STEREO IMPACT

SWEA LVPS LTC1877

PR Numbers: 1xxx=UCB, 2xxx=Caltech/JPL, 3xxx=UMd, 4xxx=GSFC/SEP, 5xxx=GSFC/Mag, 6xxx=CESR, 7xxx=Keil, 8xxx=ESTEC, 9xxx=MPAe

Assembly : SWEA	**SubAssembly :** LVPS
Component/Part Number:	**Serial Number:** FM1
Originator: David Curtis	**Organization:** U.C. Berkeley
Phone : 510-642-5998	**Email :** dwc@ssl.berkeley.edu

Failure Occurred During (Check one √)

v Functional test | Qualification test | S/C Integration | Launch operations

Environment when failure occurred:

v Ambient | Vibration | Shock | Acoustic
Thermal | Vacuum | Thermal-Vacuum | EMI/EMC

Problem Description

In the course of incremental testing of the FM1 SWEA LVPS it was determined that the 2.5V regulator (LTC1877) was non functional. See attachment for more details.

Analyses Performed to Determine Cause

In reviewing the screening data of the device is was found that excessive fallout occurred after burn-in (~14%). A visit was mode on July 6, 2004 to Wyle Lab to determine if there might be any contribution to the failures due to testing parameters or activities. Examination of the burn-in fixture revealed pin 1 of the part was left unconnected (floating), a condition specifically prohibited by the manufacturer on the data sheet. What may have happened, although not provable, is the open pin 1 allowed transients to weaken the part and allow it to eventually to fail. A failure analysis was performed on the LTC1877 device. (Ref: Q40145FA Failure Analysis Report by C. Greenwell dated July 21, 2004 attached.) As a result, the entire lot is considered suspect and should not be considered for use in flight hardware.

Corrective Action/ Resolution

v Rework | Repair | Use As Is | Scrap

All LTC1877 devices with LDC 0228 were replaced with 0326 LDC devices. These devices were replaced in all of the LVPSs. All reworked devices were successfully retested at both the board and box test level.

Date Action Taken: 2004-9-22 **Retest Results**: Success

Corrective Action Required/Performed on other Units v Serial Number(s): FM2 SWEA, FM1 & FM2 IDPU, SEP, and PLASTIC LVPS

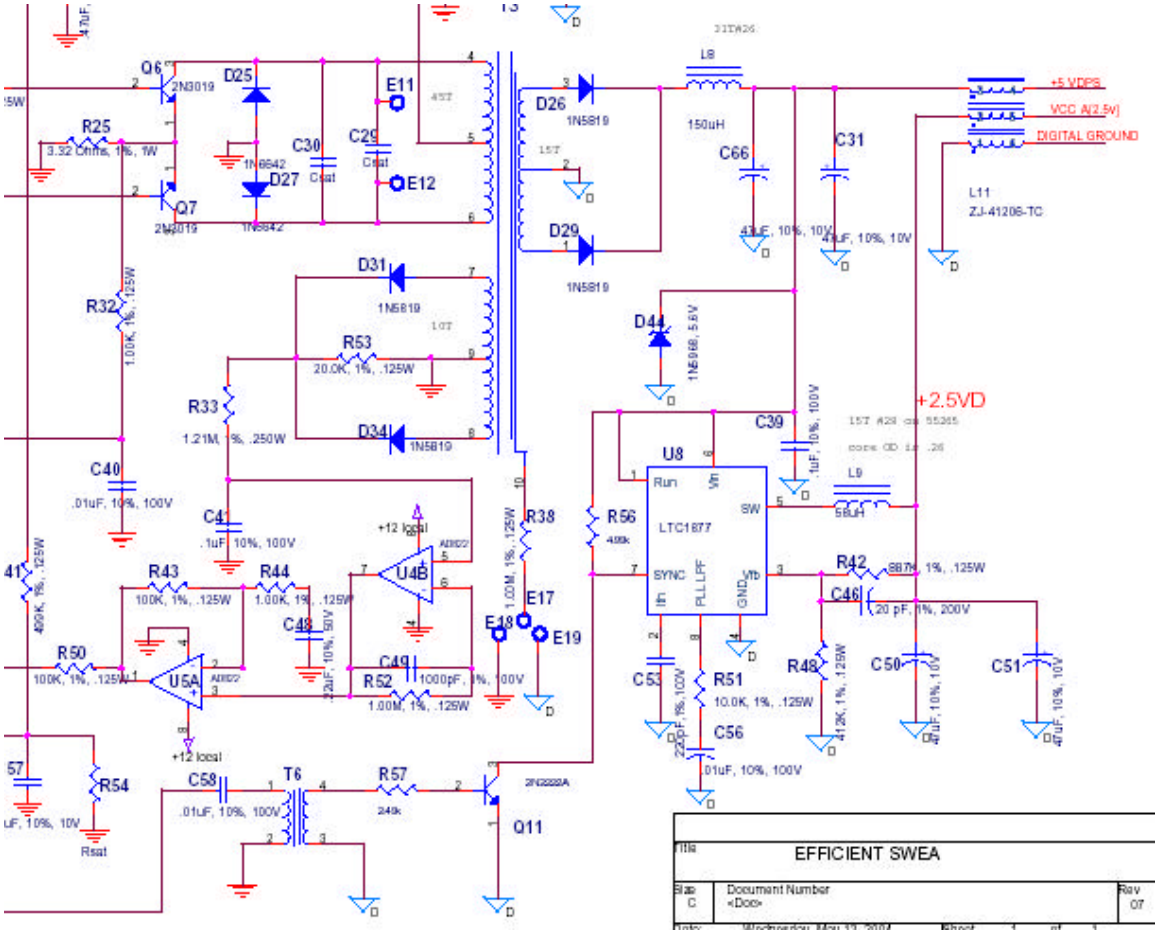
Closure Approvals

Subsystem Lead: _____ Date:_____
IMPACT Project Manager: _____ Date _____
IMPACT QA: _____ Date:_____
NASA IMPACT Instrument Manager: _____ Date:_____

Details of LTC1877 Failure Diagnostics:

The LTC1877 wasn't regulating at all. (This was the first time the LVPS was powered and tested with the transformer installed that drives that section of the supply.) There are two outputs from that section. One is 5V; this output also powers the LTC1877, which is configured to give the other output, 2.5V. The 5V output was fine, but the 2.5V output also measured 5V. The supplies were unloaded. The regulator switching output (pin 5) wasn't switching, just sitting at the 5VDC power rail. With one exception the inputs measured as expected.

The exception was the voltage feedback input (pin 3), which expects to be at ~0.8V, with the external divider (R42 & R48) chosen to give the desired output voltage. This pin measured ~0.5V, and neither this voltage nor the output changed when I put another resistor in parallel with R42 or R48 to change the divider. Both resistors were the correct values, but the resistances and measured voltages had no correlation with the design equation for them. We concluded the only remaining explanation was a bad part, and replacing the part did correct the problem.



2004-7-6
LTC1877 Test Findings

In reviewing the screening data it was found that excessive fallout occurred after burn-in (~14%).

A visit was paid on July 6, 2004 to Wyle Labs to determine if there might be any contribution to the failures due to testing parameters or activities.

Examination of the burn in fixture revealed pin 1 of the part was left unconnected (floating), a condition specifically prohibited by the manufacturer on his data sheet.

Linear Technology was called, and the cognizant engineer was consulted and asked what the result might be of leaving pin one open while power was applied. He said the part could be damaged by transients, but not destroyed. He also said there may be or may not be an output, as pin 1 controls whether the part turns on or not.

David Stone had taken a test board supplied with a LTC1877 and subjected the part to negative voltages without incident. After deciding the part was “bulletproof”, he had one part from the screened parts installed and also could not destroy it, but after his testing, it did have a wandering output voltage when unloaded (though not as bad as the parts that failed in SWEA).

What may have happened, although not provable, is the open pin 1 allowed transients to weaken the part, and allow it to eventually fail.

It is thereby recommended that Wyle correctly connect all the burn in sockets, Space Sciences review their test sockets prior to usage, and Wyle screen the new lot presented to them after SSL approval.

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Failure Analysis Report

Microcircuit, Linear, Regulator, Step-Down
Mfr.: Linear Technology
P/N: LTC1877EMS8
DC: 0228
LVPS
SN: 66

Project
STEREO
System
IMPACT-SWEA

Requester
A. Reyes (562)

Investigator
C. Greenwell (562)

Report Date
07/21/2004

Background

The details of the LTC1877EMS8 failure are provided in STEREO IMPACT Problem Report PR-1007. The regulator was identified as non-functional at first power-up at functional test at ambient environment. The failed device, along with two spare devices, was forwarded to the GSFC Parts Analysis Laboratory for investigation.

Part Description

The LTC1877EMS8 is a high efficiency synchronous step-down regulator intended for low power/battery powered applications. The monolithic silicon die is quite complex in that it has built-in thermal, over-voltage, and output short-circuit protect circuitry, as well as an integral phase lock loop and low supply dropout circuits, etc.

The die is provided in a very small 8-lead MSOP plastic encapsulated microcircuit (PEM) surface mount package.

Analysis and Discussion

The as-received condition revealed no anomalies that might indicate device failure. Pin 1 was bent towards, and solder-bridged to, pin 2. Pin 4 was cut very close to the device package. The device had what appeared to be a laser scribed serial number (66) on its top surface (top and bottom views are shown in Figure 1). Radiographic inspection revealed no anomalies (Figure 2). C-mode acoustic microscopy (C-SAM) revealed delamination between the mold compound and the lead frame fingers, at both sides of the fingers (Figure 3). They were particularly pronounced on the wire bond sides (top). These features are considered a significant reliability risk due to the possibility of an open circuit wire bond, and thus, are rejectable per applicable inspection criteria.

Fine gauge wires were soldered to the device leads to facilitate curve tracer pin-to-pin characterization. This testing revealed a 4.1kΩ short between pins 3 (V_{FB}) and 4 (GND). By comparison, the two spare devices showed no current flow (up to 5 volts) between pins 3 and 4 with

pin 3 biased positive with respect to pin 4, and showed a typical forward diode characteristic with pin 3 biased negative with respect to pin 4. This appears to be an electrostatic discharge (ESD) or reverse bias protection diode.

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Part Type:	Microcircuit LTC1877EMS8	Part No:	
Manufacturer:	Linear Technology	Date Code:	0228

One of the two spare devices had a 100kΩ short between pins 5 (SW – output pin) and 4 (GND). This was not investigated further. Aside from this finding and the short between 3 and 4 on the failed device, the majority of pin combinations for all three devices were more or less identical.

Functional bench testing/characterization was attempted with no success. The device most likely requires a very specific test board and circuit configuration to function as intended.

The failed device was deprocessed with nitric acid to reveal the die for inspection. The process left residual mold compound on the die surface making inspection somewhat difficult (Figures 4 and 5). Nonetheless, the entire die surface was inspected at 500X magnification under brightfield illumination, and in the scanning electron microscope (SEM).

Liquid crystal hot spot detection was set up, but then it was discovered that the previously documented 4.1kΩ short between pins 3 and 4 was no longer present, thus, the technique was not successful at revealing a suspected damage site.

The device was then cleaned and plasma-etched to remove glassivation/passivation. Repeated optical and SEM inspection again did not reveal a damage site.

A review of the screening data revealed 17.6% failures of the lot through initial test and after burn-in. Twelve of 82 device subjected to burn-in failed electrical test after burn-in. One of these failures may have been a parametric failure, however, the remaining 11 devices appeared to be catastrophic failures. SN 66 passed all screening tests.

It was reported in the STEREO IMPACT Problem Report PR-1007, that the burn-in boards left pin 1 open circuit (floating). This is the run control input and it is specifically stated in the manufacturers data sheet *not* to leave this pin floating. Inquiry made to Linear Technology prompted the reply that leaving this pin floating could result in the device being damaged but not necessarily destroyed.

1.1.1 Conclusion

The failure of the LTC1877ESM8 was not conclusively demonstrated (the device was not functionally tested). However, pin-to-pin curve tracer characterization revealed a 4.1 k-ohm short between pins 3 and 4.

It was discovered that the burn-in board left pin 1 floating, and that such a configuration might produce latent damage to the device. How this might affect pin 3 is not known.

The entire lot is now suspect and should not be used for flight hardware.

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Part Type:	Microcircuit LTC1877EMS8	Part No:	
Manufacturer:	Linear Technology	Date Code:	0228

Appended Images:

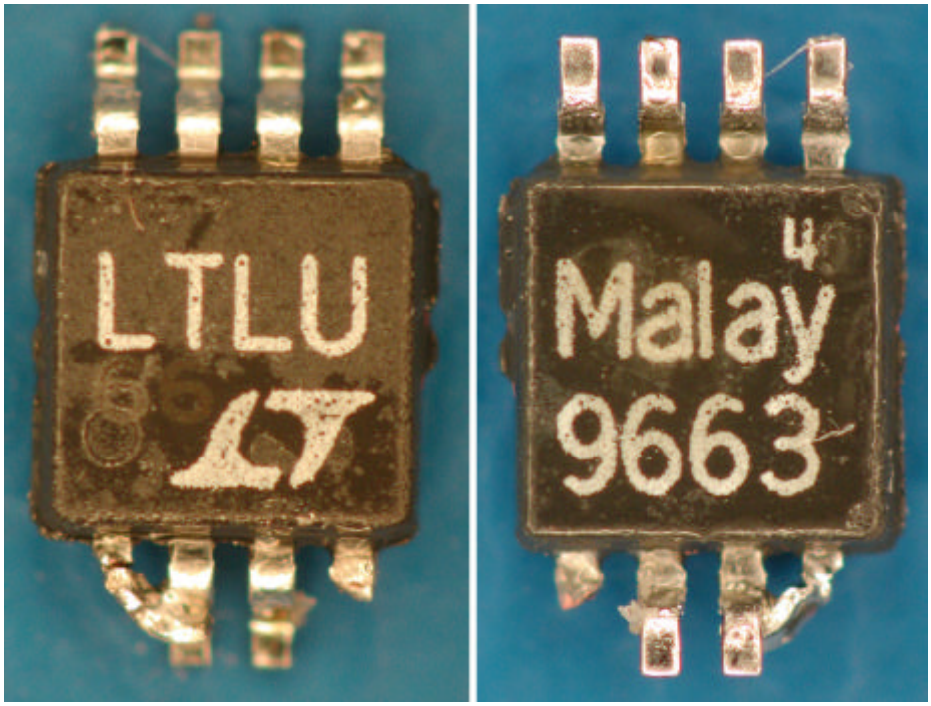

Figure 1. External top and bottom images of the device as received. Pin 4 is the cut pin.

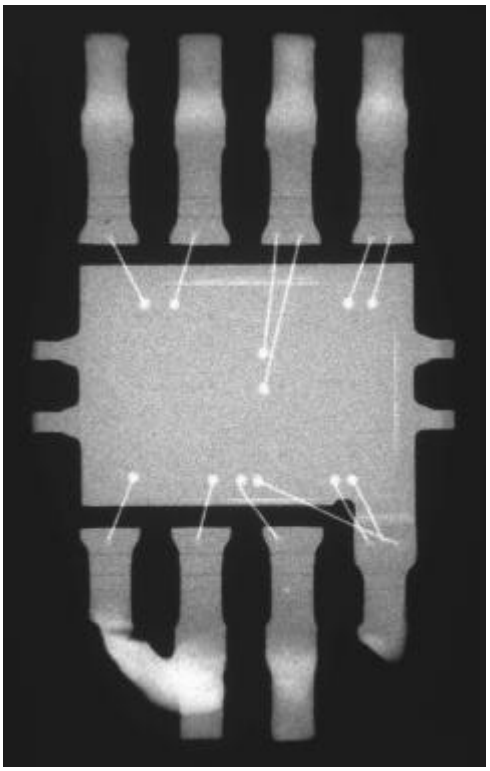

Figure 2. Radiographic image of the device. All bond wires are intact.

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Part Type:	Microcircuit LTC1877EMS8	Part No:	
Manufacturer:	Linear Technology	Date Code:	0228

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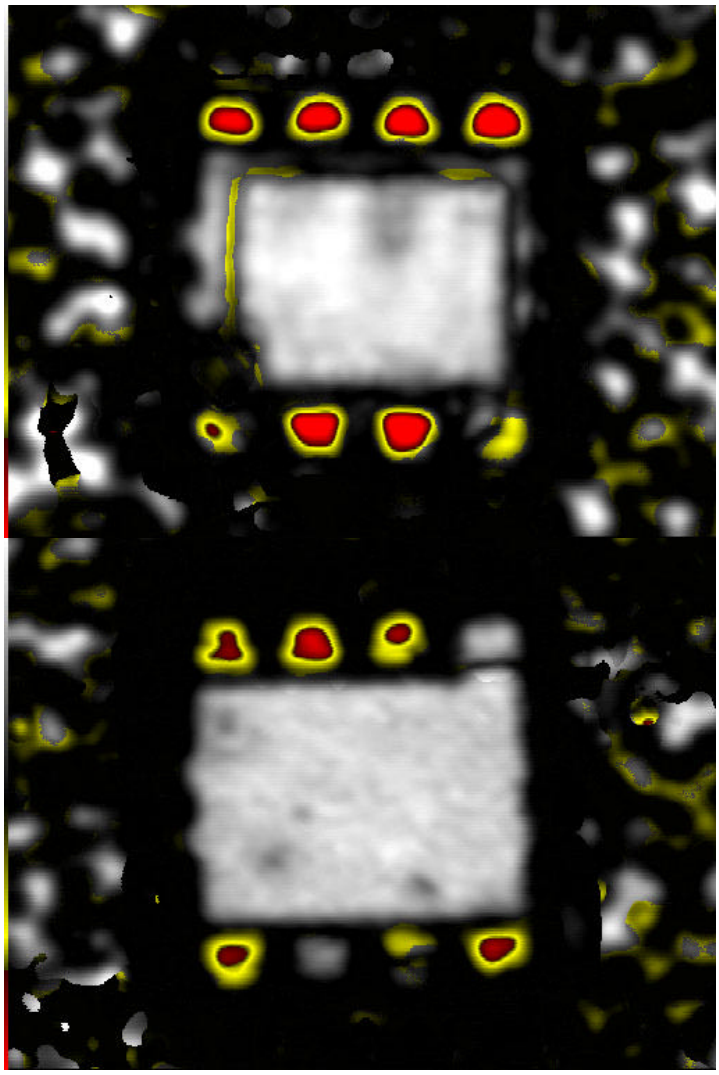

Figure 3. Top (l) and bottom (r) C-SAM inspection images show significant delamination at the lead frame fingers. These are not likely related to device failure since no open circuit conditions were observed.

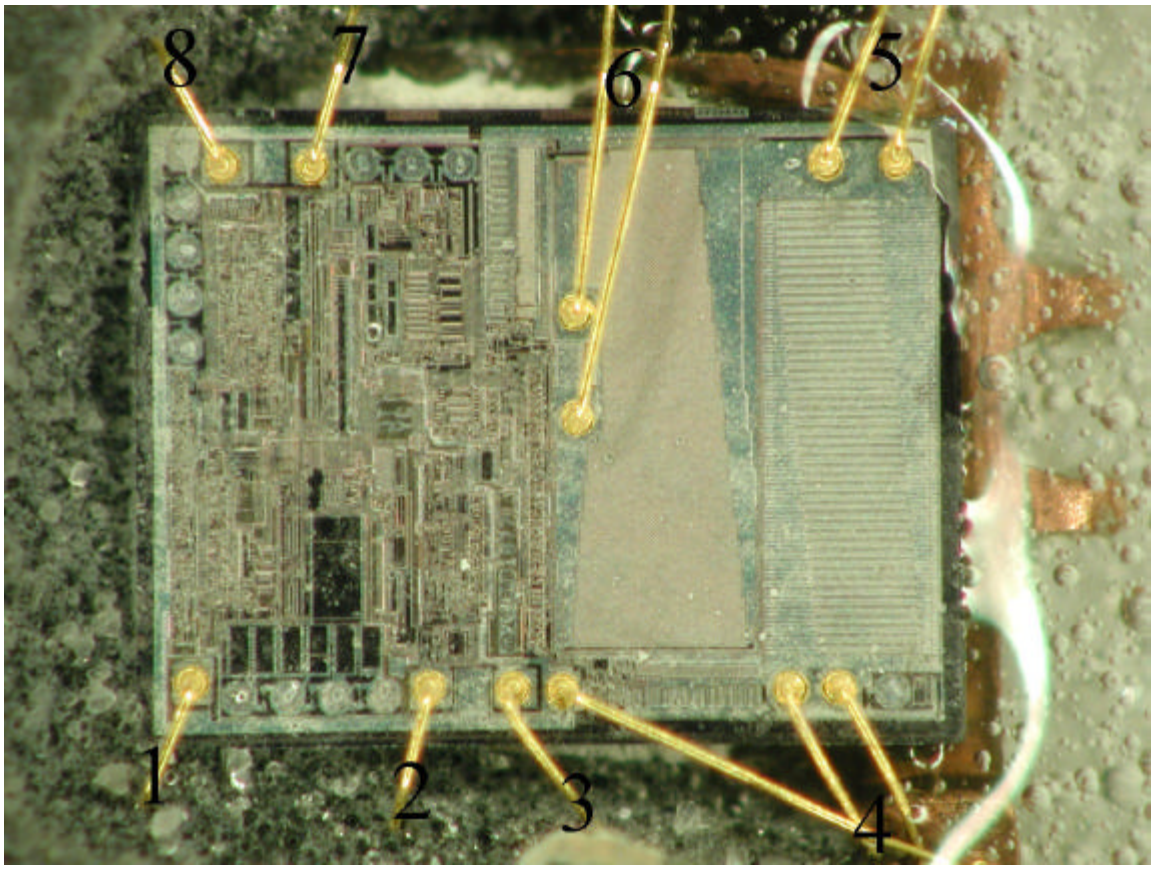

Figure 4. Overall view of the device deprocessed and mounted for internal examination.

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Part Type:	Hybrid VCO	Part No:	LV113UM
Manufacturer:	Modco	Date Code:	073102

Appended Images:

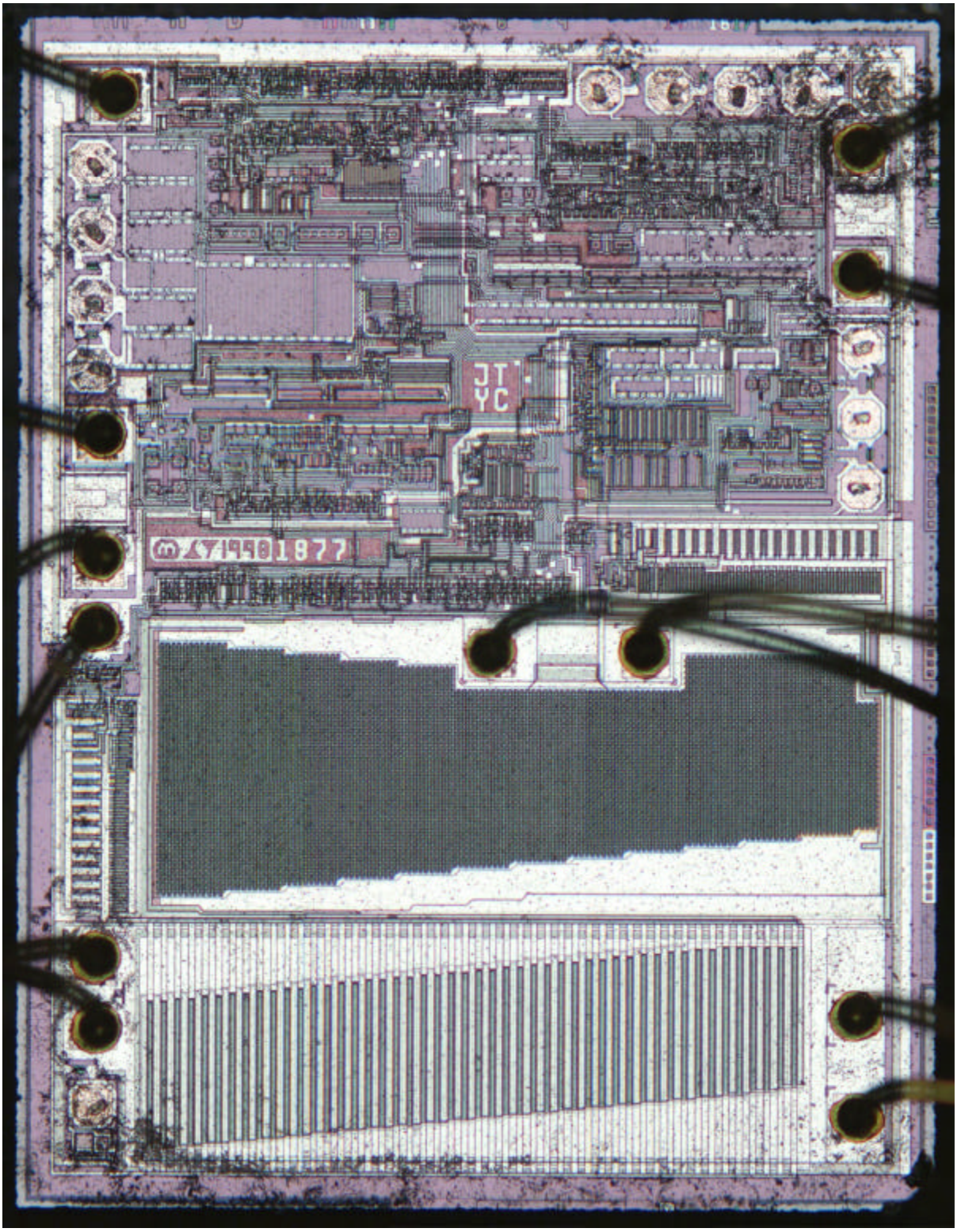

Figure 5. Overall image of the die.