (note orientation)
( ) Q4 2N4400 (note orientation)

( ) R1 22 ohm (red, red, black)
( ) R2 3.3K (orange, orange, red)
( ) R3 10K Pot (See Text)
( ) R4 5.6K (green, blue, red)
See text for value when using Kraft Sport
( ) R5 33K (orange, orange, orange)

( ) R6 100K (brown, black, yellow)
( ) R7 10K (brown, black, orange)
( ) R8 10 Meg (brown, black, blue)
( ) R9 75 ohm (violet, green, black)

( ) S1 DPDT Slide Switch (see text)

( ) U1 74C04 (note orientation)
( ) U2 74C00 (note orientation)
( ) U3 CD4022 (note orientation)
( ) U4 74C926 (note orientation)
( ) XT1 1 Mhz Crystal (see text)

VI. WIRING

( ) Cut the red and black hookup wires in half so you have two 12" pieces.

( ) Prepare the ends of all wires by stripping off 1/8" of insulation, twist the strands together and apply a small amount of solder to "Tin" the wire.

( ) Solder the red wires into holes R on the PC board.

( ) Solder the black wires into holes B on the PC board.

( ) Solder the orange wire into hole O (orange) on the PC board.

( ) Solder the yellow wire into hole Y (yellow) on the PC board.

( ) Twist one red, one black and the orange wire together to make a three wire cable.

( ) Twist one red, one black and the yellow wire together to make a three wire cable.

( ) Clean the bottom of the board with alcohol and an old toothbrush. Carefully inspect for missed joints, and solder bridges. Check for misplaced components.

( ) Refer to the Connector Wiring section to install proper connectors.

VII. FINAL ASSEMBLY

( ) Mount the completed circuit board to the faceplate with two M3 x 10mm bolts threaded into the two switch holes. Snug these up but do not strip them. The pot shaft should protrude through the faceplate without touching it. If it does, loosen the two switch bolts and "tweak" the position of the circuit board until the pot shaft no longer touches the faceplate and re-tighten the two bolts.

( ) Orient the circuit board/faceplate over the molded enclosure and lay the two three-wire cables in the prepared slot. Mount the faceplate to the enclosure with four 4-40 x 1/4" bolts.

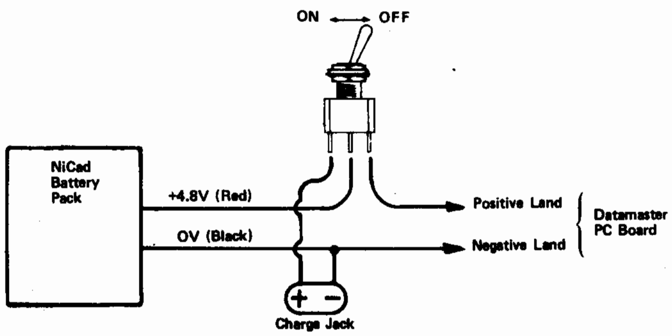
( ) Mount the knob to the pot shaft, leave a bit of clearance between the knob and the faceplate and tighten the set screw.

VIII. FINAL CHECKOUT

In order to check out the Ace Datamaster you will need to have your radio system's nicads fully charged. If you are not certain of the condition of charge it is a good idea to place the system on charge for at least a few hours.

When you are reasonably certain that the nicads are fully charged you may begin initial check out.

Make sure all switches are in the off position and connect the Datamaster to the elevator output of the receiver. Position the mode switch to "INTERNAL". Turn on the receiver battery pack. A number between .85 and 2.35 shold now appear in the display. Now rotate the pot knob from one extreme to the other. The number appearing in the readout should increase as the knob is turned clockwise and decrease as the knob is turned counter clockwise. Do not be alarmed if the range is slightly different than that given. (It will be approximately 1.2 ms to 2.6 ms if you have wired it for Kraft Sport) Now switch to the "EXTERNAL" and turn on your transmitter. Because the Datamaster is connectod to the elevator channel of your receiver, as you move the elevator stick of the transmitter the number in the display will rise and fall depending on the position of the stick. These two tests are all that is required in determining whether the unit is operating properly. If it is not, double check all wiring, component placement, and solder joints. Not much other trouble shooting can be done unless you have the equipment and knowledge of digital circuitry.



IX. OPTIONAL INTERNAL POWER SOURCE

If you use the Datamaster to test and run servos by themselves a good deal, it would be handy to install an internal power source so you don't have to continually plug a receiver/battery pack into the unit.

This can be easily done by obtaining a 4.8V 500 Mah AA nicad pack, (Ace 38K47F) small SPDT toggle switch (Ace SW005), and a charge jack (Ace 19K55). There is room in the bottom of the Datamaster enclosure to mount the battery pack with double sided servo tape. . .the switch and charge jack can mount on the side by drilling holes. (check for clearance first!)

The positive land on the Datamaster is the one that the red wires from the connectors hook to (holes R) and the negative land is the one the black wires solder to (holes B).

X. CIRCUIT DESCRIPTION

All digital radio control systems manufactured today operate by means of controlling the position of a servo by the width of a positive pulse. The term proportional means that the output wheel or arm of the servo is positioned proportionally to the width of the pulse it receives from the reciever. As this pulse width decreases or increases the servo responds by moving in the proper direction until its internal pulse width matches that of the pulse coming from the receiver. At this point the servo stops. Any time the received pulse width changes, even a very small amount, the servo will respond. The modern digital radio control system works nearly identical to its predecessor devised on or about 1965. What makes it better is the efforts of many people to refine the circuitry to achieve better servo resolution through tighter servo response. In order for you, the modeler, to better understand your radio as to how it works and how this pulse width is the key to better servo control, the Ace DataMaster has come to be designed. Its purpose is to allow the user to actually see the numerical value of the pulse width coming from any channel of your receiver, and how a particular servo responds to this pulse. The unit also contains an "on-board" pulse width generator which can be used without the receiver.

The operation of the Datamaster is both simple and complex. The simplicity stems from the method, the complexity is derived due to the actual number of transistors locked away in the four integrated circuits.

The method of operation as stated is simple, The pulse width as received from the receiver or the on-board pulse generator forms a gate through which much faster pulses can pass. Because the gate is only open for a specific amount of time, only a certain number of faster pulses are then counted and displayed by the LED's. When the gate is open for a shorter amount of time, fewer faster pulses may pass and likewise, when the gate is open longer, more faster pulses are allowed through. The count on the LED's changes as the width of the gate changes.

Electronically, Nand gates U2A and U2B clean up the received pulse width appearing at pins 9 & 10. The pulse is now fed to pin 1 on Nand gate U2D and pin 15 of U3 which is an 8 stage counter.

Nand gate U2C and the 1.00 Mhz crystal form a clock whose output is fed to pin 2 of U2D and pin 14 of U3. The function of U2D is the gate we spoke about earlier. When the pulse appearing at pin 1 is high, the 1.00 Mhz pulses are allowed to pass to the clock input of U4. When the pulse appearing at pin 1 is low, the 1.00 Mhz pulses are not allowed to pass to U4. Therefore when the received pulse goes low, counting in U4 stops. Counting does continue however in U3 after the count to U4 ceases, and sends a "store" pulse to U4 telling this IC to now display what it has just counted. Following this, U3 sends one more pulse to U4 to tell it to reset and be ready to count again. The display will hold the count even though U4 has been told to reset. The display will be "erased" and a new number replaced each time U3 sends a pulse to pin 5 of U4.

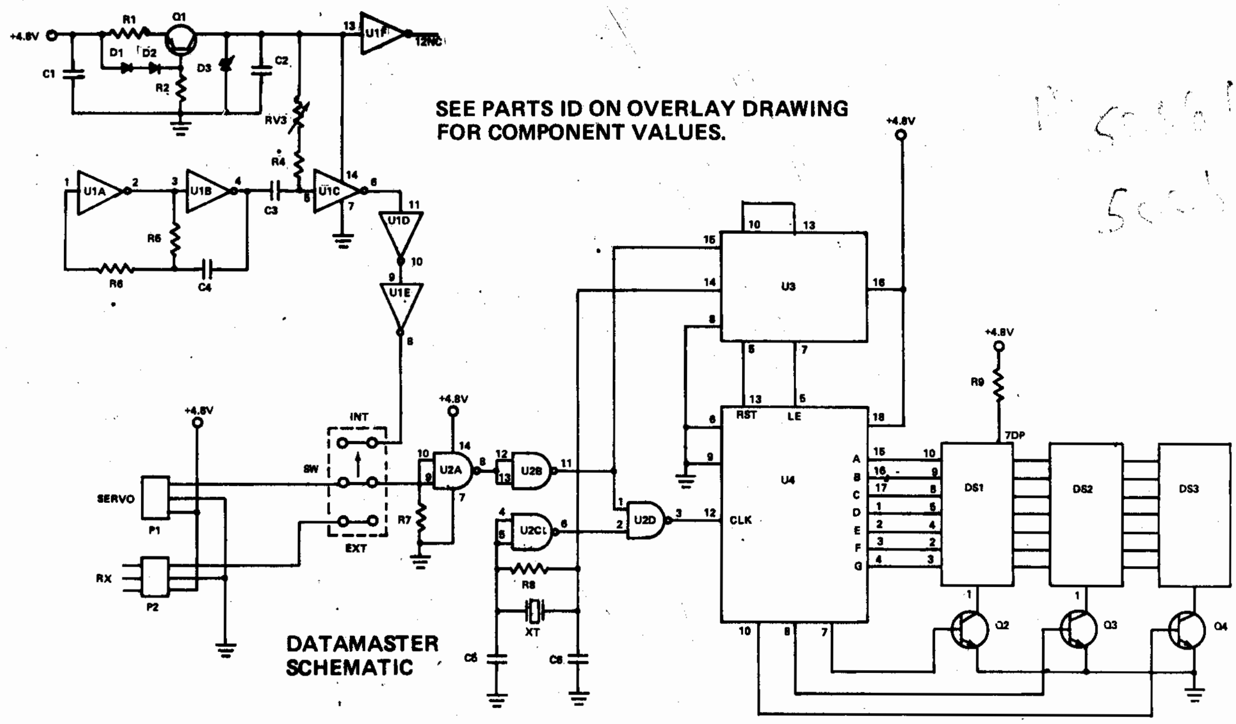
All of these events happen so fast that the human eye can not detect that the LED's are constantly changing. This happens so fast that you cannot see that only one of the LED's is lit at a time. Lighting only one digit of the three at a time conserves batteries. This is called multiplexing and is all taken care of by U4 and the three 2N4400 transistors. The actual current load of the LED's is taken by these transistors. One other function of U4 is to divide the incoming 1.00 Mhz clock pulses by 10. That is for every 1,000 pulses received, only 100 are displayed. If this appears confusing remember this; The nominal center pulse width received from the receiver is 1.50 milliseconds (ms), or 1,500 microseconds (us). Now also remember that the pulses from the crystal controlled clock are 1.00 microsecond apart. Now then shake your brain a little and think this through. If the pulse received from the receiver is exactly 1.50 milliseconds wide (equivalent to exactly 1,500 microseconds), this is precisely how long the gate will be open. During the time the gate is open it is passing the pulses from the crystal controlled clock to the input of U4. The pulses from the clock are exactly 1.00 microsecond apart so when the gate closes, U4 receives 1,500 pulses. U4 now divides this count by 10 and displays 150 of them.

Now we place a decimal point in front of the 5 to visually divide by another 100. So now the LED's are displaying the exact received pulse width; 1.50 milliseconds.

Also remember that your radio system has a frame rate (how often the information is updated) of about 60 cycles per second.

Depending on the actual frame rate of your radio, your Datamasster is counting and displaying a new number over and over again at this frame rate which you cannot see either. So as not to be confused, if you do not move the stick on the transmitter which is the channel you are looking at with the Datamaster, the displayed number is not going to appear to be changing. Your eye simply cannot see that this number is being counted over and over again.

The remaining circuitry of the Datamaster consists of an on-board pulse width generator which can be used in place of the pulse received from the receiver. U1A and U1B are connected as an astable multivibrator generating a frame rate of about 60 cycles per second. This fires U1C connected as a "one shot" whose output pulse width is determined by the .22 uf capacitor and the position of the 10K pot. The range of this "one-shot" is typically .85 to 2.50 milliseconds, which more than covers the total range of most servos. The output of U1C is fed to U1D and U1E for shaping before it enters the U2A Nand gate. Deciding on whether to use the on-board pulse generator or the pulse from the receiver is simply a matter of switch selection. So that the pulse width from the on-board pulse generator remains stable due to voltage fluctuations a voltage regulator circuit consisting of the 2N4402 transistor, the 1N5227B zener diode and associated components are employed.



DATAMASTER SCHEMATIC

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