



Test Specification

		Test Standard	Result
Torque Test		Torque values for fastening nut and body	No Change Under 0.5mm Gap
Leak Test	Water	48 hours with 60kgf/cm ² (870psi)	No Leak
	Digital Gauge	240 hours with 60kgf/cm ² (870psi)	No Leak
Tube Separation Test		Designed pressure tests for 3 minutes each, repeated 5 times	No Separation
Pressure Resistance Test		3 minutes with 150kgf/cm ² (2,176psi), repeated 20 times	No Change
Tube Burst Test		Increase pressure until tube burst	Over 2,610psi
Vacuum Test		72 hours under 10 ⁻³ torr (1 micron)	No Leak
Temperature Test		High 24 hours with 43kgf/cm ² (624psi) pressure and 120°C (248°F)	No Leak
		Low 24 hours with 43kgf/cm ² (624psi) pressure and -30°C (-22°F)	
Dissimilar Metal Test		960 Hours with saltwater immersion (NaCl 5%) at 35°C (95°F), 43kgf/cm ² (624psi)	No Leak
Vibration Test		Leak and deformation check after 72 hours with 50Hz vibration	No Leak
Refrigerant Gas and Oil Test		Test with Refrigerant (R1234yf, R134A, R410A, R22, R32)	No Leak





Torque Test

Objective	Torque confirmation test by fastening body and nut with torque wrench until the designed 0.5mm gap.			
Equipment	Inspection torque wrench (TOHNICHI, 900DB3-S, 1800DB3-S)			
Procedure	1. Installed the fittings following the installation guide. Connected valve, fitting and tube.			
	2. After hand tightening body and nut of the fitting, fastened with torque wrench until the designed gap of 0.5mm.			
Specification	Fastening torque data on website: www.smartlockfitting.com			
Conclusion	Satisfied with the designed torque data			
Test Data	Model		Quantity	Torque
	Swage Nut	3/8"	40	25.5
		5/8"	46	38.5
		3/4"	52	46.5
		7/8"	48	61.8
	Union Nut	1/4"	60	16.0
		3/8"	68	23.3
		1/2"	64	29.1
		5/8"	73	36.4
		3/4"	60	43.6
	Flare Nut	7/8"	77	58.2
		1/4"	135	16.0
		3/8"	120	23.3
		1/2"	100	29.1
		5/8"	153	36.4
	3/4"	128	43.6	






Leak Test: Water Tank

Objective	Leak test in water tank with air pressure of 60kgf/cm ² (870psi) applied.							
Equipment	Air Compressor (Ail air tech, SERIES-200, max 1,740 psi) & Water tank							
Procedure	1. Installed fitting following designed torque value with torque wrench.							
	2. Submerged fittings. Pressure of 60kgf/cm ² (870psi) was applied.							
	3. Visually inspected and checked for bubbles for 48 hours.							
Specification	No bubble during of 48 hours with the air pressure of 60kgf/cm ² (870psi).							
Conclusion	No bubbles (or leak) found							
Test Data	Model		Quantity	Tested Pressure (kgf/cm ²)	Model		Quantity	Tested Pressure (kgf/cm ²)
	Swage Union	3/8"	68	61.3	Elbow Swage Union	1/2"	18	60.1
		5/8"	73	62.5		5/8"	21	62.3
		3/4"	60	61.9		3/4"	25	60.6
		7/8"	77	62.4		7/8"	30	61.8
	Union Straight	1/4"	60	63.2	Reducer Union	3/8"-1/4"	68	62.1
		3/8"	68	60.1		1/2"-3/8"	64	62.2
		1/2"	64	62.2		3/4"-5/8"	73	63.5
		5/8"	73	60.1		3/4"-5/8"	60	61.8
		3/4"	60	60.5		7/8"-3/4"	77	60.2
		7/8"	77	62.1				
	Elbow Union	1/2"	24	62	Flare Connector	1/4"	135	62
		5/8"	28	61.5		3/8"	120	61.5
		3/4"	24	60.8		1/2"	100	60.8
		7/8"	34	62.7		5/8"	153	62.7
	FCRS	1/2"-3/8"	58	61.8	3/4"	128	63.2	



Leak Test: Digital Gauge

Objective	Leak test with digital gauge under pressure of 60kgf/cm ² (870psi) applied with R410a gas.							
Equipment	Refrigeration Compressor (Ail gas tech, SERIES-300, max 1,740 psi) & Digital Gauge (PCM 510)							
Procedure	1. Installed fitting following designed torque value with torque wrench.							
	2. Pressure applied with R410a gas (but unknown compressor oil).							
	3. Checked for bubbles on fitting and digital gauge connection in water leak tester tank.							
	4. Moved the test object to temperature-controlled chamber (23°C±1 (73.4°F±1)).							
	5. After 1 hour, read digital pressure gauge (starting pressure data).							
	6. After 240 hours, read digital pressure gauge (finish pressure data).							
Specification	Starting data – Finish data ≤ 1.5 kgf/cm ² under conditions of 240 hours with 60kgf/cm ² (870psi)							
Conclusion	No leak with 60kgf/cm ² (870psi)							
Test Data	Model		Quantity	Pressure Change (kgf/cm ²)	Model		Quantity	Pressure Change (kgf/cm ²)
	Swage Union	3/8"	68	0.07	Elbow Swage Union	1/2"	12	0.11
		5/8"	73	0.12		5/8"	19	0.13
		3/4"	60	0.01		3/4"	16	0.21
		7/8"	77	0.1		7/8"	20	0.37
	Union Straight	1/4"	60	0.07	Reducer Union	3/8"-1/4"	68	0.11
		3/8"	68	0.03		1/2"-3/8"	64	0.09
		1/2"	64	0.02		3/4"-5/8"	73	0.05
		5/8"	73	0.01		3/4"-5/8"	60	0.07
		3/4"	60	0.02		7/8"-3/4"	77	0.02
		7/8"	77	0.05				

	 Elbow Union	1/2"	16	0.15	Flare Connector	1/4"	135	0.12
		5/8"	22	0.16		3/8"	120	0.1
		3/4"	21	0.41		1/2"	100	0.85
		7/8"	18	0.32		5/8"	153	0.76
	FCRS	1/2"-3/8"	27	0.14		3/4"	128	0.13





Tube Separation Test

Objective	Tube separation test under pressure of max. 29,000 psi.							
Equipment	Water pressure tester (ENPOS KOREA HYDRAULIC CO, max 29,000 psi)							
Procedure	1. Installed fitting following designed torque value with torque wrench.							
	2. Submerged under water pressure tester and pressure was applied.							
	3. Checked tube separation while pressure was on for 3 minutes.							
	4. Visual inspection							
Specification	No separation during and after 5 cycle of 3 minutes with designed pressure							
Conclusion	No tube separation or any deformation							
Test Data	Model		Quantity	Separation	Model		Quantity	Separation
	Swage Union	3/8"	68	No separation	Elbow Swage Union	1/2"	35	No separation
		5/8"	73	No separation		5/8"	40	No separation
		3/4"	60	No separation		3/4"	39	No separation
		7/8"	77	No separation		7/8"	43	No separation
	Union Straight	1/4"	60	No separation	Reducer Union	3/8"-1/4"	68	No separation
		3/8"	68	No separation		1/2"-3/8"	64	No separation
		1/2"	64	No separation		3/4"-5/8"	73	No separation
		5/8"	73	No separation		3/4"-5/8"	60	No separation
		3/4"	60	No separation		7/8"-3/4"	77	No separation
		7/8"	77	No separation				



	Elbow Union	1/2"	55	No separation	Flare Connector	1/4"	135	No separation
		5/8"	67	No separation		3/8"	120	No separation
		3/4"	75	No separation		1/2"	100	No separation
		7/8"	83	No separation		5/8"	153	No separation
	FCRS	1/2"-3/8"	70	No separation		3/4"	128	No separation





Pressure Resistance Test

Objective	Pressure resistance test (fitting deformation test)							
Equipment	Hydro Tester (ENPOS KOREA HYDRAULIC CO, max 29,000 psi)							
Procedure	1. Installed fitting following designed torque value with torque wrench.							
	2. Submerged under water pressure tester and pressure was applied.							
	3. Checked tube separation while pressure was on for 3 minutes.							
	4. Visual inspection							
Specification	No deformation during 3 minutes of 150kgf/cm ² (2,176psi) pressure, repeated 20 times.							
Conclusion	No deformation found with 150kgf/cm ² (2,176psi)							
Test Data	Model		Quantity	Deformation	Model		Quantity	Deformation
	Swage Union	3/8"	68	No deformation	Elbow Swage Union	1/2"	20	No deformation
		5/8"	73	No deformation		5/8"	23	No deformation
		3/4"	60	No deformation		3/4"	27	No deformation
		7/8"	77	No deformation		7/8"	25	No deformation
	Union Straight	1/4"	60	No deformation	Reducer Union	3/8"-1/4"	68	No deformation
		3/8"	68	No deformation		1/2"-3/8"	64	No deformation
		1/2"	64	No deformation		3/4"-5/8"	73	No deformation
		5/8"	73	No deformation		3/4"-5/8"	60	No deformation
		3/4"	60	No deformation		7/8"-3/4"	77	No deformation
		7/8"	77	No deformation				



	Elbow Union	1/2"	65	No separation	Flare Connector	1/4"	135	No separation
		5/8"	81	No separation		3/8"	120	No separation
		3/4"	78	No separation		1/2"	100	No separation
		7/8"	96	No separation		5/8"	153	No separation
	FCRS	1/2"- 3/8"	74	No separation		3/4"	128	No separation





Burst Test

Objective	Check fitting for damages or deformation until tube burst							
Equipment	Air Compressor (Ail air tech, SERIES-200) & Hydro Tester (ENPOS KOREA HYDRAULIC CO)							
Procedure	1. Installed fitting following designed torque value with torque wrench.							
	2. Pressure applied until tube burst.							
Specification	Increase pressure until tube burst							
Conclusion	No damage to fitting when the tube burst							
Test Data	Model		Quantity	Burst Pressure (kgf/cm ²)	Model		Quantity	Burst Pressure (kgf/cm ²)
	Swage Union	3/8"	68	453	Elbow Swage Union	1/2"	21	386
		5/8"	73	371		5/8"	24	371
		3/4"	60	362		3/4"	32	392
		7/8"	77	383		7/8"	34	386
	Union Straight	1/4"	60	451	Reducer Union	3/8"-1/4"	68	436
		3/8"	68	432		1/2"-3/8"	64	392
		1/2"	64	395		3/4"-5/8"	73	368
		5/8"	73	369		3/4"-5/8"	60	361
		3/4"	60	365		7/8"-3/4"	77	362
		7/8"	77	380				
	Elbow Union	1/2"	69	385	Flare Connector	1/4"	135	450
		5/8"	72	374		3/8"	120	430
		3/4"	68	356		1/2"	100	390
		7/8"	91	378		5/8"	153	370
	FCRS	1/2"-3/8"	58	42.6		3/4"	128	360



Vacuum Test

Objective	Vacuum test with 10^{-3} torr (1 micron)							
Equipment	Vacuum Pump (Lovd 24) & Vacuum Gauge (DPF4Z) : Woosung Vacuum Technology LTD.							
Procedure	1. Installed fitting following designed torque value with torque wrench and installed analogue vacuum gauge.							
	2. Connected test object to vacuum tester and read vacuum tester with 10^{-3} torr (1 micron).							
	3. Sealed vacuum fitting line with brazing, then disconnected vacuum tester.							
	4. Moved the test objects to temperature-controlled chamber ($23^{\circ}\text{C}\pm 1$ ($73.4^{\circ}\text{F}\pm 1$)).							
	5. Checked the analogue gauge for 72 hours.							
Specification	No change after 72 hours with 10^{-3} torr (1 micron)							
Conclusion	No break in the vacuum							
Test Data	Model		Quantity	Gradation Change	Model		Quantity	Gradation Change
	Swage Union	3/8"	57	No change	Elbow Swage Union	1/2"	15	No change
		5/8"	52	No change		5/8"	12	No change
		3/4"	62	No change		3/4"	18	No change
		7/8"	62	No change		7/8"	16	No change
	Union Straight	1/4"	61	No change	Reducer Union	3/8"-1/4"	56	No change
		3/8"	50	No change		1/2"-3/8"	62	No change
		1/2"	54	No change		3/4"-5/8"	68	No change
		5/8"	55	No change		3/4"-5/8"	54	No change
		3/4"	57	No change		7/8"-3/4"	59	No change
		7/8"	61	No change				



	Elbow Union	1/2"	28	No change	Flare Connector	1/4"	65	No change
		5/8"	24	No change		3/8"	66	No change
		3/4"	29	No change		1/2"	45	No change
		7/8"	31	No change		5/8"	49	No change
	FCRS	1/2"-3/8"	38	No change		3/4"	57	No change





Low Temperature Test

Objective	Low temperature test under the pressure of 43 kg f/cm ² (624psi)							
Equipment	Low temperature chamber (JY Technology LTD.)							
Procedure	1. Installed fitting following designed torque value with torque wrench.							
	2. Applied air pressure of 43kgf/cm ² (624psi) to installed fitting.							
	3. Checked for bubble on fitting and digital gauge connection in water leak tester.							
	4. Moved test objects to temperature-controlled chamber (23°C±1 (73.4°F±1)).							
	5. After 2 hours, read digital pressure gauge (① starting pressure data).							
	6. Tested in cooling temperature chamber (-30°C (-22°F), 24 hour).							
	7. Moved test objects to temperature controlled chamber (23°C±1 (73.4°F±1)).							
	8. After 2 hours, read digital pressure gauge (② finish pressure data).							
Specification	① - ② ≤ 1.5 kgf/cm ² under conditions of 24 hours with 43kgf/cm ² (624psi) pressure and -30°C (-22°F)							
Conclusion	No leak under low temperatures of -30°C (-22°F)							
Test Data	Model		Quantity	Pressure Change (kgf/cm ²)	Model		Quantity	Pressure Change (kgf/cm ²)
	Swage Union	3/8"	45	0.07	Elbow Swage Union	1/2"	12	0.12
		5/8"	44	0.06		5/8"	10	0.08
		3/4"	48	0.01		3/4"	14	0.05
		7/8"	49	0.1		7/8"	13	0.02
	Union Straight	1/4"	55	0.04	Reducer Union	3/8"-1/4"	54	0.11
		3/8"	54	0.03		1/2"-3/8"	57	0.11
		1/2"	57	0.02		3/4"-5/8"	59	0.03
		5/8"	62	0.04		3/4"-5/8"	55	0.07
		3/4"	61	0.02		7/8"-3/4"	51	0.02
		7/8"	60	0.05		3/4"	51	0.02


+	Elbow Union	1/2"	28	0.04	Flare Connector	1/4"	58	0.04
		5/8"	32	0.05		3/8"	43	0.01
		3/4"	30	0.06		1/2"	49	0.04
		7/8"	26	0.02		5/8"	55	0.03
	FCRS	1/2"- 3/8"	31	0.05		3/4"	62	0.07





High Temperature Test

Objective	High temperature test under the pressure of 43 kg f/cm ² (624psi)							
Equipment	High temperature chamber (MG Tech, MG-HOV150)							
Procedure	1. Installed fitting following designed torque value with torque wrench.							
	2. Applied air pressure of 43kgf/cm ² (624psi) to installed fitting.							
	3. Checked for bubble on fitting and digital gauge connection in water leak tester.							
	4. Moved test objects to temperature-controlled chamber (23°C±1 (73.4°F±1)).							
	5. After 2 hours, read digital pressure gauge (① starting pressure data).							
	6. Tested in cooling temperature chamber (120°C (248°F), 24 hour).							
	7. Moved test objects to temperature controlled chamber (23°C±1 (73.4°F±1)).							
	8. After 2 hours, read digital pressure gauge (② finish pressure data).							
Specification	① - ② ≤ 1.5kgf/cm ² for 24 hours with 43kgf/cm ² (624psi) pressure and 120°C (248°F)							
Conclusion	No leak under high temperatures of 120°C (248°F)							
Test Data	Model		Quantity	Pressure Change (kgf/cm ²)	Model		Quantity	Pressure Change (kgf/cm ²)
	Swage Union	3/8"	75	0.07	Elbow Swage Union	1/2"	12	0.8
		5/8"	84	0.06		5/8"	10	0.07
		3/4"	77	0.01		3/4"	14	0.03
		7/8"	61	0.1		7/8"	13	0.06
	Union Straight	1/4"	70	0.04	Reducer Union	3/8"-1/4"	54	0.11
		3/8"	60	0.03		1/2"-3/8"	75	0.11
		1/2"	50	0.02		3/4"-5/8"	68	0.03
		5/8"	78	0.04		3/4"-5/8"	60	0.07
		3/4"	86	0.02		7/8"-3/4"	74	0.02
		7/8"	94	0.05		3/4"		

	 Elbow Union	1/2"	28	0.03	Flare Connector	1/4"	85	0.04
		5/8"	32	0.02		3/8"	80	0.01
		3/4"	30	0.04		1/2"	75	0.04
		7/8"	26	0.02		5/8"	68	0.03
	FCRS	1/2"-3/8"	36	0.03		3/4"	90	0.07





Dissimilar Metal Test

Objective	Saltwater test for dissimilar metal corrosion and fitting body corrosion damage							
Equipment	NaCl 5% saltwater tank & constant temperature chamber (P-CTC252R1, LABMATE)							
Procedure	1. Installed with copper tube (dissimilar metal setup- fitting body (aluminum alloy), ferrule (bronze alloy), and copper tube.							
	2. Installed digital pressure gauge and applied pressure up to 43kgf/cm ² (624psi).							
	3. Moved test subject to temperature-controlled chamber with saltwater tank (35°C±1 (95°F±1)).							
	4. Submerged fitting into saltwater tank.							
	5. Read pressure data after 2 hours for first pressure data ①.							
	6. Recorded pressure every 72 hours.							
	7. Read final pressure data after 960 hours ②.							
Specification	① - ② ≤ 0.15 kgf/cm ² under conditions of 960 Hours with saltwater immersion (NaCl 5%) at 35 °C (95°F), 43kgf/cm ² (624psi)							
Conclusion	1. No leak (no pressure change) means no corrosion for dissimilar metal connection inside fitting.							
	2. Fittings has no leak under 20 years of environmental condition despite corrosion on the outside body outside.							
Test Data	Model		Quantity	Pressure Change (kgf/cm ²)	Model		Quantity	Pressure Change (kgf/cm ²)
	Swage Union	3/8"	5	0.13	Elbow Swage Union	1/2"	4	0.11
		5/8"	6	0.12		5/8"	4	0.06
		3/4"	5	0.03		3/4"	4	0.10
		7/8"	4	0.08		7/8"	4	0.05
	Union Straight	1/4"	2	0.03	Reducer Union	3/8"-1/4"	2	0.13
		3/8"	3	0.11		1/2"-3/8"	3	0.11
		1/2"	4	0.6		3/4"-5/8"	2	0.03
		5/8"	3	0.08		3/4"-5/8"	1	0.12
		3/4"	3	0.07		7/8"-3/4"	1	0.05
		7/8"	2	0.02				



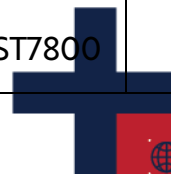
	Elbow Union	1/2"	6	0.11	Flare Connector	1/4"	5	0.10
		5/8"	6	0.06		3/8"	4	0.08
		3/4"	6	0.10		1/2"	5	0.08
		7/8"	6	0.05		5/8"	7	0.07
	FCRS	1/2"- 3/8"	6	0.12		3/4"	5	0.12





Vibration Test

Objective	No leakage after 72 hours with 50Hz vibration							
Equipment	Vibration generated by JFM Engineering							
Procedure	1. Connected two different types of fittings per tube size (total of 45 tubes).							
	2. Connected each tube to the tester and applied vibration of 50 Hz for 72 hours.							
	3. Vibration test for 72 hours for each tube.							
	4. Conducted a leak test by applying pressure of 60kgf/cm ² (870psi) to check for damages.							
Specification	No leakage with pressure of 60kgf/cm ² (870psi) after 72 hours with 50Hz vibration.							
Conclusion	No damage found in 45 tubes (total 90 fittings) after vibrating at 50 Hz for 72 hours.							
Test Data	Sample Tube		Quantity	Vibration (72 hours)	Connected Fittings		Tested Pressure (kgf/cm ²)	Test Result
	Tube 1	1/4"	5	50 Hz	FCMA1400	UNST1400	63.2	No Leak
	Tube 2	3/8"	5	50 Hz	FCMA3800	UNRD1238	60.1	No Leak
	Tube 3	1/2"	5	50 Hz	FCMA1200	UNST1200	62.2	No Leak
	Tube 4	5/8"	5	50 Hz	FCMA5800	UNRD5812	60.1	No Leak
	Tube 5	3/4"	5	50 Hz	FCMA3400	UNRD3458	60.5	No Leak
	Tube 6	3/8"	5	50 Hz	SWUN3800	UNST3800	62.1	No Leak
	Tube 7	5/8"	5	50 Hz	SWUN5800	UNST5800	61.3	No Leak
	Tube 8	5/8"-1/2"	5	50 Hz	SWUN3400	UNST3400	62.5	No Leak
	Tube 9	3/4"-5/8"	5	50 Hz	SWUN7800	UNST7800	61.9	No Leak



Tube 10	1/2"	2	50 Hz	FCMA1400	ELSW1200	62.0	No Leak
Tube 11	5/8"	2	50 Hz	FCMA3800	ELSW5800	61.8	No Leak
Tube 12	3/4"	2	50 Hz	FCMA1200	ELSW3400	60.8	No Leak
Tube 13	7/8"	2	50 Hz	FCMA5800	ELSW5800	63.1	No Leak
Tube 14	1/2"	4	50 Hz	FCMA1400	ELUN1200	61.5	No Leak
Tube 15	5/8"	4	50 Hz	FCMA3800	ELUN5800	63.0	No Leak
Tube 16	3/4"	4	50 Hz	FCMA1200	ELUN3400	60.6	No Leak
Tube 17	7/8"	4	50 Hz	FCMA5800	ELUN7800	61.2	No Leak

