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12 Polaris PowerLED Technologies, LLC

13 UNITED STATES DISTRICT COURT
14 FOR THE CENTRAL DISTRICT OF CALIFORNIA
15 WESTERN DIVISION

16 POLARIS POWERLED
17 TECHNOLOGIES, LLC,
18 Plaintiff,

19 v.

20 VIZIO, INC., HON HAI PRECISION
21 INDUSTRY CO., LTD. D/B/A
22 FOXCONN TECHNOLOGY GROUP,
23 COMPETITION TEAM TECHNOLOGY
24 USA INC., TOP VICTORY
25 ELECTRONICS (TAIWAN) CO. LTD.,
26 TOP VICTORY INVESTMENTS LTD.,
27 TPV TECHNOLOGY LTD., TPV
INTERNATIONAL (USA), INC., TREND
SMART AMERICA, LTD., INNOLUX
CORP., INNOLUX USA, INC., AMTRAN
TECHNOLOGY CO., LTD., AMTRAN
LOGISTICS, INC., and NEWEGG, INC.,

28 Defendants.

Case No. 2:23-cv-03478-GW-PDx

**PLAINTIFF'S DISCLOSURE
OF ASSERTED CLAIMS AND
INFRINGEMENT
CONTENTIONS AGAINST
VIZIO PURSUANT TO
NORTHERN DISTRICT OF
CALIFORNIA PATENT
LOCAL RULES 3-1 AND 3-2**

1 Plaintiff Polaris PowerLED Technologies, LLC (“Plaintiff” or “Polaris”)
2 serves its Disclosure of Asserted Claims and Preliminary Infringement Contentions
3 (“Disclosure”) regarding infringement of United States Patent No. 7,843,148 (“148
4 patent” or “Patent-in-Suit”) in accordance with Northern District of California Patent
5 Local Rules (“P.L.R.” or “Patent Local Rule(s)”) 3-1 and 3-2. A document
6 production accompanies P.L.R. 3-2.

7 Polaris bases this Disclosure on its current knowledge, understanding, and
8 belief as to the facts and information available as of the date of this Disclosure.
9 Polaris has not yet completed its investigation, collection of information, discovery,
10 or analysis relating to this action, and additional discovery, including discovery from
11 Defendants¹ and third parties, may lead Polaris to amend, revised, and/or supplement
12 this Disclosures. Polaris specifically reserves the right to amend, revise and/or
13 supplement this Disclosure and/or accompanying exhibits in accordance with any
14 Orders of record in this matter, Patent Local Rules, and Federal Rule of Civil
15 Procedure 26(e), as additional documents and information become available and as
16 discovery and investigation proceed.

17 Polaris reserves the right to supplement, modify or amend the Disclosure to
18 include additional products or services made, used, sold, or offered for sale in or
19 imported into the United States by Defendants.

20 This Disclosure is made without prejudice to any position Polaris may take
21 with respect to claim construction. Polaris reserves its right to supplement this
22
23

24
25 ¹ “Defendants” as used herein collectively consists of **(1) VIZIO, Inc.**, **(2) Foxconn**
26 **(Hon Hai Precision Industry Co., Ltd, and Competition Team Technology USA**
27 **Inc.), (3) Top Victory** (Top Victory Electronics (Taiwan) Co. Ltd., Top Victory
28 **Investments Ltd., TPV Technology Ltd., TPV International (USA), Inc., Trend**
Smart America, Ltd.), (4) Innolux (Innolux Corp., Innolux USA, Inc.), **(5) AmTran**
(AmTran Technology Co., Ltd., and AmTran Logistics, Inc.), and (6) Newegg, Inc.

1 Disclosure and exhibits based on the Court's claim construction. Polaris further
2 reserves the right to introduce and use such supplemental materials at trial.

3 The information in this Disclosure is not an admission regarding the scope of
4 any claims or the proper construction of those claims or any terms contained therein.
5 The production of documents accompanying this Disclosure is not an admission that
6 such documents are admissible, and Polaris does not waive any objections regarding
7 admissibility. Polaris reserves the right to supplement its production of documents
8 accompanying this disclosure upon identification or receipt of additional documents,
9 including documents from third parties.

10 **I. DOCUMENT PRODUCTION ACCOMPANYING DISCLOSURE –**
11 **PATENT LOCAL RULE 3-2**

12 Pursuant to P.L.R. 3-2, Plaintiff identifies documents corresponding to the
13 following categories by production number below:

14 Category	Production Bates Numbers
15 P.L.R. 3-2(a): Documents (<i>e.g.</i> , 16 contracts, purchase orders, invoices, 17 advertisements, marketing materials, 18 offer letters, beta site testing 19 agreements, and third party of joint 20 development agreements) sufficient to 21 evidence each discussion with, 22 disclosure to, or other manner of 23 providing to a third party, or sale of or 24 offer to sell, the claimed invention 25 prior to the date of application for the 26 patent in suit. Plaintiff's production of any documents as required herein shall not constitute an admission that such document evidences or is prior art under 35 U.S.C. § 102.	Documents of this type will be produced insofar as Plaintiff has them. Plaintiff's investigation is ongoing, and it reserves the right to produce documents as discovery in this case continues.

1	P.L.R. 3-2(b): All documents	Documents of this type will be
2	evidencing the conception, reduction to	produced insofar as Plaintiff has them.
3	practice, design, and development of	Plaintiff's investigation is ongoing, and
4	each claimed invention, which were	it reserves the right to produce
5	created on or before the date of	documents as discovery in this case
6	application for the patent in suit or the	continues.
7	priority date identified pursuant to	
8	P.L.R. 3-1(f), whichever is earlier.	
9	P.L.R. 3-2(c): A copy of the file history	POL_VZ_00000009 –
10	for each patent in suit.	POL_VZ_00000078
11	P.L.R. 3-2(d): All documents	POL_VZ_00000087 –
12	evidencing ownership of the patent	POL_VZ_00001992
13	rights by the party asserting patent	
14	infringement.	
15	P.L.R. 3-2(e): If a party identifies	N/A
16	instrumentalities pursuant to Patent	Plaintiff's investigation is ongoing, and
17	L.R. 3-1(g), documents sufficient to	it reserves the right to produce
18	show the operation of any aspects or	documents as discovery in this case
19	elements of such instrumentalities the	continues.
20	patent claimant relies upon as	
21	embodying any asserted claims.	
22	P.L.R. 3-2(f): All agreements,	POL_VZ_00001993 –
23	including licenses, transferring an	POL_VZ_00002024
24	interest in any patent-in-suit.	
25	P.L.R. 3-2(g): All agreements that the	Plaintiff's investigation is ongoing, and
26	party asserting infringement contends	it reserves the right to produce
27	are comparable to a license that would	documents as discovery in this case
28	result from a hypothetical reasonable	continues.
	royalty negotiation.	
	P.L.R. 3-2(h): All agreements that	Plaintiff's investigation is ongoing, and
	otherwise may be used to support the	it reserves the right to produce
	party asserting infringement's damages	documents as discovery in this case
	case.	continues.

P.L.R. 3-2(i): If a party identifies instrumentalities pursuant to Patent L.R. 3-1(g), documents sufficient to show marking of such embodying accused instrumentalities and if it wants to preserve the right to recover lost profits based on such products, sales, revenues, costs, and profits of such embodying accused instrumentalities.	N/A Plaintiff's investigation is ongoing, and it reserves the right to produce documents as discovery in this case continues.
P.L.R. 3-2(j): All documents comprising or reflecting a F/RAND commitment or agreement with respect to the asserted patent(s).	N/A Plaintiff's investigation is ongoing, and it reserves the right to produce documents as discovery in this case continues.

II. ASSERTED CLAIMS – PATENT LOCAL RULE 3-1(a)

'148 Patent Asserted Claim(s)	Statutory Subsection
1-6, 11-17, 22	35 U.S.C. §271 (a)

Plaintiff specifically reserves the right to amend, revise, and/or supplement its asserted claims and statutory bases as it acquires additional information and discovery regarding Defendants' activities, the Accused Instrumentalities (referenced below), and any other additional VIZIO products or Accused Instrumentalities that are identified.

III. ACCUSED INSTRUMENTALITIES – PATENT LOCAL RULE 3-1(b)

Plaintiff accuses and the Accused Instrumentalities in this case consist of VIZIO branded televisions that allegedly infringe the Patent-in-Suit. Plaintiff identifies that the Accused Instrumentalities in this case consist of all VIZIO branded

televisions made, offered for sale, sold, imported or used in the United States from May 2017 through the date of trial (and thereafter through the date of expiration of the '148 patent) that contain backlight(s) including LEDs connected in parallel paths and are controlled by PWM signals, including without limitation, the VIZIO P-series televisions, M-series televisions, V-Series televisions, D-series televisions, and E-series televisions (including without limitation the following exemplary models M50Q7-J01, V655M-K03, V505M-K09, P75Q9-J01, V435M-K04, V555M-K01, V585M-K01, V655M-K04, V705M-K03, V755M-K03, M43Q6M-K04, M50QXM-K01, M55Q6M-K01, M65Q6M-K04, M65QXM-K03, M70Q6M-K03, M75Q6M-K03, M75QXM-K03, P65Q9-J01, and E65-F0) as well as any other VIZIO televisions comprising analogous structures and functions (collectively "Accused Instrumentalities"). None of the Defendants have yet provided discovery regarding the structure and function of the VIZIO televisions or discovery regarding model numbers with the accused functionality. Plaintiff identifies below representative VIZIO televisions of which it is presently aware. Plaintiff has identified Accused Instrumentalities in this disclosure and its exhibits by name and model as described by VIZIO's publicly available website, *see, e.g.*, <https://www.vizio.com/en/home>. Plaintiff's list of names and model numbers in this disclosure and exhibits thereto is representative and also based on its current investigation of publicly available model numbers listed on third party websites. Plaintiff reserves the right to add additional products and model numbers as they are identified during discovery. To the extent that VIZIO has renamed its products, the list of Accused Instrumentalities below should be read to include both prior naming and any renaming VIZIO may adopt in the future. Nonexclusive list of examples of Accused Instrumentalities:

'148 Patent Asserted Claims(s)	Accused Instrumentalities (VIZIO)
1-6, 11-17, 22	VIZIO's D-Series, E-Series, M-Series, P-Series, and V-Series televisions, including each and every television in such product families that

	contains backlight(s) including LEDs connected in parallel paths and controlled by PWM signals
1-6, 11-17, 22	M50Q7-J01
1-3, 11-15, 22	V655M-K03
1-6, 11-17, 22	E65-F0
1-3, 11-15, 22	V505M-K09
1-6, 11-17, 22	P75Q9-J01
1-6, 11-17, 22	V435M-K04
1-6, 11-17, 22	V555M-K01
1-6, 11-17, 22	V585M-K01
1-6, 11-17, 22	V655M-K04
1-6, 11-17, 22	V705M-K03
1-6, 11-17, 22	V755M-K03
1-6, 11-17, 22	M43Q6M-K04
1-6, 11-17, 22	M50QXM-K01
1-6, 11-17, 22	M55Q6M-K01
1-6, 11-17, 22	M65Q6M-K04
1-6, 11-17, 22	M65QXM-K03
1-6, 11-17, 22	M70Q6M-K03
1-6, 11-17, 22	M75Q6M-K03
1-6, 11-17, 22	M75QXM-K03
1-6, 11-17, 22	P65Q9-J01

IV. CLAIM CHARTS – PATENT LOCAL RULE 3-1(c)

The claim charts in Exhibit A against VIZIO are representative of all the Accused Instrumentalities listed under the category “148 Patent Accused Instrumentalities.”

V. LITERAL INFRINGEMENT OR INFRINGEMENT UNDER DOCTRINE OF EQUIVALENTS – PATENT LOCAL RULE 3-1(e)

Each element of each of the asserted claims is literally present for all Accused Instrumentalities. The attached claim charts include, on an element-by-element basis, a statement explaining that the claim elements are present literally.

1 This disclosure is based upon information that Plaintiff has been able to obtain
2 publicly as Defendants have not yet made any production of documents relating to
3 the Accused Instrumentalities in this matter. Plaintiff reserves the right to
4 supplement or amend as additional facts are ascertained in discovery, and Plaintiff
5 expressly reserves its right to amend its contentions regarding infringement under the
6 doctrine of equivalents after it obtains and has been able to analyze the necessary
7 discovery from Defendants, as well as any relevant third parties. Plaintiff further
8 reserves its right to amend its infringement contentions after receiving this Court's
9 claim construction order.

10 Claim Charts:

- 11 • Exhibit A – Infringement by VIZIO

12 VI. PRIORITY DATES – PATENT LOCAL RULE 3-1(f)

13 The asserted claims are entitled to the priority dates identified below.

14 Patent	15 Asserted Claims	16 Priority Date
17 '148 Patent	18 1-6, 11-17, 22	19 The asserted claims are 20 entitled to a priority date 21 at least as early as April 22 8, 2008, and possibly 23 earlier than this date.

24 VII. POLARIS' PRODUCTS – PATENT LOCAL RULE 3-1(g)

25 Polaris is not currently relying on its own, or any licensee's, products or
26 methods as practicing the asserted claims of the Patent-in-Suit. _At the present
27 time, to the best of its knowledge, Polaris does not market, sell, produce, or
28 distribute any products that embody any of the asserted claims of the Patent-in-Suit.
If Polaris learns of licensees' products or methods that may practice or have
practiced the asserted claims of the Patent-in-Suit, it will amend this disclosure.

///

1 **VIII. INFRINGEMENT AND DAMAGES PERIOD – PATENT LOCAL**
2 **RULE 3-1(h)**

3 If Polaris learns of facts responsive to this section of this disclosure, it will
4 amend this disclosure.

5 **IX. WILLFUL INFRINGEMENT – PATENT LOCAL RULE 3-1(i)**

6 If Polaris learns of facts responsive to this section of this disclosure, it will
7 amend this disclosure.
8

9 August 28, 2023

By: /s/ Robert F. Kramer

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12 & TONKOVICH LLP
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Attorneys for Plaintiff
Polaris PowerLED Technologies, LLC

1 **CERTIFICATE OF SERVICE**

2 I, Adriana Cole, hereby declare:

3 I am over the age of eighteen years and not a party to this action. My business
4 address is Kramer Alberti Lim & Tonkovich LLP, 577 Airport Blvd., Suite 250,
5 Burlingame, CA 94010.

6 On August 28, 2023, I caused the foregoing document described as
7 **PLAINTIFF'S DISCLOSURE OF ASSERTED CLAIMS AND**
8 **INFRINGEMENT CONTENTIONS AGAINST VIZIO PURSUANT TO**
9 **NORTHERN DISTRICT OF CALIFORNIA PATENT LOCAL RULES 3-1**
10 **AND 3-2** to be served upon the following, at the addresses stated below, via
11 electronic mail as indicated below:

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25 *Attorneys for Defendants*
26 VIZIO, Inc., Top Victory Electronics
27 (Taiwan) Co. Ltd., Top Victory
28 Investments Ltd., TPV Technology Ltd.,
TPV International (USA), Inc. Trend
Smart America, Ltd., Innolux Corp.,

9

PLAINTIFF'S DISCLOSURE OF ASSERTED CLAIMS AND INFRINGEMENT
CONTENTIONS (Case No. 2:23-cv-03478-GW-PDx)

1 Innolux USA Inc., AmTran Technology
2 Co., Ltd., and AmTran Logistics, Inc.

3 I declare under penalty of perjury under the laws of the State of California that
4 the foregoing is true and correct.

5 Executed on August 28, 2023, in Orlando, Florida.

7 /s/ Adriana Cole

8 Adriana Cole

EXHIBIT A

U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES

VIZIO infringes U.S. Patent No. 7,843,148 (“the ’148 patent”) either literally or through the doctrine of equivalents, pursuant to 35 U.S.C. § 271(a) and 271(b). VIZIO makes, uses, offers to sell, or sells the Accused Televisions within the United States without authority in a manner that constitutes infringement of one or more claims of the ’148 patent.

VIZIO Accused Televisions

The Accused Televisions include, without limitation, the VIZIO P-Series, M-Series, V-Series, E-Series, and D-Series TVs featuring backlights that include LEDs connected in parallel paths and controlled by PWM signals. The “Accused P-Series Televisions” as used herein are defined as each and every model marketed under the “P-Series” name featuring backlights that include LEDs connected in parallel paths and controlled by PWM signals. The Accused P-Series Televisions include, but are not limited to, the P65Q9-J01 and P75Q9-J01 models. The “Accused M-Series Televisions” as used herein are defined as each and every model marketed under the “M-Series” name featuring backlights that include LEDs connected in parallel paths and controlled by PWM signals. The Accused M-Series Televisions include, but are not limited to, the M50Q7-J01, M43Q6M-K04, M50QXM-K01, M55Q6M-K01, M65Q6M-K04, M65QXM-K03, M70Q6M-K03, M75Q6M-K03, and M75QXM-K03 models. The “Accused V-Series Televisions” as used herein are defined as each and every model marketed under the “V-Series” name featuring backlights that include LEDs connected in parallel paths and controlled by PWM signals. The Accused V-Series Televisions include, but are not limited to, the V655M-K03, V655M-K04, V555M-K01, V435M-K04, V585M-K01, V705M-K03, V755M-K03, and V505M-K09 models. The “Accused E-Series Televisions” as used herein are defined as each and every model marketed under the “E-Series” name featuring backlights that include LEDs connected in parallel paths and controlled by PWM signals. The Accused E-Series Televisions include, but are not limited to, the E65-F0 model. The “Accused D-Series Televisions” as used herein are defined as each and every model marketed under the “D-Series”

U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES

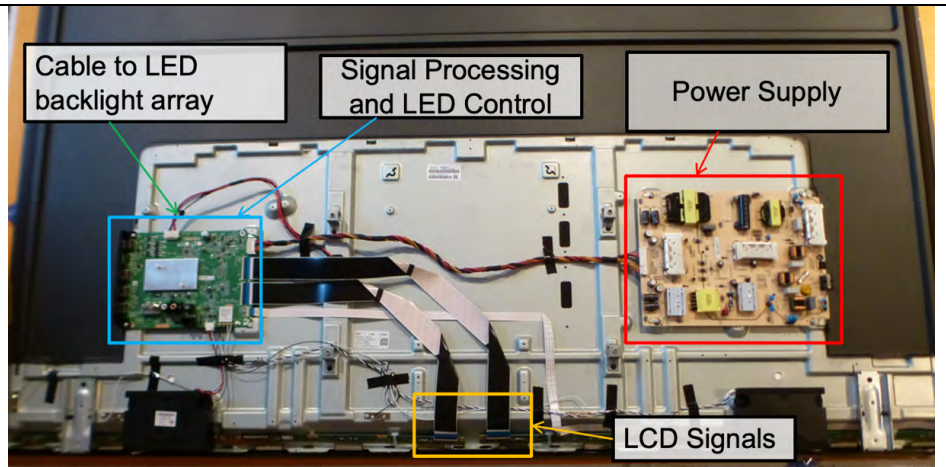
name featuring backlights that include LEDs connected in parallel paths and controlled by PWM signals. Plaintiff's identification of names and model numbers in this Exhibit is representative and based on its current investigation of publicly available model numbers listed on VIZIO's website and third-party websites. For avoidance of confusion, Plaintiff is accusing in this case, and the Accused Televisions consist of, all VIZIO branded televisions made, offered for sale, sold, imported, or used in the United States from May 2017 through the date of trial (and thereafter through the date of expiration of the '148 patent) that contain backlights including LEDs connected in parallel paths and controlled by PWM signals.

List of Asserted Claims

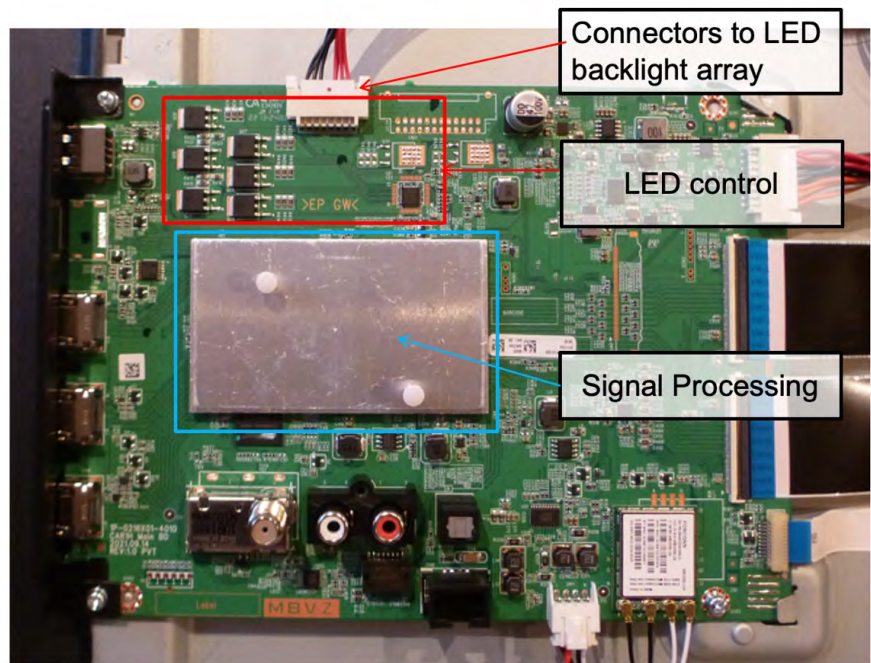
VIZIO and its Accused Televisions infringe claims 1-6, 11-17, and 22 of the '148 patent directly.

Claim	Evidence of Infringement of VIZIO Accused Televisions
1. A light emitting diode (LED) driver for driving LEDs connected to different parallel paths, the driver comprising:	VIZIO V-Series The preamble does not appear to be a limitation. To the extent the preamble is construed as a limitation, the VIZIO V-Series include a light emitting diode (LED) driver for driving LEDs connected to different parallel paths. As a representative example, the VIZIO V655M televisions include an LED control circuit (LED driver) as part of a signal processing and LED control circuit board, which includes components such as multi-channel LED driver chips and transistors for individually controlling strings of LEDs in the TV backlight.

U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES



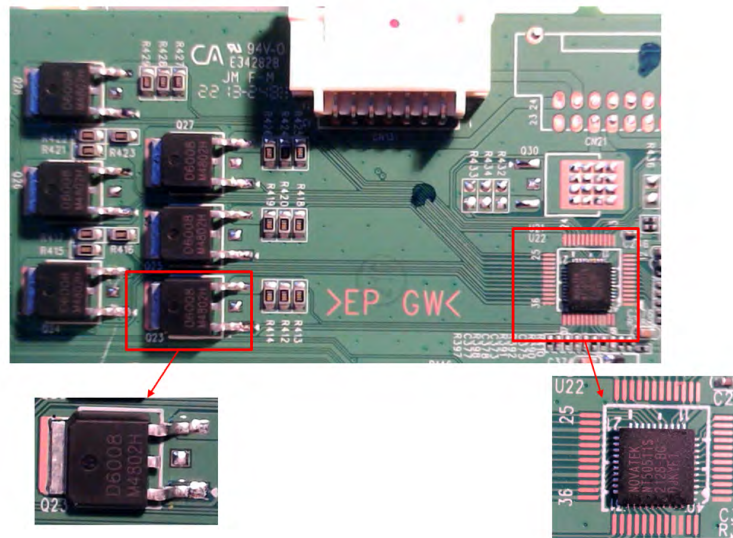
[VIZIO V655M with disassembled rear panel]



[Circuit board including LED control circuit for VIZIO V655M]

U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES

Teardown – LED Control Circuit



[Circuit board including LED control circuit for VIZIO V655M]

The LED control board is coupled to several sections of LEDs that provide Full Array Backlight features.

“The new **V-Series** promises more for everyone, with screens ranging from 43- to 75-inch-class at VIZIO’s most aggressive 4K price points. However, its universal appeal lies in its uncompromising performance and design. *The Full Array backlight renders stunning contrast, paired with broad HDR support that includes Dolby Vision, HDR10+, HDR10 and HLG.* The V-Gaming Engine delivers 4K@60Hz VRR and AMD FreeSync (V6 models), with the foolproof Auto Game Mode and three HDMI 2.1 ports to connect next-gen consoles and more.”

<https://www.VIZIO.com/en/press/2021/jun/VIZIO-s-new-tv-lineup-unleashes-enhanced-picture-quality--improv>

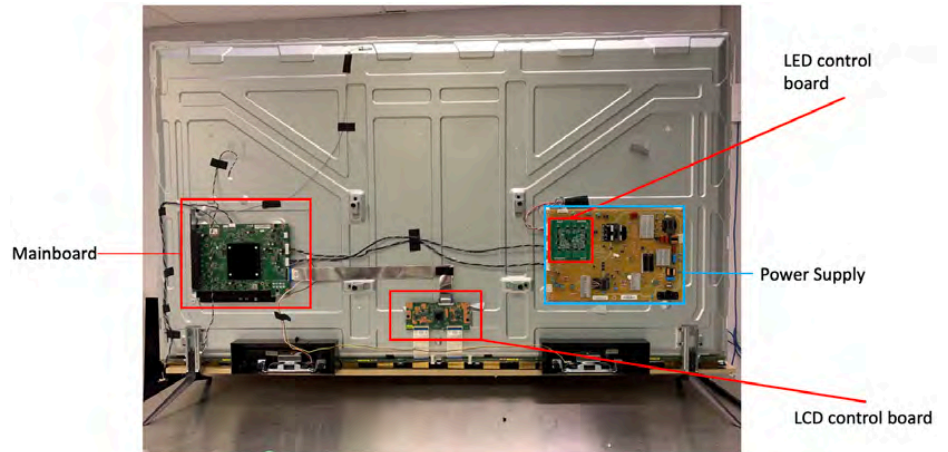
VIZIO E-Series

The preamble does not appear to be a limitation. To the extent the preamble is construed as a limitation, the VIZIO E-Series include a

U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES

light emitting diode (LED) driver for driving LEDs connected to different parallel paths.

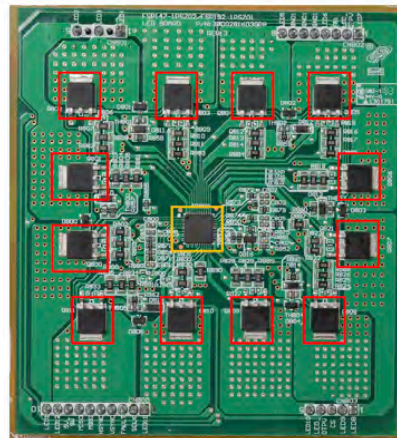
As a representative example, the VIZIO E65-F0 televisions include an LED control circuit (LED driver) as part of a signal processing and LED control circuit board, which includes components such as multi-channel LED driver chips and transistors) for individually controlling strings of LEDs in the TV backlight.



[VIZIO E65-F0 with disassembled rear panel]



ON Semi D1816
NPN Bipolar transistor



[Circuit board including LED control circuit for VIZIO E65-F0]



AMS AS3824E (16-
channel LED TV
backlight controller)

U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES

The LED control board is coupled to several sections of LEDs that provide Full Array Backlight features.

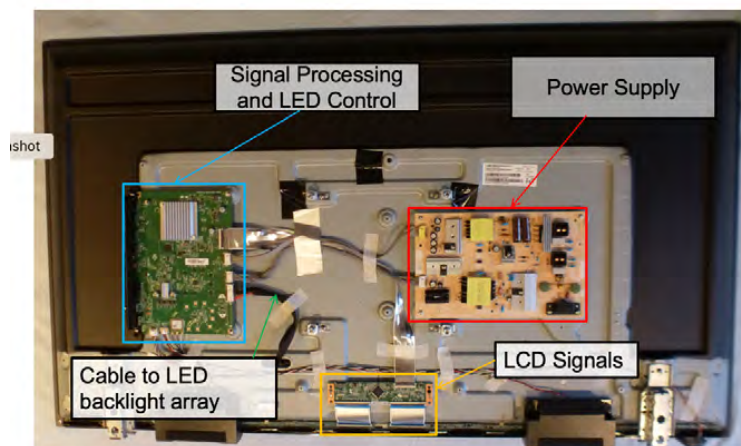
The flat panel E-Series is a new collection of LED HDTVs ranging from 23 to 70 inches. **A few of the highlights include advanced local dimming technology and full-array LED backlighting on most of the new models, with up to 18 Active LED Zones.** That basically translates into better light uniformity across the screen, better black levels, and a more vibrant image overall.

<https://www.vizio.com/en/news/2014/feb/vizio-e-series-led-smart-tvs-include-local-dimming-and-app-connection>

VIZIO M-Series

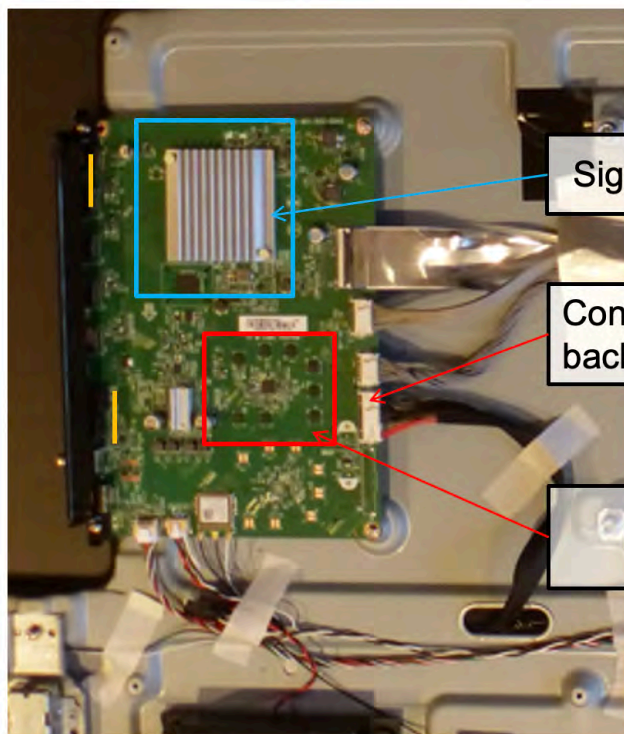
The preamble does not appear to be a limitation. To the extent the preamble is construed as a limitation, the VIZIO M-Series include a light emitting diode (LED) driver for driving LEDs connected to different parallel paths.

As a representative example, the VIZIO M50Q7 televisions include an LED control circuit (LED driver) as part of a signal processing and LED control circuit board, which includes components such as multi-channel LED driver chips and transistors) for individually controlling strings of LEDs in the TV backlight.



[VIZIO M50MQ7 with disassembled rear panel]

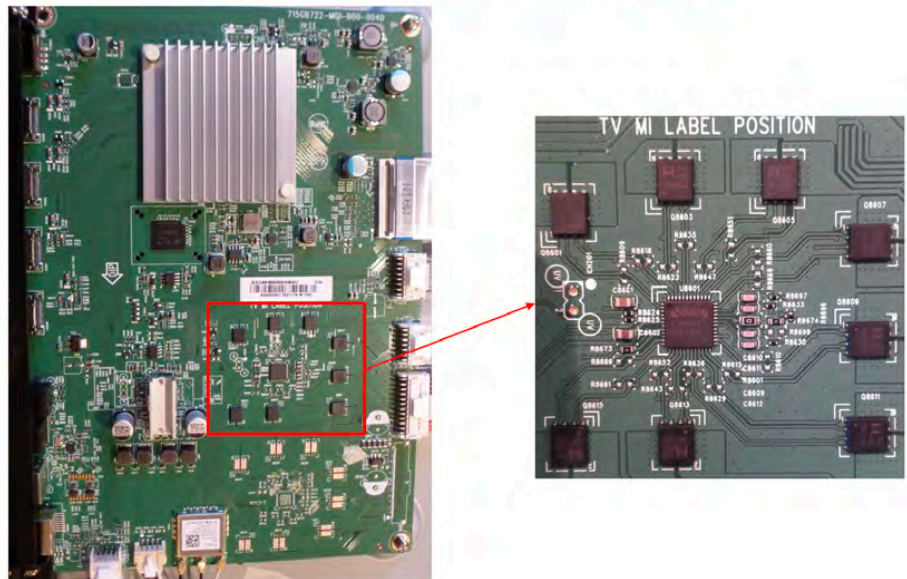
U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES



[Circuit board including LED control circuit for VIZIO M50QY-J01]

U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES

Teardown – LED Control Circuit



[Circuit board including LED control circuit for VIZIO M50QY-J01]

The LED control board is coupled to several sections of LEDs that provide zone dimming functionality.

“Unlock over a billion colors’ worth of 4K clarity with the new **M-Series**. Quantum Color delivers more color than ever and UltraBright 700 (MQ7) can achieve up to 700 nits of peak brightness for dazzling highlights. *The Active Full Array backlight (MQ7) features up to 32 local dimming zones for outstanding contrast and dynamic range.*”

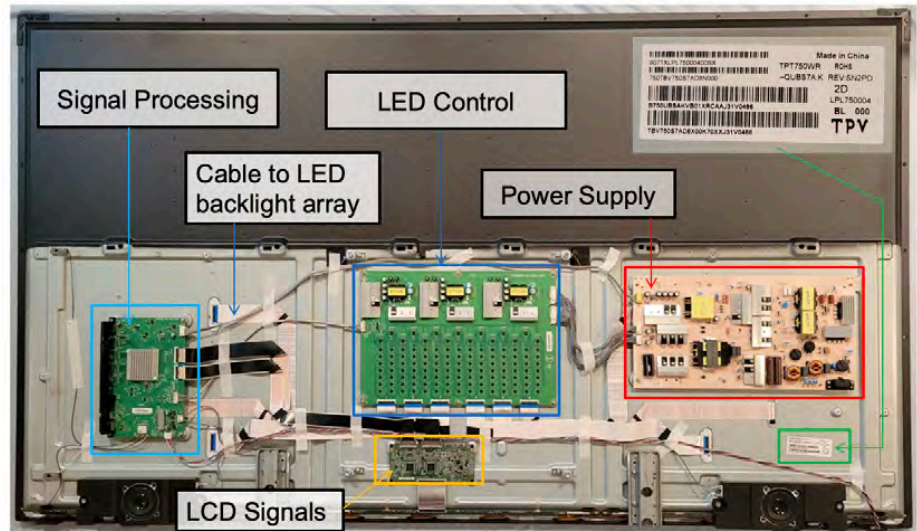
<https://www.VIZIO.com/en/press/2021/jun/VIZIO-s-new-tv-lineup-unleashes-enhanced-picture-quality--improv>

VIZIO P-Series

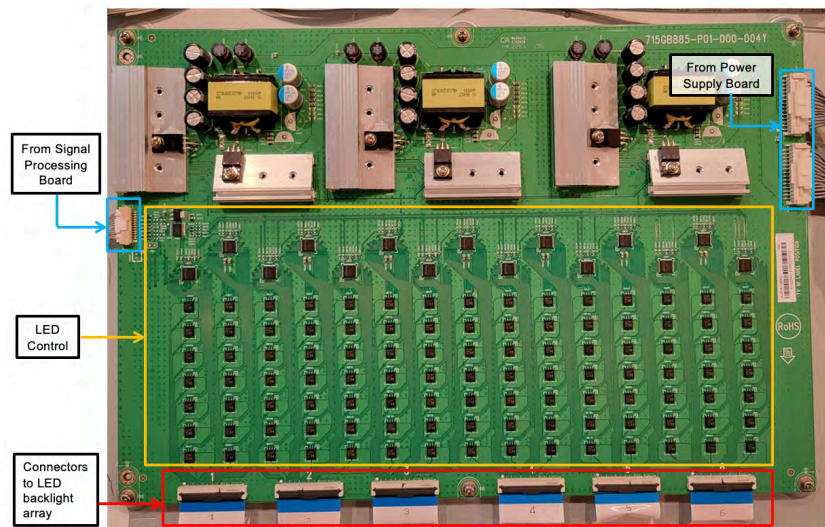
The preamble does not appear to be a limitation. To the extent the preamble is construed as a limitation, the VIZIO P-Series include a light emitting diode (LED) driver for driving LEDs connected to different parallel paths.

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As a representative example, the VIZIO P75Q9-J01 televisions include an LED control circuit (LED driver) as part of a signal processing and LED control circuit board, which includes components such as multi-channel LED driver chips and transistors) for individually controlling strings of LEDs in the TV backlight.



[VIZIO P75Q9-J01 with disassembled rear panel]



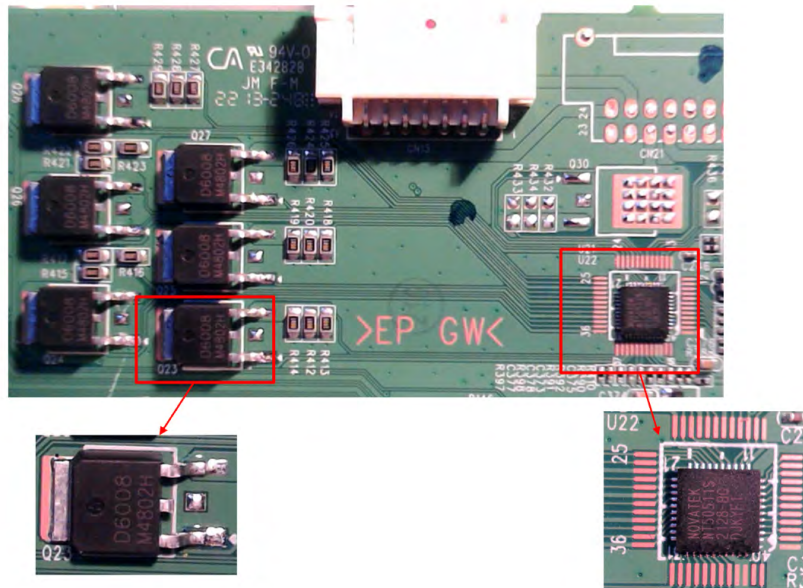
[Circuit board including LED control circuit for VIZIO P75Q9-J01]

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	The LED control board is coupled to several sections of LEDs that provide zone dimming functionality. "VIZIO's finest LED television--the P-Series--delivers best-in-class Quantum Color performance, enabling superior color volume and a wide color gamut. VIZIO's high-performance Active Full Array backlight achieves deeper, absolute black from up to 210 local dimming zones, for greater dynamic range, perfect for HDR content (Dolby Vision, HDR10+). Peak and full-screen brightness is also improved via enhanced picture processing, with up to 1200 nits for exceptional detail in highlights. The VIZIO ProGaming Engine supports Variable Refresh Rate (VRR) and AMD FreeSync Premium for the smoothest, most lifelike play from the most demanding games, up to 4K@120fps. https://www.VIZIO.com/en/press/2021/jun/VIZIO-s-new-tv-lineup-unleashes-enhanced-picture-quality--improv
a voltage source for connection to first ends of LEDs in a plurality of parallel paths;	VIZIO V-Series The VIZIO V-Series include a voltage source configured to provide a voltage (VLED) to first ends of the LEDs in a plurality of parallel paths. As a representative example, the VIZIO V655M televisions include a power supply configured to provide a regulated current to parallel LED strings. In addition, the televisions include precision current sinks in the LED driver chips. As a representative example, the LED control board in the V655M, for example, includes a Novatek NT50511S driver chip that is connected to the parallel LED strings, six power MOSFET switches, and a voltage source.

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Teardown – LED Control Circuit



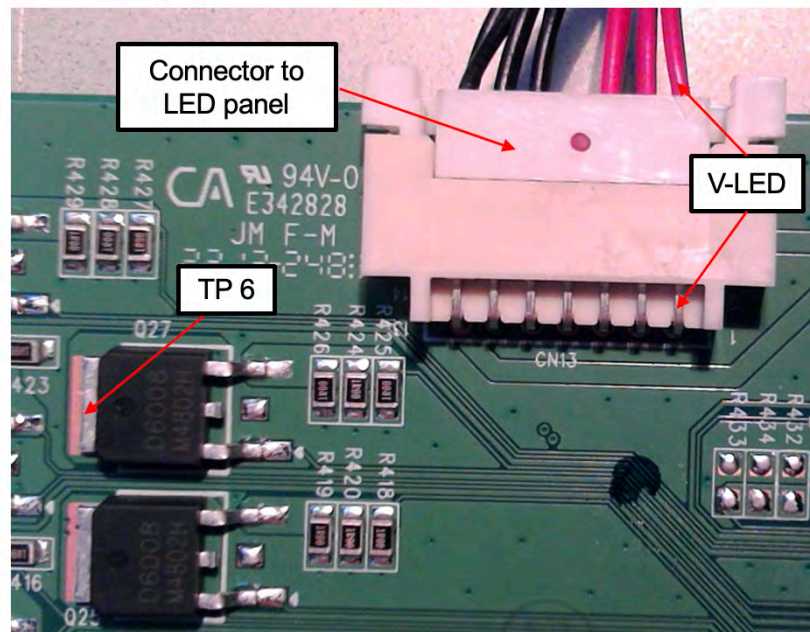
[Novatek NT50511S Driver and 6 power MOSFET switches]

Parallel strings

Through the LED power connection port, power is supplied from the power supply board to the LED control board that contains the LED driver, switches, and first ends of the LED strings.

When the device is turned on, the power supply provides VLED, which generates a current that flows through each of the respective LED strings to the LED driver chip. The current through each of the strings can be individually controlled by the Novatek driver chip and related circuitry.

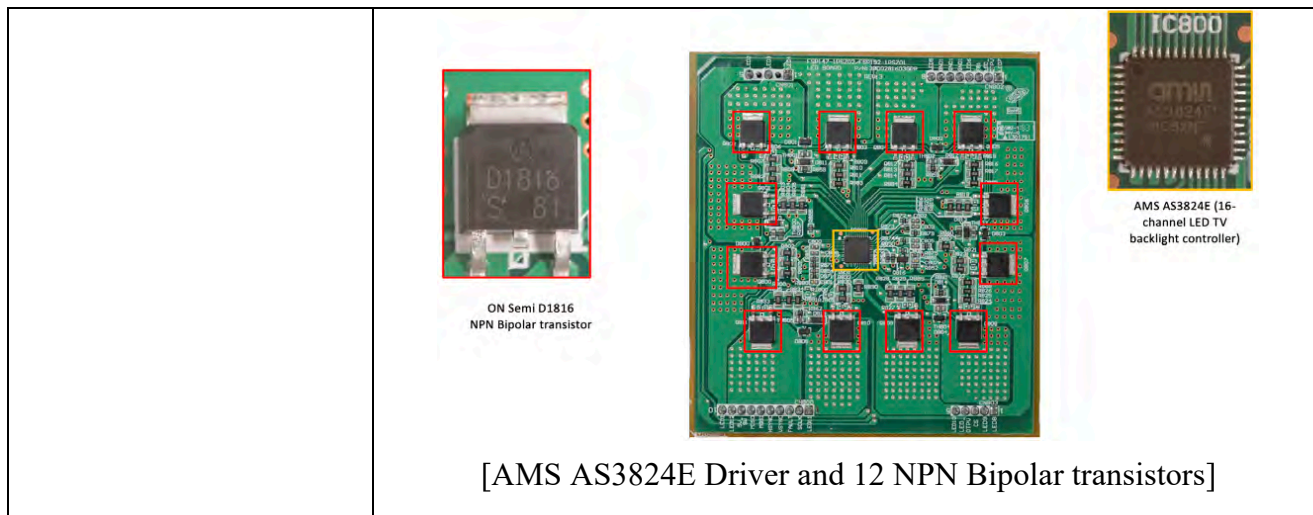
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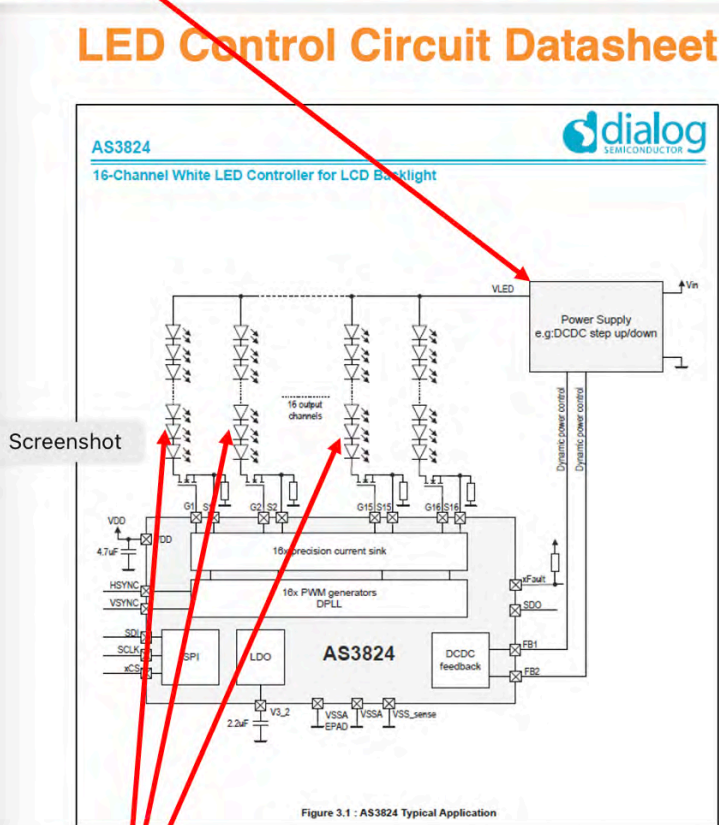
VIZIO E-Series

The VIZIO E-Series include a voltage source configured to provide a voltage (VLED) to first ends of the LEDs in a plurality of parallel paths. As a representative example, the VIZIO E65-F0 televisions include a power supply configured to provide a regulated current to parallel LED strings. In addition, the televisions include precision current sinks in the LED driver chips.

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U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES

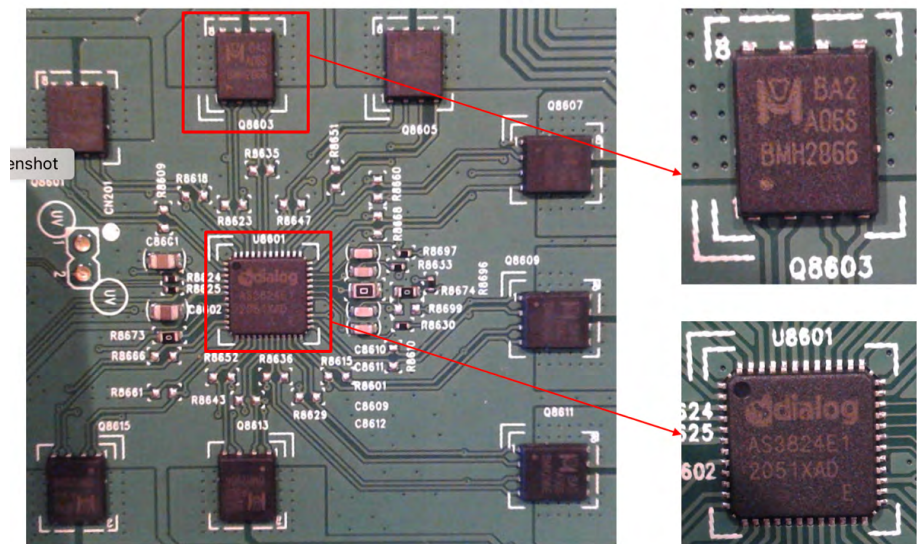
	Voltage Source LED Control Circuit Datasheet  Parallel strings Through the LED power connection port, power is supplied from the power supply board to the LED control board that contains the LED driver, switches, and first ends of the LED strings. When the device is turned on, the power supply provides VLED, which generates a current that flows through each of the respective LED strings to the LED driver chip AS3824. The current through each of the strings can be individually controlled by the AS3824 chip and related circuitry.
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VIZIO M-Series

The VIZIO M-series include a voltage source configured to provide a voltage (VLED) to first ends of the LEDs in a plurality of parallel paths. As a representative example, the VIZIO M50QY-J01 televisions include a power supply configured to provide a regulated current to parallel LED strings. In addition, the televisions include precision current sinks in the LED driver chips.

As a representative example, the LED control board in the M50QY-J01, for example, includes a Dialog AS3824 driver chip that is connected to the parallel LED strings, n-channel MOSFET switches, and a voltage source.

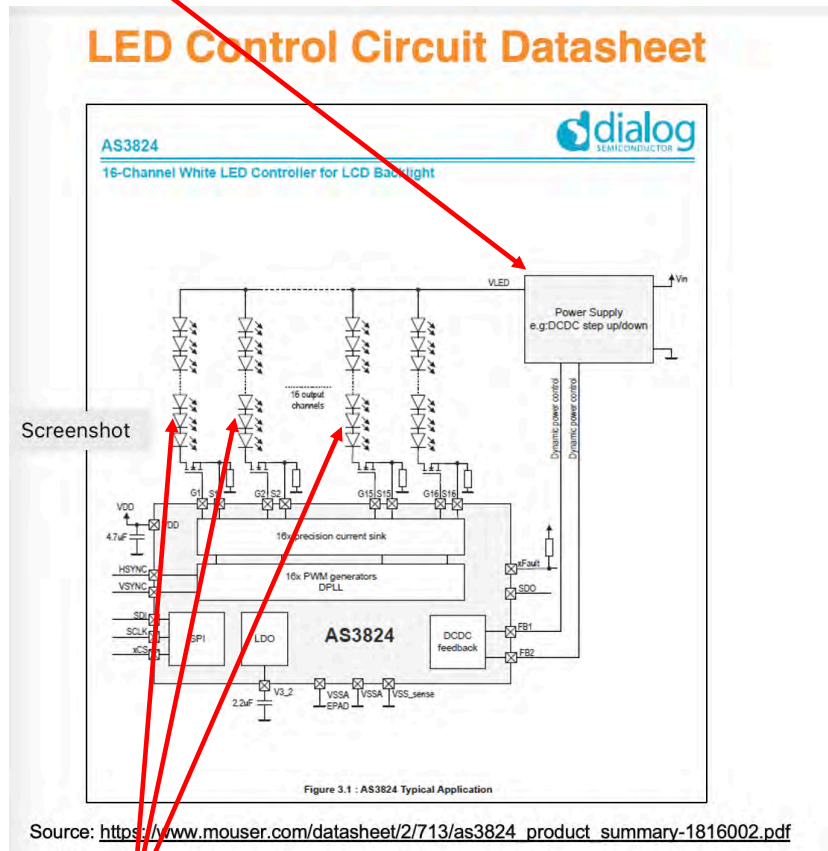


[Dialog AS3824 Driver and BA2 N-channel MOSFET switches]

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The general architecture is depicted in the AS3824 Data Sheet shown below:

Voltage Source



Parallel strings

Through the LED power connection port, power is supplied from the power supply board to the LED control board that contains the LED driver, switches, and first ends of the LED strings.

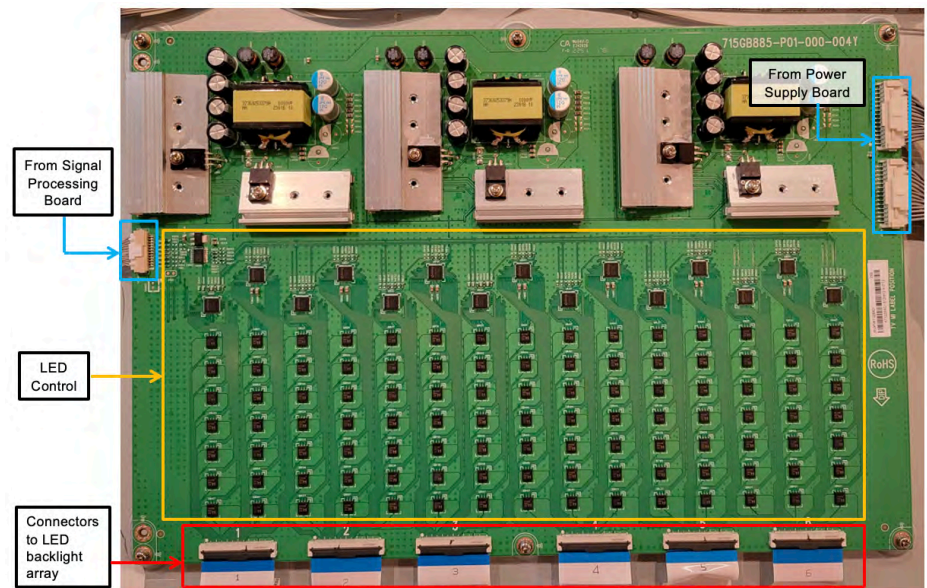
When the device is turned on, the power supply provides VLED, which generates a current that flows through each of the respective LED strings to the LED driver chip AS3824. The current through each of the strings can be individually controlled by the AS3824 chip and related circuitry.

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VIZIO P-Series

The VIZIO P-Series include a voltage source configured to provide a voltage (VLED) to first ends of the LEDs in a plurality of parallel paths. As a representative example, the VIZIO P75Q9-J01 televisions include a power supply configured to provide a regulated current to parallel LED strings. In addition, the televisions include precision current sinks in the LED driver chips.

As a representative example, the LED control board in the P75Q9-J01, for example, includes Dialog AS3824 driver chips that are connected to the parallel LED strings, n-channel MOSFET switches, and a voltage source.

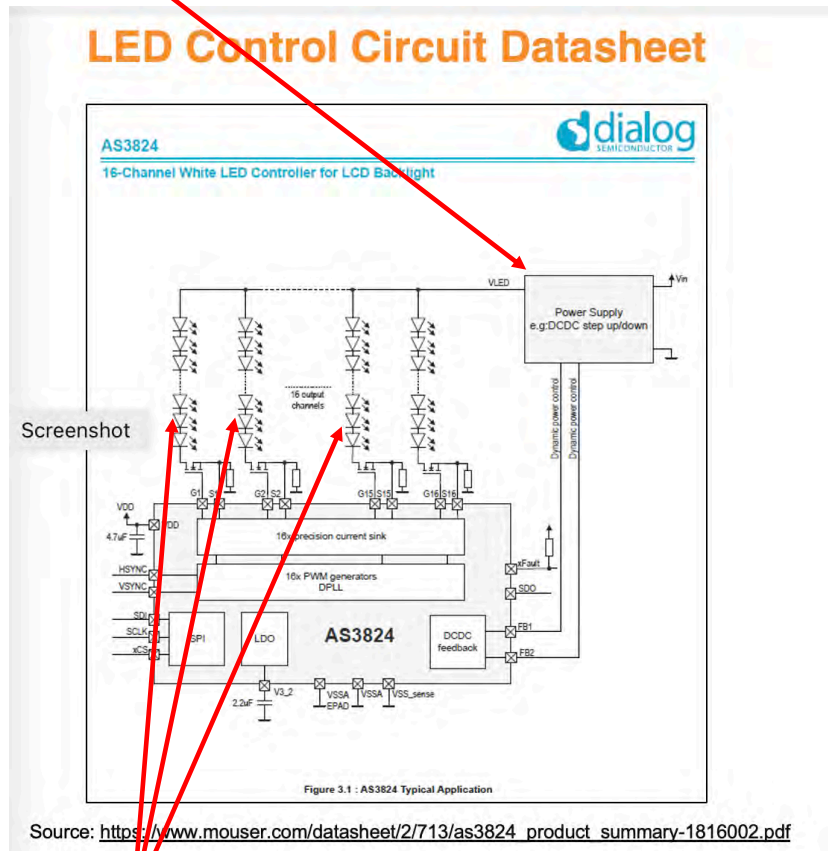


[Circuit board including 15 AS3824 LED drivers and 105 N-channel MOSFETs for VIZIO P75Q9-J01]

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The general architecture is depicted in the AS3824 Data Sheet shown below:

Voltage Source



Parallel strings

Through the LED power connection port, power is supplied from the power supply board to the LED control board that contains the LED driver, switches, and first ends of the LED strings.

When the device is turned on, the power supply provides VLED, which generates a current that flows through each of the respective LED strings to the LED driver chip AS3824. The current through each of the strings can be individually controlled by the AS3824 chip and related circuitry.

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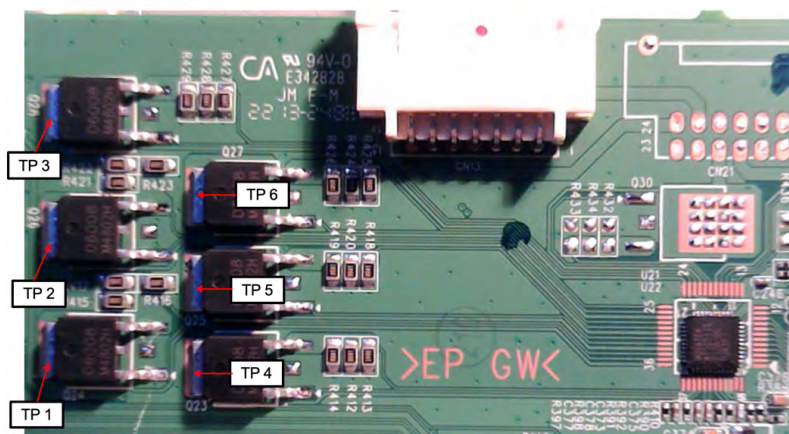
a plurality of current set circuits, one current set circuit per parallel path, each current set circuit controlling a peak current through one or more LEDs connected in each parallel path; and

VIZIO V-Series

The VIZIO Accused Televisions include a plurality of current set circuits, one current set circuit per parallel path, each current set circuit controlling a peak current through one or more LEDs connected in each parallel path.

As a representative example, the VIZIO V655M includes a current set circuit in each parallel path that controls the peak current. The LED control circuit in the V655M includes a Novatek LED driver chip. The Novatek LED driver includes current set circuitry for each parallel path of LEDs, which are connected to power MOSFETs (labeled with internal testing points TP1 – TP6).

Test Data – Internal Probing of Test Points



[Novatek LED driver connected to power MOSFETs to provided current setting through each path of LED strings]

VIZIO E-Series

The VIZIO Accused Televisions include a plurality of current set circuits, one current set circuit per parallel path, each current set circuit controlling a peak current through one or more LEDs connected in each parallel path.

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As a representative example, the VIZIO E65-F0 includes a current set circuit in each parallel path that controls the peak current. The LED control circuit in the E65-F0 includes a Dialog AS3824 LED driver chip. The AS3824 LED driver includes current set circuitry for each parallel path of LEDs.



AMS AS3824E (16-channel LED TV backlight controller)

AS3824
16-Channel White LED Controller for LCD Backlight



1 Description
The AS3824 is a 16 channel high precision LED controller for use in LCD-backlight panels. Dynamic power feedback controls the external power supply to guarantee best efficiency. One high accurate global 10 bit DAC can be used to set the LED current as well as each channel has its own additional 8 bit DAC to boost the dynamic range of LED Backlight systems.
Each channel is equipped with an independent PWM generator which can also be synchronized to an external synchronization signal (VSYNC).
A fast mode supports minimum PWM duty cycle operation which helps to further reduce the energy consumption of modern LED Backlight systems.
The PWM generator clock can be generated internally (DPLL) or an external clock source can be connected to the HSYNC input.
Built-in safety features include thermal shutdown as well as open and short LED detection. The device is programmable via serial interface (SPI).

Source: https://www.mouser.com/datasheet/2/713/as3824_product_summary-1816002.pdf

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	Current set circuits [AS3824 Datasheet] VIZIO M-Series The VIZIO Accused Televisions include a plurality of current set circuits, one current set circuit per parallel path, each current set circuit controlling a peak current through one or more LEDs connected in each parallel path. As a representative example, the VIZIO M50Q includes a current set circuit in each parallel path that controls the peak current. The LED
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control circuit in the M50Q includes a Dialog AS3824 LED driver chip. The AS3824 LED driver includes current set circuitry for each parallel path of LEDs.



AS3824



16-Channel White LED Controller for LCD Backlight

1 Description

The AS3824 is a 16 channel high precision LED controller for use in LCD-backlight panels. Dynamic power feedback controls the external power supply to guarantee best efficiency. One high accurate global 10 bit DAC can be used to set the LED current as well as each channel has its own additional 8 bit DAC to boost the dynamic range of LED Backlight systems.

Each channel is equipped with an independent PWM generator which can also be synchronized to an external synchronization signal (VSYNC).

A fast mode supports minimum PWM duty cycle operation which helps to further reduce the energy consumption of modern LED Backlight systems.

The PWM generator clock can be generated internally (DPLL) or an external clock source can be connected to the HSYNC input.

Built-in safety features include thermal shutdown as well as open and short LED detection. The device is programmable via serial interface (SPI).

Source: https://www.mouser.com/datasheet/2/713/as3824_product_summary-1816002.pdf

U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES

	Current set circuits [AS3824 Datasheet] VIZIO P-Series The VIZIO Accused Televisions include a plurality of current set circuits, one current set circuit per parallel path, each current set circuit controlling a peak current through one or more LEDs connected in each parallel path. As a representative example, the VIZIO P75Q9-J01 includes a current set circuit in each parallel path that controls the peak current. The LED control circuit in the P75Q9 includes Dialog AS3824 LED driver
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chips. The AS3824 LED driver includes current set circuitry for each parallel path of LEDs.



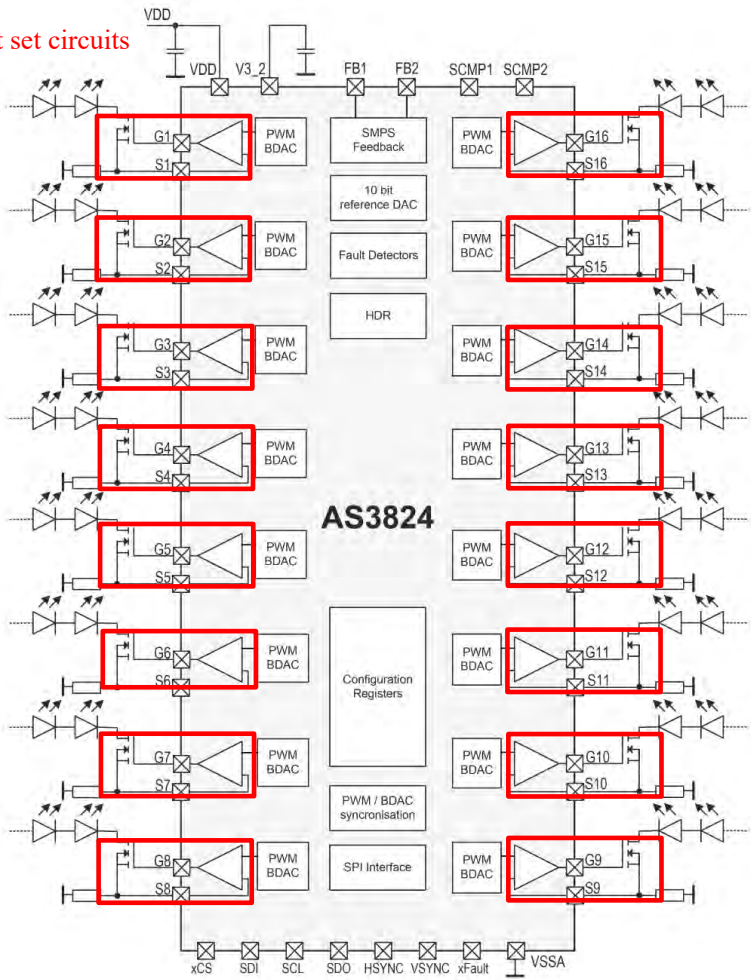


AS3824
16-Channel White LED Controller for LCD Backlight

1 Description
The AS3824 is a 16 channel high precision LED controller for use in LCD-backlight panels. Dynamic power feedback controls the external power supply to guarantee best efficiency. One high accurate global 10 bit DAC can be used to set the LED current as well as each channel has its own additional 8 bit DAC to boost the dynamic range of LED Backlight systems.
Each channel is equipped with an independent PWM generator which can also be synchronized to an external synchronization signal (VSYNC).
A fast mode supports minimum PWM duty cycle operation which helps to further reduce the energy consumption of modern LED Backlight systems.
The PWM generator clock can be generated internally (DPLL) or an external clock source can be connected to the HSYNC input.
Built-in safety features include thermal shutdown as well as open and short LED detection. The device is programmable via serial interface (SPI).

Source: https://www.mouser.com/datasheet/2/713/as3824_product_summary-1816002.pdf

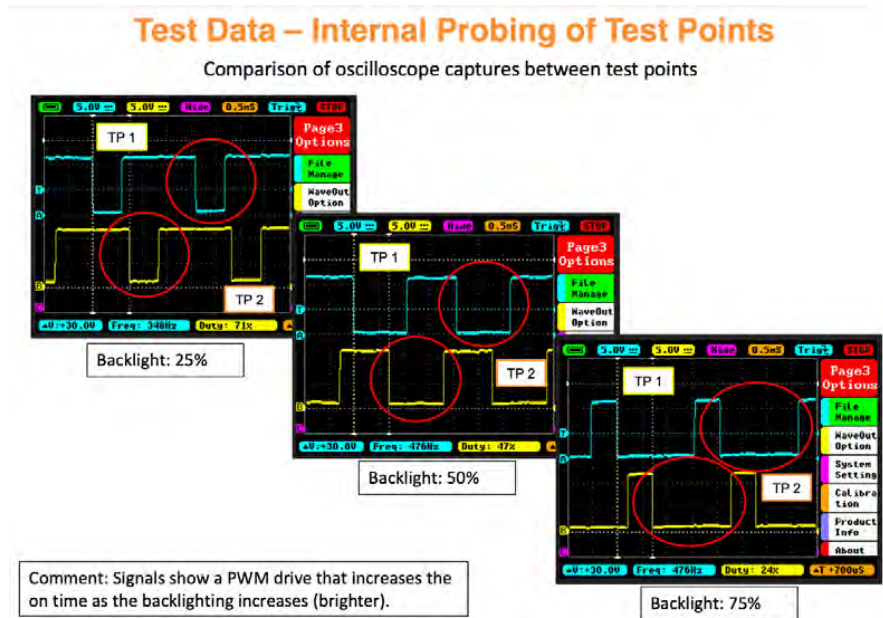
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	Current set circuits  The diagram shows the internal architecture of the AS3824 chip. It features eight current set circuits, each consisting of a PMOS transistor (G1-G8), an NMOS transistor (S1-S8), and a PWM BDAC. These are connected to a common output line. Other components include a 10-bit reference DAC, Fault Detectors, HDR, Configuration Registers, PWM / BDAC synchronisation, and SPI Interface. The chip is powered by VDD and VSSA, with various control signals like xCS, SDI, SCL, SDO, HSYNC, VSYNC, and xFault. AS3824 [AS3824 Datasheet]
a pulse-width modulated (PWM) brightness control signal generator connected to the plurality of current set circuits, the brightness control signal generator being configured to generate staggered PWM brightness control signals	VIZIO V-Series The VIZIO V-Series include a pulse-width modulated (PWM) brightness control signal generator connected to the plurality of current set circuits, the brightness control signal generator being configured to generate staggered PWM brightness control signals to the plurality of current set circuits.

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to the plurality of current set circuits,

In the V655M, for example, the Novatek LED driver uses 6 PWM generators to drive each power MOSFET and control brightness of the LED strings.



[Test point probes TP1 and TP2 showing PWM signals at different levels of brightness]

VIZIO E-Series

The VIZIO E-Series include a pulse-width modulated (PWM) brightness control signal generator connected to the plurality of current set circuits, the brightness control signal generator being configured to generate staggered PWM brightness control signals to the plurality of current set circuits.

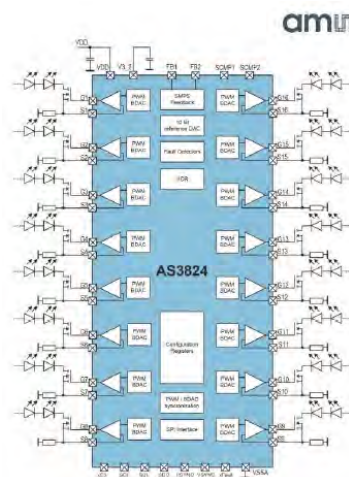
In the E65-F0, for example, the AS3824 datasheet indicates that 16 PWM generators are used to implement local dimming.

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Figure 1:
Added Value of Using AS3824

Benefits	Features
All LED backlight topologies	No limit of VLED or ILED, device is not exposed to high voltage/high current
Optimum power savings through local dimming	16 fully flexible 12 bit PWM generators (period, high time, delay, reverse)
Highest brightness uniformity	One global high accurate 10 bit DAC which sets the LED current ($\pm 0.5\%$ accuracy)

Benefits	Features
High dynamic range boost function	16 independent 8 bit DACs can be used to boost/decrease LED current within certain frames
Global dimming mode available	AS3824E is pre-programmed to external PWM mode. VSYNC pin is used as PWM input
Synchronization with TV frame	VSYNC and HSYNC inputs available as well as a digital PLL integrated
Lowest BOM	Due to 2 pin concept of the output channel: no HV protection, no cascade FETs
Digital enhanced DC-DC feedback	Feedback function is compatible to every DC-DC architecture and configurable via SPI
On chip safety features	Short/OPEN LED detection, temperature shutdown, register lock/unlock, SPI transfer checksum



Key Features

- No limit of VLED or ILED, controller not exposed to high voltage/current
- One global high accurate 10bit DAC which sets the LED current ($\pm 0.5\%$ accurate)
- 16 independent 8 bit DACs can be used to boost/decrease LED current within certain frames

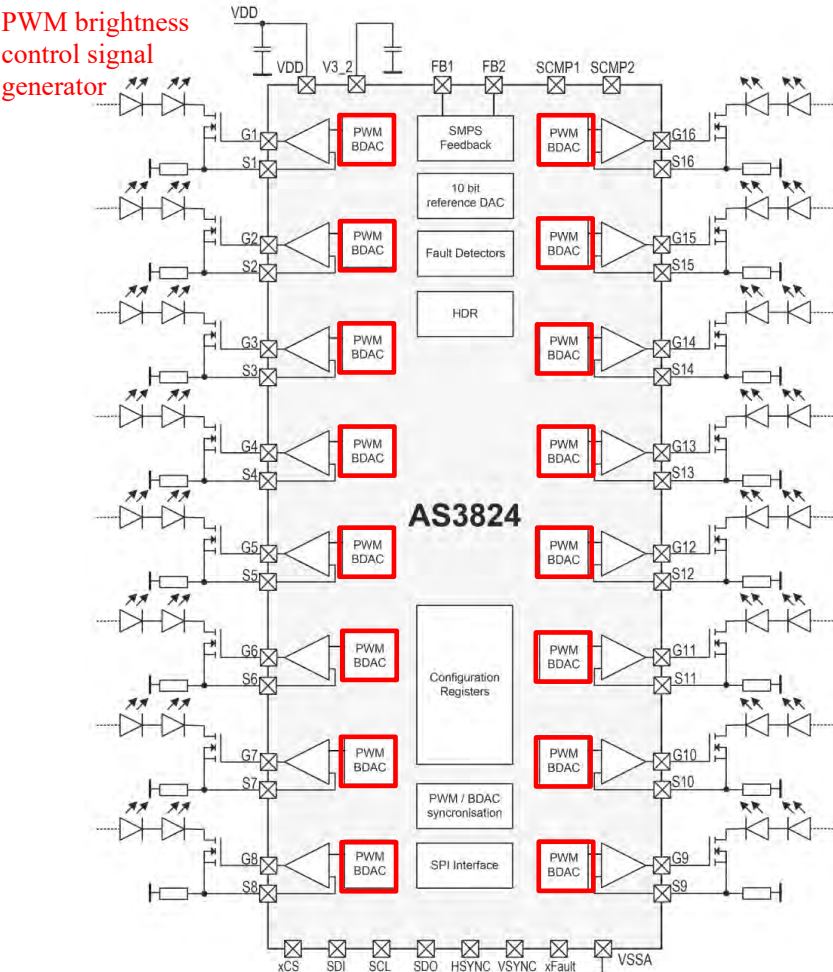
- QFN48 7x7mm with 0.5mm pitch
- LQFP44 10x10mm 0.8mm pitch

Key Benefits

- All LED backlight topologies
- Optimum power savings through local dimming
- Highest brightness uniformity
- High Dynamic range boost function
- Global Dimming Mode available
- Lowest BOM
- Two Package types available

[AS3824 Datasheet]

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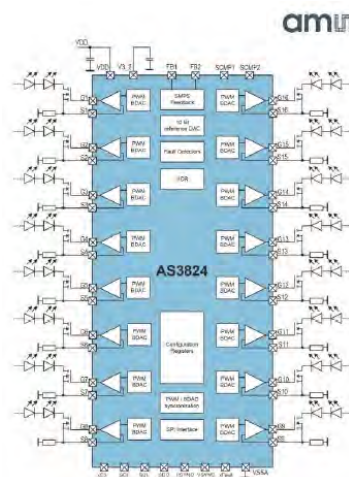
	PWM brightness control signal generator  The diagram illustrates the internal architecture of the AS3824 chip. It features a central block labeled 'AS3824' containing several functional blocks: 'SMPS Feedback', '10 bit reference DAC', 'Fault Detectors', 'HDR', 'Configuration Registers', 'PWM / BDAC synchronisation', and 'SPI Interface'. Surrounding this central block are 16 identical 'PWM BDAC' blocks, each highlighted with a red border. These blocks are organized into two columns of eight. Each 'PWM BDAC' block is connected to a gate (G1-G8 on the left, G9-G16 on the right) and a source (S1-S8 on the left, S9-S16 on the right). The gates are connected to a network of transistors and resistors, while the sources are connected to a common output line. The output line is connected to a series of pins: xCS, SDI, SCL, SDO, HSYNC, VSYNC, xFault, and VSSA. A 'PWM brightness control signal generator' is indicated by a red arrow pointing to the input of the first 'PWM BDAC' block (G1/S1). Power supply pins VDD and V3.2 are also shown at the top. [AS3824 Datasheet] VIZIO M-Series The VIZIO M-Series include a pulse-width modulated (PWM) brightness control signal generator connected to the plurality of current set circuits, the brightness control signal generator being configured to generate staggered PWM brightness control signals to the plurality of current set circuits. In the M50QY-J01, for example, the AS3824 datasheet indicates that 16 PWM generators are used to implement local dimming.
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SERIES, V-SERIES, D-SERIES, AND P-SERIES

Figure 1:
Added Value of Using AS3824

Benefits	Features
All LED backlight topologies	No limit of VLED or ILED, device is not exposed to high voltage/high current
Optimum power savings through local dimming	16 fully flexible 12 bit PWM generators (period, high time, delay, reverse)
Highest brightness uniformity	One global high accurate 10 bit DAC which sets the LED current ($\pm 0.5\%$ accuracy)

Benefits	Features
• High dynamic range boost function	• 16 independent 8 bit DACs can be used to boost/decrease LED current within certain frames
• Global dimming mode available	• AS3824E is pre-programmed to external PWM mode. VSYNC pin is used as PWM input
• Synchronization with TV frame	• VSYNC and HSYNC inputs available as well as a digital PLL integrated
• Lowest BOM	• Due to 2 pin concept of the output channel: no HV protection, no cascade FETs
• Digital enhanced DC-DC feedback	• Feedback function is compatible to every DC-DC architecture and configurable via SPI
• On chip safety features	• Short/OPEN LED detection, temperature shutdown, register lock/unlock, SPI transfer checksum



- ### Key Features

- No limit of VLED or ILED, controller not exposed to high voltage/current
- One global high accurate 10bit DAC which sets the LED current ($\pm 5\%$ accurate)
- 16 independent 8 bit DACs can be used to boost/decrease LED current within certain frames

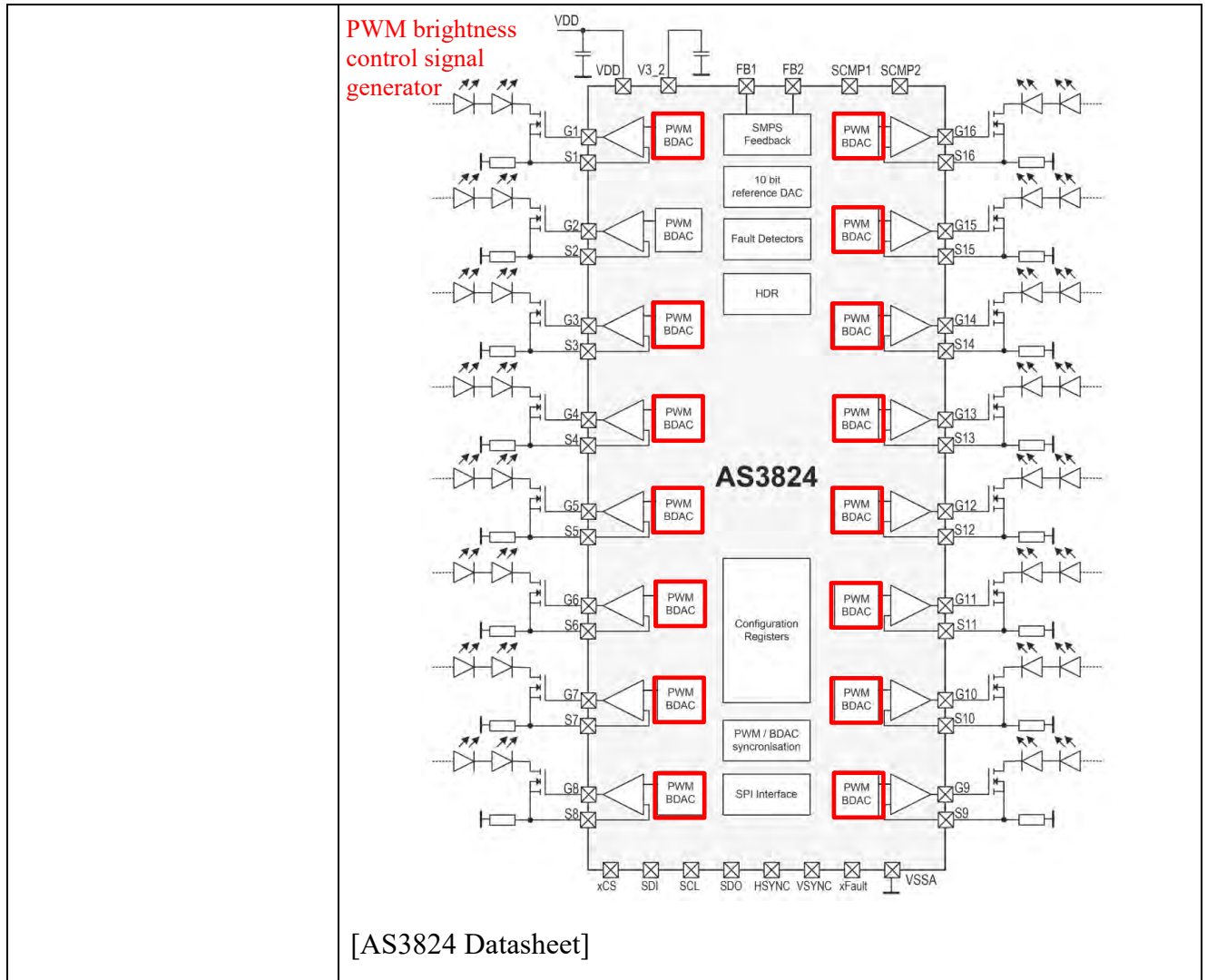
- QFN48 7x7mm with 0.5mm pitch
- LQFP44 10x10mm 0.8mm pitch

- ### Key Benefits

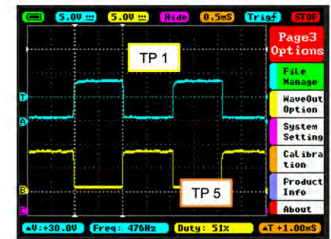
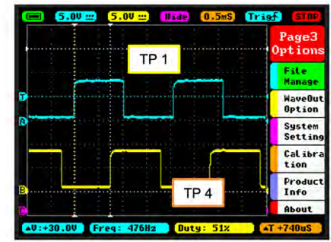
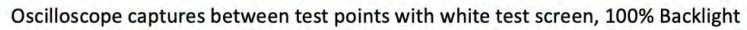
- All LED backlight topologies
- Optimum power savings through local dimming
- Highest brightness uniformity
- High Dynamic range boost function
- Global Dimming Mode available
- Lowest BOM
- Two Package types available

[AS3824 Datasheet]

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SERIES, V-SERIES, D-SERIES, AND P-SERIES



Comment: The signals captured between test points show a constant duty cycle PWM drive and have a shift in time that shows staggered and out of phase brightness control signals.

[Test point probes TP1 – TP5 showing PWM signals at different levels of brightness]

VIZIO P-Series

The VIZIO P-Series include a pulse-width modulated (PWM) brightness control signal generator connected to the plurality of current set circuits, the brightness control signal generator being configured to generate staggered PWM brightness control signals to the plurality of current set circuits.

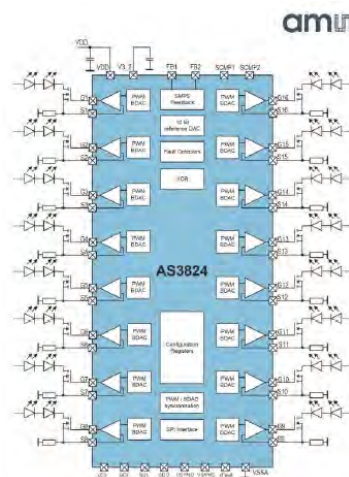
In the P75Q9-J01, for example, the AS3824 datasheet indicates that 16 PWM generators are used to implement local dimming.

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Figure 1:
Added Value of Using AS3824

Benefits	Features
All LED backlight topologies	No limit of VLED or ILED, device is not exposed to high voltage/high current
Optimum power savings through local dimming	16 fully flexible 12 bit PWM generators (period, high time, delay, reverse)
Highest brightness uniformity	One global high accurate 10 bit DAC which sets the LED current ($\pm 0.5\%$ accuracy)

Benefits	Features
High dynamic range boost function	16 independent 8 bit DACs can be used to boost/decrease LED current within certain frames
Global dimming mode available	AS3824E is pre-programmed to external PWM mode. VSYNC pin is used as PWM input
Synchronization with TV frame	VSYNC and HSYNC inputs available as well as a digital PLL integrated
Lowest BOM	Due to 2 pin concept of the output channel: no HV protection, no cascade FETs
Digital enhanced DC-DC feedback	Feedback function is compatible to every DC-DC architecture and configurable via SPI
On chip safety features	Short/OPEN LED detection, temperature shutdown, register lock/unlock, SPI transfer checksum



Key Features

- No limit of VLED or ILED, controller not exposed to high voltage/current
- One global high accurate 10bit DAC which sets the LED current ($\pm 0.5\%$ accurate)
- 16 independent 8 bit DACs can be used to boost/decrease LED current within certain frames

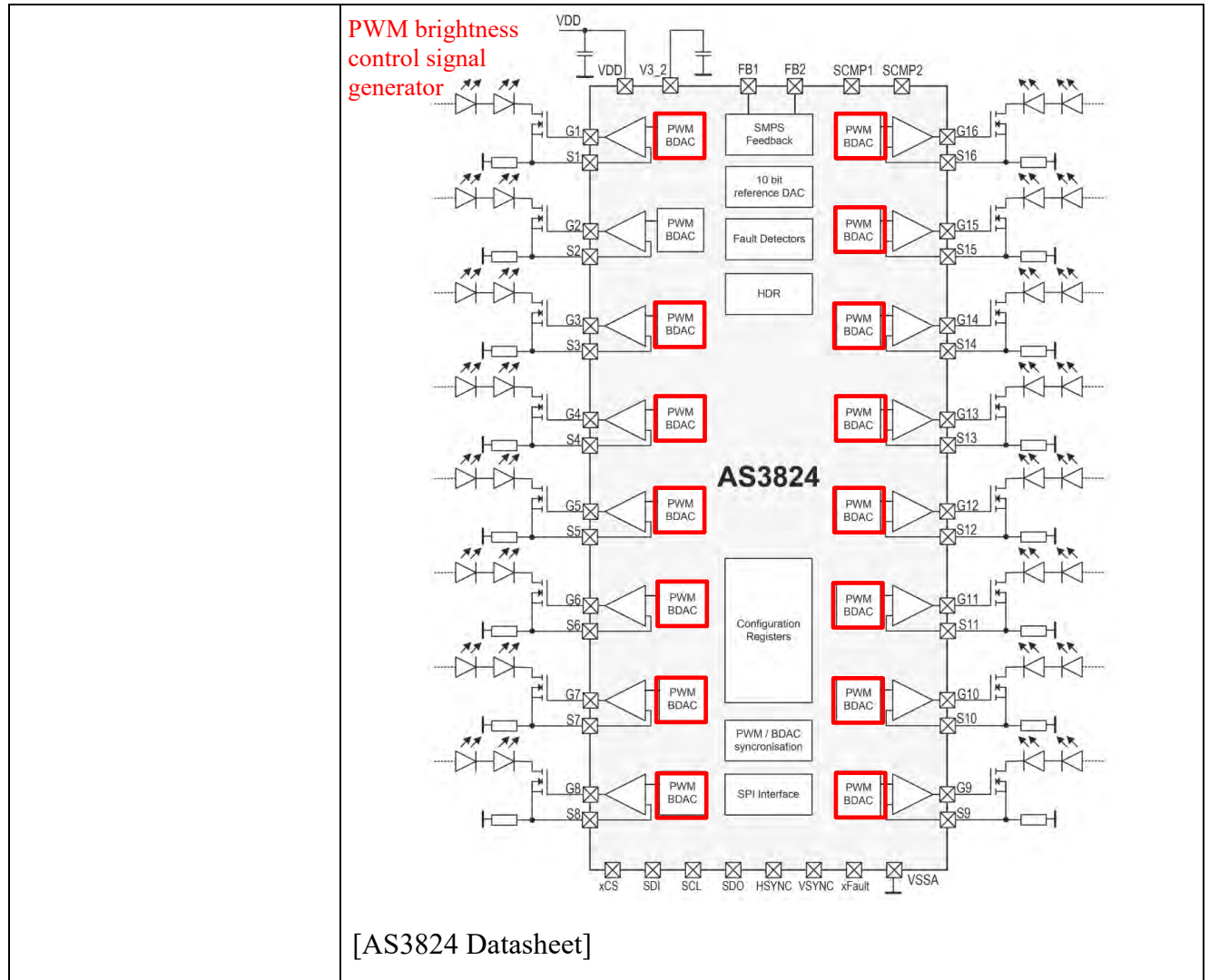
- QFN48 7x7mm with 0.5mm pitch
- LQFP44 10x10mm 0.8mm pitch

Key Benefits

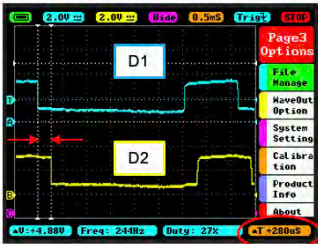
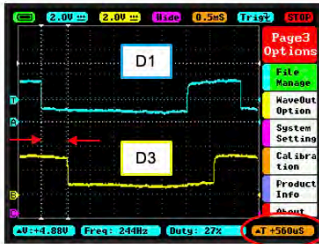
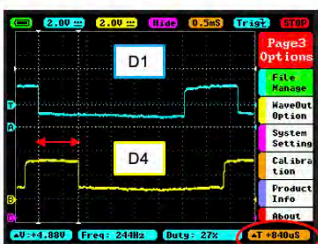
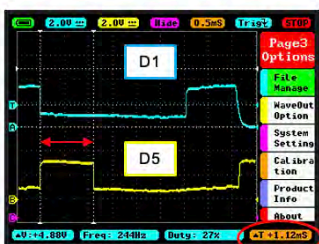
- All LED backlight topologies
- Optimum power savings through local dimming
- Highest brightness uniformity
- High Dynamic range boost function
- Global Dimming Mode available
- Lowest BOM
- Two Package types available

[AS3824 Datasheet]

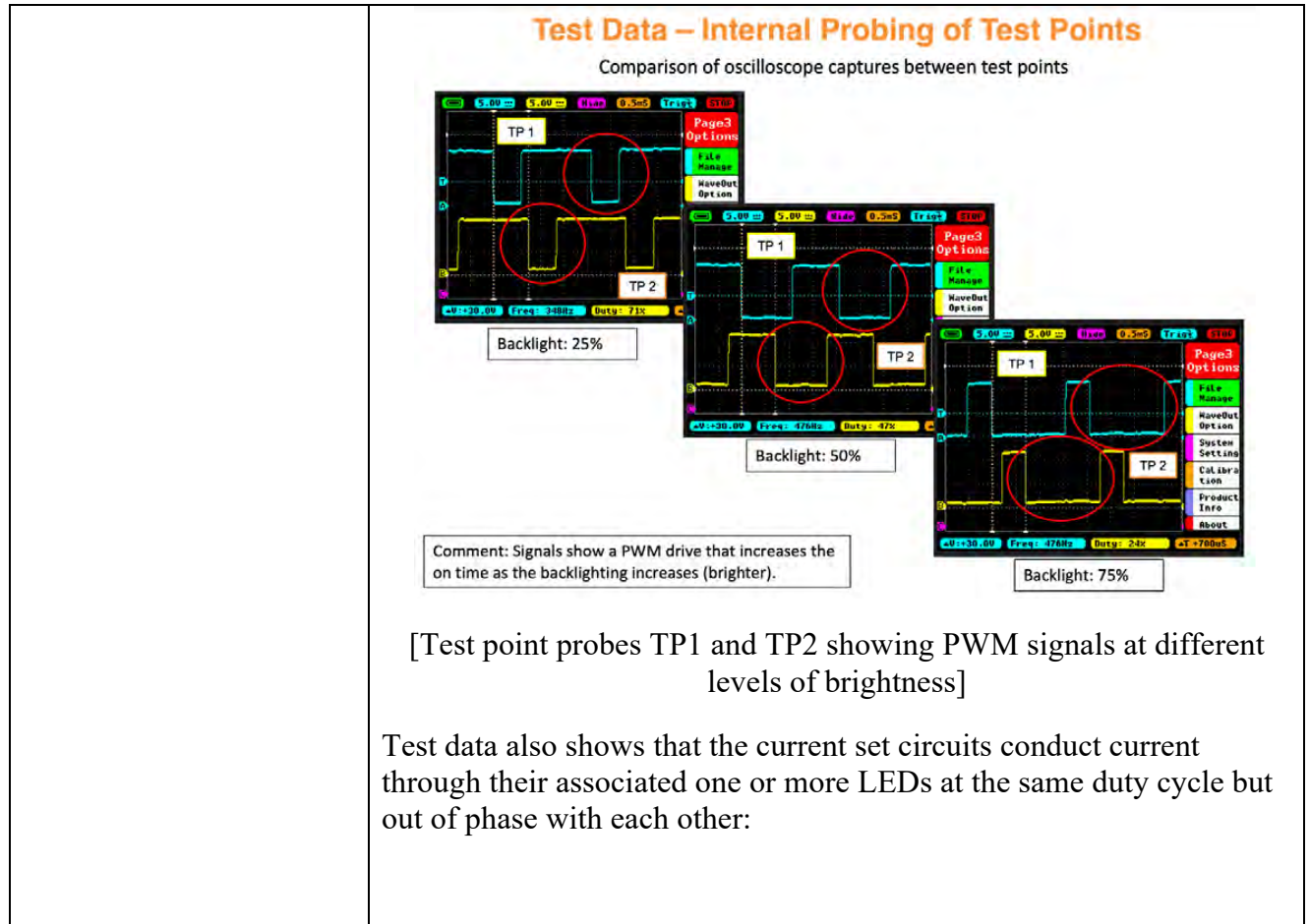
U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES



U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES

	Test Data – Internal Probing of Test Points Oscilloscope captures between test points with white test screen, 75% Backlight  IMG_013.BMP  IMG_020.BMP  IMG_027.BMP  IMG_034.BMP [Test point probes D1 – D5 showing PWM signals]
each current set circuit being configured to draw the peak current through its associated one or more LEDs at a duty cycle substantially corresponding to a duty cycle of a PWM brightness control signal applied to it, such that the plurality of current set circuits conduct current through their associated one or more LEDs at the same duty cycle but out of phase with each other.	VIZIO V-Series The current set circuits in the VIZIO V-Series are each configured to draw the peak current through its associated one or more LEDs at a duty cycle substantially corresponding to a duty cycle of a PWM brightness control signal applied to it, such that the plurality of current set circuits conduct current through their associated one or more LEDs at the same duty cycle but out of phase with each other. Testing data shows that peak current through its associated one or more LEDs at a duty cycle substantially corresponds to a duty cycle of a PWM brightness control signal applied to it:

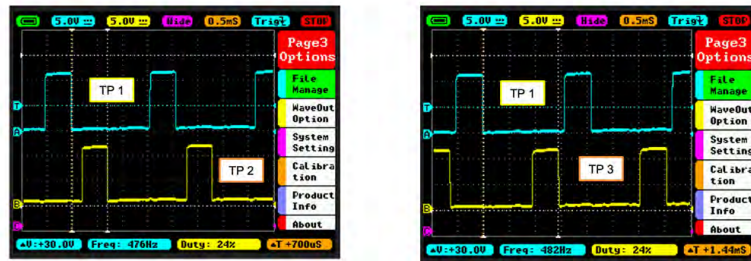
U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES



U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES

Test Data – Internal Probing of Test Points

Oscilloscope captures between test points with white test screen, 75% Backlight



Comment: The signals captured between test points show a constant duty cycle PWM drive and have a shift in time that supports staggered and out of phase brightness control signals.

VIZIO E-Series

The current set circuits in the VIZIO E-Series are each configured to draw the peak current through its associated one or more LEDs at a duty cycle substantially corresponding to a duty cycle of a PWM brightness control signal applied to it, such that the plurality of current set circuits conduct current through their associated one or more LEDs at the same duty cycle but out of phase with each other.

As shown below in the data with respect to the M-Series, which uses the same driver as the E65-F0, the AS3824 in the E65-F0's peak current through the associated one or more LEDs at a duty cycle substantially corresponds to a duty cycle of a PWM brightness control signal applied to it.

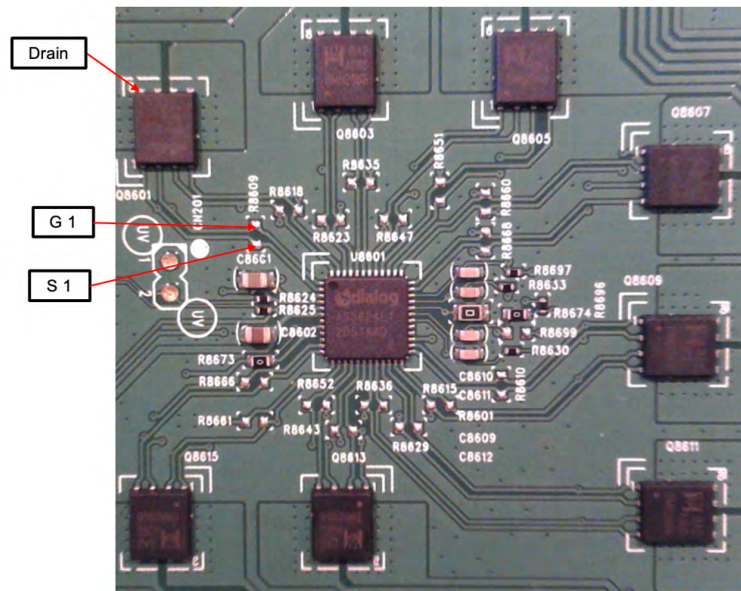
VIZIO M-Series

The current set circuits in the VIZIO M-Series are each configured to draw the peak current through its associated one or more LEDs at a duty cycle substantially corresponding to a duty cycle of a PWM brightness control signal applied to it, such that the plurality of current set circuits conduct current through their associated one or more LEDs at the same duty cycle but out of phase with each other.

U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES

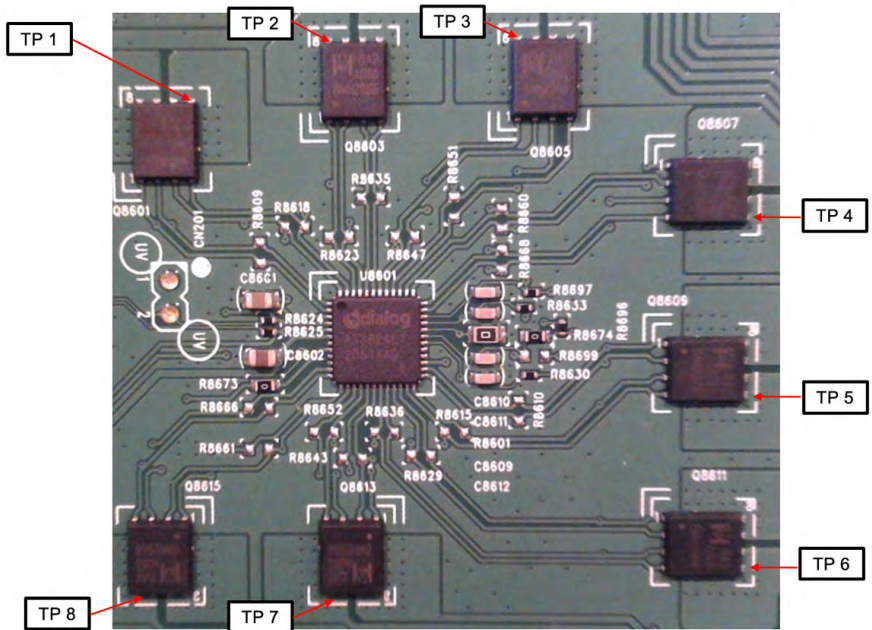
Testing data shows that peak current through its associated one or more LEDs at a duty cycle substantially corresponds to a duty cycle of a PWM brightness control signal applied to it:

Test Data – Internal Probing of Test Points

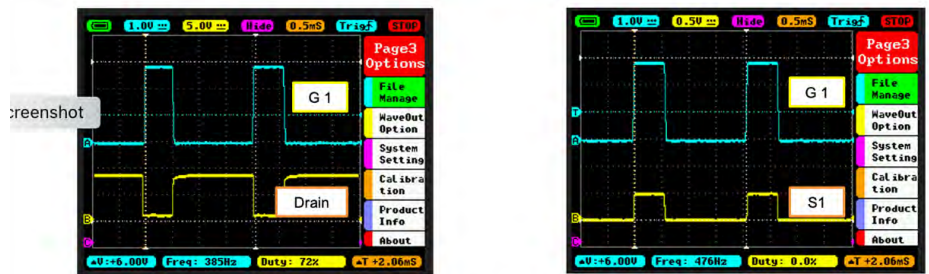


U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES

Test Data – Internal Probing of Test Points

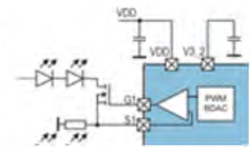


Test Data – Internal Probing of Test Points



Oscilloscope captures between test points with white test screen, 50% Backlight

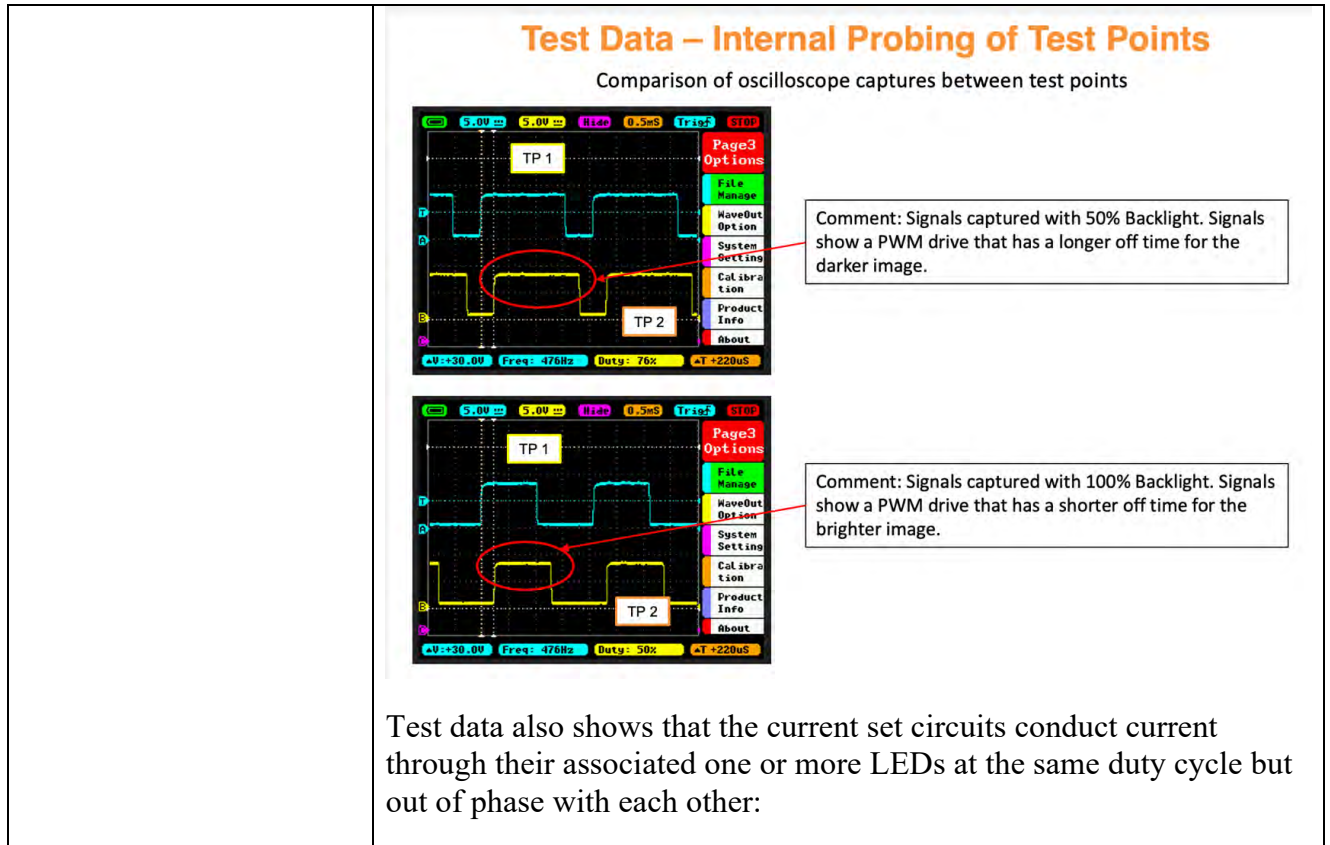
The device also includes an additional 8-bit current control DAC for each of the 16 channels. This can be used to partially boost or lower the current through the LED in a given frame, increasing the dynamic contrast ratio. This allows the AS3824 to support HDR monitors and HDR TVs.



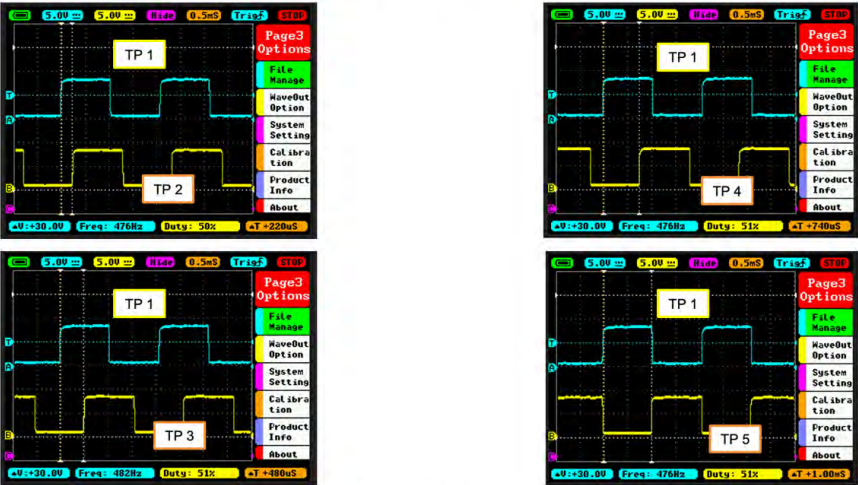
Source: <http://kidd.co.kr/news/183069>

Comment: The signal at S1, which correlates with the Drain signal, provides a feedback signal to control the G1 on time based on the signal from the PWM 8-bit current control DAC.

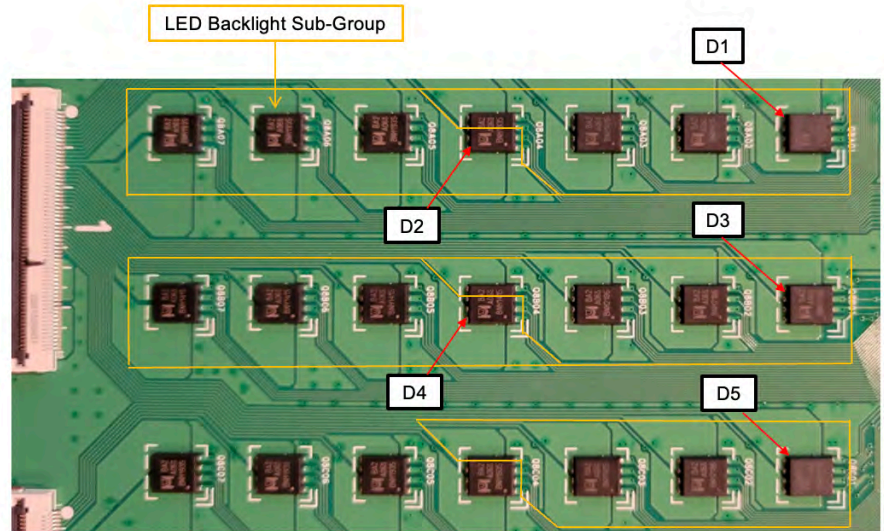
U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES



U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES

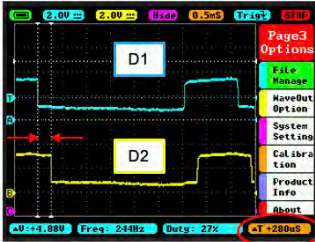
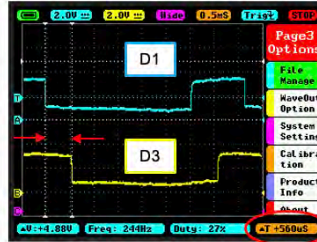
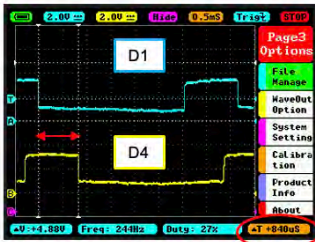
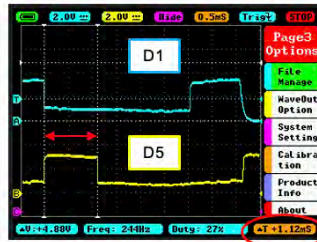
	Test Data – Internal Probing of Test Points Oscilloscope captures between test points with white test screen, 100% Backlight  Comment: The signals captured between test points show a constant duty cycle PWM drive and have a shift in time that shows staggered and out of phase brightness control signals.
	VIZIO P-Series The current set circuits in the VIZIO P-Series are each configured to draw the peak current through its associated one or more LEDs at a duty cycle substantially corresponding to a duty cycle of a PWM brightness control signal applied to it, such that the plurality of current set circuits conduct current through their associated one or more LEDs at the same duty cycle but out of phase with each other. Testing data shows that peak current through its associated one or more LEDs at a duty cycle substantially corresponds to a duty cycle of a PWM brightness control signal applied to it:

U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES

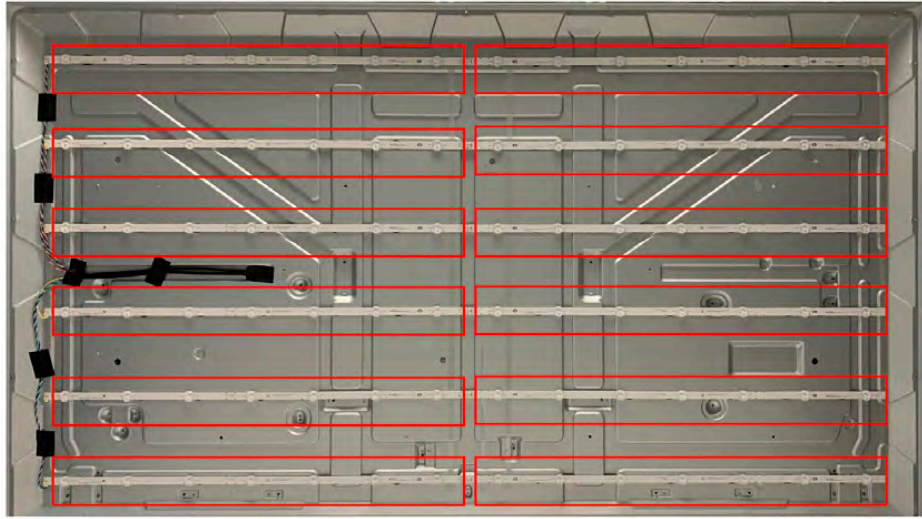


Test data also shows that the current set circuits conduct current through their associated one or more LEDs at the same duty cycle but out of phase with each other:

U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES

	Test Data – Internal Probing of Test Points Oscilloscope captures between test points with white test screen, 75% Backlight  IMG_013.BMP  IMG_020.BMP  IMG_027.BMP  IMG_034.BMP [Test point probes D1 – D5 showing PWM signals]
2. The driver of claim 1 wherein the voltage source is a step up voltage regulator.	<i>See claim 1 above.</i> On information and believe, each of the Accused Televisions in the VIZIO V-Series, M-Series, E-Series, and P-Series feature a step up voltage regulator as a voltage source. As a representative example, the E65-F0 includes 12 strings of 7 LEDs as shown below. The forward voltage drop for strings of 7 white-light LEDs exceeds the standard input voltage, meaning that the E65-F0 necessarily utilizes a step-up voltage source (i.e., a boost converter) to supply the required voltage.

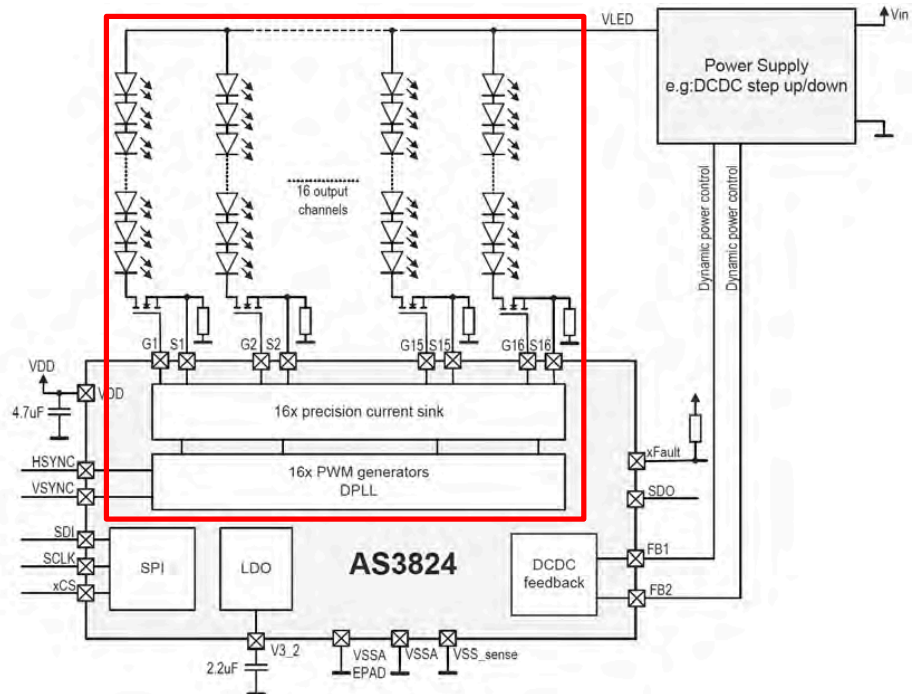
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	 [E65-F0 backlight LED array]
3. The driver of claim 1 wherein each current set circuit is a current regulator.	<i>See claim 1 above.</i> Each of the Accused Televisions in the VIZIO V-Series, M-Series, E-Series, and P-Series feature an LED driver utilizing current regulation in the current set circuit. As a representative example, the AS3824 LED driver in the VIZIO M50Q7-J01, VIZIO P75Q9-J01, and the VIZIO E65-F0 features a current set circuit comprised of 16 precision current sinks that regulate the current flowing through each LED string.

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connected to the current control transistor to control a conductivity of the current control transistor to cause the current through the parallel path to match a reference level.

As shown in the AS3824 datasheet, the driver includes 16 PWM generators connected in series to control current that are each associated with LEDs in an associated parallel path. Also, as shown below, each parallel path includes a feedback circuit consisting of a precision current sink in order to detect current through that parallel path, which is connected to the respective PWM generator, in order to precisely control conductivity through the parallel path at a reference level.



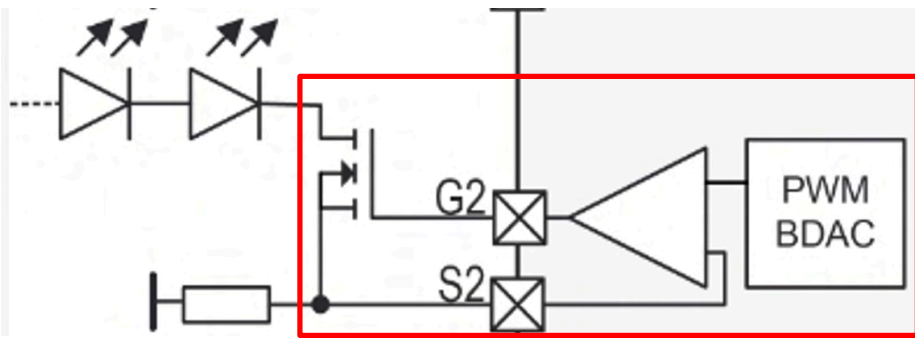
[AS3824 Datasheet]

5. The driver of claim 4 wherein each current set circuit further comprises a PWM brightness control transistor connected between an output of the feedback circuit and a control terminal of the current

See claims 1 and 4 above.

Each of the Accused Televisions in the VIZIO V-Series, M-Series, E-Series, and P-Series feature a driver with a current set circuit comprising a PWM brightness control transistor connected between an output of the feedback circuit and a control terminal of the current control transistor, the PWM brightness control transistor being connected to the PWM brightness control signal generator for receiving a staggered PWM brightness control signal to couple the

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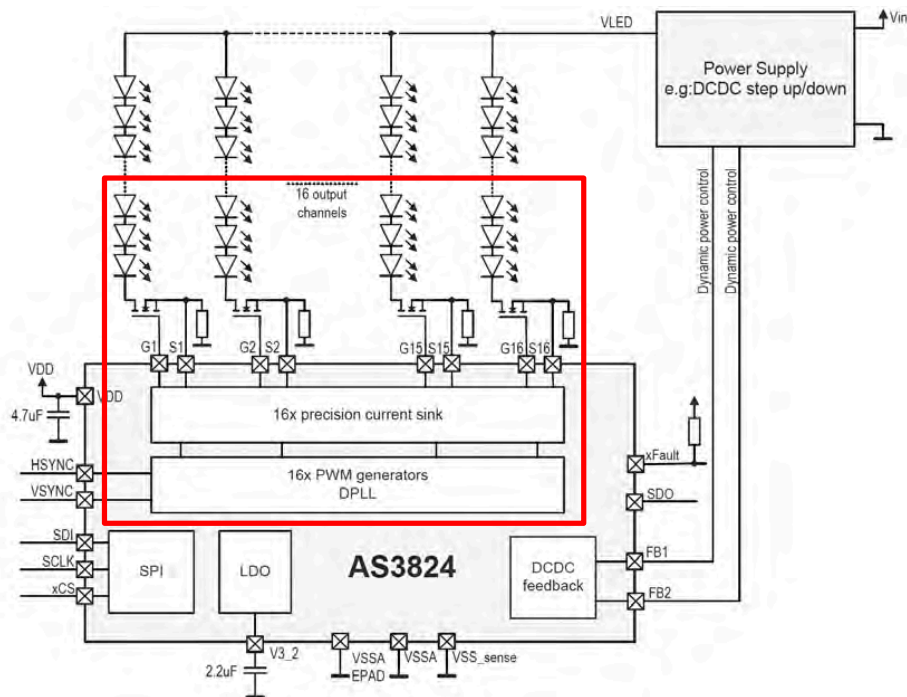
control transistor, the PWM brightness control transistor being connected to the PWM brightness control signal generator for receiving a staggered PWM brightness control signal to couple the output of the feedback circuit to the control terminal of the current control transistor at a duty cycle of the staggered PWM brightness control signal.	output of the feedback circuit to the control terminal of the current control transistor at a duty cycle of the staggered PWM brightness control signal. As a representative example, the VIZIO M50QY-J01, VIZIO P75Q9-J01, and the VIZIO E65-F0 feature an AS3824 LED driver that includes current set circuits with a PWM brightness control transistor, such as a MOSFET or a BJT, connected between an output of the feedback circuit (a precision current sink) and a control terminal of the current control transistor (the PWM signal generator). As shown below, the MOSFET or BJT is connected with the GATE pin to the output of the PWM signal generator, while the SOURCE pin is connected to the output of the feedback circuit.  [AS3824 Datasheet]
6. The driver of claim 1 wherein each current set circuit comprises: a current set resistor in series with one or more LEDs in an associated parallel path; and a PWM brightness control transistor connected in series between the current set resistor and the one or	See claim 1 above. Each of the Accused Televisions in the VIZIO V-Series, M-Series, E-Series, and P-Series feature a driver with a current set resistor in series with one or more LEDs in an associated parallel path, and a PWM brightness control transistor connected in series between the current set resistor and the one or more LEDs in an associated parallel path, with the PWM brightness control transistor connected to the PWM brightness control signal generator in order to receive a staggered PWM brightness signal. As a representative example, the VIZIO M50QY-J01, VIZIO P75Q9-J01, and the VIZIO E65-F0 feature an AS3824 LED driver that

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more LEDs in an associated parallel path, the PWM brightness control transistor being connected to the PWM brightness control signal generator for receiving a staggered PWM brightness control signal.

includes current set circuits with a current control transistor and a feedback circuit to control the conductivity of the transistors precisely.

As shown in the AS3824 datasheet, the driver includes 16 PWM generators connected to semiconductor switches comprising PWM brightness control transistors. These switches are connected between the LEDs and the precision current sinks comprising the current set resistors.



[AS3824 Datasheet]

11. The driver of claim 1 wherein the plurality of parallel paths comprises at least three paths.

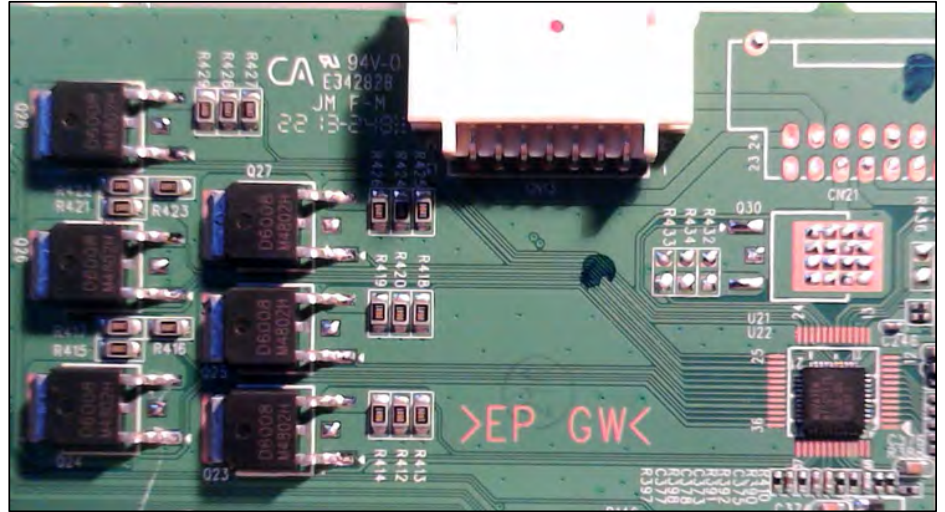
See claim 1 above.

Each of the Accused Televisions in the VIZIO V-Series, M-Series, E-Series, and P-Series feature an LED driver wherein the plurality of parallel paths comprises at least three paths.

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VIZIO V-Series

As a representative example, the VIZIO V655M-K03 features six separately-controllable parallel LED paths, each with its own power MOSFET switch.

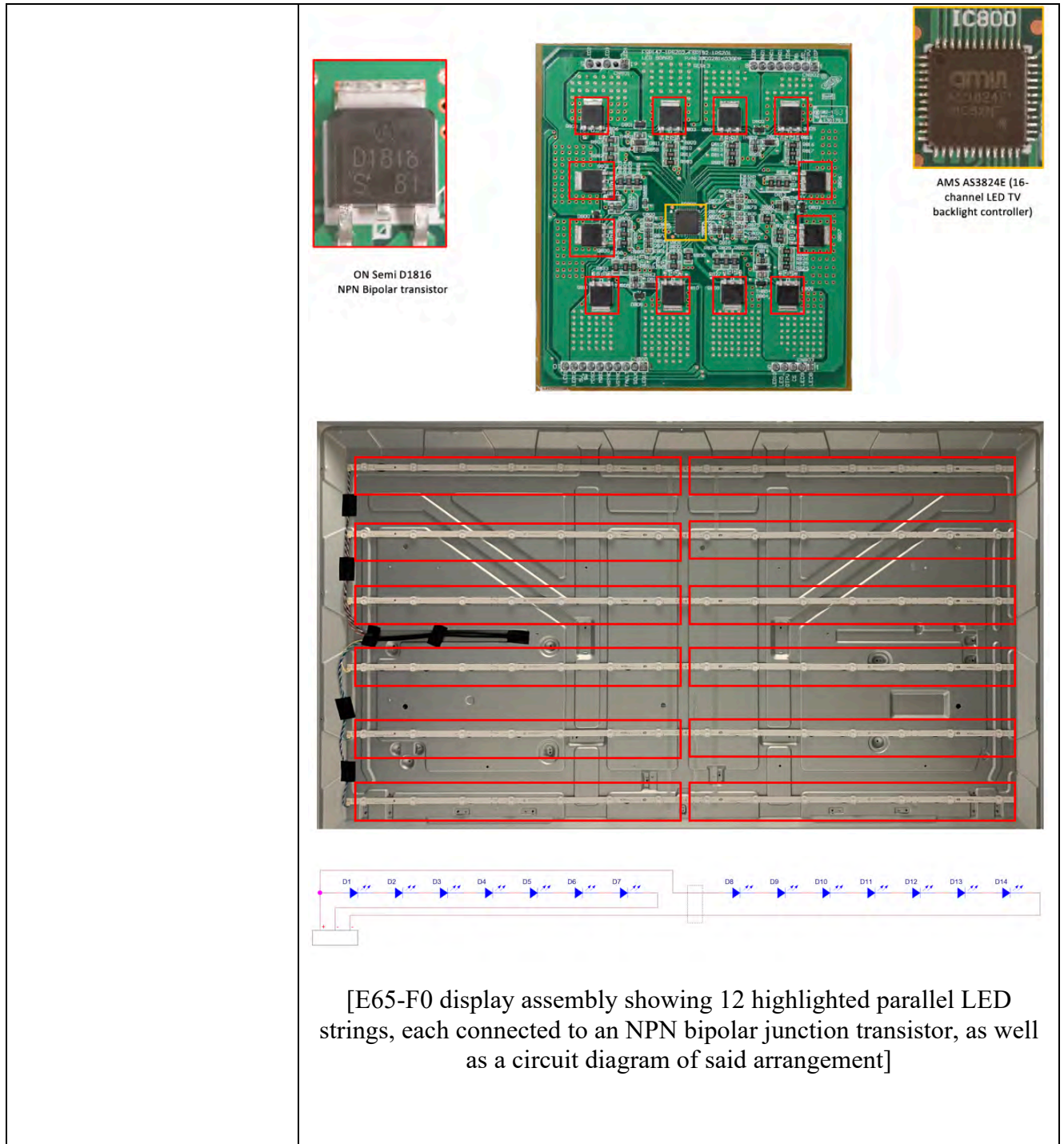


[V655M-K03 LED control board showing 6 independent parallel LED paths controlled by power MOSFETs]

VIZIO E-Series

As a representative example, the VIZIO E65-F0 features twelve separately-controllable parallel LED paths, each with its own NPN bipolar junction transistor.

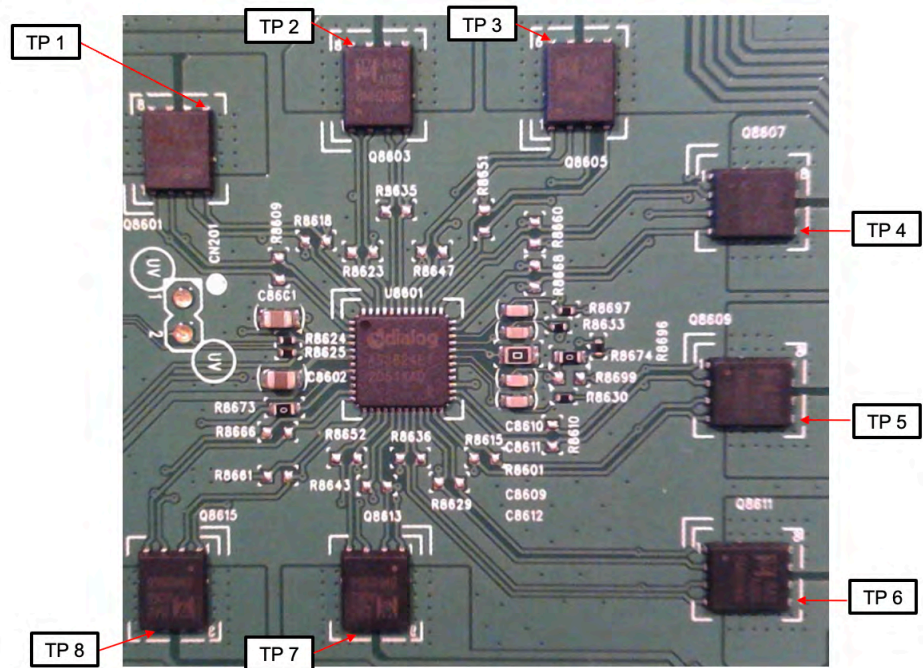
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U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES

VIZIO M-Series

As a representative example, the VIZIO M50Q7-J01 features eight separately-controllable parallel LED paths, each with its own power MOSFET switch.

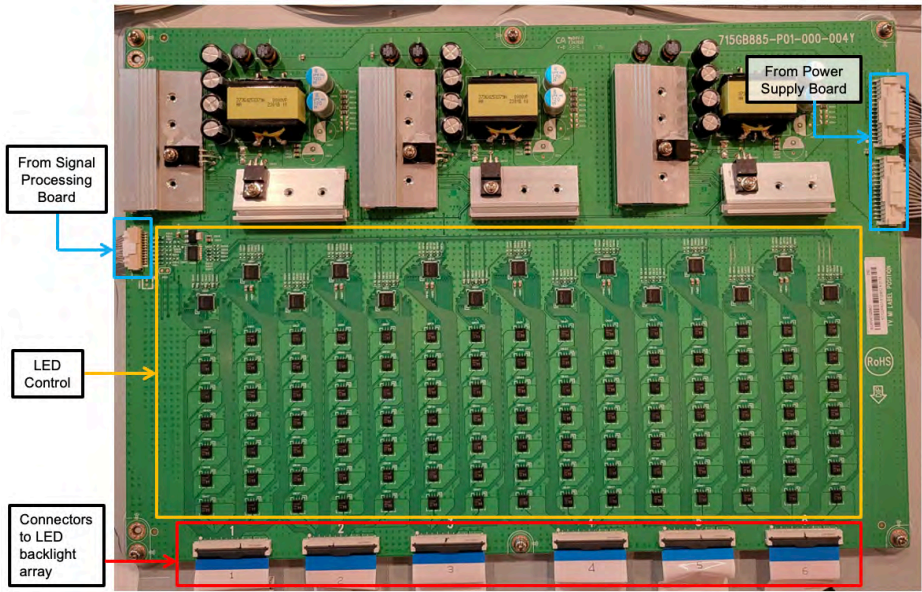


[M50Q7-J01 LED control board showing 8 independent parallel LED paths controlled by power MOSFETs]

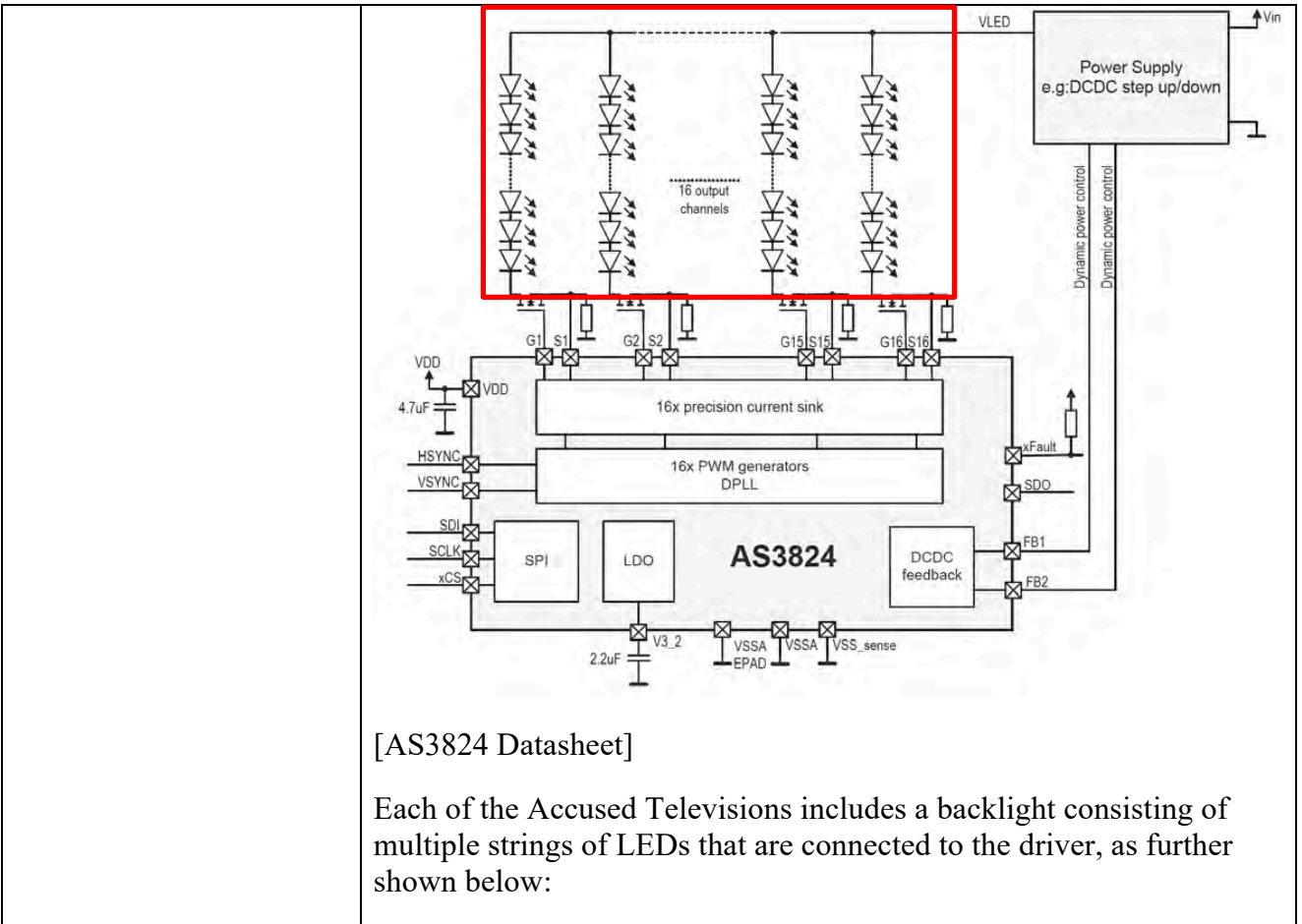
VIZIO P-Series

As a representative example, the VIZIO P75Q9-J01 features 105 dual MOSFETs (i.e., having two gate/drain pins per MOSFET) for a total of 210 separately-controllable parallel LED paths.

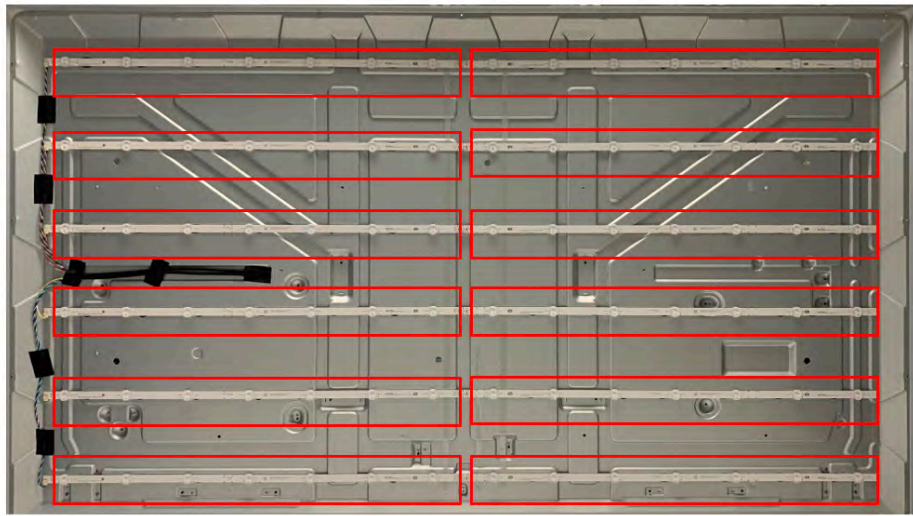
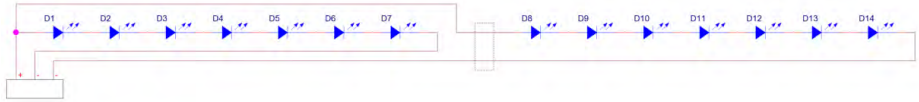
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	 [P75Q9-J01 LED control board showing 105 dual power MOSFETs for a total of 210 parallel LED paths]
12. The driver of claim 1 further comprising the LEDs connected to the driver.	<i>See claim 1 above.</i> Each of the Accused Televisions in the VIZIO V-Series, M-Series, E-Series, and P-Series feature a driver further comprising the LEDs connected to the driver. As a representative example, the VIZIO M50QY-J01, VIZIO P75Q9-J01, and the VIZIO E65-F0 feature an AS3824 LED driver that is directly connected to parallel strings of LEDs.

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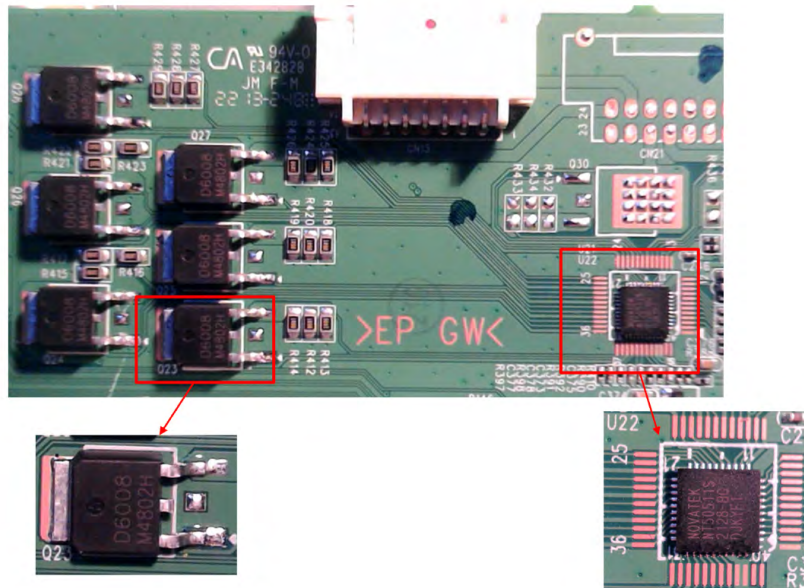


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	  [E65-F0 display assembly showing 12 highlighted parallel LED strings, each connected to an NPN bipolar junction transistor, as well as a circuit diagram of said arrangement]
13. The driver of claim 1 wherein the driver is formed as an integrated circuit.	<i>See claim 1 above.</i> Each of the Accused Televisions in the VIZIO V-Series, M-Series, E-Series, and P-Series feature an LED driver wherein the driver is formed as an integrated circuit. VIZIO V-Series As a representative example, the VIZIO V655M-K03 features a driver comprised of a Novatek NT50511S LED driver IC, as shown below.

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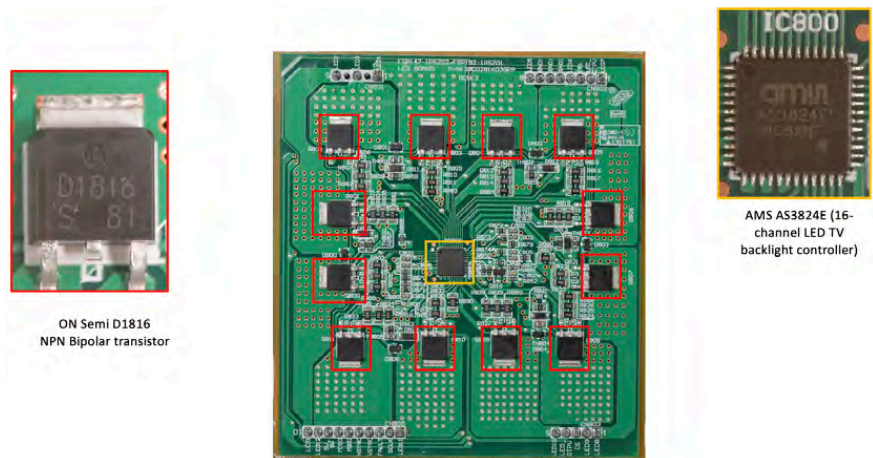
Teardown – LED Control Circuit



[Novatek NT50511S Driver and 6 power MOSFET switches]

VIZIO E-Series

As a representative example, the VIZIO E65-F0 features a driver comprised of an AS3824 LED driver IC, as shown below.

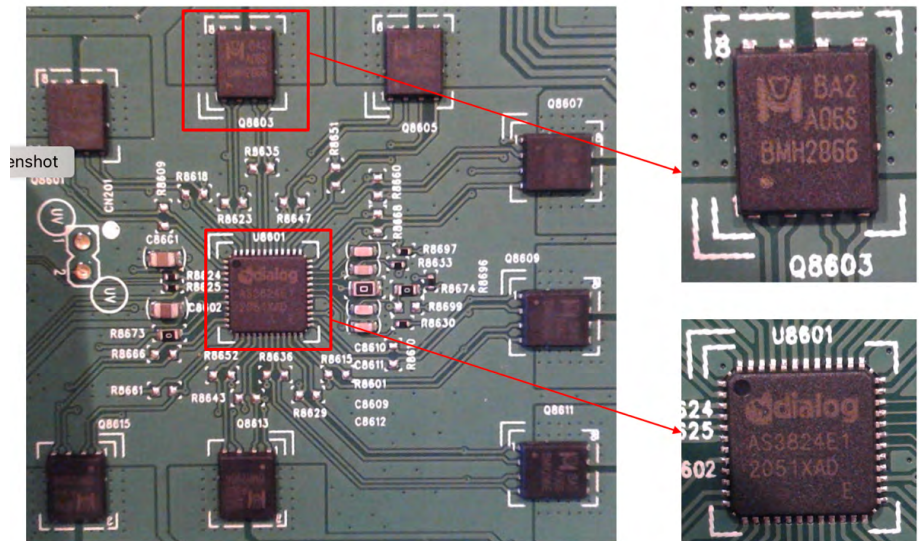


[AMS AS3824 Driver on LED control board]

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VIZIO M-Series

As a representative example, the VIZIO M50Q7-J01 features a driver comprised of an AS3824 LED driver IC, as shown below.



[Dialog AS3824 Driver on LED control board]

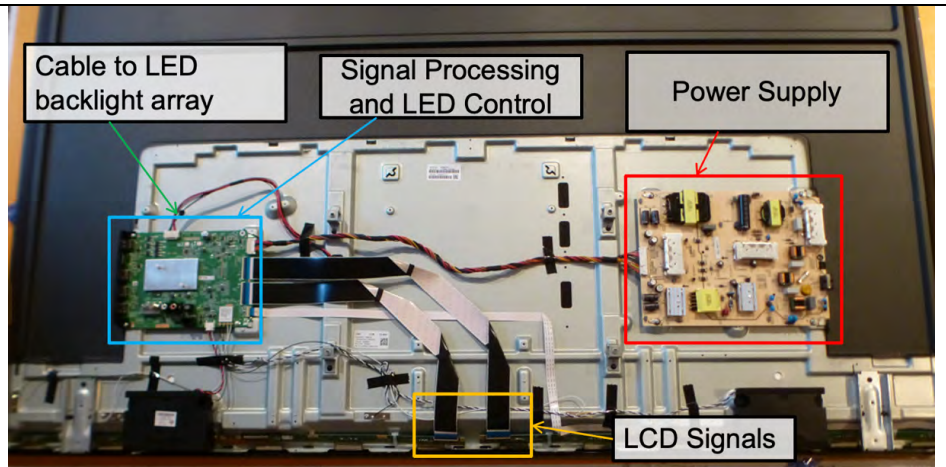
VIZIO P-Series

As a representative example, the VIZIO P75Q9-J01 features a driver comprised of an AS3824 LED driver IC, as shown below.

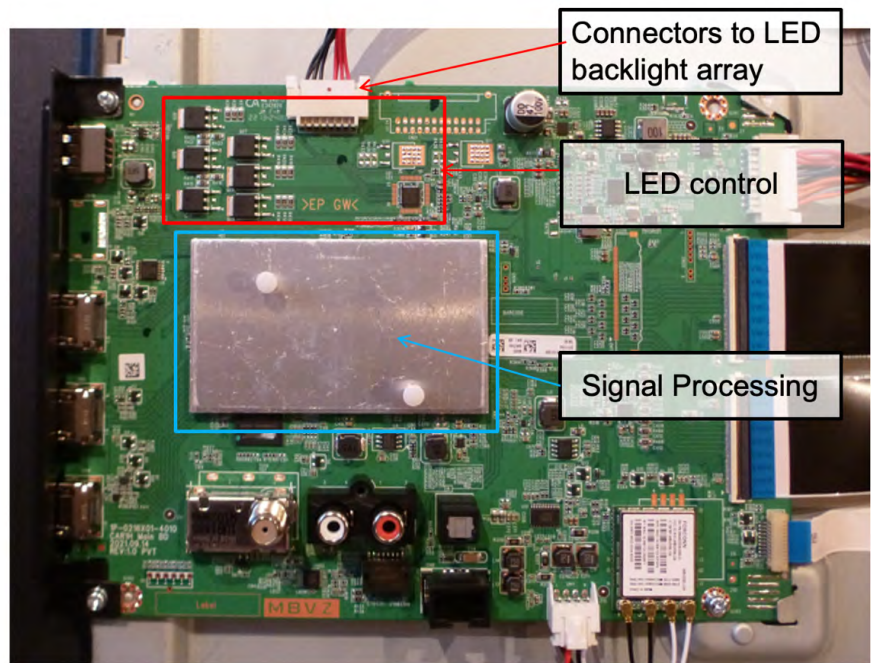
U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES

	 AS3824 16-Channel White LED Controller for LCD Backlight 1 Description The AS3824 is a 16 channel high precision LED controller for use in LCD-backlight panels. Dynamic power feedback controls the external power supply to guarantee best efficiency. One high accurate global 10 bit DAC can be used to set the LED current as well as each channel has its own additional 8 bit DAC to boost the dynamic range of LED Backlight systems. Each channel is equipped with an independent PWM generator which can also be synchronized to an external synchronization signal (VSYNC). A fast mode supports minimum PWM duty cycle operation which helps to further reduce the energy consumption of modern LED Backlight systems. The PWM generator clock can be generated internally (DPLL) or an external clock source can be connected to the HSYNC input. Built-in safety features include thermal shutdown as well as open and short LED detection. The device is programmable via serial interface (SPI). Source: https://www.mouser.com/datasheet/2/713/as3824_product_summary-1816002.pdf [Dialog AS3824 Driver on LED control board]
14. A method for driving light emitting diodes (LEDs) connected to different paths, the method comprising:	<i>See claim 1 above.</i> VIZIO V-Series The preamble does not appear to be a limitation. To the extent the preamble is construed as a limitation, the VIZIO V-Series perform a method for driving light emitting diodes connected to different paths. As a representative example, the VIZIO V655M televisions include an LED control circuit (LED driver) as part of a signal processing and LED control circuit board, which includes components such as multi-channel LED driver chips and transistors) for individually controlling strings of LEDs in the TV backlight.

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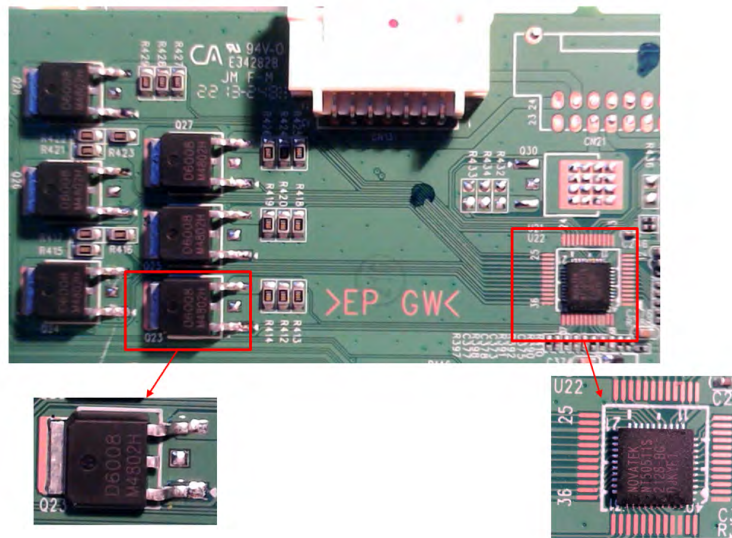
[VIZIO V655M with disassembled rear panel]



[Circuit board including LED control circuit for VIZIO V655M]

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Teardown – LED Control Circuit



[Circuit board including LED control circuit for VIZIO V655M]

The LED control board is coupled to several sections of LEDs that provide Full Array Backlight features.

“The new **V-Series** promises more for everyone, with screens ranging from 43- to 75-inch-class at VIZIO’s most aggressive 4K price points. However, its universal appeal lies in its uncompromising performance and design. **The Full Array backlight renders stunning contrast, paired with broad HDR support that includes Dolby Vision, HDR10+, HDR10 and HLG.** The V-Gaming Engine delivers 4K@60Hz VRR and AMD FreeSync (V6 models), with the foolproof Auto Game Mode and three HDMI 2.1 ports to connect next-gen consoles and more.”

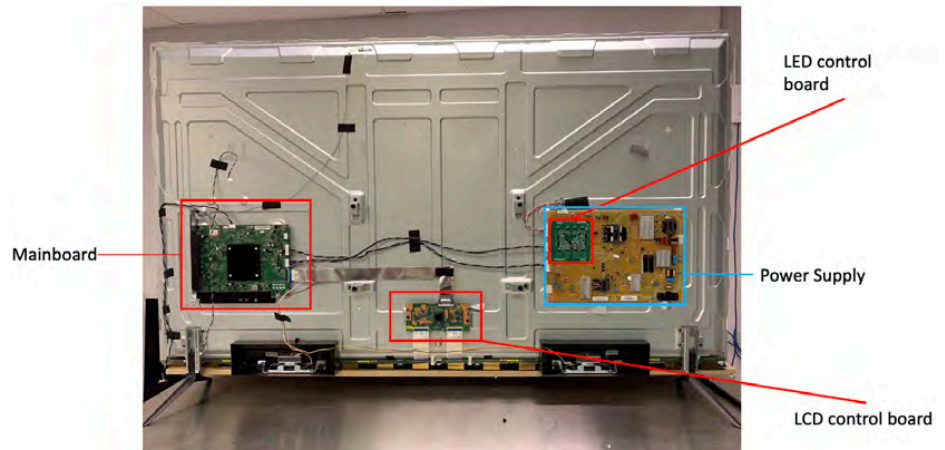
<https://www.VIZIO.com/en/press/2021/jun/VIZIO-s-new-tv-lineup-unleashes-enhanced-picture-quality--improv>

VIZIO E-Series

The preamble does not appear to be a limitation. To the extent the preamble is construed as a limitation, the VIZIO E-Series perform a method for driving light emitting diodes connected to different paths.

U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES

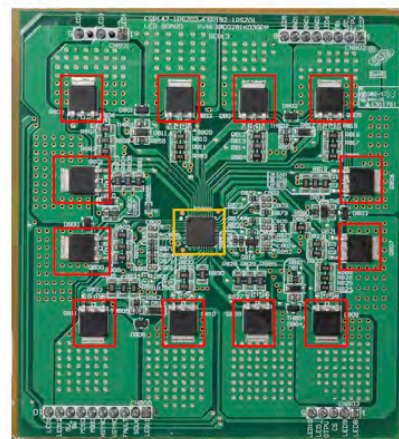
As a representative example, the VIZIO E65-F0 televisions include an LED control circuit (LED driver) as part of a signal processing and LED control circuit board, which includes components such as multi-channel LED driver chips and transistors) for individually controlling strings of LEDs in the TV backlight.



[VIZIO E65-F0 with disassembled rear panel]



ON Semi D1816
NPN Bipolar transistor



AMS AS3824E (16-
channel LED TV
backlight controller)

[Circuit board including LED control circuit for VIZIO E65-F0]

The LED control board is coupled to several sections of LEDs that provide Full Array Backlight features.

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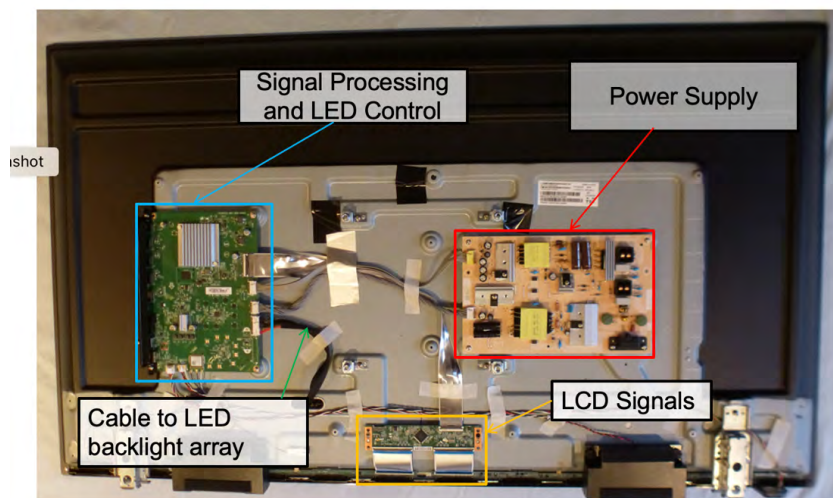
The flat panel E-Series is a new collection of LED HDTVs ranging from 23 to 70 inches. **A few of the highlights include advanced local dimming technology and full-array LED backlighting on most of the new models, with up to 18 Active LED Zones.** That basically translates into better light uniformity across the screen, better black levels, and a more vibrant image overall.

<https://www.vizio.com/en/news/2014/feb/vizio-e-series-led-smart-tvs-include-local-dimming-and-app-connection>

VIZIO M-Series

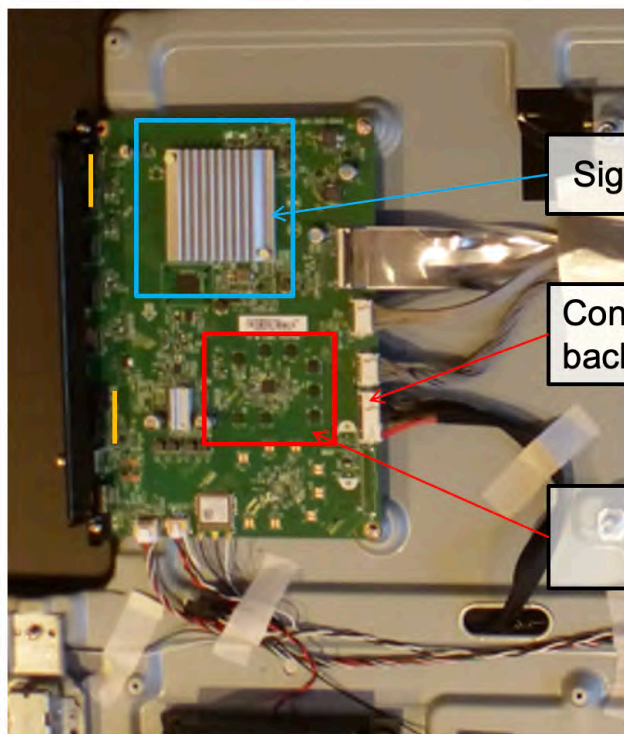
The preamble does not appear to be a limitation. To the extent the preamble is construed as a limitation, the VIZIO M-Series perform a method for driving light emitting diodes connected to different paths.

As a representative example, the VIZIO M50QY-J01 televisions include an LED control circuit (LED driver) as part of a signal processing and LED control circuit board, which includes components such as multi-channel LED driver chips and transistors) for individually controlling strings of LEDs in the TV backlight.



[VIZIO M50MQ7 with disassembled rear panel]

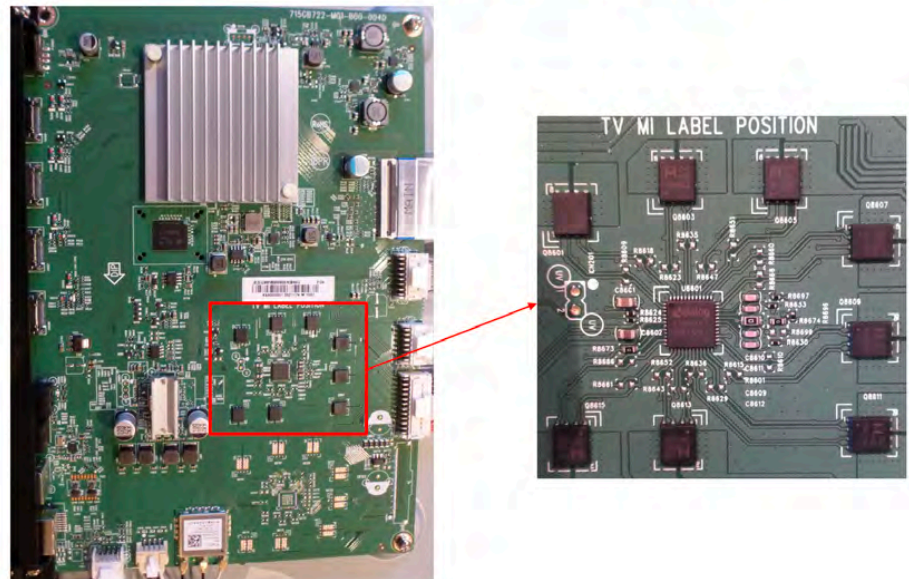
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[Circuit board including LED control circuit for VIZIO M50QY-J01]

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Teardown – LED Control Circuit



[Circuit board including LED control circuit for VIZIO M50QY-J01]

The LED control board is coupled to several sections of LEDs that provide zone dimming functionality.

“Unlock over a billion colors’ worth of 4K clarity with the new **M-Series**. Quantum Color delivers more color than ever and UltraBright 700 (MQ7) can achieve up to 700 nits of peak brightness for dazzling highlights. *The Active Full Array backlight (MQ7) features up to 32 local dimming zones for outstanding contrast and dynamic range.*”

<https://www.VIZIO.com/en/press/2021/jun/VIZIO-s-new-tv-lineup-unleashes-enhanced-picture-quality--improv>

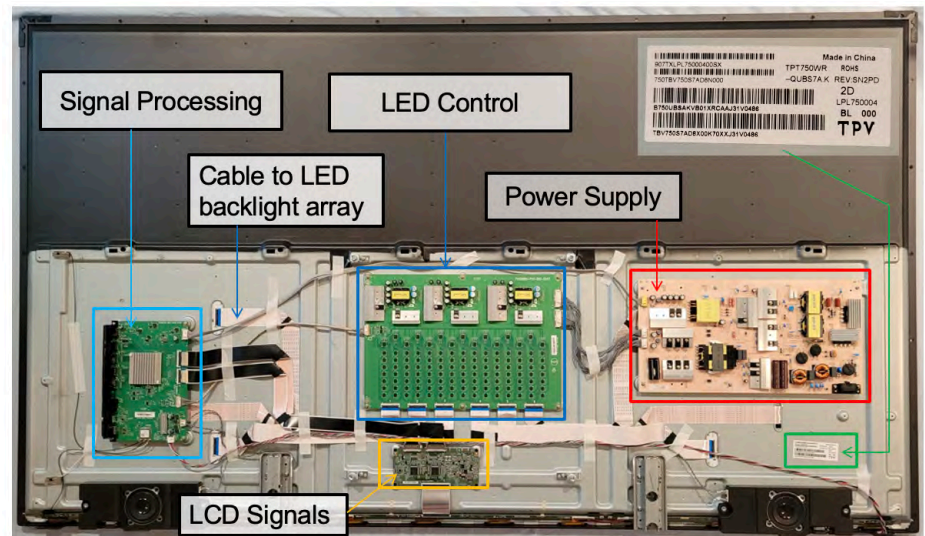
VIZIO P-Series

The preamble does not appear to be a limitation. To the extent the preamble is construed as a limitation, the VIZIO P-Series perform a method for driving light emitting diodes connected to different paths.

As a representative example, the VIZIO P75Q9-J01 televisions include an LED control circuit (LED driver) as part of a signal processing and

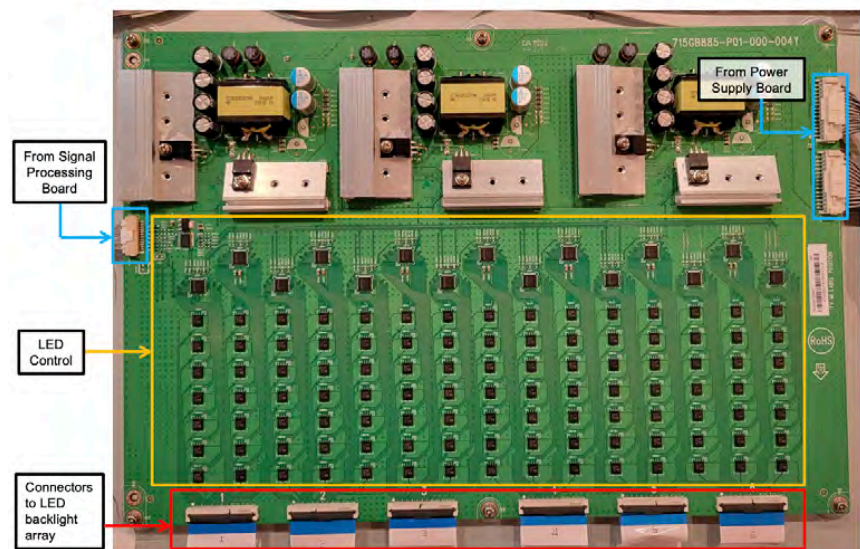
U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES

LED control circuit board, which includes components such as multi-channel LED driver chips and transistors) for individually controlling strings of LEDs in the TV backlight.



[VIZIO P75Q9-J01 with disassembled rear panel]

Teardown – LED Control Circuit



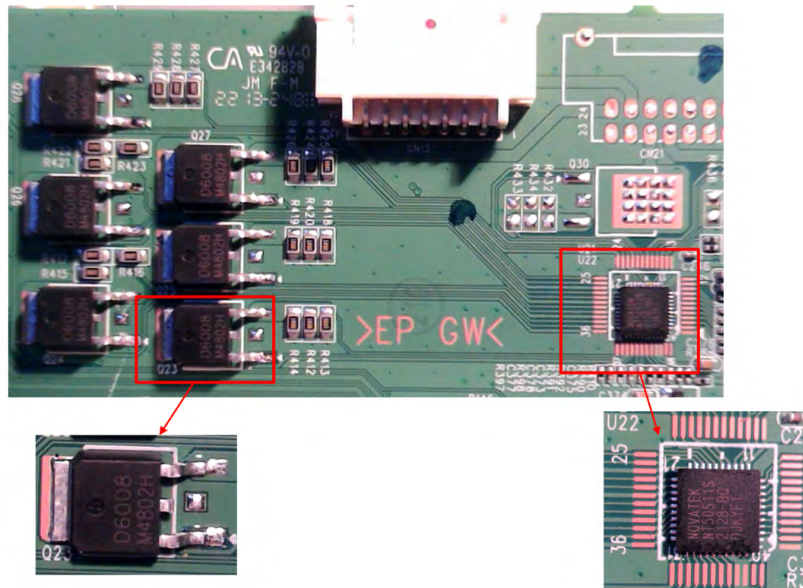
[Circuit board including LED control circuit for VIZIO P75Q9-J01]

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	The LED control board is coupled to several sections of LEDs that provide zone dimming functionality. "VIZIO's finest LED television--the P-Series--delivers best-in-class Quantum Color performance, enabling superior color volume and a wide color gamut. VIZIO's high-performance Active Full Array backlight achieves deeper, absolute black from up to 210 local dimming zones, for greater dynamic range, perfect for HDR content (Dolby Vision, HDR10+). Peak and full-screen brightness is also improved via enhanced picture processing, with up to 1200 nits for exceptional detail in highlights. The VIZIO ProGaming Engine supports Variable Refresh Rate (VRR) and AMD FreeSync Premium for the smoothest, most lifelike play from the most demanding games, up to 4K@120fps. https://www.VIZIO.com/en/press/2021/jun/VIZIO-s-new-tv-lineup-unleashes-enhanced-picture-quality--improv
Supplying a voltage to first ends of LEDs in a plurality of parallel paths;	See claim 1 above. VIZIO V-Series The VIZIO V-Series provide a voltage (VLED) to first ends of the LEDs in a plurality of parallel paths. As a representative example, the VIZIO V655M televisions include a power supply configured to provide a voltage to parallel LED strings. In addition, the televisions include precision current sinks in the LED driver chips. As a representative example, the LED control board in the V655M, for example, includes a Novatek NT50511S driver chip that is connected to the parallel LED strings, six power MOSFET switches, and a voltage source.

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Teardown – LED Control Circuit



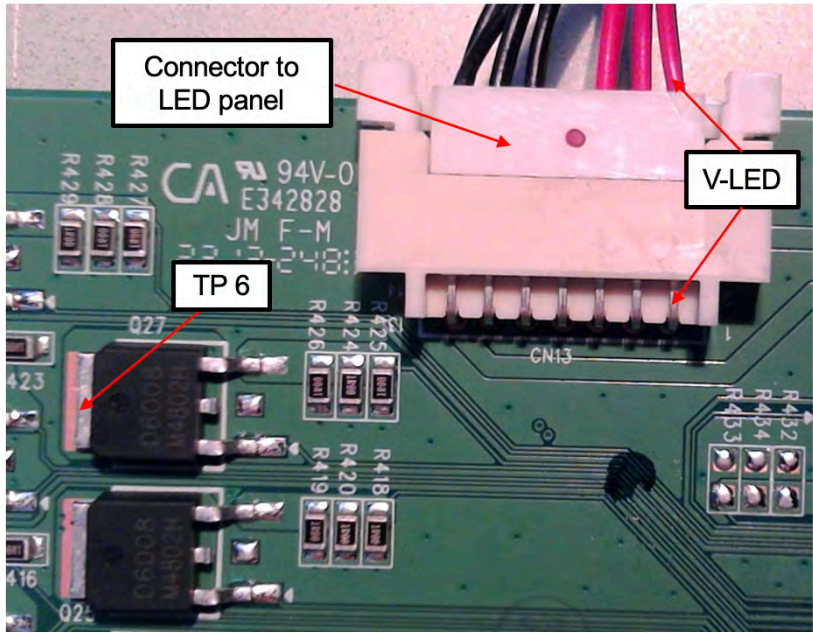
[Novatek NT50511S Driver and 6 power MOSFET switches]

Parallel strings

Through the LED power connection port, power is supplied from the power supply board to the LED control board that contains the LED driver, switches, and first ends of the LED strings.

When the device is turned on, the power supply provides VLED, which generates a current that flows through each of the respective LED strings to the LED driver chip. The current through each of the strings can be individually controlled by the Novatek driver chip and related circuitry.

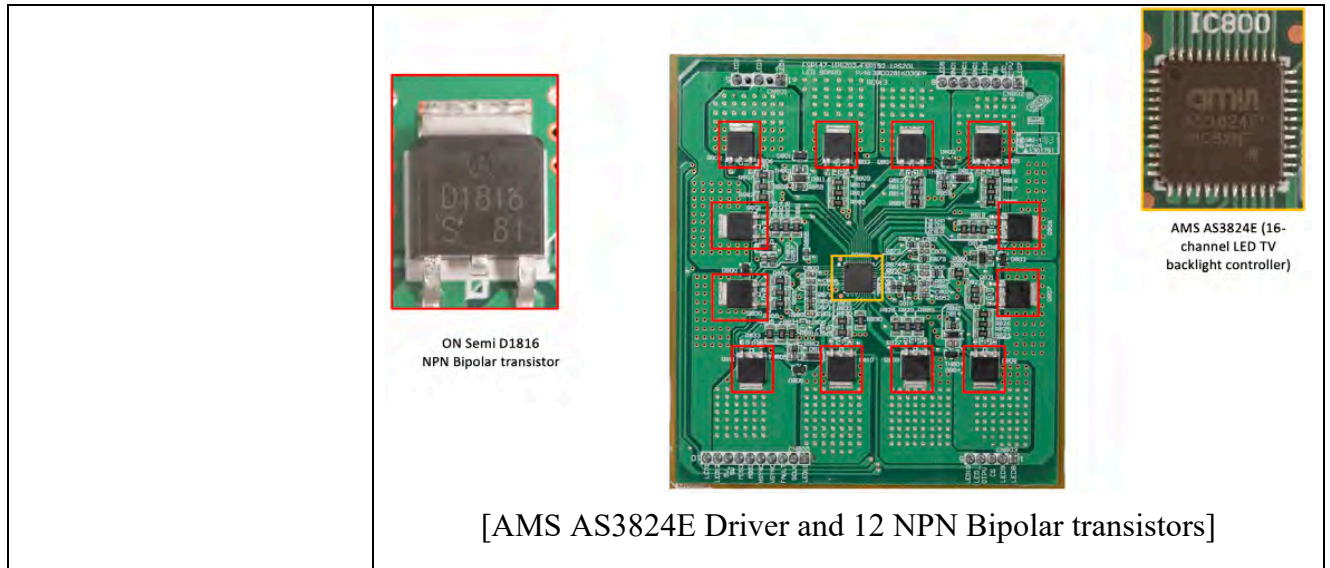
SERIES, V-SERIES, D-SERIES, AND P-SERIES



VIZIO E-Series

The VIZIO E-Series provide a voltage (VLED) to first ends of the LEDs in a plurality of parallel paths. As a representative example, the VIZIO E65-F0 televisions include a power supply configured to provide a voltage to parallel LED strings. In addition, the televisions include precision current sinks in the LED driver chips.

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U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES

Voltage Source

LED Control Circuit Datasheet

AS3824
16-Channel White LED Controller for LCD Backlight

dialog
SEMICONDUCTOR

Screenshot

Parallel strings

Figure 3.1 : AS3824 Typical Application

Source: https://www.mouser.com/datasheet/2/713/as3824_product_summary-1816002.pdf

Through the LED power connection port, power is supplied from the power supply board to the LED control board that contains the LED driver, switches, and first ends of the LED strings.

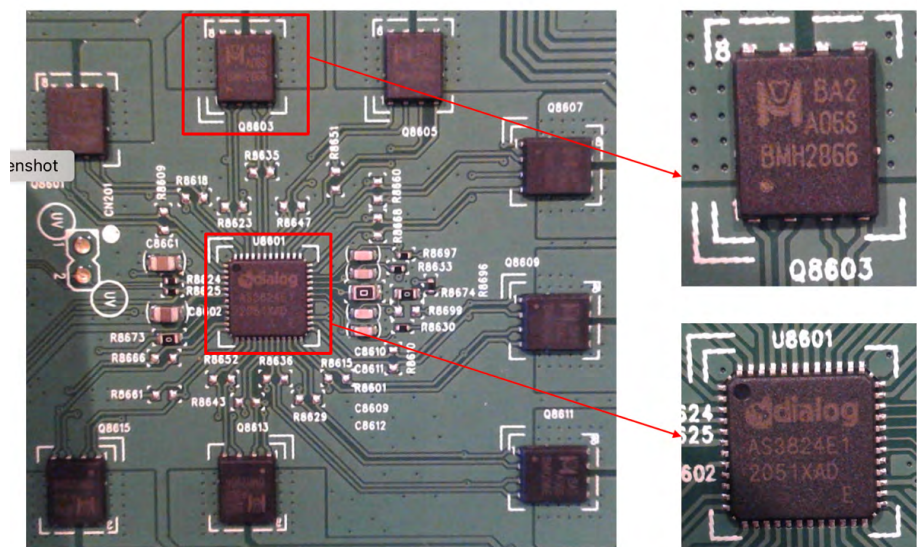
When the device is turned on, the power supply provides VLED, which generates a current that flows through each of the respective LED strings to the LED driver chip AS3824. The current through each of the strings can be individually controlled by the AS3824 chip and related circuitry.

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VIZIO M-Series

The VIZIO M-Series provide a voltage (VLED) to first ends of the LEDs in a plurality of parallel paths. As a representative example, the VIZIO M50QY-J01 televisions include a power supply configured to provide a voltage to parallel LED strings. In addition, the televisions include precision current sinks in the LED driver chips.

As a representative example, the LED control board in the M50QY-J01, for example, includes a Dialog AS3824 driver chip that is connected to the parallel LED strings, n-channel MOSFET switches, and a voltage source.

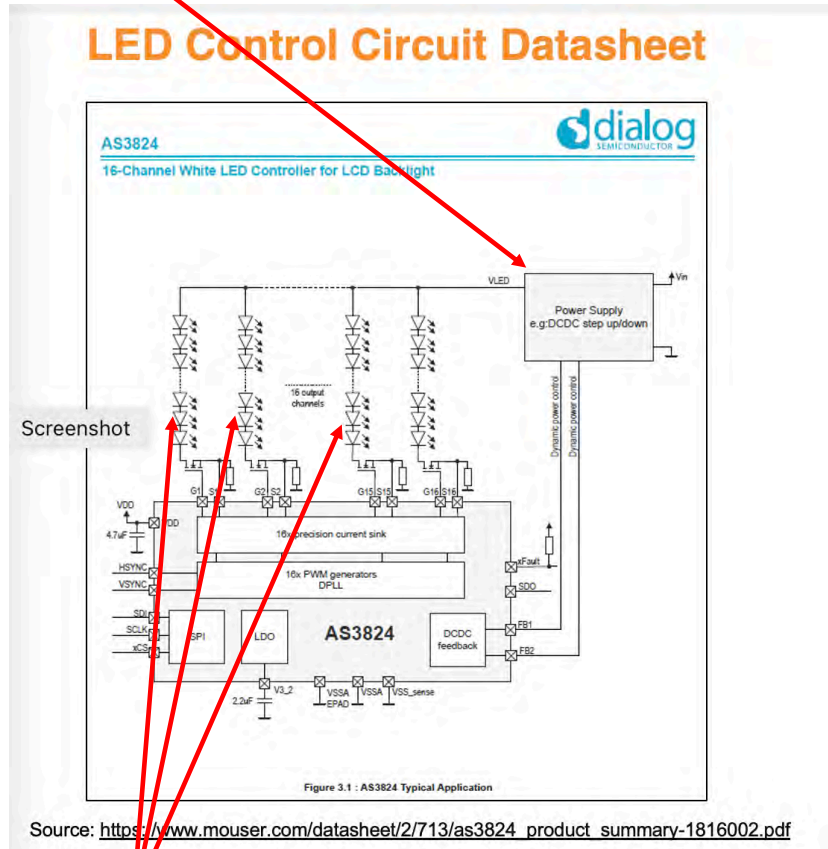


[Dialog AS3824 Driver and BA2 N-channel MOSFET switches]

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The general architecture is depicted in the AS3824 Data Sheet shown below:

Voltage Source



Parallel strings

Through the LED power connection port, power is supplied from the power supply board to the LED control board that contains the LED driver, switches, and first ends of the LED strings.

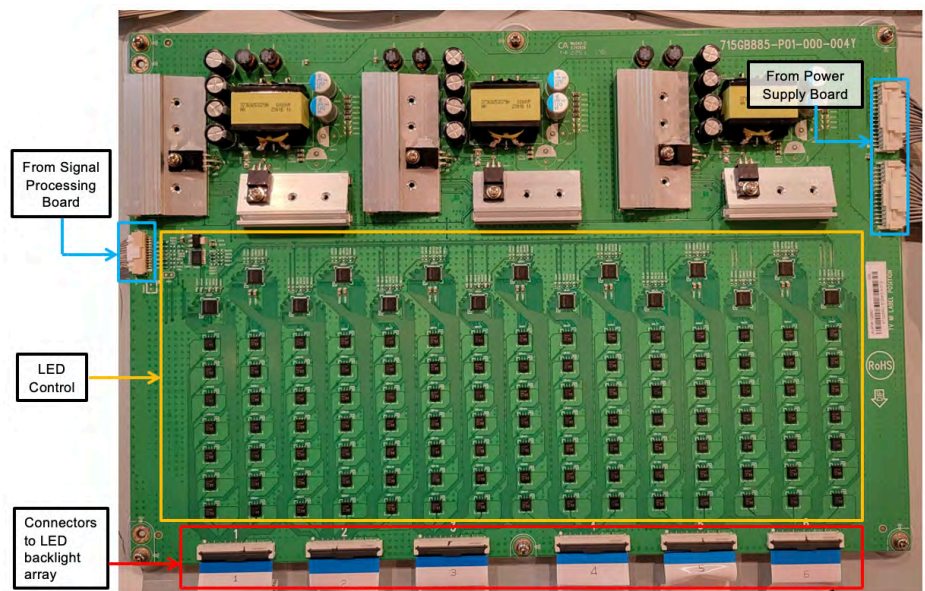
When the device is turned on, the power supply provides VLED, which generates a current that flows through each of the respective LED strings to the LED driver chip AS3824. The current through each of the strings can be individually controlled by the AS3824 chip and related circuitry.

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VIZIO P-Series

The VIZIO P-Series provide a voltage (VLED) to first ends of the LEDs in a plurality of parallel paths. As a representative example, the VIZIO P75Q9-J01 televisions include a power supply configured to provide a regulated current to parallel LED strings. In addition, the televisions include precision current sinks in the LED driver chips.

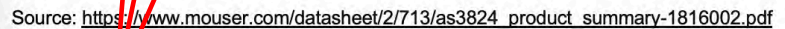
As a representative example, the LED control board in the P75Q9-J01, for example, includes Dialog AS3824 driver chips that are connected to the parallel LED strings, n-channel MOSFET switches, and a voltage source.



[Circuit board including 15 AS3824 LED drivers and 105 N-channel MOSFETs for VIZIO P75Q9-J01]

SERIES, V-SERIES, D-SERIES, AND P-SERIES

Voltage Source



Through the LED power connection port, power is supplied from the power supply board to the LED control board that contains the LED driver, switches, and first ends of the LED strings.

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Setting a peak current through one or more LEDs connected in each of the parallel paths, the peak current being set by a current set circuit for each parallel path;

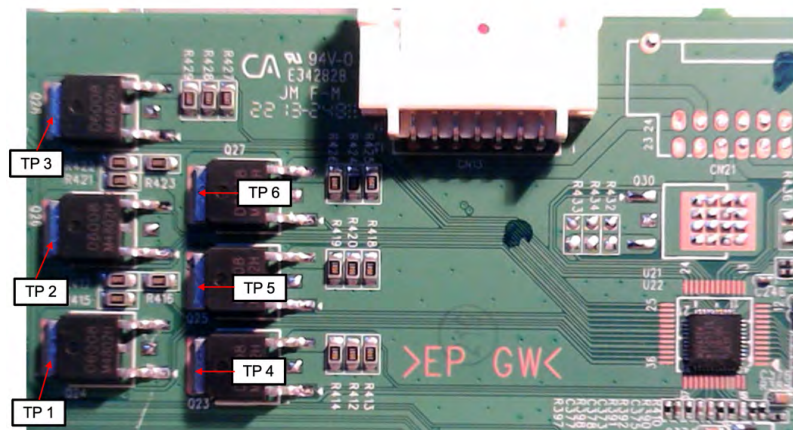
See claim 1 above.

VIZIO V-Series

The VIZIO Accused Televisions include a plurality of current set circuits, one current set circuit per parallel path, each current set circuit setting a peak current through one or more LEDs connected in each parallel path.

As a representative example, the VIZIO V655M includes a current set circuit in each parallel path that controls the peak current. The LED control circuit in the V655M includes a Novatek LED driver chip. The Novatek LED driver includes current set circuitry for each parallel path of LEDs, which are connected to power MOSFETs (labeled with internal testing points TP1 – TP6).

Test Data – Internal Probing of Test Points



[Novatek LED driver connected to power MOSFETs to provided current setting through each path of LED strings]

VIZIO E-Series

The VIZIO Accused Televisions include a plurality of current set circuits, one current set circuit per parallel path, each current set circuit setting a peak current through one or more LEDs connected in each parallel path.

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As a representative example, the VIZIO E65-F0 includes a current set circuit in each parallel path that controls the peak current. The LED control circuit in the E65-F0 includes a Dialog AS3824 LED driver chip. The AS3824 LED driver includes current set circuitry for each parallel path of LEDs.



AMS AS3824E (16-channel LED TV backlight controller)

AS3824
16-Channel White LED Controller for LCD Backlight



1 Description
The AS3824 is a 16 channel high precision LED controller for use in LCD-backlight panels. Dynamic power feedback controls the external power supply to guarantee best efficiency. One high accurate global 10 bit DAC can be used to set the LED current as well as each channel has its own additional 8 bit DAC to boost the dynamic range of LED Backlight systems.
Each channel is equipped with an independent PWM generator which can also be synchronized to an external synchronization signal (VSYNC).
A fast mode supports minimum PWM duty cycle operation which helps to further reduce the energy consumption of modern LED Backlight systems.
The PWM generator clock can be generated internally (DPLL) or an external clock source can be connected to the HSYNC input.
Built-in safety features include thermal shutdown as well as open and short LED detection. The device is programmable via serial interface (SPI).

Source: https://www.mouser.com/datasheet/2/713/as3824_product_summary-1816002.pdf

U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES

	Current set circuits [AS3824 Datasheet] VIZIO M-Series The VIZIO Accused Televisions include a plurality of current set circuits, one current set circuit per parallel path, each current set circuit setting a peak current through one or more LEDs connected in each parallel path. As a representative example, the VIZIO M50Q includes a current set circuit in each parallel path that controls the peak current. The LED control circuit in the M50Q includes a Dialog AS3824 LED driver
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U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES

chip. The AS3824 LED driver includes current set circuitry for each parallel path of LEDs.



AS3824



16-Channel White LED Controller for LCD Backlight

1 Description

The AS3824 is a 16 channel high precision LED controller for use in LCD-backlight panels. Dynamic power feedback controls the external power supply to guarantee best efficiency. One high accurate global 10 bit DAC can be used to set the LED current as well as each channel has its own additional 8 bit DAC to boost the dynamic range of LED Backlight systems.

Each channel is equipped with an independent PWM generator which can also be synchronized to an external synchronization signal (VSYNC).

A fast mode supports minimum PWM duty cycle operation which helps to further reduce the energy consumption of modern LED Backlight systems.

The PWM generator clock can be generated internally (DPLL) or an external clock source can be connected to the HSYNC input.

Built-in safety features include thermal shutdown as well as open and short LED detection. The device is programmable via serial interface (SPI).

Source: https://www.mouser.com/datasheet/2/713/as3824_product_summary-1816002.pdf

U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES

	Current set circuits [AS3824 Datasheet] VIZIO P-Series The VIZIO Accused Televisions include a plurality of current set circuits, one current set circuit per parallel path, each current set circuit setting a peak current through one or more LEDs connected in each parallel path. As a representative example, the VIZIO P75Q9-J01 includes a current set circuit in each parallel path that controls the peak current. The LED control circuit in the P75Q9 includes Dialog AS3824 LED driver
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U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES

chips. The AS3824 LED driver includes current set circuitry for each parallel path of LEDs.



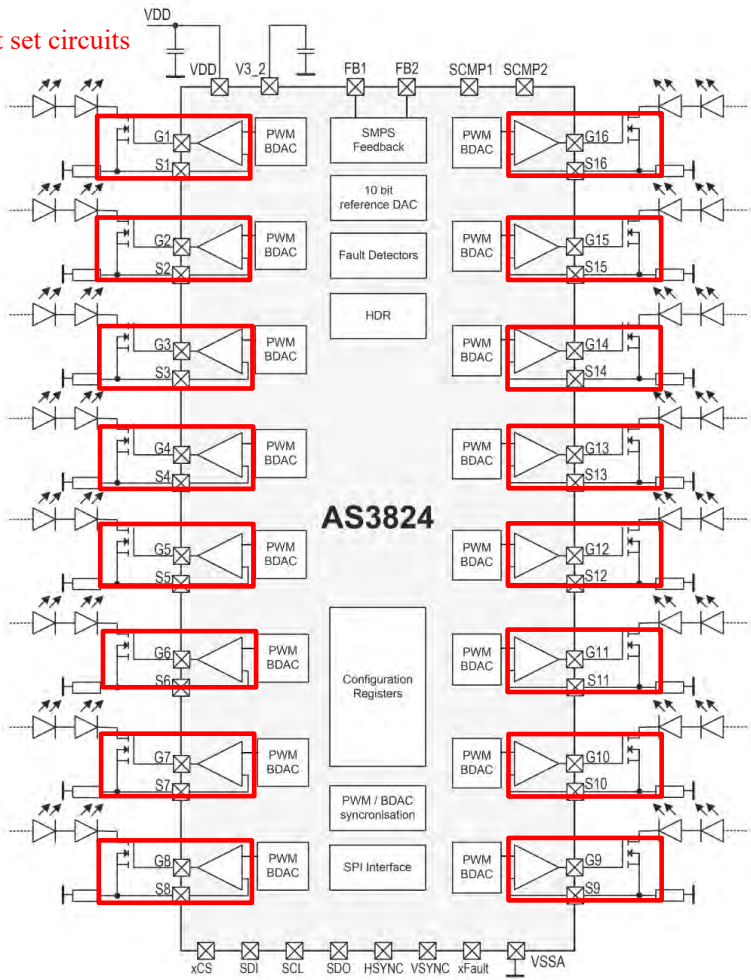


AS3824
16-Channel White LED Controller for LCD Backlight

1 Description
The AS3824 is a 16 channel high precision LED controller for use in LCD-backlight panels. Dynamic power feedback controls the external power supply to guarantee best efficiency. One high accurate global 10 bit DAC can be used to set the LED current as well as each channel has its own additional 8 bit DAC to boost the dynamic range of LED Backlight systems.
Each channel is equipped with an independent PWM generator which can also be synchronized to an external synchronization signal (VSYNC).
A fast mode supports minimum PWM duty cycle operation which helps to further reduce the energy consumption of modern LED Backlight systems.
The PWM generator clock can be generated internally (DPLL) or an external clock source can be connected to the HSYNC input.
Built-in safety features include thermal shutdown as well as open and short LED detection. The device is programmable via serial interface (SPI).

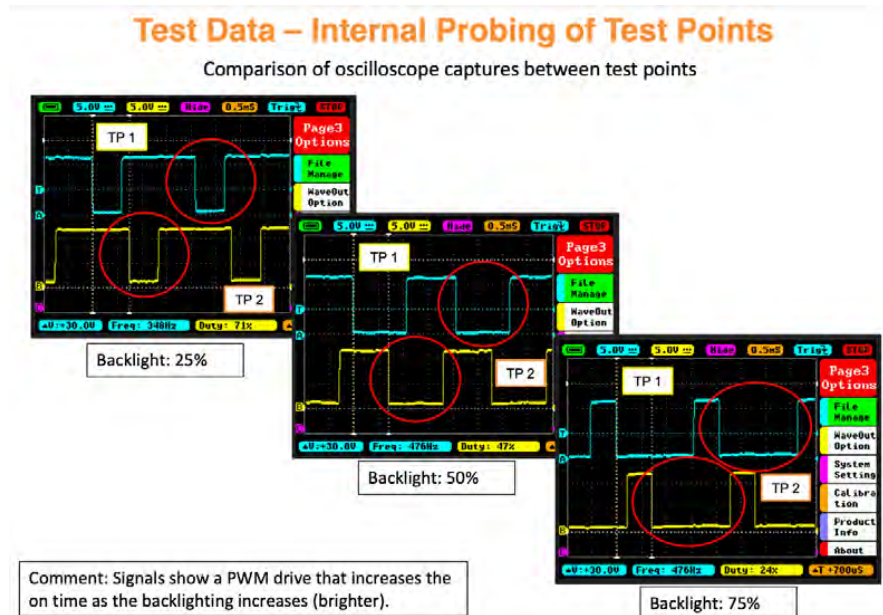
Source: https://www.mouser.com/datasheet/2/713/as3824_product_summary-1816002.pdf

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	Current set circuits  The diagram shows the AS3824 chip architecture. On the left, eight current set circuits are shown, each consisting of a PMOS transistor (G1-G8), an NMOS transistor (S1-S8), and a PWM BDAC block. These are connected to a common xCS line. On the right, another set of eight current set circuits (G9-G16, S9-S16, PWM BDAC) is shown, connected to a common VSSA line. The central core of the chip includes blocks for SMPS Feedback, 10 bit reference DAC, Fault Detectors, HDR, Configuration Registers, PWM / BDAC synchronisation, and SPI Interface. The top of the chip has VDD and V3.2 power pins, and the bottom has xCS, SDI, SCL, SDO, HSYNC, VSYNC, xFault, and VSSA pins. The chip is labeled AS3824 in the center. [AS3824 Datasheet]
Generating staggered pulse width modulated (PWM) brightness control signals;	See claim 1 above. VIZIO V-Series The VIZIO V-Series include a pulse-width modulated (PWM) brightness control signal generator that generates staggered PWM brightness control signals to the plurality of current set circuits.

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In the V655M, for example, the Novatek LED driver uses 6 PWM generators to drive each power MOSFET and control brightness of the LED strings.



[Test point probes TP1 and TP2 showing PWM signals at different levels of brightness]

VIZIO E-Series

The VIZIO E-Series include a pulse-width modulated (PWM) brightness control signal generator that generates staggered PWM brightness control signals to the plurality of current set circuits.

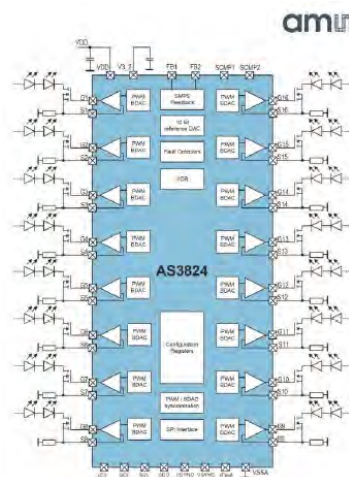
In the E65-F0, for example, the AS3824 datasheet indicates that 16 PWM generators are used to implement local dimming.

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Figure 1:
Added Value of Using AS3824

Benefits	Features
All LED backlight topologies	No limit of VLED or ILED, device is not exposed to high voltage/high current
Optimum power savings through local dimming	16 fully flexible 12 bit PWM generators (period, high time, delay, reverse)
Highest brightness uniformity	One global high accurate 10 bit DAC which sets the LED current ($\pm 0.5\%$ accuracy)

Benefits	Features
High dynamic range boost function	16 independent 8 bit DACs can be used to boost/decrease LED current within certain frames
Global dimming mode available	AS3824E is pre-programmed to external PWM mode. VSYNC pin is used as PWM input
Synchronization with TV frame	VSYNC and HSYNC inputs available as well as a digital PLL integrated
Lowest BOM	Due to 2 pin concept of the output channel: no HV protection, no cascade FETs
Digital enhanced DC-DC feedback	Feedback function is compatible to every DC-DC architecture and configurable via SPI
On chip safety features	Short/OPEN LED detection, temperature shutdown, register lock/unlock, SPI transfer checksum



Key Features

- No limit of VLED or ILED, controller not exposed to high voltage/current
- One global high accurate 10bit DAC which sets the LED current ($\pm 0.5\%$ accurate)
- 16 independent 8 bit DACs can be used to boost/decrease LED current within certain frames

- QFN48 7x7mm with 0.5mm pitch
- LQFP44 10x10mm 0.8mm pitch

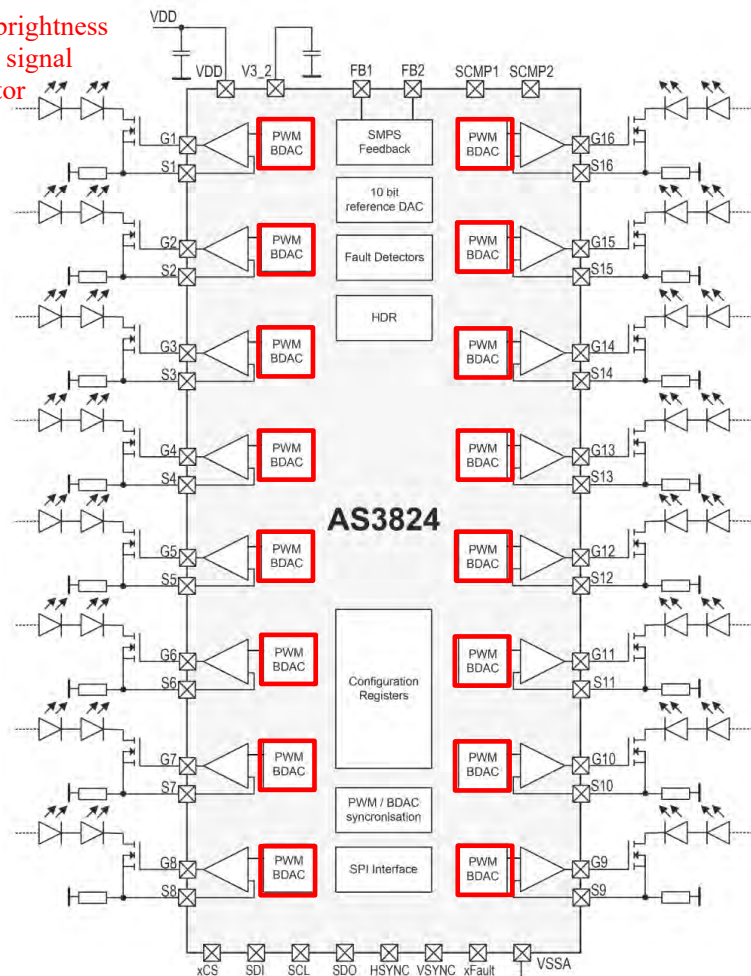
Key Benefits

- All LED backlight topologies
- Optimum power savings through local dimming
- Highest brightness uniformity
- High Dynamic range boost function
- Global Dimming Mode available
- Lowest BOM
- Two Package types available

[AS3824 Datasheet]

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PWM brightness
control signal
generator



[AS3824 Datasheet]

VIZIO M-Series

The VIZIO M-Series include a pulse-width modulated (PWM) brightness control signal generator that generates staggered PWM brightness control signals to the plurality of current set circuits.

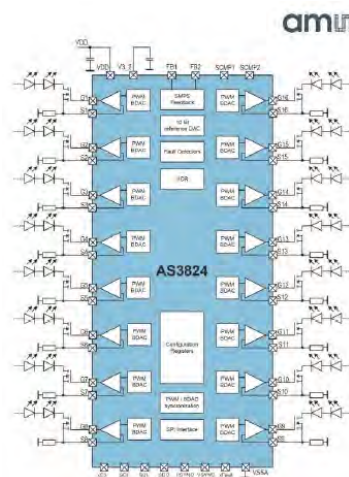
In the M50QY-J01, for example, the AS3824 datasheet indicates that 16 PWM generators are used to implement local dimming.

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Figure 1:
Added Value of Using AS3824

Benefits	Features
All LED backlight topologies	No limit of VLED or ILED, device is not exposed to high voltage/high current
Optimum power savings through local dimming	16 fully flexible 12 bit PWM generators (period, high time, delay, reverse)
Highest brightness uniformity	One global high accurate 10 bit DAC which sets the LED current ($\pm 0.5\%$ accuracy)

Benefits	Features
High dynamic range boost function	16 independent 8 bit DACs can be used to boost/decrease LED current within certain frames
Global dimming mode available	AS3824E is pre-programmed to external PWM mode. VSYNC pin is used as PWM input
Synchronization with TV frame	VSYNC and HSYNC inputs available as well as a digital PLL integrated
Lowest BOM	Due to 2 pin concept of the output channel: no HV protection, no cascade FETs
Digital enhanced DC-DC feedback	Feedback function is compatible to every DC-DC architecture and configurable via SPI
On chip safety features	Short/OPEN LED detection, temperature shutdown, register lock/unlock, SPI transfer checksum



Key Features

- No limit of VLED or ILED, controller not exposed to high voltage/current
- One global high accurate 10bit DAC which sets the LED current ($\pm 0.5\%$ accurate)
- 16 independent 8 bit DACs can be used to boost/decrease LED current within certain frames

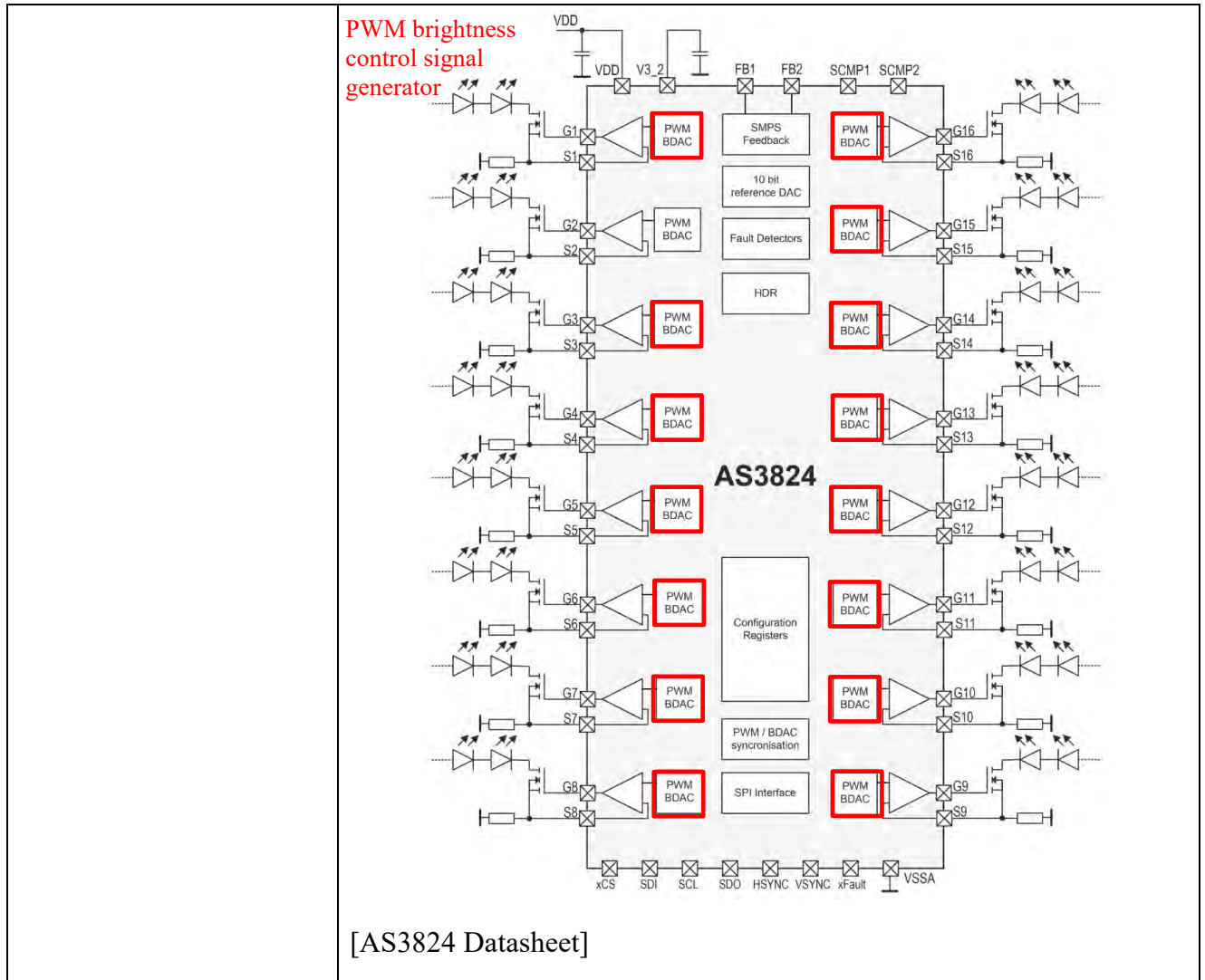
- QFN48 7x7mm with 0.5mm pitch
- LQFP44 10x10mm 0.8mm pitch

Key Benefits

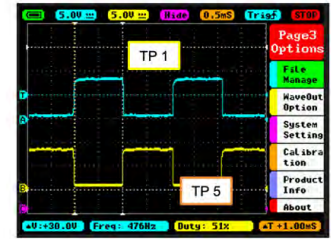
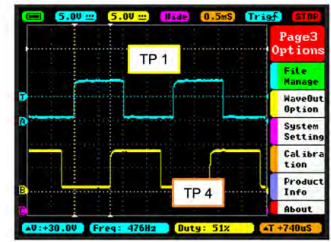
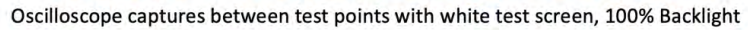
- All LED backlight topologies
- Optimum power savings through local dimming
- Highest brightness uniformity
- High Dynamic range boost function
- Global Dimming Mode available
- Lowest BOM
- Two Package types available

[AS3824 Datasheet]

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SERIES, V-SERIES, D-SERIES, AND P-SERIES



Comment: The signals captured between test points show a constant duty cycle PWM drive and have a shift in time that shows staggered and out of phase brightness control signals.

[Test point probes TP1 – TP5 showing PWM signals at different levels of brightness]

VIZIO P-Series

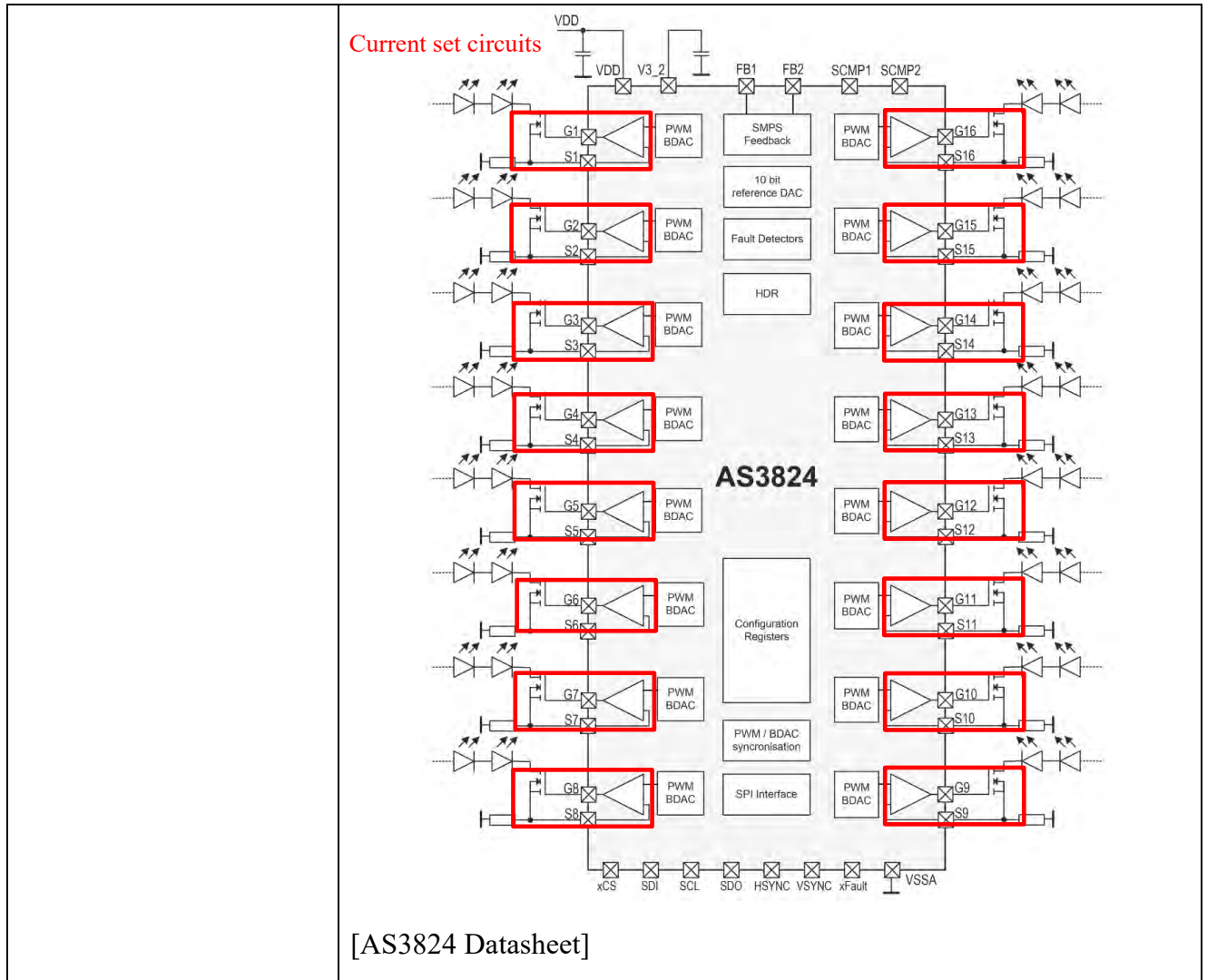
The VIZIO P-Series include a pulse-width modulated (PWM) brightness control signal generator that generates staggered PWM brightness control signals to the plurality of current set circuits.

In the P75Q9-J01, for example, the AS3824 datasheet indicates that 16 PWM generators are used to implement local dimming in each LED driver.

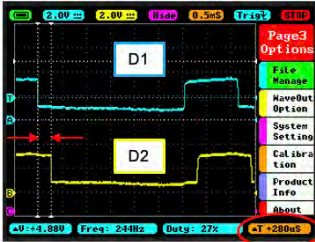
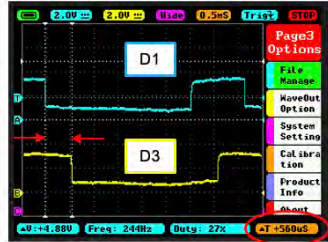
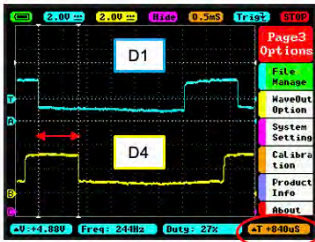
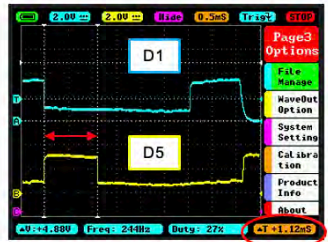
U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES

	AS3824  16-Channel White LED Controller for LCD Backlight 1 Description The AS3824 is a 16 channel high precision LED controller for use in LCD-backlight panels. Dynamic power feedback controls the external power supply to guarantee best efficiency. One high accurate global 10 bit DAC can be used to set the LED current as well as each channel has its own additional 8 bit DAC to boost the dynamic range of LED Backlight systems. Each channel is equipped with an independent PWM generator which can also be synchronized to an external synchronization signal (VSYNC). A fast mode supports minimum PWM duty cycle operation which helps to further reduce the energy consumption of modern LED Backlight systems. The PWM generator clock can be generated internally (DPLL) or an external clock source can be connected to the HSYNC input. Built-in safety features include thermal shutdown as well as open and short LED detection. The device is programmable via serial interface (SPI). Source: https://www.mouser.com/datasheet/2/713/as3824_product_summary-1816002.pdf
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U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES



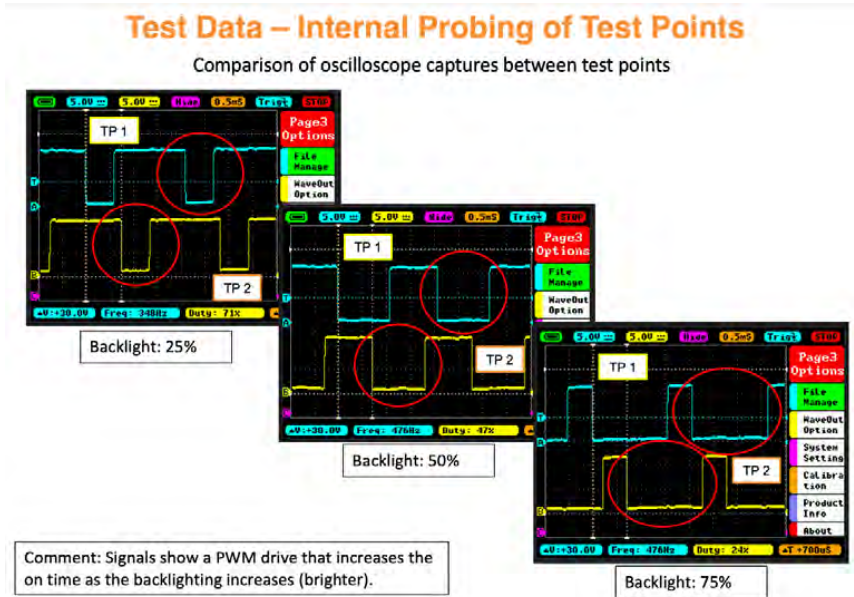
U.S. PATENT NO. 7,843,148 - INFRINGEMENT BY VIZIO M-SERIES, E-SERIES, V-SERIES, D-SERIES, AND P-SERIES

	Test Data – Internal Probing of Test Points Oscilloscope captures between test points with white test screen, 75% Backlight  IMG_013.BMP  IMG_020.BMP  IMG_027.BMP  IMG_034.BMP [Test point probes D1 – D5 showing PWM signals]
Applying a different staggered PWM brightness control signal to each current set circuit; and	See above. As shown, the VIZIO Accused Televisions generate staggered PWM brightness control signals and apply them to each current set circuit, resulting in a staggered PWM waveform across each LED path.
Drawing the peak current through the one or more LEDs in each parallel path, set by its associated current set circuit, at a duty cycle corresponding to a duty cycle of an associated PWM brightness control signal, such that the parallel paths of LEDs conduct	See claim 1 above. VIZIO V-Series The current set circuits in the VIZIO V-Series draw the peak current through its associated one or more LEDs at a duty cycle substantially corresponding to a duty cycle of a PWM brightness control signal applied to it, such that the plurality of current set circuits conduct current through their associated one or more LEDs at the same duty cycle but out of phase with each other.

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current at substantially the same duty cycle but out of phase with each other.

Testing data shows that peak current through its associated one or more LEDs at a duty cycle substantially corresponds to a duty cycle of a PWM brightness control signal applied to it:



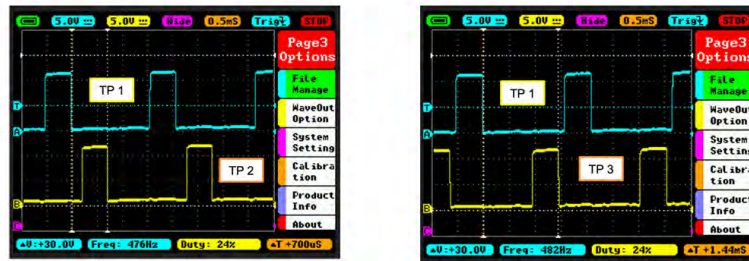
[Test point probes TP1 and TP2 showing PWM signals at different levels of brightness]

Test data also shows that the current set circuits conduct current through their associated one or more LEDs at the same duty cycle but out of phase with each other:

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Test Data – Internal Probing of Test Points

Oscilloscope captures between test points with white test screen, 75% Backlight



Comment: The signals captured between test points show a constant duty cycle PWM drive and have a shift in time that supports staggered and out of phase brightness control signals.

VIZIO E-Series

The current set circuits in the VIZIO E-Series draw the peak current through its associated one or more LEDs at a duty cycle substantially corresponding to a duty cycle of a PWM brightness control signal applied to it, such that the plurality of current set circuits conduct current through their associated one or more LEDs at the same duty cycle but out of phase with each other.

As shown below in the data with respect to the M-Series, which uses the same driver as the E65-F0, the AS3824 in the E65-F0's peak current through the associated one or more LEDs at a duty cycle substantially corresponds to a duty cycle of a PWM brightness control signal applied to it.

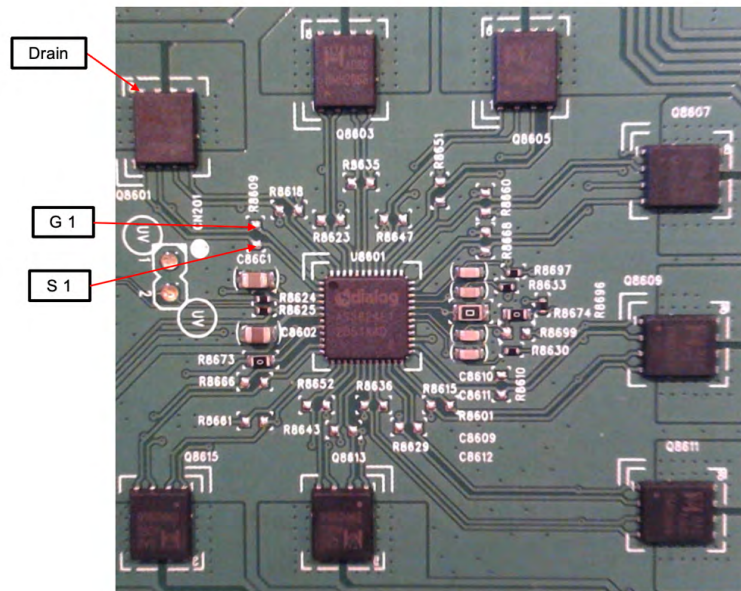
VIZIO M-Series

The current set circuits in the VIZIO M-Series draw the peak current through its associated one or more LEDs at a duty cycle substantially corresponding to a duty cycle of a PWM brightness control signal applied to it, such that the plurality of current set circuits conduct current through their associated one or more LEDs at the same duty cycle but out of phase with each other.

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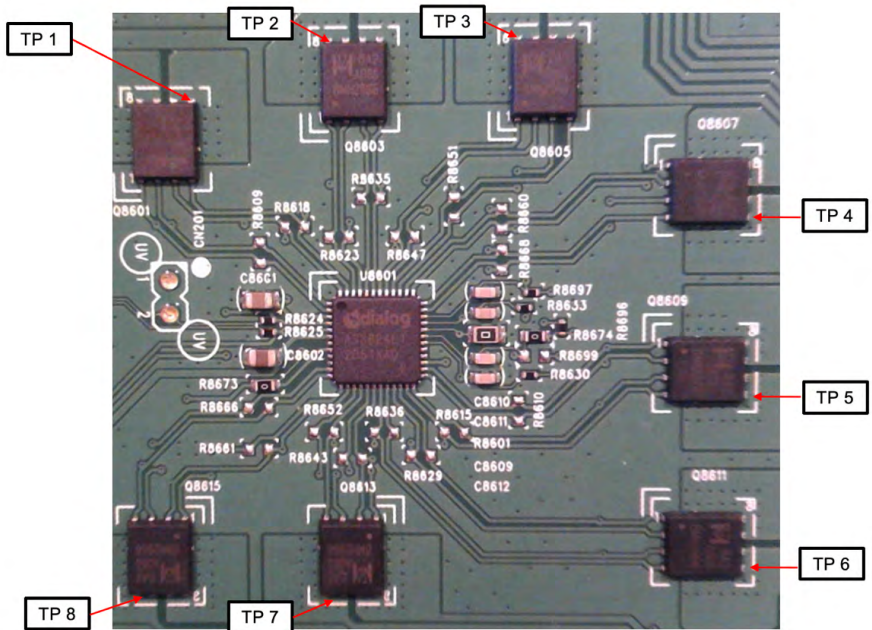
Testing data shows that peak current through its associated one or more LEDs at a duty cycle substantially corresponds to a duty cycle of a PWM brightness control signal applied to it:

Test Data – Internal Probing of Test Points

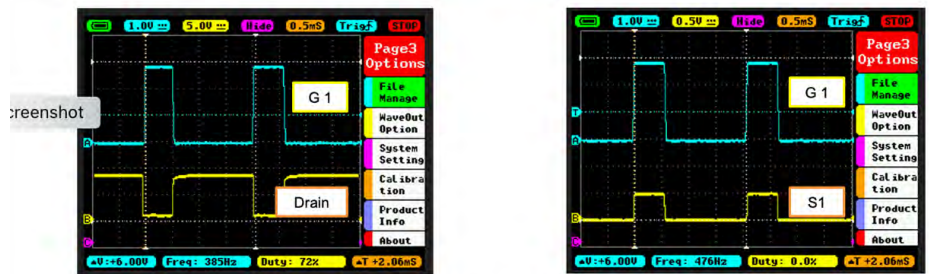


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Test Data – Internal Probing of Test Points

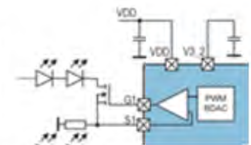


Test Data – Internal Probing of Test Points



Oscilloscope captures between test points with white test screen, 50% Backlight

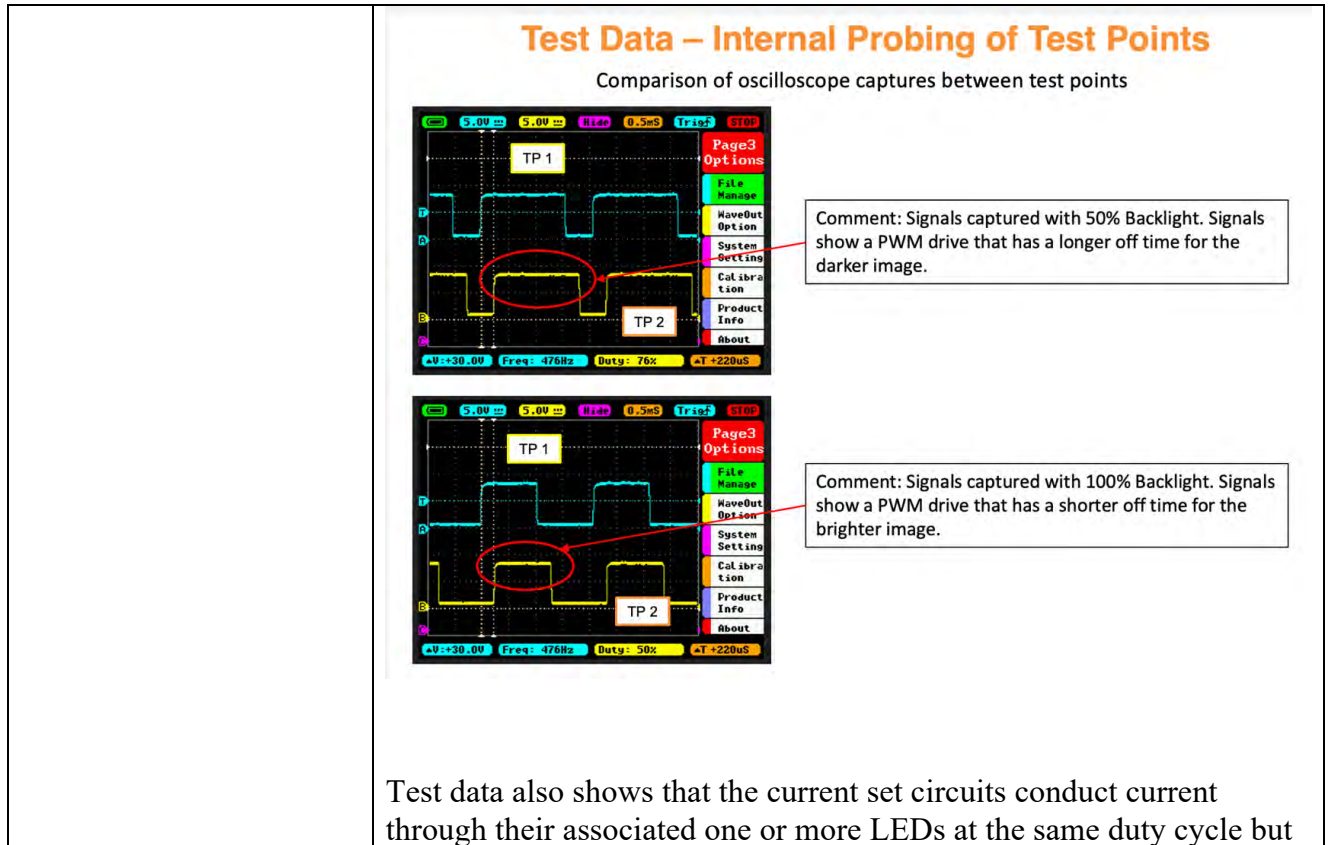
The device also includes an additional 8-bit current control DAC for each of the 16 channels. This can be used to partially boost or lower the current through the LED in a given frame, increasing the dynamic contrast ratio. This allows the AS3824 to support HDR monitors and HDR TVs.



Source: <http://kidd.co.kr/news/183069>

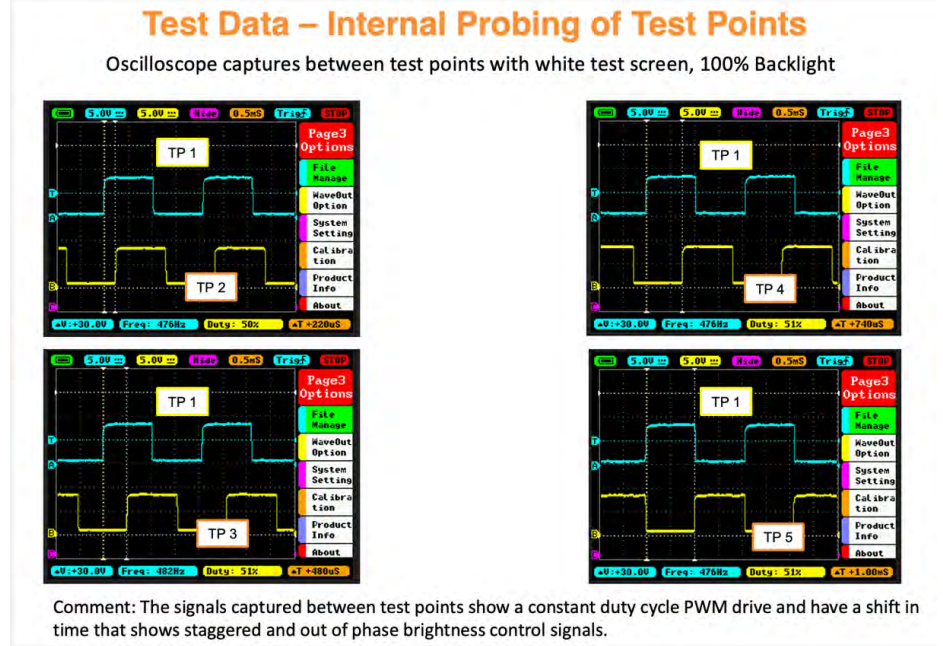
Comment: The signal at S1, which correlates with the Drain signal, provides a feedback signal to control the G1 on time based on the signal from the PWM 8-bit current control DAC.

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out of phase with each other:

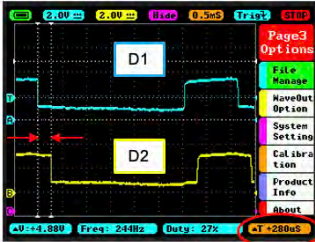
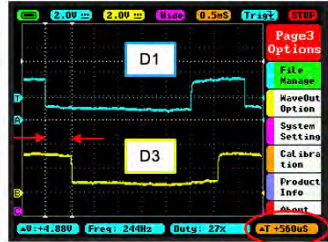
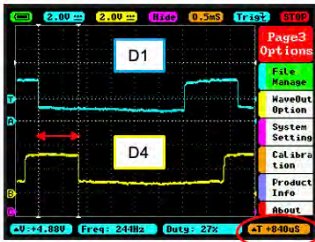
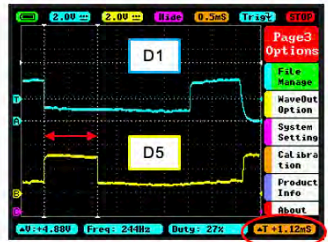


VIZIO P-Series

The current set circuits in the VIZIO P-Series draw the peak current through its associated one or more LEDs at a duty cycle substantially corresponding to a duty cycle of a PWM brightness control signal applied to it, such that the plurality of current set circuits conduct current through their associated one or more LEDs at the same duty cycle but out of phase with each other.

Testing data shows that peak current through its associated one or more LEDs at a duty cycle substantially corresponds to a duty cycle of a PWM brightness control signal applied to it:

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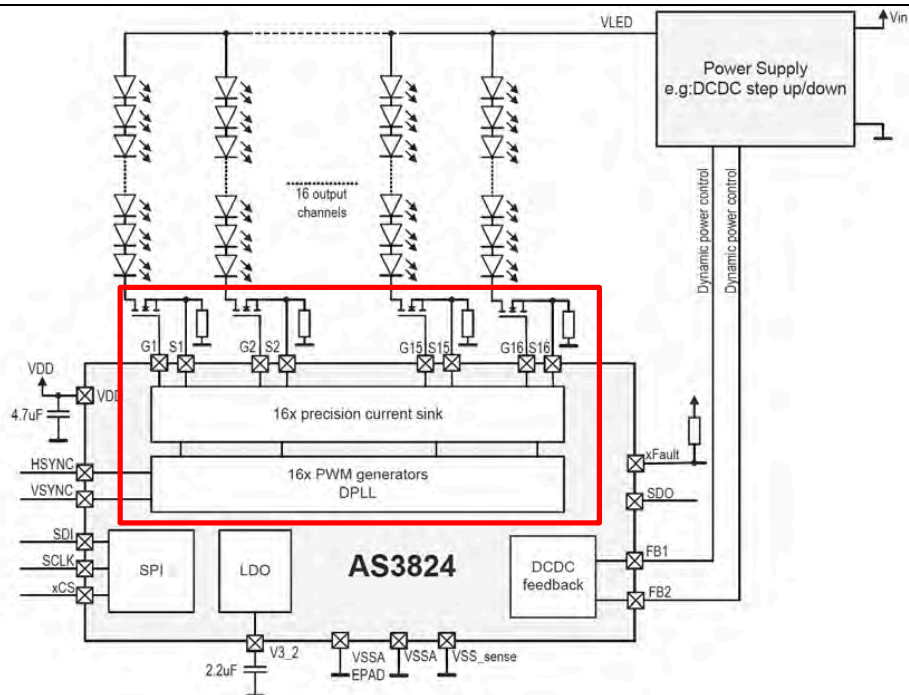
	Test Data – Internal Probing of Test Points Oscilloscope captures between test points with white test screen, 75% Backlight  IMG_013.BMP  IMG_020.BMP  IMG_027.BMP  IMG_034.BMP [Test point probes D1 – D5 showing PWM signals]
15. The method of claim 14 further comprising varying the duty cycle of the staggered PWM brightness control signals to change an average current through the parallel paths of LEDs to change a perceived brightness of the LEDs.	See claim 1, 14 above. The VIZIO Accused Televisions vary the duty cycle of the staggered PWM brightness control signals to change an average current through the parallel paths of LEDs to change a perceived brightness of the LEDs. As a representative example, as shown below, the two parallel paths probed vary the duty cycle of the staggered PWM brightness control signals in order to change an average current through the paths, changing the perceived brightness of the LEDs in the backlight system.

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	Test Data – Internal Probing of Test Points Comparison of oscilloscope captures between test points Comment: Signals captured with 50% Backlight. Signals show a PWM drive that has a longer off time for the darker image. Comment: Signals captured with 100% Backlight. Signals show a PWM drive that has a shorter off time for the brighter image.
16. The method of claim 14 wherein setting a peak current through one or more LEDs connected in each of the parallel paths comprises setting the peak current by controlling conductivity of a current control transistor in series with each parallel path, and wherein applying a different staggered PWM brightness control signal to each current set circuit comprises: coupling each staggered PWM brightness control signal to a control	See claim 1, 14 above. Each of the Accused Televisions in the VIZIO V-Series, M-Series, E-Series, and P-Series couple the PWM brightness control signal to a control terminal of an associated pass transistor (here, a MOSFET or BJT), each pass transistor being connected between a control terminal of a respective current control transistor (here, a precision current sink) and a regulating control voltage (here, the DC-DC voltage source), such that the current control transistor is turned on and off corresponding to a duty cycle of the associated pass transistor. As a representative example, the VIZIO M50QY-J01, VIZIO P75Q9-J01, and the VIZIO E65-F0 feature an AS3824 LED driver that includes current control transistors, pass transistors, and a regulating control voltage as shown below:

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terminal of an associated pass transistor, each pass transistor being connected between a control terminal of a respective current control transistor and a regulating control voltage, such that the current control transistor is turned on and off corresponding to a duty cycle of the associated pass transistor.



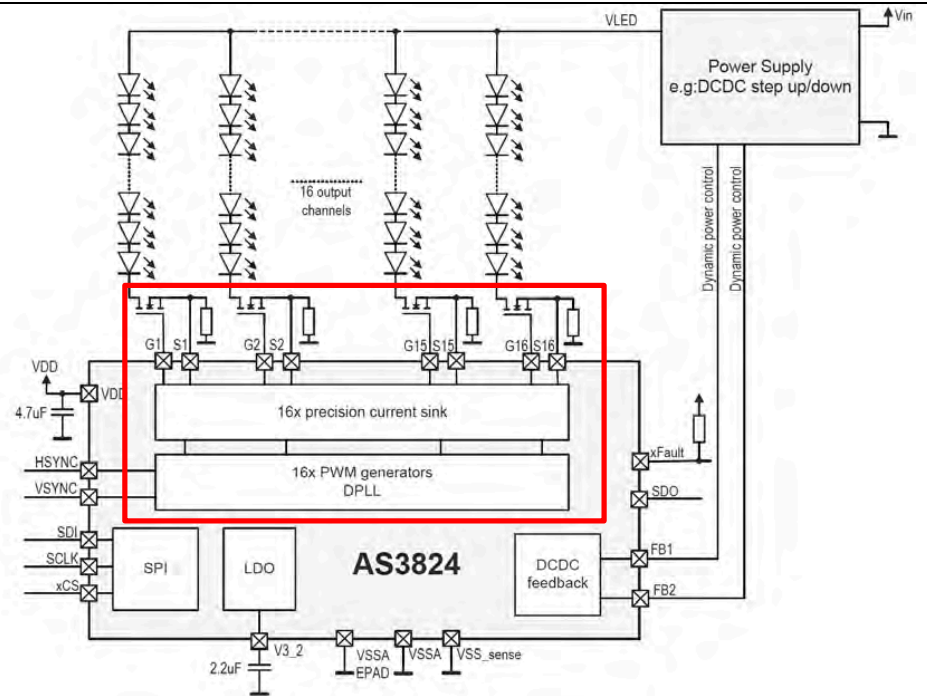
[AS3824 Datasheet]

As further shown below, the current control transistors are turned on and off corresponding to a duty cycle of the pass transistor:

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	Test Data – Internal Probing of Test Points Comparison of oscilloscope captures between test points Comment: Signals captured with 50% Backlight. Signals show a PWM drive that has a longer off time for the darker image. Comment: Signals captured with 100% Backlight. Signals show a PWM drive that has a shorter off time for the brighter image.
17. The method of claim 14 wherein applying a different staggered PWM brightness control signal to each current set circuit comprises applying each staggered PWM brightness control signal to an associated transistor connected in series with the one or more LEDs in an associated parallel path, such that the transistor is turned on and off corresponding to the duty cycle of the staggered PWM brightness control signal applied to it.	See claim 16 above. Each of the Accused Televisions in the VIZIO V-Series, M-Series, E-Series, and P-Series couple the PWM brightness control signal to an associated transistor, such that the transistor is turned on and off corresponding to a duty cycle of the staggered PWM brightness control signal applied. As a representative example, the VIZIO M50QY-J01, VIZIO P75Q9-J01, and the VIZIO E65-F0 feature an AS3824 LED driver that includes a transistor in series with LEDs that receives a PWM brightness control signal as shown below:

SERIES, V-SERIES, D-SERIES, AND P-SERIES



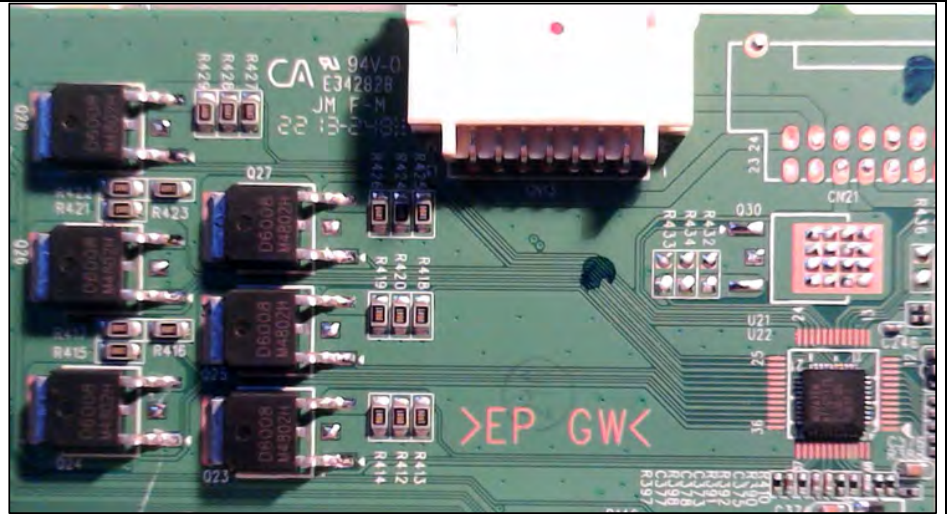
[AS3824 Datasheet]

As further shown below, the transistors are turned on and off corresponding to a duty cycle of the PWM brightness control:

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	Test Data – Internal Probing of Test Points Comparison of oscilloscope captures between test points Comment: Signals captured with 50% Backlight. Signals show a PWM drive that has a longer off time for the darker image. Comment: Signals captured with 100% Backlight. Signals show a PWM drive that has a shorter off time for the brighter image.
22. The method of claim 14 wherein the plurality of parallel paths comprises at least three paths.	See claim 14 above. Each of the Accused Televisions in the VIZIO V-Series, M-Series, E-Series, and P-Series perform the method of claim 14, wherein the plurality of parallel paths comprises at least three paths. VIZIO V-Series As a representative example, the VIZIO V655M-K03 features six separately-controllable parallel LED paths, each with its own power MOSFET switch.

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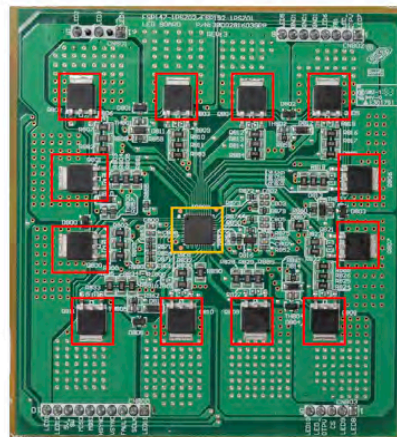
[V655M-K03 LED control board showing 6 independent parallel LED paths controlled by power MOSFETs]

VIZIO E-Series

As a representative example, the VIZIO E65-F0 features twelve separately-controllable parallel LED paths, each with its own NPN bipolar junction transistor.

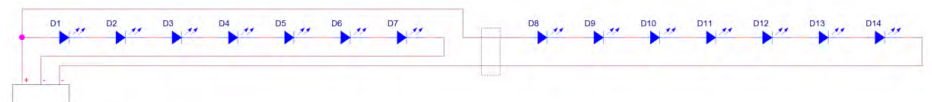
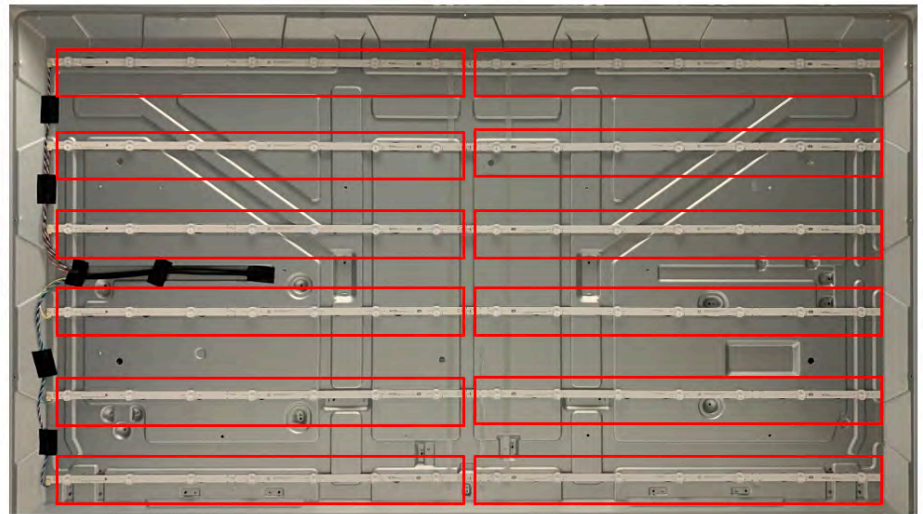


ON Semi D1816
NPN Bipolar transistor



AMS AS3824E (16-
channel LED TV
backlight controller)

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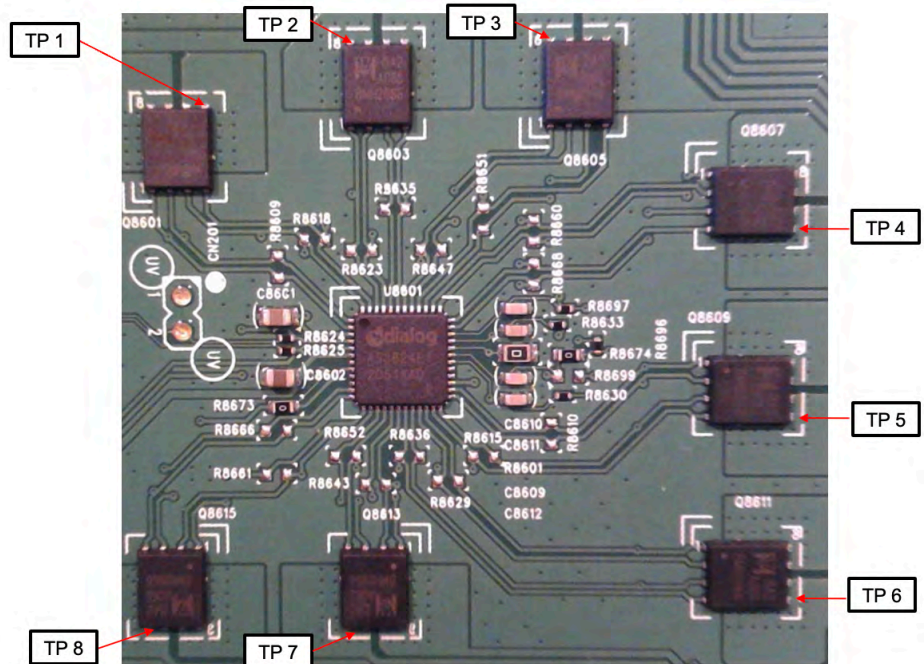


[E65-F0 display assembly showing 12 highlighted parallel LED strings, each connected to an NPN bipolar junction transistor, as well as a circuit diagram of said arrangement]

VIZIO M-Series

As a representative example, the VIZIO M50Q7-J01 features eight separately-controllable parallel LED paths, each with its own power MOSFET switch.

SERIES, V-SERIES, D-SERIES, AND P-SERIES



[M50Q7-J01 LED control board showing 8 independent parallel LED paths controlled by power MOSFETs]

VIZIO P-Series

As a representative example, the VIZIO P75Q9-J01 features 105 dual MOSFETs (i.e., having two gate/drain pins per MOSFET) for a total of 210 separately-controllable parallel LED paths.

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