SYNCHRONOUS DEVICES AND SYSTEMS

SYNCHRO

TAKUWA

A guarantee of trustworthiness— Takuwa's high-performance synchros

Synchronous devices, termed "synchros" in the industry, are widely used in the rapidly diversifying factory automation (FA) system field as highly precise and reliable positioning sensors. Among their applications are remote indication and measurement, synchronized operation, and positioning control.

In a synchro, the rotor magnetic field rotational angle is induced in the stator three-phase coil. Like small AC motors, induction-type rotational-angle transmitters have a reputation as highly reliable sensors with more resistance to vibration, temperature, and noise than electronic, magnetic, and photoelectric sensors.

Takuwa Corporation offers high-performance synchros that customers can use with confidence because of superior technology and quality standards achieved based on the Company's many years of experience in the field.

Contents

Regarding the Sale of the Instrumentation and Control Equipment Business of the Former Nippon Electric Industry Co., Ltd.

In April 2000, DENSEI-LAMBDA K.K. (formerly Nippon Electric Industry Co., Ltd.) officially sold its Instrumentation and Control Equipment Business (water gate control and industrial machinery measuring equipment) to Takuwa Corporation, which has continued with manufacturing and sales of these products.

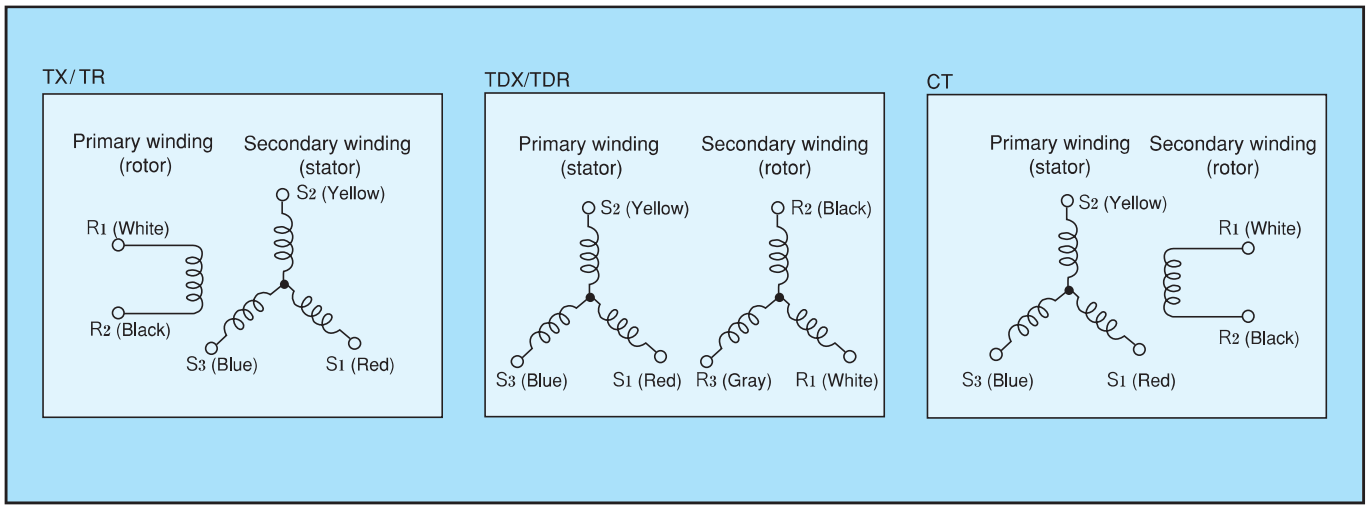
Takuwa Corporation has also continued to use the same product and model names and equipment specifications and adheres to the former delivery specifications and test reports. Therefore, the Company can offer customers smooth and speedy services for the repair or refurbishing of old products used in existing equipment or facilities requiring compatibility with previous specifications. In offering these services, the Company helps minimize the burden on customers.

Synchro Categories

The categories, properties, and special features of synchros as stipulated in the Japanese Standards Association's JIS-C4906 can be divided roughly into six categories.

TORQUE SYNCHRO (TORQUE TRANSMISSION)	CONTROL SYNCHRO (SIGNAL TRANSMISSION)
SYNCHRO TORQUE TRANSMITTER (TX) The electric angle signal corresponding to the angle assigned to the TX rotor is induced in the secondary coil resulting in output of a power signal to the receiver.	
SYNCHRO TORQUE RECEIVER (TR) The power received from the synchro transmitter (TX) causes the rotor to rotate to an angle corresponding to the electrical angle.	
SYNCHRO TORQUE DIFFERENTIAL TRANSMITTER (TDX) When this device is connected to a TX, the difference in the electrical angle of the TX and the angle assigned to the TDX rotor of the device, or the algebraic sum of these electrical angles, is induced in the secondary coil, resulting in output of a power signal to a TR.	**SYNCHRO CONTROL TRANSFORMER (CT)** When this device is connected to either a TX or TDX, it outputs a voltage signal (2-line signal) corresponding to the difference between the transmitter electrical angle and the angle assigned to the CT rotor.
SYNCHRO TORQUE DIFFERENTIAL RECEIVER (TDR) This device receives a power signal from two tx causing its rotor to rotate to a position corresponding to the difference, or algebraic sum, between the two electrical angles.	

Internal Circuit Diagrams for Synchro Categories



Synchro Models

	Product Name	Type	Torque ratio (N·m/°) (g·cm/°)	Accuracy (°)	Primary Voltage (V)	Frequency (Hz)	Secondary Voltage (V)	Page
Torque Synchro	SYNCHRO TORQUE TRANSMITTER (TX)	43G-xx	4.9×10^{-4} (5)	±0.5	100/110 or 200/220	50 or 60	78 or 86	7
		62G-xx	9.8×10^{-4} (10)					9
		64G-xx	1.67×10^{-3} (17)					10
		86G-xx 86G-15-xx	3.23×10^{-3} (33)					11 13
	SYNCHRO TORQUE RECEIVER (TR)	43M-xx	4.9×10^{-4} (5)	±1.5 (Indication precision)				7
		62M-xx	9.8×10^{-4} (10)	±1 (Indication precision)				9
		86M-xx	3.23×10^{-3} (33)					11
	SYNCHRO TORQUE DIFFERENTIAL TRANSMITTER (TDX)	86DG	1.76×10^{-3} (18)	±0.5	78 or 86			12
	SYNCHRO TORQUE DIFFERENTIAL RECEIVER (TDR)	86DM	1.76×10^{-3} (18)	±1 (Indication precision)				12
Control Synchro	SYNCHRO CONTROL TRANSFORMER (CT)	43CT	——	±0.5			52 or 57	8
		86CT 86CT-15						12 13

Combining Types of Synchros

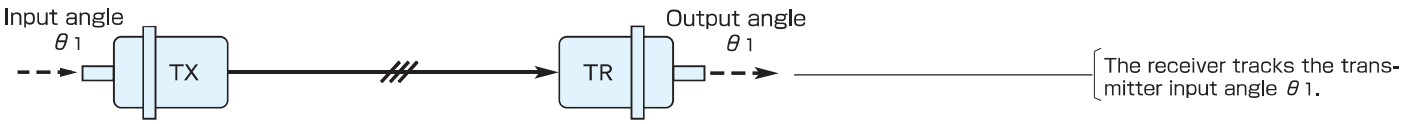
The categories, properties, and special features of synchros as stipulated in the Japanese Standards Association's JIS-C4906 can be divided roughly into six categories.
In addition, by using different interfaces, the data can be converted to the electrical signal required by the system.

1. Torque Transmission system

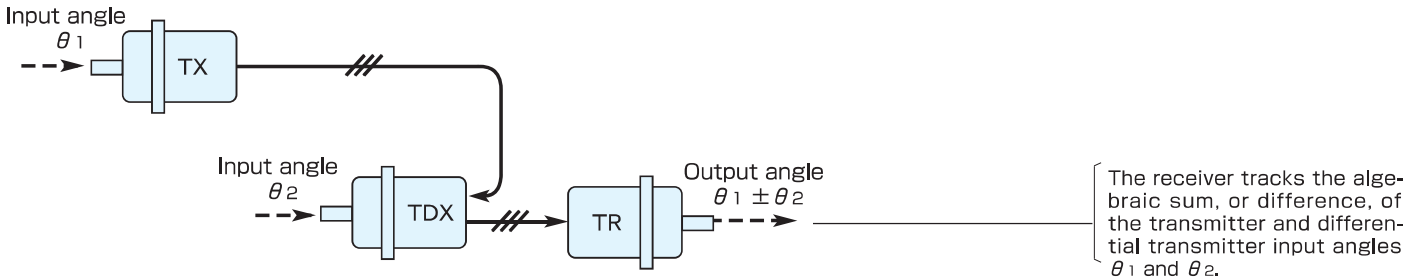
Systems where receiver rotor shaft torque tracks transmitter angle

SYNCHRO TORQUE TRANSMITTER (TX)	SYNCHRO TORQUE DIFFERENTIAL TRANSMITTER (TDX)	SYNCHRO TORQUE RECEIVER (TR)	SYNCHRO TORQUE DIFFERENTIAL RECEIVER (TDR)	EXPLANATION OF OPERATION

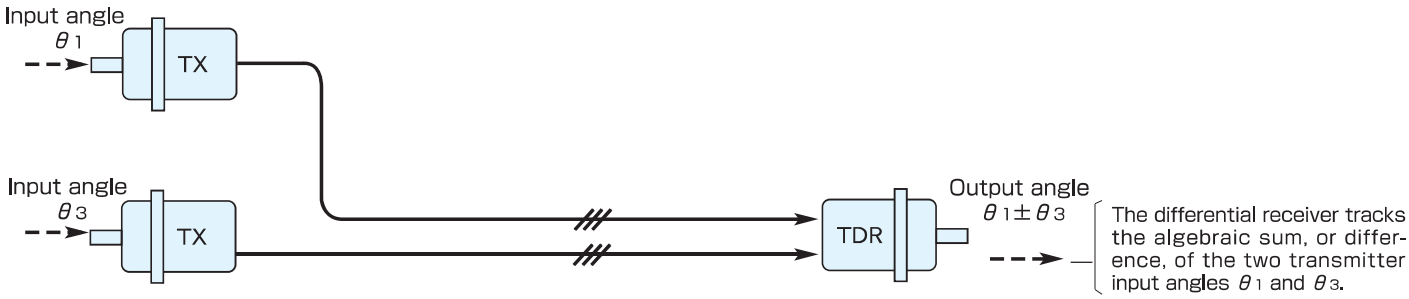
1) Combination of transmitter and receiver



2) Combination with transmitter,reciever and synchro differential transmitter



3) Combination with transmitter and synchro differential receiver

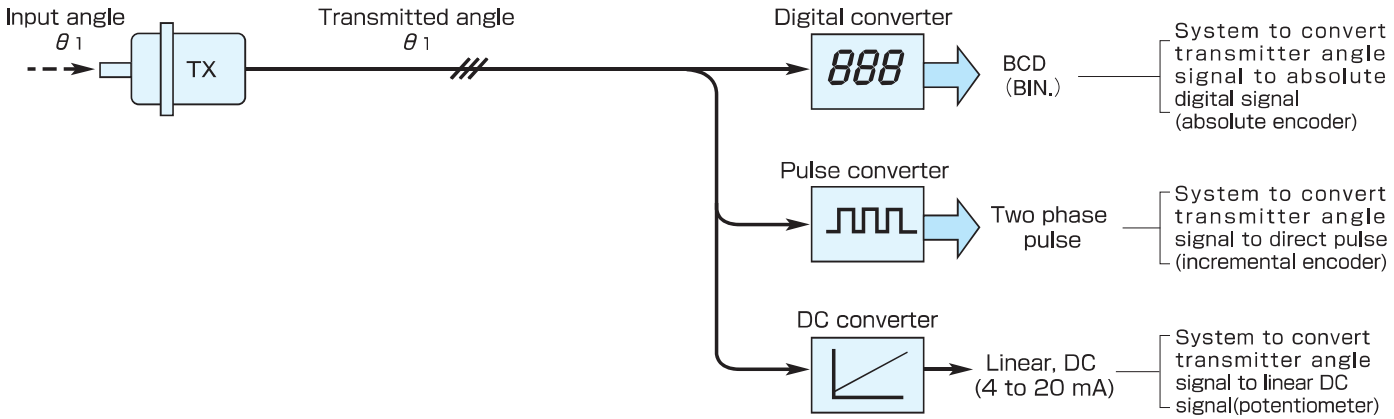


Notes: 1. ⫽⫽ indicates three-phase connection.
2. Refer to page 15 for maximum number of synchros connected to transmitter.).

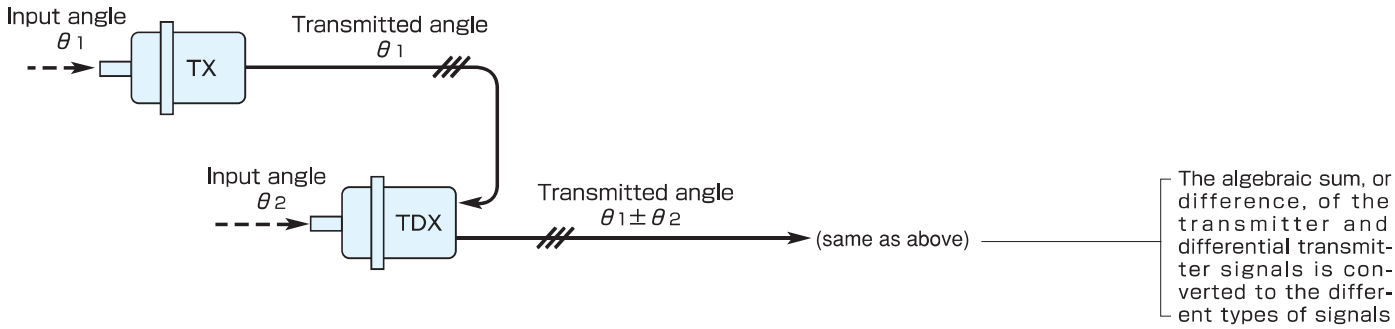
2. Signal Transmission system Systems using transmitted angle as electrical signal

SYNCHRO TORQUE TRANSMITTER (TX) | SYNCHRO CONTROL DIFFERENTIAL TRANSMITTER (TDX) | SYNCHRO CONTROL TRANSFORMER (CT) | INTERFACE | EXPLANATION OF OPERATION

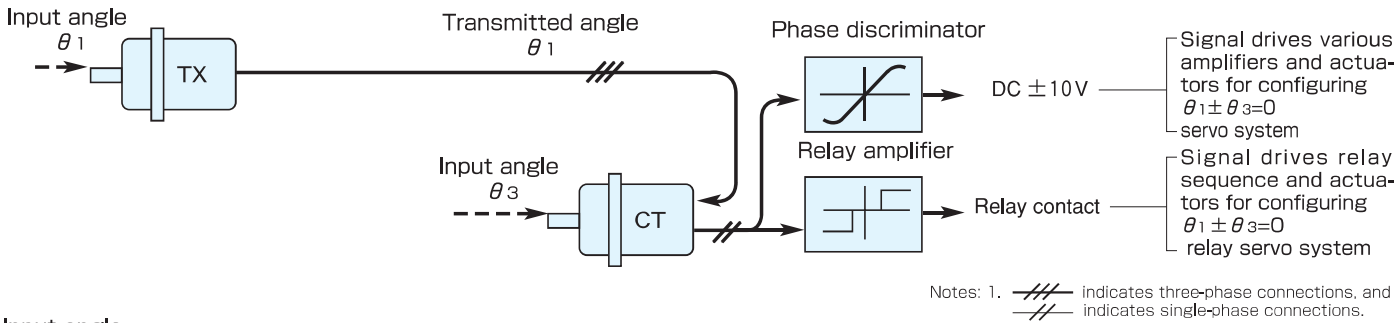
1) Transmitter signal conversion



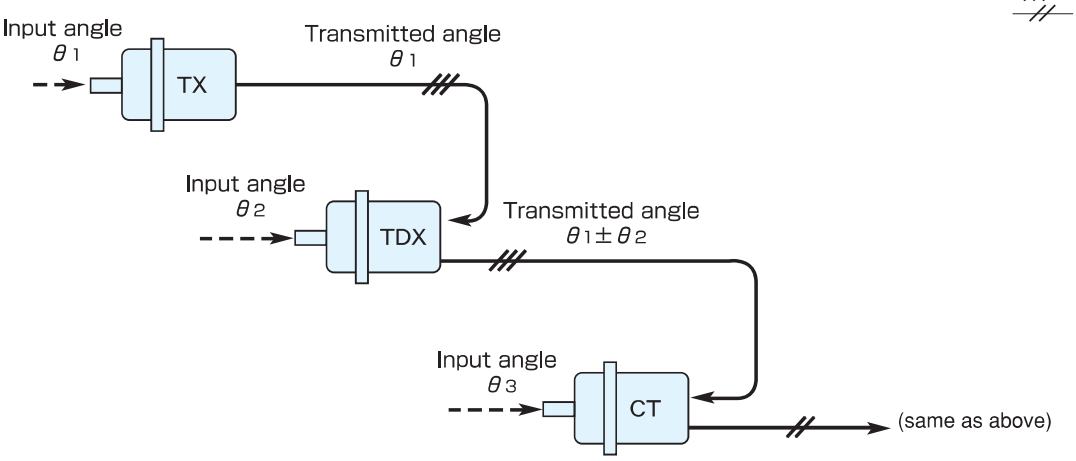
2) Differential transmitter signal conversion



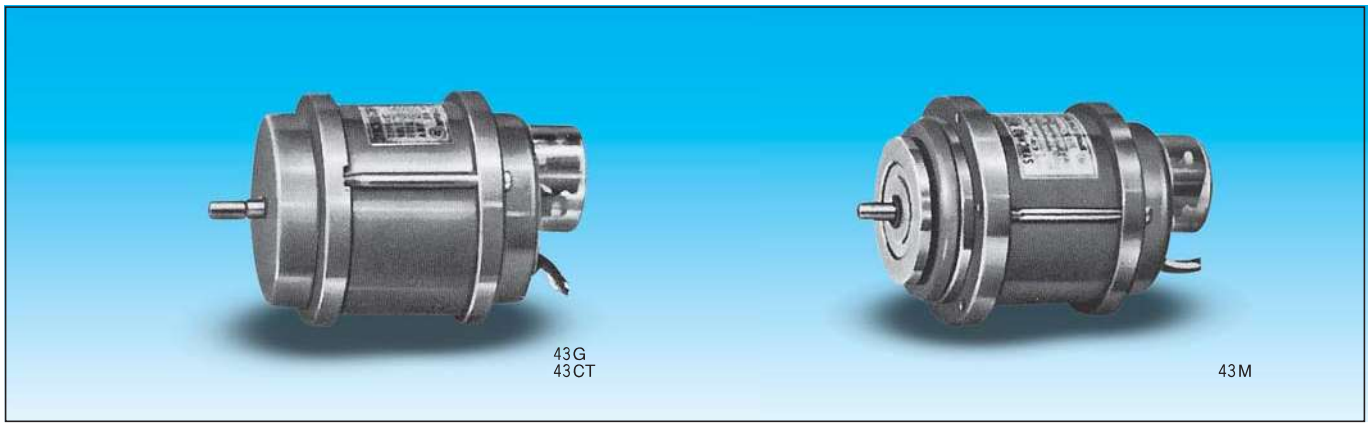
3) Control transformer signal conversion



Notes: 1. ⫽⫽ indicates three-phase connections, and // indicates single-phase connections.



43 Series Synchros

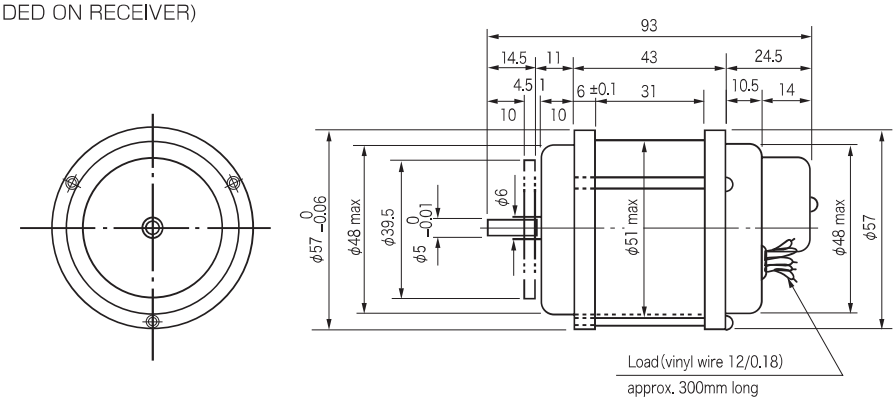


Specifications

Product Name	SYNCHRO TORQUE TRANSMITTER (TX)						SYNCHRO TORQUE RECEIVER (TR)					
Model Name	43G-10			43G-20			43M-10			43M-20		
Primary Voltage (V)	100	100	110	200	200	220	100	100	110	200	200	220
Frequency (Hz)	50	60	60	50	60	60	50	60	60	50	60	60
Primary Current (A)	0. 16	0. 13	0. 14	0. 08	0. 065	0. 07	0. 16	0. 13	0. 14	0. 08	0. 005	0. 07
Secondary Voltage (V)	78	78	86	78	78	86	78	78	86	78	78	86
Torque Gradient (N・m/°)(g・cm/°)	4.9×10^{-4} (5)	3.92×10^{-4} (4)	4.41×10^{-4} (4. 5)	4.9×10^{-4} (5)	3.92×10^{-4} (4)	4.41×10^{-4} (4. 5)	4.9×10^{-4} (5)	3.92×10^{-4} (4)	4.41×10^{-4} (4. 5)	4.9×10^{-4} (5)	3.92×10^{-4} (4)	4.41×10^{-4} (4. 5)
Temperature Rise (℃)	20	14	18	20	13	17	20	14	18	20	13	17
Stable Time (sec/175°)	————						3 or less					
Accuracy (°)	±0. 5						±1. 5					
Primary Winding Resistance (Ω)	Approx.125			Approx.500			Approx.125			Approx.500		
Secondary Winding Resistance (Ω)	Approx.165											
Insulation Resistance (MΩ)	10 over											
High Potential Voltage (AC.V 1min)	1000			1500			1000			1500		
Weight (kg)	0.6 or less						0.7 or less					
Color	Munsell 7. 5B2/2											

Dimensional Drawing

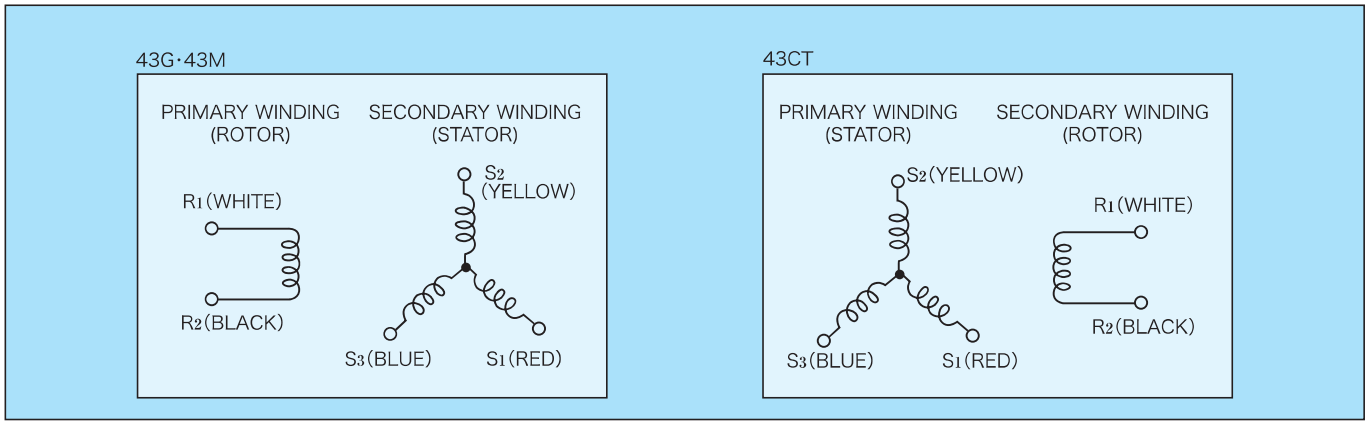
(※DAMPER IS PROVIDED ON RECEIVER)



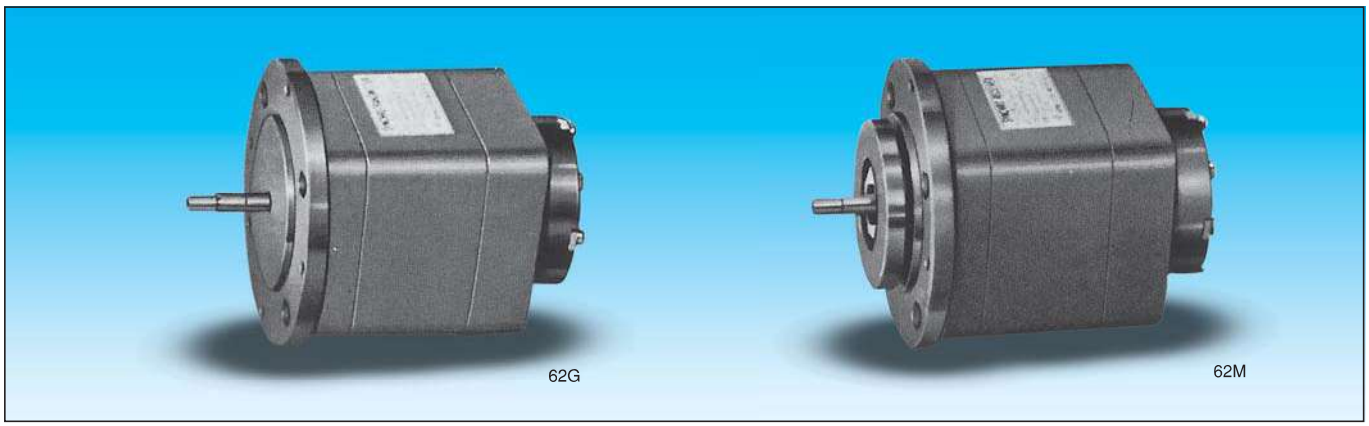
Specifications

Product Name	SYNCHRO CONTROL TRANSFORMER (CT)		
Model Name	43CT		
Primary Voltage (V)	78	78	86
Frequency (Hz)	50	60	60
Primary Current (A)	0. 058	0. 049	0. 053
Secondary Voltage (V)	52	52	57
Output Inpedance (kΩ)	0. 5	0. 54	0. 54
Voltage Gradient (V/°)	0. 825	0. 833	0. 93
Minimum Voltage (mV)	300 or less		
Accuracy (°)	±0. 5		
Angle of Phase Difference (°)	34	38	
Temperature Rise(℃)	10		
Primary Winding Resistance (Ω)	Approx. 610		
Secondary Winding Resistance (Ω)	Approx. 310		
Insulation Resistance (MΩ)	10 over		
High Potential Voltage (AC.V 1min)	1000		
Weight (kg)	0.7 or less		
Color	Munsell 7.5B2/2		

Internal Circuit Diagram



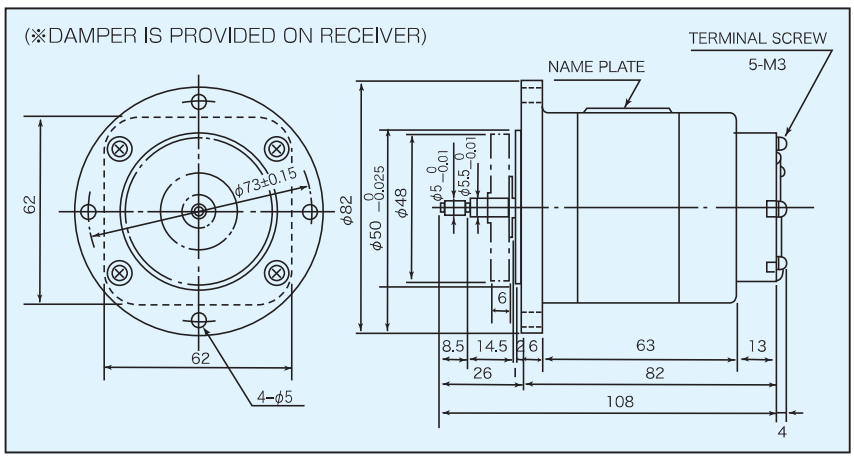
62 Series Synchros



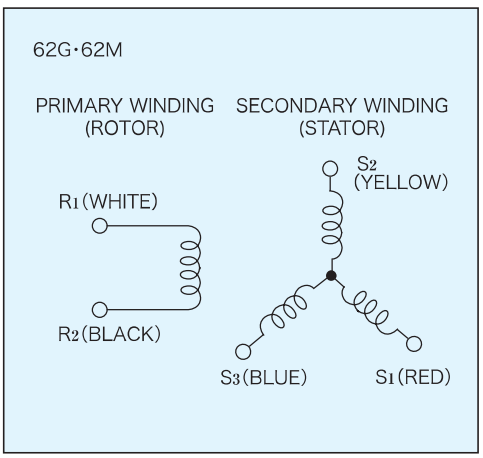
Specifications

Product Name	SYNCHRO TORQUE TRANSMITTER (TX)						SYNCHRO TORQUE RECEIVER (TR)					
Model Name	62G-10			62G-20			62M-10			62M-20		
Primary Voltage (V)	100	100	110	200	200	220	100	100	110	200	200	220
Frequency (Hz)	50	60	60	50	60	60	50	60	60	50	60	60
Primary Current (A)	0.22	0.18	0.20	0.11	0.09	0.10	0.22	0.18	0.20	0.11	0.09	0.10
Secondary Voltage (V)	78	78	86	78	78	86	78	78	86	78	78	86
Torque Gradient (N・m/°) (g・cm/°)	9.8×10^{-4} (10)	8.33×10^{-4} (8.5)	9.31×10^{-4} (9.5)	9.31×10^{-4} (9.5)	7.84×10^{-4} (8.0)	8.82×10^{-4} (9.0)	9.8×10^{-4} (10)	8.33×10^{-4} (8.5)	9.31×10^{-4} (9.5)	9.31×10^{-4} (9.5)	7.84×10^{-4} (8.0)	8.82×10^{-4} (9.0)
Temperature Rise (℃)	13	9	12	15	11	14	13	9	12	15	11	14
Stable Time (sec/175°)	———						3 or less					
Accuracy (°)	±0.5						±1.0					
Primary Winding Resistance (Ω)	Approx. 61			Approx. 270			Approx. 61			Approx. 270		
Secondary Winding Resistance (Ω)	Approx. 83											
Insulation Resistance (MΩ)	10 over											
High Potential Voltage (AC.V 1min)	1000			1500			1000			1500		
Weight (kg)	1.3 or less						1.5 or less					
Color	Munsell 7.5B2/2											

Dimensional Drawing



Internal Circuit Diagram

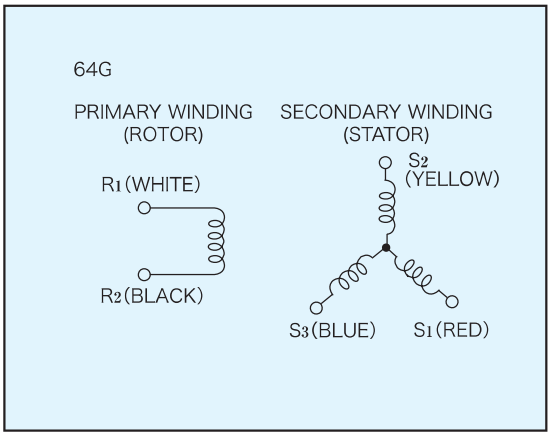


64 Series Synchros

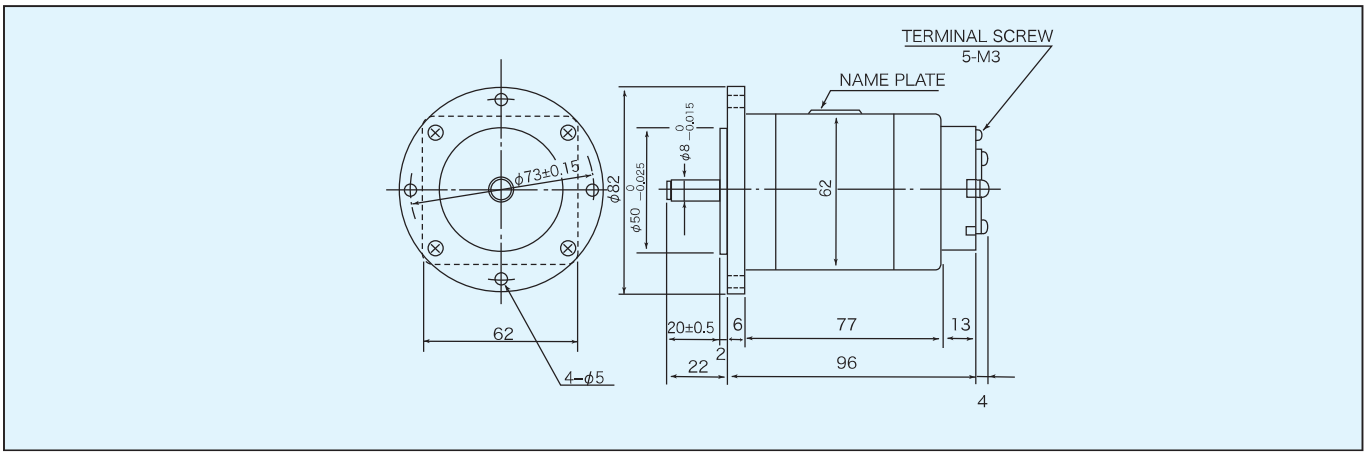
Specifications

Product Name	SYNCHRO TORQUE TRANSMITTER (TX)					
Model Name	64G-10			64G-20		
Primary Voltage (V)	100	100	110	200	200	220
Frequency (Hz)	50	60	60	50	60	60
Primary Current (A)	0. 29	0. 23	0. 26	0. 14	0. 11	0. 12
Secondary Voltage (V)	78	78	86	78	78	86
Torque Gradient (N・m/°) (g・cm/°)	1.67×10^{-3} (17)	1.27×10^{-3} (13)	1.57×10^{-3} (16)	1.72×10^{-3} (17. 5)	1.29×10^{-3} (13. 2)	1.47×10^{-3} (15)
Temperature Rise (℃)	14	10	13	13	9	11
Stable Time (sec/175°)	————					
Accuracy (°)	±0. 5					
Primary Winding Resistance (Ω)	Approx. 40			Approx.158		
Secondary Winding Resistance (Ω)	Approx. 49					
Insulation Resistance (MΩ)	10 over					
High Potential Voltage (AC.V 1min)	1000			1500		
Weight (kg)	1.7 or less					
Color	Munsell 7.5B2/2					

Internal Circuit Diagram



Dimensional Drawing



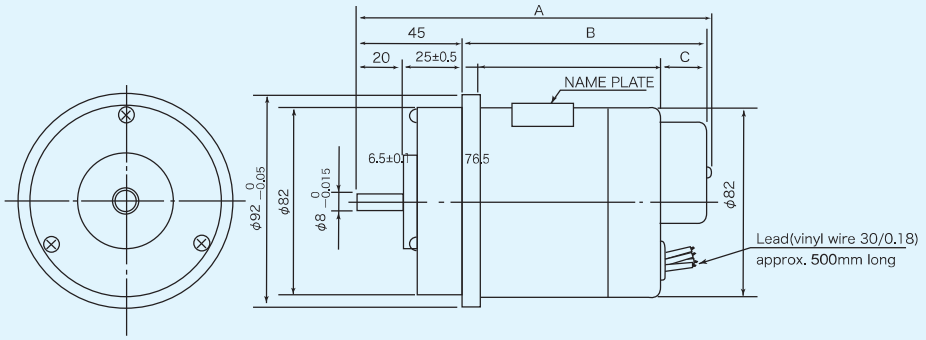
86 Series Synchros

Specifications

Product Name	SYNCHRO TORQUE TRANSMITTER (TX)						SYNCHRO TORQUE RECEIVER (TR)					
Model Name	86G-10			86G-20			86M-10			86M-20		
Primary Voltage (V)	100	100	110	200	200	220	100	100	110	200	200	220
Frequency (Hz)	50	60	60	50	60	60	50	60	60	50	60	60
Primary Current (A)	0.4	0.32	0.36	0.2	0.16	0.18	0.4	0.32	0.36	0.2	0.16	0.18
Secondary Voltage (V)	78	78	86	78	78	86	78	78	86	78	78	86
Torque Gradient (N・m/°) (g・cm/°)	3.23×10^{-3} (33)	2.45×10^{-3} (25)	2.94×10^{-3} (30)	3.23×10^{-3} (33)	2.45×10^{-3} (25)	2.94×10^{-3} (30)	3.23×10^{-3} (33)	2.45×10^{-3} (25)	2.94×10^{-3} (30)	3.23×10^{-3} (33)	2.45×10^{-3} (25)	2.94×10^{-3} (30)
Temperature Rise (℃)	9	7	8	9	7	8	9	7	8	9	7	8
Stable Time (sec/175°)	————						3 or less					
Accuracy (°)	±0.5						±1.0					
Primary Winding Resistance (Ω)	Approx.17			Approx.67			Approx.17			Approx.67		
Secondary Winding Resistance (Ω)	Approx.22											
Insulation Resistance (MΩ)	10 over											
High Potential Voltage (AC.V 1min)	1000			1500			1000			1500		
Weight (kg)	2.8 or less						2.9 or less					
Color	Munsell 7.5B2/2											

Dimensional Drawing

(※DAMPER IS PROVIDED ON RECEIVER)



Product Name	Dimensions(mm)		
	A	B	C
86G 86M 86CT	150 or less	102.5	19.5
86DG 86DM	157 or less	109	26

86 Series Synchros

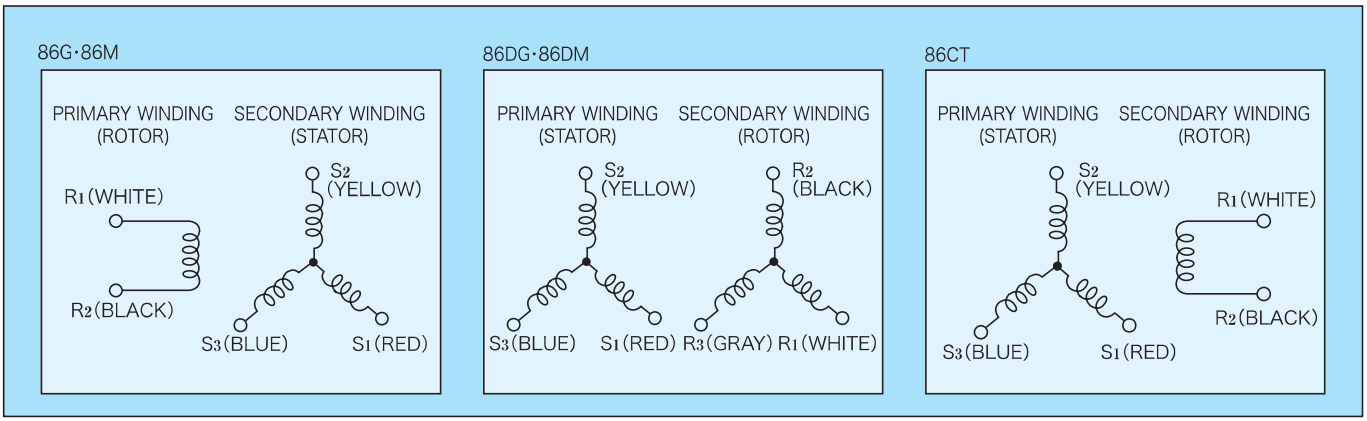
Specifications

Product Name	SYNCHRO TORQUE DIFFERENTIAL TRANSMITTER (TDX)			SYNCHRO TORQUE DIFFERENTIAL RECEIVER (TDR)		
Model Name	86DG			86DM		
Primary Voltage (V)	78	78	86	78	78	86
Frequency (Hz)	50	60	60	50	60	60
Primary Current (A)	0.40	0.33	0.35	0.40	0.33	0.35
Secondary Voltage (V)	78	78	86	78	78	86
Torque Gradient (N・m/°) (g・cm/°)	1.76×10^{-3} (18)	1.57×10^{-3} (16)	1.76×10^{-3} (18)	1.76×10^{-3} (18)	1.57×10^{-3} (16)	1.76×10^{-3} (18)
Temperature Rise (℃)	9	7.5	9	9	7.5	9
Stable Time (sec/175°)	————			3 or less		
Accuracy (°)	±0.5			±1.0		
Primary Winding Resistance (Ω)	Approx.22					
Secondary Winding Resistance (Ω)	Approx.26					
Insulation Resistance (MΩ)	10 over					
High Potential Voltage (AC.V 1min)	1000					
Weight (kg)	2.8 or less			2.9 or less		
Color	Munsell 7.5B2/2					

Specifications

Product Name	SYNCHRO CONTROL TRANSFORMER (CT)		
Model Name	86CT		
Primary Voltage (V)	78	78	86
Frequency (Hz)	50	60	60
Primary Current (A)	0.018	0.016	0.017
Secondary Voltage (V)	52	52	57
Output Inpedance (kΩ)	2.3	2.7	2.7
Voltage Gradient (V/°)	0.9	0.9	0.98
Minimum Voltage (mV)	150 or less		
Accuracy (°)	±0.5		
Angle of Phase Difference (°)	11	8	
Temperature Rise (℃)	5		
Primary Winding Resistance (Ω)	Approx.480		
Secondary Winding Resistance (Ω)	Approx.260		
Insulation Resistance (MΩ)	10 over		
High Potential Voltage (AC.V 1min)	1000		
Weight (kg)	2.8 or less		
Color	Munsell 7.5B2/2		

Internal Circuit Diagram



86-15 Series Synchros

The 86-15 series are 86 series synchro transmitters with thicker shaft diameters and strengthened mountings. These features allow the transmitters to be directly connected to and used with machines requiring vibration- and shock-resistant construction.

1. Shaft friction torque···2.45×10^{-2} N・m (250 g・cm) or less.
2. Shock resistance···98 m/S^2 (10 G)
3. Thrust load···49 N (5 kg)
   Radial load···98 N (10 kg)
4. Shaft speed···600 r/min or less.
5. Weight·····3.5 kg

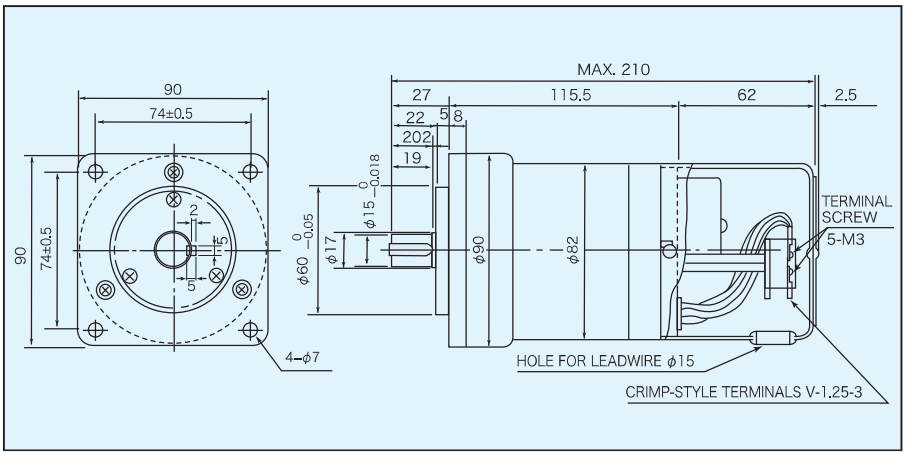
Specifications

Product Name	SYNCHRO TORQUE TRANSMITTER(TX)					
Model Name	86G-15-10			86G-15-20		
Primary Voltage (V)	100	100	110	200	200	220
Frequency (Hz)	50	60	60	50	60	60
Primary Current (A)	0.40	0.32	0.36	0.20	0.16	0.18
Secondary Voltage (V)	78	78	86	78	78	86
Torque Gradient (N·m/°)(g·cm/°)	3.23×10^{-3} (33)	2.45×10^{-3} (25)	2.94×10^{-3} (30)	3.23×10^{-3} (33)	2.45×10^{-3} (25)	2.94×10^{-3} (30)
Temperature Rise (℃)	9	7	8	9	7	8
Stable Time (sec/175°)	———					
Accuracy (°)	±0.5					
Primary Winding Resistance (Ω)	Approx.17			Approx.67		
Secondary Winding Resistance (Ω)	Approx.22					
Insulation Resistance (MΩ)	10 over					
High Potential Voltage (AC.V 1min)	1000			1500		
Weight (kg)	3.5 or less					
Color	Munsell 7.5B2/2					

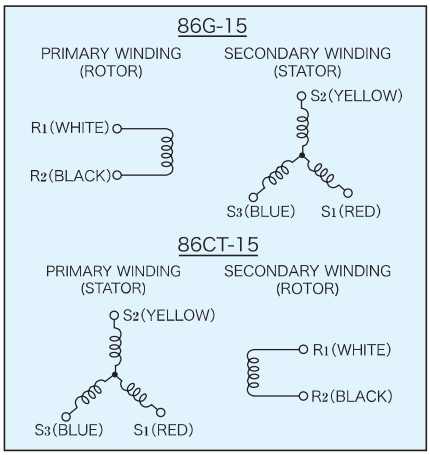
Specifications

Product Name	SYNCHRO CONTROL TRANSFORMER(CT)		
Model Name	86CT-15		
Primary Voltage (V)	78	78	86
Frequency (Hz)	50	60	60
Primary Current (A)	0.018	0.016	0.017
Secondary Voltage (V)	52	52	57
Output Inpedance(kΩ)	2.3	2.7	2.7
Voltage Gradient(V/°)	0.9	0.9	0.98
Minimum Voltage(mV)	150 or less		
Accuracy(°)	±0.5		
Angle of Phase Difference(°)	11	8	
Temperature Rise(℃)	5		
Primary Winding Resistance (Ω)	Approx.480		
Secondary Winding Resistance (Ω)	Approx.260		
Insulation Resistance(MΩ)	10 over		
High Potential Voltage(AC.V 1min)	1000		
Weight (kg)	3.5 or less		
Color	Munsell 7.5B2/2		

Dimensional Drawing



Internal Circuit Diagram



Product Use

1. Conditions of Use

The standard usage ratings for synchros are as follows.

1) Power fluctuation: ±10% of rated voltage
2) Shaft speed: 600 r/min max.
3) Ambient temperature: –20℃ to +50℃
4) Relative humidity: 95% max.
5) Shock capacity: 98 m/s^2 (10 G) max.
6) Vibration: 10 to 55 Hz, double amplitude 0.5 max.

2. Receiver Drive Torque

The selection criterion for receivers based on load torque is that the receiver must be capable of maintaining an angle difference of up to 20° with the transmitter. However, to the extent possible, an angle difference of 10° max (10 times torque) is recommended.

3. Control Transformer Load Impedance

The synchro control transformer load impedance should be approximately 5 to 10 times the output impedance (More than about 5 to10 kΩ).

4. Combining Different Synchros

Synchro torque and synchro torque differential transmitters can be used as control and control differential transmitters. However, the reverse is not true. Please refer to the following list of combinations when determining pairing.

TX — TR ····· Possible
TX — CT ····· 〃
TX — TDX — CT ····· 〃
TDX — CT ····· Not Possible

5. Number of Possible Connections

transmitter	Maximum number of synchros connected to transmitter					
	Receiver			Differential transmitter/ receiver	Control transformer	
	86M-xx (TR)	62M-xx (TR)	43M-xx (TR)	86DG (TDX) 86DM (TDR)	86CT (CT)	43CT (CT)
86G-xx (TX)	2	5	8	1	18	7
64G-xx (TX)	–	2	4	–	13	5
62G-xx (TX)	–	1	2	–	10	4
43G-xx (TX)	–	–	1	–	5	2
86DG (TDX)	1	3	5	–	18	7

Note: When connecting multiple types of receivers, select units so that the summation of load factors is 1 max.

$$\text{Load factor} = \frac{\text{Actually connected units}}{\text{Maximum possible connectable units}}$$

For example:Maximum connectable unit number to 86G is 62M × 5units and 43M × 4units
Therefore,
-Incase combination
62M × 3units and 43M × 4units
Load factor = 3/5 + 4/8 = 1.1>1.0···NG
-Incase combination
62M × 2units and 43M × 4units
Load factor = 2/5 + 4/8 = 0.9<1.0···OK

6. Transmission Distance

If there are problems with connections between transmitters and receivers, such as excess line lengths or resistance in secondary circuits, the torque of the synchro receiver drops, affecting accuracy. In such cases, the effect (reduced accuracy) is larger with smaller internal impedance (larger external dimensions). Charts 1 and 2 show an example of a test simulating the increase in resistance of the power supply line with distance by inserting an equivalent resistance into the measured circuit. The charts also show the drop in accuracy as the number of connected units increases.

Chart 1. Connection Diagram

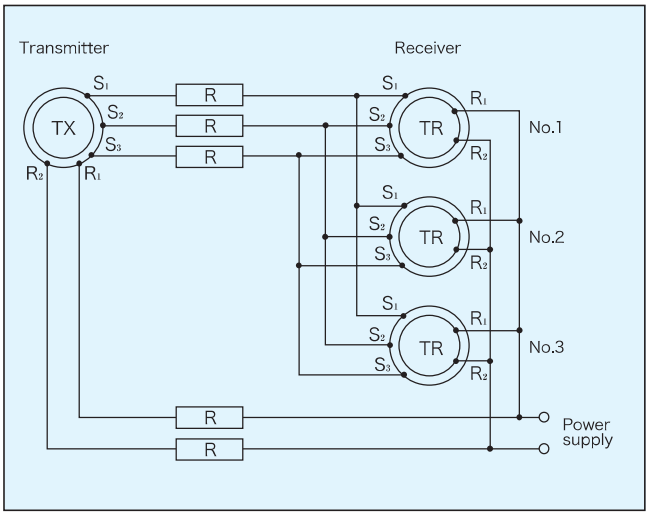
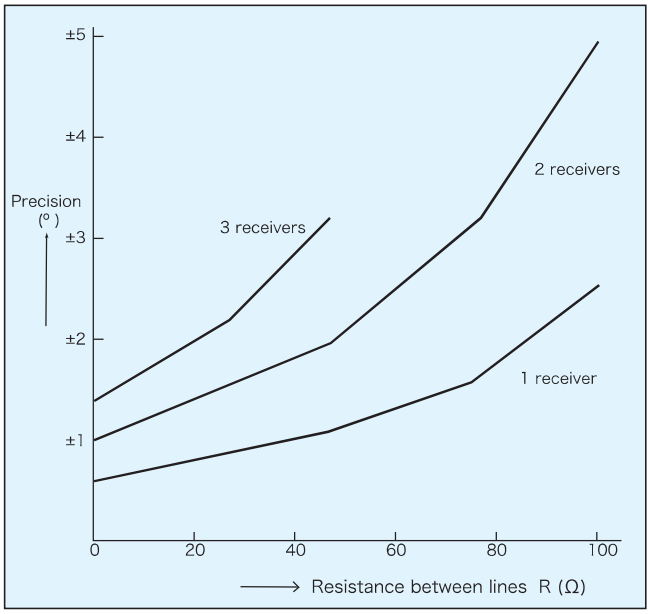


Chart 2. Precision Features Diagram



Electrical Line Resistance (at 20°C)

Conductor	Resistance (Ω/km)
0.75mm² (30本/0.18φ)	24.77
0.9mm² (7/0.4)	21.20
1.25mm² (7/0.45、50/0.18)	14.86
2.0mm² (7/0.6、37/0.26)	9.525
3.5mm² (7/0.8、45/0.32)	5.17
1.0φ (0.785mm²)	22.9
1.2φ (1.13mm²)	15.9
1.4φ (1.53mm²)	11.7
1.6φ (2.01mm²)	8.93
2.0φ (3.14mm²)	5.66

7. Rotational Direction and Connections

Synchro differential transmitters and receivers usually operate based on differential inputs, but, depending on the connections, they can also function based on cumulative input. Charts 3 and 4 show the dependence of rotational direction on the connections and the different functions of differential and cumulative inputs. The rotational directions are viewed from the shaft end.

Chart 3. Transmitter—Differential Transmitter —Receiver, Connection Diagram

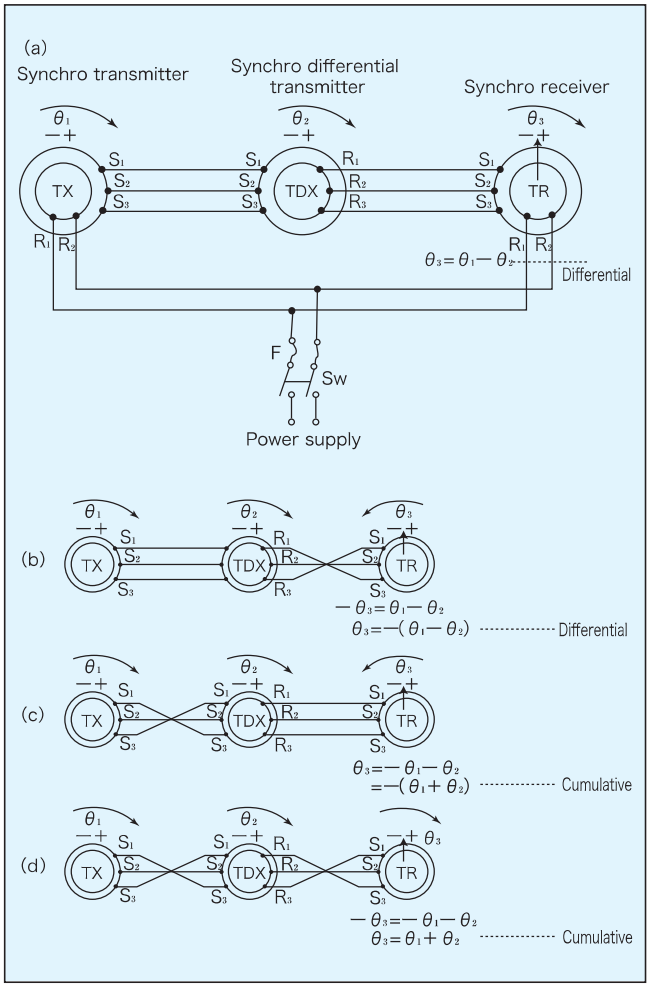
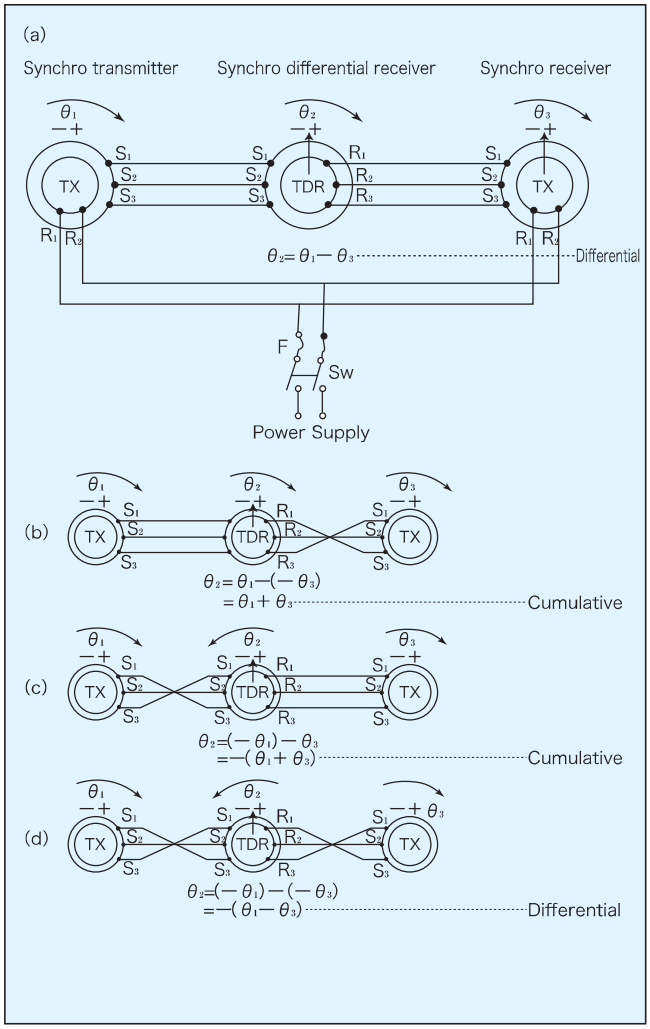


Chart 4. Transmitter—Differential Receiver—Receiver, Connection Diagram



8. Installation

Both synchro transmitters and receivers should be mounted so that there is no local external force acting on the stator body or rotor causing mechanical distortion. Moreover, care should be taken to maintain the rotor balance as far as possible when a needle, dial or some other indicator is attached to the rotor shaft. In particular, great care should be taken to avoid placing any strong frictional load on the rotational angle. Furthermore, both transmitter and receiver should be powered by the same supply. Install a switch that excites the primary windings of both transmitter and receiver simultaneously.
(Charts 5, 6, and 7)

9. Fuses

When using fuses, install them at one point in the power supply line.
Chart 5: Do not install fuses in dual excitation circuits for the transmitter and receiver.
Chart 6: In addition, the fuse capacity must be about 120% of the sum of the primary currents (no load) of the transmitter and receiver.

Chart 5. Example of Correct Power Supply

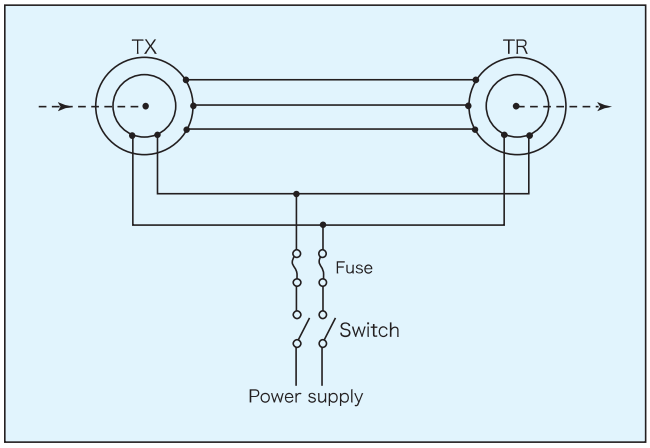


Chart 6. Example of Incorrect Power Supply (1)

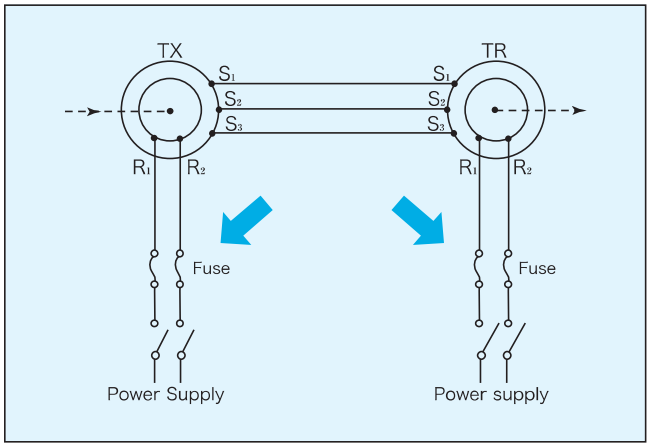
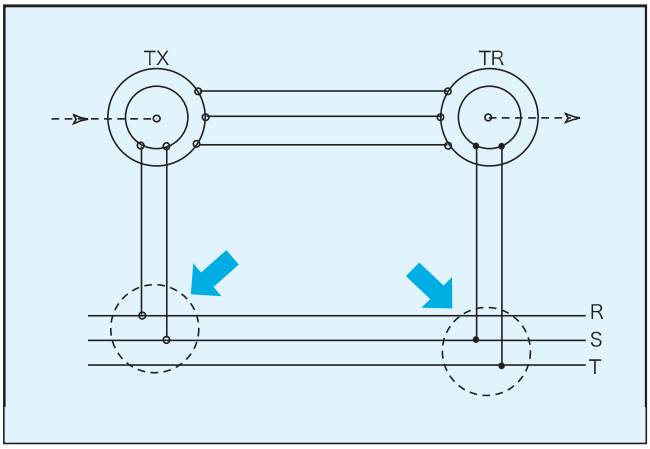


Chart 7. Example of Incorrect Power Supply (2)



Cautionary Safety Points

Please observe the following when using the products in this brochure.

- Before use (installation, operation, maintenance, inspection, etc.) of these products, read the supplied Instruction Manual and Delivery Specifications carefully.
- The Company may change and improve the contents of this brochure without prior notice.

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Safety Warning

- For safe and correct usage, always read the Instruction Manual before using these products.