

2-speed Miniaturized RDC/SDC Converter(Series MRDC /MSDC)

1 FEATURES (Outline is shown in Fig 1. Classifications are shown in table1)

- Complete 2-speed system
- Speed ratios are 1:8, 1:16, 1:32
- Digital output with 3-state latches
- Maximum resolution is 19 bit
- Maximum accuracy is $\pm 10\text{sec}$
- Small size



Size: $54.3 \times 27.9 \times 10 \text{ mm}^3$

Weight: 41g

Figure 1 Series MRDC/MSDC outline

Table1 Product classification

MRDC19-618(1:32)
MRDC19-61-36/11.8(1:32)
MRDC18-458(1:16)
MRDC16-66-6.8/3(1:8)
MRDC16-669(1:16)

2 APPLICATIONS

- Radar
- Navigation
- Satellite tracking
- Artificial technology
- Artillery control
- Industrial machine control
- Other high-accuracy measurement

3 GENERAL DESCRIPTION

2-speed RDC /SDC converters(series MRDC /MSDC) are monolithic circuits hermetically sealed by metal. They internally contain coarse/fine two way RDC/SDC converter and error correcting logical circuit required by two speed system.

Speed ratios of coarse/fine combination of series MRDC /MSDC product are 1:32, 1:16, 1:8, it is easy to use. Input signals of coarse/fine two way are signals of three-wire synchro or four-wire resolver.

4 TECHNICAL SPECIFICATIONS (Tab 2, Tab 3)

Table2 Nominal conditions and recommended working conditions

Absolute max nominal value	power supply voltage +Vs:12.5~17.5V power supply voltage -Vs: -17.5~-12.5V logic voltage V_L : +7V storage temperature range:-55~+125
Recommended working conditions	power supply voltage Vs: $\pm 15V \pm 5\%$ power supply voltage V_L : $+5V \pm 5\%$ reference voltage(significant value) V_{Ref}^* : nominal value $\pm 10\%$ signal voltage(significant value) V_i^* : nominal value $\pm 10\%$ reference frequency f^* : nominal value $\pm 10\%$ operating temperature range T_A : -40~+85 -55~+105

* means that it can be made to order.

Table3 Electrical characteristics

Characteristics	Series MRDC /MSDC	Units	Characteristics	Series MRDC /MSDC		Units
				Min	Max	
Speed ratio	1:8 1:16 1:32		Signal voltage range (significant value)	2	90	V
Resolution	16 18 19	bit	Direction signal high level	2.4	6	V
Max accuracy	±40 ±20 ±10	Arc sec	Direction signal low level	-0.3	0.8	V
tracking velocity in fine channel	- 16	rev/s	Inhibit input voltage	-0.3	0.8	V
frequency range	50 10000	Hz	Output high level	2.4	6	V
reference voltage (significant value)	2 115	V	Output low level	-0.3	0.8	V

tracking velocity can be made to order.

5 PRINCIPLES OF OPERATING (Fig 2, Fig 3)

(1) Single speed converter

The principles of operation of single speed converter are shown in fig2. Principles are summarized as follows: Internal differential isolation converts input signals of synchro(resolver) into orthogonal signals:

$$V_1=KE_0\sin\theta\sin\omega t, V_2=KE_0\cos\theta\sin\omega t$$

Where θ is analogue input angle.

The two signals are multiplied by digital angle ϕ of internal up/down counter in sin/cos multiplier, thus result in error signal:

$$KE_0\sin\theta\cos\phi\sin\omega t - KE_0\cos\theta\sin\phi\sin\omega t = KE_0\sin(\theta-\phi)\sin\omega t$$

After error magnification, phase demodulator and integrator, the signal is inputted into VCO. If $\theta-\phi \neq 0$, VCO will output pulse, up/down counter will count until $\theta-\phi=0$. During this process, converter continuously tracks changes of input angle.

(2) 2-speed converter

The principles of operation for single-speed RDC/SDC converter apply to 2-speed

RDC/SDC converter. The principles of operation of the coarse and fine channel for the 2-speed converter are the same. Data from the coarse and fine channel first undergo data weight treatment, i.e. increase multiple of data speed ratio in coarse channel. Then combine and correct data from fine channel and treated data from coarse channel. Finally get binary code output(fig.3).

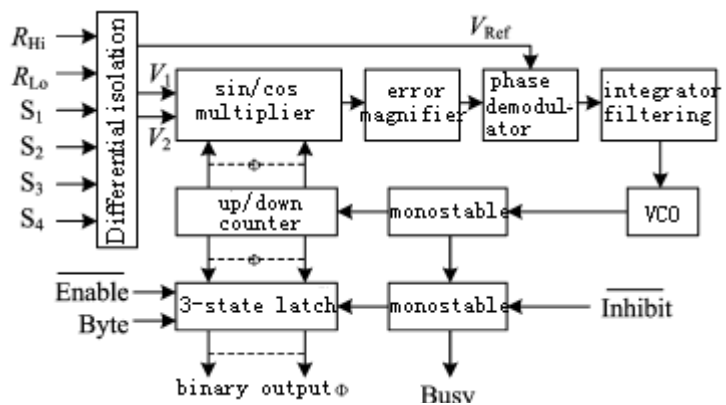


Figure2 Functional block diagram of single speed converter

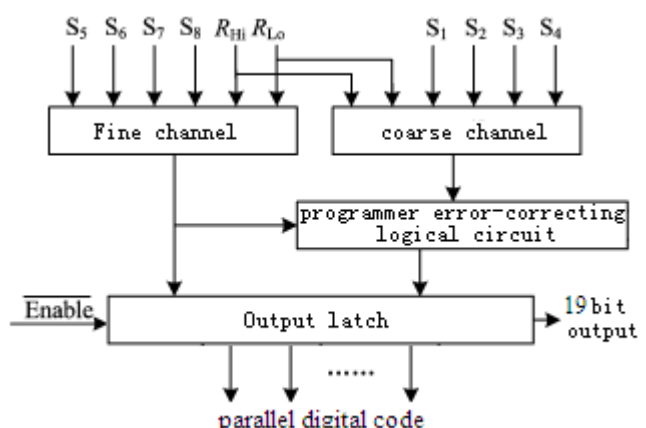


Figure3 Functional block diagram of 2 -speed converter

(3) Data transfer method and timing

Output of MDRC19 2-speed converter reaches 19bit. Through $\overline{\text{Enable}}$ which take 3-state control of output latch, 2-speed converter can be easily connected to data bus.

Data of MDRC19 2-speed converter are read as follows:

Set $\overline{\text{Inhibit}}$ to logical "0", lock valid data of converter, after $1\ \mu\text{s}$, data in 3-state latch of the converter are upgraded.

To ensure high-accuracy conversion of 2-speed converter, please pay attention to the following:

Amplitude variation of input signals of coarse and fine channels should be guaranteed within 10% of nominal value error.

Frequencies of input signals and reference signals of coarse and fine channels should be in the specified operating frequencies range.

Phase shift between input signal and reference signal of coarse channel and phase shift between input signal and reference signal of fine channel should be less than 10° .

Wave distortions of input signals and reference signals of coarse and fine channels should be less than 10%.

Variation of +5V, $\pm 15\text{V}$ power supply voltage should be guaranteed within $\pm 5\%$.

6 MTBF DIAGRAM (Fig 4)

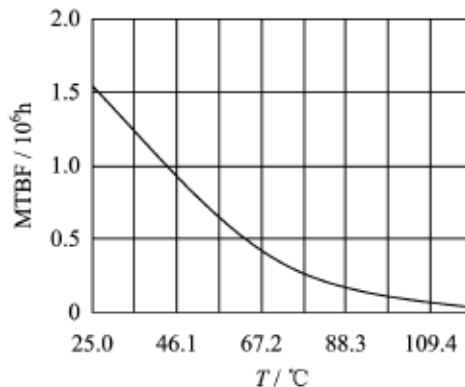


Figure 4 MTBF vs. temperature

(Note: According to GJB/Z 299B-98, assuming that ground is in good condition)

7 PIN CONFIGURATIONS (Fig 5, Tab 4)

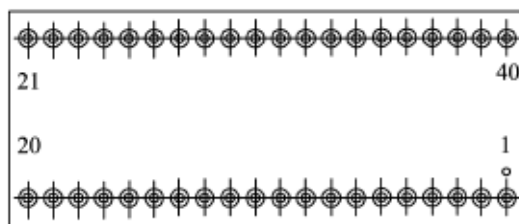


Figure 5 Pin out bottom view

Table 4 Pin description

Pin	mnemonic	description	Pin	mnemonic	description
1	D ₁ (MSB)	Data output 1 st bit	21	S ₈	Fine channel cos signal input
2	D ₂	Data output 2 nd bit	22	S ₇	Fine channel sin signal input
3	D ₃	Data output 3 rd bit	23	S ₆	Fine channel cos signal input
4	D ₄	Data output 4 th bit	24	S ₅	Fine channel sin signal input
5	D ₅	Data output 5 th bit	25	R _{Lo}	Reference input low
6	D ₆	Data output 6 th bit	26	R _{Hi}	Reference input high
7	D ₇	Data output 7 th bit	27	S ₄	Coarse channel cos signal input
8	D ₈	Data output 8 th bit	28	S ₃	Coarse channel sin signal input
9	D ₉	Data output 9 th bit	29	S ₂	Coarse channel cos signal input
10	D ₁₀	Data output 10 th bit	30	S ₁	Coarse channel sin signal input
11	D ₁₁	Data output 11 th bit	31	NC	Not connected
12	D ₁₂	Data output 12 th bit	32	case	Case ground
13	D ₁₃	Data output 13 th bit	33	<u>DIR</u>	Direction signal output pin
14	D ₁₄	Data output 14 th bit	34	<u>Enable</u>	Output control pin
15	D ₁₅	Data output 15 th bit	35	<u>Inhibit</u>	Inhibit input pin
16	D ₁₆	Data output 16 th bit	36	busy	Busy signal output pin
17	D ₁₇	Data output 17 th bit	37	+Vs	+15V power supply input pin
18	D ₁₈	Data output 18 th bit	38	GND	ground
19	D ₁₉ (LSB)	Data output 19 th bit	39	-Vs	-15V power supply input pin
20	Vel	Velocity output signal pin	40	V _L	+5V power supply input pin

Note: S₈, S₇, S₆, S₅ are fine channel input. If synchro is equipped with three wire, S₈ is not used.
S₄, S₃, S₂, S₁ are coarse channel input. If synchro is equipped with three wire, S₄ is not used.
Inhibit is inhibit signal which is connected to 5V power supply by pull-up resistor. When Inhibit is logical "0", After 1μs, data in latch are stable, data can be read. When Inhibit is logical "1", data in latch upgrade. Inhibit does not affect the tracking state of loop.
Enable are three state control pins of data output, which determined the state of outputted data. When they are logical "1", data output pin is in high impedance. When they are logical "0", data output pin outputs valid data. Outputted data state doesn't affect the loop operation inside converter.
DIR is direction signal input pin. When outputted digits increase, output voltage is in high level. When outputted digits decrease, output voltage is in low level.
Vel is velocity output signal. This signal can be drawn from fine channel. It also can be drawn from coarse channel according to customer's requirement.
D₁~D₂₀ are Outputs of combined digital angle. D₁ is most significant bit. D₂₀ is least significant bit. D₁₇~D₁₉ is not used.

8 BIT WEIGHT TABLE (Tab 5)

Table 5 Bit weight table

Bit No. (MSB)	Weight (degrees)	Bit No. (MSB)	Weight (degrees)	Bit No. (MSB)	Weight (degrees)
1	180.000 0	8	1.106 3	15	0.011 0
2	90.000 0	9	0.703 1	16(LSB 16 bit)	0.005 5
3	45.000 0	10	0.351 6	17	0.00275
4	22.500 0	11	0.175 8	18(LSB 18 bit)	0.001 375
5	11.250 0	12	0.087 9	19(LSB 19 bit)	0.000 687 5
6	5.625 0	13	0.043 9		
7	2.812 5	14	0.022 0		

9 TYPICAL CONNECTION OF CONVERTER (Fig 6)

±15V, 5V and ground are connected to the corresponding pins of the converter. Pay attention to the polarity of power supply, or it will harm device. It is suggested that 0.1μf and 6.8μf by-pass capacitors are connected between power supplies and ground.

Signal and exciting source are permitted to be connected to S₁,S₂,S₃,S₄ and R_{Hi}, R_{Lo} with 5% error. Signal input should be in coordination with exciting phase, their phases are as follows:

$$R_{Hi} \sim R_{Lo} : V_{Ref} \sin \omega t$$

In the case of synchro:

$$S_1 \sim S_3: E_{S_1 \sim S_3} = E_{R_{Lo} \sim R_{Hi}} \sin \theta \sin \omega t$$

$$S_3 \sim S_2: E_{S_3 \sim S_2} = E_{R_{Lo} \sim R_{Hi}} \sin(\theta + 120^\circ) \sin \omega t$$

$$S_2 \sim S_1: E_{S_2 \sim S_1} = E_{R_{Lo} \sim R_{Hi}} \sin(\theta + 240^\circ) \sin \omega t$$

In the case of resolver:

$$S_1 \sim S_3: E_{S_1 \sim S_3} = E_{R_{Lo} \sim R_{Hi}} \sin \theta \sin \omega t$$

$$S_2 \sim S_4: E_{S_2 \sim S_4} = E_{R_{Hi} \sim R_{Lo}} \cos \theta \sin \omega t$$

Note: input signals in R_{Hi}, R_{Lo}, S₁, S₂, S₃, S₄ are not permitted to connect other pins, or it will damage the device.

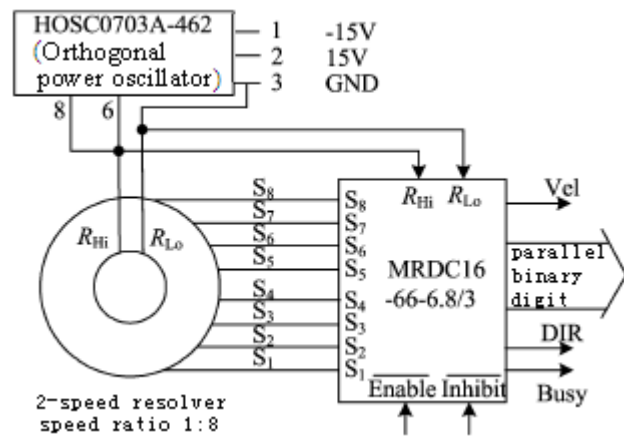


Figure6 Typical connection

10 PACKAGE OUTLINE DIMENTION AND DISCRPTION

(Unit: mm) (Fig 7, Tab 6)

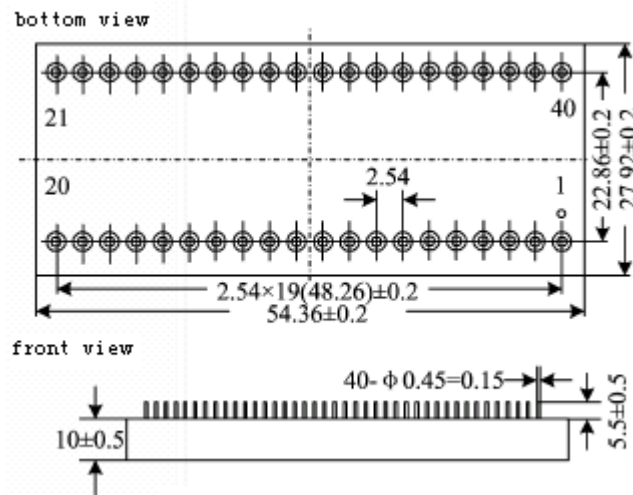


Figure 7 Package outline drawing

Table 6 Packaging case descriptions

Case model	Base material	Base coat	Lid(cap) material	Lid(cap) coat	Lead material	Lead coat	Sealing method	Comments
UP5428-40	Kovar (4J29)	Ni/Au	Fe/Ni alloy	Ni/Au	Kovar (4J29)	Ni/Au	Match sealing	

Note: The temperature of soldered pins does not surpass 300 within 10 sec.

11 DESCRIPTIONS OF PRODUCT MODEL NUMBERING (Fig 8)

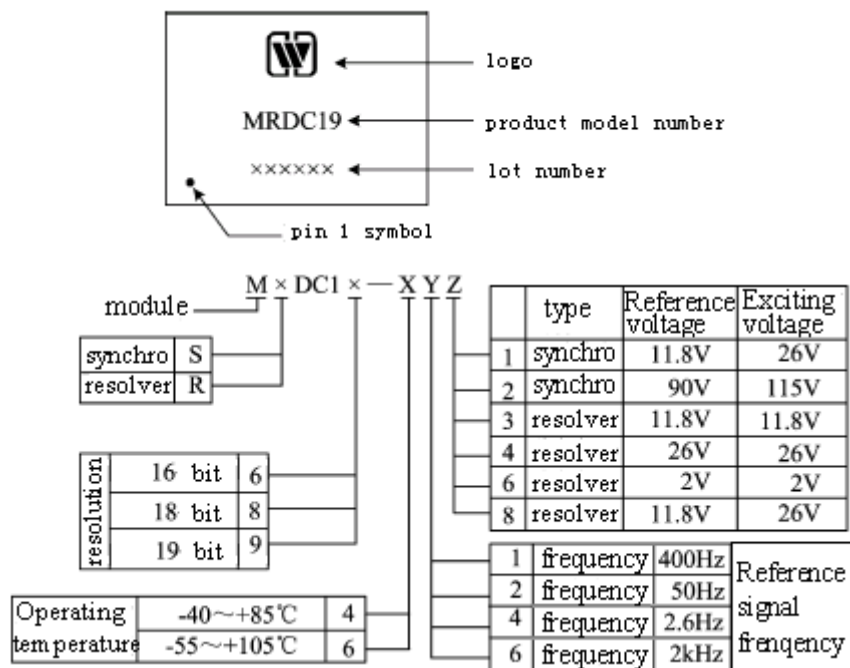


Figure 8 Descriptions of product name

Application notes:

Polar voltage of power supply should be correct to avoid burn-out.

While assembling, the bottom of the product should be placed close to the board to avoid damage to the pins. If necessary, take shockproof measures.

When product is ordered, detailed electrical performance specifications should be referred to corresponding business standard.