Key Features
- Low profile SMD
  50.2 x 46.0 x 8.5 mm (1.98 x 1.81 x 0.34 in.)
- Designed for radio link applications
- Three separately regulated outputs that can be adjusted independently
- High efficiency, typ. 87.8 % at full load
- 1500 Vdc input to output isolation
- insulation according to IEC/EN/UL 60950
- More than 4.01 million hours predicted MTBF at +40ºC ambient temperature

General Characteristics
- Input under voltage protection
- Wide range multiple output voltage adjust
- Output short-circuit protection
- Remote control
- Highly automated manufacturing ensures quality
- ISO 9001/14001 certified supplier

Design for Environment
Meets requirements in high-temperature lead-free soldering processes.

Contents
General Information ................................................................. 2
Safety Specification ................................................................. 3
Absolute Maximum Ratings .......................................................... 4
Product Program
5 V/3.3 V/9 V/33 W Electrical Specification .............................. 5
EMC Specification ................................................................. 10
Operating Information ............................................................... 11
Thermal Consideration ............................................................... 12
Connections ........................................................................ 13
Mechanical Information ............................................................... 14
Soldering Information ................................................................. 16
Delivery Information ................................................................. 17
Product Qualification Specification ............................................. 18
### Ordering Information

<table>
<thead>
<tr>
<th>Product program</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMR 603 1204/1</td>
<td>5V, 3.3V, 9V / 33W</td>
</tr>
</tbody>
</table>

### General Information

#### Reliability

The failure rate ($\lambda$) and mean time between failures (MTBF= $1/\lambda$) is calculated at max output power and an operating ambient temperature ($T_A$) of +40°C. Flex uses Telcordia SR-332 Issue 2 Method 1 to calculate the mean steady-state failure rate and standard deviation ($\sigma$).

Telcordia SR-332 Issue 2 also provides techniques to estimate the upper confidence levels of failure rates based on the mean and standard deviation.

<table>
<thead>
<tr>
<th>Mean steady-state failure rate, $\lambda$</th>
<th>Std. deviation, $\sigma$</th>
</tr>
</thead>
<tbody>
<tr>
<td>249 nFailures/h</td>
<td>46.3 nFailures/h</td>
</tr>
</tbody>
</table>

MTBF (mean value) for the BMR603 1204/1= 4.01 Mh. MTBF at 90% confidence level = 3.24 Mh

#### Compatibility with RoHS requirements

The products are compatible with the relevant clauses and requirements of the RoHS directive 2011/65/EU and have a maximum concentration value of 0.1% by weight in homogeneous materials for lead, mercury, hexavalent chromium, PBB and PBDE and of 0.01% by weight in homogeneous materials for cadmium.

Exemptions in the RoHS directive utilized in Flex Power products are found in the Statement of Compliance document.

Flex Power fulfills and will continuously fulfill all its obligations under regulation (EC) No 1907/2006 concerning the registration, evaluation, authorization and restriction of chemicals (REACH) as they enter into force and is through product materials declarations preparing for the obligations to communicate information on substances in the products.

### Quality Statement

The products are designed and manufactured in an industrial environment where quality systems and methods like ISO 9000, Six Sigma, and SPC are intensively in use to boost the continuous improvements strategy. Infant mortality or early failures in the products are screened out and they are subjected to an ATE-based final test. Conservative design rules, design reviews and product qualifications, plus the high competence of an engaged work force, contribute to the high quality of the products.

### Warranty

Warranty period and conditions are defined in Flex Power General Terms and Conditions of Sale.

### Limitation of Liability

Flex Power does not make any other warranties, expressed or implied including any warranty of merchantability or fitness for a particular purpose (including, but not limited to, use in life support applications, where malfunctions of product can cause injury to a person’s health or life).

© Flex 2017

The information and specifications in this technical specification is believed to be correct at the time of publication. However, no liability is accepted for inaccuracies, printing errors or for any consequences thereof. Flex reserves the right to change the contents of this technical specification at any time without prior notice.
Safety Specification

General information
Flex DC/DC converters and DC/DC regulators are designed in accordance with safety standards IEC/EN/UL 60950-1 Safety of Information Technology Equipment.

IEC/EN/UL 60950-1 contains requirements to prevent injury or damage due to the following hazards:

- Electrical shock
- Energy hazards
- Fire
- Mechanical and heat hazards
- Radiation hazards
- Chemical hazards

On-board DC/DC converters and DC/DC regulators are defined as component power supplies. As components they cannot fully comply with the provisions of any safety requirements without “Conditions of Acceptability”. Clearance between conductors and between conductive parts of the component power supply and conductors on the board in the final product must meet the applicable safety requirements. Certain conditions of acceptability apply for component power supplies with limited stand-off (see Mechanical Information for further information). It is the responsibility of the installer to ensure that the final product housing these components complies with the requirements of all applicable safety standards and regulations for the final product.

Component power supplies for general use should comply with the requirements in IEC 60950-1, EN 60950-1 and UL 60950-1 Safety of Information Technology Equipment. There are other more product related standards, e.g. IEEE 802.3 CSMA/CD (Ethernet) Access Method, and ETS-300132-2 Power supply interface at the input to telecommunications equipment, operated by direct current (dc), but all of these standards are based on IEC/EN/UL 60950-1 with regards to safety.

Flex DC/DC converters and DC/DC regulators are UL 60950-1 recognized and certified in accordance with EN 60950-1.

The flammability rating for all construction parts of the products meet requirements for V-0 class material according to IEC 60695-11-10, Fire hazard testing, test flames – 50 W horizontal and vertical flame test methods.

The products should be installed in the end-use equipment, in accordance with the requirements of the ultimate application. Normally the output of the DC/DC converter is considered as SELV (Safety Extra Low Voltage) and the input source must be isolated by minimum Double or Reinforced Insulation from the primary circuit (AC mains) in accordance with IEC/EN/UL 60950-1.

Isolated DC/DC converters
It is recommended that a slow blow fuse is to be used at the input of each DC/DC converter. If an input filter is used in the circuit the fuse should be placed in front of the input filter.
In the rare event of a component problem that imposes a short circuit on the input source, this fuse will provide the following functions:

- Isolate the fault from the input power source so as not to affect the operation of other parts of the system.
- Protect the distribution wiring from excessive current and power loss thus preventing hazardous overheating.

The galvanic isolation is verified in an electric strength test. The test voltage (Viso) between input and output is 1500 Vdc or 2250 Vdc (refer to product specification).

24 V DC systems
The input voltage to the DC/DC converter is SELV (Safety Extra Low Voltage) and the output remains SELV under normal and abnormal operating conditions.

48 and 60 V DC systems
If the input voltage to the DC/DC converter is 75 Vdc or less, then the output remains SELV (Safety Extra Low Voltage) under normal and abnormal operating conditions.

Single fault testing in the input power supply circuit should be performed with the DC/DC converter connected to demonstrate that the input voltage does not exceed 75 Vdc.

If the input power source circuit is a DC power system, the source may be treated as a TNV-2 circuit and testing has demonstrated compliance with SELV limits in accordance with IEC/EN/UL60950-1.

Non-isolated DC/DC regulators
The input voltage to the DC/DC regulator is SELV (Safety Extra Low Voltage) and the output remains SELV under normal and abnormal operating conditions.
Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>min</th>
<th>typ</th>
<th>max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_{P1}$ Operating Temperature (see Thermal Consideration section)</td>
<td>-40</td>
<td>+130</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>$T_S$ Storage temperature</td>
<td>-40</td>
<td>+125</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>$V_i$ Input voltage</td>
<td>-0.5</td>
<td>+72</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{iso}$ Isolation voltage</td>
<td>-0.5</td>
<td>1500</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_s$ Input voltage transient ($t_p$, 100 ms)</td>
<td>-0.5</td>
<td>100</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{RC}$ Remote Control pin voltage (see Operating Information section)</td>
<td>-0.5</td>
<td>10</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{adj}$ Adjust pin voltage (see Operating Information section)</td>
<td>-0.5</td>
<td>6</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{adj}$</td>
<td>-0.5</td>
<td>6.6</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{adj}$</td>
<td>-0.5</td>
<td>18</td>
<td>V</td>
<td></td>
</tr>
</tbody>
</table>

Stress in excess of Absolute Maximum Ratings may cause permanent damage. Absolute Maximum Ratings, sometimes referred to as no destruction limits, are normally tested with one parameter at a time exceeding the limits of Output data or Electrical Characteristics. If exposed to stress above these limits, function and performance may degrade in an unspecified manner.

Fundamental Circuit Diagram
BMR 603 1204 DC/DC Converters
Input 32-60 V, Triple Output 33 W

5V max 4A, 3.3V max 4A, 9V max 1.5A / max 33W

Electrical Specification

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Conditions</th>
<th>( V_{O} )</th>
<th>( I_{O} )</th>
<th>( P_{O} )</th>
<th>( \eta )</th>
<th>Power Dissipation</th>
<th>( P_{R} )</th>
<th>Input idling power</th>
<th>( I_{S} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input voltage range</td>
<td>( V_{I} )</td>
<td>32</td>
<td>60</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turn-off input voltage</td>
<td>( V_{out} )</td>
<td>24.5</td>
<td>26</td>
<td>27.5</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turn-on input voltage</td>
<td>( V_{on} )</td>
<td>26.5</td>
<td>28</td>
<td>29.5</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal input capacitance</td>
<td>( C_{I} )</td>
<td>6.6</td>
<td>( \mu F )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output power</td>
<td>( P_{O} )</td>
<td>33</td>
<td>W</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Efficiency</td>
<td>( \eta )</td>
<td>85</td>
<td>88</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output initial setting and accuracy</td>
<td>( \eta_{O} )</td>
<td>85</td>
<td>88</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output adjust range</td>
<td>( I_{O} )</td>
<td>0.89 A</td>
<td>0.91 A</td>
<td>1.4 A</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output voltage tolerance band</td>
<td>( V_{O} )</td>
<td>5.15</td>
<td>5.15</td>
<td>7.15</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Idling voltage</td>
<td>( I_{O} )</td>
<td>0 A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Line regulation</td>
<td>( V_{L} )</td>
<td>10</td>
<td>20</td>
<td></td>
<td>mV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Load regulation</td>
<td>( V_{L} )</td>
<td>50</td>
<td>100</td>
<td></td>
<td>mV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Load transient voltage deviation</td>
<td>( V_{L} )</td>
<td>8.73</td>
<td>9.27</td>
<td></td>
<td>V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Load transient recovery time</td>
<td>( I_{L} )</td>
<td>80</td>
<td>200</td>
<td></td>
<td>µs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ramp-up time (from 10-90% of ( V_{O} ))</td>
<td>( t_{r} )</td>
<td>0.05</td>
<td>0.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Start-up time (from ( V_{O} ) to 90% of ( V_{O} ))</td>
<td>( t_{s} )</td>
<td>3</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V(1), shut-down fall time (from ( V_{O} ) to 0% of ( V_{O} ))</td>
<td>( t_{f} )</td>
<td>0.2</td>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RC start-up time</td>
<td>( t_{r} )</td>
<td>4</td>
<td>7</td>
<td></td>
<td>ms</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RC shut-down fall time (from ( V_{O} ) to 0% of ( V_{O} ))</td>
<td>( t_{f} )</td>
<td>0.1</td>
<td>0.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output current</td>
<td>( I_{O} )</td>
<td>0.4</td>
<td>4</td>
<td></td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current limit threshold</td>
<td>( I_{L} )</td>
<td>7</td>
<td>9</td>
<td></td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short circuit current</td>
<td>( I_{S} )</td>
<td>12</td>
<td>14</td>
<td></td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recommended Capacitive Load</td>
<td>( C_{R} )</td>
<td>100</td>
<td>100</td>
<td></td>
<td>µF</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output ripple &amp; noise</td>
<td>( V_{O} )</td>
<td>20</td>
<td>55</td>
<td></td>
<td>mV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note 1: If Output 1 is adjusted below 5.6V, output 2 converter might enter in discontinuous mode which may create an additional low frequency (< 10 kHz) noise. However, the total ripple will be still within the specified level. Output 2 cannot be adjusted higher than 0.3 V below output 1. Output 3 do not operate if output 1 is adjusted below 4.5 V.

Note 2: \( C_{R} \) = 10 uF tantalum used on all outputs at load transient test.

Note 3: Hiccup mode on output 2 and 3 during current limit.
5 V, 4 A / 3.3 V, 4 A / 9 V, 1.5 A / 33 W Typical Characteristics

**Efficiency**

- Efficiency vs. load current and input voltage at \( T_{P1} = +25^\circ \text{C} \), all outputs loaded simultaneously from 0 to 0.71 x max Io (33 W)

**Power Dissipation**

- Dissipated power vs. load current (Io1) and input voltage at \( T_{P1} = +25^\circ \text{C} \), all outputs loaded simultaneously from 0 to 0.71 x max Io (33 W)

**Output 1 Characteristics**

- Output 1 voltage vs. load current at \( T_{P1} = +25^\circ \text{C} \), all outputs loaded simultaneously from 0 to 0.71 x max Io (33 W)

**Output 2 Characteristics**

- Output 2 voltage vs. load current at \( T_{P1} = +25^\circ \text{C} \), all outputs loaded simultaneously from 0 to 0.71 x max Io (33 W)

**Output 3 Characteristics**

- Output 3 voltage vs. load current at \( T_{P1} = +25^\circ \text{C} \), all outputs loaded simultaneously from 0 to 0.71 x max Io (33 W)

**Output 1 Current Limit Characteristics**

- Output 1 voltage vs. load current at Io1 > max Io1, \( T_{P1} = +25^\circ \text{C} \), Io2 = 0.4 A, Io3 = 0.15 A.
5 V, 4 A / 3.3 V, 4 A / 9 V, 1.5 A / 33 W Typical Characteristics

Start-up

Start-up enabled by connecting \( V_i \) at:
- \( T_P = +25°C, V_i = 48 \text{ V} \)
- \( I_{O1} = I_{O2} = 2.83 \text{ A} \), \( I_{O3} = 1.06 \text{ A} \) resistive load.

Top trace: output 3 voltage (5 V/div.).
Second trace: output 2 voltage (2 V/div.).
Third trace: output 1 voltage (5 V/div.).
Bottom trace: input voltage (50 V/div.).
Time scale: (5 ms/div.).

Shut-down

Shut-down enabled by disconnecting \( V_i \) at:
- \( T_P = +25°C, V_i = 48 \text{ V} \)
- \( I_{O1} = I_{O2} = 2.83 \text{ A} \), \( I_{O3} = 1.06 \text{ A} \) resistive load.

Top trace: output 3 voltage (5 V/div.).
Second trace: output 2 voltage (2 V/div.).
Third trace: output 1 voltage (5 V/div.).
Bottom trace: input voltage (50 V/div.).
Time scale: (2 ms/div.).

Output 1 Ripple & Noise

Output 1 voltage ripple at:
- \( T_P = +25°C, V_i = 48 \text{ V} \)
- \( I_{O1} = I_{O2} = 2.83 \text{ A} \), \( I_{O3} = 1.06 \text{ A} \) resistive load.

Trace: output 1 voltage (20 mV/div.).
Time scale: (2 \( \mu \text{S} \)/div.).

Output 2 Ripple & Noise

Output 2 voltage ripple at:
- \( T_P = +25°C, V_i = 48 \text{ V} \)
- \( I_{O1} = I_{O2} = 2.83 \text{ A} \), \( I_{O3} = 1.06 \text{ A} \) resistive load.

Trace: output 2 voltage (20 mV/div.).
Time scale: (2 \( \mu \text{S} \)/div.).

Output 3 Ripple & Noise

Output 3 voltage ripple at:
- \( T_P = +25°C, V_i = 48 \text{ V} \)
- \( I_{O1} = I_{O2} = 2.83 \text{ A} \), \( I_{O3} = 1.06 \text{ A} \) resistive load.

Trace: output 3 voltage (20 mV/div.).
Time scale: (2 \( \mu \text{S} \)/div.).

Output 1 Load Transient Response

Output 1 voltage response to load current step change (1-3-1 A) at:
- \( T_P = +25°C, V_i = 53 \text{ V} \)
- \( I_{O1} = I_{O2} = 0.4 \text{ A} \), \( I_{O3} = 0.15 \text{ A} \)

Top trace: output 1 voltage (0.2 V/div.).
Second trace: output 2 voltage (0.2 V/div.).
Third trace: output 3 voltage (1 V/div.).
Bottom trace: load current (2 A/div.).
Time scale: (0.2 ms/div.).
BMR 603 1204 DC/DC Converters
Input 32-60 V, Triple Output 33 W

5 V, 4 A / 3.3 V, 4 A / 9 V, 1.5 A / 33 W Typical Characteristics

Output 2 Load Transient Response

Output 3 Load Transient Response

Output Power Derating

Output 3 Derating

Available output power vs. ambient air temperature and airflow at \( V_i = 48 \) V, all outputs loaded simultaneously. See Thermal Consideration section.

Available output 3 voltage vs. load current with output 1 adjusted to 4.5 V at maximum reference temperature. (Higher output 3 current is available if output 1 is adjusted higher and at lower reference temperature.)
### Typical Characteristics

#### Output 1 voltage adjusted with resistance

![Graph](Image)

Voltage increases with a resistor between Vadj 1 and –IN (red trace).
Voltage decreases with a resistor between Vadj 1 and Vcc prim (blue trace).

#### Output 2 voltage adjusted with resistance

![Graph](Image)

Voltage increases with a resistor between Vadj 1 and Rtn (red trace).
Voltage decreases with a resistor between Vadj 1 and OUT2 (blue trace).

#### Output 3 voltage adjusted with resistance

![Graph](Image)

Voltage increases with a resistor between Vadj 1 and Rtn (red trace).
Voltage decreases with a resistor between Vadj 1 and OUT3 (blue trace).

#### Output 1 voltage adjusted with voltage

![Graph](Image)

Vadj 1 voltage is referred to –IN.

#### Output 2 voltage adjusted with voltage

![Graph](Image)

Vadj 2 voltage is referred to Rtn.

#### Output 3 voltage adjusted with voltage

![Graph](Image)

Vadj 3 voltage is referred to Rtn.
EMC Specification

Conducted EMI measured according to EN 55022, CISPR 22 and FCC part 15J (see test set-up). See Design Note 009 for further information. The fundamental switching frequency is 300 kHz for BMR 603 1204/1.

Conducted EMI Input terminal value (typ)

External filter (class B)
Required external input filter in order to meet class B in EN 55022, CISPR 22 and FCC part 15J.

Filter components:
- C1, C2, C6 = 1 µF
- C3, C4 = 2.2 nF
- C5 = 100 µF
- L1, L2 = 1.47 mH

(all three outputs are loaded)

Test set-up

Layout recommendations

The radiated EMI performance of the product will depend on the PCB layout and ground layer design. It is also important to consider the stand-off of the product. If a ground layer is used, it should be connected to the output of the product and the equipment ground or chassis.

A ground layer will increase the stray capacitance in the PCB and improve the high frequency EMC performance.

Output ripple and noise

Output ripple and noise measured according to figure below. See Design Note 022 for detailed information.

Output ripple and noise test setup (measured on all three outputs)
Operating information

Input Voltage
The input voltage range is 32 to 60 Vdc.
At input voltages exceeding 60 V, the power loss will be higher than at normal input voltage and T_P1 must be limited to absolute max +130°C. The absolute maximum continuous input voltage is 72 Vdc.

Turn-off Input Voltage
The product monitors the input voltage and will turn on and turn off at predetermined levels.
The minimum hysteresis between turn on and turn off input voltage is 1 V.

Remote Control (RC)
The product is fitted with a remote control function referenced to the primary negative input connection (-IN), with positive logic. The RC function allows the product to be turned on/off by an external device like a semiconductor or mechanical switch.

The maximum required sink current is 1 mA. When the RC pin is left open, the voltage generated on the RC pin is 8.8 - 10 V. The product is provided with "positive logic" remote control and will be on until the RC pin is connected to the -IN.
To turn off the product the voltage between RC pin and -IN should be less than 1V. To turn on the converter the RC pin should be left open, or connected to a voltage higher than 9 V referenced to -IN. In situations where it is desired to have the product to power up automatically without the need for control signals or a switch, the RC pin can be left open.

See Design Note 021 for detailed information.

Input and Output Impedance
The impedance of both the input source and the load will interact with the impedance of the product. It is important that the input source has low characteristic impedance. The product is designed for stable operation without external capacitors connected to the input or output. The performance in some applications can be enhanced by addition of external capacitance as described under External Decoupling Capacitors.

If the input voltage source contains significant inductance, the addition of a 22 - 100 µF capacitor across the input of the product will ensure stable operation. The capacitor is not required when powering the product from an input source with an inductance below 10 µH. The minimum required capacitance value depends on the output power and the input voltage. The higher output power the higher input capacitance is needed. Approximately doubled capacitance value is required for a 24 V input voltage source compared to a 48 V input voltage source.

External Decoupling Capacitors
When powering loads with significant dynamic current requirements, the voltage regulation at the point of load can be improved by addition of decoupling capacitors at the load.
The most effective technique is to locate low ESR ceramic and electrolytic capacitors as close to the load as possible, using several parallel capacitors to lower the effective ESR. The ceramic capacitors will handle high-frequency dynamic load changes while the electrolytic capacitors are used to handle low frequency dynamic load changes. It is equally important to use low resistance and low inductance PCB layouts and cabling.

External decoupling capacitors will become part of the product’s control loop. The control loop is optimized for a wide range of external capacitance and the maximum recommended value that could be used without any additional analysis is found in the Electrical specification.
The ESR of the capacitors is a very important parameter. Stable operation is guaranteed with a capacitor of minimum 100 µF with a verified ESR value of >45 mΩ across the Output 2 connections.
For further information please contact your local Flex representative.

To avoid undershoot below -0.3 V on Output 1 during shut-down. Use a capacitor of minimum 100 µF across the Output 1 connections.

Output Voltage Adjust
The product has output voltage adjust pins for all outputs. These pins can be used to adjust the output voltages above or below the initial settings.
At increased output voltages the maximum power rating of the product remains the same, and the max output current must be decreased correspondingly.
The output voltages are adjusted with voltage on the adjust pins or by connecting resistors according to the table below:

<table>
<thead>
<tr>
<th>output</th>
<th>output voltage increases with a resistor between</th>
<th>output voltage decreases with a resistor between</th>
</tr>
</thead>
<tbody>
<tr>
<td>OUT1</td>
<td>Vadj 1 and –IN</td>
<td>Vadj 1 and Vcc-prim</td>
</tr>
<tr>
<td>OUT2</td>
<td>Vadj 2 and Rtn</td>
<td>Vadj 2 and OUT2</td>
</tr>
<tr>
<td>OUT3</td>
<td>Vadj 3 and Rtn</td>
<td>Vadj 3 and OUT3</td>
</tr>
</tbody>
</table>

Over Temperature Protection (OTP)
The product is protected from thermal overload by an internal over temperature shutdown circuit.
When T_P1 as defined in thermal consideration section exceeds 130°C the product will shut down. The product will make continuous attempts to start up (non-latching mode) and resume normal operation automatically when the temperature has dropped below the temperature threshold.
Over Current Protection (OCP)
The product include current limiting circuitry for protection at continuous overload. The output voltage will decrease towards zero for output currents in excess of max output current (max $I_O$). The product will resume normal operation after removal of the overload. The load distribution should be designed for the maximum output short circuit current specified.

Thermal Consideration

General
The product is designed to operate in different thermal environments and sufficient cooling must be provided to ensure reliable operation.

For products mounted on a PCB without a heat sink attached, cooling is achieved mainly by conduction, from the pins to the host board, and convection, which is dependant on the airflow across the product. Increased airflow enhances the cooling of the product. The Output Current Derating graph found in the Output section provides the available output current vs. ambient air temperature and air velocity at $V_I = 48$ V.

The product is tested on a 254 x 254 mm, 35 µm (1 oz), 8-layer test board mounted vertically in a wind tunnel with a cross-section of 608 x 203 mm.

Definition of product operating temperature
The product operating temperatures is used to monitor the temperature of the product, and proper thermal conditions can be verified by measuring the temperature at positions P1 and P2. The temperature at these positions ($T_{P1}$ and $T_{P2}$) should not exceed the maximum temperatures in the table below. The number of measurement points may vary with different thermal design and topology. Temperatures above maximum $T_{P1}$ and $T_{P2}$ measured at the reference points P1 and P2 are not allowed and may cause permanent damage.

<table>
<thead>
<tr>
<th>Position</th>
<th>Description</th>
<th>Max Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>Reference point</td>
<td>$T_{P1}=110^\circ C$</td>
</tr>
<tr>
<td>P2</td>
<td>MOSFET case</td>
<td>$T_{P2}=125^\circ C$</td>
</tr>
</tbody>
</table>
BMR 603 1204 DC/DC Converters
Input 32-60 V, Triple Output 33 W

Connections

<table>
<thead>
<tr>
<th>Pin</th>
<th>Designation</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3</td>
<td>NC</td>
<td>Not Connected</td>
</tr>
<tr>
<td>4-5</td>
<td>+IN</td>
<td>Positive input</td>
</tr>
<tr>
<td>6-7</td>
<td>-IN</td>
<td>Negative input</td>
</tr>
<tr>
<td>8</td>
<td>RC</td>
<td>Remote Control</td>
</tr>
<tr>
<td>9</td>
<td>Vcc-prim</td>
<td>Decrease OUT1</td>
</tr>
<tr>
<td>10</td>
<td>Vadj 1</td>
<td>Output 1 voltage adjust</td>
</tr>
<tr>
<td>11-14</td>
<td>NC</td>
<td>Not Connected</td>
</tr>
<tr>
<td>15</td>
<td>Vadj 3</td>
<td>Output 3 voltage adjust</td>
</tr>
<tr>
<td>16</td>
<td>OUT3</td>
<td>Output 3</td>
</tr>
<tr>
<td>17-19</td>
<td>Rtn</td>
<td>Return</td>
</tr>
<tr>
<td>20-21</td>
<td>OUT1</td>
<td>Output 1</td>
</tr>
<tr>
<td>22</td>
<td>Vadj 2</td>
<td>Output 2 voltage adjust</td>
</tr>
<tr>
<td>23-24</td>
<td>OUT2</td>
<td>Output 2</td>
</tr>
</tbody>
</table>
Mechanical Information

All component placements – whether shown as physical components or symbolical outline – are for reference only and are subject to change throughout the product’s life cycle, unless explicitly described and dimensioned in this drawing.
Assembly Information

**APPLICATION VIEW (detail)**
- Solder bump height typical: 0.3 [0.012]
- Before Reflow
- Collapsed bump height typical: 0.05 [0.002]
- After Reflow

**SIDE VIEW** - hot-air nozzle
Illustration of a recommended design for a hot-air repair nozzle for manual removal and re-mounting

**Clearance**
Min 3.00 [0.118]

All dimensions in mm [inch]
Tolerances unless specified
X ±0.26 [0.01], X±X ±0.18 [0.007]
(not applied on footprint or typical values)

All component placements – whether shown as physical components or symbolical outline – are for reference only and are subject to change throughout the product’s life cycle, unless explicitly described and dimensioned in this drawing.
Soldering Information
The product is intended for convection reflow or vapor phase reflow in Pb-free reflow processes.

The reflow profile should be optimised to avoid excessive heating of the product. It is recommended to have a sufficiently extended preheat time to ensure an even temperature across the host PCB and to minimize the time in reflow.

A no-clean flux is recommended to avoid entrapment of cleaning fluids in cavities inside the product or between the product and the host board, since cleaning residues may affect long time reliability and isolation voltage.

<table>
<thead>
<tr>
<th>Reflow process specifications¹</th>
<th>SnPb eutectic</th>
<th>Pb-free</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average ramp-up rate</td>
<td>N/A</td>
<td>3°C/s max</td>
</tr>
<tr>
<td>Typical solder melting (liquidus) temperature Tₘ</td>
<td>N/A</td>
<td>+221°C</td>
</tr>
<tr>
<td>Minimum reflow time above Tₘ</td>
<td>N/A</td>
<td>30 s</td>
</tr>
<tr>
<td>Minimum pin temperature T_PIN</td>
<td>N/A</td>
<td>+235°C</td>
</tr>
<tr>
<td>Peak product temperature TPRODUCT</td>
<td>N/A</td>
<td>+260°C</td>
</tr>
<tr>
<td>Average ramp-down rate</td>
<td>N/A</td>
<td>6°C/s max</td>
</tr>
<tr>
<td>Maximum time 25°C to peak</td>
<td>N/A</td>
<td>8 minutes</td>
</tr>
</tbody>
</table>

¹ Note: for mixed SnPb / Pb-free soldering, special recommendations apply.

Mixed Solder Process Recommendations
When using products with Pb-free solder bumps with SnPb paste on the host board, and thereby mixing SnPb with Pb-free solder, and reflowing at SnPb process temperatures (backwards compatibility), special recommendations apply:

An extended preheat time between +170°C and +180°C for 60 to 90s and a pin reflow temperature (T_PIN) between +220°C and +225°C for 30 to 60 s is recommended. Ramp-up, ramp-down and time limitations should be according to Pb-free reflow process specifications.

The extended preheat time and soak at reflow temperature will minimize temperature gradients and maximize the wetting and solder mixing in the final solder joints. The use of nitrogen reflow atmosphere will further improve the solder joint quality.

Pin Temperature Recommendations
Pin number 18/19 - or possibly pin 6/7, depending on host board layout - are chosen as reference locations for the minimum pin temperature recommendations since either of these will likely be the coolest solder joints during reflow.

Pb-free Solder Processes
For Pb-free solder processes, a pin temperature (T_PIN) in excess of the solder melting temperature (T_M, +217 to +221 °C for SnAgCu solder alloys) for more than 30 seconds, and a peak temperature of +235°C on all solder joints is recommended to ensure a reliable solder joint.

Maximum Product Temperature Requirements
Top of the product PCB near pin 1 is chosen as reference location for the maximum (peak) allowed product temperature (T_PRODUCT), since this will likely be the warmest part of the product during the reflow process.

Pb-free Solder Processes
For Pb-free solder processes, the product is qualified for MSL 3 according to IPC/JEDEC standard J-STD-020C. During reflow, T_PRODUCT must not exceed +260 °C at any time.
Surface Mount Assembly and Repair
The solder bumps of the product require particular care during assembly since the solder bumps are hidden between the host board and the product’s PCB. Special procedures are required for successful rework of these products.

Assembly
Automatic pick and place equipment should be used to mount the product on the host board. The use of a vision system, using the fiducials on the bottom side of the product for position control, will ensure adequate accuracy. Manual mounting of solder bump products is not recommended.

Note that the actual position of the pick up surface is not necessarily in the center of the product outline. Refer to mechanical drawing for actual location.

If necessary, it is recommended to fine tune the solder print aperture size to optimize the amount of deposited solder with consideration to screen thickness and solder print capability.

Repair
For a successful repair (removal and replacement) of a solder bump product, a dedicated rework system should be used. The rework system should preferably utilize a bottom side heater and a dedicated hot air nozzle to heat the solder bumps to reflow temperature.

The product is an open frame design with a pick up surface on a large central component. This pick up surface can not be used for removal with a vacuum nozzle since the component solder joints may have melted during the removal reflow.

In order not to damage the product and nearby components during removal and replacement with a new product, it is recommended to use a double wall design of the hot air nozzle to direct the air flow only to the edges of the product, see ‘Assembly Information’ in the mechanical drawing.

Dry Pack Information
Products intended for Pb-free reflow processes are delivered in standard moisture barrier bags according to IPC/JEDEC standard J-STD-033 (Handling, packing, shipping and use of moisture/reflow sensitivity surface mount devices). The SnPb option of this product is also delivered in dry packing.

Using products in high temperature Pb-free soldering processes requires dry pack storage and handling. In case the products have been stored in an uncontrolled environment and no longer can be considered dry, the modules must be baked according to J-STD-033.

Delivery Package Information
The surface mount version of the product is delivered in antistatic injection molded trays (Jedec design guide 4.10D standard).

<table>
<thead>
<tr>
<th>Tray Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
</tr>
<tr>
<td>Surface resistance</td>
</tr>
<tr>
<td>Baking</td>
</tr>
<tr>
<td>Tray capacity</td>
</tr>
<tr>
<td>Tray thickness</td>
</tr>
<tr>
<td>Tray weight</td>
</tr>
</tbody>
</table>

BMR 603 1204 DC/DC Converters
Input 32-60 V, Triple Output 33 W

Technical Specification 17
EN/LZT 146 406 R2A  Oct. 2017
© Flex
**Product Qualification Specification**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Characteristics</th>
<th>Temperature range</th>
<th>Number of cycles</th>
<th>Dwell/transfer time</th>
</tr>
</thead>
<tbody>
<tr>
<td>External visual inspection</td>
<td>IPC-A-610</td>
<td>Temperature range</td>
<td>Number of cycles</td>
<td>Dwell/transfer time</td>
</tr>
<tr>
<td>Change of temperature</td>
<td>IEC 60068-2-14 Na</td>
<td>Temperature range</td>
<td>Number of cycles</td>
<td>Dwell/transfer time</td>
</tr>
<tr>
<td>(Temperature cycling)</td>
<td></td>
<td>-40 to +100°C</td>
<td>1000</td>
<td>15 min/0-1 min</td>
</tr>
<tr>
<td>Cold (in operation)</td>
<td>IEC 60068-2-1 Ad</td>
<td>Temperature T_A</td>
<td>Duration</td>
<td>-45°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>72 h</td>
<td></td>
</tr>
<tr>
<td>Damp heat</td>
<td>IEC 60068-2-67 Cy</td>
<td>Temperature T_A</td>
<td>Duration</td>
<td>+85°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>85 % RH</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1000 hours</td>
</tr>
<tr>
<td>Dry heat</td>
<td>IEC 60068-2-2 Bd</td>
<td>Temperature</td>
<td>Duration</td>
<td>+125°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1000 h</td>
</tr>
<tr>
<td>Electrostatic discharge susceptibility</td>
<td>IEC 61340-3-1, JESD 22-A114</td>
<td>Human body model (HBM)</td>
<td>Machine Model (MM)</td>
<td>Class 2, 2000 V</td>
</tr>
<tr>
<td></td>
<td>IEC 61340-3-2, JESD 22-A115</td>
<td></td>
<td></td>
<td>Class 3, 200 V</td>
</tr>
<tr>
<td>Immersion in cleaning solvents</td>
<td>IEC 60068-2-45 XA Method 2</td>
<td>Water</td>
<td>Glycol ether</td>
<td>Isopropanol</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+55°C</td>
<td>+35°C</td>
<td>+35°C</td>
</tr>
<tr>
<td>Mechanical shock</td>
<td>IEC 60068-2-27 Ea</td>
<td>Peak acceleration</td>
<td>Duration</td>
<td>100 g</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6 ms</td>
</tr>
<tr>
<td>Moisture reflow sensitivity</td>
<td>J-STD-020C</td>
<td>level 1 (SnPb-eutectic)</td>
<td>level 3 (Pb Free)</td>
<td>225°C</td>
</tr>
<tr>
<td>Operational life test</td>
<td>MIL-STD-202G method 108A</td>
<td>Duration</td>
<td></td>
<td>1000 h</td>
</tr>
<tr>
<td>Resistance to soldering heat</td>
<td>IEC 60068-2-20 Tb Method 1A</td>
<td>Solder temperature</td>
<td></td>
<td>270°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10-13 s</td>
</tr>
<tr>
<td>Robustness of terminations</td>
<td>IEC 60068-2-21 Test Ua1</td>
<td>Through hole mount products</td>
<td></td>
<td>All leads</td>
</tr>
<tr>
<td></td>
<td>IEC 60068-2-21 Test Ue1</td>
<td>Surface mount products</td>
<td></td>
<td>All leads</td>
</tr>
<tr>
<td>Solderability</td>
<td>IEC 60068-2-58 test Td</td>
<td>Preconditioning</td>
<td>Temperature, SnPb Eutectic</td>
<td>Temperature, Pb-free</td>
</tr>
<tr>
<td></td>
<td>IEC 60068-2-20 test Ta</td>
<td>Preconditioning</td>
<td>Temperature, SnPb Eutectic</td>
<td>Temperature, Pb-free</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vibration, broad band random</td>
<td>IEC 60068-2-64 Fh, method 1</td>
<td>Frequency</td>
<td>Spectral density</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note 1: Only for products intended for reflow soldering (surface mount products)
Note 2: Only for products intended for wave soldering (hole mounted products)