

Digital-to-synchro/resolver converter (MDSC/MDRC28 series)

1. Features (see Fig. 1 for outside view, and Table 1 for models)

- Compatible with DTL/TTL/CMOS level
- 12-bit, 14-bit and 16-bit resolution
- Short-circuit and overload protection
- Metal case, with good heat sinking
- Output power: 1.5W



Size: 79.4x66.7x20.3mm³
Weight: 214g

Fig.1 Outside view of synchro/ resolver converter

Table 1 Product models

12-bit		14-bit		16-bit	
Synchro	Resolver	Synchro	Resolver	Synchro	Resolver
MDSC2812-411	MDRC2812-418	MDSC2814-411	MDRC2814-418	MDSC2816-411	MDRC2816-418
MDSC2812-412	MDRC2812-438	MDSC2814-412	MDRC2814-438	MDSC2816-412	MDRC2816-438
MDSC2812-421	MDRC2812-414	MDSC2814-421	MDRC2814-414		MDRC2816-414
MDSC2812-422	MDRC2812-415	MDSC2814-422	MDRC2814-415		MDRC2816-41-36/11.8
					MDRC2816-415

2. Scope of application

Military servo-control system; antenna system; radar measurement system; navigation system; cannon control system; machine-tool control.

3. Description

MDSC/MDRC28 series product is a converter that converts the input binary signal to that of synchro or resolver. The input signal is compatible with DTL/TTL/CMOS level, and the output is 3-wire synchro or 4-wire resolver signal. This series of product continuously tracks the input 12-bit/14-bit/16-bit binary data, and outputs high-precision synchro/resolver signal after conversion. The product is equipped with power amplification circuit inside it, and its output power can reach 1.5W.

4. Electrical performance (Table 2, Table 3)

Table 2 Rated conditions and recommended operating conditions

Absolute max. rated value	Supply voltage +V _S : +13.5~+17.5V Supply voltage -V _S : -17.5~-13.5V Storage temperature range: -40~100°C
Recommended operating conditions	Supply voltage +V _S : +14.5~+16.5V Supply voltage -V _S : -16.5~-14.25V Reference voltage (effective value) V _{Ref} : 115V±5% Signal voltage (effective value) V _I : 90V±5% Reference frequency f: 400Hz±10% Range of operating temperature T _A : -40°C~85°C

Note: * indicates it can be customized as per user's requirement.

Table 3 Electric characteristics

Parameter	MDRC/MDSC2812	MDRC/MDSC2814 Enterprise military standard (Q/HW30857-2006)	MDRC/MDSC2816
Resolution	12-bit	14-bit	16-bit
Accuracy	±8	±4	±4
Digital input	12-bit binary code	14-bit binary code	16-bit binary code
Reference voltage (effective value)		26V/115V/4V 50Hz/400Hz	

Reference frequency	
Output signal voltage (Effective value)	11.8V (line-line, resolver or synchro) 90V (line-line, resolver or synchro)
Input data speed	
Step response time	
Output power	

Note: * means the products with different frequency and different amplitude can be made according to the user's need.

5. Operating principle (Fig. 2 and Fig. 3)

One of the distinctive characteristics of MDSC/MDRC28 series product is that it can neglect the change of radius vector. Each type of digital converter to synchro/resolver must be provided with output sin and cos function signal, however, since the law of sin and cos function is not followed precisely all the time, its error can reach $\pm 7\%$. In practical use, this error is not serious sometimes, but it is not allowed in the application of tracking rotating torque receiver or servo control loop. For MDSC/MDRC28 series product, this error can be reduced below 0.1%, which means that when the converter is used in a closed loop servo system, the closed-loop gain is independent of the input signal, thus avoiding undesired error resulting from change of reference signal.

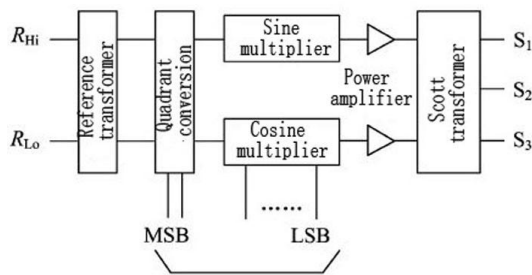


Fig.2 Schematic diagram of MDSC converter

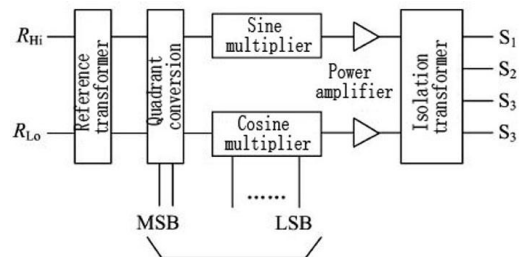


Fig.2 Schematic diagram of MDRC converter

6. MTBF curve (Fig. 4)

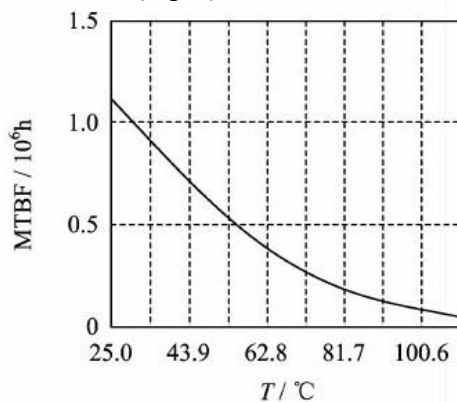


Fig. 4 MTBF-temperature curve

(Note: according to GJB/Z299B-98, envisaged good ground condition)

7. Pin designation (Fig. 4, Table 4)

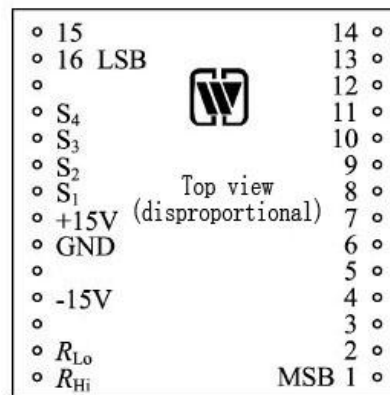


Fig.5 Schematic diagram of pins

Table 4 Pin designation

Pin	Symbol	Function	Pin	Symbol	Function	Pin	Symbol	Function
1	1 (MSB)	Digital input 1	11	11	Digital input 11	21	S ₁	Signal output 1
2	2	Digital input 2	12	12	Digital input 12	22	+15V	+15V input
3	3	Digital input 3	13	13	Digital input 13	23	GND	Ground
4	4	Digital input 4	14	14	Digital input 14	24	NC	Leave unconnected
5	5	Digital input 5	15	15	Digital input 15 (12-bit and 14-bit are leave unconnected)	25	-15V	-15V input
6	6	Digital input 6	16	16	Digital input 16	26	NC	Leave

					(12-bit and 14-bit are leave unconnected)			unconnected
7	7	Digital input 7	17	NC	Leave unconnected	27	R _{Lo}	Low end of reference input
8	8	Digital input 8	18	S ₄	Signal output 4	28	R _{Hi}	High end of reference input
9	9	Digital input 9	19	S ₃	Signal output 3			
10	10	Digital input 10	20	S ₂	Signal output 2			

Notes:

- ① Digital input: DSC/DRC292 is 1~12, altogether 12 bits; DSC/DRC2914 is 1~14, altogether 14 bits; DSC/DRC2916 is 1~16, altogether 16 bits.
- ② “1” is the highest bit (MSB);
- ③ S₁, S₂, S₃ and S₄, output are used for synchro or resolver, among them, S₄ is only used for resolver;
- ④ R_{Hi} and R_{Lo}: reference input;
- ⑤ GND: common ground of power supply and input signal;
- ⑥ ±15V: power supply.

8. Table of weight values (Table 5)

Table 5 Table of weight values

Bit (MSB)	Angle	Bit (MSB)	Angle	Bit (MSB)	Angle
1	180.000 0	6	5.625 0	11	0.175 8
2	90.000 0	7	2.812 5	12 (for 12-bit LSB)	0.087 9
3	45.000 0	8	1.406 3	13	0.043 9
4	22.500 0	9	0.703 1	14 (for 14-bit LSB)	0.022 0
5	11.250 0	10	0.351 6		

9. Connection diagram for typical application (Fig. 6)

DSC/DRC load connection

(1) Control transformer (CT)

The simplest design is using digital converter to synchro/resolver to drive the control transformer. The min. power for driving CT is:

$$(VA) = \frac{V^2}{|Z_{so}|} \times \frac{3}{4}$$

Where, V is line-line voltage, Z_{so} is the impedance between nodes after the circuit from one output end of CT to other two rotor circuits is short-circuited (Z_{so}=R_{so}+jX_{so}).

For example: when the impedance of CT is Z_S=700+j490, the line-line voltage is 90V, then

$$|Z_{so}| = \sqrt{700^2 + 490^2} = 850\Omega$$

$$(VA) = \frac{90^2}{850} \times \frac{3}{4} = 1.23VA$$

For the adjustment of CT load, it can be reduced through 3 capacitances at the output end, as shown as below:

$$C = \frac{X_{so}}{2\omega(R_{so}^2 + X_{so}^2)}$$

The required power is: (VA) (unadjusted) x $\frac{R_{so}}{Z_{so}}$
 $\frac{490}{850} = 0.576$
 $1.23 \times 0.576 = 0.708VA$

In the above example, the capacitance is:

$$1.23 \times \frac{700}{4950} = 0.17VA$$

The required power after adjustment is:

In the design, it is required to note the errors that usually exist such as coil number, capacitance, inductance, etc. in CT.

Practical prompts for CT load adjustment:

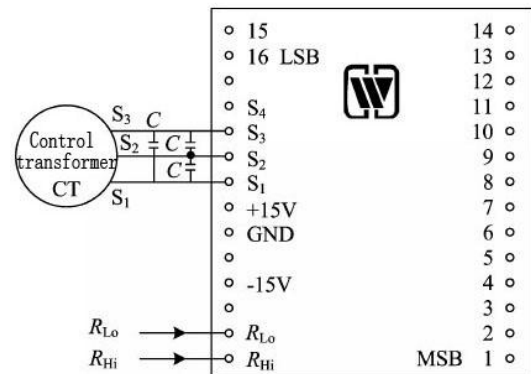


Fig. 6 Connection diagram for typical application

- ① High precision capacitance is not required, an error of 20% is enough.
- ② Three capacitances must be used between S1 and S2, S2 and S3 as well as S3 and S1.
- ③ Withstand voltage and type of capacitance

For line-line voltage of 11.8V, the withstand voltage of capacitance between pins is 25VAC, and the type of capacitance is non-polar tantalum capacitance.

For line-line voltage of 90V, the withstand voltage of capacitance between pins is 150VAC, and it is allowed to use ceramic capacitance with low dielectric constant.

- ④ The load adjustment of resolver only requires two capacitances. One is connected between S₁ and S₃, and the other between S₂ and S₄.

(2) Control differential transducer (CDX)

The load of DSC in the equipment can be considered like CT load, but its equivalent impedance Z must be calculated like CT load, its value is generally 66%~80% of Z_{SO}.

(3) Torque receiver (TR)

Compared with CT and CDX, it is relatively difficult to control the torque receiver (TR). Generally speaking, it requires an output amplifier. Because the change of radius vector of MDSC/MDRC28 series product can be neglected, it is more suitable for controlling TR than those devices with an error of ±7%. For an error with angle θ, the exciting current is:

$$\frac{2 \times V \times \sin \frac{\theta}{2}}{|Z_{ss}|}$$

Prompts:

- ① TR should not be blocked.
- ② The corresponding advance from reference input end to DSC shall conform to the provisions of TR.
- ③ The reference input must be always applied on TR and converter.
- ④ The output voltage of DSC/DRC must completely match with the voltage required by TR.

10. Package specifications (unit: mm) (Fig. 7)

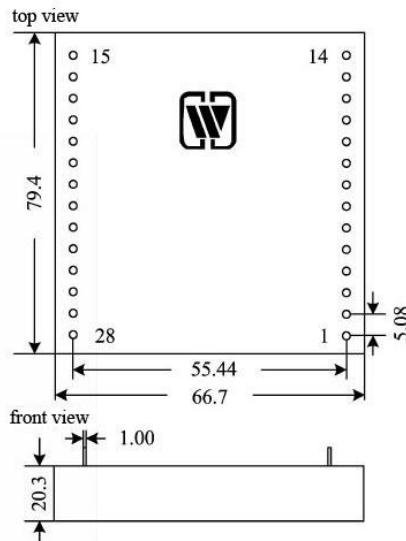


Fig. 7 Outside view and dimensions of package

11. Part numbering key (Fig. 8)

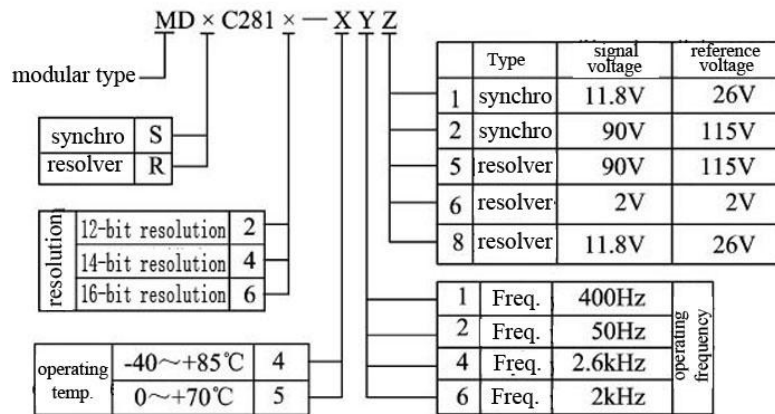
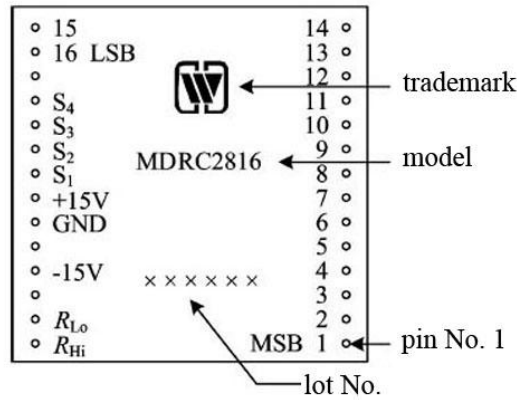


Fig. 8 Part numbering key

Note: when the above signal voltage and reference voltage (Z) are non-standard, they shall be given as follows:

$$\underbrace{\text{MDXC } 281 \times}_{\text{same as above}} - \text{X Y} - \frac{\times}{\times}$$

reference voltage / signal voltage

(e.g. reference voltage 40V and signal voltage 38V are expressed as -40/38)

Application notes

- Do not apply reference voltage of 115V to the device of 26V.
- The voltage of power supply shall not exceed the specified range.
- Do not connect reference R_{Hi} and R_{Lo} to other pins.
- Supply voltage must be kept to the voltage of correct polarity.
- When the max. absolute rated value is exceeded, the device may be damaged.
- Upon assembly, the bottom of the product shall fit to the circuit board closely so as to avoid damage of pins, and shockproof provision shall be added, if necessary.
- When the user places an order for the product, detailed electric performance indexes shall refer to the relevant enterprise standard.