MPTA C6m 2009

Frequently asked Questions on Metric Bore's and Keyways in Couplings

MPTA Primer

New Address Effective October 2011 – 5672 Strand Ct., Suite 2, Naples, FL 34110

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Abstract

This primer is intended for individuals who need additional information on the fundamentals of the metric bore and keyway system. It presents answers to common questions related to a coupling's bore and keyway.

Foreword

This Foreword is provided for informational purposes only and is not to be construed to be part of any technical specification.

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1. Are there any standards for Metric bores and / or keyways?

There many standards that cover the topics of metric bore tolerances, fits and keyway sizes. The following is listing of those standards:

Standard	Description
BS4235 P	Woodruff keys and keyways – same as ISO 391
BS46P1	Specifications, Keys and Keyways – obsolete
CSAB232	Keys and Key seats
DIN 6885 P1	Drive type fastening with out taper action; parallel
DIN 7172	ISO 286 addendum sizes 500mm – 3150mm
DIN 7154-P1	ISO - fits for hole basis system tolerances
DIN 7154-P2	ISO - fits for hole basis system tolerances
DIN 7157	Recommended selection of fits
IP-27	Specifications for Drives Using Curivilinear Toothed Synchronous belts
ISO286-1	ISO system of limits and fits – bases for tolerances deviations and fits
ISO286-2	ISO system of limits and fits
ISO391	Woodruff keys and keyways
ISO773	Rectangular or square parallel keys and their corresponding keyways
ISO775	Cylindrical and 1/10 commercial shaft ends
ISO1829	Selection of tolerances zones for general purposes
ISO2491	Thin parallel keys and their corresponding keyway
JIS1301	Sunk keys and their corresponding keyways
NA0139	Key and key slog dimensions (AIA / NAS)
AGMA 9112	Bores and Keyways for Flexible Coupling

2. Why are there so many metric standards compared with the Inch System?

To understand why there are so many metric bore and key standards, you need to first understand the basis on which each system is built. The metric bore and key standards are hole based systems and, the inch bore and key standards are shaft based systems. In a shaft based system, the shaft and key are considered the fixed members of the system. The hub bore and key tolerances are adjusted to create the proper fit with the shaft. The metric bore and key system is a hole based system. In a hole based system, the constant is the hub bore. The shaft size and tolerance are adjusted to create the proper fit between the two components.

Since most inch shaft tolerancing is controlled by NEMA and/or AGMA, (both standards agree up to 6.00" in dia.) the shaft sizes are known and controlled. Appropriate fits can be established for each shaft size and published in a standard. The standard is primarily used in United States or equipment produced in the United States that is exported around the world.

The same cannot be said about metric bores and keyways which are hole based system. For many years, there were no hard and fast universal standards for the size and tolerance of bores. Each manufacturer could choose what ever bore size and tolerance they wished. At that time in history, manufactures of equipment mainly sold their product in their own country or neighboring countries exclusively. None seamed to care what the rest of the world was doing. With so many manufacturers and countries producing equipment, different tolerance classes became popular in different regions of the world. Eventually international standards were written to quantify standard manufacturing tolerances and their relative position from the nominal values. ISO 286 is a good example. However, there are hundreds of tolerance classes in such a standard. The shear number of combinations to make clearance, transition and interference fits are staggering. As with most things, eventually economics and globalization took over, and manufacturers began to write standards that kept the 280+ tolerance grades but, subdivided the total into a list of preferred sizes. The preferred sizes were the most widely used sizes on a global basis.

For couplings, the list was further reduced by the fact that is much harder to constantly change motor, pump, gearbox and other equipment shafting than to change the coupling hub. Each equipment manufacture settled on one or two different shaft tolerances popular in their region of the world. There are about 15 different popular shaft tolerance classes used on a regular basis in the world. Considering each requires one class of hub to achieve an interference fit and another to achieve a clearance fit, it is very difficult to write one universal bore and keyway standard to address the many combinations.

3. Where can I obtain a copy of the metric standards?

Standards can be obtained directly from the governing bodies or thru standard clearing houses. Web sites for several popular standard organizations are listed below.

MPTA 6724 Lone Oak Blvd Naples, Florida 34109 Ph: (239) 514-3441 Fax: (239) 514-3470 **http://www.mpta.org**	**American Gear Manufacturers Association** 1500 King Street, Suite 201 Alexandria, VA 22314-2730 Phone: (703) 684-0211 Fax: (703) 684-0242 **http://www.agma.org**
ISO 1, rue de Varembé, CH-1211 Geneva 20, Switzerland Phone +41 22 749 01 11 Fax +41 22 749 09 47 E-mail: **http://www.iso.org**	**American National Standards Institute** 25 West 43rd Street New York NY 10036 USA Telephone:+ 1 212 642 4900 E-mail:storemanager@ansi.org Telefax:+ 1 212 398 0023 E-mail:storemanager@ansi.org
JIS **http://www.jsa.or.jp**	**Din** Burggrafenstr. 6, 10787 Berlin, Germany **http://www.din.de**

4. I tried to locate some of the metric bore and key standards listed in the engineering section of a manufacturers catalog but, found that some of the standards listed were obsolete or canceled.

It is true. Some of the most popular standards still used by manufacturers today have been allowed to expire or have been canceled. Standards organizations require that standards be reaffirmed on a regular basis. If a standards sub committee; was not convened, did not resubmit on time or, could not come to agreement with its members, the standard lapses. Normally standards have to be reaffirmed every 5 years.

5. Most metric drawings list the bore and keyway as a nominal dimension followed by a letter and number code. Eg 140 H7. What is the H7 portion and what does it tell me about the size of the feature?

The H7 code refers to a specific tolerance class listed in ISO 286-2 (ISO system of limits and fits – basis for tolerances deviations and fits). ISO 286 establishes common manufacturing tolerance classes. The letter designation in the code H7 establishes how far away the maximum shaft or minimum bore tolerance is from the nominal dimension. Each class lists tolerances for shaft and bore sizes ranging from 0 to 500 mm.

In ISO 286, upper case letters signify bores or female type components, and lower case letters signify shafts or male type components. The number designation is an indication of the width of the tolerance band. In general, the larger the number associated with the tolerance band, the greater the width of the tolerance band. Codes with the same number designations have approximately the same tolerance width for a given nominal value.

6. How do you find a tolerance class in ISO 286-1 or -2

Say you were looking for 100mm H7.

To obtain the tolerance values for any specific size, locate the Tolerance Class in ISO 286-1. Be sure you are looking at the correct chart by matching the case of the tolerance class letter (in this case, capital H). The nominal dimensional values are listed on the left hand side of each chart. Locate 100mm and move horizontally across the chart until you intersect the appropriate tolerance width class. In this case Class 7. Record the es and ei values listed in the chart. (The es and ei are the tolerance values that should be applied to the nominal dimension. However, es and ei are listed in micrometer. To convert to millimeters, divide each number by 1000) Note: Sometimes the es or ei values will be the same for the entire tolerance class range. The ei for all of the H's is the same and is only listed once at the end of the H tolerance chart. See Appendix 1 for example of ISO 287-2

Example:
For a 100mm H7 ei = 0 and es = +35. Therefore, the actual tolerance is 100mm –0mm / +.035mm or 100.00/100.035 mm.

7. With so many choices in ISO 286, what sizes are appropriate to use with couplings?

ISO286 does provide a multitude of tolerance classes. There are approximately 113 shaft tolerance grades and 106 bore tolerance grades listed. However this is one of the hardest questions to answer. Most of the metric standards written today try to limit this vast number down into a set of preferred sizes. Of those preferred sizes, here are some of the ones most commonly used on equipment shafts, keyways and coupling bores. This is not a complete list, but it is a list of sizes coupling manufacturers normally use or see.

Keyways - Js9 and P9
Shafts – k6, j6, h6, m6, s6, g6, n6 and p6
Bores – H7, H8, F7, P7, T7, R7, N7, M7

Table 1: Tolerance Zones for Internal Dimensions
First choice tolerance zones shaded (per Ansi B4.2 preferred)
Second choice tolerance zones framed (per iso 1829 selected)
Third choice tolerance zones open

							H1		JS1												
							H2		JS2												
							H3		JS3												
							H4		JS4												
						G5	H5		JS5	K5	M5	N5	P5	R5	S5	T5	U5	V5	X5	Y5	Z5
					F6	G6	H6	J6	JS6	K6	M6	N6	P6	R6	S6	T6	U6	V6	X6	Y6	Z6
			D7	E7	F7	**G7**	**H7**	J7	JS7	**K7**	M7	**N7**	**P7**	R7	**S7**	T7	**U7**	V7	X7	Y7	Z7
		C8	D8	E8	**F8**	G8	**H8**	J8	JS8	K8	M8	N8	P8	R8	S8	T8	U8	V8	X8	Y8	Z8
A9	B9	C9	**D9**	E9	F9	G9	**H9**		JS9	K9	M9	N9	P9	R9	S9	T9	U9	V9	X9	Y9	Z9
A10	B10	C10	D10	E10	F10	G10	H10		JS10	K10	M10	N10	P10	R10	S10	T10	U10	V10	X10	Y10	Z10
A11	B11	**C11**	D11	E11	F11		**H11**		JS11												
A12	B12	C12	D12	E12			H12		JS12												
A13	B13	C13					H13		JS13												
A14	B14						H14		JS14												
							H15		JS15												
							H16		JS16												

Table 2: Tolerance Zones for External Dimensions
First choice tolerance zones shaded (per Ansi B4.2 preferred)
Second choice tolerance zones framed (per iso 1829 selected)
Third choice tolerance zones open

							h1		js1												
							h2		js2												
							h3		js3												
						g4	h4		js4	k4	m4	n4	p4	r4	s4	t4	u4	v4	x4	y4	z4
					f5	g5	h5	j5	js5	k5	m5	n5	p5	r5	s5	t5	u5	v5	x5	y5	z5
				e6	f6	**g6**	**h6**	j6	js6	**k6**	m6	**n6**	**p6**	r6	**s6**	t6	**u6**	v6	x6	y6	Z6
			d7	e7	**f7**	g7	**h7**	j7	js7	k7	m7	n7	p7	r7	s7	t7	u7	v7	x7	y7	Z7
		c8	d8	e8	f8	g8	h8		js8	k8	m8	n8	p8	r8	s8	t8	u8	v8	x8	y8	Z8
a9	B9	c9	**d9**	e9	f9	g9	**h9**		js9	k9	m9	n9	p9	r9	s9	t9	u9	v9	x9	y9	Z9
a10	b10	c10	d10	e10	f10		h10		js10												
a11	b11	**c11**	d11	e11			**h11**		js11												
a12	b12	c12	d12				h12		js12												
a13	b13	c13					h13		js13												
a14	b14						h14		js14												
							h15		js15												
							h16		js16												

Although the metric system was designed as a hole based system, the reality for couplings is that it works more like a shaft based system. When designers are developing new systems, usually main equipment such as motors, gear boxes and pumps are selected first. Couplings, are normally the last items selected and therefore need to accommodate whatever shaft size is on the equipment. Besides, couplings are much easier to modify and stock.

The AGMA recently surveyed many motor, gearbox and pump manufacturers from around the world and found the most popular shafting on that type of equipment was k6, m6 and j6. The most popular bore tolerances that correspond to those shafts are H7 and P7.

The actual selection depends on whether you want a clearance fit, interference fit or a transition fit between the mating components.

8. When do you need a clearance fit, interference fit or a transition fit?

The selection of a clearance or interference fit is influenced by several factors which include; ease of assembly, system sensitivity to unbalance, available equipment and the forces generated by the operation of the coupling and equipment. ie gear forces, magnetic forces and deformation forces.

Clearance fits seem to be the most ideal fit because of ease of assembly and disassembly. Hubs easily slide onto the shaft and are secured with the tightening of the setscrews. However, during normal operation, every coupling exerts a force component that tries to push the two coupling hubs apart or towards on another. The push off force can be generated by the interaction of gear teeth mesh in gear couplings, deformation of the elastomers in elastomeric couplings, or bending of the disc pack elements in disc couplings. Clearance fits work well as long as the setscrew can generate enough friction force to overcome the forces generated by the coupling and/or applied load put on the coupling by the equipment. Typically elastomeric coupling forces do not over power the setscrew holding power in smaller size shaft ranges. As a general rule of thumb, set screws can be used on shaft sizes smaller that 100mm or 4” in diameter. That is not so say that you cannot go over that value. Some of the larger elastomeric couplings are suited to have setscrews up to 153 mm or 6”. Above 153mm, an interference should be used whenever possible.

Clearance fits may not be suited for systems that are very sensitive to coupling unbalance forces. As the setscrew on a clearance fit hub is tightened, the hub is pushed to one side until all of the clearance between the hub and shaft is taken up. The center of mass for the hub no longer lines up with the center of rotation. The shift in mass sets up an unbalance or vibration condition that is related to the square of the speed of the coupling. The higher the speed of the shaft, the higher the unbalance forces become. Therefore for very sensitive systems or couplings operating at high speed, it is not recommended to have a clearance fit.

Interference fit are not suitable for all type of coupling hub materials. Stresses caused by the interference fit can cause the hubs to crack. Consult with the manufacturer prior to using an interference fit on brittle materials.

Coupling hubs with interference fits are generally mounted to the shaft by heating the hubs. The best methods for heating the hubs are with an oven, hot plate, induction heater or a hot oil bath. Torches should be only used as a last resort as they can cause damage to the hub. Light transition fits can normally be tapped on with a non marring mallet. The proper selections of fits may be based on that availability of the tools mentioned above and/or the speed of the mounting process. Heating a hub may not be conducive to high speed assembly lines.

Transition fits are defined as any combination of shaft and bore tolerances that can result in either a clearance fit or, an interference fit depending on the actual size of the components being assembled. For example, lets exam the combination of a 25mm H7 coupling hub with a 25mm j6 shaft. Tolerances for each component are listed below.

Nominal Size	Tolerance Class	Tolerance Band (mm)	Actual Dimension
25 mm	H7	-0 / +.021	25.00 / 25.021
25 mm	j6	-.004 / +.009	24.996 / 25.009

The resultant fit between the two components can result in a 0.009 mm (0.00035") interference fit to a 0.025mm (.00098") clearance fit.
Transition fits are not very popular but, are used by some companies. The trick to using a transition fit is knowing what resultant fits are possible no matter what their probability and understanding the implications of the occurrence of either fit.

For example, in the example list above, the majority of the time the combination of a 25mm H7 hub with a 25 j6 shaft should result in a clearance fit. Therefore, the hub should always have a setscrew or some other locking method to secure the hub in place. However, there is a chance an interference fit can occur. The questions to consider are:

- What effect will the interference have on the system and on assembly?
- Can the hubs handle the stress caused by the interference?
- Will an interference fit slow or stop the assembly line?
- What tools are required to heat the hub in the event of an interference fit?
- Can selective assembly be used to compensate for tight parts?
- What happens if all of the hubs are produced on the lower limit and all of the shafts are produced on the higher limit?

As you can see, the use of transition fits is fairly complex. Knowing the implications of each type of fit is the key to successful implementation.

9. What are the common hub and shaft combinations that will produce a Clearance, transition or interference fit?

Table 3: Clearance Fit

Nominal Shaft Size (mm)		Hub Tolerance	Hub Tolerance	Shaft Tolerance	Shaft Tolerance	Fit 1)	Fit 1)	Hub / Shaft
Over	Up to and Inc	Min	Max	Min	Max	Min	Max	Combination
12	18	0.016	0.034	-0.003	0.008	0.008	0.037	F7 / j6
18	30	0.020	0.041	-0.004	0.009	0.011	0.045	F7 / j6
30	50	0.025	0.050	0.002	0.018	0.007	0.048	F7 / k6
50	80	0.030	0.060	0.011	0.030	0.000	0.049	F7 / m6
80	120	0.036	0.071	0.013	0.035	0.001	0.058	F7 / m6
120	180	0.043	0.083	0.015	0.040	0.003	0.068	F7 / m6
180	250	0.050	0.096	0.017	0.046	0.004	0.079	F7 / m6
250	315	0.056	0.108	0.020	0.052	0.004	0.088	F7 / m6
315	400	0.062	0.119	0.021	0.057	0.005	0.098	F7 / m6
400	500	0.068	0.131	0.023	0.063	0.005	0.108	F7 / m6

1) Positive values are clearance and negative values are interference

Table 4: Transition Fit

Nominal Shaft Size (mm)		Hub Tolerance	Hub Tolerance	Shaft Tolerance	Shaft Tolerance	Fit 1)	Fit 1)	Hub / Shaft
Over	Up to and Inc	Min	Max	Min	Max	Min	Max	Combination
12	18	0.000	0.018	-0.003	0.008	-0.008	0.021	H7 / j6
18	30	0.000	0.021	-0.004	0.009	-0.009	0.025	H7 / j6
30	50	0.000	0.025	0.002	0.018	-0.018	0.023	H7 / k6
50	80	0.000	0.030	0.011	0.030	-0.030	0.019	H7 / m6
80	120	0.000	0.035	0.013	0.035	-0.035	0.022	H7 / m6
120	180	0.000	0.040	0.015	0.040	-0.040	0.025	H7 / m6
180	250	0.000	0.046	0.017	0.046	-0.046	0.029	H7 / m6
250	315	0.000	0.052	0.020	0.052	-0.052	0.032	H7 / m6
315	400	0.000	0.057	0.021	0.057	-0.057	0.036	H7 / m6
400	500	0.000	0.063	0.023	0.063	-0.063	0.040	H7 / m6

1) Positive values are clearance and negative values are interference

Table 5: Interference Fit

Nominal Shaft Size (mm)		Hub Tolerance	Hub Tolerance	Shaft Tolerance	Shaft Tolerance	Fit 1)	Fit 1)	Hub / Shaft
Over	Up to and Inc	Min	Max	Min	Max	Min	Max	Combination
12	18	-0.015	-0.004	-0.003	0.008	-0.023	-0.001	M6 / j6
18	30	-0.017	-0.004	-0.004	0.009	-0.026	0.000	M6 / j6
30	50	-0.013	0.003	0.002	0.018	-0.031	0.001	K6 / k6
50	80	-0.021	0.009	0.011	0.030	-0.051	-0.002	K7 / m6
80	100	-0.035	0.000	0.013	0.035	-0.070	-0.013	M7 / m6
100	120	-0.059	-0.024	0.013	0.035	-0.094	-0.037	P7 / m6
120	180	-0.068	-0.028	0.015	0.040	-0.108	-0.043	P7 / m6
180	200	-0.079	-0.033	0.017	0.046	-0.125	-0.050	P7 / m6
200	225	-0.109	-0.063	0.017	0.046	-0.155	-0.080	R7 / m6
225	250	-0.113	-0.067	0.017	0.046	-0.159	-0.084	R7 / m6
250	280	-0.126	-0.074	0.020	0.052	-0.178	-0.094	R7 / m6
280	315	-0.130	-0.078	0.020	0.052	-0.182	-0.098	R7 / m6
315	355	-0.144	-0.087	0.021	0.057	-0.201	-0.108	R7 / m6
355	400	-0.203	-0.114	0.021	0.057	-0.260	-0.135	R8 / m6
400	450	-0.223	-0.126	0.023	0.063	-0.286	-0.149	R8 / m6
450	500	-0.229	-0.132	0.023	0.063	-0.292	-0.155	R8 / m6

1) Positive values are clearance and negative values are interference

10. What are the most common bore tolerances stocked by manufacturers?

Most coupling manufacturers stock H7 for clearance fits and P7 for interference fits. They are chosen to cover the widest range of applications. Consult with each manufacture for their stock availability.

11. Can I get in trouble or get unexpected results using the H7 and P7 tolerance from manufacturers.

At most, F7 and P7 will give you good clearance and or Interference fits with k6, m6, and j6 shafting. However, H7 fits produce a transition fit with k6, j6 and m6 shafting.. In other words, some times you may have to heat the hub slightly to get it on the shaft. The probability of the hubs and shaft being at the extreme ends of their respective tolerances is low but, with a transition fit, every now and then you will get a slight interference or clearance fit. For most clearance applications, a slight interference fit is not a problem. Slight warming of the hub will allow the part to slip on. This may be inconvenient for original equipment manufacturers. For interference fits on shaft sizes greater than 225mm, a P7 may not provide enough interference to resist the load imparted to the shaft hub interface by the coupling or equipment. An R7 or R8 hub bore should be considered. Consult with your MPTA member company to avoid any problems.

12. Will manufacturers make bores to other tolerances?

Yes, most manufactures are equipped to quickly produce other bore sizes. Contact any of the manufactures shown in the contributor's list at the front of this publication for details on special bores.

13. What do I do if I do not know the tolerance class to which the shaft was manufactured to or if the shaft had to be turned down to clean it up?

Measure the actual shaft diameter under the current coupling and consult with a manufacture for the best fit. Or use general rule of thumb. See question 14

14. What are the standard keyways that go with each shaft size?

Fortunately, the majority of the metric standards agree on the appropriate key to go with each bore size.

The following tables list the standard keyway widths and depth for each size bore and shaft.

Table 6 – Bore, keys, and keyseats

All dimensions in mm.

Bore Diameters Over	to	Key Size	Hub Keyway Width	Hub Keyway Depth	Hub Keyway Tolerance JS9 (normal) (precision)	P9
6	8	2 x 2	2	1	+/- 0.0125	-.006 / -.031
8	10	3 x 3	3	1.4	+/- 0.0125	-.006 / -.031
10	12	4 x 4	4	1.8	+/- .015	-.012 / -.042
12	17	5 x 5	5	2.3	+/- .015	-.012 / -.042
17	22	6 x 6	6	2.8	+/- .015	-.012 / -.042
22	30	8 x 7	8	3.3	+/-.018	-.015 / -.051
30	38	10 x 8	10	3.3	+/-.018	-.015 / -.051
38	44	12 x 8	12	3.3	+/-.0215	-.018 / -.061
44	50	14 x 9	14	3.8	+/-.0215	-.018 / -.061
50	58	16 x 10	16	4.3	+/-.0215	-.018 / -.061
58	65	18 x 11	18	4.4	+/-.0215	-.018 / -.061
65	75	20 x 12	20	4.9	+/-0.026	-.022 / -.074
75	85	22 x 14	22	5.4	+/-0.026	-.022 / -.074
85	95	25 x 14	25	5.4	+/-0.026	-.022 / -.074
95	110	28 x 16	28	6.4	+/-0.026	-.022 / -.074
110	130	32 x 18	32	7.4	+/- 0.031	-.026 / -.088
130	150	36 x 20	36	8.4	+/- 0.031	-.026 / -.088
150	170	40 x 22	40	9.4	+/- 0.031	-.026 / -.088
170	200	45 x 25	45	10.4	+/- 0.031	-.026 / -.088
200	230	50 x 28	50	11.4	+/- 0.031	-.026 / -.088
230	260	56 x 32	56	12.4	+/- 0.037	-.032 / -.106
260	290	63 x 32	63	12.4	+/- 0.037	-.032 / -.106
290	330	70 x 36	70	14.4	+/- 0.037	-.032 / -.106
330	380	80 x 40	80	15.4	+/- 0.037	-.032 / -.106
380	440	90 x 45	90	17.4	+/- 0.0435	-.037 / -.124
440	500	100 x 50	100	19.5	+/- 0.0435	-.037 / -.124

Table 7 – Shaft keys and key seats

All dimensions in mm.

Shaft Diameters Over	to	Key Size	Shaft Keyway Width	Shaft Keyway Depth	Shaft Keyway Tolerance N9 (normal)	P9 (precision)
6	8	2 x 2	2	-1.2	-.004 / -.029	-.006 / -.031
8	10	3 x 3	3	- 1.8	-.004 / -.029	-.006 / -.031
10	12	4 x 4	4	- 2.5	+ 0.0 / -.030	-.012 / -.042
12	17	5 x 5	5	- 3.0	+ 0.0 / -.030	-.012 / -.042
17	22	6 x 6	6	- 3.5	+ 0.0 / -.030	-.012 / -.042
22	30	8 x 7	8	- 4.0	+ 0.0 / -.036	-.015 / -.051
30	38	10 x 8	10	- 5.0	+ 0.0 / -.036	-.015 / -.051
38	44	12 x 8	12	- 5.0	+ 0.0 / -.043	-.018 / -.061
44	50	14 x 9	14	- 5.5	+ 0.0 / -.043	-.018 / -.061
50	58	16 x 10	16	- 6.0	+ 0.0 / -.043	-.018 / -.061
58	65	18 x 11	18	- 7.0	+ 0.0 / -.043	-.018 / -.061
65	75	20 x 12	20	- 7.5	+ 0.0 / -.052	-.022 / -.074
75	85	22 x 14	22	- 9.0	+ 0.0 / -.052	-.022 / -.074
85	95	25 x 14	25	- 9.0	+ 0.0 / -.052	-.022 / -.074
95	110	28 x 16	28	- 10.0	+ 0.0 / -.052	-.022 / -.074
110	130	32 x 18	32	- 11.0	+ 0.0 / -.062	-.026 / -.088
130	150	36 x 20	36	- 12.0	+ 0.0 / -.062	-.026 / -.088
150	170	40 x 22	40	- 13.0	+ 0.0 / -.062	-.026 / -.088
170	200	45 x 25	45	- 15.0	+ 0.0 / -.062	-.026 / -.088
200	230	50 x 28	50	- 17.0	+ 0.0 / -.062	-.026 / -.088
230	260	56 x 32	56	- 20.0	+ 0.0 / -.074	-.032 / -.106
260	290	63 x 32	63	- 20.0	+ 0.0 / -.074	-.032 / -.106
290	330	70 x 36	70	- 22.0	+ 0.0 / -.074	-.032 / -.106
330	380	80 x 40	80	- 25.0	+ 0.0 / -.074	-.032 / -.106
380	440	90 x 45	90	- 28.0	+ 0.0 / -.087	-.037 / -.124
440	500	100 x 50	100	- 31.0	+ 0.0 / -.087	-.037 / -.124

For elastomeric couplings, a Js9 hub keyway tolerance is the standard. P9 tolerances are reserved for close fitting keys used in high speed coupling applications. Tight keys require the person assembling the coupling to tap them it with a hammer. The interference greatly increases the possibility of cracking a hub. This is especially true when hub is manufactured out of a brittle material.

15. How do I calculate the height of the keyway in the hub and the depth of the key seats in the shaft?

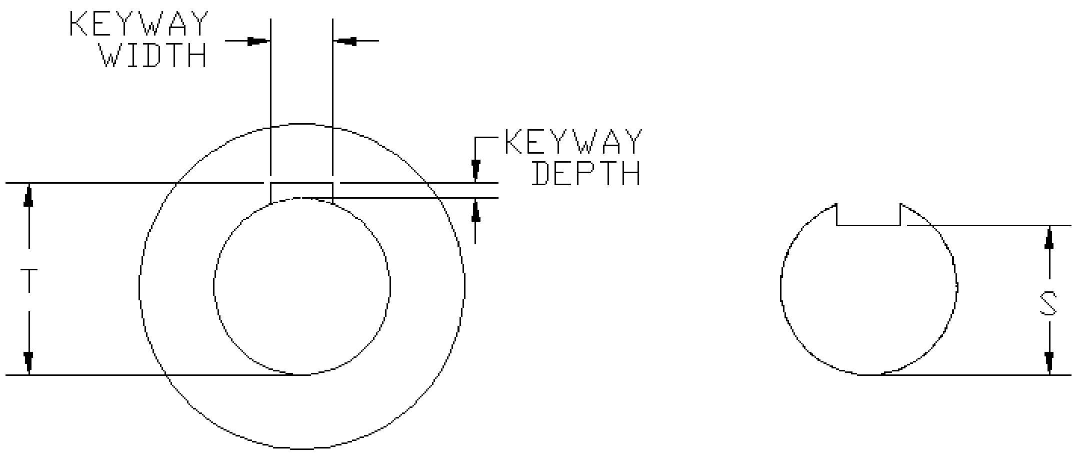
Metric key seats are much easier to calculate than their inch counter parts. To determine the hub T dimension shown in figure 1, add the keyway depth listed in question 14 (Table 8) to the nominal shaft size. To determine the shaft S dimensions shown in figure 1, subtract the shaft keyseat height listed in question 14 (Table 7) from the nominal shaft dimension. Note: The keyway depth cannot be directly measured.

The tolerances on T and S are listed in Table 8

Table 8 – Tolerance values for Hub Keyway Heights and Shaft Keyseats.

Nominal Bore or Shaft Size	T (mm)	S (mm)
< 6mm to 22 mm	-0 / + 0.1	-0 / + 0.1
< 22 mm to 130mm	-0 / + 0.2	-0 / + 0.2
< 130 mm to 500 mm	-0 / + 0.3	-0 / + 0.3

Figure 1



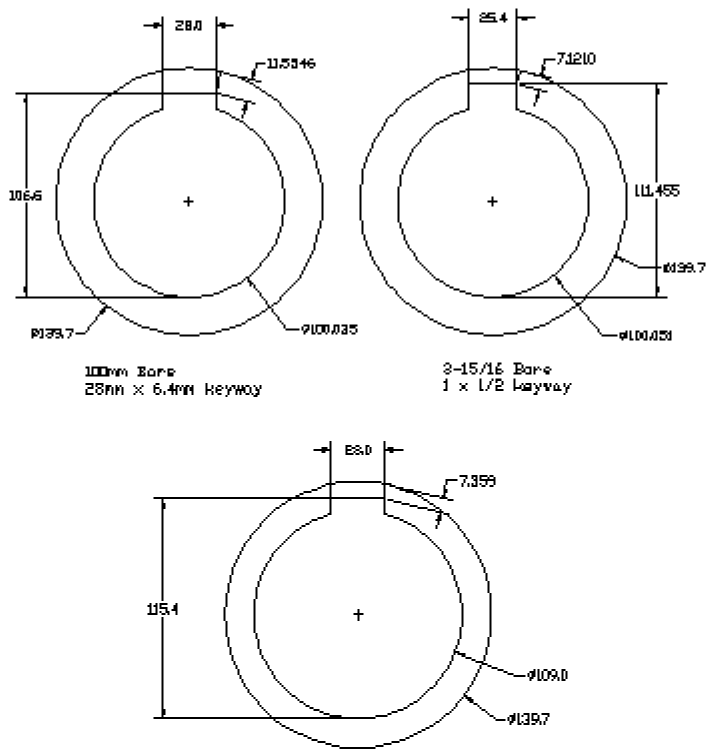
16. Do the shaft and hub keyways need a corner radii and, if so, what should it be ?

Corner radii are generally considered optional in Elastomeric coupling hubs. For bore sizes greater than 100mm, consult with one of the coupling manufactures listed in the contributors list contained in the first section of this document.

17. Given the same size hub, why is the bore capacity normally greater for Metric bores than with its equivalent inch bore?

The following sketch graphically illustrates the major differences between metric and inch keyways. Metric keys are generally rectangular in shape and are cut deeper into the shaft than they are cut into the hubs. Inch keys are generally square in shape and are placed so that half of the key is located in the hub and the other half in the shaft. As a result, for the same size bore and hub O.D., there is more material over the keyway in a metric hub than in an inch bore. The more material over the keyway corner, the lower the stress level and the higher the strength over the keyway. If the stress level in the inch bore is acceptable, a larger metric bore can be used and maintain the equivalent stress level. In this example, a 109 mm bore would produce the same amount of material over the keyway as the 3-15/16 (100 mm) inch bore.

Figure 2



Appendix 1

The following table has been extracted from ISO 286-2 first addition 1988-06-01 Page 12 with the permission of the International Standards Organization.

Table 9: ISO 286-2 : 1988 (E); Limit deviations for holes H

Upper limit deviation = ES Lower limit deviation = EI

Basic Size Mm		H																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14[1)]	15[1)]	16[1)]	17[1)]	18[1)]
Above	Up to and including	Deviations																	
		um											mm						
-	3[1)]	0.8	1.2	2	3	4	6	10	14	25	40	60	0.1	0.14	0.25	0.4	0.6		
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	6	1	1.5	2.5	4	5	8	12	18	30	48	75	0.12	0.18	0.3	0.48	0.75	1.2	1.8
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	10	1	1.5	2.5	4	6	9	15	22	36	58	90	0.15	0.22	0.36	0.58	0.9	1.5	2.2
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	18	1.2	2	3	5	8	11	18	27	43	70	110	0.18	0.27	0.43	0.7	1.1	1.8	2.7
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	30	1.5	2.5	4	6	9	13	21	33	52	84	130	0.21	0.33	0.52	0.84	1.3	2.1	3.3
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	50	1.5	2.5	4	7	11	16	25	39	62	100	160	0.25	0.39	0.62	1	1.6	2.5	3.9
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	80	2	3	5	8	13	19	30	46	74	120	190	0.3	0.46	0.74	1.2	1.9	3	4.6
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
80	120	2.5	4	6	10	15	22	35	54	87	140	220	0.35	0.54	0.87	1.4	2.2	3.5	5.4
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
120	180	3.5	5	8	12	18	25	40	63	100	160	250	0.4	0.63	1	1.6	2.5	4	6.3
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
180	250	4.5	7	10	14	20	26	46	72	115	185	290	0.46	0.72	1.15	1.85	2.9	4.6	7.2
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
250	315	6	8	12	16	23	32	52	81	130	210	320	0.52	0.81	1.3	2.1	3.2	5.2	8.1
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
315	400	7	9	13	18	25	36	57	89	140	230	360	0.57	0.89	1.4	2.3	3.6	5.7	8.9
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
400	500	8	10	15	20	27	40	63	97	155	250	400	0.63	0.97	1.55	2.5	4	6.3	9.7
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
						2)													
500	630	9	11	16	22	32	44	70	110	175	280	440	0.7	1.1	1.75	2.8	4.4	7	11
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
630	800	10	13	18	25	36	50	80	125	200	320	500	0.8	1.25	2	3.2	5	8	13
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
800	1000	11	15	21	28	40	56	90	140	230	360	560	0.9	1.4	2.3	3.6	5.6	9	14
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1000	1250	13	18	24	33	47	66	105	165	260	420	660	1.05	1.65	2.6	4.2	6.6	11	17
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1250	1600	15	21	29	39	55	78	125	195	310	500	780	1.25	1.95	3.1	5	7.8	13	20
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1600	2000	18	25	35	46	65	92	150	230	370	600	920	1.5	2.3	3.7	6	9.2	15	23
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	2500	22	30	41	55	78	110	175	280	440	700	1100	1.75	2.8	4.4	7	11	18	28
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2500	3150	26	36	50	68	96	135	210	330	540	860	1350	2.1	3.3	5.4	8.6	13.5	21	33
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

1) Tolerance grades IT14 to IT18 (incl.) shall not be used for basic sizes less than or equal to 1mm
2) The values given in the frame, for tolerance grades IT1 to IT5 (incl.), for basic sizes greater than 500 mm and less than or equal to 3150mm, are included for experimental use.