

THE APPLICATION
OF TECHNOLOGY



**SWITCHED
RELUCTANCE
MOTORS
FOR LOOMS**

Kehui International



Kehui International,
Hertford, UK

The word Kehui, literally means the Application of Technology in the Chinese language. This phrase perfectly defines the company's commitment to technological innovation, which it achieves whilst striving for the highest levels of quality.

The company was founded in 1991, utilising the best of Asian and European expertise to develop its range of cable and transmission line fault locators, as well as equipment for the automation of electrical distribution systems and its range of switched reluctance motors.



Kehui factory,
Zibo, China

Market Overview

Increases costs are affecting profit margins in the increasingly competitive textile market, such that the price of energy and other costs associated with the loom are becoming very significant. To address this, Kehui has developed high speed, direct drive machines, providing high efficiency and energy saving with intelligent control.

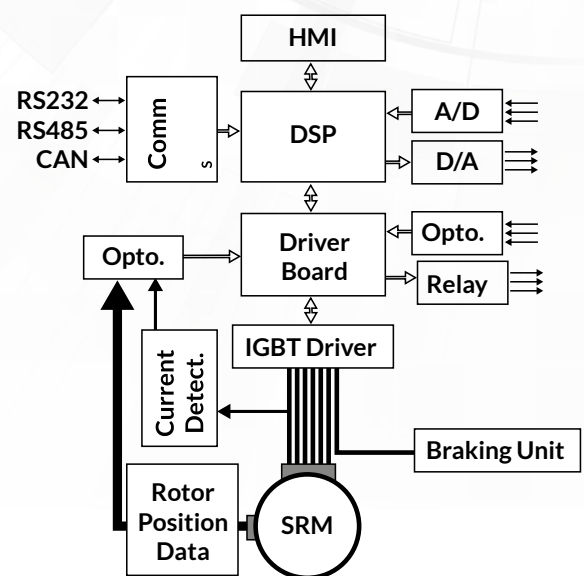
High-end rapier looms are adopting direct drive structures, eliminating the clutch and belt drive and improving the efficiency of the system, while allowing the loom to run at higher speeds. Efficiency also requires the maximum yield from the material produced and so it is important to eliminate driving marks which may appear in the cloth when the loom starts. To do this, the starting torque of the drive motor should be more than five-times the loom's rated torque. Due to their low torque and high current on starting, ordinary three-phase asynchronous induction motors are not ideal as permanent magnet motors rely on embedded permanent magnet material, which may demagnetise under high temperature and vibration. As a result, switched reluctance motors are increasingly recognised as the best choice for powering looms with tests showing efficiency savings of more than 30% compared to conventional asynchronous drives.

Switched Reluctance Motors (SRM)

Switched reluctance motors have a small starting current, a large starting torque (which can reach more than five times the rated torque), a very fast dynamic response and they can withstand large overloads. This makes them ideal for the direct drive of looms and enables their use with various enhanced weaving processes, such as variable speed weaving.

Under load, the time to accelerate from standstill to the rated speed is less than 200ms. For a direct drive spindle motor, the set speed is usually reached within one turn of the shaft; as a result, the marks caused by the starting and stopping of the loom are eliminated.

Cooling of the switched reluctance motor is achieved using an external radiator, which makes fan-cooling unnecessary and eliminating the problem of air ducts becoming blocked due to textile fluff entering the fan.



Switched reluctance motor block diagram

Advantages of SRM drives in textile machinery:

■ Simple motor structure

- Resistance to impact damage
- Elimination of the traditional clutch transmission
- Reduced requirement for system maintenance

■ Application advantages

- Connection with the loom control system is simpler, and automatic control is simplified
- Speed regulation facilitates the adoption of speed weaving functionality
- One spindle motor provides both fast driving and slow weft searching, removing the need for an additional motor

■ Performance advantages

- The transmission chain is shortened, improving system efficiency and saving energy
- During warp or weft breaks, the main motor can be easily stopped avoiding energy wastage
- Digital adjustment of the braking angle facilitates quick stopping
- The motor can achieve five-times overload allowing quick starts
- It reaches the set speed within one revolution of the loom spindle

■ Work advantages

- System safety is enhanced through the motor's electromagnetic brake and, where included, the optional mechanical brake
- Monitoring of internal winding temperature of the motor in real time and protection against high temperatures, enhances reliability

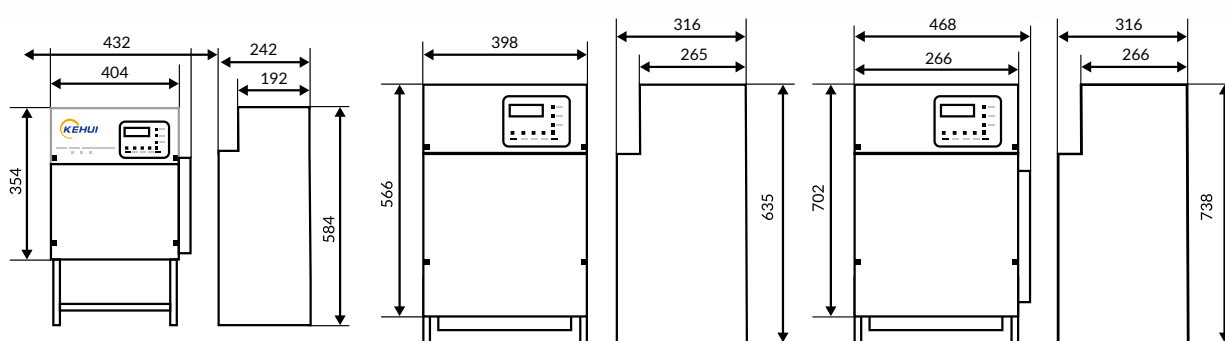


RL series for textile machinery

Motor controller

	Function	Parameter
Input	Voltage	AC380V±15% or 415V ±15% (Alternatives can be considered if required)
	Frequency	50Hz or 60Hz
Operational parameters	Rated Power	5 – 45kW
	Rotation Speed Range	0 – 2400rpm
	Speed setting	Operation panel, via communication
	Start-Stop Control	Operation panel, local switch, via communication
	Speed accuracy	≤0.1%
	Speed Change Rate	≤1%
	Communication Port	RS232, RS485, CAN
	PID	Built-in, settable speed and feedback PID control
	Input/Output Interface	5-way digital input, 1-way digital output, 2-way analog input, expandable
	Protection	Short circuit, overcurrent, overload, locked rotor, overheating, overvoltage, undervoltage and overspeed
	Display Panel Indications	Speed, parameters, fault code, running data etc.
Operating Environment	Elevation	Above 1000m, the machine must be derated
	Environmental Temperature	-5°C to +40°C
	Environment Humidity	At 40°C, the relative humidity cannot exceed 50%. At lower temperature (20°C), the maximum relative humidity cannot exceed 90%. The change in relative humidity should not exceed 5% with no condensation
	Others	No violent vibration sources
Structure	Ingress protection	IP50
	Cooling method	Natural cooling

Standard Controller Dimensions



7.5kW Textile Controller

11kW Textile Controller

18.5kW Textile Controller

Note: All dimensions in mm. Customised versions can be made for specific application requirements

Controller model name

KSC 20 - ** - *** - ** - **** * ** **

User identification code: On customised controllers these define the version. These two digits are omitted on standard units.

The configuration number of the controller attachment:

00: No the switching capacity expansion board. No RS232 to RS485 module. Can be omitted.

01: With the switching capacity expansion board

02: With the analogue expansion board

03: With the switching capacity expansion board and the analogue expansion board

10: With the RS232 to RS485 module

11: With the switching capacity expansion board and the RS232 to RS485 module

12: With the analogue expansion board, the analog expansion board and the RS232 to RS485 module

** : Defined according to user requirements

Whether the controller has a brake function:

N: Without braking function

B: With dynamic braking function

D: With DC bus brake function

G: With Grid regenerative braking function

The internal test code

The number of phases and the voltage level of the input voltage of the controllers:

Number of phases: A: Single-phase AC; D: DC; T: Three-phase AC; Voltage: 1: 24-144V; 2: 220V; 3: 380-415V; 4: 440-500V; 5: 500-575V; 6: 575-690V; 7: 1000-1140V

The rated capacity of the controller, Unit: kVA

The applications type code of the controller

Black: Universal Controller, can be omitted

RL: The controller to the Rapier Loom

EL: The controller to the Elevator

EB: The controller to the Electric Bus

EV: The controller to the Electric cars

** : According to the application defined

Controller design No.

Product Name Code:

KSC represents the Switched reluctance motor controller of Kehui



Switched Reluctance Motor for Spindle Drive of High-Speed Rapier Loom



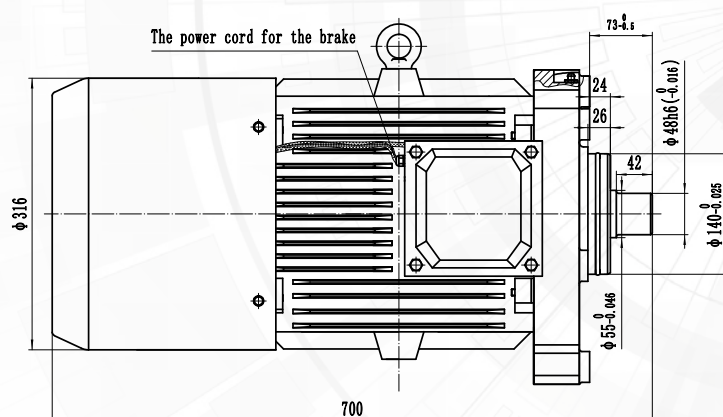
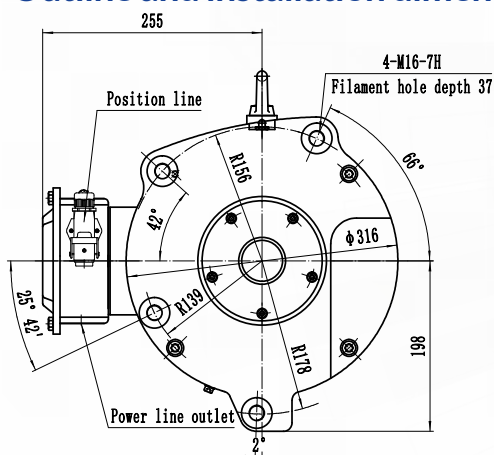
Characteristics

- The starting torque can reach more than 5 times the rated torque
- Equipped with power-on or power-off brake
- Shaft extension end is equipped with skeleton oil seal
- Both front and rear bearings have oil injection holes
- There are hexagon socket turning holes on the non-shaft extension end of the motor
- The temperature sensor Pt100 is embedded in the motor winding

Motor technical data

Parameter	Data	Parameter	Data
Motor model	KSM-RL1-160L-20	Brake	Optional power-on or power-off brake
Rated power	18.5kW	Torque characteristics	Constant torque characteristic below rated speed Constant power characteristic above rated speed
Rated speed	2000 r/min	Stall torque	Greater than or equal to 5 times rated torque
Frame and end cover material	Grey cast iron HT200	Shaft end seal	Frame oil seal
Rated voltage	DC 514V	Bearing lubrication	Front and rear bearings
Insulation class	180 (H)	Cooling method	Self- cooling
Working system	S1: continuous working system	Overload capacity	5 times rated torque, duration less than 2s. The average torque within 30s shall not exceed the rating.
Protection class	IP 54: dustproof, splash-proof	Temperature detection	Motor winding embedded temperature sensor
Matching controller model	KSC20-RL-011-T3-0300B20		

Outline and installation dimensions of the motor



GA731 SRM for Spindle Drive of Rapier Loom

Characteristics

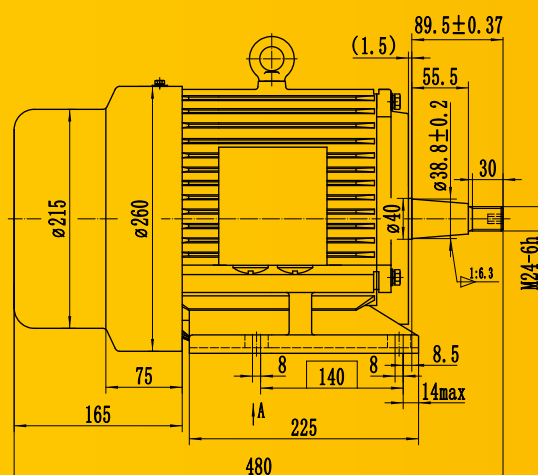
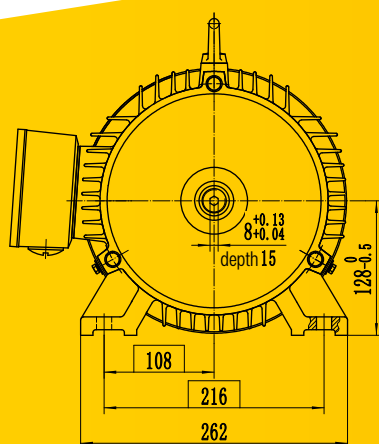
- Motor matching or modification for GA731 rapier loom
- Direct drive removes the need for a clutch and gearbox on the loom leading to much increased efficiency
- The starting torque can reach more than 3 times the rated torque
- Equipped with power-on or power-off brake
- There are hexagon socket turning holes on the non-shaft extension end of the motor
- Temperature relays are embedded in the motor windings



Motor technical data

Parameter	Data	Parameter	Data
Motor model	KSM-MB1-132M2-10	Motor model	S1: Continuous duty
Rated power	5.5kW	Torque characteristics	Constant torque characteristic below rated speed Constant power characteristic above rated speed
Rated speed	1000 r/min	Stall torque	Greater than or equal to 3 times rated torque
Frame and end cover material	Grey cast iron HT150	Cooling method	Self-cooling
Rated voltage	DC 514V	Overload capacity	3 times rated torque, duration less than 3s. The average torque within 30s shall not exceed the rating.
Insulation class	180 (H)	Bearing lubrication	Front and rear bearings
Rated voltage	DC 514V	Brake	Optional power-on or power-off brake
Protection class	IP 54: dustproof, splash-proof	Temperature detection	Motor winding embedded temperature sensor
Matching controller model	KSC20-RL-7.5-T3-0100B20		

Outline and installation dimensions of the motor



SW1 series general-purpose textile SRM

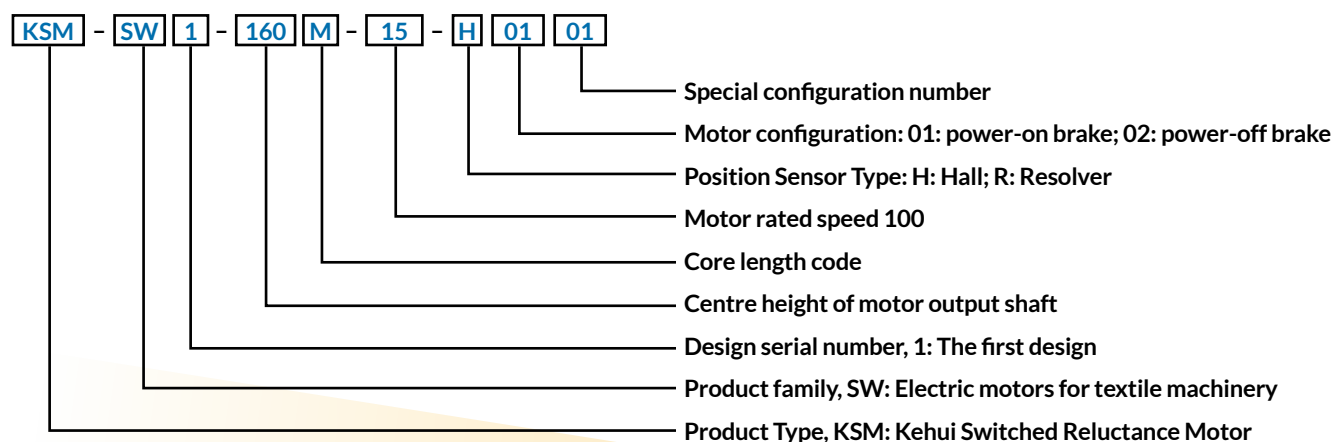
(Frame size 90~225)



Characteristics

- The starting torque can reach more than 5 times the rated torque
- Equipped with power-on or power-off brake
- There are hexagon socket turning holes on the non-shaft extension end of the motor
- Temperature sensors are embedded in the motor windings

Motor model name



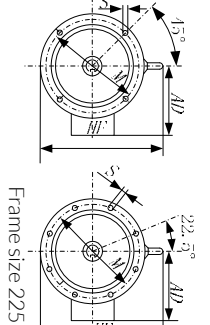
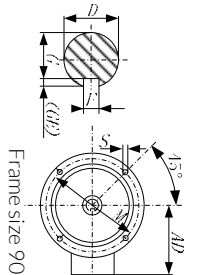
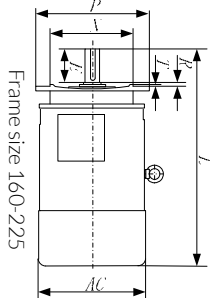
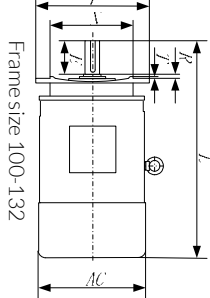
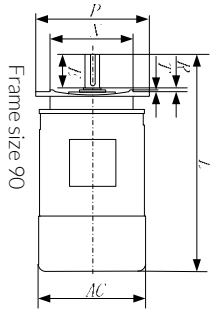
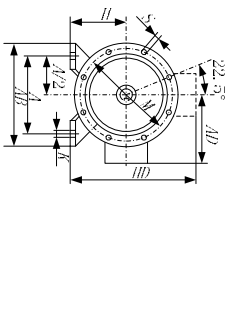
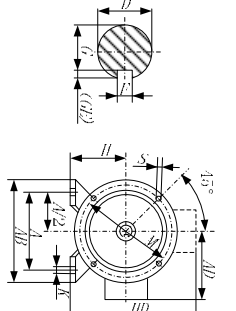
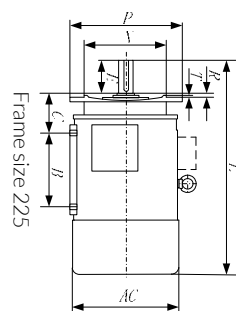
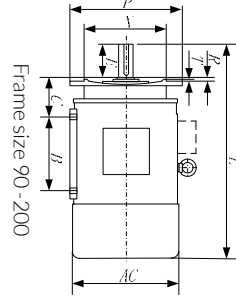
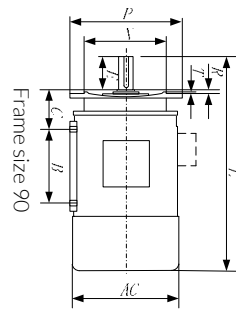
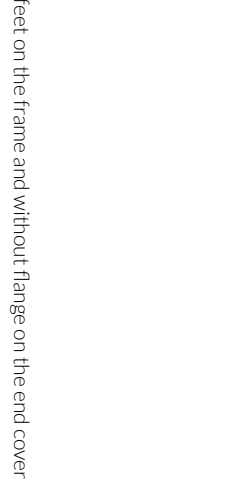
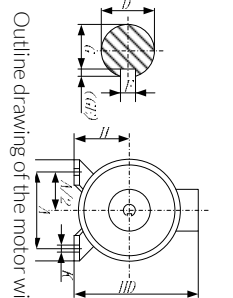
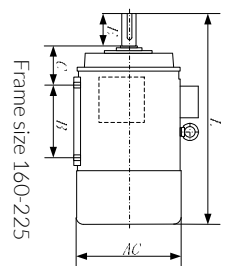
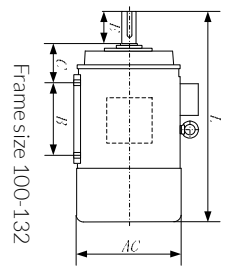
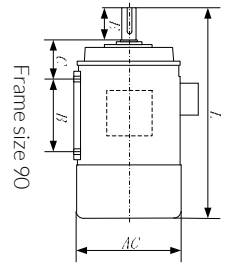
Function	Data
Frame size	90 to 225
Power	0.75 kW - 45 kW
Speed	3000 rpm, 1500 rpm, 1000 rpm
Frame and cover material	Grey cast iron HT200
Rated voltage	DC 514V which is the DC voltage of the three-phase AC 380V voltage after full-wave rectification and filtering
Insulation class	180 (H), using 200-level corona-resistant enamelled wire and solvent-free impregnating varnish, vacuum pressure impregnation (VPI)
Working system	S1: Continuous working system
Ingress protection	IP 54: dust and splash water
Cooling method	Self-cooling
Overload capacity	At 3 times rated torque, duration < 5s; at 4 times rated torque, duration < 3s; at 5 times rated torque, duration < less than 2s. The average torque within 30s must not exceed the rated torque
Temperature detection	The temperature relay and temperature sensor are embedded in the motor winding, which can be connected to the controller for thermal monitoring.
Brake	Optional power-on or power-off brake
Barring hole	There is an inner hexagonal barring hole on the non-shaft extension end
Torque characteristics	Constant torque characteristic below rated speed Constant power characteristic above rated speed
Stall torque	Greater than or equal to 5 times rated torque

Motor model selection table

Motor model	Rated power (kW)	Rated torque (Nm)	Rated torque (Nm)	Rated efficiency (%)	Speed regulation scope (r/min)	Speed regulation scope (r/min)	Quality (kg)	Matched controller output current (A)		
								Starting torque as a multiple of rated torque		
								3 times	4 times	5 times
Rated Speed 2000 rpm										
KSM-SW1-90S-15	1.1	7.00	2.52	81.4	50~3000	0.0014	25	10	10	15
KSM-SW1-90L-15	1.5	9.55	3.49	82.8	50~3000	0.0019	30	10	15	25
KSM-SW1-100L1-15	2.2	14.0	4.82	84.3	50~3000	0.0038	38	15	25	35
KSM-SW1-100L2-15	3	19.1	6.42	85.5	50~3000	0.0047	42.25	25	35	35
KSM-SW1-112M-15	4	25.5	8.27	86.6	50~3000	0.0066	52	35	35	50
KSM-SW1-132S-15	5.5	35.0	11.0	87.7	50~2500	0.013	70	35	50	75
KSM-SW1-132M-15	7.5	47.7	14.9	88.7	50~2500	0.0017	84	50	75	100
KSM-SW1-160M-15	11	70.0	22.3	89.8	50~2500	0.044	129	75	100	150
KSM-SW1-160L-15	15	95.5	30.3	90.6	50~2500	0.054	152	100	150	200
KSM-SW1-180W-15	18.5	118	40.9	91.2	50~2500	0.076	193	150	200	300
KSM-SW1-180L-15	22	140	48.7	91.6	50~2000	0.087	210	150	200	300
KSM-SW1-200L-15	30	191	69.5	92.3	50~2000	0.14	282	200	300	400
KSM-SW1-225S-15	37	236	91.3	92.7	50~2000	0.27	342	300	400	450
KSM-SW1-225M-15	45	286	107	93.1	50~2000	0.32	370	300	450	600
Rated Speed 1000 rpm										
KSM-SW1-90S-10	0.75	7.16	1.94	75.9	50~2000	0.0015	27	10	10	10
KSM-SW1-90L-10	1.1	10.5	2.77	78/1	50~2000	0.0019	31	10	10	15
KSM-SW1-100L-10	1.5	14.3	3.80	79.8	50~2000	0.0055	38	10	15	25
KSM-SW1-112M-10	2.2	21.0	5.44	81.8	50~2000	0.0092	47	15	25	35
KSM-SW1-132S-10	3	28.6	7.43	83.3	50~2000	0.0173	65	25	35	35
KSM-SW1-132M1-10	4	38.2	9.66	84.6	50~2000	0.0222	75	35	35	50
KSM-SW1-132M2-10	5.5	52.5	12.2	86.0	50~2000	0.027	86	35	50	75
KSM-SW1-160M-10	7.5	71.6	15.3	87.2	50~2000	0.041	133	50	75	100
KSM-SW1-160L-10	11	105	21.9	88.7	50~2000	0.054	155	75	100	150
KSM-SW1-180L-10	15	143	32.2	89.7	50~2000	0.082	204	100	150	200
KSM-SW1-200L1-10	18.5	177	40.2	90.4	50~1500	0.133	259	150	200	300
KSM-SW1-200L2-10	22	210	47.6	90.9	50~1500	0.14	284	150	200	300
KSM-SW1-225M-10	30	286	66.0	91.7	50~1500	0.34	342	200	300	400



SW1 Series Switched Reluctance Motor Appearance, Installation



Outline drawing of the motor with no feet on the base and flanges (with through holes) on the end caps

Frame Size	Rated speed (x100)	A	AB	AC	AD	B	C	D	DB	E	EG	F	G	GD	H	HD	HF	K	L	M	N	P	R	S	T	Z
90S	30,15,10	140	180	195	155	100	56	24	M8	50	19	8	20	7	90	250	195	10	400	165	130	200	0	12	3.5	4
90L	30,15,10	140	180	195	155	125	56	24	M8	50	19	8	20	7	90	250	195	10	425	165	120	200	0	12	3.5	4
100L	30,15,10	160	205	215	180	140	70	28	M10	60	22	8	24	7	100	270	245	12	475	215	180	250	0	14.5	4	4
112M	30,15,10	190	230	240	190	140	70	28	M10	60	22	8	24	7	112	300	265	12	485	215	180	250	0	14.5	4	4
132S	30,15,10	216	270	275	210	140	89	38	M12	80	28	10	33	8	132	345	315	12	540	265	230	300	0	14.5	4	4
132M	15,10	216	270	275	210	140	89	38	M12	80	28	10	33	8	132	345	315	12	540	265	230	300	0	14.5	4	4
160M	30,15,10	254	320	330	255	210	108	42	M16	110	36	12	37	8	160	420	385	14.5	720	300	250	350	0	18.5	5	4
160L	30,15,10	254	320	330	255	254	108	42	M16	110	36	12	37	8	160	420	385	14.5	765	300	250	350	0	18.5	5	4
180M	30,15,10	279	355	380	280	241	121	48	M16	110	36	14	42.5	9	180	455	430	14.5	780	300	250	350	0	18.5	5	4
180L	15,10	279	355	380	280	279	121	48	M16	110	36	14	42.5	9	180	455	430	14.5	820	300	250	350	0	18.5	5	4
200L	30,15,10	318	395	420	305	305	133	55	M20	110	42	16	49	10	200	505	480	18.5	860	350	300	400	0	18.5	5	4
225S	15	356	435	470	335	286	149	60	M20	140	42	18	53	11	225	560	535	18.5	915	400	350	450	0	18.5	5	8
225M	30	356	435	470	335	311	149	55	M20	110	42	16	49	10	225	560	535	18.5	945	400	350	450	0	18.5	5	8
225M	15,10	356	435	470	335	311	149	60	M20	140	42	18	53	11	225	560	535	18.5	945	400	350	450	0	18.5	5	8



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