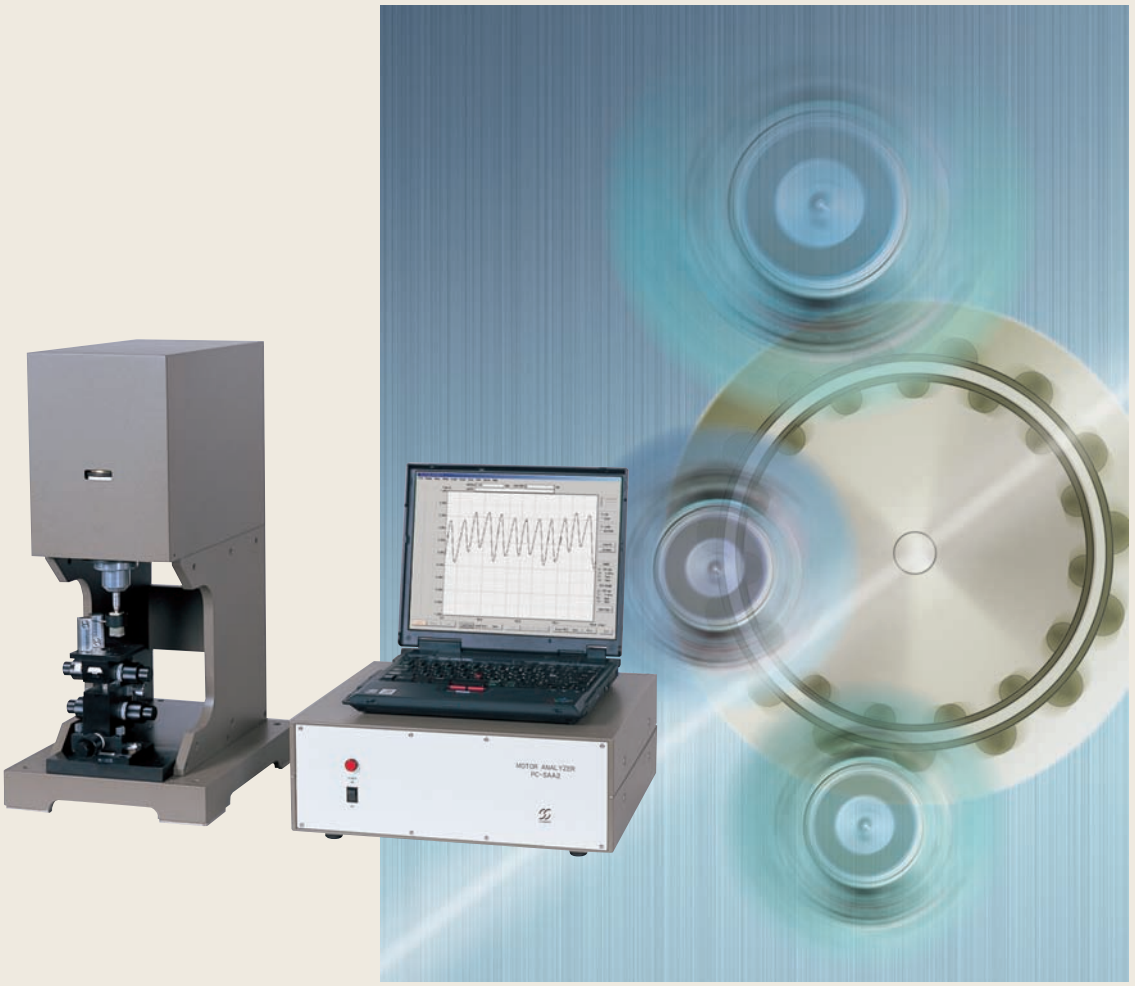
SUGAWARA

Torque Dynamometers



Speed-torque characteristics, pull-in/pull-out torque
Angle-torque characteristics, cogging torque, torque ripple

SUGAWARA Laboratories Inc.

Torque Control with Hysteresis Brake

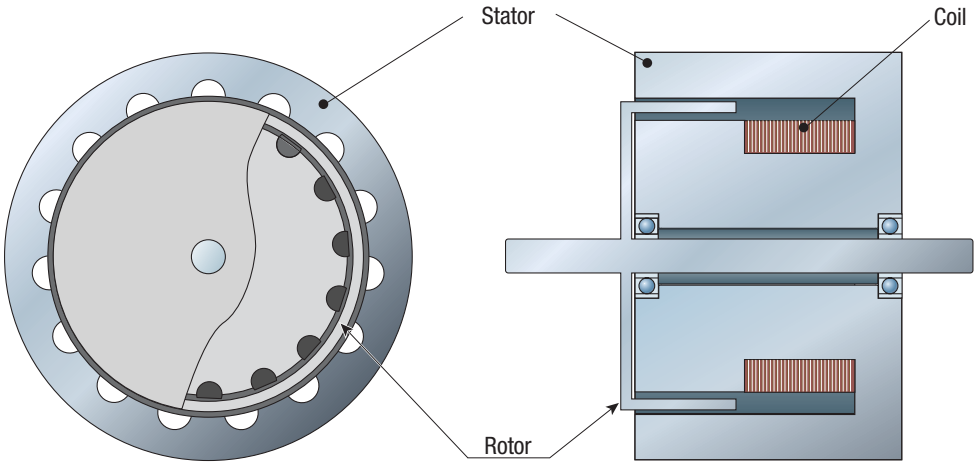


Figure 1: Hysteresis brake structure

Uses hysteresis brakes

A hysteresis brake incorporates a structure in which a rotor made of magnetic material with hysteresis characteristics is turned by a gear-shaped stator in a magnetic field aperture. Through coupling to the motor subject to measurement, the hysteresis brake functions as a brake by absorbing as hysteresis loss energy seeking to rotate this rotor. Since this energy absorption through hysteresis loss is proportional to the rate of rotation of the rotor, the brake torque generated does not depend on RPM. Rather, it functions as a stable brake from the stopped state through the high-RPM zone.

Brake torque, which can be controlled using the exciting current flowing through the stator coil, has the characteristics shown in Figure 3. The solid line represents performance when increasing and decreasing the exciter current while rotating the rotor. Brake torque is zero when the exciting current is zero.

Hysteresis brake principles

For measurements of an electric motor's speed-torque performance, the most important thing is determining which braking method (e.g., hysteresis braking, eddy current braking, powder braking, Prony braking, or motor braking) suits the nature and objectives of the measurement.
The hysteresis brakes used in Sugawara Laboratories' speed-torque measurement equipment are superior in several aspects, including their capacity for stable measurement and strong data reproducibility.

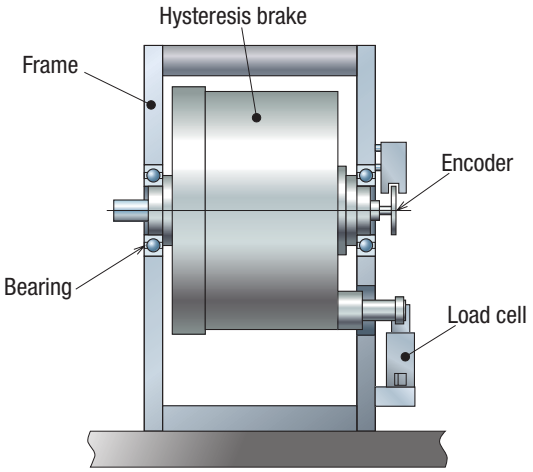


Figure 2: Load-torque detector structure

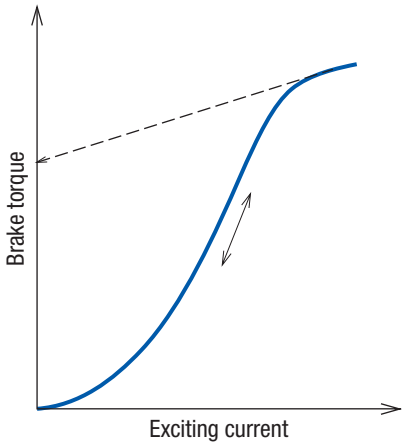


Figure 3: Brake characteristics

Methods of detecting load torque and RPM

Using a bearing in their casing frames, Sugawara Laboratories' TA/TB series of torque measurement components provides support for hysteresis brakes. In this structure, the force seeking to rotate the brake stator through operation of the motor subject to measurement is detected by a load cell using a strain gauge. When the rotor is turned by adding rotational force when brake torque is generated, the brake torque generated can be transmitted to the stator and detected by the load cell. Since this torque detection method can detect in a very static way only the force attempting to rotate the brake stator, it is more durable than detecting the torque of the axle of rotation. This can be regarded as a stable detection method suited to high-speed rotation. Although detection response can be somewhat slow, this method offers adequate response for detecting motor load characteristics.
In addition, to increase the precision of detection, losses from the bearing supporting the brake must be low. Air bearings are generally used for equipment with low rated torque.
The speed of rotation is detected through measurements with an optical encoder at 60 pulses per rotation. This encoder can also be used to detect the direction of rotation using phase relationships.

* Confirming the performance of Sugawara Laboratories torque dynamometers

Performance is confirmed through benchmark tasks using Sugawara Laboratories' work upon delivery. For this reason, we meet with clients concerning work and measurement conditions before concluding order contracts. In addition, if a client wants actual measurements using its own work, the work must be provided to Sugawara Laboratories before delivery inspections.

Speed-torque measurement

PC-SAA2 Motor Analyzer

This model allows Windows®-based measurements of the speed and torque characteristics of a wide range of motors, from DC motors to three-phase motors. It can be configured to use any measurement point and provides identical measurements values in automatic and manual modes. Users can select from 14 TA/TB-series torque measurement components, with ratings from 5 mN·m to 50 N·m. Adding optional components allows use for applications including voltage and current measurements and evaluations of high-frequency driver efficiency.

Measurements

Basic configuration	Basic configuration	
Motor analyzer Personal computer TA/TB measurement component (1) RPM (2) Torque (3) Output Po [W]	Voltage/current measurement components (4) Voltage (5) Current (6) Input (7) Efficiency Voltage/current measurement units (8) Voltage (9) Current (10) Voltage (11) Current	Digital power meter A. Voltage E1–E6 B. Current I1–I6 C. Power P1–P6 D. Σ power A E. Σ power B F. Efficiency A G. Efficiency B H. Power factor ϕ

Primary specifications

Load characteristics and voltage/current measurement

Load control method

Torque control:	controls motor load torque to configured value
Control precision:	within ±1% of full scale
Speed control:	controls motor RPM to configured value
Control precision:	within ±2% of full scale

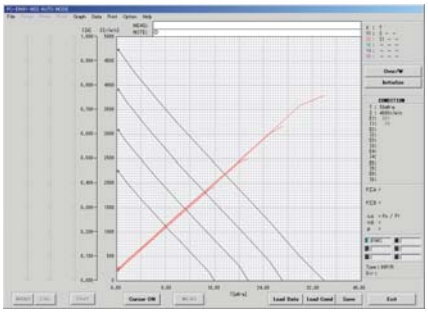
Measurement modes

Automatic mode:	load can be configured to up to 400 points
Manual mode:	load configured and measured in increments of one point
Calibration mode:	calibrates detected torque values of torque detection components
Torque measurement:	displays average value for 64 items of data sampled at intervals of 2 msec
Input sensitivity:	±2 V/range (full scale)
Torque measurement precision:	within ±0.5% of range (full scale)
Measurement range:	measurement range is set by the torque rating (see table) of measurement components
RPM measurement:	displays average value for up to 64 items of data sampled over 128 msec
Measurement precision:	within ±0.1% of range (full scale)
Measurement range:	60P/R; 4000/8000/16000/32000 r/min 600P/R; 400/800/1600/3200 r/min
Output power measurement:	T [N·m] x [r/min] x 0.1047
Voltage measurement:	displays value of root mean square of 64 items of data sampled at intervals of 2 msec
Frequencies at which measurement is possible:	DC, 50-Hz sine wave, 60-Hz sine wave
Input sensitivity:	±2 V/range (full scale)
Voltage measurement precision:	within ±0.5% of range (full scale; using standard unit); within ±0.7% of range (full scale; using expansion unit)
Measurement range:	1/2/5/10/20/50/100/200/500 V
Current measurement:	displays value of root mean square of 64 items of data sampled at intervals of 2 msec
Frequencies at which measurement is possible:	DC, 50-Hz sine wave, 60-Hz sine wave
Input sensitivity:	±2 V/range (full scale)
Current measurement precision:	within ±0.5% of range (full scale; using standard unit); within ±0.7% of range (full scale; using expansion unit)
Measurement range:	0.05/0.1/0.2/0.5/1/2/5/10/20/(50)/(100)/(200) A
Input power measurement:	displays average value for 64 items of data sampled at intervals of 2 msec
Power measurement precision:	within ±0.7% of range (full scale)
Efficiency measurement:	calculated using output/power x 100

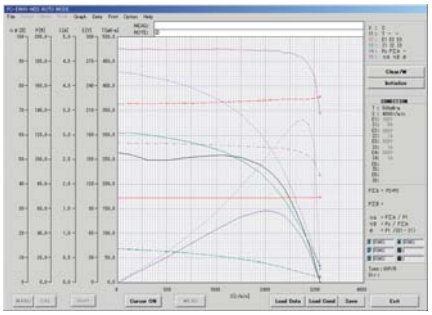
Common specifications: PC-SAA2, PC-PMA2

Compatible personal computers:	IBM PC/AT or compatible
Operating system:	Microsoft Windows®2000, XP
Communication with personal computer and WT1600 digital power meter:	
Interface:	RS232C
Connector:	D-sub 9-pin
Communication rate:	19200bps
Display of data:	graphs, values, and configuration menu displayed on personal computer monitor
Data storage and reading:	measurement data can be stored in CSV-format files; stored data can be displayed in graph and table format
Printing:	on-screen graphs and numerical data output to printer
Storage of measurement conditions:	allows user to save conditions including measurement range, measurement points, and graph sensitivity configured on the personal computer
Power supply:	single-phase AC 100 V ±10%
Power consumption:	approximately 50 VA
Dimensions:	430 (W) x 150 (H) x 360 (D) mm
Weight:	approximately 9 kg

Torque meter controls



▲ DC motor measurement using torque controls
Data differing from applied voltage displayed in overlay
X axis: torque; Y axis: RPM/current



▲ Three-phase AC motor measurement using RPM controls
All items through motor and inverter input/output and efficiency displayed
X axis: RPM; Y axis: torque, voltage, current, output power, input power, efficiency, power factor

▲ Sample display of numerical data

WT1600 Digital Power Meter

Adding the WT1600 digital power meter from Yokogawa Electric Corp. allows measurements of aspects such as driver input/output, including high-frequency specifications, and driver circuitry evaluations.

Description

- WT1600 measurement precision: ±0.15%
- Frequency power range DC, 0.5 Hz–1 MHz
- Voltage measurement
  Measurement range: 1.5 V–1,000 V
- Current measurement
  Up to six elements — 5-A elements for measurement of minor currents and 50-A elements for measurement of major currents — can be implemented randomly. A range can also be configured for each element.
  Direct 5-A implementation: 10 mA–5 A
  Direct 50-A implementation: 1 A–50 A
  CT implementation: 15 A–750 A
  Sensor voltage input range: 50 mV–10 V
  Conversion sensitivity setting range: 0.00–9999.99
- Power measurement
  Power measurement range: voltage range x power range
- Σ power measurement
  Sum total of configured power data calculated by personal computer
- Efficiency measurement
  Ratio of two configured data items calculated by personal computer
- Power factor measurement
  Ratio of effective power data and product of voltage and current data (apparent power) calculated by personal computer

TM-2S Torque Meter

Combining this with TA/TB-series torque measurement components allows measurements of speed and torque of AC and DC motors. It includes a function for measurement fluctuations in numbers of rotations through automatic load sweeping. Measurement results can be output as analog signals.

Description

- Control methods
  Brake control: open-loop control using power supply
  Torque control: fixed-torque servo control using torque value as feedback to power supply
  Speed control: fixed-speed servo control using RPM as feedback to power supply

Basic configuration

Torque meter (control component): TM-2S
Torque measurement component: TA/TB-series (fourteen models)

Speed-torque measurement

Advantages of TA/TB torque measurement components

- **Uses hysteresis brake for measurement devices**
  Sugawara Laboratories boasts many years of brake development and manufacturing experience. In addition to minimizing the magnetic field aperture in which the hysteresis cup rotates, this component minimizes the cup's moment of inertia, enabling improved torque-control precision and controlling vibrations at high RPMs.
- **Enables stable measurements from low through high RPMs**
  Torque is detected by the force exerted by the brake stator, enabling stable torque measurements from low through high RPM ranges. This component features a maximum speed of 30,000 rpm (depending on torque rating). In addition, optional components can be used to improve speed resolution for use with low-speed motors of 100 rpm or less.
- **Compatible with broad range of torque ratings from 5 mN·m through 50 N·m**
  Measurement components can be selected to suit motor power to ensure high-precision measurements. Users can select from 14 models of TA/TB torque measurement components offering differing torque ratings.
- **Long-lasting noncontact brake**
  Hysteresis brakes are noncontact devices and offer long service life. Except for bearings, hysteresis brakes have virtually no maintenance requirements.
- **Superior heat resistance**
  Another hysteresis brake advantage is its resistance to changes in torque values due to increases in brake temperature or surrounding temperature.
- **Features air bearings for low-torque use**
- **Allows measurements even in the unstable ranges of AC motors**
- **More compact than motor brakes or other brake types**

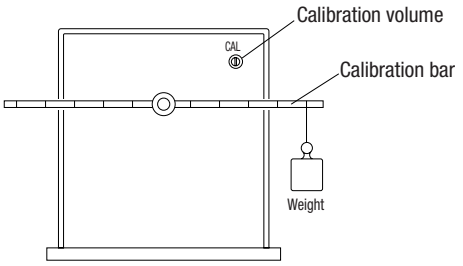
Overall torque specifications

Model	TA-50S	TA-100S	TA-200S	TB-500S	TB-1KS	TB-2KS	TB-5KS	TB-10KS	TB-20KS
Torque rating	5 mN·m	10 mN·m	20 mN·m	50 mN·m	100 mN·m	200 mN·m	500 mN·m	1 N·m	2 N·m
Torque measurement range*1	0.15–5 mN·m	0.3–10 mN·m	0.6–20 mN·m	1.5–50 mN·m	3–100 mN·m	6–200 mN·m	15–500 mN·m	0.03–1 N·m	0.06–2 N·m
Torque measurement precision	Within ±0.5% of torque rating (using control component displayed values during calibration)								
Brake support methods	Air bearings			Ball bearings					
Torque detection methods	Brake-stator reaction force detected by strain-gauge load cell								
RPM range*2	100–30,000 r/ min					100–20,000 r/ min			
RPM measurement precision	± (0.01% of range + 1 r/ min)								
RPM detection methods	Photoelectric transmission rotary encoder at 60 P/R (standard) or 600 P/R (optional)								
Rotation-direction detection	Using two photoelectric transmission signals at 1 P/R with 90° phase difference								
Brake temperature protection	—								
Brake-rotor moment of inertia	0.6×10^{-6} kg·m²	0.8×10^{-6} kg·m²	1×10^{-6} kg·m²	2.4×10^{-6} kg·m²	3.7×10^{-6} kg·m²	9×10^{-6} kg·m²	28×10^{-6} kg·m²	185×10^{-6} kg·m²	540×10^{-6} kg·m²
Shaft diameter G	ϕ3			ϕ4	ϕ6		ϕ8	ϕ10	ϕ12
Shaft shape (b x t x l)	Round				D-cut				4 x 2.5 x 20 mm
Shaft height (h)	130 mm						160 mm		200 mm
Dimensions (W x H x D)	200 x 240 x 350 mm			210 x 260 x 400 mm			210 x 300 x 500 mm		300 x 350 x 600 mm
Weight	Approx. 15 kg			Approx. 19 kg			Approx. 26 kg	Approx. 29 kg	Approx. 56 kg
Motor attachment hardware	MMJ-7B						MMJ-9B		MMJ-10B
Diameter of attachable motor	ϕ25–100 mm						ϕ50–150 mm		ϕ60–180 mm
Compatible coupling	RC-type rubber coupling				BC-type metal coupling				
Coupling moment of inertia	—				0.8×10^{-6} kg·m²		1.4×10^{-6} kg·m²	3×10^{-6} kg·m²	23×10^{-6} kg·m²
Compatible control components	PC-EMA1/PC-EMA1-W2S/TM/PC-SAA2								
Power supply	AC 100 V ±10%, 50/60 Hz (can be modified–AC 115 V, 200 V, 220 V)								

Torque meter measurement components

Torque-value calibration method

In accordance with physical moment principles, calibration can be performed using a calibration bar attached to the shaft of the torque measurement component and a weight suspended from this bar. The torque rating is displayed when the included weight is suspended from the notches at the end of the calibration bar. Volume is adjusted to allow display of the torque rating.



Air filter

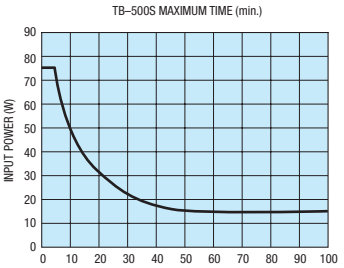
A TA-A2 regulator with air filter to eliminate fine dust and particulate matter is provided standard with model TA torque measurement components for brakes supported by air bearings.

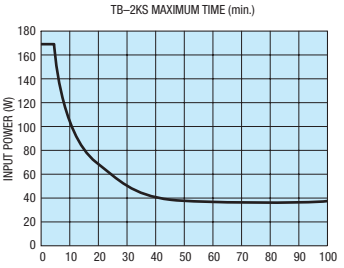
	TB-50KS	TB-100KS	TB-200KS	TB-300KS	TB-500KS
	5 N·m	10 N·m	20 N·m	30 N·m	50 N·m
	0.15–5 N·m	0.3–10 N·m	0.6–20 N·m	0.9–30 N·m	1.5–50 N·m
	100–10,000 r/ min	100–7,000 r/ min		100–5,000 r/ mim	
	Automatic cutoff of brake current at 80° or higher; also features buzzer and LED alarm				
	1.8 x 10^{-3} kg·m^2	6.3 x 10^{-3} kg·m^2	17.5 x 10^{-3} kg·m^2	31 x 10^{-3} kg·m^2	61 x 10^{-3} kg·m^2
	ϕ15	ϕ18	ϕ20	ϕ25	
	Key channel				
	5 x 3 x 20 mm	6 x 3.5 x 25 mm		8 x 4 x 25 mm	
		230 mm		300 mm	
		500 x 500 x 1000 mm	500 x 520 x 1240 mm	600 x 700 x 1100 mm	
	Approx. 63 kg	Approx. 180 kg	Approx. 210 kg	Approx. 400 kg	Approx. 450 kg
		MMJ-12B		Subject to separate consultation	
		ϕ40–200 mm			
	SA-type metal coupling with attachments				
	72 x 10^{-6} kg·m^2	113 x 10^{-6} kg·m^2	308 x 10^{-6} kg·m^2		
				PC-EMA1-U*	

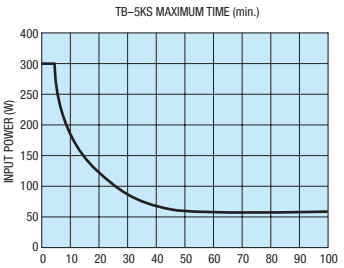
Input absorption performance

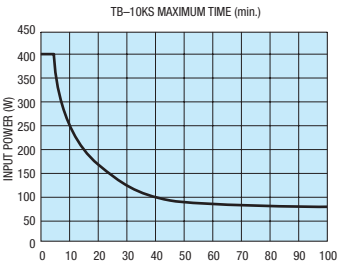
The continuous measurement time of the torque measurement component varies with input power. For this reason, the component must be used correctly, as shown in the following performance graphs. Sustained use beyond the limits indicated in these performance graphs will make it difficult to obtain correct measurements and pose risk of equipment damage.

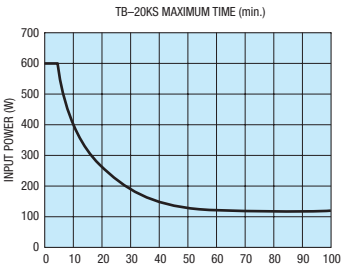
For models TB-20KS through TB-500KS, the automatic current cutoff equipment operates when the continuous-use allowance is exceeded, setting brake torque to zero.

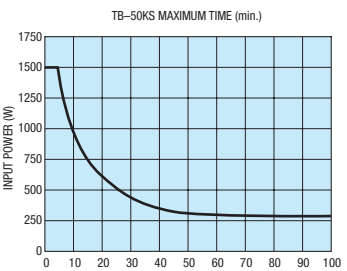


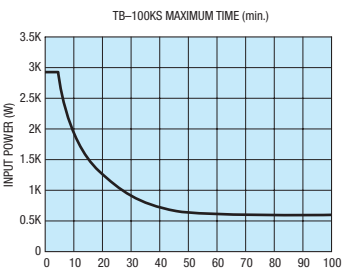


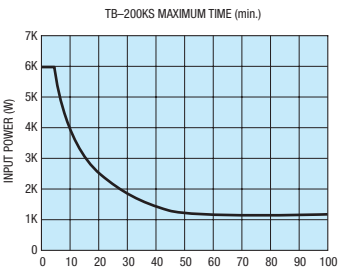












*1 Motor output power (in watts) can be calculated as follows: torque (N·m) x RPM x 0.1047.

*2 When using a rotary encoder at 600 P/R (modified model-600 pattern), RPM changes to 10 - 4000 rpm.

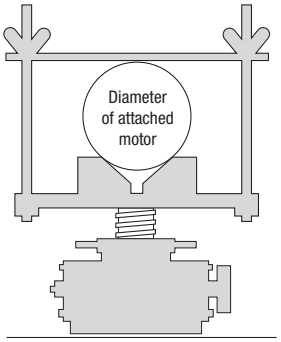
Options

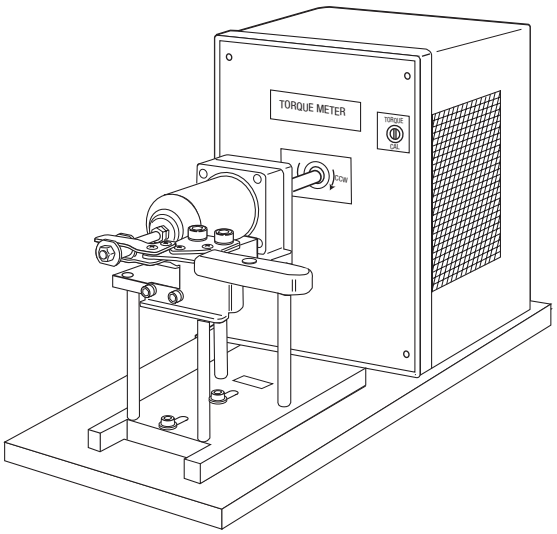
Safety cover

In certain cases — for example, when coupling core removal is performed incorrectly — the coupling may be damaged during measurement, causing it to fly off in random directions and leading to injury. Always implement adequate safety measures (e.g., attaching a safety cover).

Motor attachment hardware

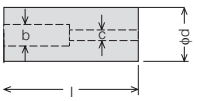
The standard hardware consists of models MMJ-7B through MMJ-12B. Sugawara Laboratories can also design and manufacture special hardware for use in production and inspection lines in addition to specialized couplings and other equipment, in accordance with client needs.





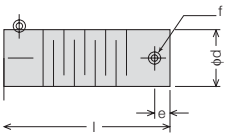
Indication of coupling dimensions

Using model BC-6-8-14 as an example, “BC” indicates the material used (RC: rubber; BC: beryllium; SC: steel). The following “6” indicates the external diameter of the torque meter axle, “8” the external diameter of the axle of the motor subject to measurement and the internal diameter when connecting attachments, and “14” the external diameter of the coupling.



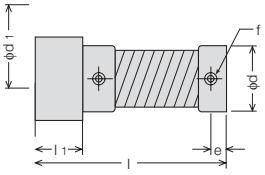
● RC coupling dimensions chart

External diameter (d)	Length (l)
ϕ6	22
ϕ10	30
ϕ13	30



● BC coupling dimensions chart

External diameter (d)	Length (l)	Position (e)	Screw (f)
ϕ14	40	3	M3
ϕ16	40	4	M4
ϕ18	48	5	M4

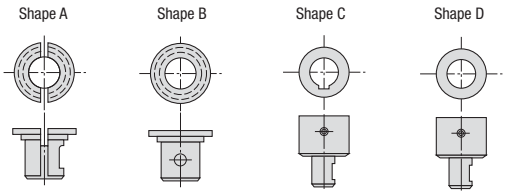


● SC coupling dimensions chart

d	l	e	f	d1	l1
ϕ26	75	7	2-M4	ϕ26	25
ϕ30	80	7	2-M4	ϕ38	30
ϕ35	98	8	2-M6	ϕ38	33
ϕ45	115	12	2-M8	ϕ45	35

Indication of attachment dimensions

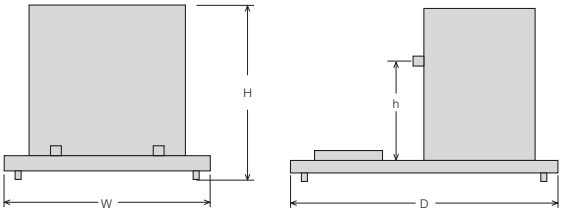
Using model BA-10-10-D as an example, “BA” or “SA” indicates the type of attachment, the first “10” the internal diameter of the coupling, the next “10” the external diameter of the axle of the motor subject to measurement, and “D” the shape.

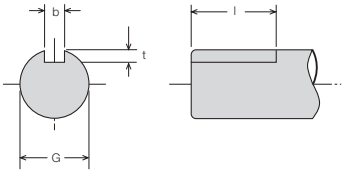


Modifications for use with low-speed motors

For measurements of low-speed motors, modifications (pattern-600 modifications) can be made to enable measurement in units of 0.1 r/min, thereby improving resolution. Note that the maximum RPM will be 4000 r/min.

External diagram of model-TA/TB measurement component





Hysteresis brake unit

A high-performance brake for use with motor measurement devices; ideal for use with specialized measurement tools and similar equipment

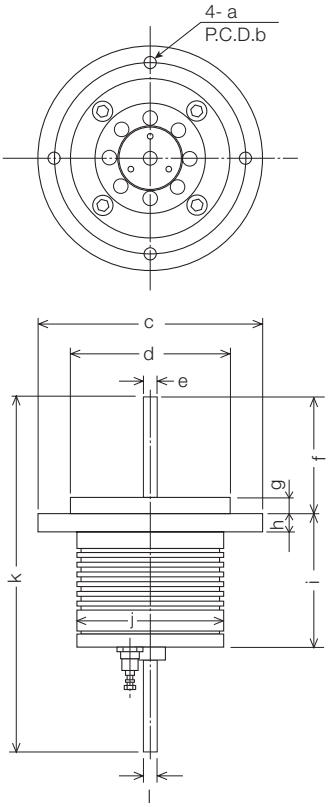
A hysteresis brake enables a fixed level of braking at all times depending on the electric current supplied, regardless of changes in RPM. The HB series is a compact, easy-to-use high-performance unit of load equipment used in Sugawara Laboratories speed and torque measurement equipment.

Advantages

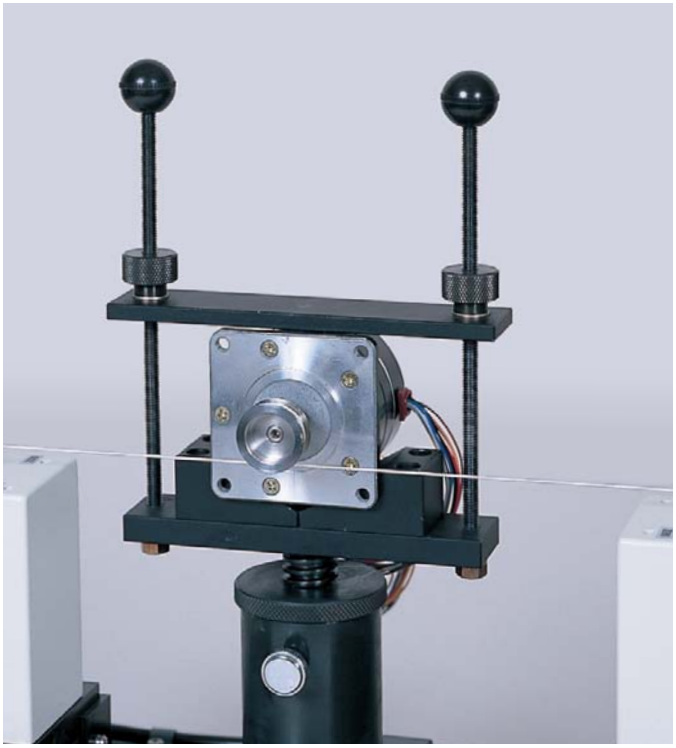
- Enables high-precision braking through improvements to internal and external teeth
- Has a structure that keeps the moment of inertia as low as possible
- Maximum RPM: 30,000 r/min
  Can handle low-speed through high-speed RPM
  Note: Maximum RPM varies with rating and by model.
- Long-lasting noncontact brake
- A brake resistant to effects of changes in surrounding temperature
- More compact in size than other brakes
- Offers a choice of 14 models, with ratings ranging from 5 mN·m to 50 N·m depending on torque rating

Specifications and external dimensions (mm)

Model	HB-500S-U*	HB-1KS-U*	HB-10KS-U*
Torque rating	50 mN·m	100 mN·m	1 N·m
Maximum RPM	30000 r/min	30000 r/min	20000 r/min
Moment of inertia	2.4 x 10^{-6} kg·m^2	3.7 x 10^{-6} kg·m^2	185 x 10^{-6} kg·m^2
Electric current rating	330 mA	330 mA	330 mA
Coil resistance	16.5 Ω	16.5 Ω	35 Ω
Maximum input	75 W	120 W	400 W
Continuous input	15 W	25 W	75 W
Weight	630 g	640 g	4500 g
a	ϕ 3.6	ϕ 3.6	ϕ 4.5
b	ϕ 58	ϕ 58	ϕ 114
c	ϕ 68	ϕ 68	ϕ 124
d	ϕ 50	ϕ 50	ϕ 104
e	ϕ 4	ϕ 6	ϕ 10
f	37	45	47
g	5	8	5
h	6	6	10
i	42	40	71
j	ϕ 46	ϕ 46	ϕ 96
k	112	116	161
l	ϕ 4	ϕ 5	ϕ 8

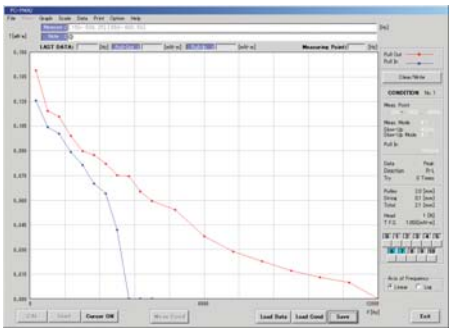


Stepping motor measurement equipment

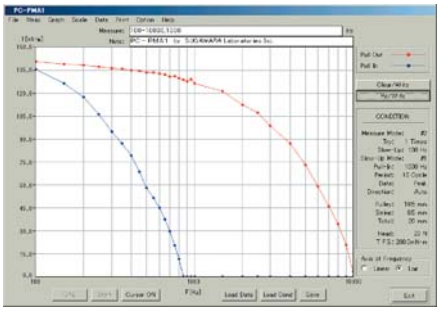


PC-PMA2 Pulse Motor Analyzer

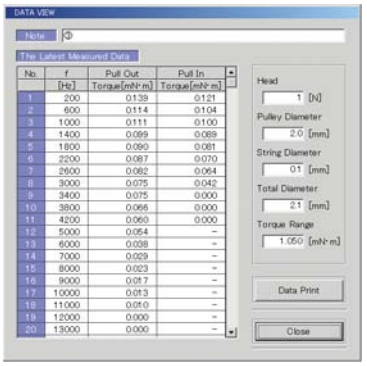
This model uses Prony (winding) braking, the braking method with the strongest demonstrated performance for stepping motor measurements. Used with a personal computer, it provides precise automatic measurements of pull-in and pull-out torque.



▲ Choose a linear scale when graphing measurements of pull-in and pull-out torque for a low-torque (0.2 mN·m or less) stepping motor.
X axis: frequency; Y axis: torque



▲ Choose a logarithmic scale when graphing measurements of pull-in and pull-out torque for a five-phase stepping motor.
X axis: frequency; Y axis: torque



▲ Sample display of numerical data

Advantages

- **Stable measurement**

  Since it uses Prony braking, this model provides stable measurement unaffected by moments of inertia and no coupling loss. In addition, the resulting measurements allow data correlation via the traditional double-balance method.

- **Precision measurement method**

  This model's judgment of synchronization loss achieves high stability using algorithms developed by Sugawara Laboratories. Measurement mode can be chosen based on step angle. For pull-in torque, startup can be measured consistently from the holding state. Allows measurement at 1-Hz resolution.

- **Broad measurement range**

  This model offers a range of seven available measurement heads, from 0.5 N to 50 N, allowing use for high-precision measurements. Through selection and use of pulleys, this model can also be used to measure small motors of 0.5 mN·m or less or 500 mN·m motors. Pulley diameters and other settings are easily configured using a personal computer running Windows®.

  Note: Any of the seven available heads may be attached to a single measurement component.

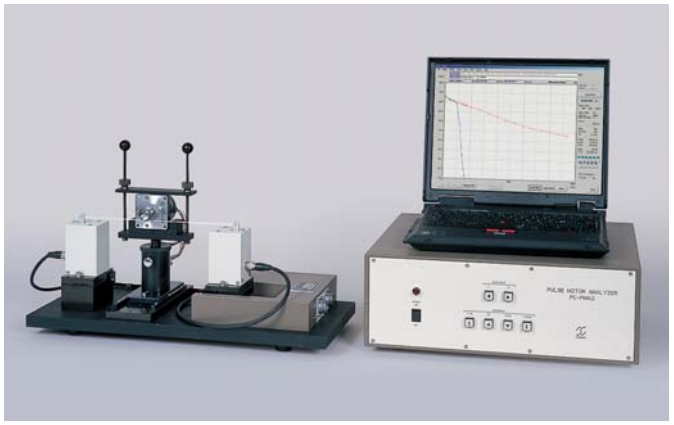
- **High-visibility measurement data**

  Motor characteristics are easily ascertained on automatically plotted performance graphs. Measurement data can be overlaid up to four times. In addition, the cursor can be used to read accurate values from measurement points. Hard copies of data displayed on-screen can be printed from a personal computer.

- **Can be controlled using standard personal computers**

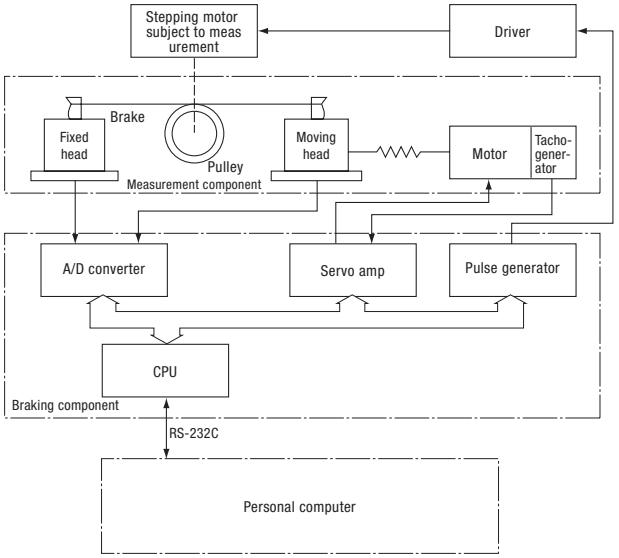
  Allows control of measurement operations and display and storage of data from a standard personal computer running Windows®. Data is stored in CSV-format files for compatibility with other software applications.

Measurement of pull-in and pull-out torque



Load-torque detection method

Braking tension is detected using two heads; the differential is calculated by the computer. When the force detected by each head is represented as F1, F2 [N], and radius R [mm] to pulley brake, detected torque T [mN·m] is R x (F1 - F2) [mN·m].



Basic configuration

Pulse motor analyzer: PC-PMA2
Measurement component: PMM-1
Torque detection head: G-PMA-H-*S
Personal computer: Microsoft Windows®2000, XP

Primary specifications

Load method: Prony braking
Force detection head rating: seven types: 0.5/1/2/5/10/20/50 N
Force detection head output sensitivity: DC 2 V/rating
Torque measurement precision: within ±1% of torque range
Maximum allowable load input: 200% of rating
Torque range: Tr = Fh x Dp / 2 [mN·m]
Tr: torque-range value [mN·m]
Fh: detection-head rating [N]
Dp: configured pulley diameter + configured brake diameter [mm]
Torque analog output: DV/2 V torque rating
Range of operating pulse frequency settings: 16 Hz - 50,000 Hz

Automatic measurement method

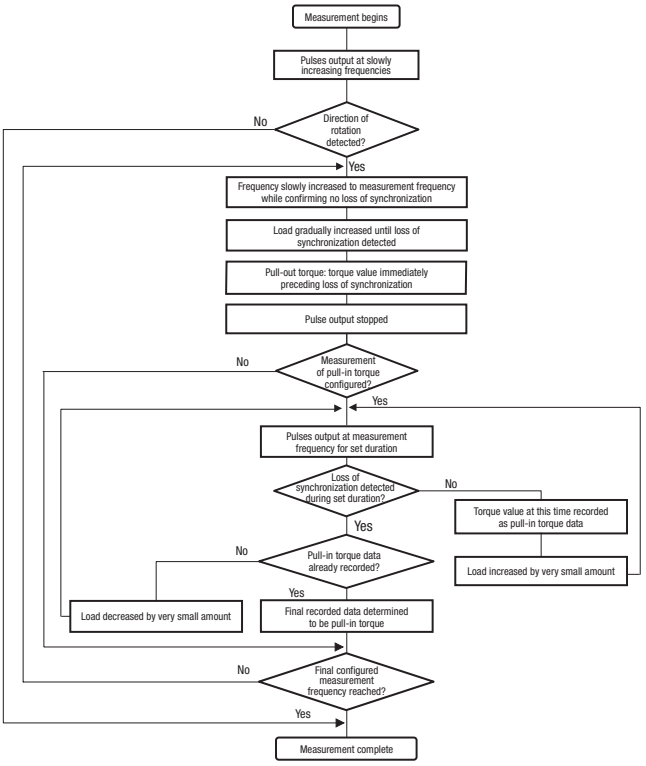
Following detection of motor rotation direction, frequency measurements are performed from low to high frequency.

Pull-out torque

Gradually increase loads after slowly revving the motor to the measurement frequency. When loss of synchronization is detected, the value immediately preceding this loss is determined to be the pull-out torque value.

Pull-in torque

Starting from the holding state following measurement of pull-out torque, the configured frequency is output to the motor and loss of synchronization detected. Based on these results, the motor is rotated at the measurement frequency while increasing and decreasing loads and loss of synchronization monitored once again. This process is repeated until the maximum load torque value at which synchronized rotation can be performed is detected. This value is determined to be the pull-in torque.



Operating pulse output: TTL-level voltage output, open-collector output, square wave; duty: 1:1
Dimensions, weight
Control component PC-PMA2: 430 (W) x 150 (H) x 360 (D) mm
Approximately 9 kg
Measurement component PMM-1:
520 (W) x 220 (H) x 220 (D) mm
Approximately 15 kg
Head PMA-H-*S: 80 (W) x 115 (H) x 60 (D) mm
Approximately 1 kg
Compatible personal computers: IBM PC/AT-compatible
Operating systems: Microsoft Windows®2000, XP
Interface: at least one RS-232C serial port
Power supply: single-phase AC 100 V ±10%, 50/60 Hz
Power consumption: approximately 50 VA

Cogging torque measurement equipment

ATM-MN Torque Meter

After securing the motor housing in place, this model measures torque per angle by rotating the rotor at 1 r/min, then uploads to a personal computer running Windows® angle-torque characteristics such as low levels of cogging torque for brushless DC motors and detent torque for stepping motors. Can also be used to measure torque of non-rotating pieces of machinery such as clutches and oil seals.

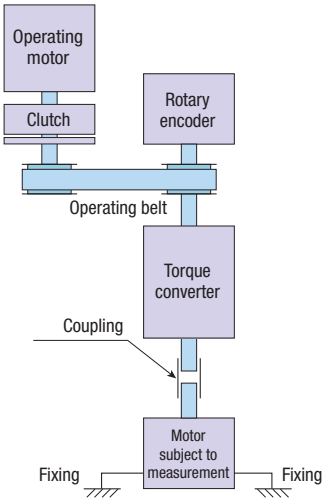


Figure 1: Measurement when the rotating spring constant is high (i.e., when using a hard spring)

Torque characteristics for the measurement target and torque detection spring characteristics intersect at a single point in all zones, allowing stable measurement from valleys to peaks.

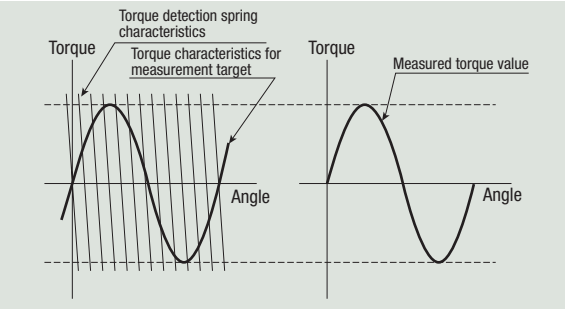
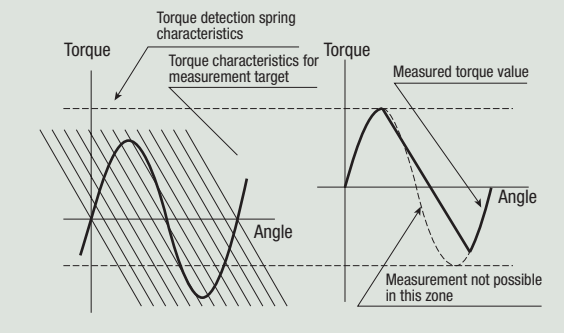


Figure 2: Measurement when the rotating spring constant is low (i.e., when using a loose spring)

In zones in which torque characteristics for the measurement target and torque detection spring characteristics intersect at multiple points, movement points will rise at more stable points (i.e., torque increases at higher angles), preventing measurements in downward zones and amplitude measurements.



Advantages

Achieves high detection sensitivity

Incorporates Sugawara Laboratories' exclusive high-rigidity torque detection component configured in a vertical structure to reduce torque-detector bearing size, enabling detection of low torque levels of 0.01 mN·m or less.

Realizes measurements with low sensitivity to eccentricity

Until now, the eccentricity resulting from coupling with the motor subject to measurement has significantly affected low-torque measurements and impeded high-precision measurement. Employing a vertical structure, ATM cogging torque measurement equipment resolves this problem by using a coupling suspended from the motor subject to measurement, allowing equipment to be fixed in place without rotating the motor's stator. This also significantly reduces the time required to set the motor subject to measurement from that of previous models.

Provides accurate peak-to-peak measurement of cogging torque

The torque detector angle of torsion is very low, enabling accurate peak-to-peak measurement of cogging torque, including even the negative range. (See Figures 1, 2.)

Broad measurement range

The model offers a wide range of five available measurement heads, with torque ratings ranging from 2 mN·m to 50 mN·m, allowing use for high-precision measurements. Note that measurement heads must be exchanged and inspected at the Sugawara Laboratories plant.

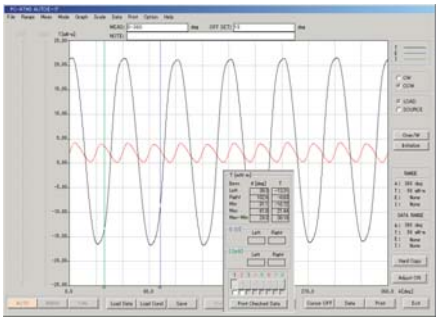
High-visibility measurement data

Motor characteristics are easily ascertained on automatically plotted performance graphs, and measurement data can be overlaid. In addition, the cursor can be used to read accurate values from measurement points. The day displayed on screen can be printed from a personal computer.

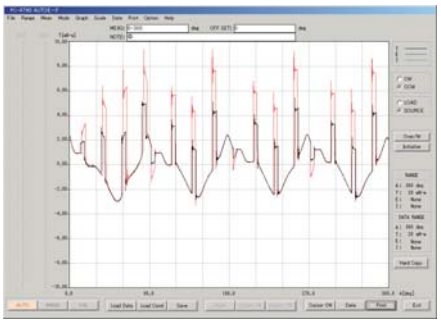
Can be controlled using standard personal computers

Allows control of measurements and display and storage of data with a standard personal computer running Windows®. Data is stored in CSV-format files for compatibility with other software applications.

Measurement of angle-torque characteristics



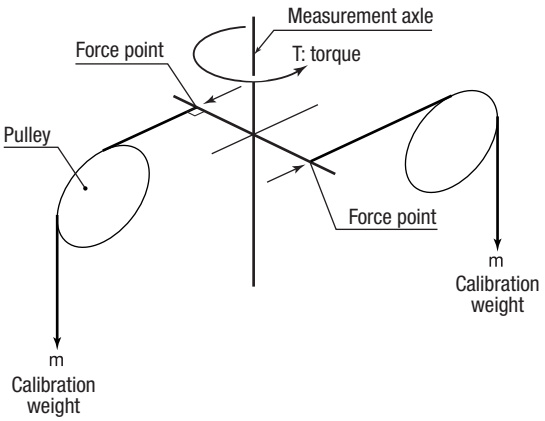
▲ Measurement of stepping motor detent torque and holding torque (overlay display)
X axis: angle 0 - 360°
Y axis: torque -25 - 25 mN·m
Function of cursor: displays peak-to-peak measurement between left and right cursors (including maximum and minimum values between cursors)



▲ Measurement of torque ripple of DC fan motor under restraint
Overlaid display of data with differing applied voltages (6 V/ 12 V)
X axis: angle 0 - 360°
Y axis: torque -10 - 10 mN·m

Calibration equipment

ATC3-* specialized calibration equipment is used to calibrate torque values fir ATM cogging torque measurement devices. The ATM has a vertical measurement axis, necessitating a structure for converting vertical weight force to a horizontal direction. This model uses two conversion structures, with calibration implemented by suspending equivalent weights from each and applying a coupling of forces to the measurement axle using the calibration bar.



Basic configuration

Torque meter:	PC-SAA2
Torque measurement component:	ATM-**MN
Torque calibration tool:	ATC3-**
Personal computer:	Microsoft Windows®2000, XP

Primary specifications

Torque rating:	
ATM-R5MN:	0.5 mN·m
ATM-2MN:	2 mN·m
ATM-5MN:	5 mN·m
ATM-10MN:	10 mN·m
ATM-20MN:	20 mN·m
ATM-50MN:	50 mN·m
Torque detection precision:	within ±1% of full scale
Torque detection component torsion angle:	1.5° or less at torque rating
Angle detection component:	3600 pulse/revolution Using pulse rotary encoder
Angle measurement precision:	±1.5° or less
Operating speed:	approximately 1 r/min
Operating direction:	CW/CCW
Operating modes	
Automatic:	measurement between configured angles performed when the user presses the start key
Manual:	measurement performed from current angle from the point at which the user presses the start key until the user presses the stop key
DC voltage measurement	
Measurement range:	1/2/5/10/20/50/100/200/500 V DC
Measurement precision:	within ±1% of full scale for each range
DC current measurement	
Measurement range:	0.05/0.1/0.2/0.5/1/2/5/10/20 A DC
Measurement precision:	within ±1% of full scale for each range
Attachable work shapes	
External diameter, length including shaft:	ϕ50 or less, 60 mm or less
Accessories included	
Control component:	power cable, connector cable, communication cable, Windows® software
Measurement component:	X-Y-Z stage
Torque calibration equipment (sold separately):	ATC3-R5MN/2MN/5MN/10MN/20MN/50MN
Dimensions, weight	
Control component (W x H x D):	430 x 161 x 400 mm Approximately 10 kg
Measurement component (W x H x D):	330 x 636 x 350 mm Approximately 64 kg
Compatible personal computers:	IBM PC/AT-compatible
Operating systems:	Microsoft Windows®2000, XP
Interface:	at least one RS-232C serial port
Power supply:	single-phase AC 100 V ±10%, 50/60 Hz
Power consumption:	approximately 50 VA

Low torque-speed measurement

Advantages

- **Also measures high-speed motors**

  The model uses an eddy-current brake for stable measurements from 30,000 r/min to the stopped state.

- **High-precision measurements of low torque levels**

  Using elastic-body distortion to detect torque, this model calculates torque from relative RPM between the motor and the magnetic-field generator, thereby minimizing the moment of inertia and enabling high-precision measurements of low torque levels.

- **Precise axle matching**

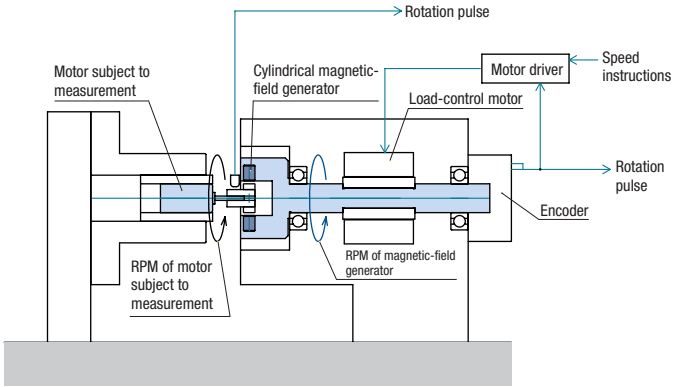
  This model enables precise matching of axles between the motor and the measurement component using embedded X-Y stages and test picking.

- **Fabrication of specialized hardware**

  Specialized motor-measurement hardware (e.g., work holders, coupling) can be fabricated to suit various applications for reliable, high-precision measurements.

- **Also measures voltage and current**

  Adding an EVA-1 voltage/current measurement component allows the model to measure voltage and current and input power and efficiency derivations.



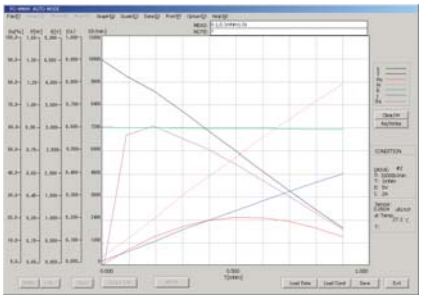
Basic configuration

Torque meter:	PC-MMA1
Torque measurement component:	MMT-1MN
Personal computer:	Microsoft Windows®2000, XP

PC-MMA1 Torque Meter

This model measures speed and torque characteristics and power output up to 30,000 r/min in compact DC motors with startup torques of 1 mN·m or less, uploading these measurements to a personal computer running Windows®. Adding a voltage/current measurement component allows the model to measure voltage and current.

Sample measurement data



◀ Measurement of compact DC brushless motor while controlling RPM (open loop)
X axis: torque
Y axis: RPM, voltage, current, power output, input power, efficiency

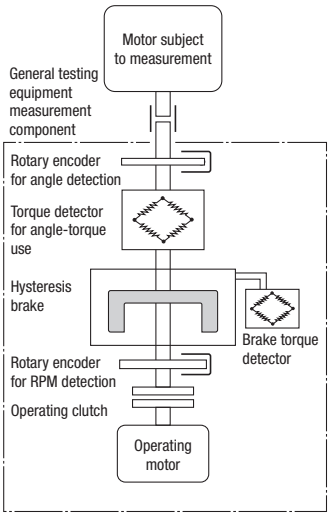
Primary specifications

Braking method:	eddy current braking
Torque measurement:	calculated from relative difference in RPM between motor subject to measurement and braking motor
Torque measurement range:	0.1 mn/m, 1 mN·m, 2 mN·m
RPM measurement:	average over intervals of 128 msec, derived by calculating optoelectric pulse frequency
RPM measurement range:	up to 30,000 r/min
RPM measurement precision:	±0.1% of range (full scale)
Power output measurement:	T [mN·m] x S [r/min] x 0.1047
Voltage/current measurement:	time-series average of 64 data points sampled at 2 msec intervals
Power measurement	
Voltage/current measurement precision:	±0.5% of range (full scale)
Voltage measurement range:	1, 2, 5, 10, 20, 50, 100, 200, 500 V
Current measurement range:	50, 100, 200, 500 mA,1, 2, 5, 10, 20 A
Efficiency measurement η:	ratio of power output to power measurement data calculated by personal computer
Load-control method	
Torque control:	servo control using fixed load torque
Open loop sweep:	RPM of load-control motor controlled
Measurement modes	
Automatic mode:	automatic measurement up to 400 points
Manual mode:	manual measurement in increments of one point
Compatible personal computers:	IBM PC/AT-compatible
Operating systems:	Microsoft Windows®2000, ME, XP
Interface:	at least one RS-232C serial port
Power supply:	single-phase AC 100 V ±10%, 50/60 Hz
Dimensions, weight	
Control component (W x H x D):	430 x 150 x 360 mm Approximately 9 kg
Measurement component (W x H x D):	400 x 260 x 360 mm Approximately 26 kg

Torque ripple measurement, etc.

Advantages

- This model uses a simple structure with brake and various sensors configured on the main shaft for superior adherence at high speeds (up to 20,000 r/min).
- Easily converted to an operating structure for measuring speed and torque characteristics at high speeds and for measuring torque ripple and induced voltage.
- Uses time-tested hysteresis braking for load control and a weight-gauge torque detector designed by Sugawara Laboratories for torque detection.
- Allows easy core matching, with high precision using special motor-fixing hardware.
- Offers superior motor fixing, thermal insulation, and bearing structure for use with environmental testing equipment.



Basic configuration

Torque measurement component:	MTS-2N01
Control component:	PC-MTS-01
Personal computer:	Microsoft Window®2000, XP
Digital power meter:	WT1600 (from Yokogawa Electric Corp.)
Environmental testing equipment:	subject to separate consultation

Primary specifications

Measurement of load torque characteristics

Load torque control range:	0.06 - 2 N·m
Load torque detection precision:	±0.5% of range (full scale)
Allowable RPM:	up to 20,000 r/min
RPM measurement precision:	±0.2% of range (full scale)
Maximum allowable power input:	600 W for five minutes

Torque ripple (restraint)/cogging torque measurement

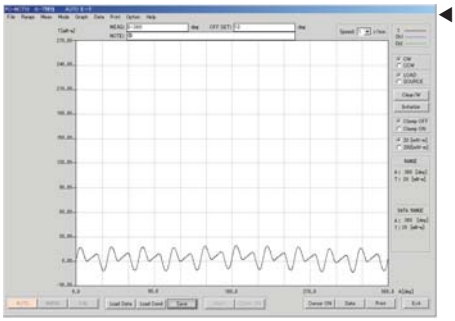
Torque detection range

When measuring torque ripple:	range (full scale) 2 N·m
When measuring cogging torque:	range (full scale) 50 mN·m

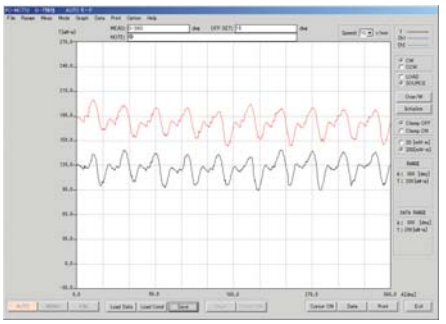
PC-MTS-01 General Motor Testing Equipment

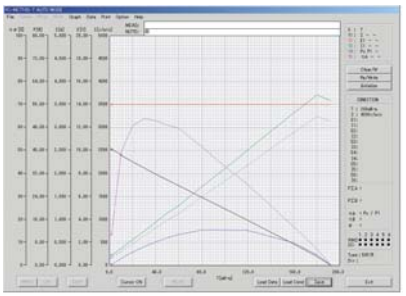
This single system covers all aspects of motor torque measurement, such as speed-torque, cogging torque, and torque ripple. Combined with a power meter, it can be used to measure induced voltage. May be used in combination with environmental testing equipment.

Sample measurement data



◀ Measurement of DC motor cogging torque in angle-torque mode RPM set to 1 r/min, torque range to 20 mN·m
X axis: angle of rotation 0–360°
Y axis: torque -30–270 mN·m





▲ Measurement of torque ripple for the same DC motor in angle-torque mode RPM set to 10 r/min, torque range to 200 mN·m
Data under changes in voltage displayed overlaid
X axis: angle of rotation 0–360°
Y axis: torque -30–270 mN·m

▲ DC motor measured under torque controls in S-T mode
X axis: torque
Y axis: RPM, voltage, current, power, efficiency

Torque detection precision

When measuring torque ripple	±0.5% of range (full scale)
When measuring cogging torque:	±1.5% of range (full scale)
Operating RPM:	1–20 r/min
Operating direction of rotation:	CW/CCW
Operating angular measurement resolution:	approximately 0.088° (2 r/min or less) approximately 0.35° (3 r/min or more)

Induced voltage measurement

Work operating RPM:	500–2,000 r/min
Work torque:	200 mN·m or less
Voltage measurement:	particulars subject to separate consultation

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Products: Stroboscopes, torque dynamometers, bearing inspection systems, etc.

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Danger Damage to or scattering of couplings or other components during measurement may cause injury.
Always use the safety cover.

*Premium data measurement services using Sugawara Laboratories' torque dynamometers are available. Please visit the Sugawara Laboratories website for more information.

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