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The Index Capability Quality Control System on Smartphone Wave Performance

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Abstract: *This study aims to evaluate the effectiveness of wave quality control in mobile phone products using conventional control charts which are considered less optimal. The Severity, Occurrence, and Detection multiplication methods are applied to find the risk value, while the Capability Index (Cpk and Cp) are used to evaluate process capability. Root cause analysis is carried out using Fault Tree Analysis (FTA) and Fishbone Diagram to identify the causes of wave quality nonconformities. The results of the study indicate that the control chart has not been able to detect fluctuations, and is less effective in finding disturbances that can change Testing capabilities. The combination of FMEA, Cpk, Cp, FTA, and Fishbone Diagram provides a more comprehensive approach to determine that process stability and consistency that can be improved. This study contributes to the development of a more robust quality control system, supports production efficiency, and increases customer satisfaction.*

Keywords: quality, wave analysis, Cp, Cpk, root cause analysis

INTRODUCTION

The manufacturing industry is a cornerstone of economic growth, characterized by its reliance on innovation, advanced technologies, and rigorous quality control. Among these, product quality is critical, shaping customer satisfaction, loyalty, and profitability (Jacobson & Aaker, 1987). As manufacturing systems grow more complex, traditional quality control tools, such as statistical process control, are increasingly supplemented by advanced approaches like Six Sigma, Lean, and Total Quality Management to enhance process efficiency and product consistency (Girdler et al., 2016; Su et al., 2019).

In electronic device manufacturing, quality control faces unique challenges, especially with imperceptible test items such as antenna frequencies and audio parameters. Studies highlight difficulties in monitoring frequency quality due to harmonics, noise disturbances, and deviations in base frequencies, leading to inaccurate defect classifications (Ramos & Serra, 2009; Carcione et al., 2021). For instance, products deemed defective during automated testing were later confirmed acceptable in 90.8% of retests. This inconsistency arises from the non-physical nature of these defects, making traditional physical inspections ineffective and emphasizing the need for statistical methods to address invisible process disturbances (Liang et al., 2022; Kapoor et al., 2018).

Process capability indices, such as Cp and Cpk, offer a robust alternative to conventional control charts by providing early warnings of potential hazards while measuring process variability and alignment with target specifications (Kane, 1986; Porter & Oakland, 1990). These indices have been applied in diverse manufacturing contexts, including cement (Saied et al., 2020) and hydraulics (Xin-chun et al., 2021), where quality is difficult to assess visually. However, their application in electronic device manufacturing, where disturbances like harmonics and noise are prevalent, remains underexplored.

This study evaluates the current process capability in electronic device manufacturing and demonstrates that relying solely on control charts is insufficient to address complex process disturbances. By integrating process capability indices, risk priority numbers, and fault tree analysis, this research aims to identify root causes of quality issues and quantify potential improvements in reducing defects. The findings contribute to advancing quality control strategies for highly complex manufacturing systems.

METHODS

The research begins by addressing the background issue where test items in gadget manufacturing cannot be physically observed, and disturbances affecting gadget quality are often intangible and difficult to detect by human senses. Data is collected from the testing of all gadget models at the gadget manufacturing company to identify general test items that apply across models, focusing on the fundamental functions of the gadgets. From this data, the test item specifically related to antenna performance is separated for further analysis. The first problem investigated is determining the capability of the production process based on the test item characteristics. This is achieved by analyzing process capability indices such as Cp, and Cpk, which reveal the current process capability values. These values are then compared to ideal values using the Risk Priority Number (RPN) and process capability indices to understand the gaps.

To identify the factors contributing to the decline in process capability values, the analysis process uses Fault Tree Analysis (FTA) and the fishbone diagram to systematically explore root causes of the quality decline. Furthermore, the Taguchi approach is employed to quantify the cost of losses arising from the rework process, providing a clearer understanding of the financial impact of poor process capability. Lastly, corrective actions are implemented to improve process capability, and the 5W+2H method (Who, What, Where, When, Why, How, and How much) is used to summarize and streamline the research findings, ensuring clarity and completeness. Overall, this research systematically identifies process capabilities, analyzes root causes for quality decline, evaluates the cost impact of rework processes, and determines the effectiveness of improvements in the supervision of the gadget production quality system.

RESULTS AND DISCUSSIONS

Data Collection

In this study, data were collected from smart phone manufacturing's non-signaling-2 antenna testing machines to evaluate the performance of electromagnetic signals, focusing on antennas, WiFi, and GPS across various test parameters. The research utilized 41 test items that evaluated the performance metrics of:

- 3G Antennas (e.g., RxLoss, TxLoss, TxPower, RxLevel for GSM Bands).
- 4G Antennas (e.g., DRxRSCP, RxLoss, TxLoss, Max Power for LTE Bands).
- WiFi (e.g., Transmission Power and Loss: CH0_A_TX, CH0_B_TX).
- GPS (e.g., Loss, CNR, Frequency Offset: GPS_RX_L1).

Each of these items was categorized by its intended function for a systematic analysis.
Among the 41 items standard, the performance of antennas was assessed using the following parameters:

- Maximum Power - The highest permissible transmitted/received power.
- Receiver Loss - Signal loss during reception.
- Transmission Loss - Signal loss during transmission.
- Transmission Power - Total power used to transmit the signal.
- Received Signal Code Power (RSCP) - Key metric in WCDMA systems.
- GPS CNR and Frequency Offset - Evaluates the signal clarity and frequency stability.

Data Processing and Analysis

Data processing analysis starts from monitoring all test result comes from the product that is tested in antenna 2 machine. This data is exported and calculated periodically to get the abnormality value of process capability. The abnormal data which is indicating poor quality of the process is then analyzed to find the root cause of the abnormality.

Based the test item characteristic, the analysis focused on process capability using Cp and Cpk value. Cp (overall process uniformity relative to specifications) and Cpk (centering of the process relative to control limits) are used to calculate all of the extracted value. From the test items analyzed, it was found that certain parameters required closer control due to abnormal values, including:

- Cp analysis which means the data need to be uniform but not necessary to be centered is suitable for wave analysis related to loss metrics (e.g., RxLoss, TxLoss in LTE/GSM tests and GPS Loss).
- Cpk analysis which means the data need to be uniform and centered is suitable for wave analysis related to power and signal strength (e.g., MaxPow, RSCP)

Root Cause Analysis for Abnormal Data Uniformity

After monitoring, this research identified three cases of data anomalies, and each was analyzed in step-by-step detail using Fishbone Diagrams and Fault Tree Analysis (FTA). The cases are Golden Sample Clone, Loose RF Cable, and Interference from WIP Devices which are named by their issue root cause after analysis has been conducted.

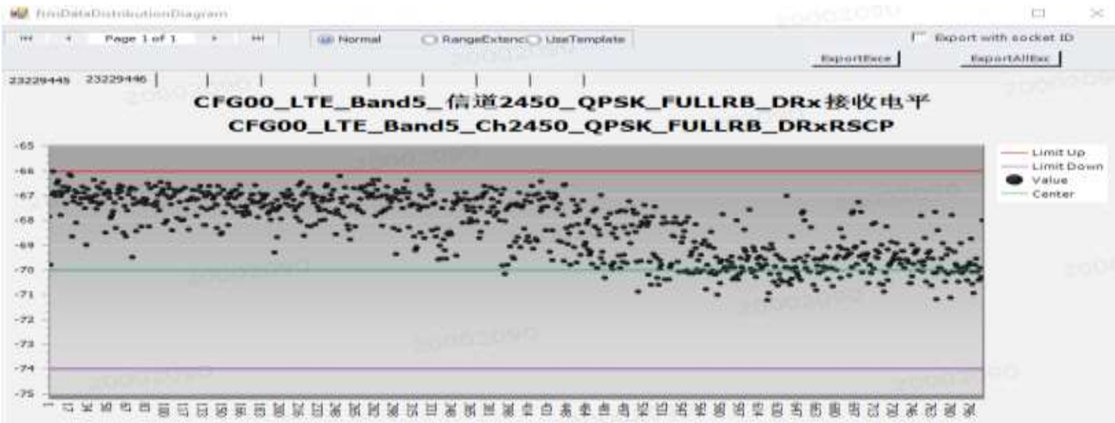


Figure 1. Visualization of Data Changes Due to Golden Sample Clone

Appendix 1 shows the abnormality in the test item with the name Item LTE Band5 Ch2450 DRxRSCP with a Cpk value of 0.8 and Figure 1 shows a visualization of the data distribution.

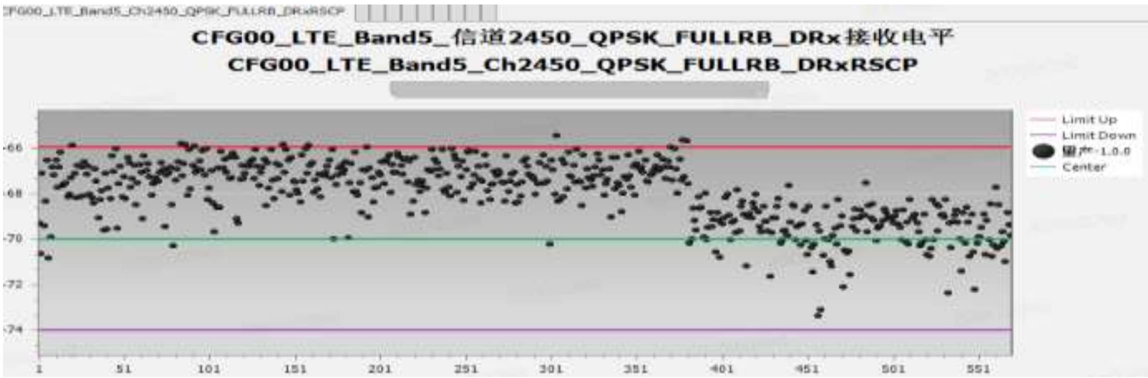


Figure 2. Visualization of Data Changes Due to Loose RF Cable

Appendix 2 shows abnormalities in the test item with the name Item LTE Band5 Ch2450 DRxRSCP with a Cpk value of 0.77 and Figure 2 shows a visualization of the data distribution.

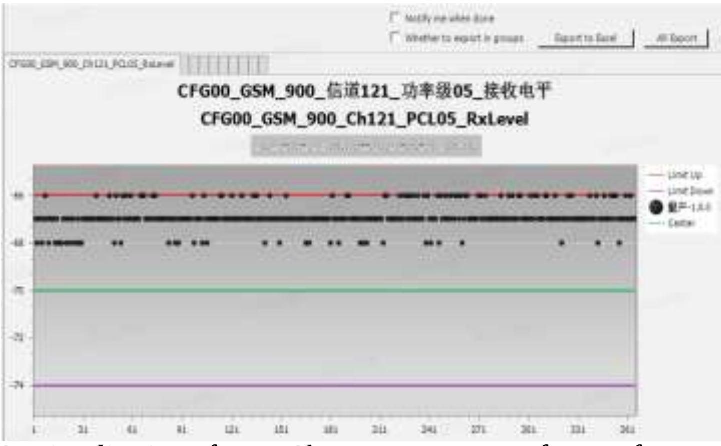


Figure 3. Visualization of Data Changes Due to Interference from WIP Devices

Appendix 3 shows the abnormality in the test item with the name Item GSM 900 Ch121 PCL05 RxLevel with a Cpk value of 0.73 and Figure 3 shows a visualization of the data distribution.

In this study, the root cause analysis of abnormalities was conducted using a *fishbone diagram* with the 4M+1E framework: Man, Machine, Method, Material, and Environment. The explanations are as follows:

1. Man: Human errors during testing, such as improper product placement, failure to activate *Engineering Mode*, or repeatedly testing the same product.
2. Machine: Machine configuration issues, such as loose RF cables, misaligned antenna positions, or transmitter positions not matching standard documentation.
3. Method: Inadequate procedures, such as incomplete or irrelevant SOPs that do not meet testing needs.
4. Material: Variations in material characteristics, such as differences in vendors, versions, or production batch dates, tested under the same standards.
5. Environment: Environmental disturbances, such as signal interference from other transmitters, high-intensity light, or high-decibel noise near the testing area.

The Measurement factor was excluded because data processing relies on synchronized data directly from a central database in China, unaffected by manufacturing noise. Analysis of factors that may cause abnormalities in cases 1, 2, and 3 are identified in Figure 4.

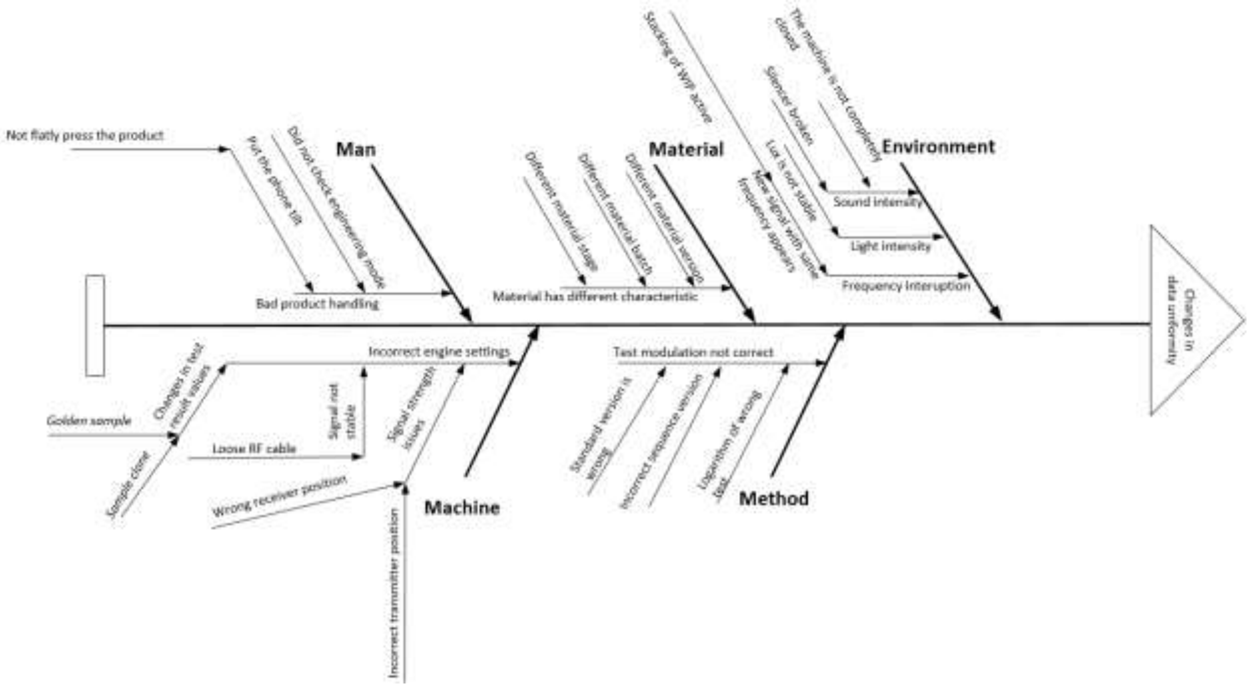


Figure 4. Fishbone

In the process of finding out the root cause of a case, a detailed analysis of the root cause is carried out using the FTA (Fault Tree Analysis) diagram is identified as Figure 5.

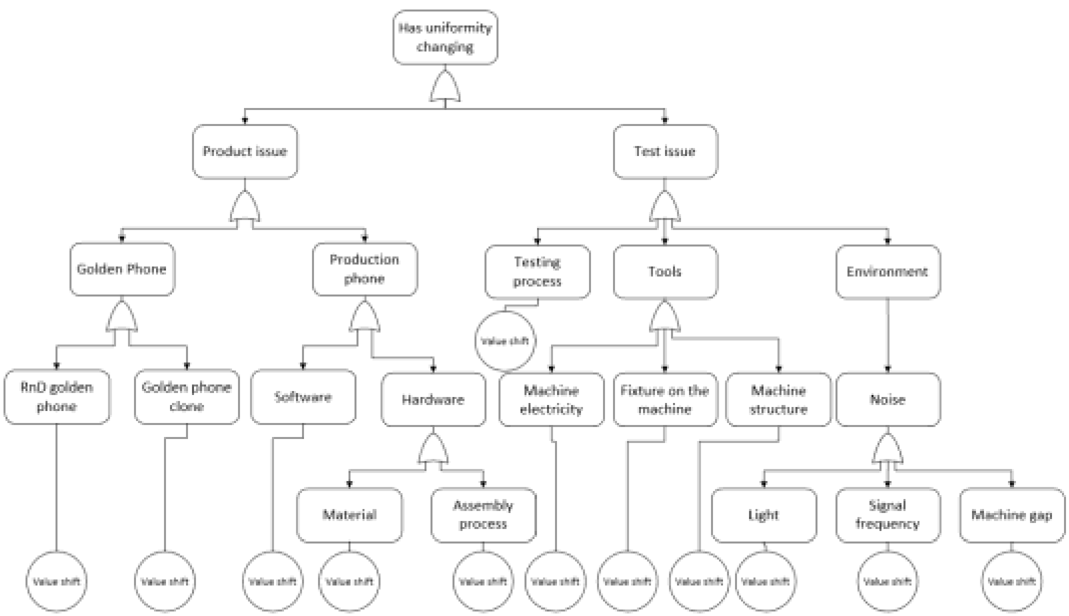


Figure 5. Fault Tree Analysis Causes of Data Uniformity Changes

Case 1: Data Abnormality Due to Golden Sample Clone
Step 1: Initial Observation
Data from the LTE Band5 Ch2450 DRxRSCP test showed an abnormal Cpk = 0.77, with deviations across all testing machines.
Step 2: Identifying the Scope

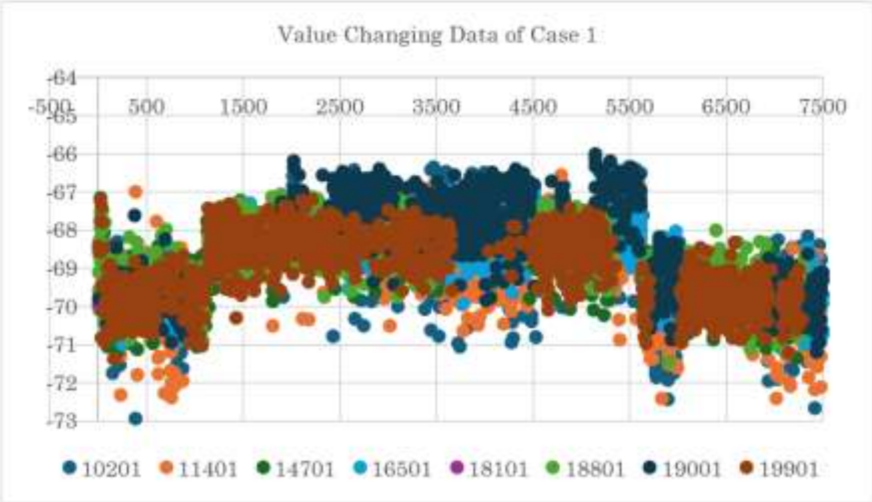


Figure 6. Value Changing Data of Case 1

From figure 6 compared data consistency across all machines. Results confirmed that the issue was systemic (not isolated to a single machine).
Step 3: Product or Machine Source Identification

Table 1. Testing Data Case 1

Sample	Calibration Device	Testing Machine	Band5 DRx Value	LCL	UCL	mid
1	GP Clone	Auto Machine	-73,5325	-74	-66	-70
	GP RnD	Analysist Machine	-71,0884	-74	-66	-70
2	GP Clone	Auto Machine	-73,5872	-74	-66	-70
	GP RnD	Analysist Machine	-70,0818	-74	-66	-70
3	GP Clone	Auto Machine	-72,0533	-74	-66	-70
	GP RnD	Analysist Machine	-69,0884	-74	-66	-70

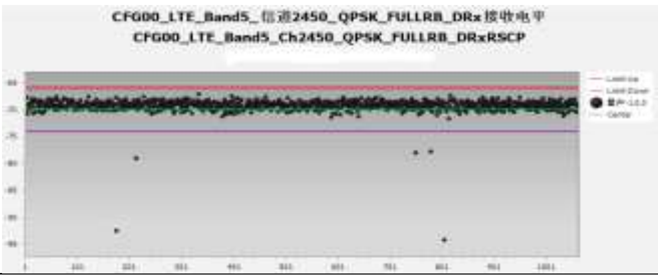
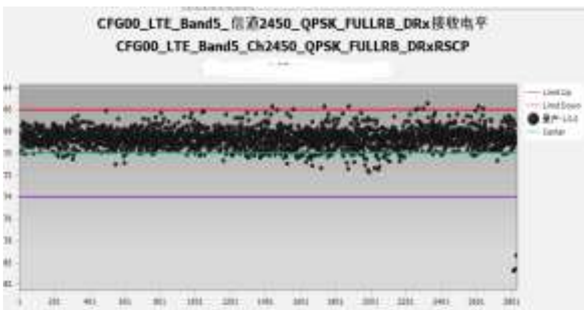
Data from mass production phones were tested manually using a calibrated RnD Golden Phone and compared to automated machines (see Table 1). Results showed significant deviation:
Example: using production line Auto Machine that is calibrated with GP clone the value is -73.53 dB, using Analysist Machine that is calibrated with GP RnD the value is -71.08 dB.
Step 4: Investigating Golden Sample Clone Stability

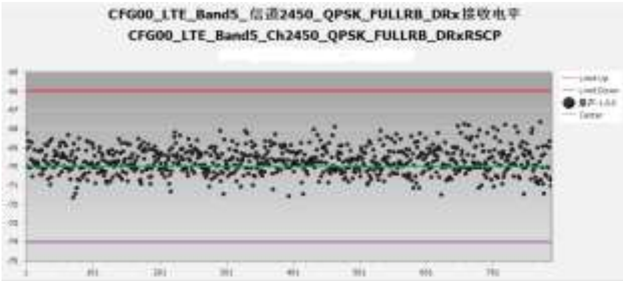
Table 2.. Historical Data

Sample	Calibration Device	Testing Machine	Band5 DRx Value	LCL	UCL	mid
GP Clone	GP RnD	Analysist Machine	-69,9794	-74	-66	-70
GP Clone	GP RnD	Auto Machine Historical	-70,2981	-74	-66	-70
GP Clone	GP RnD	Auto Machine	-69,2197	-74	-66	-70
GP Clone	GP RnD	Auto Machine	-68,1812	-74	-66	-70
GP Clone	GP RnD	Auto Machine	-68,7817	-74	-66	-70
GP Clone	GP RnD	Auto Machine	-69,9878	-74	-66	-70

historical values of the Golden Sample Clone were analyzed (see Table 2), showing inconsistent signal strength readings over time.
Conclusion: The Golden Phone Clone was unstable, leading to inconsistent calibration across machines. Replacing the unit restored data uniformity (see Table 3).

Table 3. Data Results Data Changes Due to Golden Sample Clone

Condition	Test Result
Test data using GP clone before the issue occurred	
Test data using GP clone when the issue occurred	

Condition	Test Result
Test data using new GP clone	

Case 2: Data Abnormality Due to RF Cable loose
Step 1: Initial Observation

Figure 7. Data Changing Case 2

Anomalous values were observed on a single machine (see Figure 7).
Step 2: Isolating the Machine

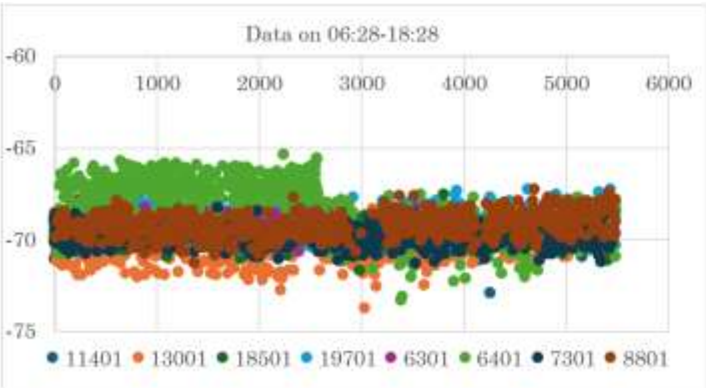


Figure 8. Data on 06:28-18:28

Using system fixture codes, the issue was traced to one specific machine in more than 1 shift (see Figure 8).

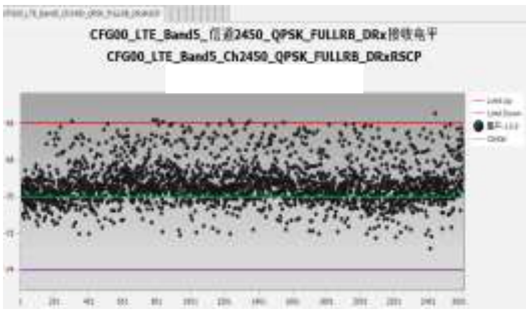
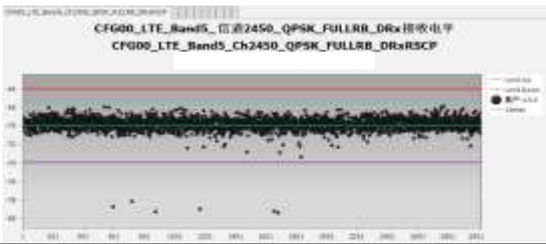
Step 3: Root Cause Validation

Table 3. RF Cable Condition

Sample	Calibration Device	Testing Machine	Band5 DRx Value	LCL	UCL	mid
1	RF Cable Swaying	Auto_Machine	-70,2122	-74	-66	-70
	RF Cable Swaying	Auto_Machine	-67,6591	-74	-66	-70
	RF Cable Swaying	Auto_Machine	-67,5716	-74	-66	-70
	RF Cable Fix	Auto_Machine	-70,1812	-74	-66	-70
	RF Cable Fix	Auto_Machine	-69,7817	-74	-66	-70
	RF Cable Fix	Auto_Machine	-69,9878	-74	-66	-70
2	RF Cable Swaying	Auto_Machine	-68,1528	-74	-66	-70
	RF Cable Swaying	Auto_Machine	-68,052	-74	-66	-70
	RF Cable Swaying	Auto_Machine	-67,3118	-74	-66	-70
	RF Cable Fix	Auto_Machine	-71,5794	-74	-66	-70
	RF Cable Fix	Auto_Machine	-72,5657	-74	-66	-70
	RF Cable Fix	Auto_Machine	-71,972	-74	-66	-70
3	RF Cable Swaying	Auto_Machine	-66,5481	-74	-66	-70
	RF Cable Swaying	Auto_Machine	-67,7356	-74	-66	-70
	RF Cable Swaying	Auto_Machine	-66,8684	-74	-66	-70
	RF Cable Fix	Auto_Machine	-70,6692	-74	-66	-70
	RF Cable Fix	Auto_Machine	-71,097	-74	-66	-70
	RF Cable Fix	Auto_Machine	-70,9134	-74	-66	-70

A comparison of RF Cable conditions was conducted (see Table 3). Results:
Loose Cable: High data deviations (e.g., -67.57 dB).
Fixed Cable: Stabilized values (e.g., -70.18 dB).
Conclusion: The loose RF cable caused data instability. Tightening the cable resolved the issue (see Table 4)

Table 4. Change in Value After Repair

Condition	Test Result
Test data before RF cable tensioning	
Test data after RF cable is tightened	

Case 3: Data Abnormality Due to WIP Device Interference
Step 1: Initial Observation

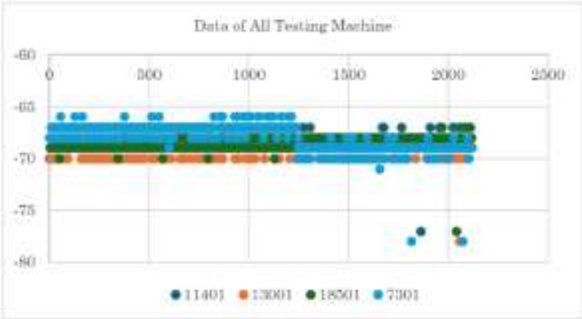
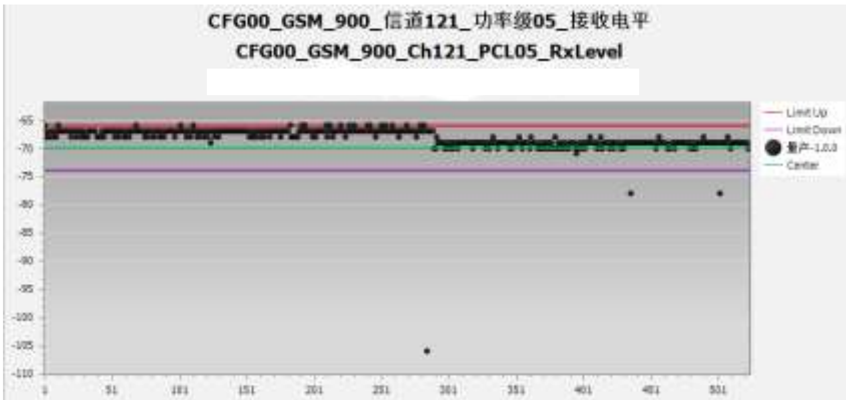
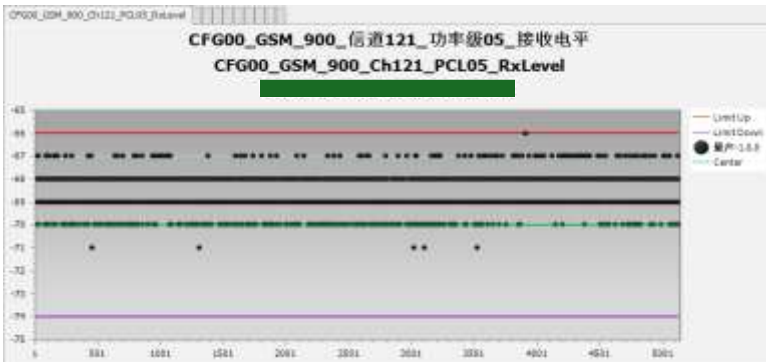


Figure 9. Data of All Testing Machine

Data deviation occurred only on machine 7301 (see Figure 9).
Step 2: Investigating Environmental Factors
Field observation revealed multiple WIP devices (powered on) emitting similar signal frequencies near the machine.
Step 3: Resolving Interference

Table 5. WIP Relocation Data Results

Condition	Test Result
When there are many WIPs ON	
When there is no WIP	

Moving the WIP devices away from the machine area and recalibrating resolved the issue (see Table 5).
Conclusion: External signal interference disrupted the testing process, emphasizing the need for environmental control.
After analyze using Fishbone Diagrams (4M+1E) and Fault Tree Analysis (FTA), root causes were identified: by Golden Sample Clone instability, Loose RF Cable, and Interference from WIP Devices (see Figure 10)

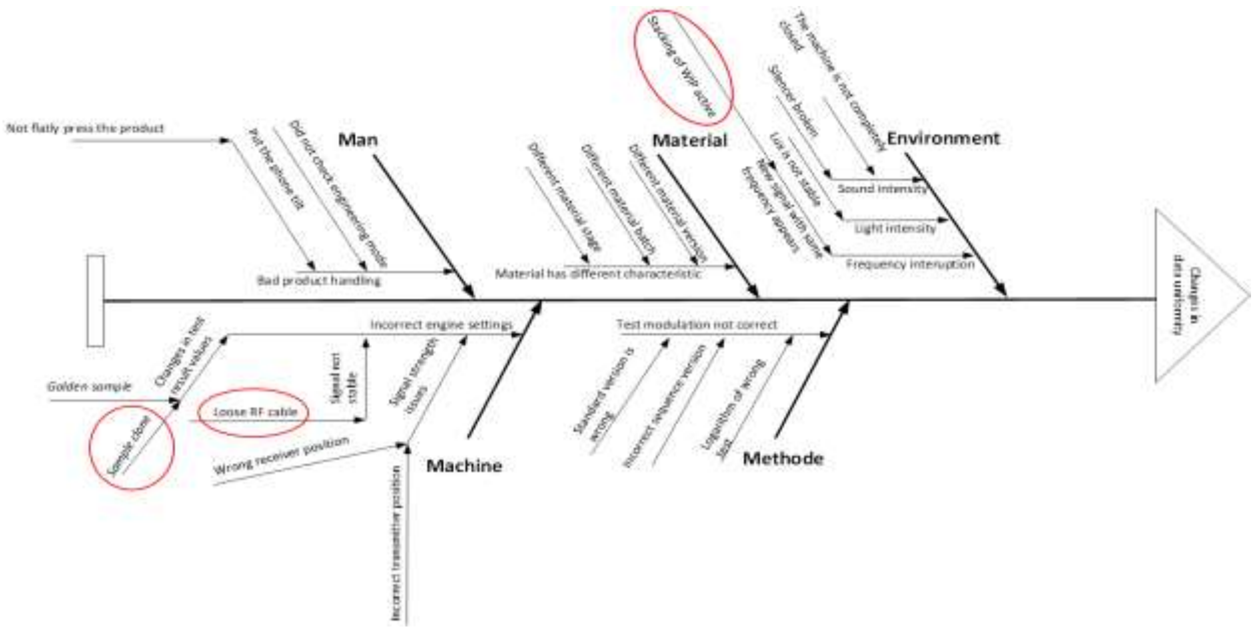


Figure 10 Fisbone with rootcause

Process Variability and Financial Impact Analysis

The analysis of process variability and its financial impact was conducted using the Taguchi Loss Method, which quantified the losses arising from test variability and the need for re-testing. In Case 1, 125 units required re-testing, while Case 2 involved 301 units and Case 3 affected 53 units. With a cost of Rp 40,000 per hour per product and a total of 15 production lines, the projected financial losses were significant. It was estimated that these anomalies could result in a monthly loss of Rp 140,506,666 across all production lines, underscoring the substantial economic consequences of undetected process variability.

Proposed Corrective Actions (5W+2H)

To address the identified root causes and reduce process variability, the following improvements are proposed as can be seen in Table 6.

: **Table 6** Suggested improvements using the 5W+2H method

	Problem	Quality control of electromagnetic wave testing that has a risk value of 800 RPN and has the potential to cause manufacturing losses of Rp140,506,666 per month
What	What is the target of improvement	Improve quality control capabilities and reduce negative impacts for the company
Why	Why improvement should be done	Quality control based on electromagnetic waves is difficult to monitor with control that relies on control limits
Where	Where improvement is done	Product performance testing process that calculates the electromagnetic wave performance of a product
When	When improvement can be done	When conducting the product testing process
Who	Who carries out improvement	Technical personnel for process quality control
How	How improvement is done	Add supervision of Ca, Cp, and Cpk values to the product quality control system
How much	How big is the improvement target	a. Reduce the risk value to below 200 RPN b. Eliminate costs caused by retesting processes due to changes in data uniformity.

CONCLUSION

Based on the analysis, three test items were identified with suboptimal Cpk values: LTE Band5 Ch2450 DRxRSCP with a Cpk of 0.8 (due to golden phone clone instability), LTE Band5 Ch2450 DRxRSCP with a Cpk of 0.77 (caused by loose RF cables), and GSM 900 Ch121 PCL05 RxLevel with a Cpk of 0.73 (resulting from interference by powered WIP stacks).

The root cause analysis revealed contributing factors across five areas: man, machine, material, method, and environment. Human-related issues included failure to check engineering mode, improper product handling, and misaligned product placement. Machine-related problems stemmed from signal instability, improper transmitter/receiver positioning, loose RF cables, and golden phone/sample clone issues. Material issues were caused by variations in material characteristics, stages, or batches. Environmental factors included interference from active WIP stacks, new signal sources, excessive sound and light intensity, incomplete machine sealing, and damaged dampers. Method-related errors involved incorrect modulation, standard version mismatches, sequence errors, and faulty test algorithms.

The study concluded that quality control of antenna wave performance successfully identified two previously undetected issue categories: false positives (poor-quality products classified as good, carrying a risk score of 800 RPN) and false negatives (good-quality products classified as poor), resulting in potential manufacturing losses of up to Rp 140,506,666 per month.

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Appendix

Apendix 1. Test Value of Golden Sample Clone Case

NameEN	Limit Up	Limit Dn	BKB	BKA	Cp	Cpk	Samples
GSM 900 Ch121 PCL05 RxLevel	-66	-74	-71,1	-66,0	1,7	1,6	7669
GSM 900 Ch121 PCL05 RxLoss	40	0	27,4	35,4	6,6	2,9	477
GSM 900 Ch121 PCL05 TxLoss	40	0	18,2	31,0	4,6	3,5	477
GSM 900 Ch121 PCL05 TxPow	35,5	29,5	29,7	35,1	2,3	2,1	7670
LTE Band1 Ch550 DRxLoss	40	0	27,0	36,0	3,3	1,6	477
LTE Band1 Ch550 DRxRSCP	-66	-74	-71,8	-68,5	1,3	1,0	7662
LTE Band1 Ch550 MaxPow	25,5	19,5	22,0	24,9	2,4	1,9	7669
LTE Band1 Ch550 RSCP	-66	-74	-71,2	-67,1	1,2	1,0	7669
LTE Band1 Ch550 RxLoss	40	0	21,3	27,7	3,7	3,0	477
LTE Band1 Ch550 TxLoss	40	0	20,0	25,2	7,2	6,6	477
LTE Band3 Ch1250 DRxLoss	40	0	26,4	34,2	4,0	2,2	477
LTE Band3 Ch1250 DRxRSCP	-66	-74	-73,2	-67,8	1,8	1,7	7665
LTE Band3 Ch1250 MaxPow	25,5	19,5	20,2	23,9	1,5	1,3	7666
LTE Band3 Ch1250 RSCP	-66	-74	-71,1	-67,6	2,9	2,4	7666
LTE Band3 Ch1250 RxLoss	40	0	21,5	26,8	7,1	5,7	477
LTE Band3 Ch1250 TxLoss	40	0	25,1	28,8	6,3	4,0	477
LTE Band40 Ch38700 DRxLoss	40	0	30,2	41,5	5,1	1,0	477
LTE Band40 Ch38700 DRxRSCP	-66	-74	-73,6	-67,9	1,3	1,2	7650
LTE Band40 Ch38700 MaxPow	25,5	19,5	20,7	25,6	1,2	1,0	7646
LTE Band40 Ch38700 RSCP	-66	-74	-71,4	-66,1	1,1	1,1	7661
LTE Band40 Ch38700 RxLoss	40	0	28,9	42,8	4,6	1,2	477
LTE Band40 Ch38700 TxLoss	40	0	28,8	42,1	5,8	1,5	477
LTE Band5 Ch2450 DRxLoss	40	0	12,7	28,3	4,3	4,1	477
LTE Band5 Ch2450 DRxRSCP	-66	-74	-70,7	-66,5	1,2	0,8	7662
LTE Band5 Ch2450 MaxPow	26	20	20,8	23,9	2,6	2,2	7666
LTE Band5 Ch2450 RSCP	-66	-74	-70,9	-67,7	3,8	3,3	7666
LTE Band5 Ch2450 RxLoss	40	0	16,5	25,4	4,0	3,9	477
LTE Band5 Ch2450 TxLoss	40	0	17,7	39,1	3,2	1,9	477
LTE Band8 Ch3750 DRxLoss	40	0	20,0	26,9	6,5	5,2	477
LTE Band8 Ch3750 DRxRSCP	-66	-74	-72,1	-69,7	2,1	2,0	7665

LTE Band8 Ch3750 MaxPow	26	20	21,9	25,3	2,4	2,4	7665
LTE Band8 Ch3750 RSCP	-66	-74	-70,5	-67,2	2,7	2,1	7665
LTE Band8 Ch3750 RxLoss	40	0	30,9	38,0	7,1	2,0	477
LTE Band8 Ch3750 TxLoss	40	0	19,8	28,7	5,7	4,4	477
CH0 A TX 149 Loss	18	-18	-2,3	4,8	5,9	5,7	477
CH0 A TX 149 PWR	-15	-25	-23,2	-18,1	3,6	3,2	7660
CH0 B TX 01 Loss	8	-10	-5,7	1,4	2,0	1,6	477
CH0 B TX 01 PWR	-8	-16	-14,3	-8,6	1,4	1,3	7660
GPS RX L1 CNR	45	36	35,0	45,0	1,4	1,0	7660
GPS RX L1 FreqOffset	2	-2	-0,3	0,1	13,5	12,7	7637
GPS RX L1 Loss	40	0	23,4	35,7	7,9	3,6	477

Apendix 2. Test Value of RF Cable Loose

NameEN	Limit Up	Limit Dn	BKB	BKA	Cp	Cpk	Samples
GSM 900 Ch121 PCL05 RxLevel	-66	-74	-71,09	-65,99	2,16	2,02	2707
GSM 900 Ch121 PCL05 RxLoss	40	0	27,42	35,41	5,42	2,50	477
GSM 900 Ch121 PCL05 TxLoss	40	0	18,21	30,98	6,22	4,25	477
GSM 900 Ch121 PCL05 TxPow	35,5	29,5	29,69	35,09	2,03	1,96	2707
LTE Band1 Ch550 DRxLoss	40	0	27,00	36,05	2,11	1,3	477
LTE Band1 Ch550 DRxRSCP	-66	-74	-71,77	-68,55	1,72	1,07	2706
LTE Band1 Ch550 MaxPow	25,5	19,5	22,02	24,87	2,32	1,14	2707
LTE Band1 Ch550 RSCP	-66	-74	-71,17	-67,06	1,74	1,51	2706
LTE Band1 Ch550 RxLoss	40	0	21,32	27,67	8,19	6,40	477
LTE Band1 Ch550 TxLoss	40	0	19,98	25,17	7,84	6,70	477
LTE Band3 Ch1250 DRxLoss	40	0	26,36	34,24	2,30	1,02	477
LTE Band3 Ch1250 DRxRSCP	-66	-74	-73,21	-67,77	2,13	1,48	2705
LTE Band3 Ch1250 MaxPow	25,5	19,5	20,23	23,86	2,59	2,52	2705
LTE Band3 Ch1250 RSCP	-66	-74	-71,12	-67,64	2,55	1,95	2705

NameEN	Limit Up	Limit Dn	BKB	BKA	Cp	Cpk	Samples
LTE Band3 Ch1250 RxLoss	40	0	21,50	26,76	9,64	7,29	477
LTE Band3 Ch1250 TxLoss	40	0	25,14	28,81	5,90	3,62	477
LTE Band40 Ch38700 DRxLoss	40	0	30,17	41,55	2,31	0,54	477
LTE Band40 Ch38700 DRxRSCP	-66	-74	-73,58	-67,90	1,60	1,51	2704
LTE Band40 Ch38700 MaxPow	25,5	19,5	20,71	25,63	1,54	1,27	2704
LTE Band40 Ch38700 RSCP	-66	-74	-71,38	-66,06	1,65	1,19	2704
LTE Band40 Ch38700 RxLoss	40	0	28,89	42,83	1,41	0,45	477
LTE Band40 Ch38700 TxLoss	40	0	28,81	42,13	1,36	1,39	477
LTE Band5 Ch2450 DRxLoss	40	0	12,72	28,35	1,53	1,19	477
LTE Band5 Ch2450 DRxRSCP	-66	-74	-70,66	-66,55	1,02	0,77	2694
LTE Band5 Ch2450 MaxPow	26	20	20,79	23,86	3,01	2,97	2705
LTE Band5 Ch2450 RSCP	-66	-74	-70,88	-67,69	3,24	2,33	2705
LTE Band5 Ch2450 RxLoss	40	0	16,50	25,36	9,63	8,62	477
LTE Band5 Ch2450 TxLoss	40	0	17,67	39,07	3,58	2,35	477
LTE Band8 Ch3750 DRxLoss	40	0	20,02	26,90	2,63	1,78	477
LTE Band8 Ch3750 DRxRSCP	-66	-74	-72,12	-69,65	2,55	2,31	2705
LTE Band8 Ch3750 MaxPow	26	20	21,90	25,27	2,05	1,59	2705
LTE Band8 Ch3750 RSCP	-66	-74	-70,51	-67,21	2,06	1,32	2705
LTE Band8 Ch3750 RxLoss	40	0	30,87	38,02	2,97	0,68	477
LTE Band8 Ch3750 TxLoss	40	0	19,76	28,71	4,95	3,25	477
CH0 A TX 149 Loss	18	-18	-2,32	4,75	5,37	4,84	477
CH0 A TX 149 PWR	-15	-25	-23,23	-18,10	3,76	3,34	2704

NameEN	Limit Up	Limit Dn	BKB	BKA	Cp	Cpk	Samples
CH0 B TX 01 Loss	8	-10	-5,72	1,42	5,99	4,31	477
CH0 B TX 01 PWR	-8	-16	-14,27	-8,64	2,32	1,80	2704
GPS RX L1 CNR	45	36	35,03	45,03	1,67	1,68	2706
GPS RX L1 FreqOffset	2	-2	-0,29	0,13	15,79	15,13	2697
GPS RX L1 Loss	40	0	23,38	35,69	21,08	9,59	477

Apendix 3. Test Value of WIP Interference

NameEN	Limit Up	Limit Dn	BKB	BKA	Cp	Cpk	Samples
GSM 900 Ch121 PCL05 RxLevel	40	0	-71,09	-65,99	3,58	1,37	2707
GSM 900 Ch121 PCL05 RxLoss	40	0	27,42	35,41	2,85	2,06	477
GSM 900 Ch121 PCL05 TxLoss	35,5	29,5	18,21	30,98	2,28	1,97	477
GSM 900 Ch121 PCL05 TxPow	-66	-74	29,69	35,09	1,22	0,73	2707
LTE Band1 Ch550 DRxLoss	-66	-74	27,00	36,05	1,72	0,82	477
LTE Band1 Ch550 DRxRSCP	40	0	-71,77	-68,55	2,14	0,81	2706
LTE Band1 Ch550 MaxPow	40	0	22,02	24,87	5,62	3,92	2707
LTE Band1 Ch550 RSCP	40	0	-71,17	-67,06	7,35	6,46	2706
LTE Band1 Ch550 RxLoss	-66	-74	21,32	27,67	2,07	1,57	477
LTE Band1 Ch550 TxLoss	25,5	19,5	19,98	25,17	2,22	1,57	477
LTE Band3 Ch1250 DRxLoss	-66	-74	26,36	34,24	2,20	2,05	477
LTE Band3 Ch1250 DRxRSCP	40	0	-73,21	-67,77	3,26	1,66	2705
LTE Band3 Ch1250 MaxPow	40	0	20,23	23,86	6,37	4,77	2705
LTE Band3 Ch1250 RSCP	40	0	-71,12	-67,64	5,09	3,21	2705
LTE Band3 Ch1250 RxLoss	-66	-74	21,50	26,76	2,24	1,88	477
LTE Band3 Ch1250 TxLoss	25,5	19,5	25,14	28,81	2,14	1,89	477
LTE Band40 Ch38700 DRxLoss	-66	-74	30,17	41,55	1,12	1,75	477
LTE Band40 Ch38700 DRxRSCP	40	0	-73,58	-67,90	1,88	1,35	2704

NameEN	Limit Up	Limit Dn	BKB	BKA	Cp	Cpk	Samples
LTE Band40 Ch38700 MaxPow	40	0	20,71	25,63	1,54	1,50	2704
LTE Band40 Ch38700 RSCP	40	0	-71,38	-66,06	1,61	1,58	2704
LTE Band40 Ch38700 RxLoss	-66	-74	28,89	42,83	1,34	1,20	477
LTE Band40 Ch38700 TxLoss	25,5	19,5	28,81	42,13	1,38	1,19	477
LTE Band5 Ch2450 DRxLoss	-66	-74	12,72	28,35	1,63	0,99	477
LTE Band5 Ch2450 DRxRSCP	40	0	-70,66	-66,55	0,81	0,70	2694
LTE Band5 Ch2450 MaxPow	40	0	20,79	23,86	6,65	5,98	2705
LTE Band5 Ch2450 RSCP	40	0	-70,88	-67,69	1,79	1,25	2705
LTE Band5 Ch2450 RxLoss	-66	-74	16,50	25,36	3,12	2,46	477
LTE Band5 Ch2450 TxLoss	26	20	17,67	39,07	2,28	2,21	477
LTE Band8 Ch3750 DRxLoss	-66	-74	20,02	26,90	2,43	2,37	477
LTE Band8 Ch3750 DRxRSCP	40	0	-72,12	-69,65	4,03	3,24	2705
LTE Band8 Ch3750 MaxPow	40	0	21,90	25,27	5,07	1,27	2705
LTE Band8 Ch3750 RSCP	40	0	-70,51	-67,21	4,48	3,40	2705
LTE Band8 Ch3750 RxLoss	-66	-74	30,87	38,02	2,33	1,67	477
LTE Band8 Ch3750 TxLoss	26	20	19,76	28,71	2,33	1,95	477
CH0 A TX 149 Loss	-15	-25	-2,32	4,75	3,15	2,95	477
CH0 A TX 149 PWR	18	-18	-23,23	-18,10	4,59	4,26	2704
CH0 B TX 01 Loss	-8	-16	-5,72	1,42	2,18	1,64	477
CH0 B TX 01 PWR	8	-10	-14,27	-8,64	6,35	4,97	2704
GPS RX L1 CNR	40	0	35,03	45,03	2,59	0,99	2706
GPS RX L1 FreqOffset	45	36	-0,29	0,13	1,47	0,63	2697
GPS RX L1 Loss	2	-2	23,38	35,69	15,32	14,15	477