Bally Arcade / Astrocade Motherboard Troubleshooting:
Hints, Tips and Fixes: An Exchange of Ideas
January 2021
Version 1.0

This is a compilation of emails about fixing and troubleshooting six non-
working Astrocade motherboards. These emails were written and exchanged in
October and November 2020 over the course of about three weeks between Michael
Matte, Allen Schweitzer and Adam Trionfo, three members of the Bally
Arcade/Astrocade community.

This compilation isn't meant to help you troubleshoot a non-working astrocade,
although there are probably many hints to be picked up here. This collection
is meant to provide inspiration for those trying to get a broken Astrocade home
videogame console up and running again. The six bad motherboards that Michael
worked on repairing were shipped to him by Allen. There were boards that Allen
was unable to fix himself. This means, that they had hardware issues that were
extremely difficult to track down under normal circumstances. Allen had given
up on them and sent them to Michael with hopes that he might be able to track
down some of these issues. Michael labeled each board as Allen board BD1
through BD6; you'll see the motherboards referenced by these names throughout
this correspondence.

As you read this document, imagine this exchange of ideas taking place over
several weeks. Not all of the emails were sent to each of the three
individuals, so sometimes the order of the emails preserved here might seem out
of sequence. If you persevere and read the document from the start to the
finish, then it will begin to make sense to you. Oh, and spoiler alert:
Michael was able to fix all six of the dead Astrocade motherboards!

The emails have not been changed, although bits of them have been omitted and
marked with "[...]" so that you can see when something is missing. You'll also
notice that there may be terms used which are unfamiliar to you, especially if
you're unfamiliar with fixing hardware. For instance, words such as "Bal
Check," or "BalCheck" wouldn't be encountered outside of fixing an Astrocade.
When you come across words that hold no meaning for you, then do a search on
BallyAlley.com and you'll probably find a definition for the word(s). Michael
also has created some software and hardware to help him troubleshoot hardware.
When you run across terms such as "Z80 Check" and "SetScreen," then he's
referring to this diagnostic software. If you're really stumped and need to
understand some terminology, then drop by the Bally Arcade/Astrocade discussion
forum and ask your questions there. The forum is here:

https://groups.io/g/ballyalley

Michael refers to components on the motherboard with the names used in the
Bally Service Manual. This manual contains such useful information as system
operation, disassembly, motherboard parts list, layout, schematic and more. If
your Bally Astrocade is broken and you have some electronics knowledge, then
this manual should be just what you are looking for to fix it and also to help
follow Michael's comments. The service manual can be downloaded here:

https://ballyalley.com/documentation/misc_hardware_docs/Bally/Bally.html#PA-
1BallyServiceManual

Keep in mind as you read this document that it isn't meant to be a how-to guide on troubleshooting an Astrocade; it's more like a mesmerizing story that proves that it's possible to fix even the most troubled Astrocade system.

Hopefully this document is inspiring and will allow someone who is not able to fix their Astrocade to be encouraged. With an uplifted mindset, it will probably be possible to power-through the struggle to get non-working Astrocade equipment up and running again. If you've reached the end of your rope and you feel like your Astrocade is dead, just completely unable to be revived, then take a deep breath and read the exchange of thoughts here. You just might be inspired to take out your test equipment and give another go to that dead Astrocade motherboard that you are about to throw away into the trash.

Special thanks to Michael for allowing his email updates to Allen and me to be shared with the general Astrocade community.

Adam Trionfo
January 22, 2021

Subject: Allen BD6
From: Michael Matte
Date: 10/27/2020, 12:20 PM
To: Allen
CC: Adam Trionfo

Good news Allen!

I ran a quick check on all 6 motherboards you shipped to me. I attempted to run Z80 Check on all the boards. On the boards that executed Z80 Check, I ran Balcheck, then attempted to run SetScreen3. Boards BD2 and BD3 executed Z80 Check. I likely will be able to determine what's wrong with these 2 boards.

Z80 Check may be the preferred first choice for a black screen scenario instead of running Balcheck because:

It doesn't need the on-board ROM to execute.
It attempts to disable on-board ROM.
RAM does not need to be operating to execute Z80 Check.
It attempts to output a simple graphics display to screen RAM, similar to the original SetScreen (version 0).
You can insert a Motherboard Test cartridge into the cassette connector to run an additional custom test program to add to or replace the Z80 Check program.

If Z80 Check does execute, then you can run Balcheck and SetScreen3 to help further isolate the problem area.

I took the socketed Z80 from BD6 and installed it into the Z80 socket in BD3. Z80 Check still executed on BD3. Good!

That's great news for BD6. Its Z80 is ok. I also observed when that Z80 was in BD6, its HALT (active low) pin 18 was near 0 volts. I wonder if the Z80 can sense a problem, then goes into the HALT state, just executing internal NOPs (no operation instructions)?

This news for BD6 is promising. I will now use an ohmmeter and the Bally schematic to run a continuity test searching for a disconnect in Zone 2, which is related to the operation of the Z80 and its surrounding address and data bus connections to ROM, U8, U9, U10, U5, etc. I will start with the Z80, checking all of its 40 pin connections. All the chips on this cool motherboard are in sockets. I'm expecting to find a disconnect in a top solder pad below a socket where the flowing solder didn't make contact with the top pad. This is easy to do, but may take some time to find a bug. This board is in really good condition, so I think it's unlikely there could be a standard trace crack or break.

You know Allen, after working on these 6 boards, I'm likely going to be able to document a really nice Check Procedure for a black screen scenario. This procedure would hopefully speed up troubleshooting and reduce the chances of having to use a last resort "hit or miss" approach by just replacing chips. That's good news for both you and me.

Bye.
MCM

Subject: Hi-Res Multi-Page Test Demo Coding Copy
From: Michael Matte
Date: 10/29/2020, 5:14 PM
To: Adam Trionfo
CC: Allen

Hi Adam. Just wanted to let you know today I started photo copying my hand written program for my 8KB hi-res multi-page Test Demo. I'll let you know when it is time to ship my package of photo copies to you, perhaps in 10 days.

All my next Astrocade projects have been postponed temporarily. I've been side tracked again now with Allen's 6 failed motherboards that he shipped to me last week. I'm just too excited desiring to fix all 6 boards if I can. I have the tools and enough expertise to get the job done. Allen is willing to ship me parts if I need any. This job when finished, will likely inspire me to write a reference doc, a troubleshooting procedure for a black screen scenario, so Allen and I don't have to spend extra time recalling how to troubleshoot this scenario efficiently. The goal of the doc would be to provide tips to reduce having to use that awful last resort "hit or miss" approach by simply desoldering/installing chips. I plan to investigate, by purposely using bad chips on a motherboard to see if a LA can be used more effectively to point or at least bring suspect to a bad chip. Allen and I could then consult this procedure step by step (or skip steps) to make it easier/faster to arrive at a more accurate diagnosis. There would initially be some gaps in the procedure which Allen or I could eventually update. The procedure would be based primarily on the utilization of the 32KB BalcheckHR package, a frequency counter and/or a logic analyzer, a logic probe, VOM and of course basic troubleshooting skills. Working on these 6 boards would really help me develop this idea of documenting a troubleshooting procedure.

Bye.
MCM

Subject: Allen BD6
From: Michael Matte
Date: 10/28/2020, 2:55 PM
To: Allen
CC: Adam Trionfo

I found another top solder pad disconnect.

I sent a copy of this email to Adam because I thought he might be interested in
how I am conducting a continuity test for the Z80/ROM zone 2.

I sketched a large Z80 pin out labeling the pin numbers and Z80 lines. I use
this sketch as a checkoff list.

I photocopied the 11x17" Bally schematic from my Bally Service Manual PA-1. I
use the photocopy as a progress report. When a chip pin has been checked for
continuity, the schematic is marked with a highlight felt pen.

I keep the negative ohmmeter lead always on the Z80 chip pin when running a
continuity test. Using the positive ohmmeter lead, perhaps for some internal
ohmmeter reason, sometimes displays some resistance, which confuses my test
reading.

As a precaution, I also check for shorts the neighboring chip pins including
the neighboring pins on the opposite side of the chip, just in case the top
solder flow manages to contact a neighboring motherboard trace running past
that solder pad.

Here's what I discovered. The data line D6 for the ROM and cassette connector
was not connected to the Z80 because the solder flow did not connect to the top
pad at socket U10, pin 7.

I added a short jumper to fix that disconnect.

The expansion D6 line was still connected. So, this disconnect would not affect
the execution of Z80 Check, which does not use the onboard ROM.

So far, I have checked 10 Z80 pins for continuity. If I find a disconnect that
would affect the execution of Z80 Check, then I will fix the disconnect and run
Z80 Check to see if the Z80 will now run that program.

Bye.
MCM

Subject: Allen BD6
From: Michael Matte
Date: 10/30/2020, 12:35 AM
To: Allen
CC: Adam Trionfo

Guess what? I am happy to report the Allen BD6 is now up and running. As I am
texting in this email, Checkmate is running great.

I found a disconnect at the RAM U27 socket (video data line 3, MD3) thanks to
Balcheck and SetScreen3. These are awesome diagnostic tools.

I thought the disconnect might be along this data line, but it wasn't. The top pad of the U27 socket pin 6 was not connected to the RAM A2 line.

I soldered in a jumper wire of two twisted together #30 wrapping wire, having insulation which can easily withstand a 20W soldering tip. I replaced my personal working custom address and data chips with Allen's chips, his address chip coming from BD3. I didn't even bother hooking up my BalcheckHR breadboard. I powered on the motherboard using my MCM Design power transformer substitution board. When I saw the menu appear, boy did I jump for joy. The board is fixed man. How about that!

Considering all the sockets that you installed Allen, there were only 3 disconnects. I find that amazing. Good job Allen.

This is a really clean near new motherboard and all its chips have sockets. Nice!

Bye.
MCM

Subject: More Good News
From: Michael Matte
Date: 10/30/2020, 8:16 PM
To: Allen
CC: Adam Trionfo
Attachments: Accomodate U21.JPG   170 KB

You can modify the cassette connector slightly to accommodate U14, U21 and U22 installed in sockets.

File down the plastic riser where the stationary end of the spring is attached. File it down until it is flush with the rest of the plastic support. Drill a tiny hole off to the side, then attach the spring. This is a very simple modification. See photo.

I mounted this modified cassette connector on Allen BD6. The plastic is a bit warped probably from heat. The connector fits easily over the motherboard.

I'm running BalcheckHR test demos on Allen BD6. Some time ago, I copied BalcheckHR to an EEPROM and installed the 28 pin EEPROM in a cassette cartridge.

Bye.
MCM

^ file down plastic
^ riser. Spring was
^ located here.

Modified Astrocade
Cassette Connector
Accommodates U21
Installed In Socket
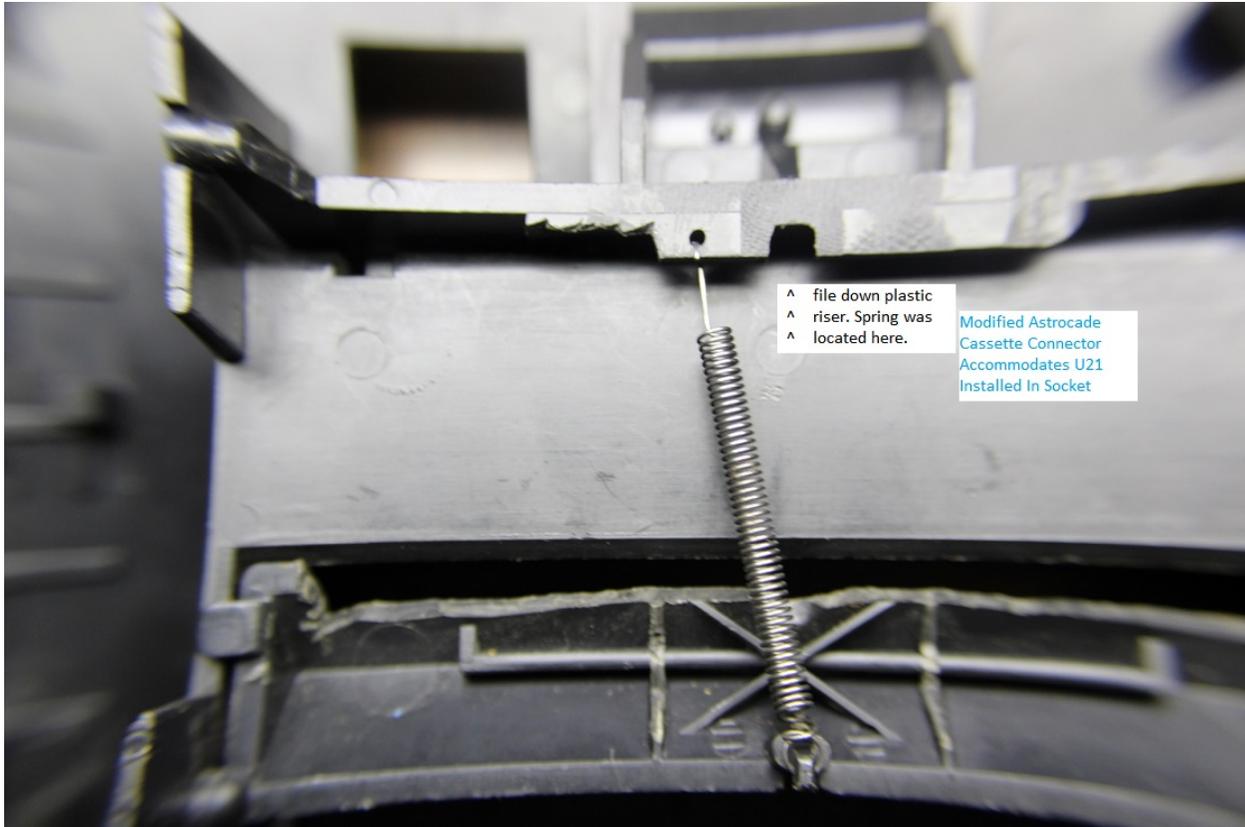
Subject: Re: Allen BD6
From: Michael Matte
Date: 11/3/2020, 8:55 PM
To: Adam Trionfo

I take it you'll settle for a perfect working Astrocade from Allen even if only
a few chips are in sockets.

That's acceptable to me to have my videos [that I plan to make to cover my hi-
res Astrocade, and, possibly Astrocade diagnosis videos] posted on YouTube.

I'm still working on Allen's board BD1. The Z80 is not working. My Z80 Check
program doesn't execute. Tonight I ran a logic probe on the Z80. The probe
indicates the system clock pulse on pin 6. The probe is indicating five Z80
control signals are stuck at a logic 1 with no pulse activity. Looks like the
Z80 is not doing anything. The Z80 checked out good on the working board BD6.
I'm running out of check ideas. I'm having difficulty finding the bug. I
checked the chips wired to the Z80. I think with all those sockets there is a
bad connection somewhere. I just haven't found it yet.

Bye.
MCM

Subject: Re: Allen BD6
From: Adam Trionfo
To: Michael Matte
Cc: Sent: Tuesday November 3 2020 12:48:36PM

Michael,

[...]

Yes, an assortment of videos with you diagnosing black screen scenarios sounds
(really!) great. I would link to them from BallyAlley, but the videos would be
posted to YouTube (I have no way to host videos on my website). I've always
wanted to see BalCheck and the other software you mentioned work.

You always inspire me!

Adam

Subject: Re: Allen BD6
From: Michael Matte
Sent: Saturday, October 31, 2020 12:48 PM
To: Adam Trionfo

[...]

Watching me trying to fix a motherboard would likely be pretty boring. I'm kind
of slow and sometimes must ponder on an issue for a while to decide what to
test next. What about if I recorded some videos showing some of the steps used
to diagnose a black screen scenario. The videos could be posted on the Bally
Alley. Viewers would get to see the software Balcheck, SetScreen3, Z80 Check
and Remote ROM in action, how to run my continuity test and more. This might
entice some Astrocade techs out there to build a BalcheckHR board and fix some
failed Astrocades. I could record some raw videos, after I finish writing my
black screen scenario troubleshooting procedure, the portion when the Z80 won't
execute instructions. This documented black screen troubleshooting procedure,
an on-going doc, could also be posted on the Bally Alley.

Bye.
MCM

From: Adam Trionfo
To: Michael Matte
Cc: Sent: Friday October 30 2020 8:08:36AM
Subject: Re: Allen BD6

Hey, guys, this is such wonderful news. I can only imagine how nice it must
have felt to see the board fire up for the first time.

As a side note, maybe I should mention that I might be able to use one of these
Astrocade motherboards as a spare.

This makes me regret, once again, trashing about 10 or so Astrocade boards back in the 1990s. Man, I was an idiot back then. I still am, I guess, but now I wouldn't throw away Astrocade motherboards.

Adam

From: Michael Matte
Sent: Friday, October 30, 2020 12:48 PM
To: Adam Trionfo
Subject: Re: Allen BD6

[...] I'm going to work next on Allen BD1. Only 3 chips on this board have no sockets. I recall Allen saying his customer wanted this particular board back if it was fixed. Allen sent that customer another working board instead. The board ended up in Allen's little pile of "not fixable motherboards". Since the 6 boards Allen shipped to me are boards he went as far as he could with at the time, I bet Allen would give away one of these boards to you if it was fixed, except BD6, which I have reason to believe was promised to me if that particular board was fixed. Allen is still on the learning curve. This new recent revelation I discovered on how to approach a "black screen" board when the Z80 is not operating will help Allen, myself and perhaps other troubleshooters a lot once the revelation is documented and posted on the Bally Alley. Maybe I could throw the hint at Allen for you. What do you think?

We all have are moments of idiocy. As old as I am, I still have those "I'm such an idiot" moments, but I try to learn from that experience.

Bye.
MCM

Subject: Re: Allen BD1 Check Tests
From: Michael Matte
Date: 11/4/2020, 12:44 PM
To: Allen
CC: Adam Trionfo

I will check your recommendation. I may have already done that with my Z80/ROM zone 2 continuity check.

My logic probe is a cool tool. Last night, I just learned how powerful this tool is. I had no idea of its potential for troubleshooting. I can check the Z80 real time for activity. Before I probed the Z80 in BD1, I had already swapped Z80's on the BD1 and BD6. I also used the probe on the BD6 Z80. There's all kinds of activity there when running Z80 Check. The pulse LED on the probe, when placed on the IORQ (active low) line is in sync with each incrementation of the 7-segment dual display, which is what should be happening. Back on BD1, the probe is indicating no activity on A0-A15 and D0-D7 with voltage levels between logic 0 and logic 1. Using the probe has also created new check ideas.

Fortunately the Z80 socket is an open socket allowing me to view traces underneath the socket. This has created a great idea to check and document possible top solder spill over onto a neighboring trace creating a bad

connection. I really like this idea. I really have hope in finding the bug if solder spill over is the culprit.

Tonight I'm going to make sure the system clock is normal by checking it with my LA [logic analyzer]. I'll check some other lines too. I think the LA may only report a logic 0 or 1 with nothing in between. If so, that could display a misleading waveform, a false report.

By slowly determining what is working, what connections are good, I am getting closer to finding a bug. Hopefully, there is only one bug shutting down the Z80.

Bye.
MCM

From: Allen Schweitzer
To: Michael Matte
Cc: Sent: Wednesday November 4 2020 9:16:15AM
Subject: Re: Allen BD1 Check Tests

Just throwing this out there - maybe check continuity on the z80 socket between pins 5 & 6 and 6 & 7 to make sure I didn't get too much solder topside and am shorting across a line?

On Tuesday, November 3, 2020, 10:22:17 PM CST, <Michael Matte> wrote:

Confirmed Z80 connections to BalcheckHR board are good.

Ran logic probe on Z80 during an attempt at running the Z80 Check program
Results:
Logic 0 with pulse activity was present at Z80 system clock pin 6
Probe is indicating five Z80 control signals MREQ, RD, IORQ, WR and RFSH (all active low) are at logic 1 with NO pulse activity
The Halt (active low) line at pin 18 is at a logic 1. So the Z80 is NOT halted and executing NOPS (no operation instructions)

Tonight I ran a logic probe on the Z80. The probe indicates the system clock pulse at pin 6. The probe indicates five Z80 control signals are stuck at a logic 1 with NO pulse activity. Looks like the Z80 is not doing anything.

Will try this probe on working BD6 as a comparison to see how the probe will react.

I plan to take a look at the system clock waveform on my LA to see if the clock waveform looks normal.

I'm nearly at the bottom of my ideas check list.

I still believe there is a bad connection somewhere in the Z80/ROM zone 2 area of the motherboard preventing the Z80 from operating. I just haven't found it yet. All it takes is one bad connection to shut down the Z80. The associated chips have checked out OK. I did remove the custom address and even the custom I/O and ran the motherboard for a few seconds.

Bye.
MCM

Subject: Allen BD1
From: Michael Matte
Date: 11/7/2020, 2:50 AM
To: Allen
CC: Adam Trionfo

I don't believe it. I simply just don't believe it. Allen BD1 is up and
running. Not only is it up and running, but it's running perfect. Yippee! As I
am writing this email, I am running Checkmate and it's running perfect.

What was wrong with it you ask? I don't believe that either. Remember I told
you the Z80 was shut down. I told you I thought there was a problem with the
operation of the Z80 relating to its control, address or data bus lines, so I
spent a lot of time looking for a bad connection specifically where the sockets
were installed. I ran two different continuity tests and neither test showed
any bad connection. Well, it turns out I was looking in the wrong area, so
that's why I couldn't find a bug. By the way Allen, you soldered all those
sockets perfectly. That's amazing.

Yesterday I was looking at my upgraded BalcheckHR breadboard schematic for my
optional operation of a remote Z80, which I spoke to Adam some time ago as a
crazy but new idea for troubleshooting, that might come in handy someday when
there is an issue with the Z80. I was actually thinking of utilizing that
option tonight or tomorrow. The schematic mentioned that a Z80 could be put
into a tri-state condition which basically turns off the Z80 without causing
any data conflict. So I thought that's kind of the way the Z80 is acting right
now. Maybe it's in the tri-state mode right now. So I checked the Z80 BUSREQ
(active low) line pin 25, which is used to bring the Z80 into a tri-state mode
when that line is brought to a logic 0. But, my logic probe showed it as being
high, so the Z80 wasn't in a tri-state mode.

Yesterday, I also was thinking about the Z80 RESET (active low) line pin 26. I
did check the reset circuit last week and the reset button was functioning. But
it didn't occur to me until yesterday, after Allen sent me an email commenting
on the reset capacitor C13, that maybe this cap or the other cap C14 might be
shorted preventing the RESET line from going to a logic 1, which is necessary
for the Z80 to operate. I desoldered one end of each capacitor and I thought I
might be able to determine if one of them was shorted by using an ohmmeter. I
was wrong about that. My ohmmeter didn't tell me anything. So I left cap C13
disconnected and replaced C14 with a temporary brand new 0.1uf disc capacitor.
I powered on and attempted to run Z80 Check. Nothing happened. Then I pressed
the reset button and the Z80 Check program started executing and the 7-segment
dual display started counting up in hexadecimal. Can you imagine how excited I
was to see that?

Then I thought heck I'm going to put those 6 chips, including the onboard ROM,
that I removed during my tests (because they weren't necessary to run Z80 Check
and I thought they might create a data conflict) back into the motherboard and
see if the menu powers on. Well I did that and the motherboard powered on with
a black screen. Of course, I was very disappointed. But, I forgot that I didn't
press the reset button. Apparently cap C13 is required for an automatic reset
at power on. Well guess what happened when I hit the reset button? You got it.

The menu was displayed. Man, I was jumping up all over my hobby room with great
joy.

So there you have it. I was wrong with my thinking why the Z80 wasn't
operating, that is, I was looking in the wrong area, but I was right that the
issue was related to a connection to the Z80. This was such an easy fix if you
knew where to look first. I am embarrassed to say, guess where I'll be looking
first if I run into another motherboard when the Z80 is shut down? What's also
kind of interesting is I just had a good feeling that tonight I would get the
board running. How about that!

Bye.
MCM

Subject: Re: Allen BD1
From: Allen
Date: 11/7/2020, 9:04 AM
To: Michael Matte
CC: Adam Trionfo

That's pretty awesome! I wish I had your skills! Maybe one day? Just be
careful. I've gotten boards to work and thought all was well, only to find a
black screen the next time I power it on. But I'm betting you've found the
issue. This could be a common bug for many of the FF boards I have. It sounds
like an easy check, so maybe start there on the next one? Assuming it is an FF
board. This might not have been an FF board, I don't remember. I do remember
that it is the last one I had been questioning you about. The crystal was bad,
then a voltage regulator was bad (I think) then a RAM was bad, and I think I
had gotten it working once and ran it for an hour. Then the next time I
powered it on, black screen. This is a customers board (from [...]).
I can't thank you enough, Michael, for being up for this challenge!

From: Michael Matte
To: Allen
Cc: Sent: Saturday November 7 2020 12:39:37PM
Subject: Re: Allen BD1

Allen, you did a lot of work on BD1 and I believe you fixed it. I'm willing to
bet that when you ran the board for a long time, to confirm it was fixed, then
the aged reset cap C14 failed shorting out the Z80 RESET line.

My expertise in troubleshooting a motherboard developed over time. I am still
learning. Working with BD1 was a real learning experience. My experience
building a hi-res Astrocade and programming in machine language really helps in
troubleshooting.

Whenever you get a black screen at power on:

Check the 4 power supply voltages first, then the clocks.
Run Z80 Check because it doesn't need the ROM chip to execute.
If Z80 Check doesn't run, then you know there is a Z80 related issue.
Check the Z80 RESET (active low) line using a logic probe. If the probe reads
logic low, then check the reset circuit wired to the Z80.

If the RESET line reads a logic high, then you have a Z80 related issue
somewhere else in the Z80/ROM zone 2 area.
Once you get Z80 Check executing, then run Balcheck even if the executing Z80
Check now gives you a TV display.
If Balcheck reports a RAM error, then you can use SetScreen3 to help isolate
the problem area.

Notes:

The Z80 and ROM chip MUST be operating to execute Balcheck or SetScreen3.
If the primary (input) side of your black Bally power transformer is not fused
with a 1/2A fast blow fuse, you should make the time to modify a short
extension cord to help protect your transformer from a shorted or near shorted
motherboard power supply line.

The above basic guide is my recommendation and the procedure I have noted to
follow. I plan to expand on this procedure some what after I finish with your 6
boards.

I plan to work on Allen BD3 next. If I get another board running perfectly,
I'll ship you 2 fixed boards. Note that I run all my boards with a small 6" fan
blowing over the motherboard. These custom chips have only a flat piece of
metal on them for a heat sink. I'm not confident enough that this heat sink
will protect the custom data chip from overheating.

Bye.
MCM

Subject: Allen BD3
From: Michael Matte
Date: 11/8/2020, 1:56 AM
To: Allen
CC: Adam Trionfo

This board is now up and running. Checkmate is running great. I'll run some
demos and Balcheck nonstop.

Chip U20 was bad. Z80 Check executed with a TV display. Balcheck reported 04][
FF with a black screen. SetScreen displayed graphics. The SetScreen pixel write
routines displayed graphics which I have seen before, so I suspected U20. I
knew the custom address chip was OK because I borrowed it from the working BD6
to run BD3. I desoldered the chip and ran it in your working board BD1. The
identical problem occurred in the working board. That was an easy fix. I just
soldered a working U20 chip back into BD3. I decided not to solder in a socket
because these are your boards. I don't have much socket installing experience,
so I decided to play it safe by just soldering in the chip.

I think this board has another issue. There is a momentary video disturbance at
power on just for a couple of seconds, possibly because a power supply is not
up to specs during a power on. Maybe I can watch each power line power on using
an oscilloscope to see if there is some visual disturbance on the scope. Right
now I'm thinking in terms of a weak capacitor. This board has a 15V power
supply for its MK4096N-15 RAM chips. There's one replacement RAM chip on the
board, possibly a Mostek (gray and gold package) with a warn off label. Is that
chip rated for 15V?

This board also has a gray and gold Mostek ROM chip. Cool!

BD3 like BD6 puts out a really clean video display. BD1 is not so clean with wavy RF interference. I made a note to look into that issue for BD1 later.

Man I love these BalcheckHR package tools.

Bye.
MCM

Subject: Allen BD2
From: Michael Matte
Date: 11/10/2020, 9:16 PM
To: Allen
CC: Adam Trionfo

Allen BD2 is up and running. This is the board with the custom data chip producing odd colors. Checkmate is running right now. It's running pretty good.

There was a disconnect at the top pad of the U10 socket, pin 13. I tried to heat up the solder hoping it would contact the top pad. I used just a 20W soldering iron. I fixed the disconnect with a jumper.

Also, RAM chip U29 was bad. I had difficulty extracting this chip from the motherboard because the bottom of the chip was butted right against the top of the motherboard. I cracked 3 capacitors in the process of prying U29 loose. I just soldered a working 4027 RAM chip to the motherboard. Like before, I didn't want to take a chance of soldering a socket to the motherboard because I don't have too much experience in that right now.

Something is wrong with my BalcheckHR board now or there's still an issue with BD2 related to the 50 pin expand connection.

Bye.
MCM

Subject: Re: Allen BD3
From: Michael Matte
Date: 11/11/2020, 5:04 PM
To: Allen
CC: Adam Trionfo

The gray/gold ROM chip on BD3 displays 1978.

Do you have a logic probe? If yes, does it have 3 LEDs LO, HI and PULSE? I am just now finding this tool very useful for determining if a chip pin is active or is suspicious.

I found another use for the Z80 Check program for a black screen scenario. As you know this program attempts to output some simple graphics to the TV display similar to SetScreen, then it attempts to instruct the Z80 to count up the BalcheckHR display in hex. The Z80 in this program during the incrementation of

the BalcheckHR display does NOT write to screen RAM or read any data from
screen RAM, but the Z80 does attempt to refresh screen RAM using the
Microcycler circuitry, chips like U8, U9 and U10.

So, when the motherboard situation is such that Z80 Check is executing,
counting up the BalcheckHR display in hex, but is not able to display anything
in the way of TV graphics, then Z80 Check (like SetScreen) is telling you that
the custom data chip is likely not processing Z80 Check's graphic instructions.
That means it is likely the Microcycler or the custom data chip has an
operating issue.

If you suspect one of the Microcycler chips U8, U9, U10, U13 (3 gates), U6 (2
gates) or the custom data chip MC1 pin 17 or MC0 pin 18 may have an issue
during the execution of Z80 Check, you can use a logic probe or your LA (Logic
Analyzer) to help check for a bad chip or gate instead of just replacing chips.
Remember, the Z80 during the attempted run of Z80 Check is attempting to use
the Microcycler only to refresh RAM. This is a significant revelation.

Microcycler references to use posted on the Bally Alley website:

The hand written scanned drawing of the Microcycler in the BalcheckHR User
Manual
The Nutting Manual system description pertaining to the Microcycler or Z80
refresh cycle
A Z80 Manual description of the Z80 refresh cycle. The Bally Alley has more
than one of these manuals.

Z80 Check is turning out to be a really awesome diagnostic tool. Now its
application is standard procedure for me when troubleshooting a motherboard
with an unknown history.

Here's my new troubleshooting procedure. This procedure will likely be
expanded.

ASTROCADE MOTHERBOARD TROUBLESHOOTING PROCEDURE 1.0
MCM Design
Nov 2020

Note 1:
This procedure requires the implementation of MCM Design's Upgraded BalcheckHR
board utilizing a programmed 32KB multi-carted BalcheckHR software package on
EEPROM or equal. Reference also Bally Service Manual PA-1 for motherboard
schematic, layout and more. Documentation is posted on the Bally Alley website.

Note 2: Take precautionary measures when handling or working on the motherboard
or components (static electricity from your body may damage components) or
reading voltages with a VOM (to prevent electrical shock never use both hands
to read a voltage).

Visually inspect the motherboard with a magnifying glass for suspicious
looking/cracked components, nicked traces or custom data chip socket
abnormalities.

Use ohmmeter for a continuity check on all 4 power supply lines including the
gnd line to ALL the chips. Use power supply caps C3, C5, C7 and C12 as starting
test points. Resolve any power or gnd line disconnects before you proceed.

Set up the BalcheckHR board to run Z80 Check.
Option: If possible, confirm the set up is working using a working motherboard.
Option: Wait until you confirm all 4 power supply voltages are present and correct before you connect the BalcheckHR board.

Set up your VOM to check the 4 power supply voltages.
You can clip on the VOM neg test lead at the neg (grounded) end of C1 or C6 and leave the lead there.

Power on the motherboard.

Quickly, take readings and note the 4 power supply voltages.
Use +5v at any TTL chip.
Use +10V at custom I/O chip pin 22.
Use +12/+15V at a RAM chip pin 8.
Swap VOM test leads (at the meter) and use -5V at a RAM chip pin 1.

If a power supply voltage is not present or is incorrect, turn off the motherboard immediately and feel if the Bally black power transformer is hot.

Resolve any power supply issue before you proceed.

If the 4 voltages are present and correct, note if the BalcheckHR display is counting up in hex and if any TV graphics or just colors are visible.

If the BalcheckHR display is not counting up, there is an issue related to the operation of the Z80.
Resolve this issue before you proceed.

If a black screen is displayed, confirm custom data chip is OK using a working motherboard. If this chip is OK, there is likely an issue with the Microcycler. If any of these Microcycler chips (indicated above) are in a socket, confirm first using an ohmmeter that the socket with the chip in place is wired correctly.
Use the logic probe, then LA if necessary, to search for pins with suspicious or no activity. Use a working motherboard as a comparison (document the working readings) to search for suspicious activity.
You resolved the Microcycler issue when Z80 Check displays at least a black and blue colored split screen.

Once you know the Z80 is running displaying at least a black and blue colored split screen, then you can run Balcheck, then SetScreen3 to help you locate and resolve screen RAM issues.

I like this new procedure. If you have any recommendations/updates for the procedure, email me the update. Thanks.

Bye.
MCM

From: Allen
To: Michael Matte
Cc: Sent: Tuesday November 10 2020 6:10:14PM

Subject: Re: Allen BD3

Yes, I have 4096 chips, and I'll replace that after I replace all of the caps and see what happens. It's not rare to find a board that's had a RAM replaced before I get it, or the oscillator worked on, or the RF pins, or the diodes, etc. :)
I'll take a good look at it when I get it back. THANK YOU SO MUCH! Can you tell me something I've been wanting to know about that ROM for a long time? Does it show 1977 or 1978 on the menu?

On Tuesday, November 10, 2020, 02:38:07 PM CST, <Michael Matte> wrote:

You've seen some gray/gold 4027s? Wow! Do you have some MK4096-15 chips? I'm going to run some more demos on this board for a long period of time to see if a demo will crash. Otherwise, I'm pretty much done with this board. If you have the correct RAM chip, you can replace that gray/gold RAM chip. Maybe that will eliminate that momentary video disturbance. Maybe one of those original RAM bypass caps C62, C63 or C64 is acting up I don't know. I don't know what to do with this momentary disturbance, which seems to be related to the motherboard power on or reset. I doubt its the Z80 RESET pin 26 acting up because the Z80 seems to be a pretty reliable chip and you only see this disturbance when you initially turn on the motherboard. Perhaps its a power supply component acting up. It might be best just to let the intermittent issue fail completely to find the faulty component.

Bye.
MCM

From: Allen Schweitzer
To: Michael Matte
Cc: Sent: Tuesday November 10 2020 6:11:33AM
Subject: Re: Allen BD3

It's possible that it is a 4027. I have seen a set of those before in a board. They seem to be much more durable than the regular 4027's. If you want to send that one back to me, I'll pull and socket whatever chips you want and return it to you. If I remember correctly, I did have that board going for a bit at one time. But if that's true, it was a long time ago, and I cannot say for certain.

On Monday, November 9, 2020, 09:42:56 PM CST, <Michael Matte> wrote:

This gray/gold RAM is not in a socket, so you received BD3 with this replacement chip already soldered into the board. There's a possibility it is not a 4096-15 but a chip with its pin 8 rated only for 12v. Could this chip already be weakening and having difficulty with a 15v power-on surge at pin 8 creating the momentary video disturbance, I don't know. I ran BD3 with Balcheck nonstop for 2h 15m. Balcheck did not report anything during that time.

Bye.
MCM

From: Allen

To: Michael Matte
Cc: Sent: Monday November 9 2020 6:12:46PM
Subject: Re: Allen BD3

Did you replace a RAM chip with that gray/gold RAM chip? Its label is worn off.
Any idea what chip type it is?
^^^^^^^^^^^^
Pull the chip out and look on the "belly" of it. It should be printed in
white. It should say 4096. If the chip is socketed, I replaced it. If not,
someone else did.

You're going to love the odd color! I have 2 of those, and I think I sent you
the worse of them. Both are grey ceramic.

On Monday, November 9, 2020, 01:56:17 AM CST, Michael Matte <Michael Matte>
wrote:

Hi Allen. I mentioned this board has a video display disturbance issue at power
on. This disturbance lasts around three seconds.

I spent some time looking at this issue. I used my oscilloscope on the 4 power
supply lines hoping I might see something at power on. I didn't. I replaced the
reset capacitor C13 with a 0.1uf monolithic cap and also soldered a temporary
1uf tantalum for C14. This did not resolve the issue.

Did you replace a RAM chip with that gray/gold RAM chip? Its label is worn off.
Any idea what chip type it is? Texas Instruments made a gray/gold TMS4116 chip
with the pin 8 rated for a 12V power supply. I know this because I have 2 of
these chips on my original hi-res Astrocade. I think you gave me these 2 chips.
This board has a 15V supply utilizing MK4096-15 RAM as you know rated for 15V.
The RAM bypass caps are all original.

This issue is beyond my understanding. If that gray/gold RAM chip is rated for
12V, its just a matter of time when it will fail. I'm not going to use a hit or
miss approach, guessing a bypass cap or power supply component or something
else is at issue. Since the board seems to work perfectly once the video
disturbance is passed, I'm officially finished with this board.

I'm going to work on BD2 next. This is the board with the "odd color" custom
data chip.

Bye.
MCM

Subject: Allen BD4
From: Michael Matte
Date: 11/12/2020, 3:02 AM
To: Allen
CC: Adam Trionfo

Allen, I wowed myself tonight with my new procedure and my new application
using a logic probe to help troubleshoot the motherboard. Allen BD4 is up and
running. So far it's running great.

This is briefly what I did.

Cleaned heatsink compound off the sides of the custom data chip pins.
Used old piece of 400 grit wet/dry sand paper to lightly remove oxidation off
the custom data pins.

Used ohmmeter to check the 4 power supply lines and ground lines for continuity
to every chip.

Ran Z80 Check and checked the 4 power supply voltages.
The 4 power supplies were okay.
Z80 Check executed and there were colors displayed on the TV screen.

Ran Balcheck which reported 04][FF. A RAM error in all 8 video data lines.

Ran SetScreen3.
The TV display suggested that all RAM bits were stuck at logic one or the
custom data chip wasn't receiving the video scanning data from screen RAM. All
pixels were at 11 with colors green (L) and cyan (R) in the split screen RAM
area along with the usual split black and blue borders.

I used the logic probe to check for activity at the following listed below,
while SetScreen was executing the Fill Screen pixel write program at maximum
speed. Since this is a write only program, SetScreen will attempt to execute
this program even if RAM is not operating. You can tell the program is
executing even if you can't see it executing on the screen, by watching the
Balcheck display count up 1, 2, 3 and 4 repeatedly. The Fill Screen program
attempts to write the different pixels 00, 01, 10 and 11 in 4 passes nonstop.
Each pass while being written is displayed on the Balcheck board as 01, 02, 03
and 04 nonstop. Since the TV screen RAM area during this motherboard failure is
"stuck' showing only pixels as 11, you can't see SetScreen trying to write the
pixels 00, 01, 10 or even 11.

U23 was enabled (turned on) for reading RAM
CS/RAS was stuck low, not active
CAS was stuck low, not active
WE was high with a fast pulse, active
RAS and CAS are generated from U22
PX clock at U22 was dead
PX clock at U6 pin 4 was dead
PXCLK at U6 pin 3 from custom data chip was low with a medium pulse, active
The custom chip PXCLK output was active. That was good news.
U6 power supply at pin 14 was okay

Diagnosis
PX clock at U6 pin 4 is stuck low, inactive
Looks like the logic gate at U6 pins 3 and 4 is bad
Two other U6 gates in Microcycler were active
Replace chip U6

Result
Soldered a working U6 chip (taken from Allen BD6) into motherboard
Ran Balcheck and it reported no errors.
The motherboard was fixed.

How cool was that! I don't think I ever approached a motherboard failure with a
perfect logical analysis until tonight. I really wowed myself tonight. Using a
logic probe can really save a lot of time trying to diagnose a motherboard

failure. I just learned that this week. Isn't that something? Up to this week my logic probe was just sitting in my hobby room collecting dust.

Bye.
MCM

Subject: Allen BD5
From: Michael Matte
Date: 11/13/2020, 11:29 PM
To: Allen
CC: Adam Trionfo

Allen BD5 is now up and running. Here's my TS [Trouble Shoot] report.

Inspection revealed 24 ohm jumping resistor in front of transistor Q1 was discolored black 50%, likely from overheating

Ohmmeter across C3 indicated a short. Disconnected pos end of C3

The short was actually somewhere along the 12V power line to RAM past C3

The RAM 12V bypass C62 was shorted. This was an original cap, not a recap. I lucked out. This was the first cap I checked for a short. Once C62 was disconnected, there was no short.

Replaced C62 with a new cap.

Went ahead and replaced VR1

Rectifier CR diodes and C1 were not shorted

Checked 4 power lines and gnd lines to all chips for continuity

Powered on motherboard to check all 4 power supply voltages

12V supply okay, 5V supply under 2v

VC8 = 27v normal, VC6 = 9.0v normal

Removed VR3

Used ohmmeter to check transistor Q1. Seemed okay

Soldered in a new VR3

All 4 power supplies now okay

Z80 Check executed and with TV graphics

Balcheck reported 04][20, video bit 5 in error

SetScreen indicated bit 5 in RAM had difficulty resetting to 0 at times

Replaced U29 with working 4027 RAM from BD1

Balcheck then reported no errors.

The TV display for this board is really clean.

6 for 6 fixed. How about that! I am really wowed!

Bye.
MCM

Subject: Time To Troubleshoot
From: Michael Matte
Date: 11/14/2020, 4:27 PM
To: Allen
CC: Adam Trionfo

Thank you so much for letting me keep Allen BD1. This is such a cool test board
with all those chips in sockets. Really cool what you did to this board. This
board will really help me with troubleshooting future failed boards. All your
Allen boards are labeled with a stick on to identify the BD number.

After I ship your boards back to you soon, I'm going to use this 6 board
experience to revise and expand that TS procedure I emailed you. I will break
it down into 2 parts.

Part 1 will be kind of like a flow chart, its goal to help us be more
productive in attacking a motherboard failure. This way, when its time to TS a
board, the procedure will be there to help guide us in the TS process, so we
don't have to rethink how to approach every failed motherboard. This idea
should save time and hopefully make the TS tasks more enjoyable.

Part 2 will be broken down into sections of tips and reminders relating to part
1. Part 1 will at times point to specific sections of part 2 as available
references, if they are needed.

When I'm finished with the first draft, I'll send it to you hoping you'll spend
some time looking it over for any recommended editing. I value any input from
you. When I'm finished with the checks for typos and clarity, Adam will want to
post the TS procedure.

This procedure will not be complete addressing every issue of failure, but it
definitely will be beneficial. Perhaps at a later time, the procedure can be
updated to address neglected issues.

Bye.
MCM

From: Adam Trionfo
To: Michael Matte
Cc: Sent: Wednesday November 18 2020 10:03:15AM
Subject: Re: Allen Package Shipped

Michael,

I have one "perfect" Astrocade-- although it sometimes resets when I'm using the keypad. The Astrocade that has a problem with the BASIC cartridge is unusual. I can load AstroBASIC programs using the build-in interface and 300-baud programs via the 300-baud interface. If I try to load a 300-baud program using the 2000-baud interface, and the program in the AstroBASIC manual, then it crashes. There's more to it than that, but I forget the details. I suspect it might have some troublesome RAM.

Adam

Subject: Re: Allen Package Shipped
From: Michael Matte
Date: 11/18/2020, 10:45 AM
To: Adam Trionfo

On the board with the reset issue, did you try running the board without the keypad/cassette combo mounted on the board? You could still experiment with that portion of the keypad wired to the board using Calculator to see if the board still resets. Maybe that cassette connector assembly is a little tight around the reset button, so pushing down on a key also pushes down on the button enough to reset the board. Just a little press on that button is all it takes to reset the system. This issue might be a mechanical issue.

Is that electronically possible to successfully load a 300 baud program on tape using the built-in 2000 baud audio interface? The load software program in the Basic cartridge with the built in audio interface and possibly the electronic interface itself may not be compatible with a 300 baud audio recording.

Would you like me to take a look at those 2 boards, run some tests to see if the electronics in the board is running perfect?

Bye.
MCM

From: Michael Matte
Sent: Wednesday, November 18, 2020 1:15 AM
To: Adam Trionfo
Subject: Re: Allen Package Shipped

I forgot. Did you say you had 2 perfect working motherboards, but one had an issue with your basic cartridge? Did you try cleaning the cassette connector and internal cartridge contacts?

Bye.
MCM

From: Adam Trionfo
To: Michael Matte
Cc: Sent: Tuesday November 17 2020 8:22:31PM
Subject: Re: Allen Package Shipped

Michael,

No, Allen didn't mention anything about a "spare" astrocade for me. You're constantly improving your Bally diagnostic software. Looking good!

Adam

From: Michael Matte
Sent: Tuesday, November 17, 2020 4:10 PM
To: Adam Trionfo
Subject: Allen Package Shipped

I dropped off Allen's package at the USPS this afternoon. I included some BalcheckHR board spare chips for Allen including a programmed Xicor 32KB EEPROM with its data protection option enabled, so it acts like an EPROM. This EEPROM is programmed for four 8KB multi-cart program execution on the BalcheckHR board. One of the programs on that EEPROM is my new revised Z80 Halt program mentioned to you a while ago. This 66 byte revised Z80 HALT program combines both of those 2 new program ideas that I mentioned. So, this EEPROM is slightly different then the one he is using now. Instead of 2 copies of Balcheck, this new EEPROM has Balcheck and Z80 Halt.

[...]

Bye.
MCM

This concludes the compilation of emails.

END OF DOCUMENT