Texas Instruments Annual Paper Audit

The Annual Paper Audit addresses the most commonly asked manufacturing questions that the TI sites receive from our customers. If you have any questions that remain unanswered, please contact your TI Sales representative.

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External Certifications

What are some of the external/3rd party certifications that TI holds?

TI is involved in several initiatives to improve semiconductor quality and reliability, including the development and advancement of industry standards and participation in a range of industry symposia. TI holds several external certifications including ISO9001, IATF 16949, ISO14001, ISO45001, and EMAS. TI has been International Organization for Standardization (ISO) certified for Quality Management System (ISO 9001) and Environmental Management System (ISO 14001) since 1996 and has maintained compliance to the ISO requirements since that time. A current list of TI Certifications can be found on TI.com/quality.

Does the company hold automotive specific certifications?

Yes, TI is compliant with IATF 16949. IATF 16949 is an international quality system standard specifically formulated for the global automotive industry. IATF 16949 certificates for each TI factory can be found on TI.com/quality.

Does the company hold environmental certifications?

Yes, all TI manufacturing sites are compliant with ISO14001, an international standard that recognizes environmental management systems. Our European manufacturing site is compliant with EMAS, a European regulation to measure environmental improvement. Certifications for both ISO14001 and EMAS are available at TI.com/quality.

Quality Manual

Does your company have a documented quality manual that is accessible to everyone?

Yes, TI has a Quality System Manual (QSM) that is available to all employees. The QSM is the root of TI's Quality System and defines policies and procedures used to assure our products and services meet our customer's requirements along with international and national standards. The manual is available at TI.com/quality.

How is TI's quality manual communicated to employees?

Employee awareness of their impact on quality is inherent in TI's quality culture. It's a thread that runs through all TI training, requirements, and systems. All employees receive annual training that includes a "Responsible Business Practices" component. TI's Responsible Business Practice training includes information regarding TI's standard practices, policies and procedures including the Quality Systems Manual.

Is TI's quality manual kept up to date?

Yes. TI's Quality System Manual is updated as needed to reflect changes in customer requirements and TI operations. Additionally, each quality specification in TI's Quality System Manual is subject to a mandatory periodic review and re-approval process.

Audits

How often do internal audits happen?

Internal audits are conducted at every manufacturing location and support organization on an annual basis. Audits are conducted using the process approach to verify compliance. Integrated within these audits, the auditor samples customer-specific quality management system requirements for effective implementation. The organization audits all manufacturing processes over each three-year calendar period to determine their effectiveness and efficiency. Within each individual audit plan, each manufacturing process is audited on all shifts where it occurs, including the appropriate sampling of the shift handover. The manufacturing process audit includes an audit of the effective implementation of the process risk analysis (such as PFMEA), control plan, and associated documents.

How do you set audit frequency?

To ensure a high standard of quality, TI participates in internal audits, customer audits, and external certification audits. The frequency of audits is reviewed and, where appropriate, adjusted based on occurrence of process changes, internal and external nonconformities, and/or customer complaints. The effectiveness of the audit program is reviewed as part of management review.

Where can I find more information on the quality management and the audit process at TI?

The quality management and audit process are further explained in the Texas Instruments Manufacturing Quality Annual Audit Report. This report is updated annually by Texas Instrument's Customer Audit Team.

Continuous Improvement Projects (CIP)

Does CIP result in positive results in defect rates (PPM) or cost of poor quality (CoPQ)?

Yes, TI has demonstrated a significant improvement in quality over the last decade as a direct result of Continuous Improvement Projects. These quality improvements have directly reduced both

defect rates (PPM) and CoPQ. Our PPM, CoPQ and continuous projects are closely monitored throughout the year using the management review process.

How is continuous improvement supported at TI?

Continuous improvement projects are identified based on customer feedback, audits, formal reviews, failure analysis and customer/TI meetings. These projects are implemented by various groups across TI as part of quality improvement plans and initiatives. TI has over 450 continuous improvement projects across all sites applied to reduce risk of future customer returns.

Risk Analysis/Error Proofing

How does the company use appropriate error proofing methods?

TI's culture drives risk-based thinking and error proofing throughout all aspects of our business. TI uses risk management as part of new product development and manufacturing. Examples of risk management strategies include phased gated new product development, project risk assessments, business continuity planning, product qualification, and characterization methodologies and change management methodologies.

For IATF 16949 requirements, TI uses FMEA to prevent errors and assess risk. FMEA is done on small building blocks of the design or process to have a clear focus on the issue and then combined to create an exhaustive FMEA of the entire layout or process node. A core team of employees representing the affected functions reviews and develops the FMEA using a multidisciplinary approach.

Is there a Process Control Plan available?

Control plans are in place for all technologies and captures critical process parameters. MSA for all tool families along with measurement frequency and sampling size are listed in the control plan. All processes that appear in the control plan are also found in the PFMEA system.

How does TI implement New Product Development?

New product development follows a phased approach consisting of assess, plan, create, validate and the possibility to sustain after release to market. Each phase has documented deliverables and phase exit review to ensure approval for the next phase.

FMEAs

How are PFMEAs updated?

PFMEA are updated every year or as applicable. The One Make PFMEA System documents all PFMEAs and tracks modifications made to all PFMEAs with a FMEA Change Number (FCN).

When is Design FMEA (DFMEA) developed?

DFMEA is initiated by design concept finalization for new products and updated as changes occur through the phases of product development. DFMEAs are reviewed and updated as changes occur or additional information is obtained.

When is Process FMEA (PFMEA) developed?

PFMEA is developed and updated when developing new semiconductor processing technology, transferring a new or existing technology, and such existing technology in a production facility. PFMEAs are reviewed and updated as applicable at least once a year.

Business Continuity Plan

Does TI have an up to date Disaster Recovery/Business Continuity Plan?

TI has a Business Continuity Program that covers contingency planning, incident management, crisis management, customer response, and business recovery. TI uses the plan to prepare for continuity of supply in the event of key equipment failures; interruptions from externally provided products, process and services; recurring natural disasters, fire, utility interrupts; labor shortages; cyber-attacks on information technology systems; and infrastructure disruptions.

How are potential risks addressed by TI's business continuity program?

The TI Business Continuity Program protects TI's corporate interests by doing the following:

- Minimize the impact and potential disruption to TI customers and stakeholders
- Support a timely and effective response, recovery and contingency for interrupted TI business operations, such as design planning, supply chain, manufacturing, sales and, shipping
- Minimizing TI financial and operational impacts that could seriously jeopardize the corporation and brand
- Satisfy TI's business obligations throughout the crisis event
- Communicate effectively in order to provide accurate and consistent information to internal and external stakeholders
- Address TI employee, humanitarian and community concerns where TI operates
- Ensure TI leadership support and expectations for program elements

Where can I find additional information about TI's Business Continuity Plan?

Additional information about TI's risk management and business continuity plans can be found in TI's

annual Corporate Citizenship Report located on TI.com.

Non-Conforming Material

What is the procedure for identifying, isolating and controlling non-conforming material?

Once identified, nonconforming material is first segregated electronically. It is subsequently segregated physically when appropriate. Segregation includes such activities as lot trace, outlier identification, lot hold and lot restriction. Detailed containment and notification procedures for defective or suspect product are specified in TI's quality manual. The 8D process and 3x5 why methods are used to address the root cause of an issue and determine corrective action as applicable.

What is allowed for rework?

Rework is allowed for certain approved processes using pre-defined approved rework procedures as documented in the control plan. All rework procedures undergo risk analysis prior to approval and deployment (e.g. FMEA, Control Plan, qualification, etc.). Instructions for rework, including re-inspection and traceability requirements, are utilized by personnel performing rework. No other rework is allowed. Records of the completed rework are documented in the lot history.

How is process measurement and monitoring used to reduce product variation and out of control occurrences?

TI uses process measurement and monitoring for manufacturing process control and to minimize process and product variation with a goal to achieve zero defects. Important characteristics are identified, data is analyzed, and statistical process control (SPC) is the used manufacturing process with an emphasis on defect prevention versus detection. Automated systems are applied for product statistical yield outlier (SYL) and standard statistical bin outlier (SBL) with quarterly limit recalculation, where applicable. Additional statistical based controls may be available for specific design and process technology that is based on business product engineering.

What is the process for notifying a supplier of non-conforming material?

TI follows the control process guidelines of non-conforming material per the IATF 16949. TI will notify the customer in the event that nonconforming product has been shipped. Initial communication will be followed with detailed documentation of the event. TI requires a supplier's root cause analysis of a non-conforming material to perform corrective action(s). The quality event management system is utilized to help track events and actions to keep employees within the company updated on the quality events including customer returns and instances of non-conforming material.

Environmental Control

What are the required garments to be worn in cleanrooms?

For clean rooms below class 100, personnel are required to wear a jump suit, a hood with face mask, dedicated clean room shoes, and clean room approved gloves. For clean rooms above class 100, personnel are required to wear a full length or ¾ length smock, face mask, shoe covers or clean room shoes, and clean room approved gloves or antistatic finger cots. Everything worn in the cleanroom must be kept clean and dry and changed immediately if contaminated with chemicals or other materials. For areas classified as class 10k or cleaner, cosmetic and face powders are prohibited.

What is the cleanroom rating of the site?

All TI Fab cleanrooms comply to class 1, 100 or ISO 5 standards to prevent environmental induced wafer contamination. Wafers are exposed minimally to air in the clean room as they are stored in protective wafer handling containers in the fab and transferred to machines.

For Automated Factories (i.e. RFAB, DMOS6, LFAB) wafers are exposed only to class 1 environment as wafers are contained in FOUP (front opening unified pod).

At A/T sites, back grind and mold compound processes take place in a class 200k or ISO 9 cleanroom. All other front-end processes from wafer incoming inspection to molding are conducted inside a class 10k, 100k or ISO8 clean. The end of line processes from post-mold to post-test are conducted outside of a clean room.

What is the mini environment rating of wafer handling containers?

Protective storage containers for wafers such as FOUPs and SMIFs have class one mini environments, so they allow the lowest number of particles. The protective containers for the wafers are small, isolated environments around the wafer allowing for more control of particle contamination. In fabs with automatic wafer handling, the wafers are only exposed to the air inside the wafer containers and machines, meaning they have no exposure to higher class rating areas, decreasing the chance of contamination.

How are particles monitored throughout the Fab?

Particles are measured by area of the fab and through individual tools. The cleanroom areas are monitored with a minimum particle concentration, duration, and number of measurements per sample compliant with ISO class limits for the designated ISO class. Measurement equipment for particle concentration is calibrated and not exceed upper limits from manufacturer for particle concentration or size. Tools in the fab have individual SPC charts to monitor particles. If particles are out of control limits the equipment is taken out of service. If particles remain out of control then cleaning cycle maintenance is performed.

What is the temperature and humidity control?

The temperature and the moisture content of the air is tightly controlled. Air that leaves the clean room through the exhaust is replaced and sent through make-up air units that adjust the latent and sensible heat of the air. Recirculating air handling equipment such as air handling units, vertical laminar fans, and fan-filter units remove sensible heat and keep the air flow as laminar as possible. Humidity is controlled with steam control valves and dewpoint sensors. Control limits for environmental parameters are well documented and in the case of any out of tolerance conditions, notifications will be sent to the interested parties.

What is done to prevent contamination in the Fab?

Contamination in the fab is prevented by the commitment to TI's 5S program and adherence to proper gowning practices. TI's 5S program is used to ensure a clean workplace and TI's gowning procedure prevents contamination from individuals bringing particles in from outside of the fab.

How frequently are cleanrooms monitored?

Clean rooms are monitored periodically for temperature, humidity, pressure, air flow rates of laminar-flow hoods and particle concentrations.

How do you maintain a neat and clean facility? Does the company follow 5S?

The 5S program at TI is used to align employees on the housekeeping expectations and cleanliness standards of clean rooms and clean zones. The 5 steps of the 5S program consist of sort, set in order, shine, standardize, and sustain which aim to clean the workspace as well as keeping employees constantly responsible with maintaining a clean workspace. Signage in the fabs is used as a reminder of the program.

ESD

How is the workplace ensured to be ESD safe/compliant?

Multi-probe, back-grind operations, and labs follow a specification outlining all ESD requirements. Where necessary, TI employees use a wrist strap or ESD protective footwear and ESD protective smocks for personal ESD protection. Further protection can be achieved by the use of air ionizers, ESD caution signs and the removal of items with high electrostatic potential from ESD sensitive devices. Audits are performed for each operation involving the processing, handling or storage of ESD sensitive wafers to verify compliance.

What are the requirements for ESD Sensitive Devices and Assemblies?

To ensure that ESD sensitive devices are protected, TI has a designated ESD coordinator to ensure the protective requirements are being fulfilled. ESD sensitive devices are held in ESD safe area with proper grounding protocols protective work surfaces. When not in a protected environment, devices are packed in ESD protective packaging that is properly labeled. Employees receive training in ESD safety before access to ESD sensitive areas to ensure ESD safe practices are being followed by all employees.

Calibration and Preventative Maintenance

Is the calibration system automated?

To error proof calibration details, TI uses calibration activities to ensure accurate calibration equipment is used and meets IATF 16949 requirements, such as labels or a barcode system to read the equipment ID and retrieve the calibration data. Some sites may utilize a calibration specialist or the calibration management system as they control the calibration schedule, security, and sign off for the equipment. When a problem occurs with the calibration report, out of tolerance and broken report notifications inform employees of how to aid with the solution. The metrology tool will be put on hold till the calibration/verification update is within spec.

Does TI implement well documented Preventative Maintenance (PM) procedures for all equipment?

Yes, TI invests heavily in Preventative Maintenance. Each TI manufacturing operation determines which equipment requires Preventative Maintenance (PM) and maintains it by cleaning, lubricating, replacing parts, cleaning and replacing air filters, and making necessary adjustments. The maintenance programs are defined through written procedures that specify the frequency and schedule of maintenance activities, the responsible function for maintenance, and provisions for adjusting maintenance frequencies. Records of these activities must be kept. The maintenance intervals for equipment are determined based on industry practices, manufacturer recommendations, and feedback from technicians. Commercial equipment follows the manufacturer's instructions unless history indicates a change is needed. If customized PM procedures are used instead of the manufacturer's manuals, equipment-specific PM procedures are published, covering frequency, instructions, responsibilities, and criteria for adjusting intervals. If calibration or verification is part of the PM procedure, the PM record includes calibration records.

How are preventative maintenance and calibration schedules tracked?

Preventative maintenance and calibration schedules are tracked within TI’s scheduling software as per IATF 16949.

Is there regular calibration?

Calibration is performed internally or by sources on TI's approved Calibration Sources that are either ISO/IEC 17025 accredited or an original equipment manufacturer. Tools are tracked to provide a schedule for tools due for calibrations. Some sites may utilize the calibration schedule status and due date that is listed in the Calibration Alert and Daily Recall Report to alert employees of upcoming calibration.

What happens to tools if calibration of PM is missed?

Equipment is removed from service or removed from the factory when it is flagged by TI's Manufacturing Execution System for requiring PM calibration. An out of tolerance notice from equipment results in containment of the product handled by the equipment and corrective action to resolve the out of tolerance conditions.

How is unauthorized calibration of equipment prevented?

Equipment is sealed with tamper resistant materials to prevent tampering with the calibration settings. External calibration requires certificates to ensure the quality of the calibration.

How often is the equipment cleaned?

To ensure the reduction of particle contamination, TI establishes a cleaning schedule and procedure for all equipment. This ensures all employees are aware of the standard for the cleaning program and contamination elimination is a top priority.

Customer Returns / Customer Satisfaction

How is customer satisfaction maintained at TI?

TI promotes customer satisfaction by obtaining customer input through customer scorecards, feedback and customer specific requirements. This input is then used to create improvement plans intended to fully address customer satisfaction. Further information about customer satisfaction and returns can be found in the General Quality Guidelines on TI.com.

What are the company's quality goals?

TI sites follow the Quality Management System (QMS) spec requirements with quality metrics reviewed periodically with site management. TI strives to continuously reduce the number of parts returned through continuous improvement projects and preventative maintenance. Quality objectives are reviewed on a weekly basis to ensure they stay up to date with changes.

How are customer returns addressed?

TI has an established customer return process to address non-conformance requests through the Customer Return Portal (CRP) on TI.com. Customer returns are addressed with preliminary and final 8D reports that include FA data from the investigation to address the root cause of the problem. These reports are used to determine corrective actions that can be implemented in the company if needed.

What is the 8D reporting response time?

8D reports are one of the many ways that TI uses to find the root cause of problems to help prevent repeated issues. The response time for these reports is dependent on the severity of the customer return. Customers are updated periodically throughout the analysis. Further information on the customer return process can be found in the General Quality Guidelines on TI.com.

Employee Training

Does management require assessment of ongoing training needs?

Training is tracked and recorded through the myLearning system. Employees receive required training modules through the system and management can assign extra modules additionally to required training.

Do all relevant employees have SPC training?

Employees and their supervisors decide on whether SPC-related training is needed. Supervisors assign employees the required SPC-training if required for their work.

How is employee training implemented?

Most employee training is performed through TI's myLearning system. Training can be assigned and tracked through the system to ensure that employees are receiving adequate instructions. Clean room access is restricted to personnel that have gone through the required training and successfully passed any required test about the material.

How are new trainings/protocols/new information established through company?

TI has A/T sites and fabs all over the world. To ensure that all TI locations share findings and follow the same standards, new information is conveyed through TI's formalized fan in fan out (FIFO) process. TI utilizes shared learnings across the fabs and A/T sites to ensure that best practices are utilized across the company. A multifunctional team of subject matter experts at all fabs and A/T

sites access information tracked in TI's Quality Event Manager System to implement lessons learned.

Training Areas

How is confidential information kept private?

Documents have different classification levels with distinctive confidential labels based on who is able to access the information. Non-confidential information is available to the public, Selective Disclosure information is stored on the TI internal network and can be disclosed with the proper marking, Confidential-NDA Restrictions can only be disclosed on a need to know basis to outside parties with an NDA with TI, and the information with a Confidential-Maximum Restrictions has restricted access within the company and very rarely disclosed to external parties with NDAs with special information handling requirements. Employees participate in periodic training to ensure they understand how to properly handle and label confidential information.

How does TI ensure counterfeit part prevention awareness?

TI employees receive counterfeit detection and mitigation training as deemed appropriate. Training is tracked and assigned through TI's myLearning system. TI works actively with the Semiconductor Industry Association to advance standards to reduce the incidence of counterfeits and assist law enforcement in their efforts to address the problem.

How is intellectual property protected?

TI supports and encourages employees submit patentable ideas to the TI Patent Team in order to protect intellectual property (IP). TI has a Patent Award program to reward employees for the time and effort they put in to get a patent filed. To protect intellectual property from cyber-attacks, items such as tool recipes and test programs are sanitized from tools before being sold or delivered to non-TI entities. Confidentiality of customer products and projects under development, including related product information, is a critical aspect of operational planning and control in IATF 16949. Texas Instruments takes the appropriate measures to protect the confidentiality of such information.

How is TI protected against cyber-attacks?

TI employees participate in training, including simulated phishing and spear-phishing emails, to inform and protect themselves against cyber-attacks. The IT team works extensively to protect TI's internal network and sensitive information from attacks. There are established processes for employees and suppliers to protect TI from cyber-attacks including virus scanning and system hardening requirements. TI is compliant with regulations such as EU General Data Protection Regulation and the China Cybersecurity Law. Further information on the reduction of cybersecurity

risks can be found in the Texas Instrument Annual Corporate Citizenship Report located on ti.com.

Management Review

How does top management demonstrate commitment to quality management?

TI uses the role of Worldwide SC Quality VP on the technology and manufacturing group's leadership team to lead TI's quality department. The quality department aids other teams with focusing on quality expectations and compliance with required regulations. Top management ensures the policy in the quality manual is deployed through quality objectives and processes, and supports teams with adequate resources to manage, maintain and improve the Quality Management System (QMS).

How often are management reviews?

Management reviews occur at a minimum yearly, however their frequency is increased based on risk to compliance, scoring metrics, and/or customer complaints. Top management uses all process found on the business process model to assess the effectiveness of the quality management system. Some of these processes include: customer satisfaction, quality objective, nonconformities, and audit results.

What is the organization of the quality department?

Each position in the quality department has defined responsibilities and objectives. Every function has a primary employee assigned to it along with a backup employee to ensure all required jobs within the quality department are covered.

Environmental Standards/Chemicals

Is the company compliant with banned/restricted substances?

TI's extensive approach to environmental stewardship involves transparency on environmental standards about restricted materials and how TI parts adhere to or are exempt from these standards. Statements about specific laws such as EU RoHS and EU REACH can be found on the Environmental information page of TI.com. Information about specific parts and their material composition can be found on the material content search.

How are new materials accepted?

The acceptance of new materials includes initiating the RCM (Restricted Chemical and Material) process for ESH screening, WPL material management and WW (World Wide) packaging material content data.

Storage and Incoming Materials

Are incoming materials subjected to Certification of Compliance/Conformance check?

To ensure the quality of outside materials entering into manufacturing areas, all incoming materials require a Certification of Compliance/Conformance. Incoming materials are checked using a e-COA system. The e-COA repository provides electronic receipt, approval and storage of COC and COA records from vendors. Every material lot is inspected against supplier data with purchase specification as COC.

How are incoming parts or materials evaluated?

Most incoming material does not require verification as it is only required for certain direct material commodities. Purchased material quality is verified through either incoming inspection or review of supplier data. Incoming parts and materials that require evaluation are segregated from inspected pieces and appropriately identified until the completion of the require inspections.

Do incoming and outgoing materials have barcodes?

Incoming and outgoing materials are labeled with barcodes to simplify batch management and decrease manual errors of tracking. The barcode data includes a tracking number, customer inventory part number, lot number, and expiration date to aid with the tracking of a product. Additionally, the outgoing barcode, included on the lot card, includes the factory, Lot number, Device and 'Automotive' designation (for automotive only).

Are materials stored in appropriate environments?

To ensure the high-quality storage of incoming materials, sensitive items like chemical materials and photo resist are stored in environmentally controlled storage rooms or locations.

What is the tracking system for material storage?

To aid with organization, containers of wafers are labeled with both machine-readable data and human readable text. To ensure the use of FIFO to release accepted materials into production, wafer boxes and assembly materials are marked with date codes, receive dates, and partial box quantity. TI's manufacturing execution systems are used to track all materials to tell what material lots were used to fabricate certain products.

What are the requirements to track specific parts?

To maintain traceability at TI, wafers and ICs are marked with an Assembly Lot Trace Code (LTC)

that includes a batch number and an LTC. Therefore, it is easy to track where parts came from if there are problems with a specific lot. For critical application products, each die is given a die trace code for individual die traceability with the Assembly LTC and the coordinate of the die on the wafer.

How is FIFO inventory implemented in your company?

Inventory system (SAP) manages FIFO and tracks the earliest receipt for parts automatically to exhaust the oldest date code before allocating the next date code. Using the FIFO system dedicates location for old stock and new replenishments to aid with the organization of inventory and further implement 5S system within TI.

Change Notice

Does TI have a PCN system?

Yes, TI has implemented a product change notification system to alert customers of a change to a TI manufactured production released product, process, or service. Consistent with the industry standard, J-STD-046, customers will be notified of major changes which affect the form, fit, function, or adversely affect quality or reliability of the product.

How are customers notified of changes to product? How are significant changes handled?

Customers who have purchased the product in the last 2 years are alerted to changes through TI's product change notification (PCN) system. Major changes that impact form, fit, function, quality, or reliability require customers to receive a description of the change, qualification testing and reason of the change to benefit the customers transition. There is a minimum of a 90-day notice before implementation of major changes to non-automotive parts and a minimum of a 180-day notice before implementation of major changes to automotive parts. These significant changes are handled by the Business Unit Change Control Board. TI performs a full evaluation of minor changes and these updates are sent as informational notices.

Is change implemented only after customer acceptance?

Customer approval for a change is not always required. The PCN system documents if customer acceptance is required. If customer approval is not required and there is no customer response, then the change is approved to implement once the PCN has expired.

How are specification changes proposed and authorized?

Specification changes are approved by the Change Control Board (CCB) and implemented in

engineering change notices (ECN). The approval for these changes is authorized through the IT system.

How are specification changes implemented?

Changes are implemented through TI's Manufacturing Execution System. Once a change in spec or parameter is signed off then the MES will automatically set the implementation of the change. The MES also controls monitoring inspection items and measurements specifications.

How are easy changes to the process recipe avoided?

The ECN system controls the process recipe to assure proper authorization before changes are implemented to the recipe.

Is there a document control system in place that tracks and implements changes?

The Engineering Change Notice is a formal process used to track approved procedural and process changes through implementation. Documentation approval goes through defined workflows and revision history is maintained.

Cpk values / Control limits

Are Cpk values within WECO rules?

TI applies WECO rules as appropriate. Exceptions to WECO rules being turned on are reviewed by SFC Steering Team. Adherence to WECO rules improves process performance by reducing or eliminating sources of variability from nonrandom patterns. WECO rule violations are treated with the same severity as out of control situation.

Is Cpk greater than 1.67?

TI uses a criterion of Cpk greater than 1.67 to ensure the Cpk value is wide enough to allow process variation and tight enough to control process variation. The continual improvement program strives to achieve a Cpk greater than 1.67.

Is corrective action required for Cpk <1.33?

All processes or control plan items with a Cpk value below 1.33 are considered statistically incapable or unstable. An out of control reaction plan is implemented to improve the Cpk value to greater than 1.33. The reaction plan includes root cause analysis, FMEA or SFC to be reviewed to understand risk and corrective action and containment of the out of spec conditions.

How are control limits calculated and implemented?

The control limits are statistically derived.

What is the process for product that fails SPC limit?

If a product fails an SPC limit, the tool and the lot are put on hold to prevent further errors. The failed SPC limit requires an engineering review to understand the effect and solution to the failure for both critical and noncritical processes. Disposition of material and tool is per the site's respective disposition spec of reaction plan.

Is TI's SPC system automatic?

Yes, TI utilizes Statistical Factory Control (SFC), SPACE, or an equivalent system to maintain quality and stability and collect data. Charts are accessible through select computers. The system automatically tracks critical and non-critical in-line and electrical parameters. Automation is used to take tools down, stop processes and hold lots. Automation also places traces on lots and sets future holds at outgoing.

What is the process for reviewing and revising SPC limits?

To increase control limits, process engineers need approval from SPC steering team and must present the changes in an SFC review meeting.

Record Retention

What is the minimum document/record retention period for quality records?

Record retention at TI is dependent on the application and type of record being stored which is documented in a global record retention policy.

Site-Specific

Are air showers used to remove dust prior to entering the clean room?

Air showers are not used prior to entering most TI clean rooms. Extensive testing disclosed that particle count in the clean rooms from the weekly particle test was not affected by the use of air showers. Employees use proper gowning techniques and clean protocol to decrease the particle count. Certain AT sites use air showers.

AIZU	Yes
CFAB	No

DFAB	No
DMOS5	No
DMOS6	No
FFAB	Yes
LFAB	No
MFAB	No
MIHO	No
RFAB	No
SFAB	No
CDAT	Yes
CLARK	Yes
TIEM	Yes
TIM	Yes
TIPI	Yes
TITL	Yes
TIMX	Yes

Is there Automatic Visual Inspection of parts?

AIZU	Yes
CFAB	Yes
DFAB	No (done at SCT)
DMOS5	No (done at SCT)
DMOS6	Yes
FFAB	Yes
LFAB	Yes
MFAB	Yes
MIHO	Yes
RFAB	Yes
SFAB	Yes
CDAT	Yes
CLARK	Yes
TIEM	Yes

TIM	Yes
TIPI	Yes
TITL	Yes
TIMX	Yes

Does this site have automatic wafer handling?

The A/T sites have limited capability or no capability for automatic wafer handling. A/T sites apply the best practices for wafer handling and use vacuum pens and wands to avoid contamination and defects.

AIZU	Yes
CFAB	Yes
DFAB	Limited
DMOS5	Yes
DMOS6	Yes
FFAB	Yes
LFAB	Yes
MFAB	Yes
MIHO	Yes
RFAB	Yes
SFAB	Limited
CDAT	No
CLARK	Yes
TIEM	Limited
TIM	No
TIPI	Limited
TITL	No
TIMX	Yes

Process

What handling methods are used to prevent damage?

TI requires the use of ESD safe equipment, personnel and carts and the appropriate used of finger cots or gloves to eliminate ESD damage. Equipment is added to protect the die, lead frames, write bonds, and lead coplanarity during processing and inspection.

How are scratches prevented on wafers?

For handling, A/T sites utilize vacuum pens and vacuum wands instead of tweezers to reduce the risk of scratches and cracks. Some sites have limited automatic wafer handling so wafers are not handled by employees decreasing the risk of scratches and cracks.

Is the recipe and test program automated?

To reduce errors from manually inputted data, the recipe and test program are automated running on a barcode system. Barcodes include at a minimum the part number, supplier lot number, and the expiration date of a part.

How long are dicing blades used?

The machine will alarm when blade is at the end of its life to alert employees that the dicing blade requires a replacement.

Are capillaries reused?

Capillaries are not reused at TI. The frequency at which the capillaries are changed is dependent on the type of capillary and the life of the capillary defined by the design of experiments and evaluations. Re-cleaned capillaries are not used.

Does the dicing machine do a sampling check on kerf?

The dicing machine does have a sampling check on the kerf. The dicing machine has two blades, a blade to create the first cut through the top half of the die and a thinner blade to cut through the die. The kerf check function verifies the alignment of the two blades and the final kerf of the completed step cut. The machine alarms if the kerf check is too wide, too narrow, or off centered. The automated kerf check is conducted at a minimum of 2 times per sawing channel.

Are magazines cleaned and replaced regularly?

Yes, magazines are cleaned regularly. An automated cleaner with deionized water is used to clean contaminants and corrosive elements from the magazines. During regular cleaning, magazines are examined and unusable ones are scraped.

What is done to prevent die cracking at die attach?

To prevent die cracking, machines are equipped with 100% epoxy dispense inspections to detect any abnormality and prevent die attach. The machines flag out of tolerance epoxy levels and trigger a reaction plan. Die attach fillet size is defined in FMEA. The die attach epoxies/glue are designed to

have fillers or spacers for stability during dispense and settling.

How are lifted bonding and squashed wires avoided?

In order to protect assembled parts, they are transported in carried with end covers. To prevent wire deformity from manual loading, mold machines are equipped with automated loading.

How is mold resin controlled?

Mold resin is stored at a minimum of 0°C and thawed at room temperature for 16 hours. Resin that has achieved its useful life in floor after stabilization process is discarded. The temperature is controlled and desiccant is used to prevent moisture absorption before the mold compound is fed into the machine. Systems like Material Tool verification system and Material Management Inventory system do not allow use of expired mold compound.

What type of lead plating is used?

TI uses pre-plated lead frame and post plated lead frames. Pre-plated lead frames are made of nickel, palladium and gold. Post plated lead frames are made of tin. More information on the specific type of lead frame used for a part can be found on the material content search on ti.com/quality.

How is conductivity managed for die cutting?

The die cutting process happens in a bath of deionized water that is cleaned of solvents to ensure a low conductivity. To manage the conductivity, the resistivity of the deionized water is actively monitored with a conductivity meter.

When are mold parameters checked?

Mold parameter are checked after die cleaning, adjustments of parameters, machine conversion, preventative maintenance, major repairs, minor repairs, mold die conversions, and at mold compound conversion with program change.

Do A/T sites require wafer map data from the fabs?

Yes, electronic wafer map data is stored in the WISH system. This system prevents a lot start system of a fab lot without a wafer map, prevents two maps being uploaded to the same wafer ID and requires IT personnel to change permission for the server. Manual upload of wafer map data to the server is prohibited.

How is the Material Tool Verification System (MTVS) used to reduce errors?

The MTVS ensures that the correct and qualified tools, materials, and machines are used before

processing lots. The system can also detect misprocessed lots and will prohibit machines from running if material verification fails. To ensure fool-proof detection, the MTVS is connected to other preventative maintenance and inventory tools such as the material management inventory system (MMIS) and the computerized maintenance management system (CMMS). The PM expiration date of a machine is controlled by the MTVS to assure only qualified machines being used.

How does the Material Tools Validation System (MTVS) prevent errors in the process and recipe?

The Material Tools Validation System uses a barcode check for all machine tools for the recipe to prevent skipping process, missing process errors, and preventing selection miss for recipe.

Automotive

Is there rework for automotive parts?

TI does allow automotive reworks that are qualified and allowed per spec.

What is the minimum document/record retention period for automotive testing records?

Automotive records are stored according to IATF standards. For certain critical record types, including lot history records, reliability monitor results, design review documents, and new product approval data, the retention periods for automotive products are longer than for other products.

Is there an automotive identifier on lots?

TI's manufacturing execution systems clearly identify lots as automotive and sites have a clear automotive identification on the lot traveler. Automotive identifiers are used to label the lot from the wafer fab through shipping to the A/T.

Is there an automotive identifier on tools and equipment?

All tools are capable of probing automotive lots; the tools do not have automotive labels.

Appendix A (TI Abbreviations):

Abbreviation	Definition
8D	Eight Disciplines (8Ds) Problem Solving is a method developed at Ford Motor Company used to approach and to resolve problems. Its purpose is to identify, correct, and eliminate recurring problems, and it is focused on product and process improvement. It establishes a permanent corrective action based on statistical analysis of the problem and on the origin of the problem by determining the root causes.
A/T	Assembly Test Site
A-B-A swap	The A-B-A swap method is used to investigate whether the observed issue is caused by non-TI part related aspects on the board.

Abbreviation	Definition
ACO	Assembly County of Origin
AEO	Analog Engineering Operations
AFM	Atomic Force Microscope
AIZU	TI internal abbreviation for TI Aizu, Japan Wafer Fab
APC	Advanced Process Control
APQP	Advanced Product Quality Planning
ASO	Assembly Site of Origin
ATE	Automated Test Equipment or Final Test
ATSS	Assembly Test Spec System
Batch #	Manufacturing Batch = SAP Batch number
BiCOM	Complementary Bi Polar
BCP	Business Continuity Program and Crisis Management
BOAC	Bond Over Active Circuit (BOAC)
C/T	Curve Tracer (C/T), a typical initial verification analysis measurement equipment for voltage vs. current curves
CA	Corrective action (CA): the action taken to help eliminate the root cause
CAPA	Corrective Action & Preventive Action
Carrier	Carrier is a pocket tape, tray, tube, or other fixture used to store and transport devices and components.
CCB	Change Control Board
CCO	Chip County of Origin
CDA	Code for TI Chengdu, China Assembly Site
CDA	Compressed Dry Air
CDM	Charged Device Model (an ESD Test)
CFAB	TI internal abbreviation for TI Chengdu, China Wafer Fab
CIP	Continuous Improvement Process
CLARK	TI internal abbreviation for TI Pampanga (Clark), Philippines A/T Site
CMMS	Computerized Maintenance Management System
CMP	Chemical Mechanical Polishing
CMS	Change Management System
CoA	Certificate of Analysis
CoC	Certification of Compliance/Conformance
COO	County of Origin
COP	Crystal Originated Particle(s)
COP	Customer Oriented Process
CoPQ	Cost of Poor Quality
Cover Tape	Cover Tape is a clear or transparent tape
Cpk	Capability Index-Centering
CPW	Chips Per Wafer
CQE	Customer Quality Engineer
CRCT	Customer Return Cycle Time
CRP	Customer Return Portal
CRU	Customer Returned Unit
CSO	Chip Site of Origin
CT	Cold Temperature
CT, C/T	Cycle Time
CU3	Code for TI Chengdu, China Wafer Fab
CU6	Code for TI Malacca (Melaka), Malaysia A/T Site
CUA	Code for TI Maine (Portland), USA Wafer Fab
CV	Capacitance-Voltage Measurement
CVD	Chemical Vapor Deposition
D/N	Delivery Note
DARC	Dielectric Anti-reflective Coating

Abbreviation	Definition
DC	Datecode (D), typically shown on the TI box label in the format "YYWW" (year-year-week-week).
DDAO	TI Dallas Device Analysis Organization (Lab)
Desiccant	Desiccant is a moisture-adsorbing material placed inside sealed dry-pack bags to adsorb internal bag moisture.
DFAB	TI internal abbreviation for TI Dallas, USA Wafer Fab DFAB
DFMEA	Design FMEA
Die	During this process, a wafer with up to thousands of circuits is cut into rectangular pieces, each called a Die.
DIP	Dual-In-Line Package
DIW	Deionized Water
DLN	Code for TI Dallas, USA Wafer Fab DFAB
DLS	Dynamic Laser Stimulation (DLS) can be used for failure isolation of functional failures dependent on voltage, temperature, frequency, using TTL input of XIVA.
DM5	Code for TI Dallas, USA Wafer Fab DMOS5
DM6	Code for TI Dallas, USA Wafer Fab DMOS6
DMOS5	TI internal abbreviation for TI Dallas, USA Wafer Fab DMOS5
DMOS6	TI internal abbreviation for TI Dallas, USA Wafer Fab DMOS6
DOE	Design of Experiment
DPPM	Defects Parts per Million
DT	Deep Trench
DUF	Diffusion under film
DUT	Device Under Test
DUV	Deep UV - (Stabilization of Resist)
ECN	Engineering Change Note
ECU	Electrical Control Unit
EDX	Energy Dispersive X-ray Spectroscopy (EDX)
EE	Equipment Engineering
EELS	Electron Energy Loss Spectroscopy
EFA	Electrical Failure Analysis
EIPD	Electrically Induced Physical Damage
EM	Electromigration (void formation)
EM	External Manufacturing
EMEA	Europe Middle East and Africa (Sales Region)
EMMI (PEM)	Photon Emission Microscopy (EMMI / PEM) is a light sensing technique basically microscope with NIR objective lenses and a NIR detector
EOL	End of Life, same as Last Time Buy (LTB)
EOS	Electrical Overstress
EPI	Epitaxy
E-pin	Ejection Pin
ESD	Electrostatic Discharge
ESD	Estimated Shipping Date
ESDAQ	Enhanced Software Defect Analysis
ESH	Environmental Safety and Health
ETA	Eagle Test Automatic Test system
EVM	Evaluation Module that allows users to evaluate the operation and performance of TI parts
FA	Failure Analysis
FCT	Functional Circuit Test
FDAO	TI Freising Device Analysis Organization (Lab)
FFAB	TI internal abbreviation for TI Freising, Germany Wafer Fab
FIB	Focused Ion Beam
FIFO	First in First out (storage)
FIFO	Fan in Fan out (shared learning)
FMEA	Failure Mode and Effects Analysis (FMEA)

Abbreviation	Definition
FMX	TI internal abbreviation for TI Aguascalientes, Mexico A/T Site (FMX)
FOUP	Front Opening Unified Pod
FQAE	Field Quality Application Engineer
FT	Final Test, usually the latest revision of the test program used in the A/T site.
FTIR	Fourier Transform Infrared Microscopy
FTY	Final Test Yield (after Packaging)
GEC	Good Electrical Chip
GF6	Code for TI Greenock, Scotland Wafer Fab (6" = 150mm)
GF8	Code for TI Greenock, Scotland Wafer Fab (8" = 200mm)
GFAB	TI internal abbreviation for TI Greenock, Scotland Wafer Fab
GOI	Gate Oxide Integrity
GRR	Gauge Reproducibility and Repeatability
GSP	Good Sample Probe
HBM	Human Body Model ESD Test
HCI	Hot Carrier Injection
HDP	High Density Plasma
HIC	Humidity Indicator Card
HT	High Temperature
HTO	High Temperature Oxide (oxidation)
HTOL	High Temperature Operating Life (a Reliability test)
HTSL	High Temp Storage Life (a Reliability test)
IC	Integrated Circuit
ICP	Inductively Coupled Plasma (Dry Etch)
ICPMS	Inductively Coupled Plasma Mass Spectroscopy
ICT	In-Circuit Test
ILD	Inter Level Dielectric
ILD-n	Inter Level Dielectric between Metal Levels n and n+1
ILO	Inter Level Oxide
IMD	Inter Metal Dielectric
IMDS	International Material Data System
IMPL	Implant
INQ	Inquiry
IP	Intellectual Property
IPQC	In-Line Process control
IQC	Inline Quality Control
ITY	Integrated Test Yield
KGU	Known Good Unit
LBE	Local Business Entity
Lead-frame	Lead-frame insists as the interface area to the external terminals of the part.
LL	Lesson(s) Learned
LPCVD	Low Pressure Chemical-Vapor Deposition
LRR	Lot Reject Rate
LTB	Last Time Buy, same as End of Life (EOL)
LTC	Lot Trace Code; each TI part is marked with a unique LTC
LTO	Low Temperature Oxide (Oxidation)
MBB	Moisture Barrier Bag (MBB) or Dry Pack
MCLT	Minority Carrier Lifetime (TAU)
MCS	Metallurgic Cross-Section sample preparation is used to reveal the true component structure at a certain device location (e.g. solder joints, bond wire connection or die attach)
MDAO	TI Manchester Device Analysis Organization (Lab)
MEI	Manufacturing Equipment Installation
MES	Manufacturing Execution System
MEX	Code for TI Aguascalientes, Mexico A/T Site (FMX)

Abbreviation	Definition
MFAB	TI internal abbreviation for TI Main (Portland), USA Wafer Fab
MFC	Mass Flow Controller
MFF	Multi Factory Flow
Mfg	Manufacturing
MH5	Code for TI Miho, Japan Wafer Fab (5")
MH6	Code for TI Miho, Japan Wafer Fab (6" = 150mm)
MH8	Code for TI Miho, Japan Wafer Fab (8" = 200mm)
MIF	TI internal abbreviation for TI Miho, Japan Assembly Site
MIHO	TI internal abbreviation for TI Miho, Japan Wafer Fab
MIM	Metal-Insulator-Metal
MLA	Code for TI Kuala Lumpur, Malaysia A/T Site
MLO	Multi-Level Oxide
MM	Manufacturing Maintenance
MMIS	Material Management Inventory System
MOCVD	Metal-organic Chemical Vapor Deposition
MOS	Metal Oxide Semiconductor Junction (Technology)
MOSFET	MOS Field Effect Transistor
MPY	Multiprobe Yield
MRB	Material Review Board
MSA	Measurement System Analysis
MSL	Moisture Sensitivity Level
MTVS	Material Tool Verification System
NAC	TI will conduct a background check on the device to determine whether case monitoring is sufficient. A non-actionable case (NAC) is a direct result of this upfront background verification or physical analysis.
NMOS	N Channel Metal Oxide Semiconductor
NPD	New Product Development
NTF	No Trouble Found; TI could not verify the customer reported issue
NVA	Non-Value Added
O/S	Open / Shorts failures
OCAP	Out of Control Action Plan
OEE / OEU	Overall Equipment Efficiency / Overall Equipment Utilization
OFI	Opportunities for Improvement
OOC	Out of Control
OOS	Out of Spec
OPN	Operation
PA	Preventive action
Pb-free	a product that is rated RoHS & high temperature solderable (260°C) compatible.
PCD	Process Control Document
PCN	Process/Product Change Notification
PDC	Product Distribution Center (warehouse)
PDN	Product Discontinue Notification (EOL)
PE	Process Engineer(ing)
PECVD	Plasma Enhanced Chemical Vapor Deposition
PEM	Production Equipment Maintenance
PEM (EMMI)	Photon Emission Microscopy (EMMI / PEM) is a light sensing technique basically microscope with NIR objective lenses and a NIR detector
PFA	Physical Failure Analysis
PFMEA	Process Failure Mode and Effects Analysis
PHI	Code for TI Baguio, Philippines A/T Site
PI	Polyimide
Pitch	The distance from pin to pin or inter-lead spacing.
Pizza Box	Intermediate container for the fully loaded reel, carrier tape, and cover tape

Abbreviation	Definition
PM	Preventive Maintenance
PMC	Process Monitoring Chip
PMD	Poly-Metal Dielectric(s)
PMOS	P Channel Metal Oxide Semiconductor
PO	Protective/Passivation Overcoating
PO	Purchase Order
POR	Process of Record
PPAP	Production Part Approval Process (PPAP)
PPB	Parts Per Billion
PPE	Personal Protective Equipment
PPM	Parts Per Million
PRM	Photo Resist Mask
PSD	P Implant Source/Drain
PSG	Phosphorous Silicate Glass
PSOG	Phosphorous Spin on Glass
PSW	Part Submission Warrant (PSW)
PTN	Product Termination Notification (PTN)
PVD	Physical Vapor Deposition
QA	Quality Assurance
QAB	Code for TI Pampanga (Clark), Philippines A/T Site
QBD	Charge to Breakdown
QBS	Qualification by Similarity
QC	Quality Control
QEM	Quality Event Manager system for 8D reports
QLT	Quality Leadership Team
QMS	Quality Management System
QRA	Quality & Reliability Assurance
QSM	Quality System Manual
QSS	Quality System Standard
QST	Quality Steering Team
QTY	Quantity
RC	Root Cause
RCM	Restricted Chemical and Material
REB	Resist Etch Back
RFAB	TI internal abbreviation for TI Richardson, USA Wafer Fab
RFB	Code for TI Richardson, USA Wafer Fab
RoHS	Restriction of Hazardous Substances Directive 2002/95/EC
RPN	Risk Potential Number
RPPM	Returned Parts per Million
RT	Room Temperature
RTA	Rapid Thermal Anneal
RTM	Release to market
RTO	Rapid Thermal Oxidation
RTP	Rapid Thermal Processing
RTV	Ramp to Volume
SACVD	Sub-Atmospheric Chemical - Vapor Deposition
SAM	Scanning Acoustic Microscopy; using ultrasonic waves to check for delamination.
SBE	Strategic Business Entity
SCADA	Supervisory Control and Data Acquisition
SCI	Sub Collector Implant
SCM	Scanning Capacitance Microscopy
SCR	Standard Change Request
Scribe Line	Thin non-functional spacing is between neighboring Dies on a wafer where a saw can safely cut the

Abbreviation	Definition
	wafer without damaging the circuits.
SD	Source-Drain (NSD, PSD)
SEM	Scanning Electron Microscope; imaging defects / damages beyond the resolution of an optical microscope
SFAB	TI internal abbreviation for TI Sherman, USA Wafer Fab
SFC	Statistical Factory Control
ShDAO	TI Shanghai Device Analysis Organization (Lab)
SHE	Code for TI Sherman, USA Wafer Fab
Shelf Life	Length of time that a TI part may be stored in controlled environment before mounted onto applications.
SIMS	Secondary Ion Mass Spectroscopy
SMC	Statistic Machine Control or Scribe line Monitoring Chip
SMD	Surface Mount Device
SMIF	Standard Mechanical Interface
sMPY	Standardized Multiprobe Yield
SMS	Semiconductor Manufacturing System
SO	Sales Order
SOF	State of Finish
SOG	Spin on Glass
SPC	Statistical Process Control
SRP	Spreading Resistance Probe
SS	Sample Size
STC	Unique tracking number on the TI label (1T) for each shipping container.
STI	Shallow Trench isolation
STM	Scanning Tunneling Microscope (Microscopy)
SVDAO	TI Santa Clara Device Analysis Organization (Lab)
SWR	Special Work Request
T&R	The tape-and-reel (T&R) configuration is used for transport and storage
TAI	Code for TI Taiwan A/T Site
TBD	To be done / defined
TCI	Test Coverage Issue/Improvement
TDAO	TI Tucson Device Analysis Organization (Lab)
TDBD	Time to Dielectric Breakdown
TEM	Transmission Electron Microscope
TFR	Thin Film Resistor
TI	Texas Instruments
TICL	TI internal abbreviation for TI Pampanga (Clark), Philippines A/T Site
TID	TI Freising, Germany Wafer Fab
TID	Code for Texas Instruments Deutschland
TIEM	TI internal abbreviation for TI Malacca (Melaka), Malaysia A/T Site
TIM	TI internal abbreviation for TI Kuala Lumpur, Malaysia A/T Site
TIMS	Tool Interdiction and Monitoring System
TIPI	TI internal abbreviation for TI Baguio, Philippines A/T Site
TITL	TI internal abbreviation for TI Taiwan A/T Site
TIW	Code for Texas Instruments Warrenville
TMG	Technology and Manufacturing Group
TMX	TI internal abbreviation for TI Aguascalientes, Mexico A/T Site (FMX)
TNI	Trouble Not Identified; TI's investigation does not confirm the customer problem.
UPW	Ultra-Pure water
V/I	Voltage (V) vs. Current (I) verification
Via-n	Connection between Metal Levels n and n+1
VPD	Vapor Phase Decomposition
VPO	Versaport Pod Opener

Abbreviation	Definition
VTN	Voltage Threshold N
VTP	Voltage Threshold P
W/F	Wafer Fab
WECO	Western Electric Company
WEE	Wafer Edge Exposure
WIC	Workplace Inventory Control
WIP	Work in Process
WLP	Wafer Level Package
WLR	Wafer Level Reliability
WPL	Worldwide Procurement and Logistics
XIVA (LSIM)	Laser Signal Injection Microscopy (LSIM) is a current sensing technique Externally Induced Voltage Alterations
X-RAY	Electromagnetic radiation that differentially penetrates structures and creates images of these structures on photographic film or a fluorescent screen. These images are called diagnostic x rays.
YE	Yield Enhancement

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