**OKI-78SR Series**
Fixed Output 1.5 Amp SIP DC/DC Converters

**FEATURES**
- Ultra wide 7 to 36 VDC input range
- Fixed Outputs of 3.3 or 5 VDC up to 1.5 Amps
- Vertical or horizontal SIP-mount, small footprint package
- “No heat sink” direct replacement for 3-terminal 78xx-series linear regulators
- High efficiency with no external components
- Short circuit protection
- Outstanding thermal derating performance
- UL/EN/IEC 60950-1, 2nd Edition safety approvals

**PRODUCT OVERVIEW**
Fabricated on a 0.41 by 0.65 inch (10.4 by 16.5 mm) Single Inline Package (SIP) module, the OKI-78SR series are non-isolated switching regulator (SR) DC/DC power converters for embedded applications. The fixed single output converters offer both tight regulation and high efficiency directly at the power usage site and are a direct plug-in replacement for TO-220 package 78xx series linear regulators. Typically, no extra outside components are required.

Two nominal output voltages are offered (3.3 and 5 VDC), each with 1.5 Amp maximum output. Based on fixed-frequency buck switching topology, the high efficiency means very low heat and little electrical noise, requiring no external components. The ultra wide input range is 7 to 36 Volts DC.

Protection features include short circuit current limit protection. The OKI-78SR is designed to meet all standards approvals. RoHS-6 (no lead) hazardous material compliance is specified as standard.

**CONNECTION DIAGRAM**

- **F1**
- **+Vin**
- **+Vout**
- **Common**
- **Controller**
- **Switching**
- **Filters**
- **Current Sense**
- **Reference and Error Amplifier**
- **RLoad**

Note: Murata Power Solutions strongly recommends an external input fuse, F1. See specifications.
FUNCTIONAL SPECIFICATIONS SUMMARY AND ORDERING GUIDE

<table>
<thead>
<tr>
<th>Output</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vout (Volts)</td>
<td>Vout Nom. (Volts)</td>
</tr>
<tr>
<td>Iout (Amps max)</td>
<td>Range (Volts)</td>
</tr>
<tr>
<td>Power (Watts)</td>
<td>Im, no load (mA)</td>
</tr>
<tr>
<td>R/N (mVp-p)</td>
<td>Im, full load (Amps)</td>
</tr>
<tr>
<td>Regulation (Typ.)</td>
<td>Min. Typ.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Root Model</th>
<th>Vout</th>
<th>Iout</th>
<th>Power</th>
<th>R/N (mVp-p)</th>
<th>Regulation (Typ.)</th>
<th>Vout Nom.</th>
<th>Range</th>
<th>Im, no load</th>
<th>Im, full load</th>
<th>Min.</th>
<th>Typ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>OKI-78SR-3.3/1.5-W36-C</td>
<td>3.3</td>
<td>1.5</td>
<td>4.95</td>
<td>40</td>
<td>±0.25%</td>
<td>24</td>
<td>7-36</td>
<td>5</td>
<td>0.48</td>
<td>84%</td>
<td>85.5%</td>
</tr>
<tr>
<td>OKI-78SR-5/1.5-W36-C</td>
<td>5</td>
<td>1.5</td>
<td>7.5</td>
<td>75</td>
<td>±0.25%</td>
<td>24</td>
<td>7-36</td>
<td>5</td>
<td>0.69</td>
<td>89%</td>
<td>90.5%</td>
</tr>
</tbody>
</table>

Dimensions are in inches (mm).

All specifications are at nominal line voltage, Vout = nominal and full load, +25 ˚C., with no external capacitor, unless otherwise noted.

PART NUMBER STRUCTURE

Product Label

Because of the small size of these products, the product label contains a character-reduced code to indicate the model number and manufacturing date code. Not all items on the label are always used. Please note that the label differs from the product photograph on page 1. Here is the layout of the label: The label contains three rows of information:

- First row – Murata Power Solutions logo
- Second row – Model number product code (see table)
- Third row – Manufacturing date code and revision level

The manufacturing date code is four characters:

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Product Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>OKI-78SR-3.3/1.5-W36-C</td>
<td>I33115</td>
</tr>
<tr>
<td>OKI-78SR-5/1.5-W36-C</td>
<td>I50115</td>
</tr>
<tr>
<td>OKI-78SR-3.3/1.5-W36H-C</td>
<td>I33115H</td>
</tr>
<tr>
<td>OKI-78SR-5/1.5-W36H-C</td>
<td>I50115H</td>
</tr>
</tbody>
</table>

First character – Last digit of manufacturing year, example 2009
Second character – Month code (1 through 9 = Jan-Sep; 0, N, D = Oct, Nov, Dec)
Third character – Day code (1 through 9 = 1 to 9, 10 = 0 and 11 through 31 = A through Z)
Fourth character – Manufacturing information

www.murata-ps.com/support
**Performance and Functional Specifications**

**Input**
- Input Voltage Range: See Ordering Guide.
- Recommended External Fuse: 2 Amps fast blow
- Reverse Polarity Protection (Note 9): None. Install an external fuse.
- Isolation (note 5): Not isolated. The input and output share a common return.
- Start-Up Voltage: NA
- Undervoltage Shutdown: NA
- Overvoltage Shutdown: None
- Internal Input Filter Type: Capacitive
- Input Current: See Ordering Guide
- Inrush Transient: 0.16 A/Sec.
- Shutdown Mode (Off, UV, OT): 1 mA
- Output in Short Circuit: 5 mA
- No Load: 5 mA
- Low Line (Vin=Vmin, Vout=Vnom): 0.8 Amps (OKI-78SR-3.3/1.5-W36)
- 1.16 Amps (OKI-78SR-5/1.5-W36)
- Reflect (Back) Ripple Current (Note 2): 10 mA pk-pk (OKI-78SR-3.3/1.5-W36)
- 49 mA pk-pk (OKI-78SR-5/1.5-W36)

**Output**
- Output Voltage: See Ordering Guide
- Output Current Range: 0 to 1.5 Amps
- Minimum Loading (Note 11): No minimum load
- Maximum Output Power: 5.15 Watts (OKI-78SR-3.3/1.5-W36)
- 7.8 Watts (OKI-78SR-5/1.5-W36)
- Efficiency: See Ordering Guide and performance graphs
- Overvoltage Protection (Note 7): None
- Temperature Coefficient: ±0.02% per °C of Vout range
- Ripple/Noise (20 MHz bandwidth) and note 11
- Line/Load Regulation: See Ordering Guide and note 10
- Maximum Capacitive Loading:
  - Cap-ESR=0.001 to 0.01 Ohms: 300 μF
  - Cap-ESR >0.01 Ohms: 3300 μF
- Current Limit Inception: 3.5 Amps
- Short Circuit Mode (Notes 6, 11):
  - Short Circuit Current: 10 mA
  - Protection Method: Hiccup autorecovery upon overload removal. (Note 8)
  - Short Circuit Duration: Continuous, no damage (output shorted to ground)
  - Prebias Startup: The converter will start up if the external output voltage is less than Vnominal.

**Dynamic Characteristics**
- Dynamic Load Response: 500 KHz
- dv/dt = 1A/JSec: 25 μSec settling time to within ±2% of final value
- Peak deviation: 100 mV

---

**Environmental**

<table>
<thead>
<tr>
<th>Specification</th>
<th>OKI-78SR-3.3/1.5-W36-C</th>
<th>OKI-78SR-5/1.5-W36-C</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTBF (Note 4)</td>
<td>Ambient Temp. Hours</td>
<td></td>
</tr>
<tr>
<td>OKI-78SR-3.3/1.5-W36-C</td>
<td>+25°C</td>
<td>78,721,000</td>
</tr>
<tr>
<td>OKI-78SR-5/1.5-W36-C</td>
<td>+25°C</td>
<td>59,017,000</td>
</tr>
</tbody>
</table>

**Specifications Notes:**

1. All specifications are typical unless noted. General conditions for Specifications are +25 deg C, ambient temperature, Vin=Vnominal, Vout=Vnominal, full rated load. Adequate airflow must be supplied for extended testing under power. See Derating curves.
2. All models are tested and specified with no external capacitors. All models are stable and regulate within spec under no-load conditions.
3. Note that Maximum Power Derating curves indicate an average current at nominal input voltage. At higher temperatures and/or lower airflow, the DC/DC converter will tolerate brief full current outputs if the total RMS current over time does not exceed the Derating curve. All Derating curves are presented near sea level altitude. Be aware of reduced power dissipation with increasing altitude.
4a. Mean Time Before Failure is calculated using the Telcordia (Bellcore) SR-332 Method 1, Case 3, ground fixed conditions, Tpcboard=+25°C, full output load, natural air convection.
4b. Mean Time Before Failure is calculated using the MIL-HDBK-217N2 method, ground benign, +25°C, full output load, natural convection.
5. The input and output are not isolated. They share a single COMMON power and signal return.
6. Short circuit shutdown begins when the output voltage degrades approximately 2% from the selected setting. Output current limit and short circuit protection are non-latching. When the overcurrent fault is removed, the converter will immediately recover.
7. The output is not intended to sink appreciable reverse current.
8. *“Hiccup” overcurrent operation repeatedly attempts to restart the converter with a brief, full-current output. If the overcurrent condition still exists, the restart current will be removed and then tried again. This short current pulse prevents overheating and damaging the converter.
9. Input Fusing: If reverse polarity is accidentally applied to the input, to ensure reverse input protection, always connect an external input fast-blow fuse in series with the +Vin input. Use approximately twice the full input current rating with nominal input voltage.
10. Regulation specifications describe the deviation as the line input voltage or output load current is varied from a nominal midpoint value to either extreme.
11. Output noise may be further reduced by installing an external filter. Do not exceed the maximum output capacitance. At zero output current and no external capacitor, the output may contain low frequency components which exceed the ripple specification. The output may be operated indefinitely with no load.
PERFORMANCE DATA – OKI-78SR-3.3/1.5-W36

Efficiency vs. Line Voltage and Load Current @ +25°C, (Vout = Vnom.)

Maximum Current Temperature Derating at sea level (Vin=7V to 36V.)

Output Ripple and Noise (Vin=7V, Vout=nominal, Iout=1.6A, Cload=0, Ta=+25°C., ScopeBW=100MHz)

Output Ripple and Noise (Vin=12V, Vout=nominal, Iout=1.6A, Cload=0, Ta=+25°C., ScopeBW=100MHz)

Output Ripple and Noise (Vin=36V, Vout=nominal, Iout=1.6A, Cload=0, Ta=+25°C., ScopeBW=100MHz)
PERFORMANCE DATA – OKI-78SR-3.3/1.5-W36

Step Load Transient Response (Vin=7V, Vout=nominal, Cload=0, Iout=0.75A to 1.5A, Slew=1A/μS, Ta=+25˚C.) Trace 2=Vout, 100 mV/div. Trace 4=Iout, 0.5A/div.

Step Load Transient Response (Vin=12V, Vout=nominal, Cload=0, Iout=0.75A to 1.5A, Slew=1A/μS, Ta=+25˚C.) Trace 2=Vout, 100 mV/div. Trace 4=Iout, 0.5A/div.

Step Load Transient Response (Vin=7V, Vout=nominal, Cload=0, Iout=1.5A to 0.75A, Slew=1A/μS, Ta=+25˚C.) Trace 2=Vout, 100 mV/div. Trace 4=Iout, 0.5A/div.

Step Load Transient Response (Vin=12V, Vout=nominal, Cload=0, Iout=1.5A to 0.75A, Slew=1A/μS, Ta=+25˚C.) Trace 2=Vout, 100 mV/div. Trace 4=Iout, 0.5A/div.
PERFORMANCE DATA – OKI-78SR-5/1.5-W36

Efficiency vs. Line Voltage and Load Current @ +25˚C, (Vout = Vnom.)

Maximum Current Temperature Derating at sea level (Vin=7V. to 36V.)

Output Ripple and Noise (Vin=7V, Vout=nominal, Iout=1.6A, Cload=0, Ta=+25˚C., ScopeBW=100MHz)

Output Ripple and Noise (Vin=12V, Vout=nominal, Iout=1.6A, Cload=0, Ta=+25˚C., ScopeBW=100MHz)

Output Ripple and Noise (Vin=36V, Vout=nominal, Iout=1.6A, Cload=0, Ta=+25˚C., ScopeBW=100MHz)
## PERFORMANCE DATA – OKI-78SR-5/1.5-W36

<table>
<thead>
<tr>
<th>Description</th>
<th>Trace 2</th>
<th>Trace 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step Load Transient Response (Vin=7V, Vout=nominal, Cload=0, Iout=1.5A to 0.75A, Slew=1A/μS, Ta=+25°C)</td>
<td>100mV/div</td>
<td>0.5A/div</td>
</tr>
<tr>
<td>Trace 2=Vout, 100 mV/div. Trace 4=Iout, 0.5A/div.</td>
<td>100mV/div</td>
<td>0.5A/div</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>Trace 2</th>
<th>Trace 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step Load Transient Response (Vin=12V, Vout=nominal, Cload=0, Iout=1.5A to 0.75A, Slew=1A/μS, Ta=+25°C)</td>
<td>100mV/div</td>
<td>0.5A/div</td>
</tr>
<tr>
<td>Trace 2=Vout, 100 mV/div. Trace 4=Iout, 0.5A/div.</td>
<td>100mV/div</td>
<td>0.5A/div</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>Trace 2</th>
<th>Trace 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step Load Transient Response (Vin=36V, Vout=nominal, Cload=0, Iout=1.5A to 0.75A, Slew=1A/μS, Ta=+25°C)</td>
<td>100mV/div</td>
<td>0.5A/div</td>
</tr>
<tr>
<td>Trace 2=Vout, 100 mV/div. Trace 4=Iout, 0.5A/div.</td>
<td>100mV/div</td>
<td>0.5A/div</td>
</tr>
</tbody>
</table>
MECHANICAL SPECIFICATIONS, VERTICAL MOUNT

**Pin #1**

- Pin Material: Copper Alloy
- Pin Finish: Pure Matte Tin 100-300 μ" over 75-150 μ" Nickel

**Pin #3**

- Dimensions: 0.030 ± 0.002

**INPUT/OUTPUT CONNECTIONS**

<table>
<thead>
<tr>
<th>Pin</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Positive Input</td>
</tr>
<tr>
<td>2</td>
<td>Common (Ground)</td>
</tr>
<tr>
<td>3</td>
<td>Positive Output</td>
</tr>
</tbody>
</table>

**Tolerances (unless otherwise specified):**
- XX = 0.02 (0.5)
- XXX = 0.010 (0.25)
- Angles ± 1°

Components are shown for reference only.

Dimensions are in inches (mm shown for ref. only).
MECHANICAL SPECIFICATIONS, HORIZONTAL MOUNT

Pin #1

PIN MATERIAL: COPPER ALLOY
PIN FINISH: PURE MATTE TIN 100-300 µ"
OVER 75-150 µ" NICKEL

INPUT/OUTPUT CONNECTIONS

<table>
<thead>
<tr>
<th>Pin</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Positive Input</td>
</tr>
<tr>
<td>2</td>
<td>Common (Ground)</td>
</tr>
<tr>
<td>3</td>
<td>Positive Output</td>
</tr>
</tbody>
</table>

Tolerances (unless otherwise specified):

XX ± 0.02 (0.5)
XXX ± 0.010 (0.25)
Angles ± 1°

Dimensions are in inches (mm shown for ref. only).

Components are shown for reference only.
STANDARD PACKAGING

Each static dissipative polyethylene foam tray accommodates 120 converters

Dimensions are in inches (mm shown for ref. only).

Components are shown for reference only.

Tolerances (unless otherwise specified):
- .XX ± 0.02 (0.5)
- .XXX ± 0.010 (0.25)
- Angles ± 2°

Notes:
1. Material: Dow 220 antistat ethafoam (Density: 34-35 kg/m³)
2. Dimensions: 252 x 252 x 16 mm
   8 x 15 array (120 per tray)

Carton accommodates three (3) trays of 120 yielding 360 converters per carton.

Dimensions are in inches (mm shown for ref. only).

Tolerances (unless otherwise specified):
- .XX ± 0.02 (0.5)
- .XXX ± 0.010 (0.25)
- Angles ± 2°

Components are shown for reference only.
Input Fusing

Certain applications and/or safety agencies may require fuses at the inputs of power conversion components. Fuses should also be used when there is the possibility of sustained input voltage reversal which is not current-limited. For greatest safety, we recommend a fast blow fuse installed in the ungrounded input supply line.

The installer must observe all relevant safety standards and regulations. For safety agency approvals, install the converter in compliance with the end-user safety standard.

Recommended Input Filtering

The user must assure that the input source has low AC impedance to provide dynamic stability and that the input supply has little or no inductive content, including long distributed wiring to a remote power supply. The converter will operate with no additional external capacitance if these conditions are met.

For best performance, we recommend installing a low-ESR capacitor immediately adjacent to the converter’s input terminals. The capacitor should be a ceramic type such as the Murata GRM32 series or a polymer type. Initial suggested capacitor values are 10 to 22 μF, rated at twice the expected maximum input voltage. Make sure that the input terminals do not go below the undervoltage shutdown voltage at all times. More input bulk capacitance may be added in parallel (either electrolytic or tantalum) if needed.

Recommended Output Filtering

The converter will achieve its rated output ripple and noise with no additional external capacitor. However, the user may install more external output capacitance to reduce the ripple even further or for improved dynamic response. Again, use low-ESR ceramic (Murata GRM32 series) or polymer capacitors. Initial values of 10 to 47 μF may be tried, either single or multiple capacitors in parallel. Mount these close to the converter. Measure the output ripple under your load conditions.

Use only as much capacitance as required to achieve your ripple and noise objectives. Excessive capacitance can make step load recovery sluggish or possibly introduce instability. Do not exceed the maximum rated output capacitance listed in the specifications.

Input Ripple Current and Output Noise

All models in this converter series are tested and specified for input reflected ripple current and output noise using designated external input/output components, circuits and layout as shown in the following figures. The Cbus and Lbus components simulate a typical DC voltage bus. Please note that the values of Cin, Lbus and Cbus will vary according to the specific converter model.
Minimum Output Loading Requirements
All models regulate within specification and are stable under no load to full load conditions. Operation under no load might however slightly increase output ripple and noise.

Temperature Derating Curves
The graphs in this data sheet illustrate typical operation under a variety of conditions. The Derating curves show the maximum continuous ambient air temperature and decreasing maximum output current which is acceptable under increasing forced airflow measured in Linear Feet per Minute (“LFM”). Note that these are AVERAGE measurements. The converter will accept brief increases in current or reduced airflow as long as the average is not exceeded.

Note that the temperatures are of the ambient airflow, not the converter itself which is obviously running at higher temperature than the outside air. Also note that “natural convection” is defined as very flow rates which are not using fan-forced airflow. Depending on the application, “natural convection” is usually about 30-65 LFM but is not equal to still air (0 LFM).

Murata Power Solutions makes Characterization measurements in a closed cycle wind tunnel with calibrated airflow. We use both thermocouples and an infrared camera system to observe thermal performance. As a practical matter, it is quite difficult to insert an anemometer to precisely measure airflow in most applications. Sometimes it is possible to estimate the effective airflow if you thoroughly understand the enclosure geometry, entry/exit orifice areas and the fan flowrate specifications.

CAUTION: If you routinely or accidentally exceed these Derating guidelines, the converter may have an unplanned Over Temperature shut down. Also, these graphs are all collected at near Sea Level altitude. Be sure to reduce the derating for higher altitude.

Soldering Guidelines
Murata Power Solutions recommends the specifications below when installing these converters. These specifications vary depending on the solder type. Exceeding these specifications may cause damage to the product. Your production environment may differ; therefore please thoroughly review these guidelines with your process engineers.

<table>
<thead>
<tr>
<th>Wave Solder Operations for through-hole mounted products (THMT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>For Sn/Ag/Cu based solder: Maximum Preheat Temperature 115° C.</td>
</tr>
<tr>
<td>For Sn/Pb based solder: Maximum Preheat Temperature 105° C.</td>
</tr>
<tr>
<td>Maximum Pot Temperature 270° C. Maximum Solder Dwell Time 7 seconds</td>
</tr>
<tr>
<td>Maximum Pot Temperature 250° C. Maximum Solder Dwell Time 6 seconds</td>
</tr>
</tbody>
</table>

Output Fusing
The converter is extensively protected against current, voltage and temperature extremes. However your output application circuit may need additional protection. In the extremely unlikely event of output circuit failure, excessive voltage could be applied to your circuit. Consider using an appropriate fuse in series with the output.

Output Current Limiting
Current limiting inception is defined as the point at which full power falls below the rated tolerance. See the Performance/Functional Specifications. Note particularly that the output current may briefly rise above its rated value in normal operation as long as the average output power is not exceeded. This enhances reliability and continued operation of your application. If the output current is too high, the converter will enter the short circuit condition.

Output Short Circuit Condition
When a converter is in current-limit mode, the output voltage will drop as the output current demand increases. If the output voltage drops too low (approximately 98% of nominal output voltage for most models), the bias voltage may shut down the PWM controller. Following a time-out period, the PWM will restart, causing the output voltage to begin rising to its appropriate value. If the short-circuit condition persists, another shutdown cycle will initiate. This rapid on/off cycling is called “hiccup mode”. The hiccup cycling reduces the average output current, thereby preventing excessive internal temperatures and/or component damage.

The “hiccup” system differs from older latching short circuit systems because you do not have to power down the converter to make it restart. The system will automatically restore operation as soon as the short circuit condition is removed.

Murata Power Solutions, Inc.
11 Cabot Boulevard, Mansfield, MA 02048-1151 U.S.A.
ISO 9001 and 14001 REGISTERED

www.murata-ps.com/support