



MIC24056 Evaluation Board

12A, High-Efficiency, Synchronous DC/DC Buck Regulator with HyperLight Load[®]

SuperSwitcher II[™]

General Description

The MIC24056 DC/DC synchronous buck regulator operates over an input supply range of 4.5V to 19V and provides a regulated output at up to 12A of load current. The output voltage is adjustable down to 0.8V with a typical accuracy of $\pm 1\%$.

Micrel's HyperLight Load[®] architecture maintains high efficiency under light load conditions by transitioning to variable frequency, discontinuous mode operation. The Hyper Speed Control[™] allows using smaller output capacitance. The device operates at a switching frequency of 600kHz, which remains relatively constant with changes in input voltage and output load.

The MIC24056 utilizes an adaptive T_{ON} ripple control architecture. An undervoltage lockout feature is provided to ensure proper operation under power-sag conditions. An internal soft-start feature is provided to reduce the inrush current. Foldback current limit and "hiccup" mode short-circuit protection and thermal shutdown ensures protection of the IC during fault conditions.

The HyperLight Load and Hyper Speed Control features allow ideal transition from light load to full load and vice versa. The 19V operating rating of the device provides ample design safety margin for 12V input applications.

The basic parameters of the MIC24056 evaluation board are a VIN supply of 5V to 19V, output voltage of 0.8V to 5V at 12A⁽¹⁾, and 600kHz switching frequency.

Note:

1. Refer to the temperature curves presented in the [Evaluation Board Performance](#) section. Also, note that the typical minimum input voltage to maximum output voltage conversion is limited by the maximum duty cycle.

Datasheets and support documentation are available on Micrel's web site at: www.micrel.com.

Requirements

The MIC24056 evaluation board requires only a single power supply with at least 10A current capability. The MIC24056 has internal VDD LDO so no external linear regulator is required to power the internal biasing of the IC. When $V_{IN} < 5.5V$, VDD should be tied to PVIN pins to bypass the internal linear regulator by a jumper. The output load can either be an active or passive load.

HyperLight Load is a registered trademark of Micrel, Inc.

Hyper Speed Control, SuperSwitcher II, and Any Capacitor are trademarks of Micrel, Inc.

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Power-Up Precautions

The evaluation board does not have reverse polarity protection. Applying a negative voltage to the VIN terminal may damage the device. The maximum VIN operating voltage of the MIC24056 evaluation board is 19V. It has two different layout designs, one ([Figure 1](#)) optimized for evaluation and a second ([Figure 2](#)) optimized for a smaller footprint. The evaluation board is only populated with components shown in [Figure 1](#).

Getting Started

1. VIN Supply.

Connect a supply to the VIN and GND terminals, paying careful attention to the polarity and the supply range ($5V < V_{IN} < 19V$). An ammeter may be placed between the input supply and the VIN terminal to the evaluation board. Ensure that the supply voltage is monitored at the VIN terminal. The ammeter and/or power lead resistance can reduce the voltage supplied to the input. Do not apply power until Step 4.

2. Connect the load to the VOUT and ground terminals.

The load can be either passive (resistive) or active (as in an electronic load). An ammeter can be placed between the load and the VOUT terminal. Ensure that the output voltage is monitored at the VOUT terminal.

3. Enable Input.

An EN connector is provided on the evaluation board for users to easily access the enable feature. The output of the MIC24056 turns on when VDD exceeds the UVLO threshold. The output of the MIC24056 may be turned off by shorting the EN pin to ground.

4. Turn on the power.

Turn on VIN power supply and verify that the output voltage is regulated to 1.8V.

Ordering Information

| Part Number | Description |
|----------------|---|
| MIC24056YJL EV | 12A HLL DC/DC Buck Regulator Evaluation Board |

Output Voltage

The output voltage on the MIC24056 evaluation board is adjustable. It is set by adjusting the feedback resistors, referring Equation 1:

$$V_{\text{OUT}} = V_{\text{FB}} \times \left(1 + \frac{R4}{R_{\text{BOTTOM}}} \right) \quad \text{Eq. 1}$$

where $V_{\text{FB}} = 0.8\text{V}$ and R_{BOTTOM} is one of the R5, R6, R7, R8, R9, R10, R11, R12 which corresponds to 0.9V, 1.0V, 1.2V, 1.5V, 1.8V, 2.5V, 3.3V, or 5V. Leaving the R_{BOTTOM} open gives a 0.8V output voltage. The output voltage above is set at the factory for a 1.8V output, but it can easily be changed by moving the jumper to a respective position to get an indicated voltage on the board. If a desired voltage is not shown on the board, it is easily modified by removing R_{BOTTOM} and replacing it with the values that yield the desired output voltage. Once R4 is selected, R_{BOTTOM} can be calculated using Equation 2:

$$R_{\text{BOTTOM}} = \frac{R4 \times V_{\text{FB}}}{V_{\text{OUT}} - V_{\text{FB}}} \quad \text{Eq. 2}$$

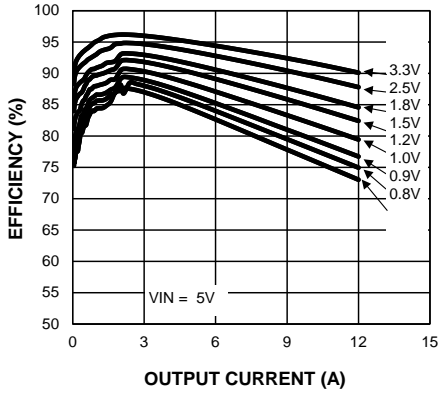
For $V_{\text{FB}} = 0.8\text{V}$, as in Equation 3:

$$R_{\text{BOTTOM}} = \frac{R4 \times 0.8\text{V}}{V_{\text{OUT}} - 0.8\text{V}} \quad \text{Eq. 3}$$

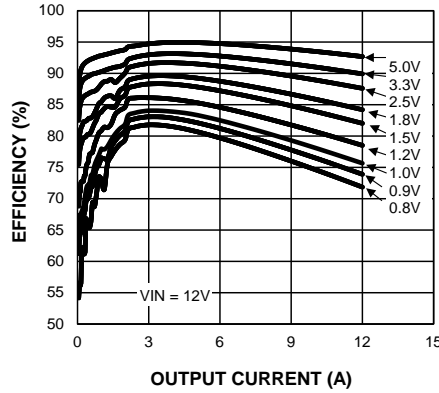
The output voltage should not be set to exceed 5V due to the 6.3V rating of the output capacitor and limitation on line regulation. Please refer to the "Setting the Output Voltage" and Ripple Injection" subsections in the *Application Information* section of the MIC24056 datasheet for more detailed information.

Evaluation Board Performance

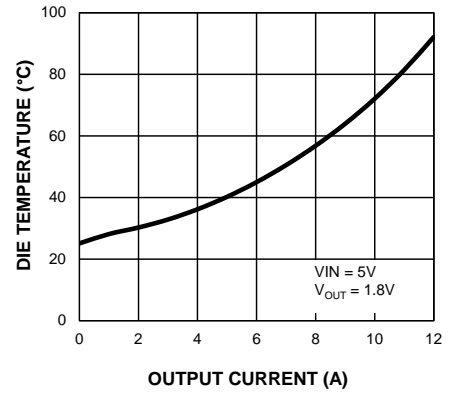
**Efficiency (VIN = 5V)
vs. Output Current**



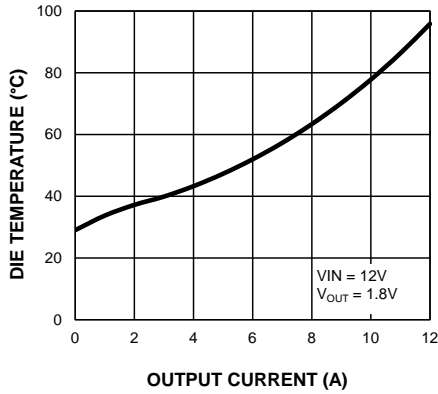
**Efficiency (VIN = 12V)
vs. Output Current**



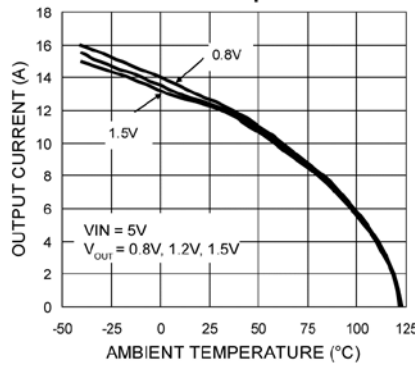
**Die Temperature* (VIN = 5V)
vs. Output Current**



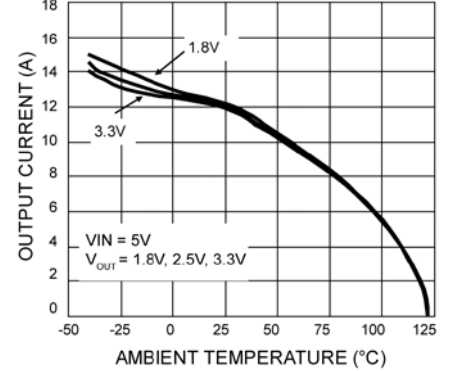
**Die Temperature* (VIN = 12V)
vs. Output Current**



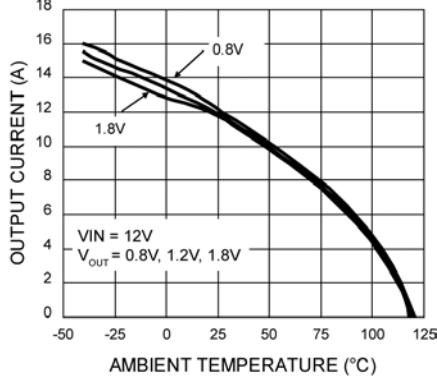
**Thermal Derating*
vs. Ambient Temperature**



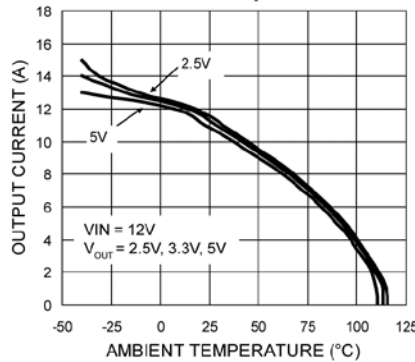
**Thermal Derating*
vs. Ambient Temperature**



**Thermal Derating*
vs. Ambient Temperature**



**Thermal Derating*
vs. Ambient Temperature**



Die Temperature* : The temperature measurement was taken at the hottest point on the MIC24056 case mounted on a 5 square inch 4 layer, 0.62 inch, FR-4 PCB with 2oz finish copper weight per layer, see the *Thermal Measurement* section in the MIC24056 datasheet. Actual results will depend upon the size of the PCB, ambient temperature and proximity to other heat-emitting components.

Evaluation Board Schematic

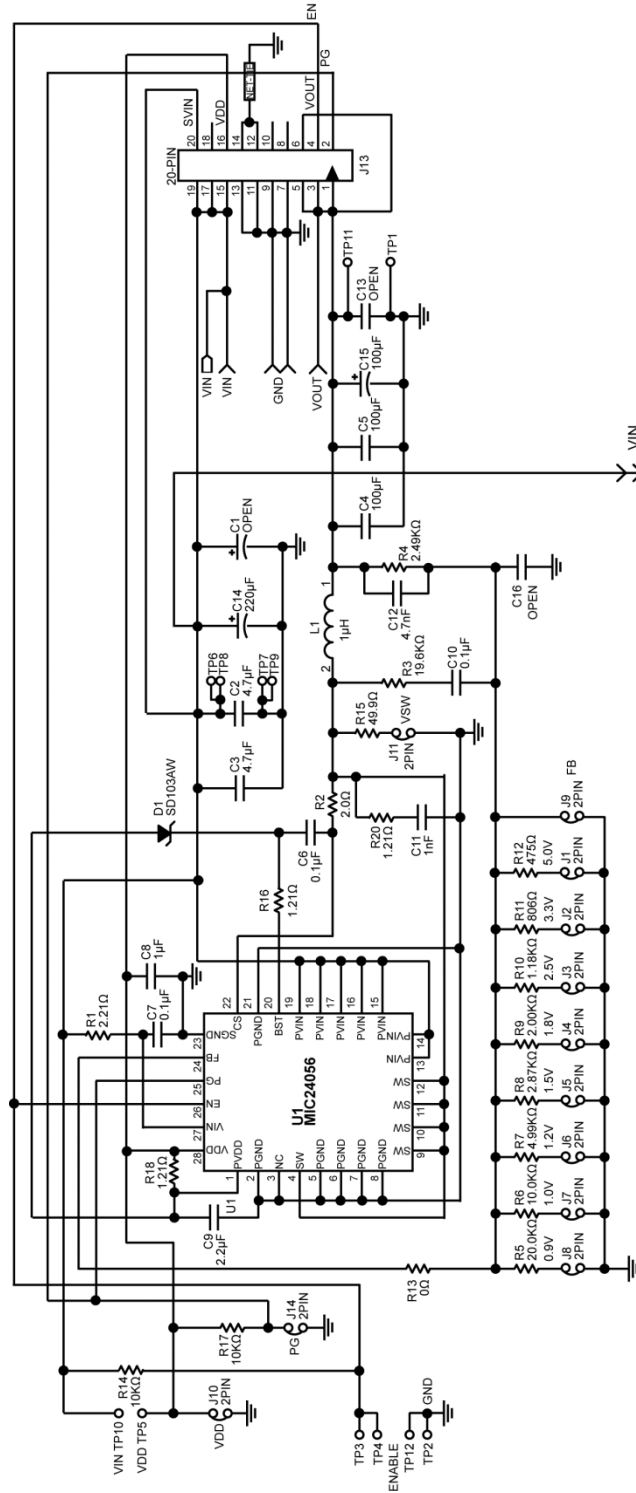


Figure 1. Schematic of MIC24056 Evaluation Board (J11, R13, and R15 are for testing purposes)

Bill of Materials

| Item | Part Number | Manufacturer | Description | Qty. |
|-------------|--------------------|--------------------------------|---|------|
| C1 | Open | | | |
| C2, C3 | 12103C475KAT2A | AVX ⁽¹⁾ | 4.7 μ F Ceramic Capacitor, X7R, Size 1210, 25V | 2 |
| | GRM32DR71E475KA61K | Murata ⁽²⁾ | | |
| | C3225X7R1E475K | TDK ⁽³⁾ | | |
| C4, C5, C13 | 12106D107MAT2A | AVX | 100 μ F Ceramic Capacitor, X5R, Size 1210, 6.3V | 3 |
| | GRM32ER60J107ME20L | Murata | | |
| | C3225X5R0J107M | TDK | | |
| C15 | Open | | | |
| C6, C7, C10 | 06035C104KAT2A | AVX | 0.1 μ F Ceramic Capacitor, X7R, Size 0603, 50V | 3 |
| | GRM188R71H104KA93D | Murata | | |
| | C1608X7R1H104K | TDK | | |
| C8 | 0603ZC105KAT2A | AVX | 1.0 μ F Ceramic Capacitor, X7R, Size 0603, 10V | 1 |
| | GRM188R71A105KA61D | Murata | | |
| | C1608X7R1A105K | TDK | | |
| C9 | 0603ZD225KAT2A | AVX | 2.2 μ F Ceramic Capacitor, X5R, Size 0603, 10V | 1 |
| | GRM188R61A225KE34D | Murata | | |
| | C1608X5R1A225K | TDK | | |
| C12 | 06035C472KAZ2A | AVX | 4.7nF Ceramic Capacitor, X7R, Size 0603, 50V | 1 |
| | GRM188R71H472K | Murata | | |
| | C1608X7R1H472K | TDK | | |
| C14 | B41851F7227M | EPCOS ⁽⁴⁾ | 220 μ F Aluminum Capacitor, 35V | 1 |
| C11, C16 | Open | | | |
| D1 | SD103AWS | MCC ⁽⁵⁾ | 40V, 350mA, Schottky Diode, SOD323 | 1 |
| | SD103AWS-7 | Diodes Inc. ⁽⁶⁾ | | |
| | SD103AWS | Vishay ⁽⁷⁾ | | |
| L1 | HCF1305-2R2-R | Cooper Bussmann ⁽⁸⁾ | 2.2 μ H Inductor, 15A Saturation Current | 1 |
| R1 | CRCW06032R21FKEA | Vishay Dale | 2.21 Ω Resistor, Size 0603, 1% | 1 |
| R2 | CRCW06032R00FKEA | Vishay Dale | 2.00 Ω Resistor, Size 0603, 1% | 1 |
| R3 | CRCW060319K6FKEA | Vishay Dale | 19.6k Ω Resistor, Size 0603, 1% | 1 |
| R4 | CRCW06032K49FKEA | Vishay Dale | 2.49k Ω Resistor, Size 0603, 1% | 1 |
| R5 | CRCW060320K0FKEA | Vishay Dale | 20.0k Ω Resistor, Size 0603, 1% | 1 |

Notes:

1. AVX: www.avx.com.
2. Murata: www.murata.com.
3. TDK: www.tdk.com.
4. EPCOS: www.epcos.com.
5. MCC: www.mccsemi.com.
6. Diodes, Inc.: www.diodes.com.
7. Vishay: www.vishay.
8. Cooper Bussmann: www.cooperbussmann.com.

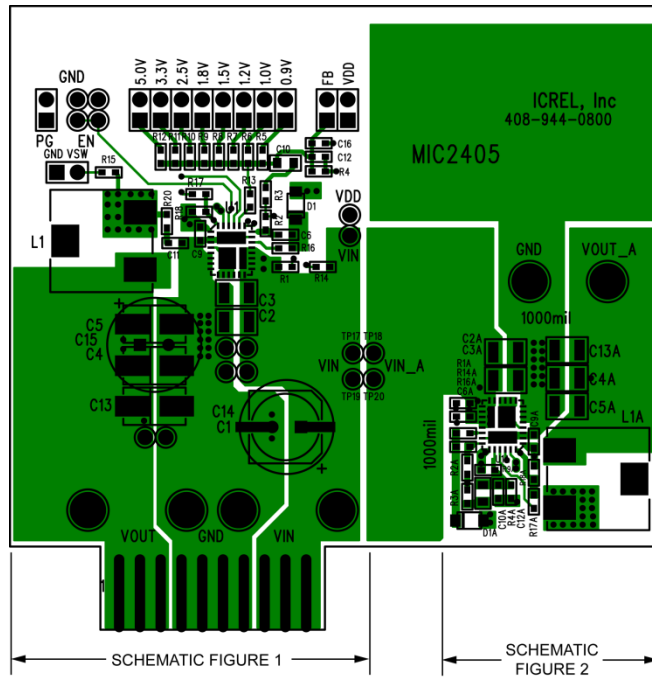
Bill of Materials (Continued)

| Item | Part Number | Manufacturer | Description | Qty. |
|---|--------------------|-----------------------------------|---|----------|
| R6, R14, R17 | CRCW060310K0FKEA | Vishay Dale | 10.0k Ω Resistor, Size 0603, 1% | 3 |
| R7 | CRCW06034K99FKEA | Vishay Dale | 4.99k Ω Resistor, Size 0603, 1% | 1 |
| R8 | CRCW06032K87FKEA | Vishay Dale | 2.87k Ω Resistor, Size 0603, 1% | 1 |
| R9 | CRCW06032K006FKEA | Vishay Dale | 2.00k Ω Resistor, Size 0603, 1% | 1 |
| R10 | CRCW06031K18FKEA | Vishay Dale | 1.18k Ω Resistor, Size 0603, 1% | 1 |
| R11 | CRCW0603806RFKEA | Vishay Dale | 806 Ω Resistor, Size 0603, 1% | 1 |
| R12 | CRCW0603475RFKEA | Vishay Dale | 475 Ω Resistor, Size 0603, 1% | 1 |
| R13 | CRCW06030000FKEA | Vishay Dale | 0 Ω Resistor, Size 0603, 5% | 1 |
| R15 | CRCW060349R9FKEA | Vishay Dale | 49.9 Ω Resistor, Size 0603, 1% | 1 |
| R16, R18 | CRCW06031R21FKEA | Vishay Dale | 1.21 Ω Resistor, Size 0603, 1% | 2 |
| R20 | Open | | | |
| All Reference designators ending with "A" | Open | | | |
| U1 | MIC24056YJL | Micrel, Inc.⁽⁹⁾ | 12A, High-Efficiency, Synchronous DC/DC Buck Regulator with Hyper Light Load | 1 |

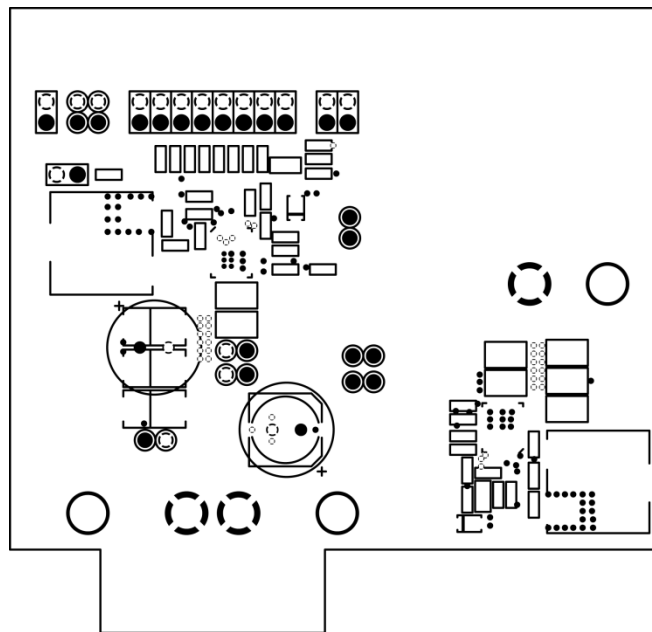
Note:

9. Micrel, Inc.: www.micrel.com.

PCB Layout Recommendations⁽¹⁾



Top Layer

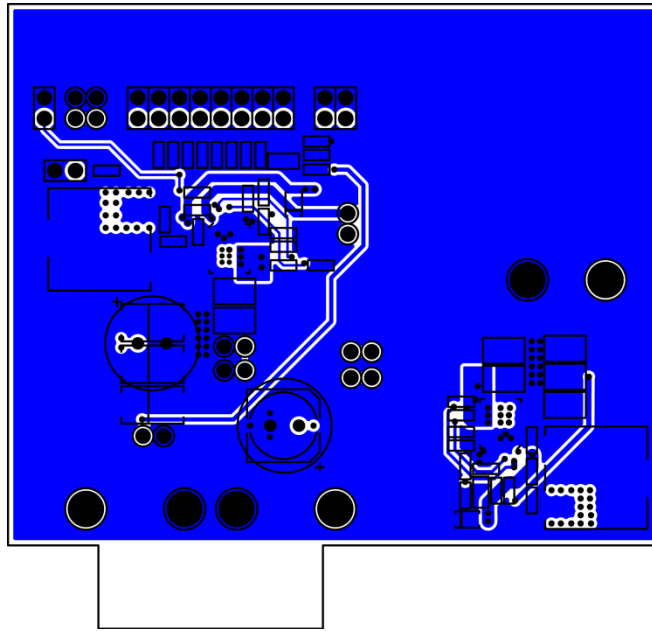


Mid-Layer 1

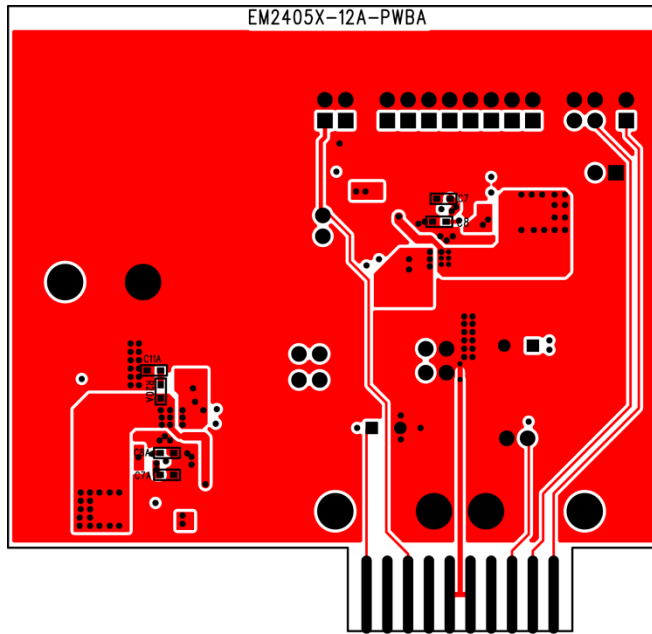
Note:

1. Refer to "PCB Layout Guideline" section for component placement and layout in MIC24056 datasheet on Micrel web page (www.micrel.com)

PCB Layout Recommendations⁽¹⁾ (Continued)



Mid-Layer 2



Bottom Layer

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