TI Fluid Systems

General Requirements for Injection Molded Quick Connector Bodies and Adaptors - C 600.019.0021.00

TI Fluid Systems- Global Supplier Specification for Injection Molding

No.	Date	Released Document	Released	Approved TC	Approved ME	Approved Quality
00	Feb 22	New document	08.02.22	A. Haeckel	M. Kambakhsh	T-M. Adams
01	July 22	Changing document title	18.07.22			John Gunter

Table of content

1. Scope

This specification is valid for injection molding components specific to (quick connectors and adapters) for fuel, fuel vapor and Thermal Products (Glycol) applications. All parts produced within this specification must be considered Safety Critical or Safety Functional and treated as such by the chosen supplier. TIFS deems them an SRF component. (Safety, Reliability and Functional)
This specification is relevant for all PPAP approvals submitted to TIFS locations globally.

2. Internal restriction

3. Conditioning

In case of needed measurement, the components shall not be measured until a temperature of +23° ± 2°C is reached. Deviations in temperature and a disproportional amount of moisture can lead to variation of the measurement results. All other temperatures are setup with a tolerance of ± 2°C.

4. Documents/References

DIN ISO 20457
Component drawings

5. General technical aspects

5.1. Material selection

The required resin is clearly defined on the drawing and is not changeable without prior written consent from TIFS. Use of regrind material is not allowed, unless otherwise defined on the drawing.
In addition, the injection molding supplier is not allowed to use alternative resins, even if they are defined on the drawing as an option, without prior written approval of

TI Fluid Systems. The required resin, which is defined in the purchase order and engineering drawing, must be used.

5.2. Material processing information

The processing of the selected resin must follow the processing instructions and notes from the resin supplier. Any Deviations from these processing instruction/notes must be approved by the resin supplier and must be announced to TI Fluid Systems prior to any deviations from those processing instructions.

6. Process & Quality requirements

6.1. Mould flow analysis / Tool Design

The suppliers mold tooling concept, gate locations and size (incl. hot runner geometry and dimension, when used) plus mold flow analysis results must be shared with TI Fluid Systems, unless this is already specified by TI Fluid Systems in the drawing or other official communications/documents.

General:
The supplier is responsible for developing/building Injection molding tools which will ensure that all parts produced meet the required and specified TIFS requirements.

The following documents must be shared with TIFS as a part of the PPAP and APQP processes.

- Maintenance plan for Injection moulding tool
- Mold flow Analyses, related to injection gate and special product characteristics
- Ventilation design for mold separation of cavities and cores
- Hot runner drawing with valve gate nozzles and mold insert
- If cold runner is implemented TIFS will require runner to part %. (Part weight / shot weight).
- Cooling circuits and connection diagram
- Resin shrinkage calculation.
- BOM incl. steel suppliers and all certificates of conformity

6.2. Usage of regrind

The TI global requirement for the usage of regrind materials is prohibited unless specifically called out and allowed per the engineering drawing.

6.3. General aspects

As mentioned above, use of regrind is not allowed, unless otherwise defined on the engineering drawing. Additionally, the injection molding supplier is not allowed to use any alternative resins, without written approval of TI Fluid Systems at the time of the APQP process. If the supplier chooses to utilize an alternative material that may be defined on the drawing, this action/decision on the part of the supplier must receive prior written approvals from TIFS Purchasing and engineering prior to any changes. Basically, the resin, which is defined in the purchase order, must be used.

Regrind is obtained by grinding used plastic materials from the original runs produced. Regrind has different and irregular particle sizes and may contain dust particles. This potential contamination can cause major issues with safety critical fuel components and must be tightly controlled to prevent contamination if deviated with approval from TIFS. If re-grind is approved, use only “pure” materials from the corresponding TI part families specified on the drawing. “Pure” means that only one plastic from one raw material manufacturer with the same type of designation (incl. same colour) is reprocessed.
In case of multiple material callouts on the drawing only the approved material from original (PPAP documentation) is allowed to use.
Origin of regrind can be sprues and runners, start-up part & nok parts. The maximum specified percentage of regrind will be defined on the drawing is the supplier is not allowed to exceed this percentage.

Maximum particle sizes & moisture content should correlate with the original material to avoid feed problems during processing and structural imperfects on the components (e.g., flow lines & voids).

If in the case, the use of regrind is allowed by TIFS in writing, The maximum defined amount of regrind allowed must be validated and fully documented.

6.3.1. Continuous regrind usage (in cases of regrind use)

In the case of an inline regrind system, usage of regrind material in a continuously closed regrind system must be utilized to avoid cross material contamination.
The grinder unit must be equipped with defined screen filters to secure uniform regrind particles/chips, an incapsulated dust separator and metal separator to prevent feeding problems and mechanical damages on the plasticising unit.
A Metal separator is recommended as the grinder blades are subjected to ware and small metal particles can end-up in the regrind material.

Focus must be put on environmental contamination during dust & metal separation. Injection molding machine itself and produced parts could be negatively affected. The same risk exists during cleaning/maintenance process of grinder unit. Could lead to insufficient internal cleanliness of TI's components.

The continuous process leads to the risk of varying regrind percentages – driven by the ratio component weight vs. sprue/runner weight. This can lead to fluctuating process conditions pending on the amount of regrind. IM machine control system should be able to handle this fluctuation effects.

6.3.2. Serial production (in case of re-grind use)

A decentralized material collecting/grinding process for sprues, runners, start-up parts and NOK components followed by an independent usage in an Injection molding process should be tightly controlled. In other words, the grinder should be dedicated to the injection molding machine with dedicated material collection and conveyance system, ideally located next to the injection molding machine.
Advantages:

- stable percentage of regrind in use,
- easier process control,
- uniform component structure,
- traceability of material composition
- prevention of dust contamination close to IM machine & TI components.

The following aspects needs to be considered:

- type-pure sorting of components from the same TI family or regrind material
- dedicated grinder for material types
- or capable cleaning process (grinder unit)

6.3.3. Further processing (Injection Molding process)

Drying of regrind depends on storage conditions and material origin and must be considered for serial production approaches. Drying is not necessary when material is directly milled in a dedicated grinder which is placed next to the Injection Molding machine & processed immediately (continuous process).

Minimum Injection Molding equipment requirements for metering & feeding regrind material:

- gravimetric blender with a sufficient mixing element which provides a homogenous material distribution and with at least two separate hoppers for origin material and regrind material
- suitable for processing of regrind with a low bulk density
- integrated conveying regulation
- hopper load control

6.4. Component aspects – Part To Part Morphological Consistency

Varying processing conditions, due to the usage of fluctuating regrind contents, or varying regrind quality (e.g. multiple generations of regrind) can lead to variation in rheology of the molten plastic in the mold which in turn would influence the morphology of the molded components. In other words, the variation introduced to the process due varying regrind quality, can result in morphological defects in the molded component, which will result in varying degrees of structural weaknesses in the components. These defects can negatively impact the component's structural integrity and reduce the design intent functionality of the part during either the assembly process at TIFS plant or the in-service functionality and durability, once it is assembled in the vehicle.

To determine impact of morphology "deviations" a destructive investigation (e.g., cross-section) must be performed. For this evaluation main functional areas of the components must be considered and determined jointly in a discussion between the supplier's experts and the designated TIFS Manufacturing Engineering representative who has expertise in injection molding, among other participants. The special characteristics callouts off the component drawing can be used as a guideline to determine the functional relevant areas of a component. In addition, via mold flow analysis identified areas for occurrence of sink marks, weld lines and air inclusions should be considered for a component integrity check.

6.5. Process control

Supplier must show at time of PPAP and annually thereafter, verified proof of the injection molding machine barrel thermocouple performance evaluation. This shall be performed via a calibrated Drywell verifier. The Molding machine is not valid for this test. Example, figure 1, page 10. This test is to ensure the thermocouples are not allowing the heaters to override the settings and degrade the resin. Tolerance requirement is +/- 6° F. of set point indicated on the Drywell verifier.

The supplier must monitor, capture, and document the critical process parameters throughout the production shift at a frequency which is agreed between the supplier and the designated TIFS Manufacturing Engineering representative who has expertise in injection molding. This records must be archived and available to TIFS representatives upon request.

In addition, the following parameters are considered critical by TI Manufacturing Engineering and the supplier is required to verify and document them per shift. These parameters must also be included in the control plan and in the PPAP submission package.

Injection molding process must be monitored by operations/quality. At minimum the following parameters are to be monitored as critical parameters: (See 7.0 for other requirements).

- Filling time
- Charging time
- Cycle time
- Shift position
- Cushion
- Injection pressure
- Barrel heats
- Shot size
- Packing pressure
- Packing time
- Interruptions, and normal shutdowns.
- Time and date
- Resin moisture analysis log

The following process parameters must be listed and documented in the control plan:

1. Cylinder temperature
2. Mold temperature
3. Injection time
4. Part weight

The tolerance range for items 1 to 4 must be evaluated and optimized by the supplier during the development process and proposed to TIFS for review and discussion. The final tolerance range must be explicitly ***signed off by TIFS*** designated Manufacturing Engineering representative who has expertise in injection molding.

For the sake of transparency please note that in TIFS internal injection molding process for Quick Connector bodies, TIFS uses the following tolerance range for the above 4 parameters.
Item 1: +/-20°F (6.5°C)
Item 2: +/-10°F (6.5°C)
Item 3: +/-0.05s
Item 4: For components which weigh more than 1 g the tolerance range is +/-1%

As noted earlier, TIFS designated Manufacturing Engineering representative will review supplier's process optimization records, and together with the supplier, they come to an agreement on tolerance range of the above 4 critical process parameters.

7.0 Quality Requirements

Control plan and FMEA must be submitted and approved by TIFS Quality and the designated Injection Molding Manufacturing Engineer prior to final PPAP submission.

Supplier must show proof of QC (quick connector) lot traceability. Frequency: Bulk 1 returnable or box identification.

Supplier must be able to provide records of Injection molding process limits verification. TI would prefer electronic records, but hand-written documents that can corelate to any given lot number produced with time and date recorded are also accepted.

7.1 Product component testing / Test to failure

Fuel and vaper QC Bodies only

Structural Integrity Test: As part of the injection molding start-up routine for each production lot, and prior to release of the machine to production, the first pieces of injection molded QC bodies must be tested for structural integrity. The Structural Integrity test is intended to assess the robustness of morphology and integrity of injection molding process at the start of each production lot. This test is above and beyond the requirements of SAE J2044.

Cone Test: TIFS preferred test method to assess structural integrity of the QC body is the “cone test” which is a destructive test. The test uses the tensile tester and a conical pin to measure the force required to break the QC body.

The supplier is welcome to propose an alternative test methodology to replace the “cone test”. TIFS team will evaluate the proposal internally and discuss the issue with the supplier. However, the alternative to “cone test” must be explicitly approved in writing by the TIFS Quality representative **and** designated Manufacturing Engineering representative with expertise in injection molding prior to PPAP. For avoidance of doubt, without a written authorization as noted above, the only accepted test method for structural integrity of QC body is the “cone test”. The “cone test” protocol is described in the following passage.

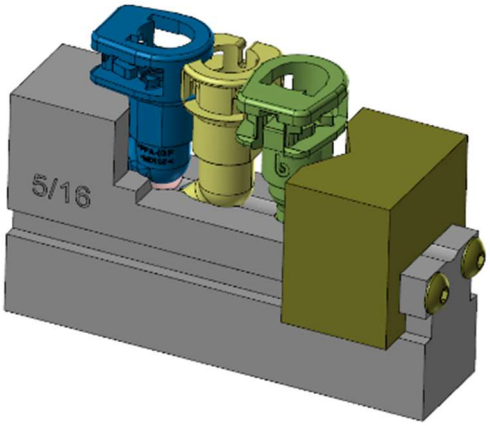
Cone Test Sample Size: Cone test must be part of the FPO (First Piece OK) of the machine start-up protocol for each production lot. Please follow the sampling production as it is outlined below;

1. For molds with 1 or 2 cavities consider 3 samples to be tested at FPO
2. For 4-cavity molds or higher cavity molds consider 1 sample per cavity to be tested at FPO. . Samples must be tested and documented before the start-up of each run. Cone test records must be archived and be available to TIFS for review routinely.

Cone Test Protocol

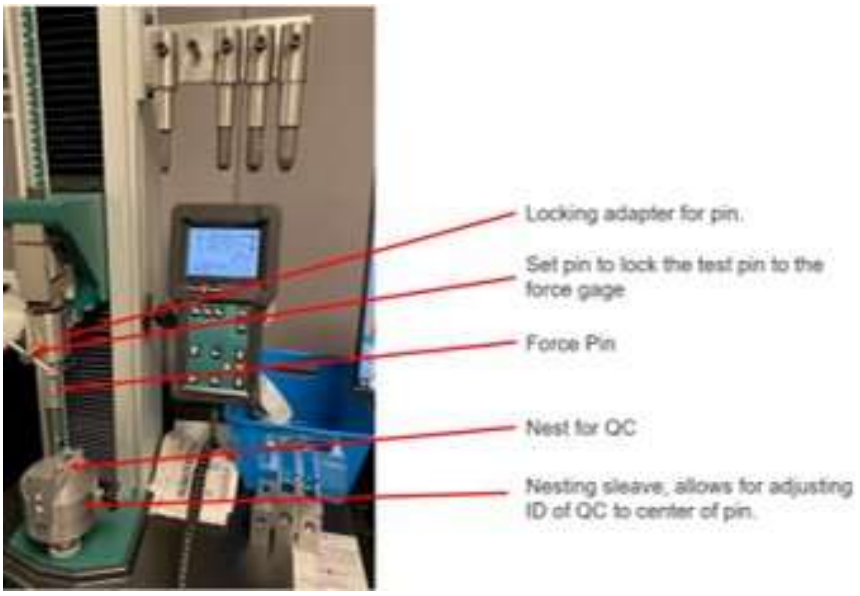
- Testing must be incorporated into the process control plan and PFMEA.
- Using a Tensile tester applying force to the o-ring bore and tube pocket transition with an oversized conical pin that has a lead in of 17deg.
- Pin Hardening Specification: RC-55
- Apply pin force until the QC fractures or the unit has reached a predetermined lower threshold acceptance force limit.
- Record the test results. Note: Each QC is unique with respect to the force that it takes to fracture the body. TIFS studies 10 samples from 10 different production lots to determine the lower limit force to fracture the QC housing.
- The lower threshold of force to fracture value for each QC must be determined through an individual test study (based on sampling of 10 pieces from 10 production batches.
- For the sake of continuity, please note that the accepted threshold force for TI QC bodies which are injection molded in-house is 600 lbf.

***QC bodies externally may appear and measure correctly but should always be tested for structural integrity outside of the SAE J2044.*



setup example

Nest Example



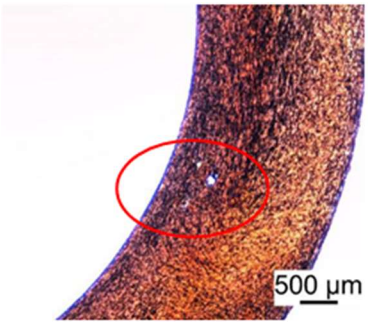
force pins Example

Note: The conical test is one example of how to test and understand the performance of the resin with respect to tensile straight. The supplier can use any means necessary to perform this test however the “conical test” is the preferred choice internal to TIFS and has been proven to contain any risks due to low tensile strength.

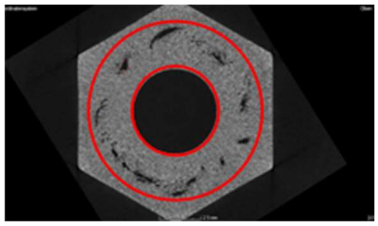
7.2 Addendum for Product Quality

Examples: Component's imperfections

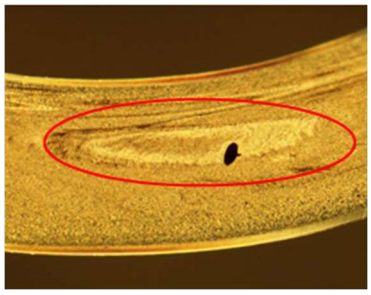
Voids in Component



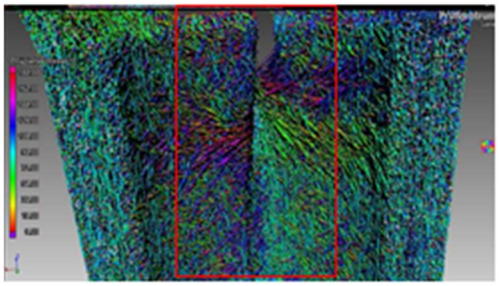
Voids in Component



Voids in Component



Flow line & inclusions



Weld line

Figure 1. Drywell example

FLUKE

Drywell, Field Dry-Well, Fluke 9140, 95° to 662°F/35° to 350°C

Item # 33W930
UNSPSC # 41113646
Catalog Page # 562

Mfr. Model # 9140-A-156
Catalog Group # K3067

Country of Origin USA. Country of Origin is subject to change.

The adjustable setpoints on these drywell calibrators allow users to program multiple setpoints when calibrating their RTDs, thermocouple, and bimetal thermometers. Select models may be compatible with optional interchangeable inserts fo View More