Q1036 Recorder S/N 95120161 Failure Analysis Report

Date: January 25, 2017

Location: Marion Kentucky Manufacturing Plant

Unit: Q1036 NJT Recorder S/N 95120161

Equipment Used During Investigation: Power supply GPR 7550D, Agilent 1252 DMM, Fluke 190-204 Scope Meter, RS-232 Serial adapter cable, Windows XP Desktop PC, Quantum Recorder Service Toolkit TI version revision R. Known good Q1036 recorder S/N 95120090.

Personnel: Robert Lovelace and Ivan Garza

Description: Q1036 NJT recorder s/n 95120161 was involved in the September 29, 2016 Hoboken NJ train accident. The unit was sent to Siemens on October 1, 2016 for a download of the recorder event logs. The NTSB sent Cassandra Johnson to the Siemens Marion Kentucky location on October 1, 2016 to witness the recorder download. Attempts to download the unit as a whole were unsuccessful. The event memory chips from s/n 95120161 were placed in functioning Q1036 event recorder s/n 95120090 and it was used as a surrogate to recover the event memory. The event memory contained no entries beyond 7/19/2016 suggesting that at this time s/n 95120161 had stopped functioning. Siemens was asked by NTSB to perform a failure analysis on Q1036 s/n 95120161.

Below is a brief description of the process used to trouble shoot recorder.

- Test failed unit with standard test procedures until failure point.
- Visually inspect the Printed Circuit Board Assembly (hereafter referred to as PCBA's), connectors and harnesses on failed unit for obvious signs of damage.
- Use known good PCBA's, socket Integrated Circuits (also known as chips but hereafter referred to as IC's) and harnesses from Q1036 s/n 95120090 to identify faulty assemblies in failed unit.
- Troubleshoot faulty assembly

Actions Taken: The external connectors on the unit were visual inspected for signs of damage. No damage was noted. Next the standard test procedure was performed on the unit. The unit would not proceed past step 6.2.5 of standard test procedure. At this time the outer case was removed and the 60181 main processor board and internal harness assemblies were inspected for signs of obvious damage. No obvious damage was noticed. The socket IC's from the known good recorder unit were

swapped one by one with the ones in the failed unit. No change in operation of the failed unit was noticed. All IC's were returned back to their original board. Next the 60181 board was removed from the failed unit. This exposed the 60117 I/O PCBA. The 60117 PCBA was inspected. No obvious signs of failure were noticed. The 60181 PCBA from the known good assembly was then placed in the failed unit. With the 60181 from the known good Q1036 installed in the failed unit the failed unit was functional indicating the failure was on the 60181 board.

The power supply circuitry on the 60181 was operating as expected. The 5 VDC bus measured 4.98 VDC with minimal ripple, but it appeared as if the processor was not operating and no activity was seen on the data bus. The 3.684 MHz crystal oscillator was not operating as expected. The frequency appeared to be drifting and inconsistent. Also a very quick transitioning dip was measured on RESET line circuitry to the processor. The dip was consistently occurring approximately every 2.5seconds.

Thinking the inconsistencies seen in the oscillator frequency could be causing the anomalies on the reset circuit, crystal oscillator reference designator Y1 (see Figure 1) was replaced.

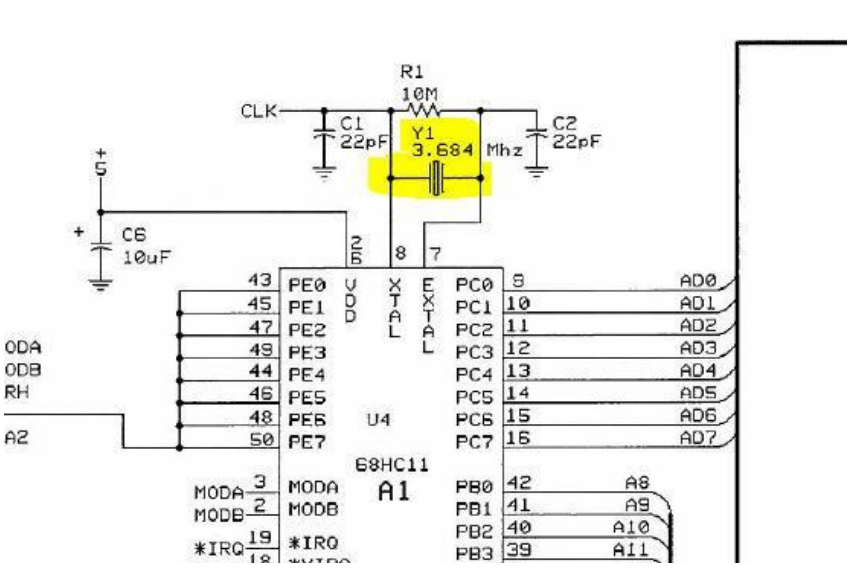

Figure 1

With a new oscillator the frequency measured was consistent and as expected, but the anomalies on the reset circuit were still present. The reset circuit has a voltage monitoring device, reference designator Q1 (see Figure 2) manufacturer part number S-80840CNY, that will force the processor to reset if low voltage is detected on the 5V bus. Thinking this might be failing it was replaced.

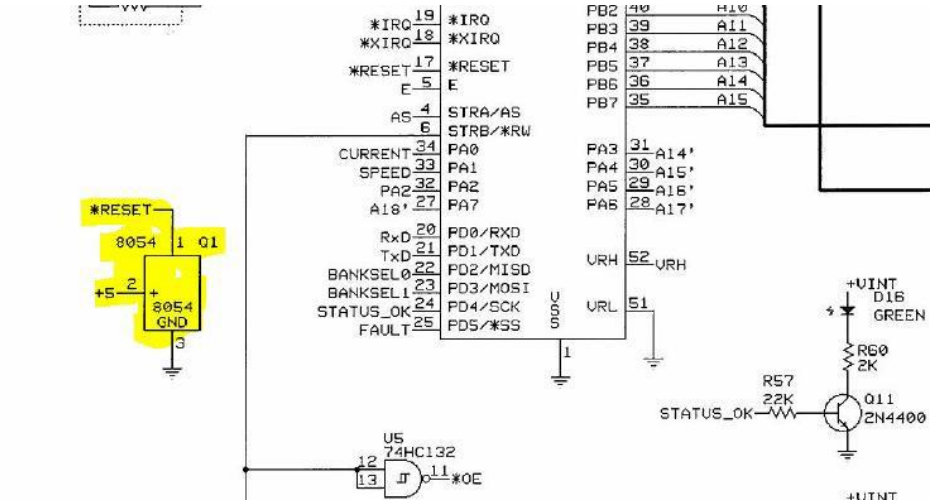

Figure 2

Replacing Q1 cleared the anomalies seen on the reset line, but the processor still did not appear to be operating and no activity was seen on the data bus. The U4 processor chip (see Figure 3) was removed from the socket and the socket was inspected for any damage.

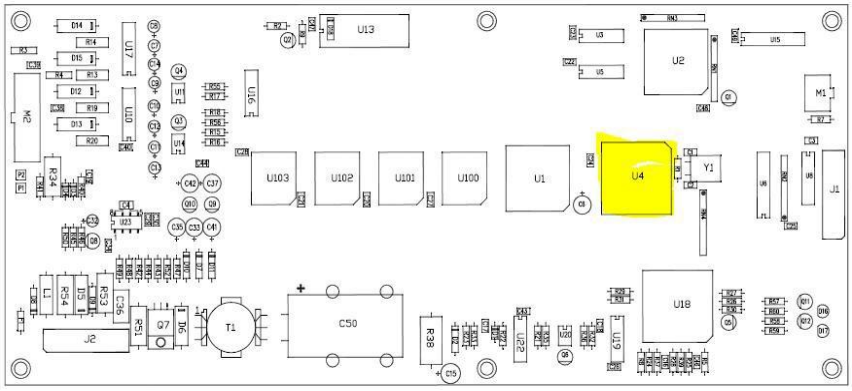

Figure 3

Several pins in the socket looked to be sprung and possibly not making good contact with the chip. A small dental pick was used to pull out the compressed or sprung pins and the processor was re-installed.

The board was still not functioning, so again each socket IC was replaced with the corresponding IC from the known good board. When IC U103 (see Figure 4) was replaced the unit began functioning. IC U103 is the flash memory where the recorder application software is stored.

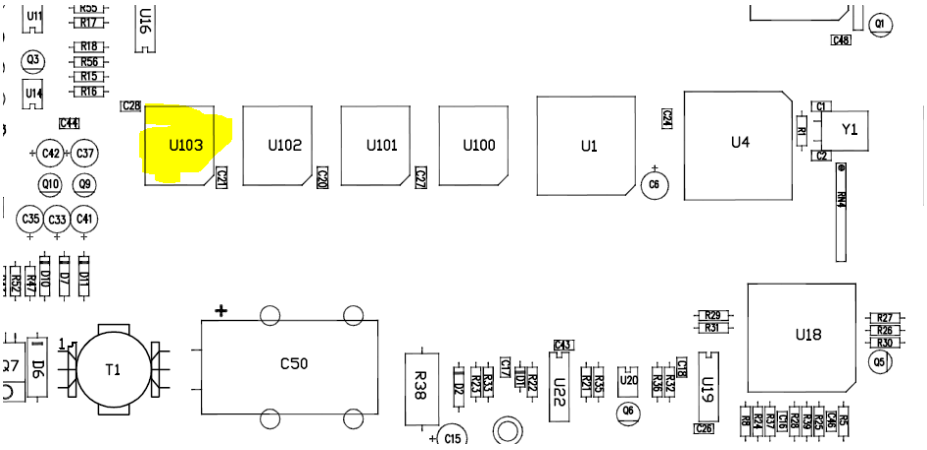

Figure 4

Summary of Findings: Q1036 NJT recorder s/n 95120161 was not functioning when received. It was determined that the failure of the unit resided on the 60181 main processor board. Closer inspection of the 60181 PCBA indicated that the main processor U4 was not functioning as expected and appeared to be in constant reset loop. By swapping the processor out with a known good processor it was determined that the problem was not the processor IC itself. Something on the board external to the processor was causing the processor to be in the constant reset state. Electrical inspection of crystal oscillator Y1 and the U4 processor Reset circuitry showed unexpected and inconsistent signals present.

First the Y1 crystal was replaced and a consistent frequency was now present, but the fast transitioning dip on the U4 Reset circuitry was still present and processor still appeared to be in a constant reset loop.

Voltage monitor Q1 on the Reset circuit was replaced. After replacing Q1 the fast transition dip on the reset circuit was no longer present, but the unit was still not functioning.

The processor IC in socket U4 was then removed and the socket was inspected closely for any signs of damage. Several pins in the socket were noticed to be compressed or sprung in the slots possibly not making good contact with the pins on the processor chip. A small dental pick was used to re-shape the deformed pins and the processor IC was re-installed. The unit still did not function.

Each socket IC was replaced one at a time with the corresponding socket IC from the known good functioning unit. By this process it was determined that the flash memory IC in U103 was bad. With original socket IC and the known good U103 IC, the unit was functioning.

Four problems were identified on the 60181 board. Three of the problems were corrected and it is recommended that the IC socket for U4 be replaced. We recommend the unit go through the FRR process before being sent back to the customer. The U4 socket should be replaced at this time and every external I/O connection would be tested.