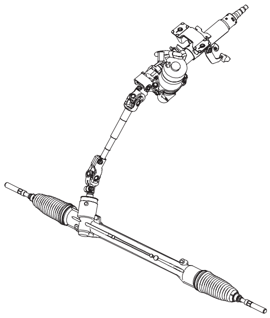
# Column Type Electric Power Steering for TMC Compact Cars



This paper is to introduce a column type electric power steering newly developed for TMC compact cars in response to the needs for improvement of steering feeling and collision safety mechanism.

## Characteristics

1. Column

① Improvement of steering feeling

For easy motion of main shaft, worm shaft is sandwiched between elastic materials which can prevent the main shaft from being normally restricted in motion by motor loss torque. Thus, smooth motion of reducer at the start of steering is realized, resulting in smooth steering feeling.

② Optimum driving posture

Tilt & telescopic functions are added for the first time to TMC's domestic vehicle.

Steering wheel position can be adjusted in both the back-and-forth and up-and-down directions for more suitable driving posture.

③ Improvement of collision safety mechanism

Compared with the preceding generation compact cars ①, collapsible stroke (displacement of steering wheel) is enlarged from 35mm to 70mm in favor of survival space after collision.

④ Applicability in diverse destinations

For North American different in collision safety regulations, the collision safety objective is achieved by adding ripping plates to the same basic structure (only for compact cars ①).

2. Manual Gear

Following modifications are given for improvement of steering feeling.

· Stroke ratio is increased from 40mm/rev to 50mm/rev (by approximately 20%).
· Improved contact ratio
· Reduced friction coefficient on manual gear guide sheet
· Expansion of side clearance on rack-guide and adoption of O–ring

3. ECU

For compact cars ①, STEP1 ECU, that is, improvement of the conventional ECU, is adopted.
For compact cars ②, STEP2 ECU, that is, further improvement of STEP1, is applied.

STEP1 ECU
· V/A design incorporated in conventional ECU
· Adoption of CAN (Controller Area Network) communication for interface with vehicle
· Adoption of vehicle speed-sensitive phase compensation as a new logic in order to improve the steering responsiveness at driving.

STEP2 ECU
· Further V/A design incorporated in STEP1 ECU
· Microcomputor and custom IC are refined in order to improve the steering feeling around the on-center position of steering (low electric current zone).
· Control monitoring logic is reviewed and microcomputer self monitoring function is enhanced in order to improve the safety.

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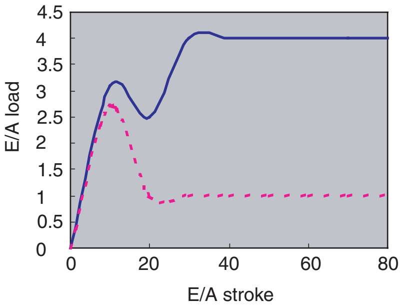
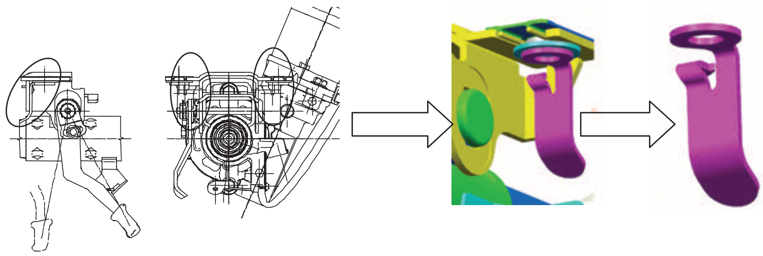
## Structures

<Column>

<Ripping plate (Added only for North America) > (Characteristics 1–④)

It is fixed on column mounting brackets (at 2 places on the right and left sides). Whereas the basic structure of column is unchanged, addition of the ripping plate can provide different E/A characteristics to the column to meet the regulations for the North America.



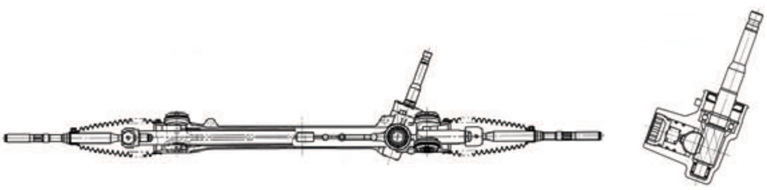



<MS Gear> (Characteristics 2)

R&P gear basic specification is changed (Precise displacement transmission and response improvement).

Cost reduction through productivity improvement. Better steering feeling by improving contact ratio.

- Stroke raito increased (20%), EPS 40.0mm/rev → 49.93mm/rev (Restriction of vehicle yaw and nonlinearity)
- Gear specification improvement, transversal contact ratio 1.0
- Pinion support mechanism changed (Double row angular contact ball bearing → Deep groove ball bearing + Needle roller bearing)
- Expansion of side clearance on rack guide with O–ring (Improvement of steering feeling, noise reduction)
- Adoption of low friction coefficient material for guide sheet (Precise displacement transmission, Reduction of friction)



## Main Specification

| <Column> | Compact cars ① | Compact cars ② |
|---|---|---|
| Theoretical output (Input torque 5.1 N·m) | 48.8 N·m | 56.9 N·m |
| Motor rated torque | 3.2 N·m | 3.45 N·m |
| Reduction gear ratio | 13.67 : 1 | 15 : 1 |
| Torque sensor | Non-contact variable inductance method | |
| Specification | For RHD and LHD respectively, available with tilt type or tilt & telescopic type<br>Steering lock systems are applicable to the latest steering lock-free systems | |

<MS gear>

| | | |
|---|---|---|
| Stroke ratio | 49.93mm/rev | |
| Rack stroke | ±80.5, ±75.5, ±63.9 (3 types) | ±74.5, ±75.5 (2 types) |
| Lock to lock | 3.22, 3.02, 2.56 (3 types ) | |
| Gear module | 1.95 | |
| Rack diameter | $\phi$24 (FF), $\phi$26 (4WD) | $\phi$26 only |

(System Engineering Dept. 1, Steering System Operations Headquarters)

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