Autotech Controls
M8000 Resolver Decoder
Input Modules
Instruction & Operation Manual

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MAN-M8000-000
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1. Introduction to the M8000 Series Resolver Modules

The Series 8000 Single-Turn and Multi-Turn Resolver Decoder Input Modules use state-of-the-art CMOS circuits to provide high noise immunity and low backplane current requirement. These modules are used to decode resolver signals and provide decoded digital position information to an Allen-Bradley PLC.

Single and Multi-turn

The single-turn module decodes resolver signals into 3 or 4-digit BCD rotary position and the multi-turn module provides 6-digit BCD linear position. All models feature digital static-offset thumbwheels to facilitate aligning resolver zero during machine setup. In addition, these modules have a bright LED display, a built-in BCD remote display driver bus for each digit (compatible with Autotech 1855D remote display). Four additional auxiliary 12 VDC inputs are available on the D1000 module.

Allen-Bradley Compatible

The Resolver Decoder Input Modules are Allen-Bradley compatible and plug directly into any A-B 1771 chassis. The single-turn modules use single-turn resolvers such as the Autotech RL100, E6R, E7R, or E8R. The multi-turn modules use multi-turn resolvers such as the Autotech SAC-RL210. The single-turn 4-digit input module occupies two I/O slots (1 word) and the multi-turn 6-digit input modules occupy three I/O slots (1-1/2 words).

Fully Absolute Rugged Encoder

A Series M8000 decoder in conjunction with Autotech's resolvers provides a fully absolute encoder. Even if a machine moves during power outage the resolver always knows its true position when the power is restored The NEMA 13 resolver can withstand hostile environment such as mechanical shock, vibration, extreme humidity & temperature changes, oil mists, coolants, solvents and can be mounted 2500 feet away from the decoder. The ratiometric converter assures high tracking speed of 1800 RPM and very high noise immunity.

Variety of Models

This manual should be used for the following resolver decoder input models that are available to meet the requirements of different application needs:

ASY-M8000-D360: 3-digit with resolution of 360 counts/turn of resolver shaft

ASY-M8000-D1000: 3-digit with resolution of 1000 counts/turn of resolver shaft

ASY-M8000-D3600: 4-digit with resolution of 3600 counts/turn of resolver shaft

ASY-M8000-D6,10: 6-digit with 64:1 @ 1000 counts/turn of resolver shaft (64,000 total counts)

ASY-M8000-D7,10: 6-digit with 128:1 @ 1000 counts/turn of resolver shaft (128,000 total counts)

2. Specifications

Customer Power Input Requirements: ..... 12 VDC +/10% (10.8 - 13.2 VDC)
Single-Turn Models: ..... 0.4 Ampere Typical
Multi-Turn Models: ..... 0.6 Ampere Typical

Chassis Power Requirements:
Single-Turn Models: ..... 0.17 Ampere Typical
Multi-Turn Models: ..... 0.23 Ampere Typical

Auxiliary DC Inputs: *(M8000-D1000 and -D360 only)*
Voltage: ..... 12VDC, 8VDC "ON" threshold
Current:..... 10 mA Typical

Number of Digits:
M8000-D1000 and M8000-D360: ..... 3-digits (3/4 full word)
M8000-D3600:..... 4-digits (1 full word)
M8000-D6,10 and M8000-D7,10: ..... 6-Digits (1-1/2 full words)

Remote Display Bus: ..... BCD 5 VDC logic (TTL Level), positive true logic for each digit. Compatible with Autotech 1855 BUS and 1855D Remote Display.

Front Panel Thumbwheel Offsets: ..... Full scale thumbwheel programmable

Rotor Excitation Voltage: ..... 2.5 VAC at 2.5 KHz Typical

Stator Signals: ..... 2.5 VAC sine-cosine Typical

Ambient Temperature: ..... 0° to 55° C

Humidity: ..... 5 to 95% non condensing

3. Installation

Keying the Allen-Bradley Chassis

CAUTION
I/O modules *MUST NEVER* be removed or inserted into the chassis while the system power is "ON". Failure to observe this may result in damage to module circuitry.

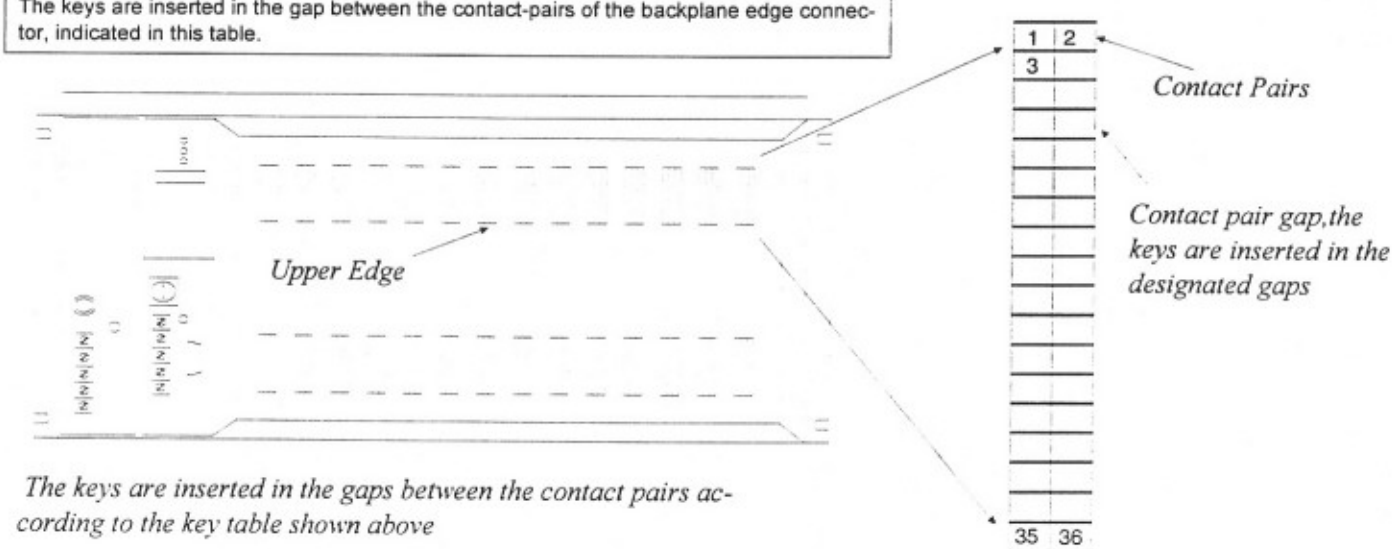
The I/O modules from Autotech are slotted so that they can only be inserted in the I/O slots (back-plane edge connectors) in the Allen-Bradley 1771 I/O rack. The I/O modules may be used in any I/O slot. After deciding which slots the module will be used in, it is recommended that the selected I/O slots (backplane edge connectors) be keyed to prevent accidental insertion of any other type of module. Each printed circuit card of the resolver module is slotted in two places at the rear edge that are unique to this type of input/output module. Two keys are inserted in the upper, 36-contact backplane edge connector corresponding to the slots in I/O module. These keys may be removed and placed at a different position if a different type of module must be inserted in the slot. The plastic keys are supplied in a packet taped to the module Needle nose pliers may be used to place the keys in desired position.

As shown in Figure 1, below, keying requires the insertion of keys in the gap between designated contact pairs in the backplane edge connectors. Table 1 provides the key locations for the resolver modules.

Table 1. Key Table

Module(s)	*Slot (Connector)*	Key #1	Key #2
M8000-D1000,and M8000-D360 (Uses 2 slots)	Left Right	#3, 4 and #5, 6 #3, 4 and #5, 6	#25, 26 and #27, 28 #31, 32 and #33, 34
M8000-D3600 (Uses 2 slots)	Left Right	#3, 4 and #5, 6 #3, 4 and #5, 6	#27, 28 and #29, 30 #31, 32 and #33, 34
M8000-D6, 10 M8000-D7, 10 (Uses 3 slots)	Left Center Right	#7, 8 and #9, 10 #3, 4 and #5, 6 #7, 8 and #9, 10	#13, 14 and #15, 16 #31, 32 and #33, 34 #31, 32 and #33, 34

The keys are inserted in the gap between the contact-pairs of the backplane edge connector, indicated in this table.



The keys are inserted in the gaps between the contact pairs according to the key table shown above

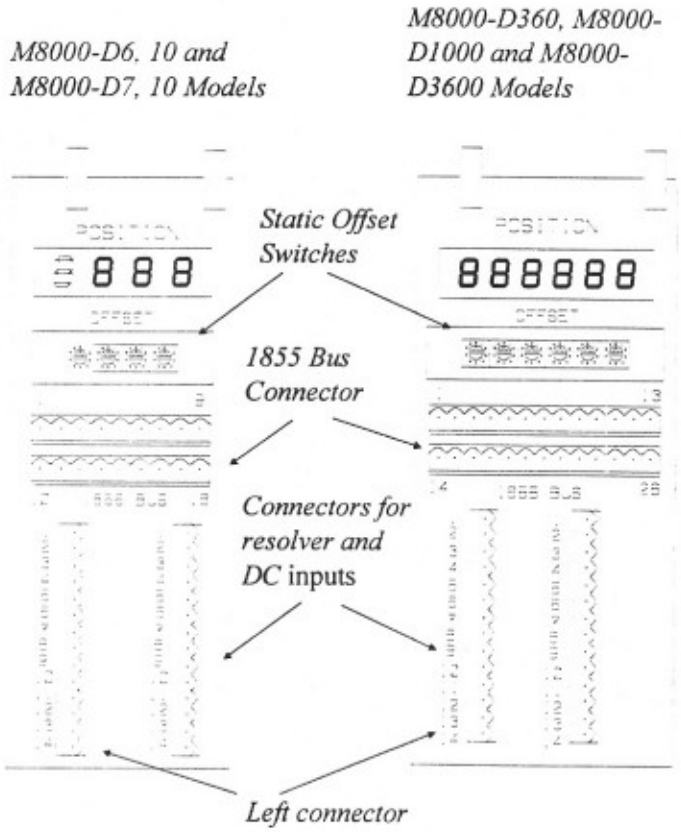
Illustration 1. Key Insertion in Edge Connector

4. Wiring

The user must wire a resolver and DC power to the resolver input module. Two quick disconnect connectors are provided on the front of the module for this purpose as shown in the diagram below. Table 2 lists the pin designations and the functions of these pins on different resolver input modules.

If the 1855 Bus is being used to drive a remote display, two more connectors are to be wired according to table 3, shown on the next page. Single-turn modules have two 9-pin quick disconnect connectors. Multi-turn units use two 13-pin connectors.

Illustration 2.
Front View of Resolver Input Modules



The mating connectors in all cases are provided by the factory and are keyed according to the tables shown here to prevent improper insertion.

Table 2. Resolver Connections and DC Inputs

Pin	M8000-D360, M8000-D1000, M8000-D-3600		M8000-D6,10 M8000-D7,10	
	Left	Right	Left	Right
1	Key	Vs + (+12VDC)	Key	Vs+ (+12VDC)
2	NC	NC	NC	NC
3	NC	NC	S1 Fine	NC
4	NC	Key	S2 Fine	Key
5	NC	NC	S3 Fine	NC
6	NC	NC	S4 Fine	NC
7	S1	NC	S1 Coarse	NC
8	S2	Input1/NC	S2 Coarse	NC
9	S3	Input 2/NC	S3 Coarse	NC
10	S4	Input 3/NC	S4 Coarse	NC
11	R2	Input 4/NC	RH (R2)	NC
12	R1	NC	RL (R1)	NC
13	NC	Key	NC	Key
14	Key	Vs- (Sig Ref)	Key	Vs- (Sig Ref)

Notes:
1. Left column indicates connection to the left connector, right column indicates connection to the right connector of the module.
2. NC = Not connected
3. Pin numbers 4-7 on right connector of model M8000-D1000 and M8000-D360 may be used as DC input terminals.

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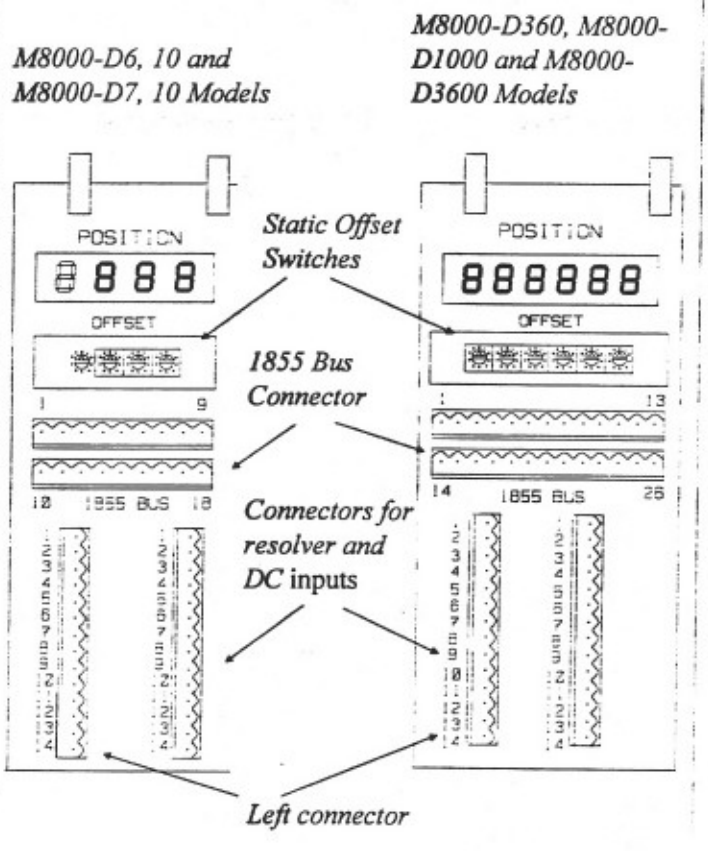

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	Left	Right	Left	Right
1	Key	Vs + (+12VDC)	Key	Vs+ (+12VDC)
2	NC	NC	NC	NC
3	NC	NC	S1 Fine	NC
4	NC	Key	S2 Fine	Key
5	NC	NC	S3 Fine	NC
6	NC	NC	S4 Fine	NC
7	S1	NC	S1 Coarse	NC
8	S2	Input1/NC	S2 Coarse	NC
9	S3	Input 2/NC	S3 Coarse	NC
10	S4	Input 3/NC	S4 Coarse	NC
11	R2	Input 4/NC	RH (R2)	NC
12	R1	NC	RL (R1)	NC
13	NC	Key	NC	Key
14	Key	Vs- (Sig Ref)	Key	Vs- (Sig Ref)

Notes:
1. Left column indicates connection to the left connector, right column indicates connection to the right connector of the module.
2. NC = Not connected
3. Pin numbers 4-7 on right connector of model M8000-D1000 and M8000-D360 may be used as DC input terminals.

Table 3. 1855 Bus Pin Out

Pin #	M8000-D360 M8000-D1000	M8000-3600	M8000-D6,10 M8000-D7,10
1	NC	Bit 1	Bit 1
2	Bit 1	2	2
3	2	4	4
4	4	8	8
5	8	10	10
6	10	20	20
7	20	40	40
8	40	80	80
9	NC	100	100
10	NC	200	200
11	80	400	400
12	100	800	800
13	200	1000	1000
14	400	2000	2000
15	800	4000	4000
16	Fault	8000	8000
17	Sig Ref	Fault	10K
18	NC	Sig Ref	20K
19			40K
20			80K
21			100K
22			200K
23			400K
24			800K
25			Fault
26			Sig Ref

Grounding and Shielding

It is essential to properly ground and shield during initial installation. Wiring should be completed and thoroughly checked before applying power. The following are the general guidelines for grounding and shielding:

General Rules:

1. The resolver and P.L.C. Earth Ground planes must be held to the same RF potential by metallic connections (e.g., building frame, conduit, wire trays).

2. All shielded cable must be continuous (no splices).

3. Variable DC or AC motor drive wiring, including motor wiring,must be kept at least 12 inches away from all signal cable conduits (resolver or P.L.C.).

4. Never connect or disconnect cables with power "ON".

Resolver Connections:

1. The resolver housing must have a good continuous metallic RF connection (resolver Earth Ground plane), we recommend using Autotech mounting bracket MMB-EN359-010.2.

2. The resolver connection to the Resolver Decoder Input Module must be done with twisted-pair shielded cable — we recommend using Autotech cable CBL-10T22-xxxx or CBL-RL210-xxxx.

3. The shielded drain wire at the resolver end must be connected to Earth Ground on the resolver housing (green screw).

4. The shielded resolver cable must not be routed with any high voltage, high current or inductive wiring. The resolver cable should be run in its own conduit.

P.L.C. Connections:

1. The P.L.C. housing must have a good metallic RF connection to the P.L.C. panel (P.L.C. Earth Ground plane tied to a good Earth Ground).

2. The shielded drain wire at the P.L.C. must be connected to Earth Ground.

3. There must be a minimum of 100k ohms of resistance between P.L.C. Sig Ref (Common) and Earth Ground.

5. Programming

Display

The bright LED display on the Resolver Decoder Input Module displays position information The position information displayed is the resolver position plus the static offset entered through the front panel offset switches. This position is also sent to the processor module.

Static Offset

The BCD switches on the front provide a means of offsetting the indicated resolver shaft position without mechanically adjusting the actual position of the resolver shaft at the machine. The displayed position equals to the actual position plus the static offset.

The single-turn resolver input modules offer an offset switch for each displayed digit, while the multi-turn units offer offset switches for the 4 most significant digits.

Example:

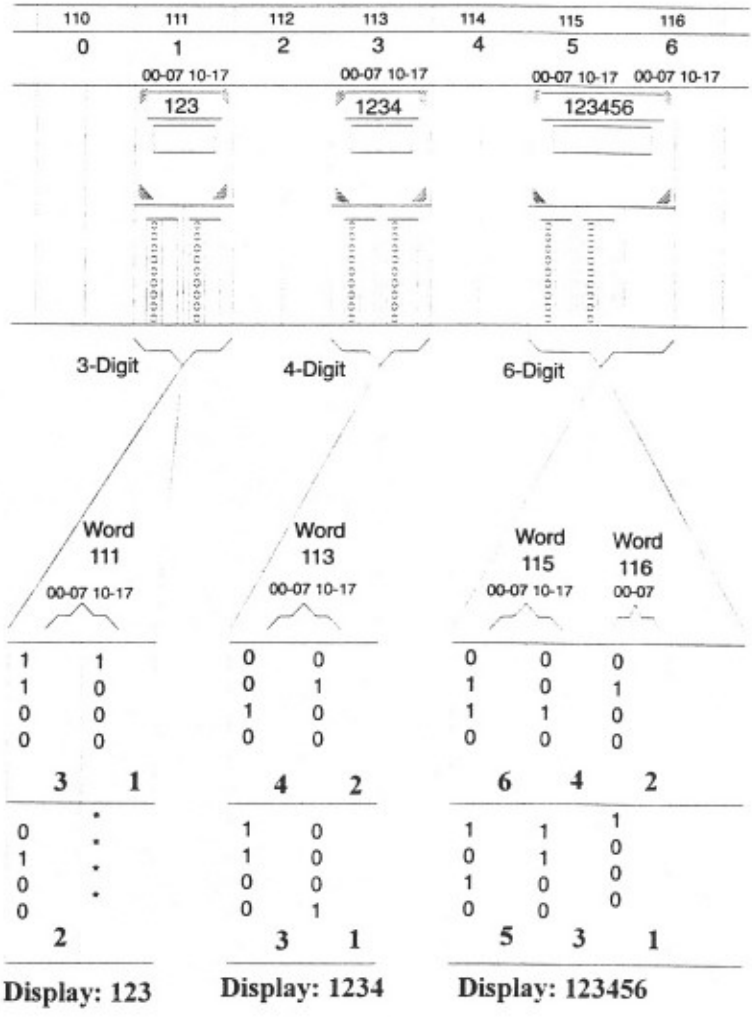
Unit: M8000-D1000 (1000 counts per turn)

Actual Position	= 700
Static Offset	= 020
Total	= 720
Displayed position	= 720

Reading Resolver Input Modules by Processor

The resolver modules are used as an interface between a resolver and an Allen-Bradley processor (in a 1771 I/O rack). The processor reads the I/O slots during every scan. The I/O information is saved in memory words with addresses corresponding to those of the I/O slots. The data from a module group (2 slots) is saved in a memory word. (A word is 16 bits, each slot contributes 8 bits of information or 2 BCD digits). Although a word consists of 16 bits or 4 BCD digits, the data manipulation (such as comparison) and arithmetic instructions in a PLC. operate only on the lower 3 BCD digits of the word. The higher 4 bits, or the most significant BCD digit is ignored in those operations and is not displayed on the programming terminal. The GET-PUT sequence transfers *all 16 bits* from one address to another.

Illustration 3.
Storage of position data for different models



*The values in bits 14,15,16 and 17, of the 3-digit models reflect the states of the DC inputs on terminals 4, 5, 6 and 7 on the right connector.

Single-turn resolver input modules (D360, D1000, -D3600) occupy two slots (or one module group) in the 1771 I/O rack. Therefore, the position information for a single-turn module is saved in one word in memory. For example, if the module is placed in slots 0 and 1 of module group 1 (Input address 111), the position information from the module will be available in memory word 111. If the module is placed in Module group 0, the position data will be in word 110, etc.

Since multi-turn resolver input modules (M8000-D6,10 and -D7,10) occupy 3 slots (1.5 module groups), the position information from these modules is saved in more than one word (in 1.5 words). Illustration 3 on the preceding page depicts this concept and shows how the displayed digits are stored in memory.

Single-Turn 3-digit Modules (M8000-D360, M8000-D1000)

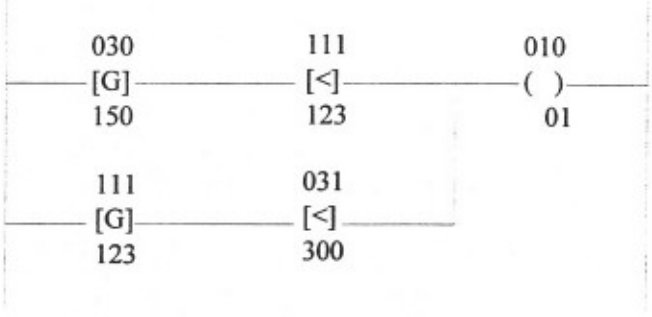
For the 3-digit single-turn modules, the position data is saved in the 3 lower BCD digits of a word. Therefore this data may be directly used in data manipulation and 3 digit arithmetic instructions.

The 3-digit module provides four additional DC inputs (12VDC levels) on the right connector (pins 4-7) of the resolver decoder module. These inputs can be tested using examine bit commands.The connector-pins and bit-number correspondence is given below:

Pin	Bit Number
4	14
5	15
6	16
7	17

The specific word address is determined by which chassis slot the module is plugged into.

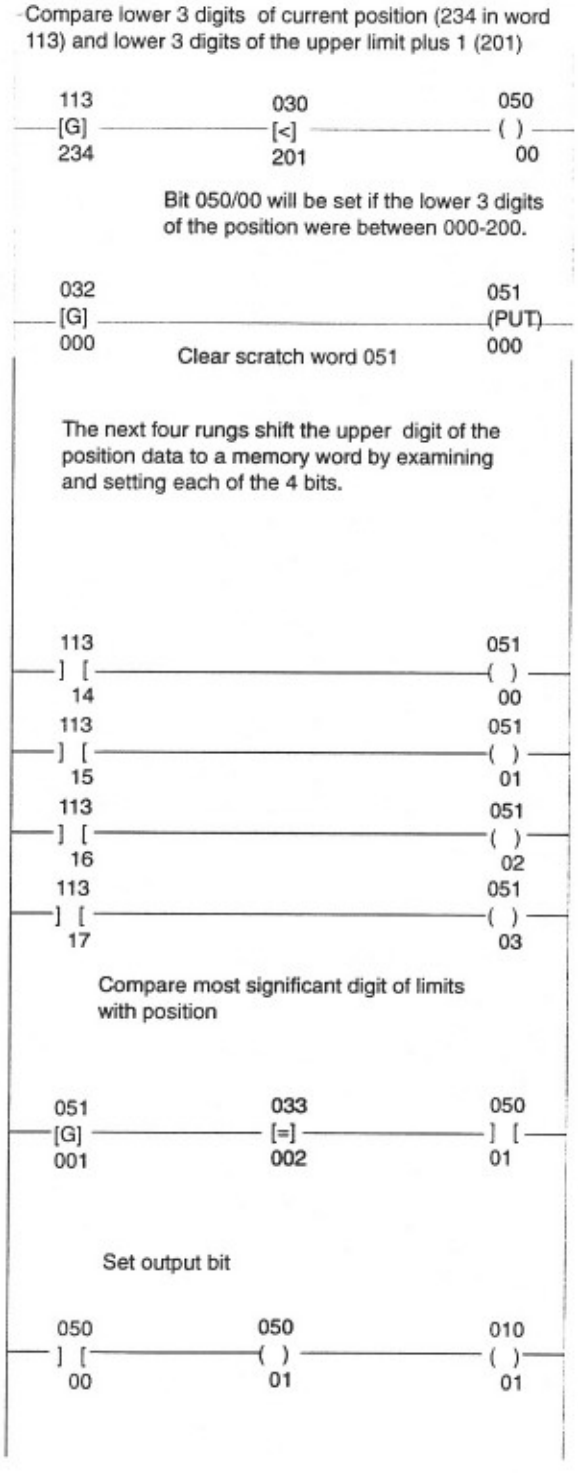
Example: Assume that the module is placed in module group 1 (address 111). The following rungs may be used to compare position data against limits. Assume that output bit 010/01 is to be turned ON whenever the position is between, but not including, 150 and 300. The limits are saved in words 030 and 031. The value associated with word 111 is the current position:



Single-Turn 4-digit Module (M8000-D3600)

The position data for a 4 digit unit is saved in one memory word. The lower 3 digits may be accessed using a GET instruction The higher digit (4th digit) is shifted into the low 4 bits of another memory word using examine bit and output energize instructions. That word may then be used in data manipulation and arithmetic instructions as required.

Example: In the following example, we want to turn "ON" an output (010/01) when resolver position is between 2000 and 2200 (1 resolver revolution = 3600 counts). Assume the resolver decoder has been installed in Module Group 3 (address 113) and the current position is at 1234 (123.4 degrees).



Multi-turn 6-digit Module (ASY-M8000-D6,10 and -D7, 10)

The 6 digit module occupies 3 slots or one and one half module groups in an I/O rack. Accordingly, the position data is stored in one and one half words in the memory. (Refer back to the diagram showing position data storage for different models.)

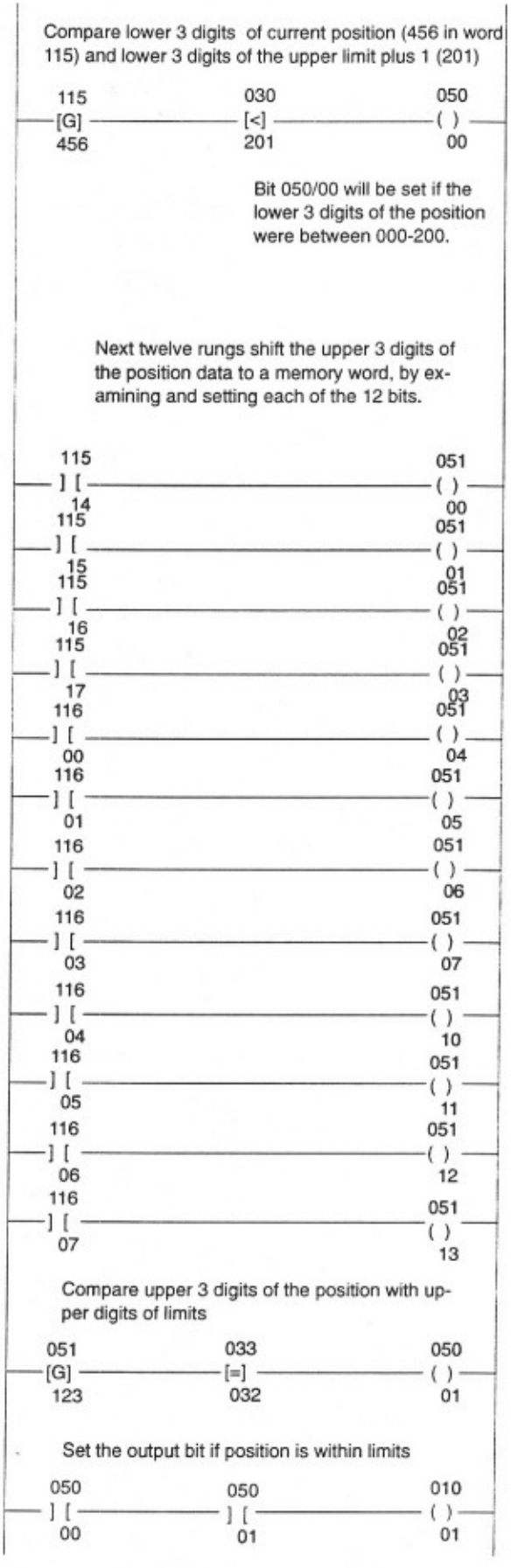
The module should be placed so that the left and center printed circuit board of the module occupy one module group, and the right printed circuit board occupies half of the adjacent module group. Then the lower 3 digits of the position data may be accessed by a [GET] instruction using the address of the full module group. For example, assume that the module occupies both slots of module group 5 (address 115) and one slot of the module group 6 (address 116). The lower 3 digits of the position will be in word 115. The other digits may be shifted to another memory word using an examine on and output energize rung for each bit. These digits may then be used in any arithmetic or data manipulation instructions.

Example:

In the following example, we want to turn "ON" an output (010/01) when resolver position is between 032,000 and 032,200 (1 resolver revolution = 10000 counts, but 128 turns can be registered by the -D7,10 for max. of 128,000 counts). Assume the resolver decoder module has been installed in Module Group 5 and Module Group 6 (addresses 115 and 116). The current resolver position is 123456 counts.

The data evaluation procedure is a three-step process very similar to the previous example. First, the lower 3 BCD digits of word 115 (*digits 456*) is evaluated and the result stored. Secondly, the upper 3 digits of the resolver display (*digits 123*) are transferred to the scratch word 051 prior to evaluation. This is accomplished by fetching the high BCD digit from word 115 (*digit 3*) bit by bit and

storing it in the first (or lower) BCD digit of scratch word 051. In a similar manner, the lower first and second BCD digits of 116 (*digits 12*) are transferred bit by bit to the 2nd and 3rd BCD digits of scratch word 051. When this process is completed, scratch word 051 will contain the BCD value 123 and can easily be evaluated. The final results of the 2 evaluations above are then AND'd together and, if true, the output (010/01) will turn "ON". In this example, 123456 is outside the set point range of 032,000 to 032,200 and the output (010/01) should be "OFF".



6. How to Order

Single-Turn Resolver Input Modules

For use in an Allen Bradley 1771-I/O rack or to decode signals from a single-turn resolver

ASY-M8000-D360	3-digit with a resolution of 360 counts per turn of Resolver shaft
ASY-M8000-D1000	3-digit with a resolution of 1000 counts per turn of Resolver shaft
ASY-M8000-D3600	4-digit with a resolution of 3600 counts per turn of Resolver shaft

Multi-Turn Resolver Input Modules

For use in an Allen Bradley 1771-I/O rack to decode signals from a multi-turn resolver

ASY-M8000-D6, 10	6-digit with 64:1 gear ratio, 1000 counts per turn of resolver shaft *(total 64,000 counts)*
ASY-M8000-D7, 10	6-digit with 128:1 gear ratio, 1000 counts per turn of resolver shaft *(total 128,000 counts)*

Remote Display

SAC-M1855-DISP	Display Module
SAC-M1855-L	Limit Module

Cables

In cable part numbers, xxx = length in feet. Replace xxx by one of the standard lengths: 010, 020, 050 and increments of 50 feet (e.g., 100, 150, 200 feet, etc.)

CBL-10T22-Cxxx	Cable for resolver, 10 Conductor shielded cable
CBL-10T22-Mxxx	Cable for resolver, 10 Conductor shielded cable with MS connector at one end
CBLRL210-Mxxx	Cable for multi-turn geared resolver
CBL-29S22-Mxxx	Cable for 1855 Bus to 1855 Display

Position Transducers

Select one of the resolver models RL100, E6R, E7R, E8R or RL101, RL210. See Autotech Controls Catalog, Position Transducer Section, "How to Order" for information on these transducers and appropriate accessories.

7. Warranty

WARRANTY

Autotech Corporation warrants its products to be free from defects in materials or workmanship for a period of one year from the date of shipment, provided the products have been installed and used under proper conditions. The defective products must be returned to the factory freight prepaid and must be accompanied by a Return Material Authorization (RMA) number. The Company's liability under this limited warranty shall extend only to the repair or replacement of a defective product, at The Company's option. The Company disclaims all liability for any affirmation, promise or representation with respect to the products.

The customer agrees to hold Autotech Controls harmless from, defend, and indemnify Autotech Controls against damages, claims, and expenses arising out of subsequent sales of Autotech Controls' products or products containing components manufactured by Autotech Controls and based upon personal injuries, deaths, property damage, lost profits, and other matters which Buyer, its employees, or subcontractors are or may be to any extent liable, including without limitation penalties imposed by the Consumer Product Safety Act (P.L. 92-573) and liability imposed upon any person pursuant to the Magnuson-Moss Warranty Act (p.l. 93-637), as now in effect or as amended hereafter.

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CAUTION

Autotech Controls' products are carefully engineered and rigorously tested to provide many years of reliable operation. However any solid-state device may fail or malfunction sometime.The user must ensure that his system design has built-in redundancies if Autotech Controls' product is being used in applications where a failure or malfunction of the unit may directly threaten life or cause human injury. The system should be so designed that a single failure or malfunction does not create an unsafe condition. Regularly scheduled inspections, at least once a week, should be made to verify that the redundant circuits are fully functional. All faults should be immediately corrected by repair or replacement of the faulty unit. In addition, the user may have to comply with OSHA, ANSI, state or local standards of safety. The user of Autotech Controls' products assumes all risks of such use and indemnifies Autotech Controls against any damages.

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