

## BRUSHLESS RESOLVERS

# Smartsyn<sup>®</sup> FA-SOLVER<sup>®</sup>

BUILT-IN RESOLVERS  
SHAFT RESOLVERS  
HOLLOW SHAFT RESOLVERS



# BRUSHLESS RESOLVERS

## MEET YOUR NEEDS IN MOTION CONTROL APPLICATIONS

Wide Range of Built-in types  
for Direct Mounting onto Motors

Smartsyn, and brushless resolvers, are to offer you highly enhanced reliability which has been enabled by excluding human-dependent works in the major production / inspection procedures from parts processing, assembling to shipping.

We'd like to offer the resolvers for such applications as follows.

- Commutation of brushless motors
- Feedback sensor of servo systems
- Robots
- Machine tools
- Aerospace servo systems
- Others where harsh environmental condition is involved

Smartsyn is a name of our brushless resolvers of a new type. They have their inherent characteristics as a resolver : maintenance-free brushless design, immunity to noise, vibration, shock, and high temperature.

And now they have more to offer : homogeneity in the ever-variable parameters like accuracy, transformation ratio, phase shift, etc, which has been realized by highly automated production. Now this new quality can be taken for granted.



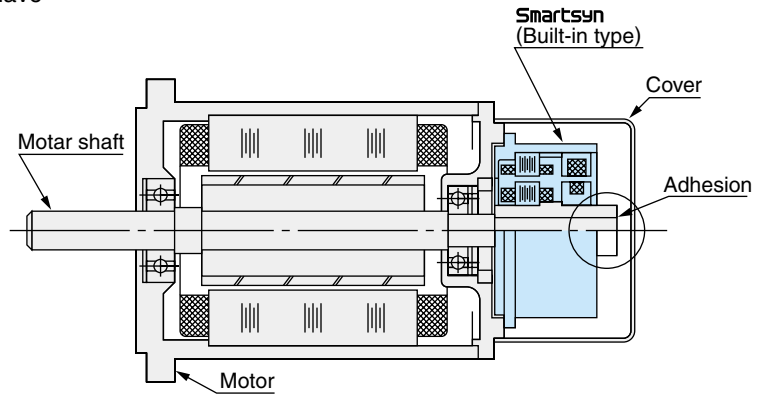
## FEATURES

- Wide Operating Temperature Range
  - 55 to +155°C (Built-in type)
  - 30 to +100°C (All Shaft types, TS2028, and TS2054)
- Usable in Demanding Environments
  - Vibration : 196m/s<sup>2</sup> (20G) at 10~500Hz
  - Shock : 981m/s<sup>2</sup> (100G) for 11ms
  - Humidity : 90% Rh Min. at 60°C
- High reliability and long life owing to having no brush
- Operating speed up to :
  - 10,000~30,000min<sup>-1</sup> (Built-in type)
  - 6,000min<sup>-1</sup> (Shaft type)
- Free from electrical and mechanical noise

## MOUNTING REQUIREMENTS

The following mounting requirements should be kept to satisfy the specifications.

- **Shaft Run-out**  
A motor shaft on which Rotor is mounted should have a run-out less than 0.050mm (TIR).
- **Concentricity**  
Centers of resolver and motor shaft should be aligned within 0.050mm (TIR).
- **Perpendicularity**  
Resolver case should be perpendicular to the motor shaft within 0.050mm (TIR).
- **Axial Alignment**  
For built-in types, Stator and Rotor should be axially aligned within the tolerance of MTG.DIM.



## PRINCIPLE

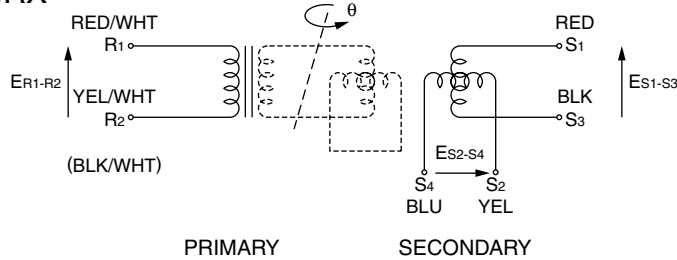
Resolver is a rotary transformer, which outputs AC voltage in accordance with angular position of the shaft. There are two types of resolvers, BRX and BRT, having different types of winding.

BRX resolver is excited by AC voltage to the rotor winding, and outputs from the stator windings sine and cosine voltages proportion to the rotation angle  $\theta$ .

BRT resolver is excited by sine and cosine voltages to the stator windings, and outputs from the rotor winding a sine voltage phase-shifted in proportion to  $\theta$ .

The difference is illustrated as follows.

### BRX



Excitation :  $E_{R1-R2} = E \sin \omega t$

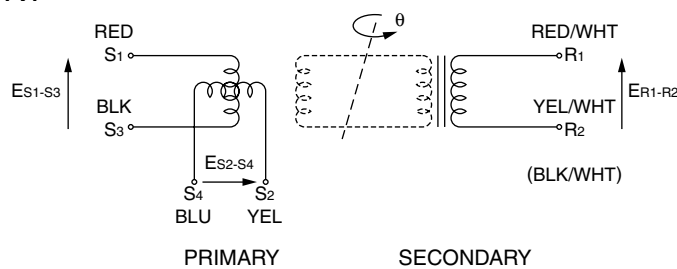
Output :  $E_{S1-S3} = K E_{R1-R2} \cos \theta$

$E_{S2-S4} = K E_{R1-R2} \sin \theta$  (Normal Type)

$E_{S2-S4} = -K E_{R1-R2} \sin \theta$  (Reverse Type)

K : Transformation Ratio

### BRT



Excitation :  $E_{S1-S3} = E \sin \omega t$

$E_{S2-S4} = E \cos \omega t$

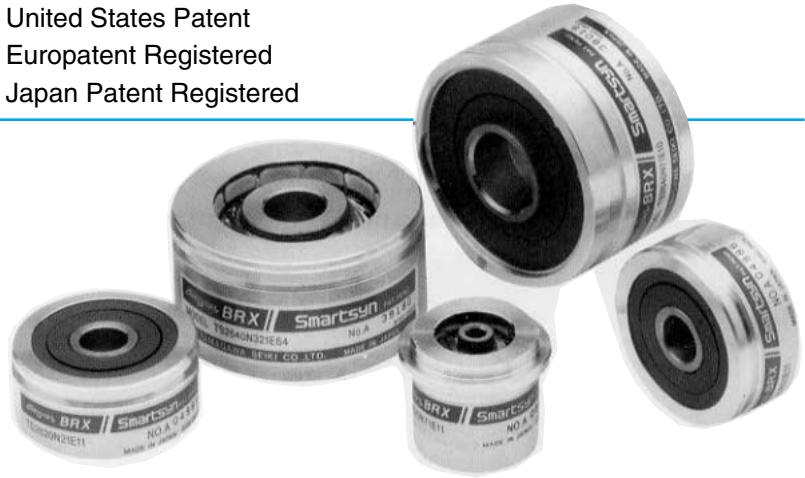
Output :  $E_{R1-R2} = K E_{S1-S3} \cos \theta - K E_{S2-S4} \sin \theta$   
 $= K E \sin (\omega t - \theta)$  (Normal Type)

$E_{R1-R2} = K E_{S1-S3} \cos \theta + K E_{S2-S4} \sin \theta$   
 $= K E \sin (\omega t + \theta)$  (Reverse Type)

K : Transformation Ratio

+ $\theta$ : CCW is positive when viewed from mounting end.

## BUILT-IN RESOLVERS

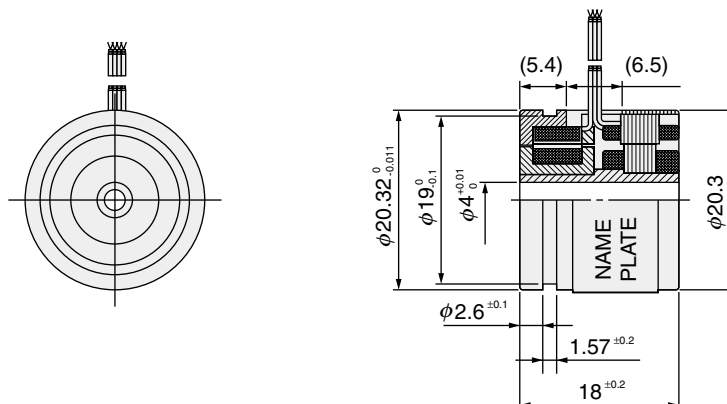


SIZE	08	10	15			21		
Model No.	TS2605N1E64	TS2610N171E64	TS2620N21E11	TS2620N271E14	TS2620N691E126	TS2640N321E64	TS2640N691E125	
Type	BRX	←	←	←	←	←	←	
Primary	R1-R2	←	←	←	←	←	←	
Input Voltage/Frequency	7Vrms 10kHz	7Vrms 10kHz	7Vrms 10kHz	10Vrms 4.5kHz	10Vrms 4.5kHz	7Vrms 10kHz	5Vrms 4kHz	
Transformation Ratio	0.5±5%	0.5±5%	0.5±5%	0.5±10%	0.5±10%	0.5±5%	0.5±10%	
Error	±10' Max.	±10' Max.	±10' Max.	±10' Max.	±8' Max.	±10' Max.	±8' Max.	
Null Voltage	20mVrms Max.	20mVrms Max.	20mVrms Max.	20mVrms Max.	20mVrms Max.	25mVrms Max.	—	
Phase Shift	+10° Nom.	+5° Nom.	0° Nom.	+8° Nom.	+3 ~ +13°	-5° Nom.	+0 ~ +10°	
Impedance	ZRo	140Ω	160Ω	70+j100Ω	90+j180Ω	90+j180Ω	110+j140Ω	290Ω Nom.
	Zso	—	160Ω	180+j300Ω	220+j350Ω	220+j350Ω	150+j270Ω	—
	Zss	120Ω	130Ω	175+j257Ω	210+j300Ω	210+j300Ω	130+j240Ω	420Ω Nom.
Operating Temperature	-55~+155°C	-55~+155°C	←	←	←	←	←	
Max. Operating Speed	30,000min. <sup>-1</sup>	10,000min. <sup>-1</sup>	←	←	←	←	←	
Mass	0.028kg	0.04kg	0.06kg	0.07kg	0.065kg Max	0.22kg	0.25kg	
Output Type	Reverse	Reverse	Normal	Normal	Reverse	Normal	Normal	

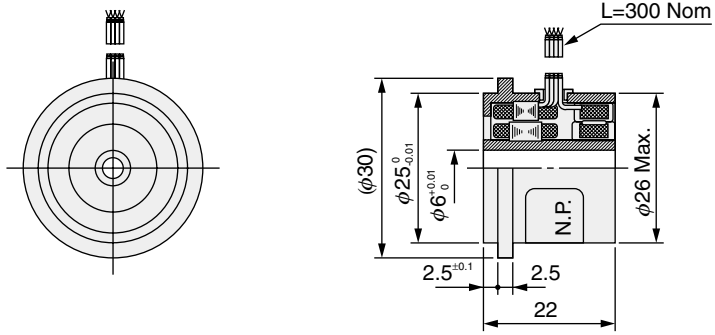
## OUTLINE

(DIMENSION : mm)

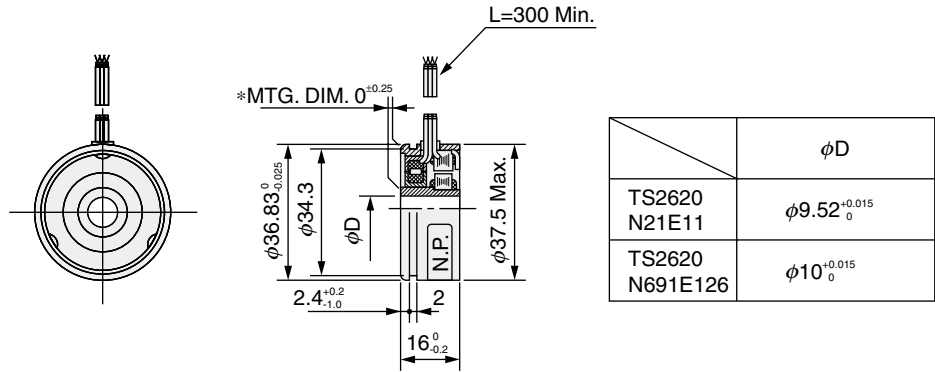
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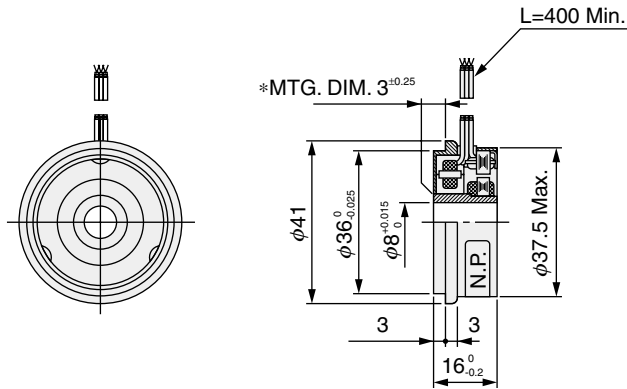
**SIZE 10 TS2610N171E64**



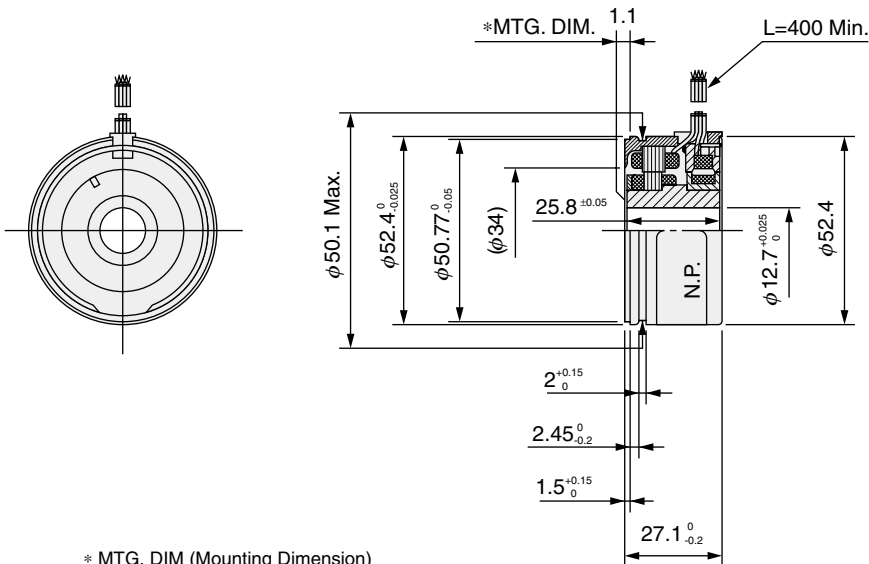
**SIZE 15 TS2620N21E11, TS2620N691E126**



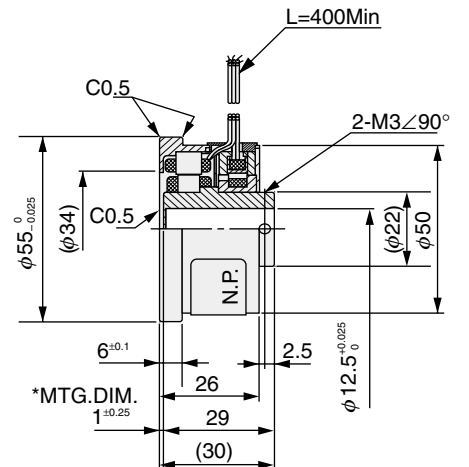
**SIZE 15 TS2620N271E14**



**SIZE 21 TS2640N321E64**



**TS2640N691E125**



\* MTG. DIM (Mounting Dimension)

# FA-SOLVER®

## BUILT-IN RESOLVERS



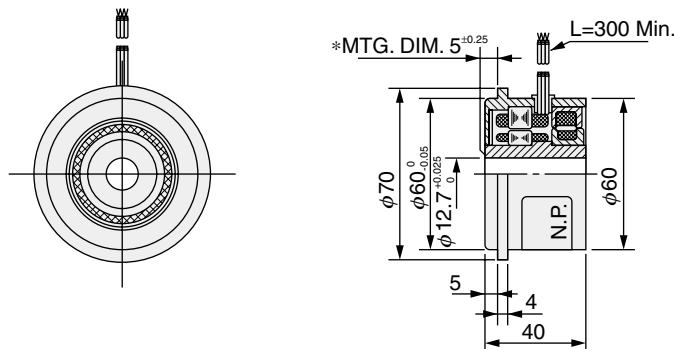
Products on this page are within FA-SOLVER® series.

SIZE	25	30	35	43	47	
Model No.	TS2013N211E57	TS2142N1E63	TS2158N21E63	TS2028N41E48	TS2054N91E51	
Type	BRX	←	←	←	←	
Primary	R1-R2	←	←	←	←	
Input Voltage/Frequency	10Vrms 4.5kHz	7Vrms 5kHz	10V 5kHz	10V 4.5kHz	6V 10kHz	
Transformation Ratio	0.5 ± 10%	0.5 ± 10%	0.5 ± 10%	0.5 ± 10%	0.28 ± 10%	
Electrical Error	± 10' Max.	± 10' Max.	± 10' Max.	± 10' Max.	± 10' Max.	
Null Voltage	20mVrms Max.	20mVrms Max.	30mVrms Max.	30mVrms Max.	20mVrms Max.	
Phase Shift	-8° Nom.	-10° Nom.	-15° Nom.	-15° Nom.	-40° Nom.	
Impedance	Z <sub>RO</sub>	250+j377Ω	120+j200Ω	176Ω	200Ω	200+j345Ω
	Z <sub>SO</sub>	400+j690Ω	—	—	—	—
	Z <sub>SS</sub>	326+j623Ω	145+j280Ω	250Ω	285Ω	214+j338Ω
Operating Temperature	-55 ~ +155°C	←	←	-30 ~ +100°C	-30 ~ +100°C	
Max. Operating Speed	10,000min. <sup>-1</sup>	←	←	←	←	
Mass	0.35kg	0.6kg	0.9kg	1.4kg	1.6kg	
Output Type	Reverse	Normal	Normal	Normal	Normal	

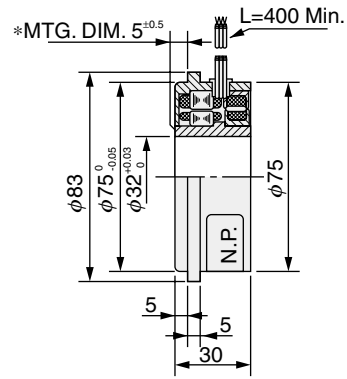
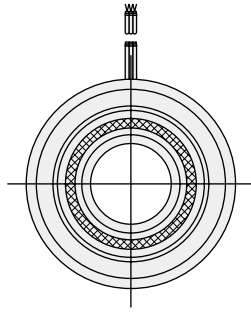
## OUTLINE

(DIMENSION : mm)

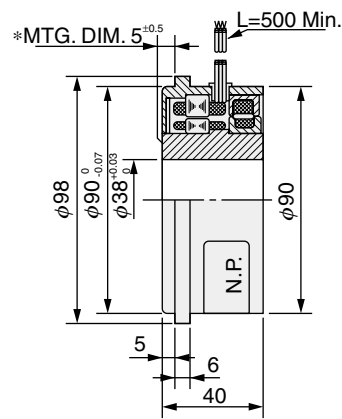
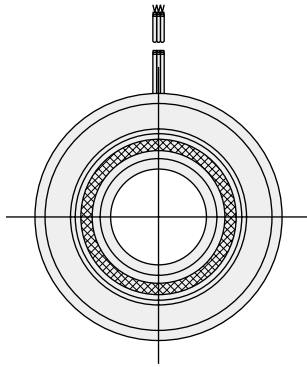
### SIZE 25 TS2013N211E57



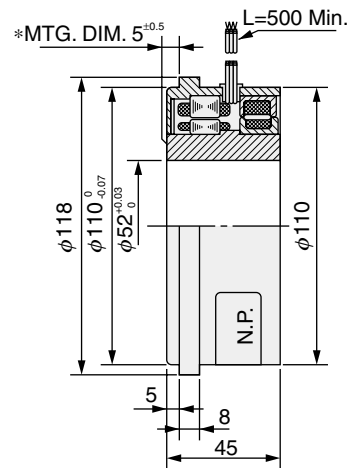
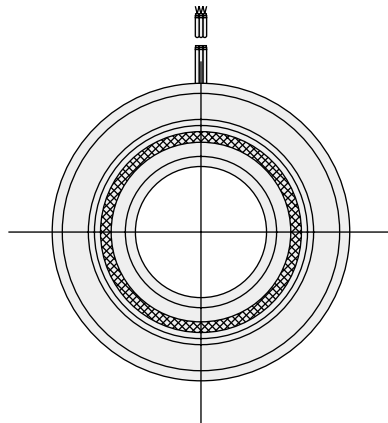
**SIZE 30 TS2142N1E63**



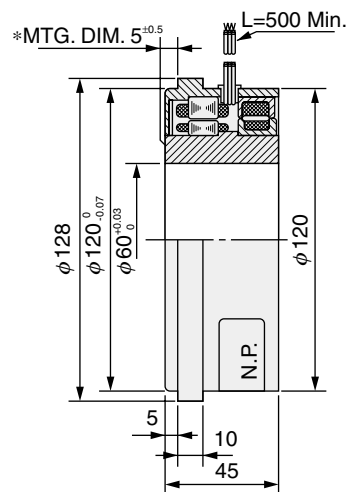
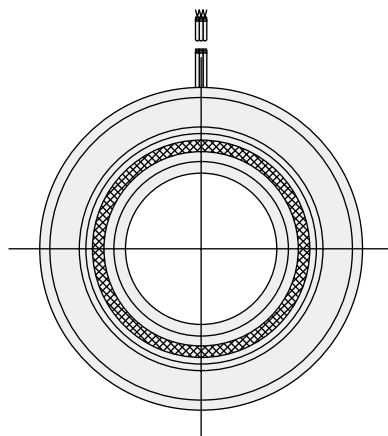
**SIZE 35 TS2158N21E63**



**SIZE 43 TS2028N41E48**



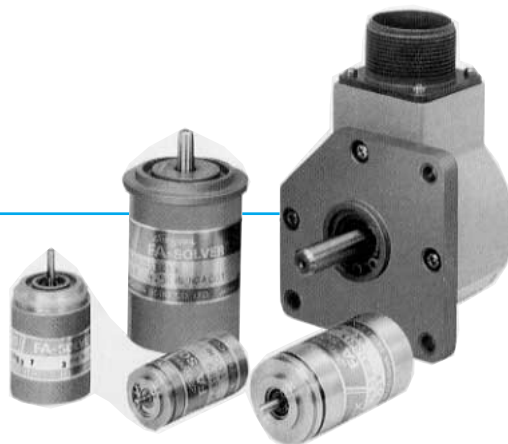
**SIZE 47 TS2054N91E51**



\* MTG. DIM (Mounting Dimension)

# FA-SOLVER®

## SHAFT RESOLVERS



### BRX

Products on this page are within FA-SOLVER® series.

SIZE		08	10	11	15	25
Model No.		TS510N35E18	TS520N46E9	TS530N33E10	TS540N33E12	TS2014N141E26
Type		BRX	←	←	←	←
Primary		R1-R2	←	←	←	←
Input Voltage/Frequency		7Vrms 3kHz	7Vrms 3kHz	18Vrms 5kHz	15Vrms 4kHz	10Vrms 4.5kHz
Transformation Ratio		0.5 ± 10%	0.5 ± 10%	0.5 ± 20%	0.5 ± 10%	0.5 ± 10%
Electrical Error		±15' Max.	±10' Max.	Spread 10'	±10' Max.	±10' Max.
Null Voltage		15mVrms Max.	15mVrms Max.	15mVrms Max.	20mVrms Max.	15mVrms Max.
Phase Shift		+9.5° Nom.	+6.5° Nom.	-5° Nom.	+5° Nom.	-7.5° Nom.
Impedance	Z <sub>RO</sub>	860+j1,230Ω	847Ω	1,000Ω	1,030Ω	250+j377Ω
	Z <sub>SO</sub>	—	—	—	680Ω	400+j690Ω
	Z <sub>SS</sub>	205+j190Ω	252Ω	380Ω	540Ω	326+j623Ω
Operating Temperature		-30 ~ +100°C	←	←	←	←
Max. Operating Speed		6,000min. <sup>-1</sup>	←	←	←	←
Mass		0.045kg	0.07kg	0.11kg	0.24kg	0.62kg
Output Type		Normal	Normal	Normal	Reverse	Normal

### BRT

SIZE		08	10	11	15	25
Model No.		TS510N36E10	TS520N47E4	TS530N33E19	TS540N33E10	TS2014N221E1
Type		BRT	←	←	←	←
Primary		S1-3, S2-4	←	←	←	←
Input Voltage/Frequency		12Vrms 2.5kHz	7Vrms 1kHz	3.5Vrms 3kHz	10Vrms 4.5kHz	10Vrms 4.5kHz
Transformation Ratio		0.5 ±10%	0.5 ±10%	0.6 ±10%	0.5Nom.	0.3Nom.
Electrical Error		±15' Max.	Spread 20'	±7' Max.	Spread 10'	Spread 15'
Null Voltage		15mVrms Max.	15mVrms Max.	10mVrms Max.	15mVrms Max.	15mVrms Max.
Phase Shift		+5° Nom.	(+10° Nom.)	-3° Nom.	-5° Nom.	(-7° Nom.)
Impedance	Z <sub>RO</sub>	—	2,030Ω	1,600Ω	—	—
	Z <sub>SO</sub>	800Ω	780Ω	2,800Ω	1,600Ω	1,800Ω
	Z <sub>SS</sub>	350Ω	2,000Ω	1,200Ω	1,500Ω	3,800Ω
Operating Temperature		-30 ~ +100°C	←	←	←	←
Max. Operating Speed		6,000min. <sup>-1</sup>	←	←	←	←
Mass		0.045kg	0.07kg	0.11kg	0.24kg	0.62kg

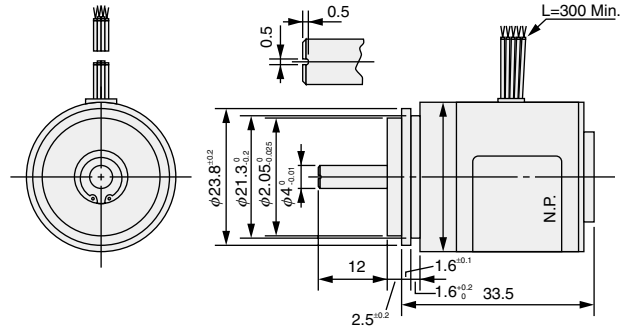
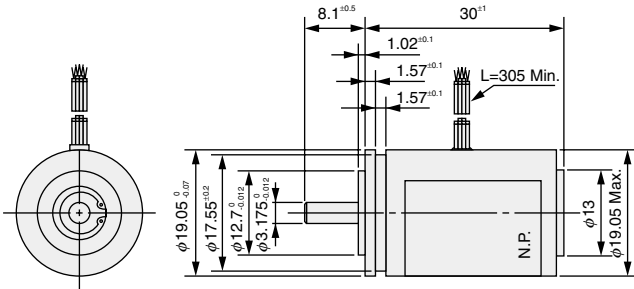


# OUTLINE

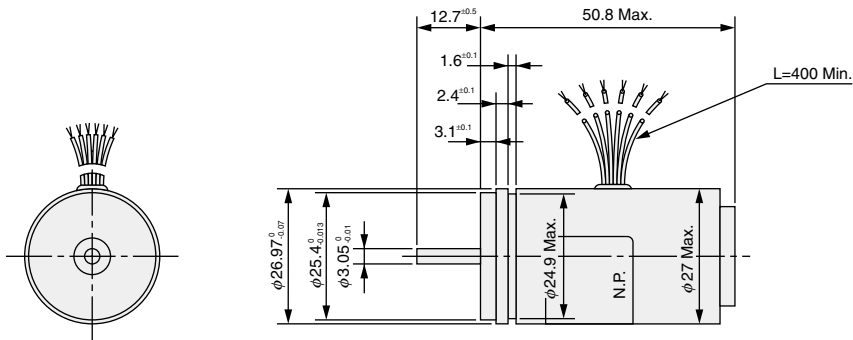
(DIMENSION : mm)

**SIZE 08** TS510N35E18, TS510N36E10

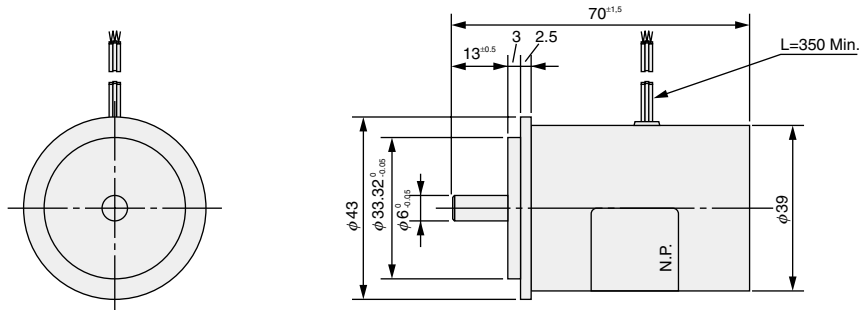
**SIZE 10** TS520N46E9, TS520N47E4



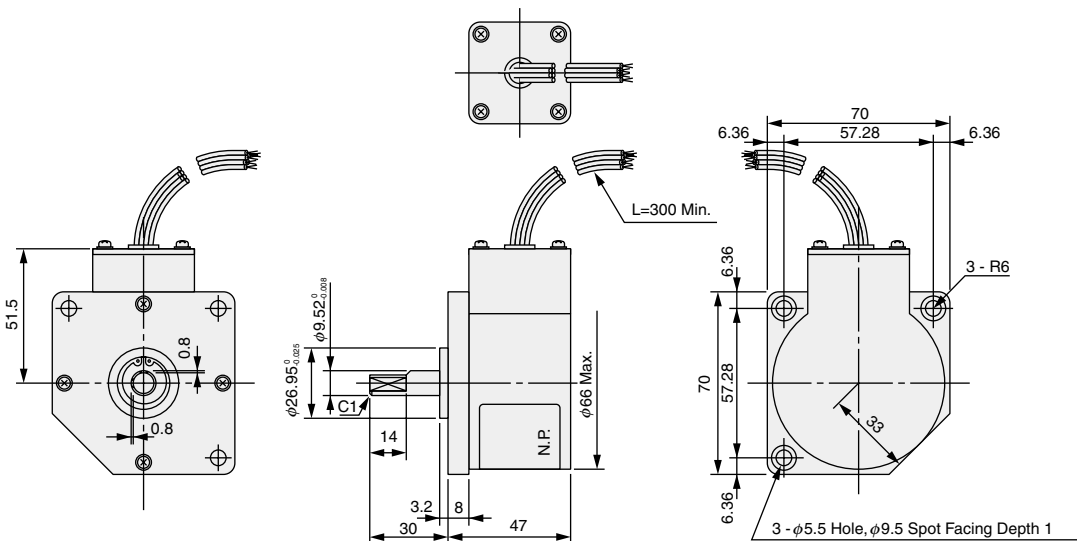
**SIZE 11** TS530N33E10, TS530N33E19



**SIZE 15** TS540N33E12, TS540N33E10



**SIZE 25** TS2014N141E26, TS2014N221E1



# FA-SOLVER®

## HOLLOW SHAFT RESOLVERS



Products on this page are within FA-SOLVER® series.

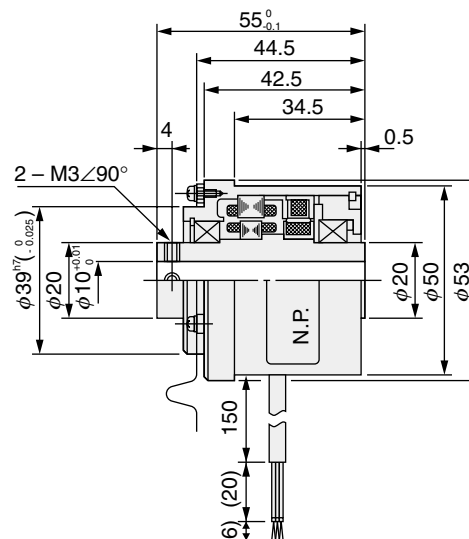
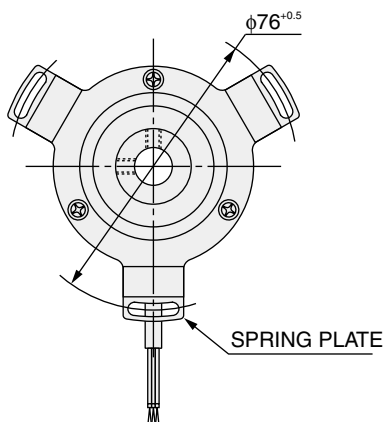
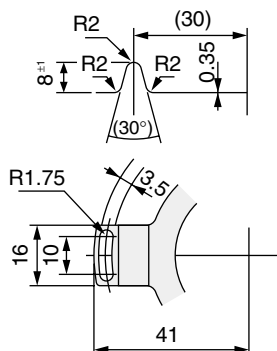
SIZE		21	
Model No.		TS2151N1E26	TS2151N1E45
Type		BRX	←
Primary		R1-R2	←
Input Voltage/Frequency		10Vrms 4.5kHz	3.5Vrms 10kHz
Transformation Ratio		0.5 ± 5%	0.5 ± 5%
Electrical Error		±10' Max.	±10' Max.
Null Voltage		20mVrms Max.	20mVrms Max.
Phase Shift		+9° Nom.	-5° Nom.
Impedance	Z <sub>Ro</sub>	75+j95Ω	290+j505Ω
	Z <sub>So</sub>	100+j140Ω	420+j810Ω
	Z <sub>SS</sub>	70+j120Ω	350+j710Ω
Operating Temperature		-30 ~ +100°C	←
Max. Operating Speed		6,000min. <sup>-1</sup>	←
Mass		0.31kg	0.31kg
Output Type		Reverse	Reverse

## OUTLINE

(DIMENSION : mm)

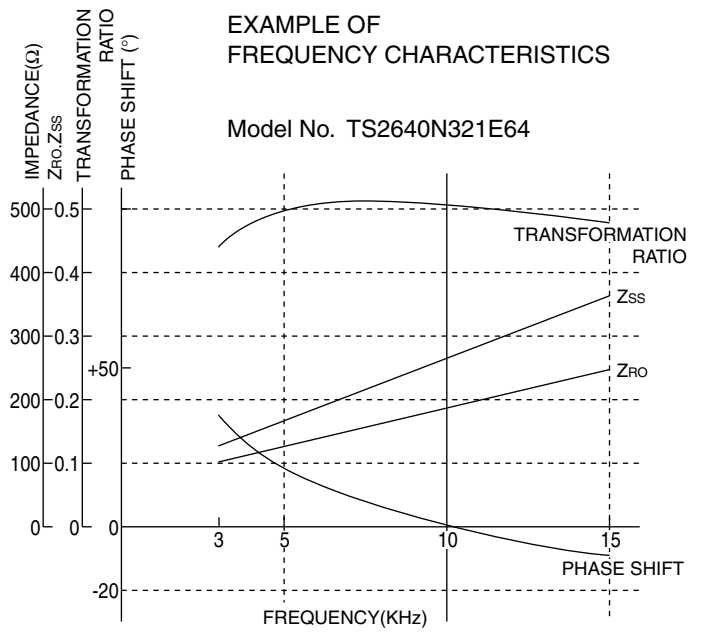
### SIZE 21 TS2151N1E26, E45

#### DETAIL OF SPRING PLATE



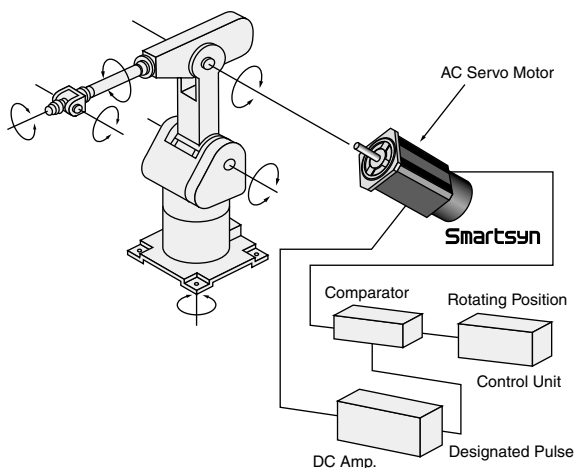
## APPLICATION NOTES

- The supply voltage is a rated value, and a resolver can accept a voltage from 3V to approx. 1.2 times as high as the rating. However, the supply frequency should only be altered within  $\pm 5\%$  lest it should affect the accuracy. Electrical parameters largely vary as the frequency varies as shown on the right.
- When a noise source is in vicinity, or when signal transfer distance is long, twisted/shielded pair cables should be used. When a noise still exists on the signals, they should be received by a differential amplifier.
- In BRX resolver, the two output voltages should be connected to the same amount of loads each other, or the voltages will get disproportionate, thus affect the accuracy.
- When an intense magnetic field surrounds a resolver, it may not work properly with its magnetic flux affected.
- When a resolver is used in a high humidity as close to 100% Rh for a long time, waterproof structure should be considered lest its insulation materials should deteriorate.
- All resolver in the catalog are  $1 \times (2 \text{ poles})$  resolvers. For winding modifications to other speeds, please consult us.

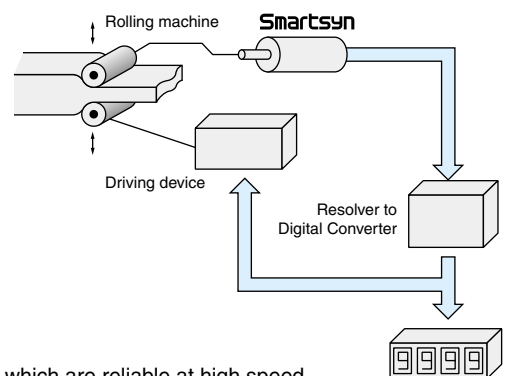


## APPLICATIONS

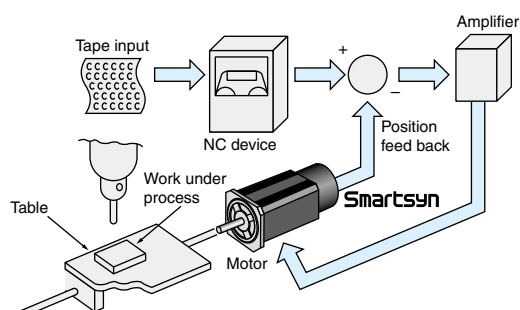
- For Driving Robot Hand and Body.



- Applicable to the roller positioning control of rolling mills.



- Smartsyn resolvers which are reliable at high speed are suitable for numerical control systems.





**TAMAGAWA TRADING CO.,LTD.**  
**A COMPANY OF TAMAGAWA SEIKI CO.,LTD.**

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ISO 14001 Certificate on Head office

URL <http://www.tamagawa-seiki.co.jp>

**WARRANTY**

Tamagawa Seiki warrants that this product is free from defects in material of workmanship under normal use and service for a period of one year from the date of shipment for its factory. This warranty, however, excludes incidental and consequential damages caused by careless use of the product by the user. Even after the warranty period, Tamagawa Seiki offers repair service, with charge, in order to maintain the quality of the product. The MTBF (mean time between failures) of our product is quite long; yet, the predictable failure rate is not zero. The user is advised, therefore, that multiple safety means be incorporated in your system or product so as to prevent any consequential troubles resulting from the failure of your product.

All specifications are subject to change without notice.

'00.2

T12-1182N16. 2,000. 2000.2