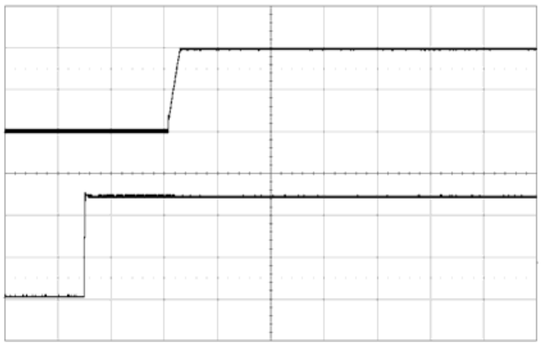
Typical Characteristics
Start-up and shut-down

BMR 463 2002 (SIP)

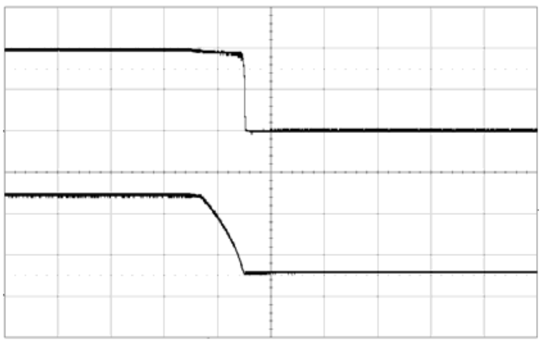
Start-up by input source



Start-up enabled by connecting V_I at:
T_{P1} = +25°C, V_I = 12 V, V_O = 1.0 V
C_O = 470 µF/10 mΩ, I_O = 20 A

Top trace: output voltage (0.5 V/div.).
Bottom trace: input voltage (5 V/div.).
Time scale: (20 ms/div.).

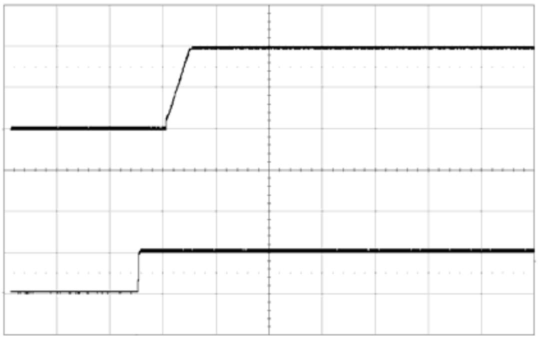
Shut-down by input source



Shut-down enabled by disconnecting V_I at:
T_{P1} = +25°C, V_I = 12 V, V_O = 1.0 V
C_O = 470 µF/10 mΩ, I_O = 20 A

Top trace: output voltage (0.5 V/div).
Bottom trace: input voltage (5 V/div.).
Time scale: (2 ms/div.).

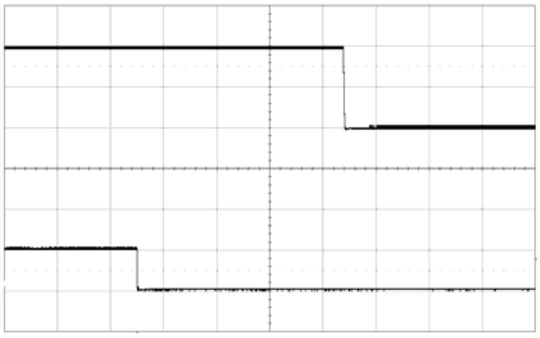
Start-up by CTRL signal



Start-up by enabling CTRL signal at:
T_{P1} = +25°C, V_I = 12 V, V_O = 1.0 V
C_O = 470 µF/10 mΩ, I_O = 20 A

Top trace: output voltage (0.5 V/div.).
Bottom trace: CTRL signal (5 V/div.).
Time scale: (20 ms/div.).

Shut-down by CTRL signal



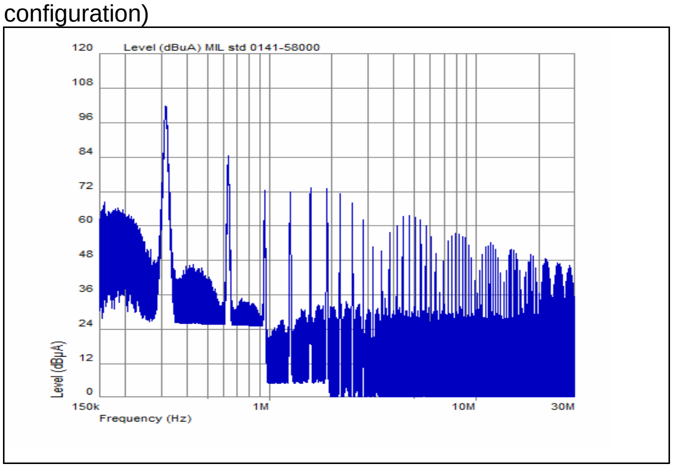
Shut-down enabled by disconnecting V_I at:
T_{P1} = +25°C, V_I = 12 V, V_O = 1.0 V
C_O = 470 µF/10 mΩ, I_O = 20 A

Top trace: output voltage (0.5 V/div).
Bottom trace: CTRL signal (5 V/div.).
Time scale: (2 ms/div.).

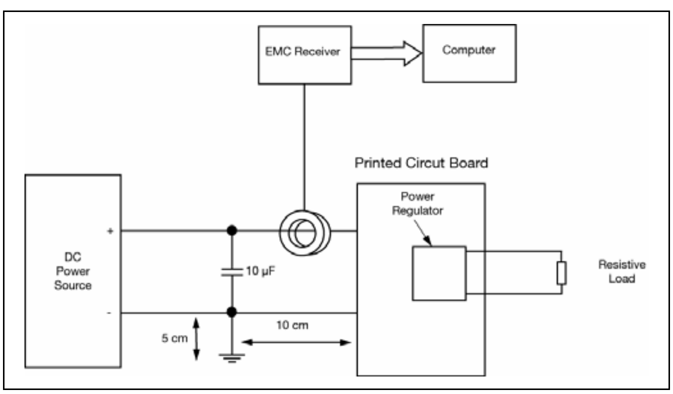
EMC Specification

Conducted EMI measured according to test set-up and standard MIL std 0141 - 58000.
The fundamental switching frequency is 320 kHz for BMR463 at V_I = 12.0 V, max I_O.

Conducted EMI Input terminal value (typical for default configuration)



EMI without filter



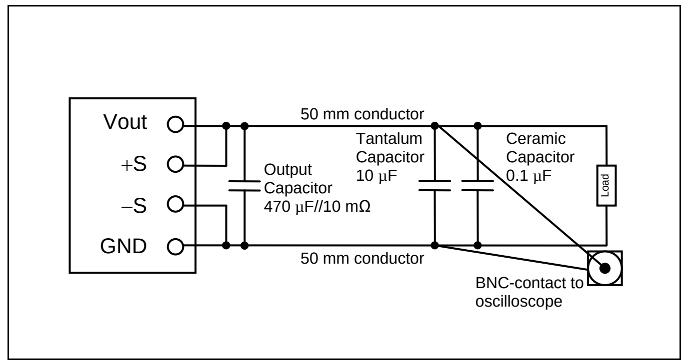
Test set-up

Layout Recommendations

The radiated EMI performance of the product will depend on the PWB 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 PWB and improve the high frequency EMC performance.

Output Ripple and Noise

Output ripple and noise is measured according to figure below. A 50 mm conductor works as a small inductor forming together with the two capacitances a damped filter.



Output ripple and noise test set-up.

Operating information

Power Management Overview

This product is equipped with a PMBus interface. The product incorporates a wide range of readable and configurable power management features that are simple to implement with a minimum of external components. Additionally, the product includes protection features that continuously safeguard the load from damage due to unexpected system faults. A fault is also shown as an alert on the SALERT pin.
The following product parameters can continuously be monitored by a host: Input voltage, output voltage/current, and internal temperature. If the monitoring is not needed it can be disabled and the product enters a low power mode reducing the power consumption. The protection features are not affected.
The product is delivered with a default configuration suitable for a wide range operation in terms of input voltage, output voltage, and load. The configuration is stored in an internal Non-Volatile Memory (NVM). All power management functions can be reconfigured using the PMBus interface. Please contact your local Ericsson Power Modules representative for design support of custom configurations or appropriate SW tools for design and down-load of your own configurations.

Input Voltage

The input voltage range, 4.5 - 14 V, makes the product easy to use in intermediate bus applications when powered by a non-regulated bus converter or a regulated bus converter. See Ordering Information for input voltage range.

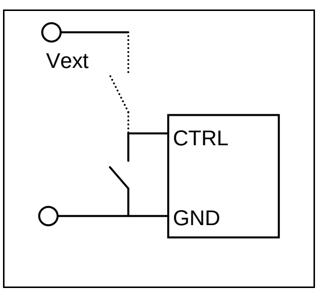
Input Under Voltage Lockout, UVLO

The product monitors the input voltage and will turn-on and turn-off at configured levels. The default turn-on input voltage level setting is 4.20 V, whereas the corresponding turn-off input voltage level is 3.85 V. Hence, the default hysteresis between turn-on and turn-off input voltage is 0.35 V. Once an input turn-off condition occurs, the device can respond in a number of ways as follows:

1. Continue operating without interruption. The unit will continue to operate as long as the input voltage can be supported. If the input voltage continues to fall, there will come a point where the unit will cease to operate.
2. Continue operating for a given delay period, followed by shutdown if the fault still exists. The device will remain in shutdown until instructed to restart.
3. Initiate an immediate shutdown until the fault has been cleared. The user can select a specific number of retry attempts.

The default response from a turn-off is an immediate shutdown of the device. The device will continuously check for the presence of the fault condition. If the fault condition is no longer present, the product will be re-enabled. The turn-on and turn-off levels and response can be reconfigured using the PMBus interface.

Remote Control



The product is equipped with a remote control function, i.e., the CTRL pin. The remote control can be connected to either the primary negative input connection (GND) or an external voltage (Vext), which is a 3 - 5 V positive supply voltage in accordance to the SMBus Specification version 2.0.

The CTRL function allows the product to be turned on/off by an external device like a semiconductor or mechanical switch. By default the product will turn on when the CTRL pin is left open and turn off when the CTRL pin is applied to GND. The CTRL pin has an internal pull-up resistor. When the CTRL pin is left open, the voltage generated on the CTRL pin is max 5.5 V.
If the device is to be synchronized to an external clock source, the clock frequency must be stable prior to asserting the CTRL pin.
The product can also be configured using the PMBus interface to be “Always on”, or turn on/off can be performed with PMBus commands.

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 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 a capacitor with low ESR at the input of the product will ensure stable operation.

External Capacitors

Input capacitors:
The input ripple RMS current in a buck converter is equal to

Eq. 1. $I_{inputRMS} = I_{load}\sqrt{D(1-D)}$,

where I_{load} is the output load current and D is the duty cycle. The maximum load ripple current becomes $I_{load}/2$. The ripple current is divided into three parts, i.e., currents in the input source, external input capacitor, and internal input capacitor. How the current is divided depends on the impedance of the input source, ESR and capacitance values in the capacitors. A minimum capacitance of 300 µF with low ESR is recommended. The ripple current rating of the capacitors must follow Eq. 1. For high-performance/transient applications or wherever the input source performance is degraded, additional low ESR ceramic type capacitors at the input is recommended. The additional input low ESR capacitance above the minimum level insures an optimized performance.

Output 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 capacitors in parallel 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. Ceramic capacitors will also reduce high frequency noise at the load.
It is equally important to use low resistance and low inductance PWB layouts and cabling.
External decoupling capacitors are a part of the control loop of the product and may affect the stability margins.
Stable operation is guaranteed for the following total capacitance C_O in the output decoupling capacitor bank where

Eq. 2. $C_O = [C_{\min}, C_{\max}] = [300, 15000]$ µF.

The decoupling capacitor bank should consist of capacitors which has a capacitance value larger than $C \geq C_{\min}$ and has an ESR range of

Eq. 3. $ESR = [ESR_{\min}, ESR_{\max}] = [5, 30]$ mΩ

The control loop stability margins are limited by the minimum time constant $\tau_{\min}$ of the capacitors. Hence, the time constant of the capacitors should follow Eq. 4.

Eq. 4. $\tau \geq \tau_{\min} = C_{\min} ESR_{\min} = 1.5\ \mu s$

This relation can be used if your preferred capacitors have parameters outside the above stated ranges in Eq. 2 and Eq.3.

- If the capacitors capacitance value is $C < C_{\min}$ one must use at least N capacitors where $N \geq \left\lceil \frac{C_{\min}}{C} \right\rceil$ and $ESR \geq ESR_{\min} \frac{C_{\min}}{C}$.
- If the ESR value is $ESR > ESR_{\max}$ one must use at least N capacitors of that type where

$$N \geq \left\lceil \frac{ESR}{ESR_{\max}} \right\rceil \text{ and } C \geq \frac{C_{\min}}{N} .$$

- If the ESR value is $ESR < ESR_{\min}$ the capacitance value should be

$$C \geq C_{\min} \frac{ESR_{\min}}{ESR} .$$

For a total capacitance outside the above stated range or capacitors that do not follow the stated above requirements above a re-design of the control loop parameters will be necessary for robust dynamic operation and stability.

Control Loop Compensation

The product is configured with a robust control loop compensation which allows for a wide range operation of input and output voltages and capacitive loads as defined in the section External Decoupling Capacitors. For an application with a specific input voltage, output voltage, and capacitive load, the control loop can be optimized for a robust and stable operation and with an improved load transient response. This optimization will minimize the amount of required output decoupling capacitors for a given load transient requirement yielding an optimized cost and minimized board space. The control loop parameters can be reconfigured using the PMBus interface.

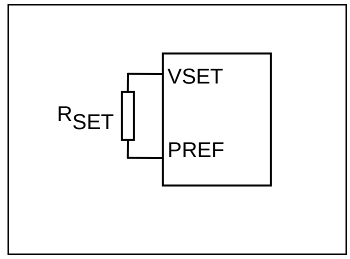
Load Transient Response Optimization

The product incorporates a Non-Linear transient Response, NLR, loop that decreases the response time and the output voltage deviation during a load transient. The NLR results in a higher equivalent loop bandwidth than is possible using a traditional linear control loop. The product is pre-configured with appropriate NLR settings for robust and stable operation for a wide range of input voltage and a capacitive load range as defined in the section External Decoupling Capacitors. For an application with a specific input voltage, output voltage, and capacitive load, the NLR configuration can be optimized for a robust and stable operation and with an improved load transient response. This will also reduce the amount of output decoupling capacitors and yield a reduced cost. However, the NLR slightly reduces the efficiency. In order to obtain maximal energy efficiency the load transient requirement has to be met by the standard control loop compensation and the decoupling capacitors. The NLR settings can be reconfigured using the PMBus interface.

Remote Sense

The product has remote sense that can be used to compensate for voltage drops between the output and the point of load. The sense traces should be located close to the PWB ground layer to reduce noise susceptibility. Due to derating of internal output capacitance the voltage drop should be kept below $V_{DROPMAX} = (5.5 - V_{OUT})/2$. A large voltage drop will impact the electrical performance of the regulator. If the remote sense is not needed +S should be connected to VOUT and −S should be connected to GND.

Output Voltage Adjust using Pin-strap Resistor



Using an external Pin-strap resistor, R_{SET}, the output voltage can be set in the range 0.6 V to 3.3 V at 28 different levels shown in the table below. The resistor should be applied between the VSET pin and the PREF pin.

R_{SET} also sets the maximum output voltage, see section "Output Voltage Range Limitation". The resistor is sensed only during product start-up. Changing the resistor value during normal operation will not change the output voltage. The input voltage must be at least 1 V larger than the output voltage in order to deliver the correct output voltage. See Ordering Information for output voltage range.

The following table shows recommended resistor values for R_{SET}. Maximum 1% tolerance resistors are required.

V_{OUT} [V]	R_{SET}[kΩ]	V_{OUT} [V]	R_{SET}[kΩ]
0.60	10	1.50	46.4
0.65	11	1.60	51.1
0.70	12.1	1.70	56.2
0.75	13.3	1.80	61.9
0.80	14.7	1.90	68.1
0.85	16.2	2.00	75
0.90	17.8	2.10	82.5
0.95	19.6	2.20	90.9
1.00	21.5	2.30	100
1.05	23.7	2.50	110
1.10	26.1	3.00	121
1.15	28.7	3.30	133
1.20	31.6		
1.25	34.8		
1.30	38.3		
1.40	42.2		

The output voltage and the maximum output voltage can be pin strapped to three fixed values by connecting the VSET pin according to the table below.

V_{OUT} [V]	VSET
0.60	Shorted to PREF
1.2	Open "high impedance"
2.5	Logic High, GND as reference

Output Voltage Adjust using PMBus

The output voltage of the product can be configured using the PMBus interface in the range 0.54 to 3.63 V. See Ordering Information for output voltage range.

Output Voltage Range Limitation

The output voltage range configurable by the PMBus interface is limited by the pin-strap resistor $R_{SET.}$ R_{SET} sets the maximum output voltage to approximately 110% of the nominal output value, $V_{OUTMAX} = 1.1 \times V_{OUT} - calibration\_offset$, where calibration offset is max 70 mV. A PMBus command can not set the output voltage higher than V_{OUTMAX} . This protects the load from an over voltage due to an accidental wrong PMBus command.

Over Voltage Protection (OVP)

The product includes over voltage limiting circuitry for protection of the load. The default OVP limit is 15% above the nominal output voltage. If the output voltage exceeds the OVP limit, the product can respond in different ways:

1. Initiate an immediate shutdown until the fault has been cleared. The user can select a specific number of retry attempts.
2. Turn off the high-side MOSFET and turn on the low-side MOSFET. The low-side MOSFET remains ON until the device attempts a restart, i.e. the output voltage is pulled to ground level (crowbar function).

The default response from an overvoltage fault is to immediately shut down as in 2. The device will continuously check for the presence of the fault condition, and when the fault condition no longer exists the device will be re-enabled. For continuous OVP when operating from an external clock for synchronization, the only allowed response is an immediate shutdown. The OVP limit and fault response can be reconfigured using the PMBus interface.

Under Voltage Protection (UVP)

The product includes output under voltage limiting circuitry for protection of the load. The default UVP limit is 15% below the nominal output voltage. The UVP limit can be reconfigured using the PMBus interface.

Power Good

The product provides a Power Good (PG) flag in the Status Word register that indicates the output voltage is within a specified tolerance of its target level and no fault condition exists. If specified in section Connections, the product also provides a PG signal output. The PG pin is active high and by default open-drain but may also be configured as push-pull via the PMBus interface.
By default, the PG signal will be asserted if the output is within -10%/+15% of the target voltage. These limits may be changed via the PMBus interface. A PG delay period is defined as the time from when all conditions within the product for asserting PG are met to when the PG signal is actually asserted. By default, the PG delay is set equal to the soft-start ramp time setting. Therefore, if the soft-start ramp time is set to 10 ms, the PG delay will be set to 10 ms. The PG delay may be set independently of the soft-start ramp using the PMBus interface.

Switching Frequency

The fundamental switching frequency is 320 kHz, which yields optimal power efficiency. The switching frequency can be set to any value between 200 kHz and 640 kHz using the PMBus interface. The switching frequency will change the efficiency/power dissipation, load transient response and output ripple. For optimal control loop performance the control loop must be re-designed when changing the switching frequency.

Synchronization

Synchronization is a feature that allows multiple products to be synchronized to a common frequency. Synchronized products powered from the same bus eliminate beat frequencies reflected back to the input supply, and also reduces EMI filtering requirements. Eliminating the slow beat frequencies (usually <10 kHz) allows the EMI filter to be designed to attenuate only the synchronization frequency. Synchronization can also be utilized for phase spreading, described in section Phase Spreading.
The products can be synchronized with an external oscillator or one product can be configured with the SYNC pin as a SYNC Output working as a master driving the synchronization. All others on the same synchronization bus should be configured with SYNC Input or SYNC Auto Detect (Default configuration) for correct operation. When the SYNC pin is configured in auto detect mode the product will automatically check for a clock signal on the SYNC pin.

Phase Spreading

When multiple products share a common DC input supply, spreading of the switching clock phase between the products can be utilized. This dramatically reduces input capacitance requirements and efficiency losses, since the peak current drawn from the input supply is effectively spread out over the whole switch period. This requires that the products are synchronized. Up to 16 different phases can be used.
The phase spreading of the product can be configured using the PMBus interface.

Parallel Operation (Current Sharing)

Paralleling multiple products can be used to increase the output current capability of a single power rail. By connecting the GCB pins of each device and configuring the devices as a current sharing rail, the units will share the current equally, enabling up to 100% utilization of the current capability for each device in the current sharing rail. The product uses a low-bandwidth, first-order digital current sharing by aligning the output voltage of the slave devices to deliver the same current as the master device. Artificial droop resistance is added to the output voltage path to control the slope of the load line curve, calibrating out the physical parasitic mismatches due to power train components and PWB layout. Up to 7 devices can be configured in a given current sharing group.

Phase Adding and Shedding for Parallel Operation

During periods of light loading, it may be beneficial to disable one or more phases (modules) in order to eliminate the current drain and switching losses associated with those phases, resulting in higher efficiency. The product offers the ability to add and drop phases (modules) using a PMBus command in response to an observed load current change. All phases (modules) in a current share rail are considered active prior to the current sharing rail ramp to power-good. Phases can be dropped after power-good is reached. Any member of the current sharing rail can be dropped. If the reference module is dropped, the remaining active module with the lowest member position will become the new reference. Additionally, any change to the number of members of a current sharing rail will precipitate autonomous phase distribution within the rail where all active phases realign their phase position based on their order within the number of active members. If the members of a current sharing rail are forced to shut down due to an observed fault, all members of the rail will attempt to re-start simultaneously after the fault has cleared.

Adaptive Diode Emulation

Most power converters use synchronous rectification to optimize efficiency over a wide range of input and output conditions. However, at light loads the synchronous MOSFET will typically sink current and introduce additional energy losses associated with higher peak inductor currents, resulting in reduced efficiency. Adaptive diode emulation mode turns off the low-side FET gate drive at low load currents to prevent the inductor current from going negative, reducing the energy losses and increasing overall efficiency. Diode emulation is not available for current sharing groups. Note: the overall bandwidth of the product may be reduced when in diode emulation mode. It is recommended that diode emulation is disabled prior to applying significant load steps. The diode emulation mode can be configured using the PMBus interface.

Adaptive Frequency and Pulse Skip Control

Since switching losses contribute to the efficiency of the power converter, reducing the switching frequency will reduce the switching losses and increase efficiency. The product includes an Adaptive Frequency Control mode, which effectively reduces the observed switching frequency as the load decreases. Adaptive frequency mode is only available while the device is operating within Adaptive Diode Emulation Mode. As the load current is decreased, diode emulation mode decreases the Synch-FET on-time to prevent negative inductor current from flowing. As the load is decreased further, the Switch-FET pulse width will begin to decrease while maintaining the programmed frequency, f_{PROG} (set by the FREQ_SWITCH command). Once the Switch-FET pulse width (D) reaches 50% of the nominal duty cycle, D_{NOM} (determined by V_I and V_O), the switching frequency will start to decrease according to the following equation:

Eq. 5. $$f_{sw} = D\left(\frac{2\left(f_{PROG} - f_{MIN}\right)}{D_{NOM}}\right) + f_{MIN}\ .$$

Disabling a minimum Synch-FET makes the product also pulse skip which reduces the power loss further.
It should be noted that adaptive frequency mode is not available for current sharing groups and is not allowed when the device is placed in auto-detect mode and a clock source is present on the SYNC pin, or if the device is outputting a clock signal on its SYNC pin. The adaptive frequency and pulse skip modes can be configured using the PMBus interface.

Efficiency Optimized Dead Time Control

The product utilizes a closed loop algorithm to optimize the dead-time applied between the gate drive signals for the switch and synch FETs. The algorithm constantly adjusts the deadtime non-overlap to minimize the duty cycle, thus maximizing efficiency. This algorithm will null out deadtime differences due to component variation, temperature and loading effects. The algorithm can be configured via the PMBus interface.

Over Current Protection (OCP)

The product includes current limiting circuitry for protection at continuous overload. The following OCP response options are available:

3. Initiate a shutdown and attempt to restart an infinite number of times with a preset delay period between attempts.
4. Initiate a shutdown and attempt to restart a preset number of times with a preset delay period
5. Continue operating for a given delay period, followed by shutdown if the fault still exists.
6. Continue operating through the fault (this could result in permanent damage to the product).
7. Initiate an immediate shutdown.

The default response from an over current fault is an immediate shutdown of the device. The device will continuously check for the presence of the fault condition, and if the fault condition no longer exists the device will be re-enabled.The load distribution should be designed for the maximum output short circuit current specified. The OCP limit and response of the product can be reconfigured using the PMBus interface.

Start-up Procedure

The product follows a specific internal start-up procedure after power is applied to the VIN pin:

1. Status of the address and output voltage pin-strap pins are checked and values associated with the pin settings are loaded.
2. Values stored in the Ericsson default non-volatile memory are loaded. This overwrites any previously loaded values.
3. Values stored in the user non-volatile memory are loaded. This overwrites any previously loaded values.

Once this process is completed and the start-up time has passed (see Electrical Specification), the product is ready to be enabled using the CTRL pin. The product is also ready to accept commands via the PMBus interface, which will overwrite any values loaded during the start-up procedure.

Soft-start Power Up

The soft-start control introduces a time-delay before allowing the output voltage to rise. Once the start-up time has passed and the output has been enabled, the device requires approximately 2 ms before its output voltage may be allowed to start its ramp-up process. If a soft-start delay period less than 2 ms has been configured the device will default to a 2 ms delay period. If a delay period greater than 2 ms is configured, the device will wait for the configured delay period prior to starting to ramp its output. After the delay period has expired, the output will begin to ramp towards its target voltage according to the configured soft-start ramp time.
The default settings for the soft-start delay period and the soft-start ramp time is 10 ms. Hence, power-up is completed within 20 ms in default configuration using remote control. Precise timing reduces the delay time variations and is by default activated. The soft-start power up of the product can be reconfigured using the PMBus interface.

Output Voltage Sequencing

A group of products may be configured to power up in a predetermined sequence. This feature is especially useful when powering advanced processors, FPGAs, and ASICs that require one supply to reach its operating voltage prior to another. Multi-product sequencing can be achieved by configuring the start delay and rise time of each device through the PMBus interface and by using the CTRL start signal.

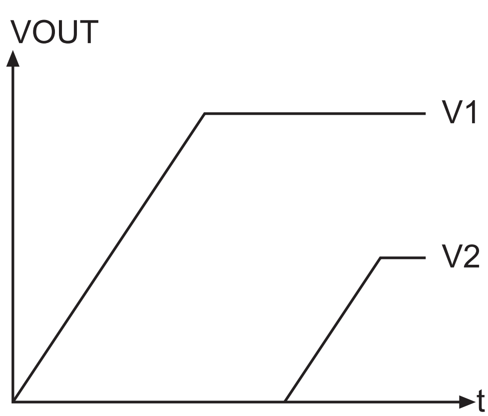


Illustration of Output Voltage Sequencing.

Voltage Tracking

The product integrates a lossless tracking scheme that allows its output to track a voltage that is applied to the VTRK pin with no external components required. During ramp-up, the output voltage follows the VTRK voltage until the preset output voltage level is met. The product offers two modes of tracking as follows:

1. Coincident. This mode configures the product to ramp its output voltage at the same rate as the voltage applied to the VTRK pin.

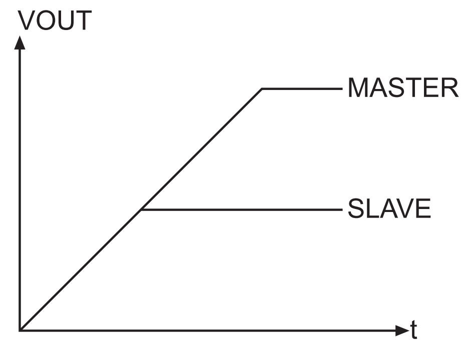


Illustration of Coincident Voltage Tracking.

2. Ratiometric. This mode configures the product to ramp its output voltage at a rate that is a percentage of the voltage applied to the VTRK pin. The default setting is 50%, but a different tracking ratio may be set by an external resistive voltage divider or through the PMBus interface.

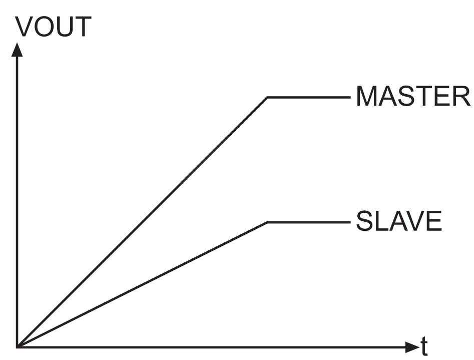


Illustration of Ratiometric Voltage Tracking

The master device in a tracking group is defined as the device that has the highest target output voltage within the group. This master device will control the ramp rate of all tracking devices and is not configured for tracking mode. All of the CTRL pins in the tracking group must be connected and driven by a single logic source. It should be noted that current sharing groups that are also configured to track another voltage do not offer pre-bias protection; a minimum load should therefore be enforced to avoid the output voltage from being held up by an outside force.

Voltage Margining Up/Down

The product can adjust its output higher or lower than its nominal voltage setting in order to determine whether the load device is capable of operating over its specified supply voltage range. This provides a convenient method for dynamically testing the operation of the load circuit over its supply margin or range. It can also be used to verify the function of supply voltage supervisors. Margin limits of the nominal output voltage ±5% are default, but the margin limits can be reconfigured using the PMBus interface.

Pre-Bias Startup Capability

Pre-bias startup often occurs in complex digital systems when current from another power source is fed back through a dual-supply logic component, such as FPGAs or ASICs. The BMR463 product family incorporates synchronous rectifiers, but will not sink current during startup, or turn off, or whenever a fault shuts down the product in a pre-bias condition. Pre-bias protection is not offered for current sharing groups that also have voltage tracking enabled.

Group Communication Bus

The Group Communication Bus, GCB, is used to communicate between products. This dedicated bus provides the communication channel between devices for features such as sequencing, fault spreading, and current sharing. The GCB solves the PMBus data rate limitation. The GCB pin on all devices in an application should be connected together. For robust communication it is recommended that 27 ohm series resistors are placed, close to the GCB pin, between each device and the common GCB connection. A pull-up resistor is required on the common GCB in order to guarantee the rise time as follows:

Eq. 6 $\tau = R_{GCB} C_{GCB} \le 1 \mu s$,

where R_{GCB} is the pull up resistor value and C_{GCB} is the bus loading. The pull-up resistor should be tied to to an external 3.3 V or 5 V supply voltage, which should be present prior to or during power-up.

Fault spreading

The product can be configured to broadcast a fault event over the GCB to the other devices in the group. When a non-destructive fault occurs and the device is configured to shut down on a fault, the device will shut down and broadcast the fault event over the GCB. The other devices on the GCB will shut down together if configured to do so, and will attempt to re-start in their prescribed order if configured to do so.

Over Temperature Protection (OTP)

The products are protected from thermal overload by an internal over temperature shutdown circuit. When T_{P1} as defined in thermal consideration section exceeds 120°C the product will shut down. The product will make continuous attempts to start up and resume normal operation automatically when the temperature has dropped >15°C below the over temperature threshold. The specified OTP level and hysteresis are valid for worst case operation regarding cooling conditions, input voltage and output voltage. This means the OTP level and hysteresis in many cases will be lower. The OTP level, hysteresis, and fault response of the product can be reconfigured using the PMBus interface. The fault response can be configured as follows:

1. Initiate a shutdown and attempt to restart an infinite number of times with a preset delay period between attempts (default configuration).
2. Initiate a shutdown and attempt to restart a preset number of times with a preset delay period between attempts.
3. Continue operating for a given delay period, followed by shutdown if the fault still exists.
4. Continue operating through the fault (this could result in permanent damage to the power supply).
5. Initiate an immediate shutdown.

Optimization examples

This product is designed with a digital control circuit. The control circuit uses a configuration file which determines the functionality and performance of the product. It is possible to change the configuration file to optimize certain performance characteristics. In the table below is a schematic view on how to change different configuration parameters in order to achieve an optimization towards a wanted performance.

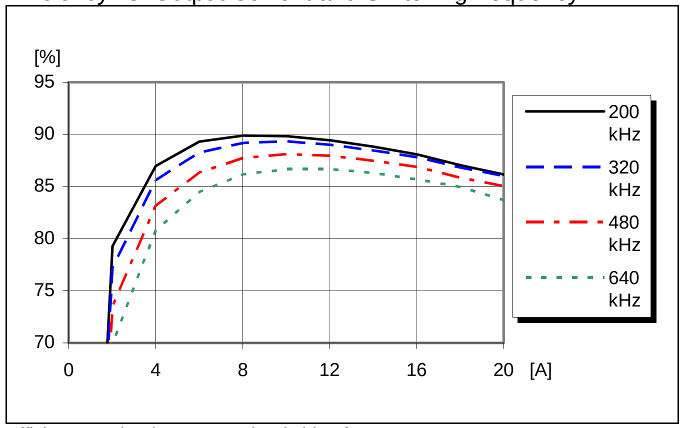
↑	Increase
→	No change
↓	Decrease

Config. parameters	Switching frequency	Control loop bandwidth	NLR threshold	Diode emulation (DCM)	Min. pulse
Optimized performence					
Maximize efficiency	↓	→	↑	Enable	Disable
Minimize ripple ampl.	↑	→	↑	Enable or disable	Enable or disable
Improve load transient response	↑	↑	↓	Disable	Disable
Minimize idle power loss	↓	↑	→	Enable	Enable

P_{li}	Input idling power (no load)	Default configuration: Continues Conduction Mode, CCM	V_O = 0.6 V	0.56	W
			V_O = 1.0 V	0.57	
			V_O = 1.8 V	0.68	
			V_O = 3.3 V	0.99	
		DCM, Discontinues Conduction Mode	V_O = 0.6 V	0.36	W
			V_O = 1.0 V	0.30	
			V_O = 1.8 V	0.20	

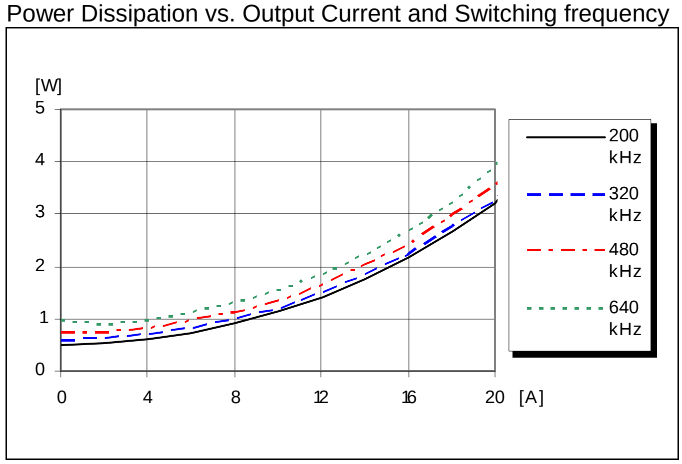
P_{li}	Input idling power (no load)	DCM with Adaptive Frequency and Minimum Pulse Enabled	V_O = 0.6 V	0.26	W
			V_O = 1.0 V	0.27	
			V_O = 1.8 V	0.34	
			V_O = 3.3 V	0.43	
		DCM with Adaptive Frequency and Minimum Pulse Disabled	V_O = 0.6 V	0.25	W
			V_O = 1.0 V	0.20	
			V_O = 1.8 V	0.20	
			V_O = 3.3 V	0.20	
P_{CTRL}	Input standby power	Turned off with CTRL-pin	Default configuration: Monitoring enabled, Precise timing enabled	180	mW
			Monitoring enabled, Precise timing disabled	120	mW
			Low power mode: Monitoring disabled, Precise timing disabled	85	mW
V_{tr1}	Load transient peak voltage deviation Load step 25-75-25% of max I_O	Default configuration di/dt = 2 A/µs C_O=470 µF	V_O = 0.6 V	85	mV
			V_O = 1.0 V	85	
			V_O = 1.8 V	90	
			V_O = 3.3 V	135	
		Optimized PID and NLR configuration di/dt = 2 A/µs C_O=470 µF	V_O = 0.6 V	65	mV
			V_O = 1.0 V	80	
			V_O = 1.8 V	80	
			V_O = 3.3 V	100	
t_{tr1}	Load transient recovery time Load step 25-75-25% of max I_O	Default configuration di/dt = 2 A/µs C_O=470 µF	V_O = 0.6 V	80	us
			V_O = 1.0 V	90	
			V_O = 1.8 V	100	
			V_O = 3.3 V	100	
		Optimized PID and NLR configuration di/dt = 2 A/µs C_O=470 µF	V_O = 0.6 V	45	
			V_O = 1.0 V	50	
			V_O = 1.8 V	55	
			V_O = 3.3 V	55	

Efficiency vs. Output Current and Switching frequency



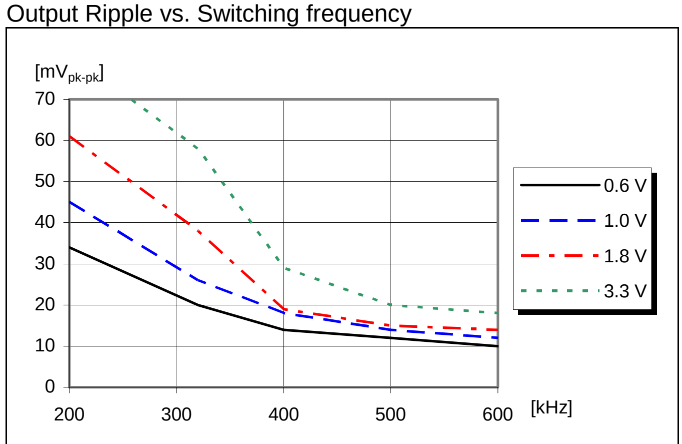
Efficiency vs. load current and switching frequency at T_{P1} = +25°C. V_I=12 V, V_O=1.0V, C_O=470 µF/10 mΩ
Default configuration except changed frequency

Power Dissipation vs. Output Current and Switching frequency



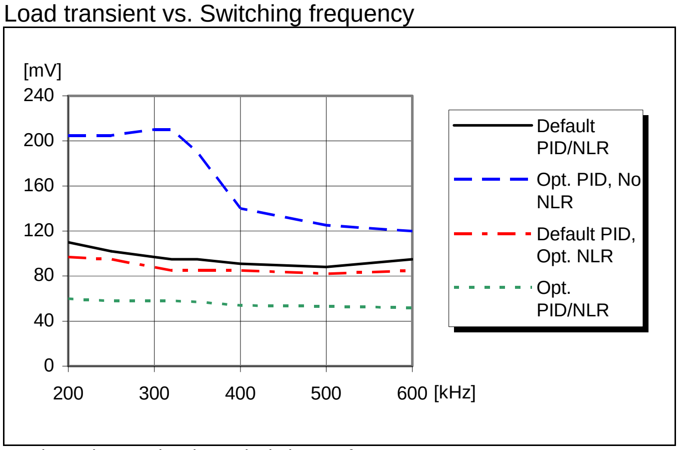
Dissipated power vs. load current and switching frequency at T_{P1} = +25°C. V_I=12 V, V_O=1.0V, C_O=470 µF/10 mΩ
Default configuration except changed frequency

Output Ripple vs. Switching frequency



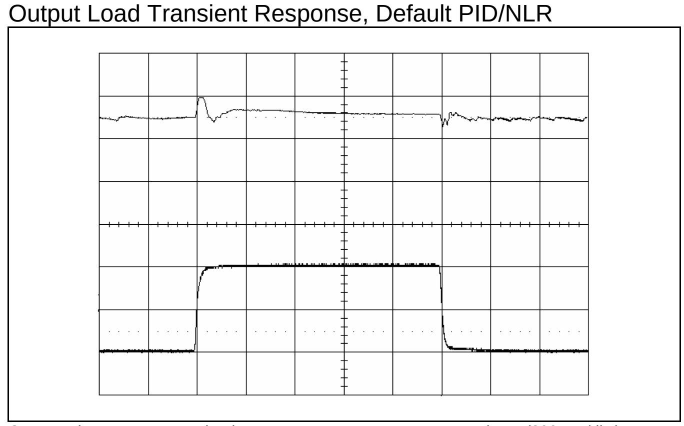
Output voltage ripple V_{pk-pk} at: T_{P1} = +25°C, V_I = 12 V, C_O=470 µF/10 mΩ, I_O = 20 A resistive load. Default configuration except changed frequency.

Load transient vs. Switching frequency



Load transient peak voltage deviation vs. frequency.
Step-change (5-15-5 A).
T_{P1} = +25°C. V_I=12 V, V_O=1.0 V, C_O=470 µF/10 mΩ

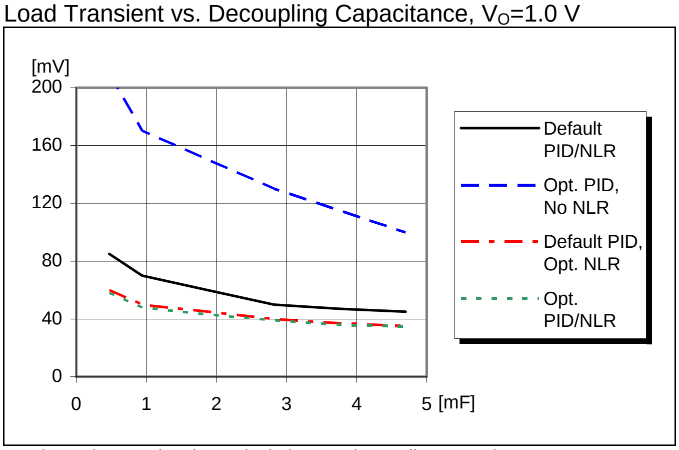
Output Load Transient Response, Default PID/NLR



Output voltage response to load current step-change (5-15-5 A) at:
T_{P1} = +25°C, V_I = 12 V, V_O =1.0 V
di/dt=2 A/µs, f_{sw}=320 kHz, C_O=470 µF/10 mΩ
Default PID Control Loop and NLR

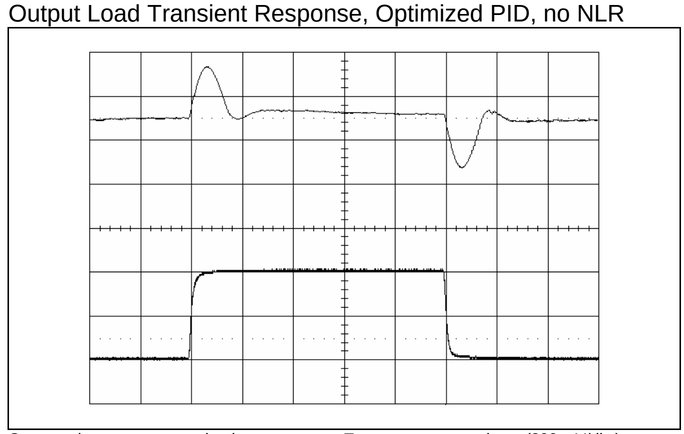
Top trace: output voltage (200 mV/div.).
Bottom trace: load current (5 A/div.).
Time scale: (0.1 ms/div.).

Load Transient vs. Decoupling Capacitance, V_O=1.0 V



Load transient peak voltage deviation vs. decoupling capacitance.
Step-change (5-15-5 A). Parallel coupling of capacitors with 470 µF/10 mΩ,
T_{P1} = +25°C. V_I=12 V, V_O=1.0V, f_{sw}=320 kHz, di/dt=2 A/µs

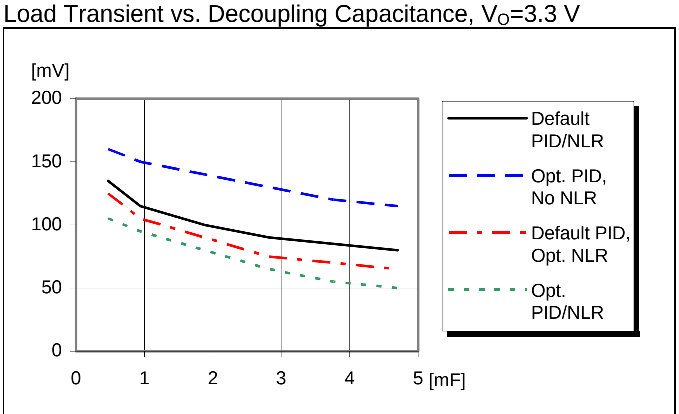
Output Load Transient Response, Optimized PID, no NLR



Output voltage response to load current step-change (5-15-5 A) at:
T_{P1} = +25°C, V_I = 12 V, V_O =1.0 V
di/dt=2 A/µs, f_{sw}=320 kHz, C_O=470 µF/10 mΩ
Optimized PID Control Loop and no NLR

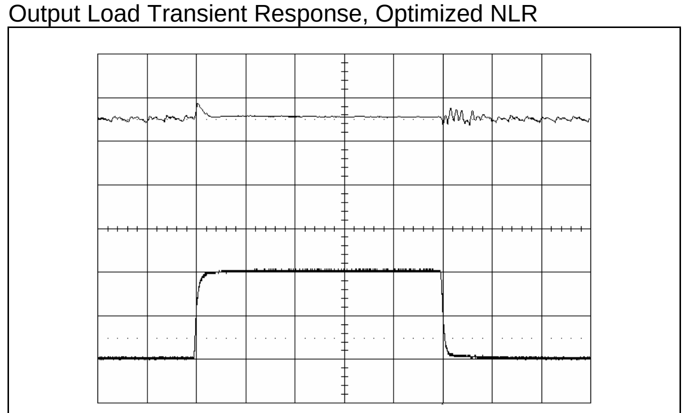
Top trace: output voltage (200 mV/div.).
Bottom trace: load current (5 A/div.).
Time scale: (0.1 ms/div.).

Load Transient vs. Decoupling Capacitance, V_O=3.3 V



Load transient peak voltage deviation vs. decoupling capacitance.
Step-change (5-15-5 A). Parallel coupling of capacitors with 470 µF/10 mΩ,
T_{P1} = +25°C. V_I=12 V, V_O=1.0 V, f_{sw}=320 kHz, di/dt=2 A/µs

Output Load Transient Response, Optimized NLR



Output voltage response to load current step-change (5-15-5 A) at:
T_{P1} = +25°C, V_I = 12 V, V_O =1.0 V
di/dt=2 A/µs, f_{sw}=320 kHz, C_O=470 µF/10 mΩ
Default PID Control Loop and optimized NLR

Top trace: output voltage (200 mV/div.).
Bottom trace: load current (5 A/div.).
Time scale: (0.1 ms/div.).

Thermal Consideration

General

The product is designed to operate in different thermal environments and sufficient cooling must be provided to ensure reliable operation.
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 for each model provides the available output current vs. ambient air temperature and air velocity at specified V_I.

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

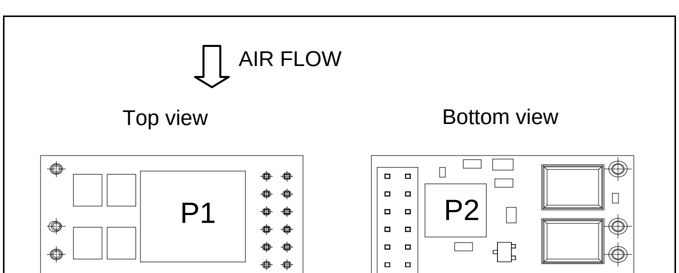
Proper cooling of the product can be verified by measuring the temperature at positions P1 and P2. The temperature at these positions should not exceed the max values provided in the table below.
Note that the max value is the absolute maximum rating (non destruction) and that the electrical Output data is guaranteed up to T_{P1} +85°C.

See Design Note 019 for further information.

Definition of product operating temperature

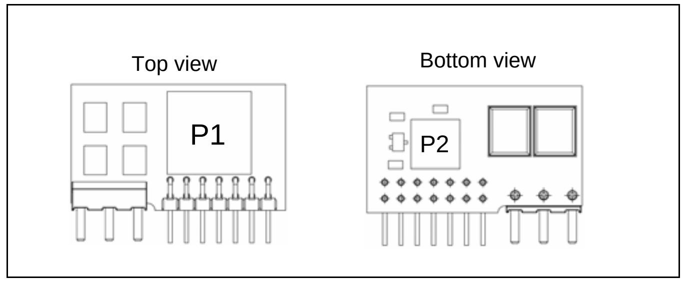
The product operating temperatures are used to monitor the temperature of the product, and proper thermal conditions can be verified by measuring the temperature at positions P1 and P2. The temperature at these positions (T_{P1}, T_{P2}) should not exceed the maximum temperatures in the table below.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

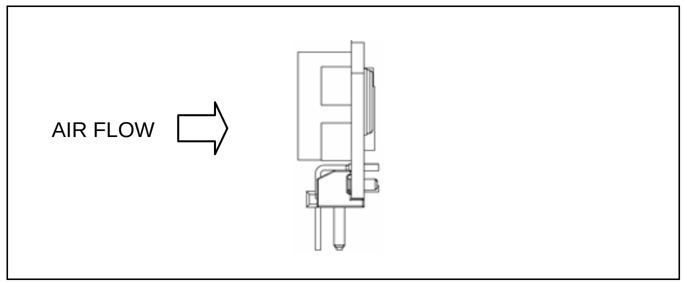
Position	Description	Max Temp.
P1	Reference point, L1, inductor	120º C
P2	N1, control circuit	120º C



Temperature positions and air flow direction.

SIP version





Temperature positions and air flow direction.

Definition of reference temperature T_{P1}

The reference temperature is used to monitor the temperature limits of the product. Temperature above maximum T_{P1}, measured at the reference point P1 is not allowed and may cause degradation or permanent damage to the product. T_{P1} is also used to define the temperature range for normal operating conditions. T_{P1} is defined by the design and used to guarantee safety margins, proper operation and high reliability ot the product.

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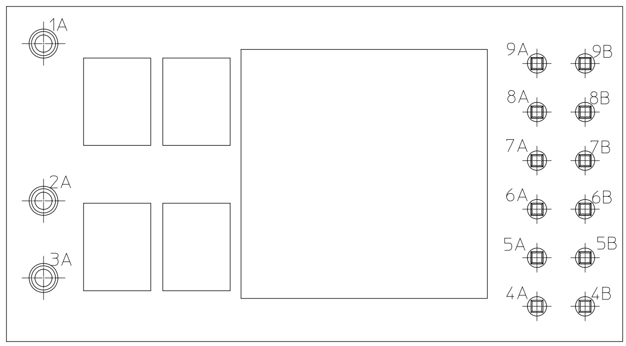
Connections



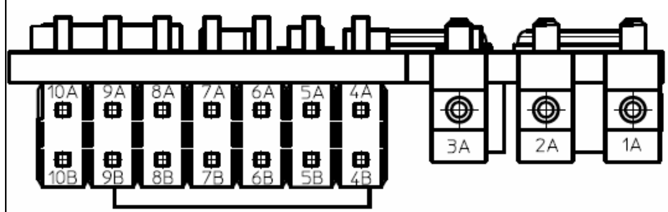
Pin layout, top view (component placement for illustration only).

Pin	Designation	Function
1A	VIN	Input Voltage
2A	GND	Power Ground
3A	VOUT	Output voltage
4A	VTRK	Voltage Tracking input
4B	PREF	Pin-strap reference
5A	+S	Positive sense
5B	−S	Negative sense
6A	SA0	PMBus address pinstrap
6B	GCB	Group Communication Bus
7A	SCL	PMBus Clock
7B	SDA	PMBus Data
8A	VSET	Output voltage pinstrap
8B	SYNC	Synchronization I/O
9A	SALERT	PMBus Alert
9B	CTRL	Remote Control

PWB layout considerations

The pinstrap resistors, Rset, and R_{SA0} should be placed as close to the product as possible to minimize loops that may pick up noise.
Avoid current carrying planes under the pinstrap resistors and the PMBus signals.
The capacitor C_I (or capacitors implementing it) should be placed as close to the input pins as possible.
Capacitor C_O (or capacitors implementing it) should be placed close to the load.

Connections (SIP version)



Pin layout, side view (component placement for illustration only).

Pin	Designation	Function
1A	VIN	Input Voltage
2A	GND	Power Ground
3A	VOUT	Output Voltage
4A	+S	Positive sense
4B	−S	Negative sense
5A	VSET	Output voltage pinstrap
5B	VTRK	Voltage Tracking input
6A	SALERT	PMBus Alert
6B	SDA	PMBus Data
7A	SCL	PMBus Clock
7B	SA1	PMBus address pinstrap 1
8A	SA0	PMBus address pinstrap 0
8B	SYNC	Synchronization I/O
9A	PG	Power Good
9B	CTRL	Remote Control
10A	GCB	Group Communication Bus
10B	PREF	Pin-strap reference

Unused input pins

Unused SDA, SCL and GCB pins should still have pull-up resistors as specified. Unused VTRK or SYNC pins should be left unconnected or connected to the PREF pin. Unused CTRL pin can be left open due to internal pull-up.
VSET and SA0/SA1 pins must have pinstrap resistors as specified.

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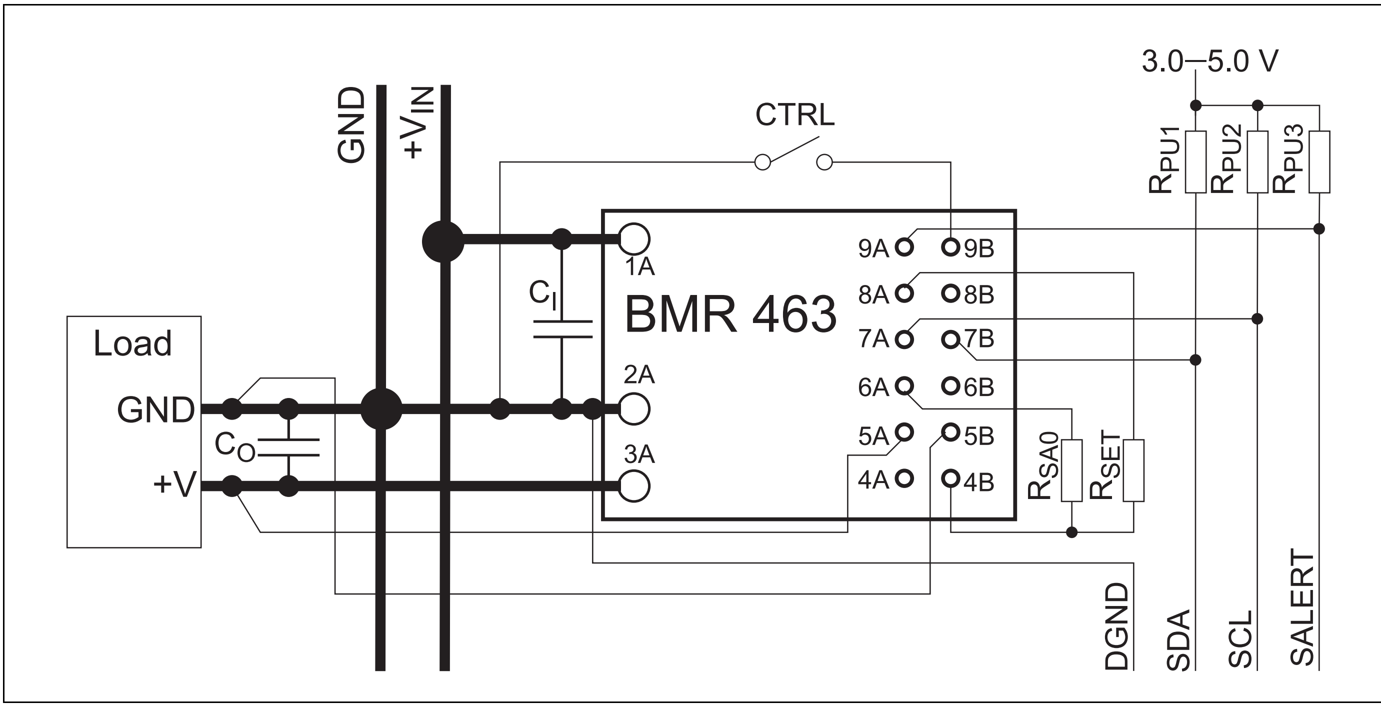
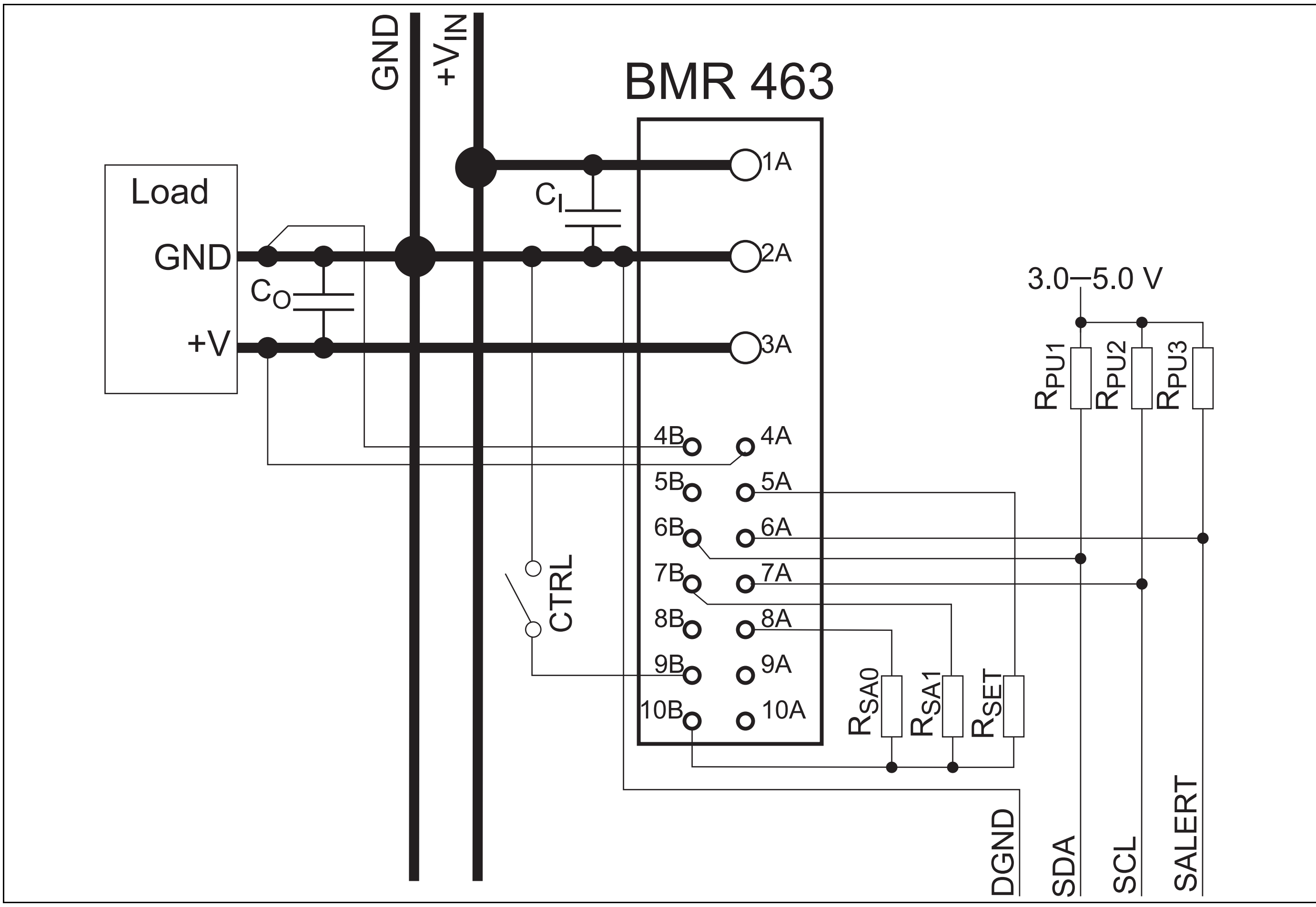
Typical Application Circuit



Standalone with PMBus communication

Typical Application Circuit (SIP version)



Standalone with PMBus communication. Top side view of product footprint.

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PMBus Interface

This product provides a PMBus digital interface that enables the user to configure many aspects of the device operation as well as to monitor the input and output voltages, output current and device temperature. The product can be used with any standard two-wire I^2C or SMBus host device. In addition, the module is compatible with PMBus version 1.1 and includes an SALERT line to help mitigate bandwidth limitations related to continuous fault monitoring. The product supports 100 kHz bus clock frequency only. The PMBus signals, SCL, SDA and SALERT require passive pull-up resistors as stated in the SMBus Specification. Pull-up resistors are required to guarantee the rise time as follows:

Eq. 7 $$\tau = R_P C_p \leq 1\mu s$$

where R_p is the pull-up resistor value and C_p is the bus loading, the maximum allowed bus load is 400 pF. The pull-up resistor should be tied to an external supply voltage in range from 2.7 to 5.5V, which should be present prior to or during power-up. If the proper power supply is not available, voltage dividers may be applied. Note that in this case, the resistance in the equation above corresponds to parallel connection of the resistors forming the voltage divider.

Monitoring via PMBus

It is possible to monitor a wide variety of different parameters through the PMBus interface. Fault conditions can be monitored using the SALERT pin, which will be asserted when any number of pre-configured fault or warning conditions occur. It is also possible to continuously monitor one or more of the power conversion parameters including but not limited to the following:

- Input voltage
- Output voltage
- Output current
- Internal junction temperature
- Switching frequency
- Duty cycle

Snap Shot Parameter Capture

This product offers a special feature that enables the user to capture parametric data during normal operation or following a fault. The following parameters are stored:

- Input voltage
- Output voltage
- Output current
- Internal junction temperature
- Switching frequency
- Duty cycle
- Status registers

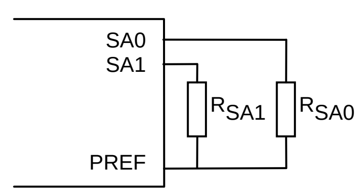
The Snapshot feature enables the user to read the parameters via the PMBus interface during normal operation, although it should be noted that reading the 22 bytes will occupy the bus for some time. The Snapshot enables the user to store the snapshot parameters to Flash memory in response to a pending fault as well as to read the stored data from Flash memory after a fault has occurred. Automatic store to Flash memory following a fault is triggered when any fault threshold level is exceeded, provided that the specific fault response is to shut down. Writing to Flash memory is not allowed if the device is configured to restart following the specific fault condition. It should also be noted that the device supply voltage must be maintained during the time the device is writing data to Flash memory; a process that requires between 700-1400 µs depending on whether the data is set up for a block write. Undesirable results may be observed if the input voltage of the modules drops below 3.0 V during this process

Software Tools for Design and Production

Ericsson provides software for configuration and monitoring of this product via the PMBus interface.
For more information please contact your local Ericsson sales representative.

PMBus Addressing

The PMBus address should be configured with resistors connected between the SA0/SA1 pins and the PREF pin, as shown in the figure below. Recommended resistor values for hard-wiring PMBus addresses are shown in the table. 1% tolerance resistors are required.



Schematic of connection of address resistor.

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Index	R_{SA} [kΩ]	Index	R_{SA} [kΩ]
0	10	13	34.8
1	11	14	38.3
2	12.1	15	42.2
3	13.3	16	46.4
4	14.7	17	51.1
5	16.2	18	56.2
6	17.8	19	61.9
7	19.6	20	68.1
8	21.5	21	75
9	23.7	22	82.5
10	26.1	23	90.9
11	28.7	24	100
12	31.6		

The PMBus address follows the equation below:

Eq. 8 PMBus Address (decimal) = 25 x (SA1 index) + (SA0 index)

The user can theoretically configure up to 625 unique PMBus addresses, however the PMBus address range is inherently limited to 128. Therefore, the user should use index values 0 - 4 on the SA1 pin and the full range of index values on the SA0 pin, which will provide 125 device address combinations. The user shall also be aware of further limitations of the address space as stated in the SMBus Specification.
Note that address 0x4B is allocated for production needs and can not be used.

Products with no SA1 pin have an internally defined SA1 index as follows.

Product	SA1 index
BMR 463 (non SIP)	3

Optional PMBus Addressing

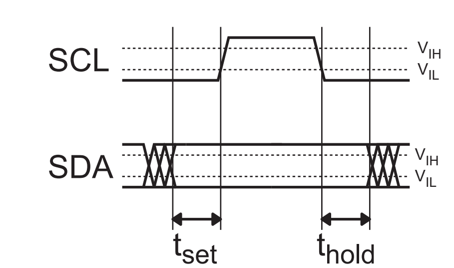
Alternatively the PMBus address can be defined by connecting the SA0/SA1 pins according to the following table. SA1 = open for products with no SA1 pin.

		SA0		
		low	open	high
SA1	low	0x20	0x21	0x22
	open	0x23	0x24	0x25
	high	0x26	0x27	Reserved

Low = Shorted to PREF
Open = High impedance
High = Logic high, GND as reference

Logic High definitions see Electrical Specification

I²C/SMBus – Timing



Setup and hold times timing diagram

The setup time, t_{set}, is the time data, SDA, must be stable before the rising edge of the clock signal, SCL. The hold time t_{hold}, is the time data, SDA, must be stable after the rising edge of the clock signal, SCL. If these times are violated incorrect data may be captured or meta-stability may occur and the bus communication may fail. When configuring the product, all standard SMBus protocols must be followed, including clock stretching. Additionally, a bus-free time delay between every SMBus transmission (between every stop & start condition) must occur. Refer to the SMBus specification, for SMBus electrical and timing requirements. Note that an additional delay of 20 ms has to be inserted in case of storing the RAM content into the internal non-volatile memory.

PMBus Commands

The product is PMBus compliant. The following table lists the implemented PMBus commands. For more detailed information see PMBus Power System Management Protocol Specification; Part I – General Requirements, Transport and Electrical Interface and PMBus Power System Management Protocol; Part II – Command Language.

Designation	Cmd	Impl
Standard PMBus Commands		
Control Commands		
PAGE	00h	No
OPERATION	01h	Yes
ON_OFF_CONFIG	02h	Yes
WRITE_PROTECT	10h	No
Output Commands		
VOUT_MODE (Read Only)	20h	Yes
VOUT_COMMAND	21h	Yes
VOUT_TRIM	22h	Yes
VOUT_CAL_OFFSET	23h	Yes
VOUT_MAX	24h	Yes
VOUT_MARGIN_HIGH	25h	Yes
VOUT_MARGIN_LOW	26h	Yes
VOUT_TRANSITION_RATE	27h	Yes
VOUT_DROOP	28h	Yes
MAX_DUTY	32h	Yes
FREQUENCY_SWITCH	33h	Yes
IOUT_CAL_GAIN	38h	Yes
IOUT_CAL_OFFSET	39h	Yes
VOUT_SCALE_LOOP	29h	No
VOUT_SCALE_MONITOR	2Ah	No
COEFFICIENTS	30h	No
Fault Limit Commands		
POWER_GOOD_ON	5Eh	Yes
VOUT_OV_FAULT_LIMIT	40h	Yes
VOUT_UV_FAULT_LIMIT	44h	Yes
IOUT_OC_FAULT_LIMIT	46h	Yes
IOUT_UC_FAULT_LIMIT	4Bh	Yes
OT_FAULT_LIMIT	4Fh	Yes
OT_WARN_LIMIT	51h	Yes
UT_WARN_LIMIT	52h	Yes
UT_FAULT_LIMIT	53h	Yes
VIN_OV_FAULT_LIMIT	55h	Yes
VIN_OV_WARN_LIMIT	57h	Yes

Designation	Cmd	Impl
VIN_UV_WARN_LIMIT	58h	Yes
VIN_UV_FAULT_LIMIT	59h	Yes
VOUT_OV_WARN_LIMIT	42h	No
VOUT_UV_WARN_LIMIT	43h	No
IOUT_OC_WARN_LIMIT	4Ah	No
Fault Response Commands		
VOUT_OV_FAULT_RESPONSE	41h	Yes
VOUT_UV_FAULT_RESPONSE	45h	Yes
OT_FAULT_RESPONSE	50h	Yes
UT_FAULT_RESPONSE	54h	Yes
VIN_OV_FAULT_RESPONSE	56h	Yes
VIN_UV_FAULT_RESPONSE	5Ah	Yes
IOUT_OC_FAULT_RESPONSE	47h	No
IOUT_UC_FAULT_RESPONSE	4Ch	No
Time setting Commands		
TON_DELAY	60h	Yes
TON_RISE	61h	Yes
TOFF_DELAY	64h	Yes
TOFF_FALL	65h	Yes
TON_MAX_FAULT_LIMIT	62h	No
Status Commands (Read Only)		
CLEAR_FAULTS	03h	Yes
STATUS_BYTE	78h	Yes
STATUS_WORD	79h	Yes
STATUS_VOUT	7Ah	Yes
STATUS_IOUT	7Bh	Yes
STATUS_INPUT	7Ch	Yes
STATUS_TEMPERATURE	7Dh	Yes
STATUS_CML	7Eh	Yes
STATUS_MFR_SPECIFIC	80h	Yes
Monitor Commands (Read Only)		
READ_VIN	88h	Yes
READ_VOUT	8Bh	Yes
READ_IOUT	8Ch	Yes
READ_TEMPERATURE_1	8Dh	Yes
READ_TEMPERATURE_2	8Eh	No
READ_FAN_SPEED_1	90h	No
READ_DUTY_CYCLE	94h	Yes
READ_FREQUENCY	95h	Yes

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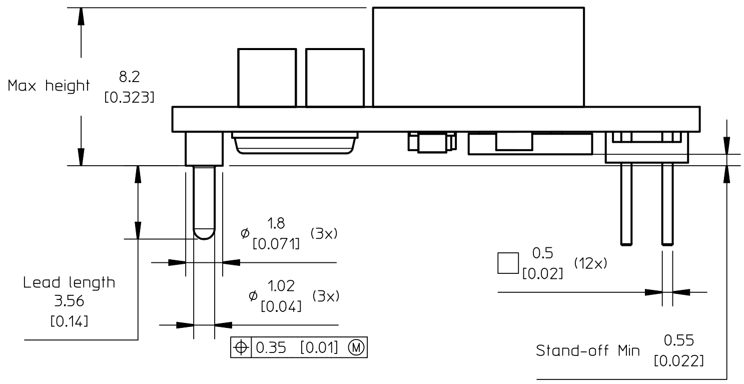
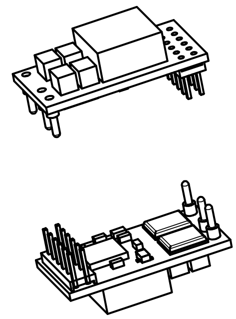
Designation	Cmd	Impl
Identification Commands (Read Only)		
PMBUS_REVISION	98h	Yes
MFR_ID	99h	Yes
MFR_MODEL	9Ah	Yes
MFR_REVISION	9Bh	Yes
MFR_LOCATION	9Ch	Yes
MFR_DATE	9Dh	Yes
MFR_SERIAL	9Eh	Yes
Group Commands		
INTERLEAVE	37h	Yes
Supervisory Commands		
STORE_DEFAULT_ALL	11h	Yes
RESTORE_DEFAULT_ALL	12h	Yes
STORE_USER_ALL	15h	Yes
RESTORE_USER_ALL	16h	Yes
Product Specific Commands		
Time Setting Commands		
POWER_GOOD_DELAY	D4h	Yes
Fault limit Commands		
IOUT_AVG_OC_FAULT_LIMIT	E7h	Yes
IOUT_AVG_UC_FAULT_LIMIT	E8h	Yes
Fault Response Commands		
MFR_IOUT_OC_FAULT_RESPONSE	E5h	Yes
MFR_IOUT_UC_FAULT_RESPONSE	E6h	Yes
OVUV_CONFIG	D8h	Yes
Configuration and Control Commands		
MFR_CONFIG	D0h	Yes
USER_CONFIG	D1h	Yes
MISC_CONFIG	E9h	Yes
PID_TAPS	D5h	Yes
INDUCTOR	D6h	Yes
NLR_CONFIG	D7h	Yes
TEMPCO_CONFIG	DCh	Yes
DEADTIME	DDh	Yes
DEADTIME_CONFIG	DEh	Yes
DEADTIME_MAX	BFh	Yes
SNAPSHOT	EAh	Yes
SNAPSHOT_CONTROL	F3h	Yes
DEVICE_ID	E4h	Yes
USER_DATA_00	B0h	Yes

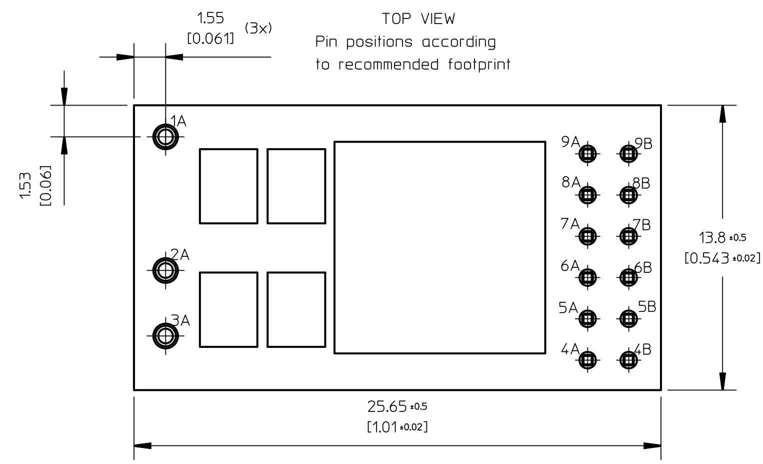
Designation	Cmd	Impl
Group Commands		
SEQUENCE	E0h	Yes
GCB_GROUP	E2h	Yes
ISHARE_CONFIG	D2h	Yes
PHASE_CONTROL	F0h	Yes
Supervisory Commands		
PRIVATE_PASSWORD	FBh	Yes
PUBLIC_PASSWORD	FCh	Yes
UNPROTECT	FDh	Yes
SECURITY_LEVEL	FAh	Yes

Notes:
Cmd is short for Command.
Impl is short for Implemented.

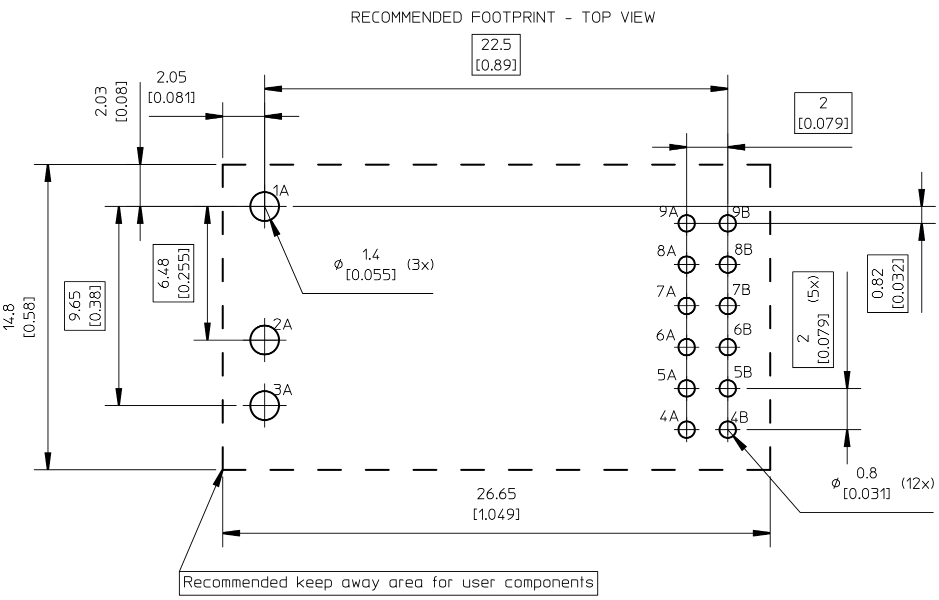
Mechanical Information – Through hole mount version







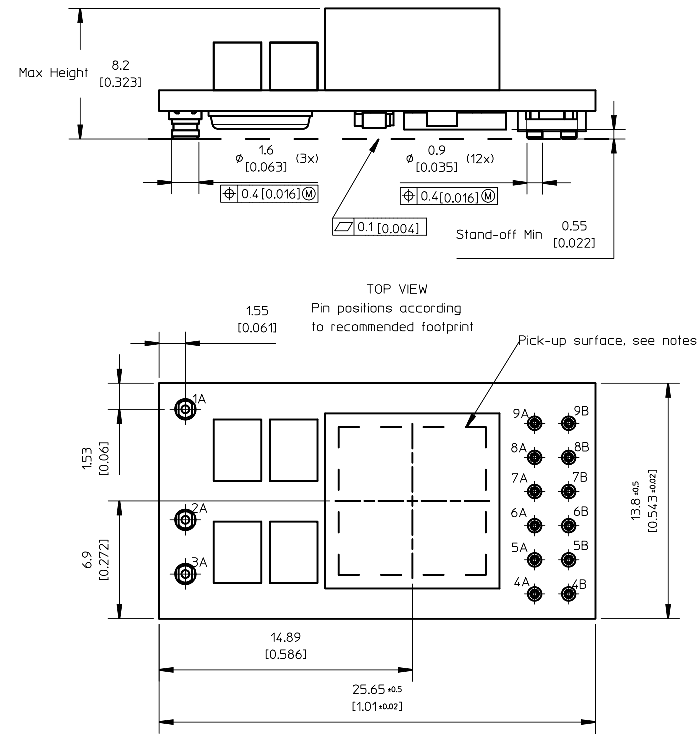
PIN SPECIFICATIONS
Pin 1A-3A Material: Copper alloy
Plating: Min Matte tin 8-13 µm over 2.5-5 µm Ni.
Pin 4A-9B Material: Brass
Plating: Min Au 0.2 µm over 1.27 µm Ni.

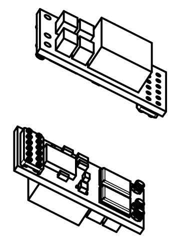


Weight: Typical 5.6 g
All dimensions in mm [inch].
Tolerances unless specified:
x.x ±0.50 mm [0.02],
x.xx ±0.25 mm [0.01]
(not applied on footprint or typical values)

BMR 463 series POL Regulators Input 4.5-14 V, Output up to 20 A / 66 W	EN/LZT 146 434 R2B September 2011 © Ericsson AB

Mechanical Information – Surface Mount Version



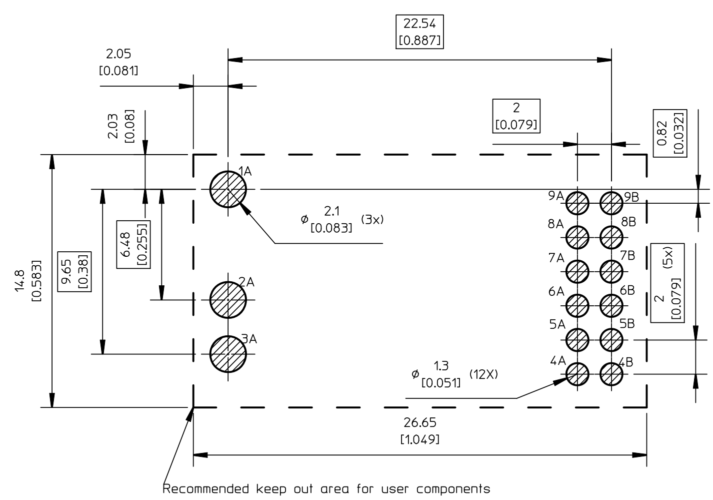


NOTES

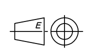
PIN SPECIFICATIONS
Pin 1A-3A Material: Copper alloy
Plating: Au 0.1 µm over 1-3 µm Ni.
Pin 4A-9B Material: Brass
Plating: Au 0.1 µm over 2 µm Ni.

PICK-UP SURFACE
Recommended pick-up nozzle size for assigned pick-up area is maximum Ø8 [0.315].

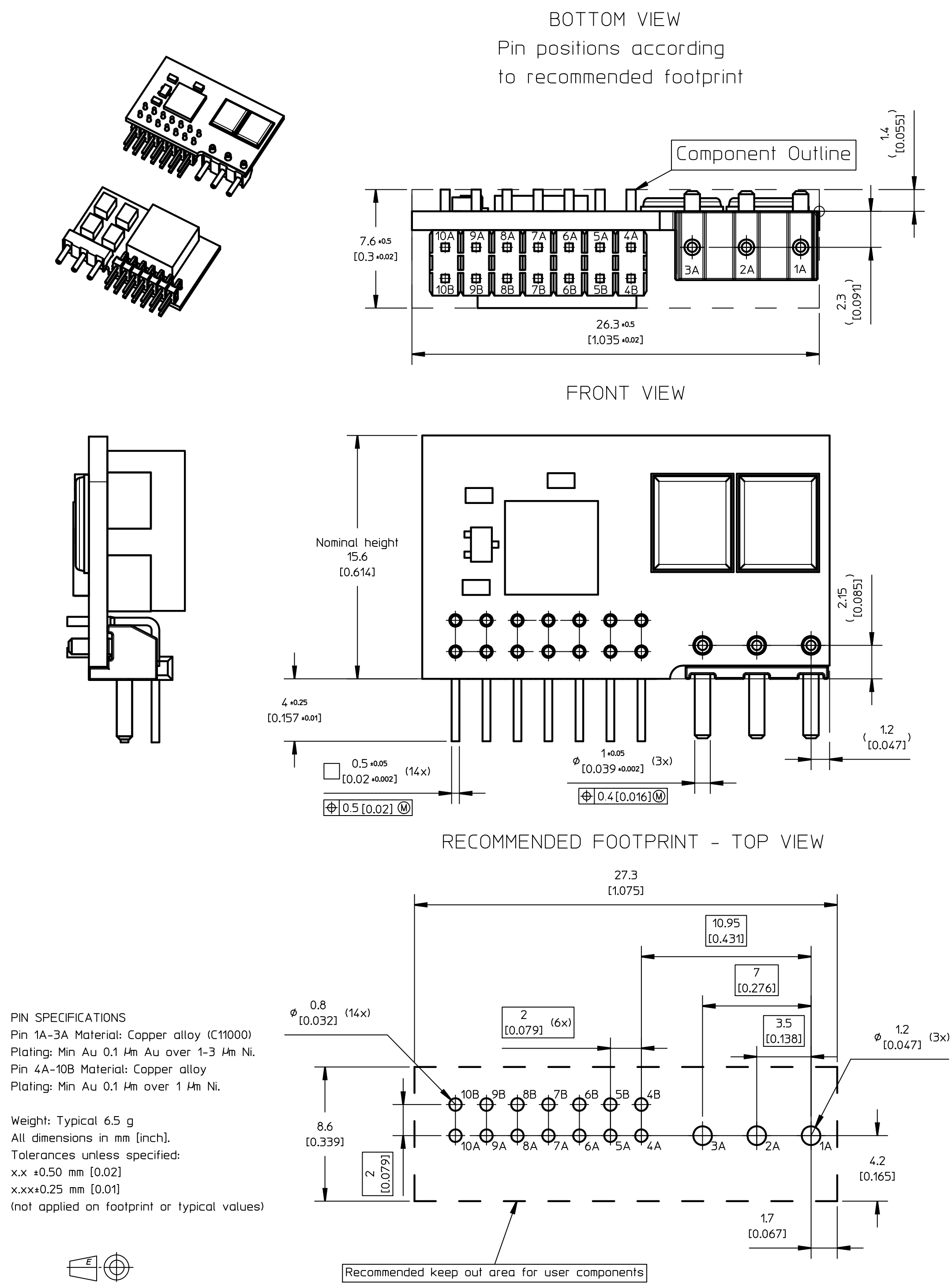
RECOMMENDED FOOTPRINT - TOP VIEW



Weight: Typical 5.6 g
All dimensions in mm [inch].
Tolerances unless specified:
x.x ±0.50 [0.02]
x.xx±0.25 [0.01]
(not applied on footprint or typical values)



Mechanical Information (SIP version)



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Soldering Information - Surface Mounting

The surface mount product is intended for forced convection or vapor phase reflow soldering in SnPb or Pb-free 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 it is also recommended 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.

Minimum Pin Temperature Recommendations

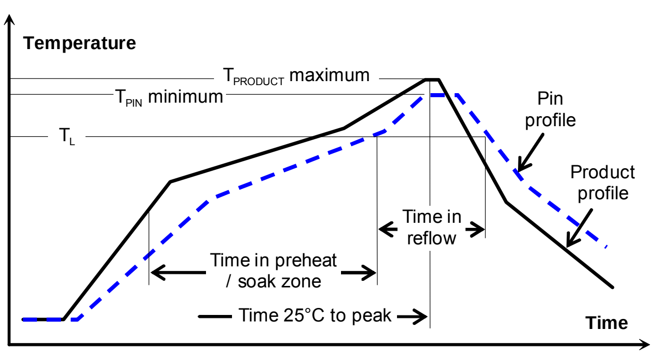
Pin number 2A chosen as reference location for the minimum pin temperature recommendation since this will likely be the coolest solder joint during the reflow process.

SnPb solder processes

For SnPb solder processes, a pin temperature (T_{PIN}) in excess of the solder melting temperature, (T_L, 183°C for Sn63Pb37) for more than 30 seconds and a peak temperature of 210°C is recommended to ensure a reliable solder joint.

For dry packed products only: depending on the type of solder paste and flux system used on the host board, up to a recommended maximum temperature of 245°C could be used, if the products are kept in a controlled environment (dry pack handling and storage) prior to assembly.

General reflow process specifications		SnPb eutectic	Pb-free
Average ramp-up ($T_{PRODUCT}$)		3°C/s max	3°C/s max
Typical solder melting (liquidus) temperature	T_L	183°C	221°C
Minimum reflow time above T_L		30 s	30 s
Minimum pin temperature	T_{PIN}	210°C	235°C
Peak product temperature	$T_{PRODUCT}$	225°C	260°C
Average ramp-down ($T_{PRODUCT}$)		6°C/s max	6°C/s max
Maximum time 25°C to peak		6 minutes	8 minutes



Lead-free (Pb-free) solder processes

For Pb-free solder processes, a pin temperature (T_{PIN}) in excess of the solder melting temperature (T_L, 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 4B 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.

SnPb solder processes

For SnPb solder processes, the product is qualified for MSL 1 according to IPC/JEDEC standard J-STD-020C.

During reflow $T_{PRODUCT}$ must not exceed 225 °C at any time.

Pb-free solder processes

For Pb-free solder processes, the product is qualified for MSL 3 according to IPC/JEDEC standard J-STD-020C.

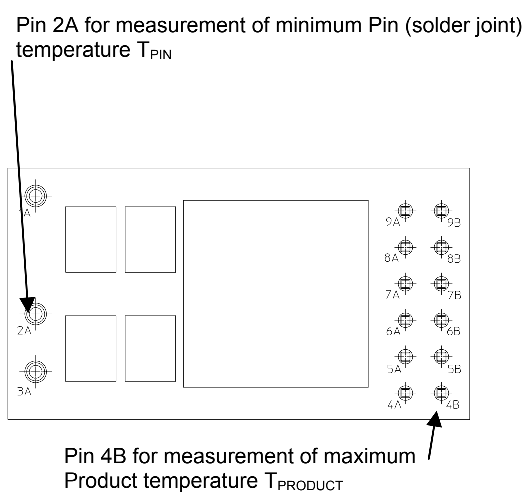
During reflow $T_{PRODUCT}$ must not exceed 260 °C at any time.

Dry Pack Information

Surface mounted versions of the products 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).

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.

Thermocoupler Attachment



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Soldering Information - Hole Mounting

The hole mounted product is intended for plated through hole mounting by wave or manual soldering. The pin temperature is specified to maximum to 270°C for maximum 10 seconds.

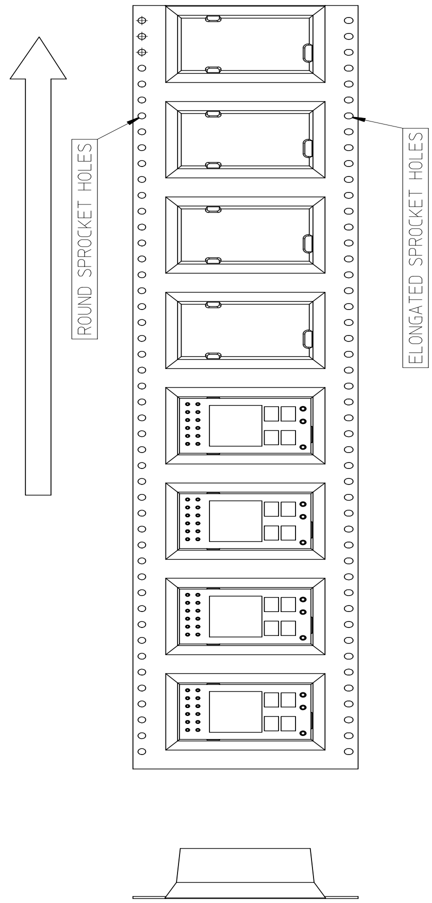
A maximum preheat rate of 4°C/s and maximum preheat temperature of 150°C is suggested. When soldering by hand, care should be taken to avoid direct contact between the hot soldering iron tip and the pins for more than a few seconds in order to prevent overheating.

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. The cleaning residues may affect long time reliability and isolation voltage.

Delivery Package Information

The products are delivered in antistatic carrier tape (EIA 481 standard).

Carrier Tape Specifications	
Material	PS, antistatic
Surface resistance	< 10^7 Ohm/square
Bakeability	The tape is not bakable
Tape width, W	44 mm [1.73 inch]
Pocket pitch, P_1	24 mm [0.95 inch]
Pocket depth, K_0	12.4 mm [0.488 inch]
Reel diameter	381 mm [15 inch]
Reel capacity	200 products /reel
Reel weight	TBD kg/full reel



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Soldering Information - Hole Mounting (SIP version)

The product is intended for plated through hole mounting by wave or manual soldering. The pin temperature is specified to maximum to 270°C for maximum 10 seconds.

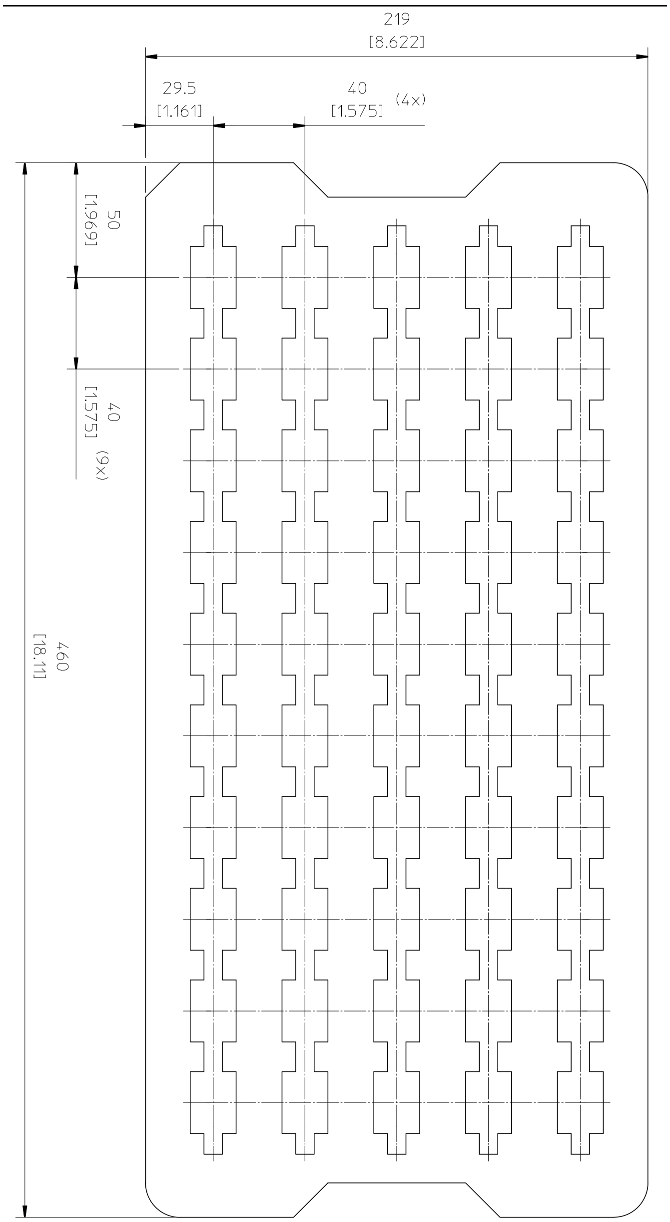
A maximum preheat rate of 4°C/s and maximum preheat temperature of 150°C is suggested. When soldering by hand, care should be taken to avoid direct contact between the hot soldering iron tip and the pins for more than a few seconds in order to prevent overheating.

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. The cleaning residues may affect long time reliability and isolation voltage.

Delivery Package Information (SIP version)

The products are delivered in antistatic trays

Tray Specifications	
Material	Antistatic Polyethylene foam
Surface resistance	10^5< Ohms/square <10^{12}
Bakability	The trays are not bakeable
Tray thickness	15 mm [0.709 inch]
Box capacity	100 products, 2 full trays/box)
Tray weight	35 g empty tray, 357 g full tray



Product Qualification Specification

Characteristics			
External visual inspection	IPC-A-610		
Change of temperature (Temperature cycling)	IEC 60068-2-14 Na	Temperature range Number of cycles Dwell/transfer time	-40 to 100°C 1000 15 min/0-1 min
Cold (in operation)	IEC 60068-2-1 Ad	Temperature T_A Duration	-45°C 72 h
Damp heat	IEC 60068-2-67 Cy	Temperature Humidity Duration	85°C 85 % RH 1000 hours
Dry heat	IEC 60068-2-2 Bd	Temperature Duration	125°C 1000 h
Electrostatic discharge susceptibility	IEC 61340-3-1, JESD 22-A114 IEC 61340-3-2, JESD 22-A115	Human body model (HBM) Machine Model (MM)	Class 2, 2000 V Class 3, 200 V
Immersion in cleaning solvents	IEC 60068-2-45 XA, method 2	Water Glycol ether	55°C 35°C
Mechanical shock	IEC 60068-2-27 Ea	Peak acceleration Duration	100 g 6 ms
Moisture reflow sensitivity [1]	J-STD-020C	Level 1 (SnPb-eutectic) Level 3 (Pb Free)	225°C 260°C
Operational life test	MIL-STD-202G, method 108A	Duration	1000 h
Resistance to soldering heat [2]	IEC 60068-2-20 Tb, method 1A	Solder temperature Duration	270°C 10-13 s
Robustness of terminations	IEC 60068-2-21 Test Ua1 IEC 60068-2-21 Test Ue1	Through hole mount products Surface mount products	All leads All leads
Solderability	IEC 60068-2-58 test Td [1] IEC 60068-2-20 test Ta [2]	Preconditioning Temperature, SnPb Eutectic Temperature, Pb-free Preconditioning Temperature, SnPb Eutectic Temperature, Pb-free	150°C dry bake 16 h 215°C 235°C Steam ageing 235°C 245°C
Vibration, broad band random	IEC 60068-2-64 Fh, method 1	Frequency Spectral density Duration	10 to 500 Hz 0.07 g^2/Hz 10 min in each direction

Notes
[1] Only for products intended for reflow soldering (surface mount products)
[2] Only for products intended for wave soldering (plated through hole products)

ERICSSON

Technical Specification

BMR 464 series POL Regulators Input 4.5-14 V, Output up to 40 A / 132 W	EN/LZT 146 435 R2B August 2011

Key Features

- Small package
  30.85 x 20.0 x 8.2 mm (1.215 x 0.787 x 0.323 in)
  SIP: 33.0 x 7.6 x 18.1 mm (1.30 x 0.30 x 0.713 in)
- 0.6 V - 3.3 V output voltage range
- High efficiency, typ. 97.2% at 5Vin, 3.3Vout half load
- Configuration and Monitoring via PMBus
- Synchonization & phase spreading
- Current sharing, Voltage Tracking & Voltage margining
- MTBF 10.9 Mh

General Characteristics

- Fully regulated
- For narrow board pitch applications (15 mm/0.6 in)
- Non-Linear Response for reduction of decoupling cap.
- Input under voltage shutdown
- Over temperature protection
- Output short-circuit & Output over voltage protection
- Remote control & Power Good
- Voltage setting via pin-strap or PMBus
- Advanced Configurable via Graphical User Interface
- ISO 9001/14001 certified supplier
- Highly automated manufacturing ensures quality

PMBus

Safety Approvals

c UL us — Pending

UL EU — ETL number

Design for Environment

Pb RoHS compatible

Meets requirements in high-temperature lead-free soldering processes.

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40A/ 0.6-3.3V Single in Line version (SIP) — BMR4642002 13

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Ordering Information

Product program	Output
BMR 464	0.6-3.3 V, 40 A/ 132 W

Product number and Packaging

BMR 464 $n_1n_2n_3n_4/n_5n_6n_7n_8$									
Options	n_1	n_2	n_3	n_4	/	n_5	n_6	n_7	n_8
Mounting	o				/				
Mechanical		o			/				
Digital interface			o	o	/				
Configuration file					/	o	o	o	
Packaging					/				o

Options	Description	
n_1	0 1 2	Through hole mount version (TH) Surface mount version (SMD) Single in line (SIP)
n_2	0	Open frame
n_3 n_4	02	PMBus and analog pin strap
n_5 n_6 n_7	001	Standard configuration
n_8	B C	Antistatic tray of 100 products (SIP only) Antistatic tape & reel of 130 products (Sample delivery avalable in lower quantities. Not for SIP)

Example: Product number BMR 464 0002/001C equals a through-hole mounted, open frame, PMBus and analog pin strap, standard configuration variant.

General Information

Reliability

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

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

Mean steady-state failure rate, λ	Std. deviation, σ
92 nFailures/h	13.0 nFailures/h
MTBF (mean value) for the BMR 464 series = 10.9 Mh. MTBF at 90% confidence level = 9.2 Mh	

Compatibility with RoHS requirements

The products are compatible with the relevant clauses and requirements of the RoHS directive 2002/95/EC 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 Ericsson Power Modules products are found in the Statement of Compliance document.

Ericsson Power Modules 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 Ericsson Power Modules General Terms and Conditions of Sale.

Limitation of Liability

Ericsson Power Modules 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).

Safety Specification

General information

Ericsson Power Modules 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.

Ericsson Power Modules 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 (V_{iso}) 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.

BMR 464 series POL Regulators Input 4.5-14 V, Output up to 40 A / 132 W	EN/LZT 146 435 R2B August 2011 © Ericsson AB

Absolute Maximum Ratings

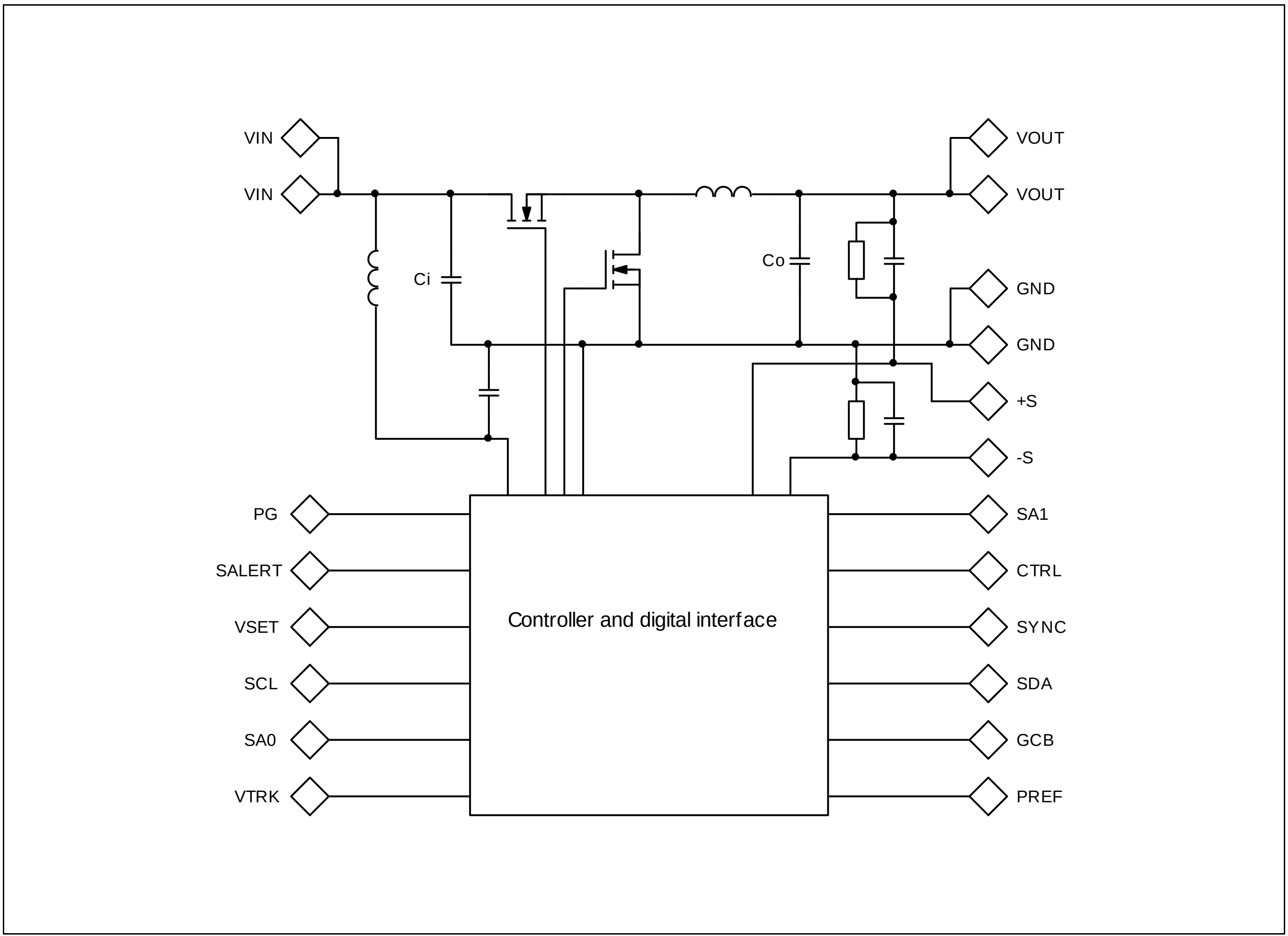
Characteristics		min	typ	max	Unit
T_{P1}	Operating temperature (see Thermal Consideration section)	-40		120	°C
T_S	Storage temperature	-40		125	°C
V_I	Input voltage (See Operating Information Section for input and output voltage relations)	-0.3		16	V
Logic I/O voltage	CTRL, SA0, SA1, SALERT, SCL, SDA, VSET, SYNC, GCB, PG	-0.3		6.5	V
Ground voltage differential	-S, PREF, GND	-0.3		0.3	V
Analog pin voltage	V_O, +S, VTRK	-0.3		6.5	V

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 in the Electrical Specification. If exposed to stress above these limits, function and performance may degrade in an unspecified manner.

Configuration File

This product is designed with a digital control circuit. The control circuit uses a configuration file which determines the functionality and performance of the product. The Electrical Specification table shows parameter values of functionality and performance with the default configuration file, unless otherwise specified. The default configuration file is designed to fit most application need with focus on high efficiency. If different characteristics are required it is possible to change the configuration file to optimize certain performance characteristics. In this Technical specification examples are included to show the possibilities with digital control. See Operating Information section for information about trade offs when optimizing certain key performance characteristics.

Fundamental Circuit Diagram



C_i=140 µF C_o =400 µF

Electrical Specification

BMR 464 0002, BMR 464 1002

T_{P1} = -30 to +95ºC, V_I = 4.5 to 14 V, $V_I > V_O$ + 1.0 V
Typical values given at: T_{P1} = +25°C, V_I = 12.0 V, max I_O, unless otherwise specified under Conditions.
Default configuration file, 190 10-CDA 102 0206/001.
External C_{IN} = 470 µF/10 mΩ, C_{OUT} = 470 µF/10 mΩ. See Operating Information section for selection of capacitor types.
Sense pins are connected to the output pins.

Characteristics			Conditions	min	typ	max	Unit
V_I	Input voltage rise time		monotonic			2.4	V/ms

V_O	Output voltage without pin strap				1.2		V
	Output voltage adjustment range			0.60		3.30	V
	Output voltage adjustment including margining			0.54		3.63	V
	Output voltage set-point resolution				±0.025		% V_O
	Output voltage accuracy		Includes, line, load, temp.	-1		1	%
	Line regulation		V_O = 0.6 V		2		mV
			V_O = 1.0 V		3		
			V_O = 1.8 V		3		
			V_O = 3.3 V		3		
	Load regulation; I_O = 0 - 100%		V_O = 0.6 V		2		mV
			V_O = 1.0 V		2		
			V_O = 1.8 V		2		
			V_O = 3.3 V		2		
V_{Oac}	Output ripple & noise C_O=470 µF (minimum external capacitance). See Note 12		V_O = 0.6 V		15		mVp-p
			V_O = 1.0 V		20		
			V_O = 1.8 V		25		
			V_O = 3.3 V		35		

I_O	Output current					40	A
I_S	Static input current at max I_O		V_O = 0.6 V		2.4		A
			V_O = 1.0 V		3.8		
			V_O = 1.8 V		6.5		
			V_O = 3.3 V		12		
I_{lim}	Current limit threshold			41		54	A
I_{sc}	Short circuit current	RMS, hiccup mode, See Note 3	V_O = 0.6 V		10		A
			V_O = 1.0 V		9		
			V_O = 1.8 V		9		
			V_O = 3.3 V		7		

η	Efficiency	50% of max I_O	V_O = 0.6 V		84.6		%
			V_O = 1.0 V		89.7		
			V_O = 1.8 V		93.3		
			V_O = 3.3 V		95.3		
		max I_O	V_O = 0.6 V		81.8		%
			V_O = 1.0 V		87.6		
			V_O = 1.8 V		92.4		
			V_O = 3.3 V		95.0		
P_d	Power dissipation at max I_O		V_O = 0.6 V		5.4		W
			V_O = 1.0 V		5.7		
			V_O = 1.8 V		6.3		
			V_O = 3.3 V		7.5		
P_{li}	Input idling power (no load)	Default configuration: Continues Conduction Mode, CCM	V_O = 0.6 V		1.1		W
			V_O = 1.0 V		1.1		
			V_O = 1.8 V		1.4		
			V_O = 3.3 V		2.2		
P_{CTRL}	Input standby power	Turned off with CTRL-pin	Default configuration: Monitoring enabled, Precise timing enabled		180		mW

Characteristics		Conditions	min	typ	max	Unit
C_i	Internal input capacitance			140		µF
C_o	Internal output capacitance			400		µF
C_{OUT}	Total external output capacitance	See Note 10	470		30 000	µF
	ESR range of capacitors (per single capacitor)	See Note 10	5		30	mΩ

V_{tr1}	Load transient peak voltage deviation Load step 25-75-25% of max I_O	Default configuration di/dt = 2 A/µs C_O=470 µF (minimum external capacitance) see Note 13	V_O = 0.6 V	250	mV
			V_O = 1.0 V	250	mV
			V_O = 1.8 V	240	mV
			V_O = 3.3 V	220	mV
t_{tr1}	Load transient recovery time, Note 5 Load step 25-75-25% of max I_O	Default configuration di/dt = 2 A/µs C_O=470 µF (minimum external capacitance) see Note 13	V_O = 0.6 V	150	µs
			V_O = 1.0 V	100	µs
			V_O = 1.8 V	100	µs
			V_O = 3.3 V	50	µs

			min	typ	max	Unit
f_s	Switching frequency			320		kHz
	Switching frequency range	PMBus configurable		200-640		kHz
	Switching frequency set-point accuracy		-5		5	%
	Control Circuit PWM Duty Cycle		5		95	%
	Minimum Sync Pulse Width		150			ns
	Synchronization Frequency Tolerance	External clock source	-13		13	%

			min	typ	max	Unit
Input Under Voltage Lockout, UVLO	UVLO threshold			3.85		V
	UVLO threshold range	PMBus configurable		3.85-14		V
	Set point accuracy		-150		150	mV
	UVLO hysteresis			0.35		V
	UVLO hysteresis range	PMBus configurable		0-10.15		V
	Delay				2.5	µs
	Fault response	See Note 3		Automatic restart, 70ms		
Input Over Voltage Protection, IOVP	IOVP threshold			16		V
	IOVP threshold range	PMBus configurable		4.2-16		V
	Set point accuracy		-150		150	mV
	IOVP hysteresis			1		V
	IOVP hysteresis range	PMBus configurable		0-11.8		V
	Delay				2.5	µs
	Fault response	See Note 3		Automatic restart, 70ms		
Power Good, PG, See Note 2	PG threshold			90		% V_O
	PG hysteresis			5		% V_O
	PG delay			10		ms
	PG delay range	PMBus configurable		0-500		s
Output voltage Over/Under Voltage Protection, OVP/UVP	UVP threshold			85		% V_O
	UVP threshold range	PMBus configurable		0-100		% V_O
	UVP hysteresis			5		% V_O
	OVP threshold			115		% V_O
	OVP threshold range	PMBus configurable		100-115		% V_O
	UVP/OVP response time			25		µs
	UVP/OVP response time range	PMBus configurable		5-60		µs
	Fault response	See Note 3		Automatic restart, 70ms		
Over Current Protection, OCP	OCP threshold			48		A
	OCP threshold range	PMBus configurable		0-50		A
	Protection delay,	See Note 4		5		T_{sw}
	Protection delay range	PMBus configurable		1-32		T_{sw}
	Fault response	See Note 3		Automatic restart, 70ms		

Characteristics		Conditions	min	typ	max	Unit
Over Temperature Protection, OTP at P1 See Note 9	OTP threshold			120		°C
	OTP threshold range	PMBus configurable		-40…+120		°C
	OTP hysteresis			15		°C
	OTP hysteresis range	PMBus configurable		0-160		°C
	Fault response	See Note 3		Automatic restart, 70ms		

V_{IL}	Logic input low threshold	SYNC, SA0, SA1, SCL, SDA, GCB, CTRL, VSET			0.8	V
V_{IH}	Logic input high threshold		2			V
I_{IL}	Logic input low sink current	CTRL			0.6	mA
V_{OL}	Logic output low signal level	SYNC, SCL, SDA, SALERT, GCB, PG			0.4	V
V_{OH}	Logic output high signal level		2.25			V
I_{OL}	Logic output low sink current				4	mA
I_{OH}	Logic output high source current				2	mA
t_{set}	Setup time, SMBus	See Note 1	300			ns
t_{hold}	Hold time, SMBus	See Note 1	250			ns
t_{free}	Bus free time, SMBus	See Note 1	2			ms
C_p	Internal capacitance on logic pins				10	pF

Start-Up time		See Note 11		30		ms
Output Voltage Delay Time See Note 6	Delay duration			10		ms
	Delay duration range	PMBus configurable		2-500000		
	Delay accuracy	Default configuration: CTRL controlled Precise timing enabled		±0.25		ms
		PMBus controlled Precise timing disabled		-0.25/+4		ms
Output Voltage Ramp Time	Ramp duration			10		ms
	Ramp duration range	PMBus configurable		0-200		
	Ramp time accuracy			100		µs

VTRK Input Bias Current	V_{VTRK} = 5.5 V		110	200	µA
VTRK Tracking Ramp Accuracy, Note 8	100% Tracking (V_O - V_{VTRK})	-100		100	mV
VTRK Regulation Accuracy	100% Tracking (V_O - V_{VTRK})	-1		1	%

Max current difference between products in a sharing group			20		% of full scale
Number of products in a current sharing group				7	

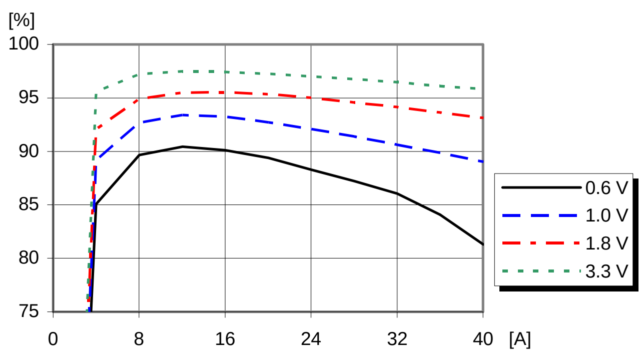
Monitoring accuracy	READ_VIN vs V_I			3		%
	READ_VOUT vs V_O			1		%
	READ_IOUT vs I_O	I_O =0-40 A, T_{P1} = 0 to +95°C V_I = 12 V		±2.5		A
	READ_IOUT vs I_O	I_O =0-40 A, T_{P1} = 0 to +95°C V_I = 4.5-14 V		±4		A

Note 1: See section I2C/SMBus Setup and Hold Times – Definitions.
Note 2: Monitorable over PMBus Interface.
Note 3: Continuous re-starts with 70 ms between each start. See Power Management section for additional fault response types.
Note 4: T_{sw} is the switching period.
Note 5: Within +/-3% of V_O
Note 6: See section Soft-start Power Up.
Note 8: Tracking functionality is designed to follow a VTRK signal with slewrate < 2.4V/ms. For faster VTRK signals accuracy will depend on the regulator bandwidth.
Note 9: See section Over Temperature Protection (OTP).
Note 10: See section External Capacitors.
Note 11: See section Start-Up Procedure.
Note 12: See graph Output Ripple vs External Capacitance and Operating information section Output Ripple and Noise.
Note 13: See graph Load Transient vs. External Capacitance and Operating information section External Capacitors.

Typical Characteristics
Efficiency and Power Dissipation

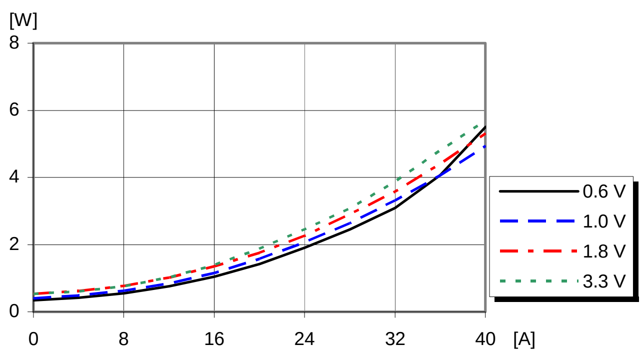
BMR 464 0002, BMR 464 1002

Efficiency vs. Output Current, V_I=5 V



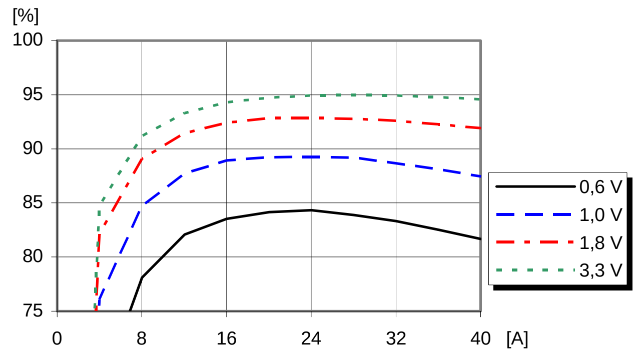
Efficiency vs. load current and output voltage:
T_{P1} = +25°C. V_I=5 V, f_{sw}=320 kHz, C_O=470 µF/10 mΩ.

Power Dissipation vs. Output Current, V_I=5 V



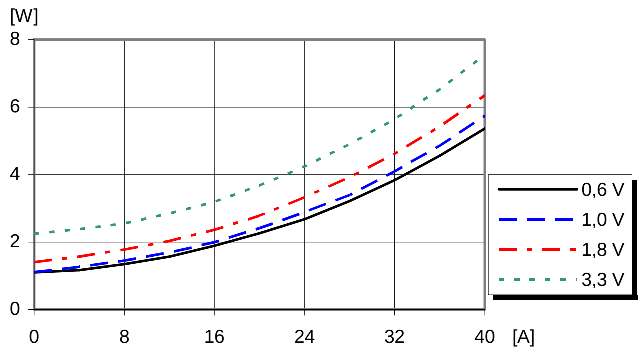
Dissipated power vs. load current and output voltage:
T_{P1} = +25°C. V_I=5 V, f_{sw}=320 kHz, C_O=470 µF/10 mΩ.

Efficiency vs. Output Current, V_I=12 V



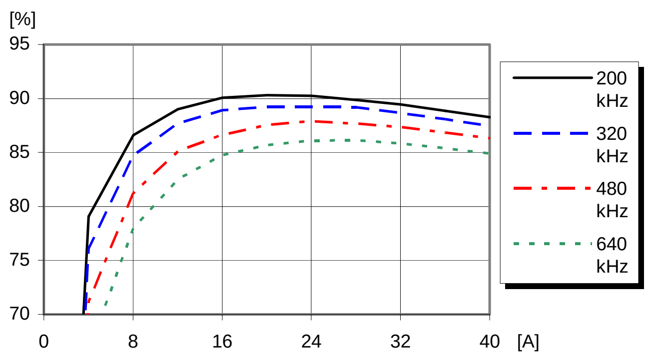
Efficiency vs. load current and output voltage at
T_{P1} = +25°C. V_I=12 V, f_{sw}=320 kHz, C_O=470 µF/10 mΩ.

Power Dissipation vs. Output Current, V_I=12 V



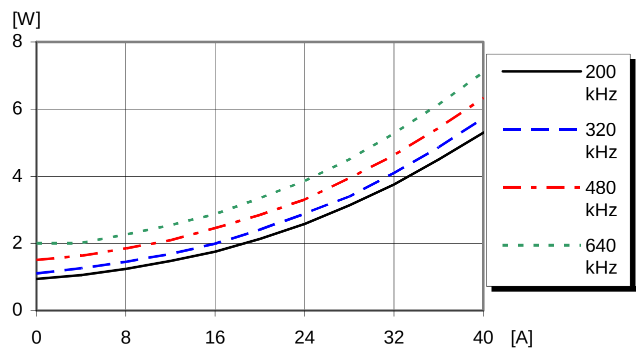
Dissipated power vs. load current and output voltage:
T_{P1} = +25°C. V_I=12 V, f_{sw}=320 kHz, C_O=470 µF/10 mΩ.

Efficiency vs. Output Current and Switching Frequency



Efficiency vs. load current and switch frequency at
T_{P1} = +25°C. V_I=12 V, V_O=1.0 V, C_O=470 µF/10 mΩ
Default configuration except changed frequency

Power Dissipation vs. Output Current and Switching frequency



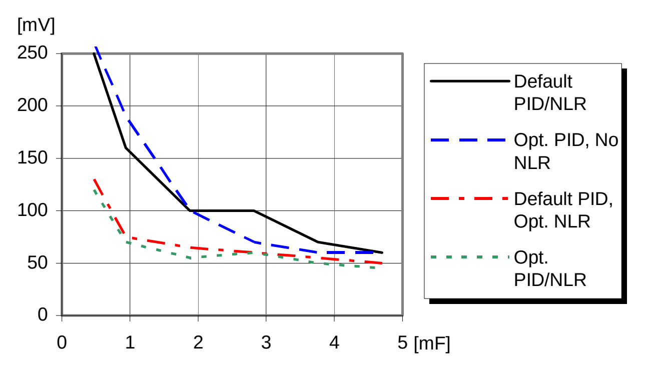
Dissipated power vs. load current and switch frequency at
T_{P1} = +25°C. V_I=12 V, V_O=1.0 V, C_O=470 µF/10 mΩ
Default configuration except changed frequency

BMR 464 series POL Regulators Input 4.5-14 V, Output up to 40 A / 132 W	EN/LZT 146 435 R2B August 2011 © Ericsson AB

Typical Characteristics
Load Transient

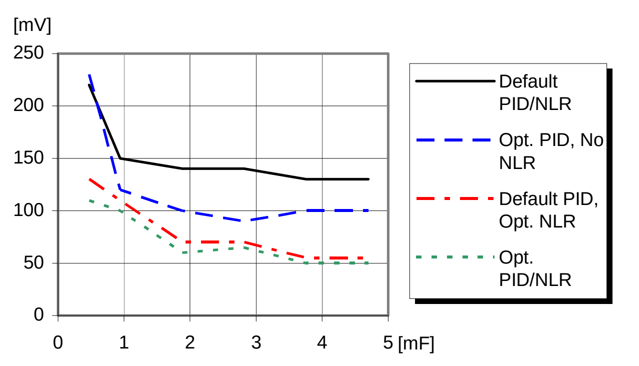
BMR 464 0002, BMR 464 1002

Load Transient vs. External Capacitance, V_O=1.0 V



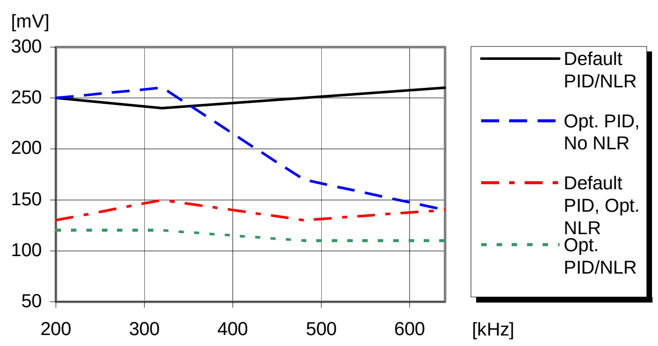
Load transient peak voltage deviation vs. external capacitance.
Step-change (10-30-10 A). Parallel coupling of capacitors with 470 µF/10 mΩ,
T_{P1} = +25°C. V_I=12 V, V_O=1.0 V, f_{sw}=320 kHz, di/dt=2 A/µs

Load Transient vs. External Capacitance, V_O=3.3 V



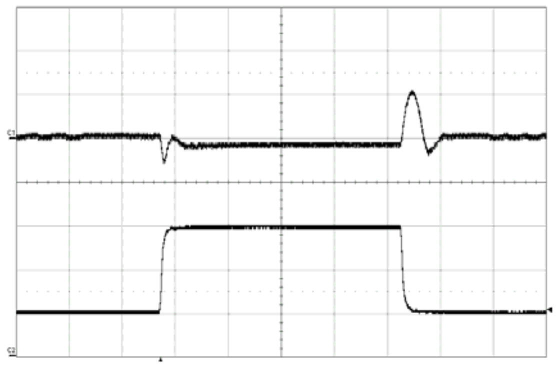
Load transient peak voltage deviation vs. external capacitance.
Step-change (10-30-10 A). Parallel coupling of capacitors with 470 µF/10 mΩ,
T_{P1} = +25°C. V_I=12 V, V_O=3.3 V, f_{sw}=320 kHz, di/dt=2 A/µs

Load transient vs. Switch Frequency



Load transient peak voltage deviation vs. frequency.
Step-change (10-30-10 A).
T_{P1} = +25°C. V_I=12 V, V_O=1.0 V, C_O=470 µF/10 mΩ

Output Load Transient Response, Default PID/NLR



Output voltage response to load current step-change (10-30-10 A) at:
T_{P1} = +25°C, V_I = 12 V, V_O =1.0 V
di/dt=2 A/µs, f_{sw}=320 kHz, C_O=470 µF/10 mΩ

Top trace: output voltage (200 mV/div.).
Bottom trace: load current (10 A/div.).
Time scale: (0.1 ms/div.).

BMR 464 series POL Regulators Input 4.5-14 V, Output up to 40 A / 132 W	EN/LZT 146 435 R2B August 2011
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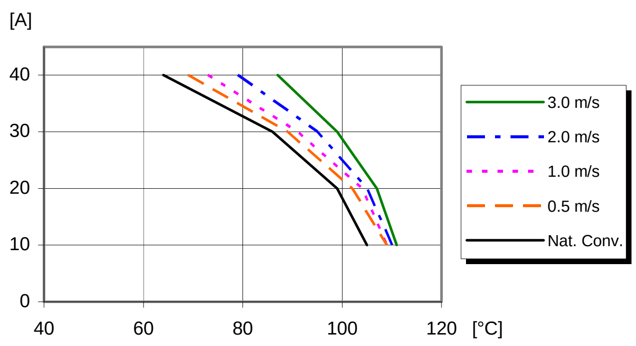
Typical Characteristics
Output Current Characteristic

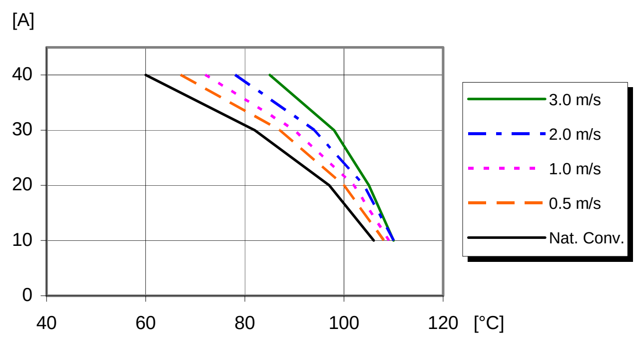
BMR 464 0002, BMR 464 1002

Output Current Derating, V_O=0.6 V



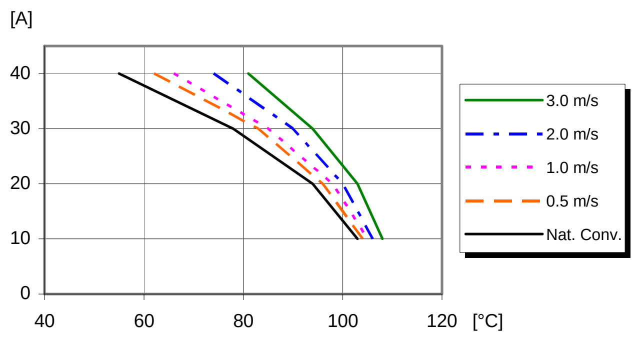
Available load current vs. ambient air temperature and airflow at V_O=0.6V, V_I = 12 V. See Thermal Consideration section.

Output Current Derating, V_O=1.0 V



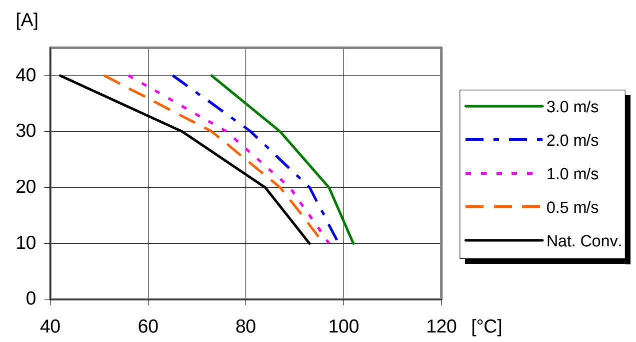
Available load current vs. ambient air temperature and airflow at V_O=1.0V, V_I = 12 V. See Thermal Consideration section.

Output Current Derating, V_O=1.8 V



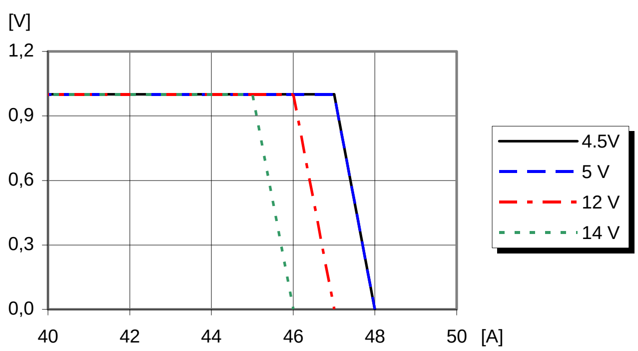
Available load current vs. ambient air temperature and airflow at V_O=1.8V, V_I = 12 V. See Thermal Consideration section.

Output Current Derating, V_O=3.3 V



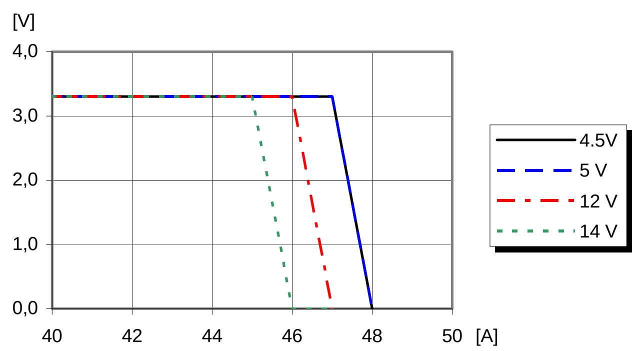
Available load current vs. ambient air temperature and airflow at V_O=3.3V, V_I = 12 V. See Thermal Consideration section.

Current Limit Characteristics, V_O=1.0 V



Output voltage vs. load current at T_{P1} = +25°C. V_O=1.0V.

Current Limit Characteristics, V_O=3.3 V



Output voltage vs. load current at T_{P1} = +25°C. V_O=3.3V.

BMR 464 series POL Regulators Input 4.5-14 V, Output up to 40 A / 132 W	EN/LZT 146 435 R2B August 2011
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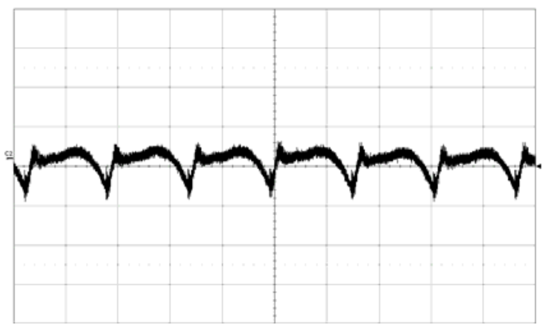
Typical Characteristics
Output Voltage

BMR 464 0002, BMR 464 1002

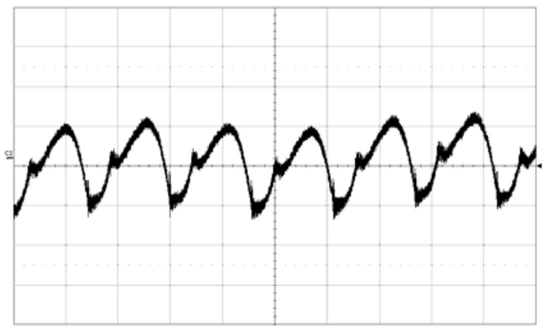
Output Ripple & Noise, V_O=1.0 V



Output voltage ripple at:
T_{P1} = +25°C, V_I = 12 V, C_O=470 µF/10 mΩ
I_O = 40 A

Trace: output voltage (10 mV/div.).
Time scale: (2 µs/div.).

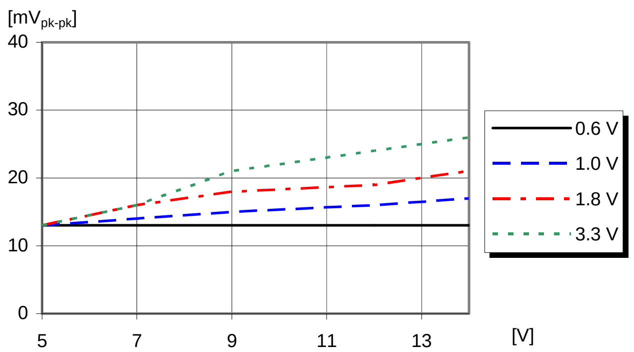
Output Ripple & Noise, V_O=3.3 V



Output voltage ripple at:
T_{P1} = +25°C, V_I = 12 V, C_O=470 µF/10 mΩ
I_O = 40 A

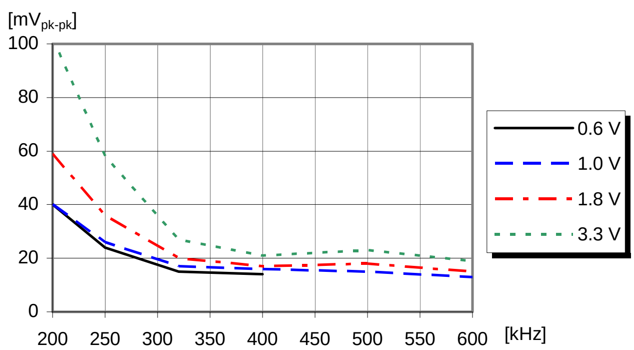
Trace: output voltage (10 mV/div.).
Time scale: (2 µs/div.).

Output Ripple vs. Input Voltage



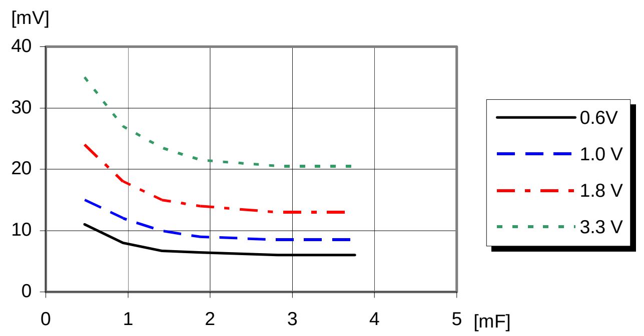
Output voltage ripple V_{pk-pk} at: T_{P1} = +25°C, C_O=470 µF/10 mΩ, I_O = 40 A.

Output Ripple vs. Frequency



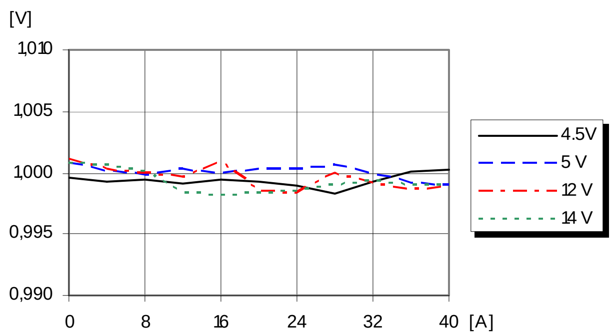
Output voltage ripple V_{pk-pk} at: T_{P1} = +25°C, V_I = 12 V, C_O=470 µF/10 mΩ, I_O = 40 A. Default configuration except changed frequency.

Output Ripple vs. External Capacitance



Output voltage ripple V_{pk-pk} at: T_{P1} = +25°C, V_I = 12 V. I_O = 40 A. Parallel coupling of capacitors with 470 µF/10 mΩ,

Load regulation, V_O=1.0V



Load regulation at V_o=1.0 V at: T_{P1} = +25°C, C_O=470 µF/10 mΩ

BMR 464 series POL Regulators Input 4.5-14 V, Output up to 40 A / 132 W	EN/LZT 146 435 R2B August 2011
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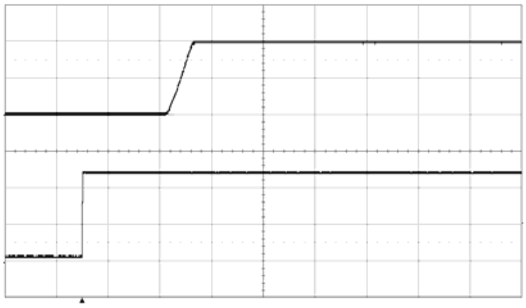
Typical Characteristics
Start-up and shut-down

BMR 464 0002, BMR 464 1002

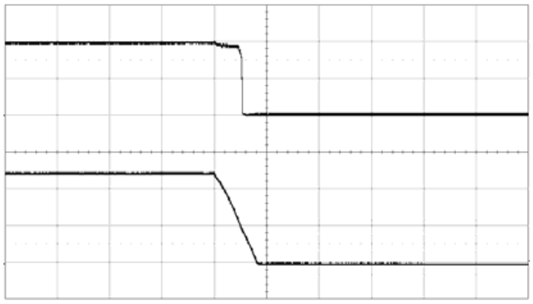
Start-up by input source



Start-up enabled by connecting V_I at:
T_{P1} = +25°C, V_I = 12 V, V_O = 1.0 V
C_O = 470 µF/10 mΩ, I_O = 40 A

Top trace: output voltage (0.5 V/div.).
Bottom trace: input voltage (5 V/div.).
Time scale: (20 ms/div.).

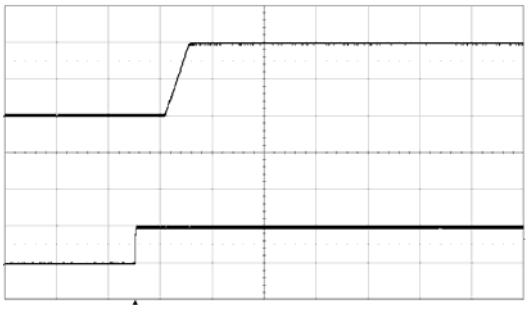
Shut-down by input source



Shut-down enabled by disconnecting V_I at:
T_{P1} = +25°C, V_I = 12 V, V_O = 1.0 V
C_O = 470 µF/10 mΩ, I_O = 40 A

Top trace: output voltage (0.5 V/div).
Bottom trace: input voltage (5 V/div.).
Time scale: (2 ms/div.).

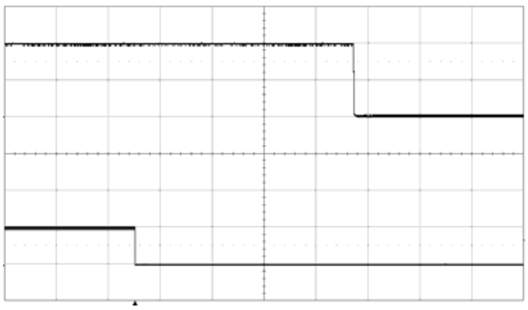
Start-up by CTRL signal



Start-up by enabling CTRL signal at:
T_{P1} = +25°C, V_I = 12 V, V_O = 1.0 V
C_O = 470 µF/10 mΩ, I_O = 40 A

Top trace: output voltage (0.5 V/div.).
Bottom trace: CTRL signal (5 V/div.).
Time scale: (20 ms/div.).

Shut-down by CTRL signal



Shut-down enabled by disconnecting V_I at:
T_{P1} = +25°C, V_I = 12 V, V_O = 1.0 V
C_O = 470 µF/10 mΩ, I_O = 40 A

Top trace: output voltage (0.5 V/div).
Bottom trace: CTRL signal (5 V/div.).
Time scale: (2 ms/div.).

Electrical Specification

BMR 464 2002 (SIP)

T_{P1} = -30 to +95ºC, V_I = 4.5 to 14 V, $V_I > V_O$ + 1.0 V
Typical values given at: T_{P1} = +25°C, V_I = 12.0 V, max I_O, unless otherwise specified under Conditions.
Default configuration file, 190 10-CDA 102 0259/001.
External C_{IN} = 470 µF/10 mΩ, C_{OUT} = 470 µF/10 mΩ. See Operating Information section for selection of capacitor types.
Sense pins are connected to the output pins.

Characteristics			Conditions	min	typ	max	Unit
V_I	Input voltage rise time		monotonic			2.4	V/ms
V_O	Output voltage without pin strap				1.2		V
	Output voltage adjustment range			0.60		3.30	V
	Output voltage adjustment including margining			0.54		3.63	V
	Output voltage set-point resolution				±0.025		% V_O
	Output voltage accuracy		Includes, line, load, temp.	-1		1	%
	Line regulation		V_O = 0.6 V		2		mV
			V_O = 1.0 V		2		
			V_O = 1.8 V		2		
			V_O = 3.3 V		2		
	Load regulation; I_O = 0 - 100%		V_O = 0.6 V		2		mV
			V_O = 1.0 V		2		
			V_O = 1.8 V		2		
			V_O = 3.3 V		2		
V_{Oac}	Output ripple & noise C_O=470 µF (minimum external capacitance). See Note 12		V_O = 0.6 V		20		mVp-p
			V_O = 1.0 V		25		
			V_O = 1.8 V		30		
			V_O = 3.3 V		45		
I_O	Output current					40	A
I_S	Static input current at max I_O		V_O = 0.6 V		2.5		A
			V_O = 1.0 V		3.8		
			V_O = 1.8 V		6.5		
			V_O = 3.3 V		11.6		
I_{lim}	Current limit threshold			41		54	A
I_{sc}	Short circuit current	RMS, hiccup mode, See Note 3	V_O = 0.6 V		9		A
			V_O = 1.0 V		8		
			V_O = 1.8 V		8		
			V_O = 3.3 V		6		
η	Efficiency	50% of max I_O	V_O = 0.6 V		85.8		%
			V_O = 1.0 V		90.5		
			V_O = 1.8 V		93.7		
			V_O = 3.3 V		95.5		
		max I_O	V_O = 0.6 V		81.4		%
			V_O = 1.0 V		87.5		
			V_O = 1.8 V		92.1		
			V_O = 3.3 V		94.7		
P_d	Power dissipation at max I_O		V_O = 0.6 V		5.5		W
			V_O = 1.0 V		5.7		
			V_O = 1.8 V		6.2		
			V_O = 3.3 V		7.3		
P_{li}	Input idling power (no load)	Default configuration: Continues Conduction Mode, CCM	V_O = 0.6 V		0.9		W
			V_O = 1.0 V		0.9		
			V_O = 1.8 V		1.1		
			V_O = 3.3 V		1.7		
P_{CTRL}	Input standby power	Turned off with CTRL-pin	Default configuration: Monitoring enabled, Precise timing enabled		170		mW

BMR 464 series POL Regulators Input 4.5-14 V, Output up to 40 A / 132 W	EN/LZT 146 435 R2B August 2011

Characteristics		Conditions	min	typ	max	Unit
C_i	Internal input capacitance			140		µF
C_o	Internal output capacitance			400		µF
C_{OUT}	Total external output capacitance	See Note 10	470		30 000	µF
	ESR range of capacitors (per single capacitor)	See Note 10	5		30	mΩ

V_{tr1}	Load transient peak voltage deviation Load step 25-75-25% of max I_O	Default configuration di/dt = 2 A/µs C_O=470 µF (minimum external capacitance) see Note 13	V_O = 0.6 V	240	mV
			V_O = 1.0 V	240	
			V_O = 1.8 V	220	
			V_O = 3.3 V	200	
t_{tr1}	Load transient recovery time, Note 5 Load step 25-75-25% of max I_O	Default configuration di/dt = 2 A/µs C_O=470 µF (minimum external capacitance) see Note 13	V_O = 0.6 V	120	µs
			V_O = 1.0 V	100	
			V_O = 1.8 V	80	
			V_O = 3.3 V	40	

f_s	Switching frequency			320		kHz
	Switching frequency range	PMBus configurable		200-640		kHz
	Switching frequency set-point accuracy		-5		5	%
	Control Circuit PWM Duty Cycle		5		95	%
	Minimum Sync Pulse Width		150			ns
	Synchronization Frequency Tolerance	External clock source	-13		13	%

Input Under Voltage Lockout, UVLO	UVLO threshold			3.85		V
	UVLO threshold range	PMBus configurable		3.85-14		V
	Set point accuracy		-150		150	mV
	UVLO hysteresis			0.35		V
	UVLO hysteresis range	PMBus configurable		0-10.15		V
	Delay				2.5	µs
	Fault response	See Note 3		Automatic restart, 70ms		
Input Over Voltage Protection, IOVP	IOVP threshold			16		V
	IOVP threshold range	PMBus configurable		4.2-16		V
	Set point accuracy		-150		150	mV
	IOVP hysteresis			1		V
	IOVP hysteresis range	PMBus configurable		0-11.8		V
	Delay				2.5	µs
	Fault response	See Note 3		Automatic restart, 70ms		
Power Good, PG, See Note 2	PG threshold			90		% V_O
	PG hysteresis			5		% V_O
	PG delay			10		ms
	PG delay range	PMBus configurable		0-500		s
Output voltage Over/Under Voltage Protection, OVP/UVP	UVP threshold			85		% V_O
	UVP threshold range	PMBus configurable		0-100		% V_O
	UVP hysteresis			5		% V_O
	OVP threshold			115		% V_O
	OVP threshold range	PMBus configurable		100-115		% V_O
	UVP/OVP response time			25		µs
	UVP/OVP response time range	PMBus configurable		5-60		µs
	Fault response	See Note 3		Automatic restart, 70ms		
Over Current Protection, OCP	OCP threshold			48		A
	OCP threshold range	PMBus configurable		0-50		A
	Protection delay,	See Note 4		5		T_{sw}
	Protection delay range	PMBus configurable		1-32		T_{sw}
	Fault response	See Note 3		Automatic restart, 70ms		

BMR 464 series POL Regulators Input 4.5-14 V, Output up to 40 A / 132 W	EN/LZT 146 435 R2B August 2011
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Characteristics		Conditions	min	typ	max	Unit
Over Temperature Protection, OTP at P1 See Note 9	OTP threshold			120		°C
	OTP threshold range	PMBus configurable		-40…+120		°C
	OTP hysteresis			15		°C
	OTP hysteresis range	PMBus configurable		0-160		°C
	Fault response	See Note 3		Automatic restart, 70ms		

			min	typ	max	Unit
V_{IL}	Logic input low threshold	SYNC, SA0, SA1, SCL, SDA, GCB, CTRL, VSET			0.8	V
V_{IH}	Logic input high threshold		2			V
I_{IL}	Logic input low sink current	CTRL			0.6	mA
V_{OL}	Logic output low signal level	SYNC, SCL, SDA, SALERT, GCB, PG			0.4	V
V_{OH}	Logic output high signal level		2.25			V
I_{OL}	Logic output low sink current				4	mA
I_{OH}	Logic output high source current				2	mA
t_{set}	Setup time, SMBus	See Note 1	300			ns
t_{hold}	Hold time, SMBus	See Note 1	250			ns
t_{free}	Bus free time, SMBus	See Note 1	2			ms
C_p	Internal capacitance on logic pins				10	pF

			min	typ	max	Unit
Start-Up time		See Note 11		30		ms
Output Voltage Delay Time See Note 6	Delay duration			10		ms
	Delay duration range	PMBus configurable		2-500000		
	Delay accuracy	Default configuration: CTRL controlled Precise timing enabled		±0.25		ms
		PMBus controlled Precise timing disabled		-0.25/+4		ms
Output Voltage Ramp Time	Ramp duration			10		ms
	Ramp duration range	PMBus configurable		0-200		
	Ramp time accuracy			100		µs

		min	typ	max	Unit
VTRK Input Bias Current	V_{VTRK} = 5.5 V		110	200	µA
VTRK Tracking Ramp Accuracy, Note 8	100% Tracking (V_O - V_{VTRK})	-100		100	mV
VTRK Regulation Accuracy	100% Tracking (V_O - V_{VTRK})	-1		1	%

		min	typ	max	Unit
Max current difference between products in a sharing group			20		% of full scale
Number of products in a current sharing group				7	

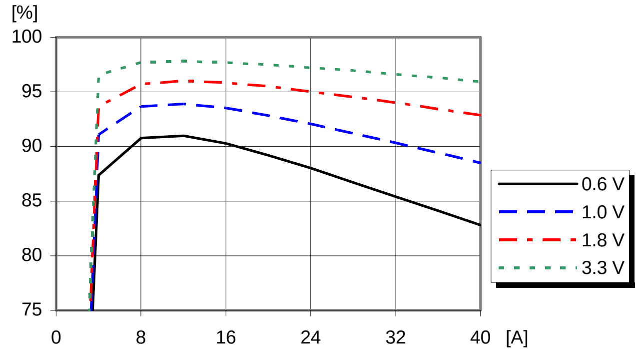
			min	typ	max	Unit
Monitoring accuracy	READ_VIN vs V_I			3		%
	READ_VOUT vs V_O			1		%
	READ_IOUT vs I_O	I_O =0-40 A, T_{P1} = 0 to +95°C V_I = 12 V		±2.5		A
	READ_IOUT vs I_O	I_O =0-40 A, T_{P1} = 0 to +95°C V_I = 4.5-14 V		±4		A

Note 1: See section I2C/SMBus Setup and Hold Times – Definitions.
Note 2: Monitorable over PMBus Interface.
Note 3: Continuous re-starts with 70 ms between each start. See Power Management section for additional fault response types.
Note 4: T_{sw} is the switching period.
Note 5: Within +/-3% of V_O
Note 6: See section Soft-start Power Up.
Note 8: Tracking functionality is designed to follow a VTRK signal with slewrate < 2.4V/ms. For faster VTRK signals accuracy will depend on the regulator bandwidth.
Note 9: See section Over Temperature Protection (OTP).
Note 10: See section External Capacitors.
Note 11: See section Start-Up Procedure.
Note 12: See graph Output Ripple vs External Capacitance and Operating information section Output Ripple and Noise.
Note 13: See graph Load Transient vs. External Capacitance and Operating information section External Capacitors.

Typical Characteristics
Efficiency and Power Dissipation

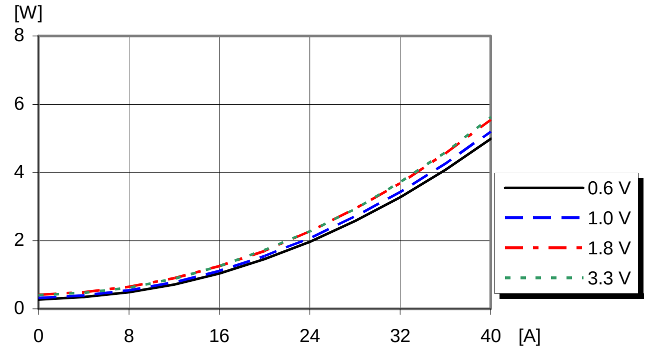
BMR 464 2002 (SIP)

Efficiency vs. Output Current, V_I=5 V



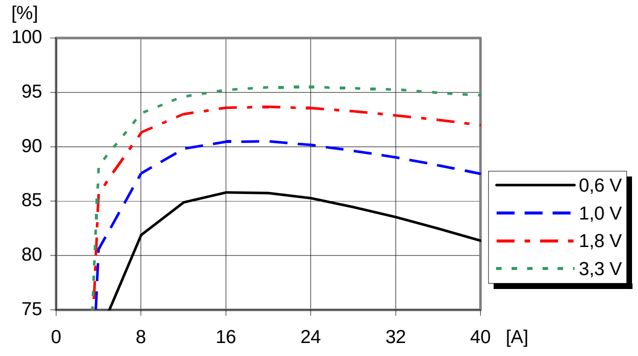
Efficiency vs. load current and output voltage:
T_{P1} = +25°C. V_I=5 V, f_{sw}=320 kHz, C_O=470 µF/10 mΩ.

Power Dissipation vs. Output Current, V_I=5 V



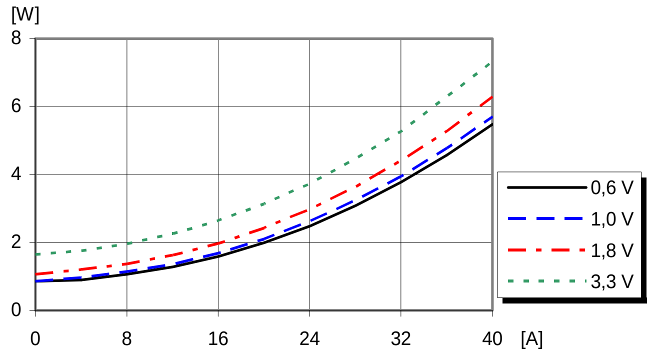
Dissipated power vs. load current and output voltage:
T_{P1} = +25°C. V_I=5 V, f_{sw}=320 kHz, C_O=470 µF/10 mΩ.

Efficiency vs. Output Current, V_I=12 V



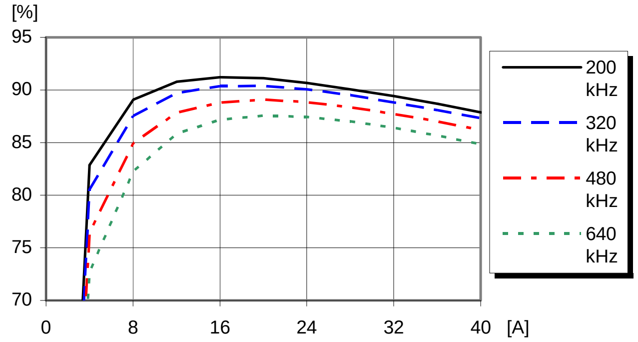
Efficiency vs. load current and output voltage at
T_{P1} = +25°C. V_I=12 V, f_{sw}=320 kHz, C_O=470 µF/10 mΩ.

Power Dissipation vs. Output Current, V_I=12 V



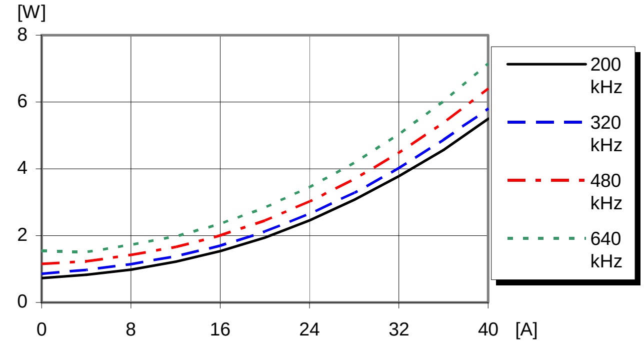
Dissipated power vs. load current and output voltage:
T_{P1} = +25°C. V_I=12 V, f_{sw}=320 kHz, C_O=470 µF/10 mΩ.

Efficiency vs. Output Current and Switching Frequency



Efficiency vs. load current and switch frequency at
T_{P1} = +25°C. V_I=12 V, V_O=1.0 V, C_O=470 µF/10 mΩ
Default configuration except changed frequency

Power Dissipation vs. Output Current and Switching frequency



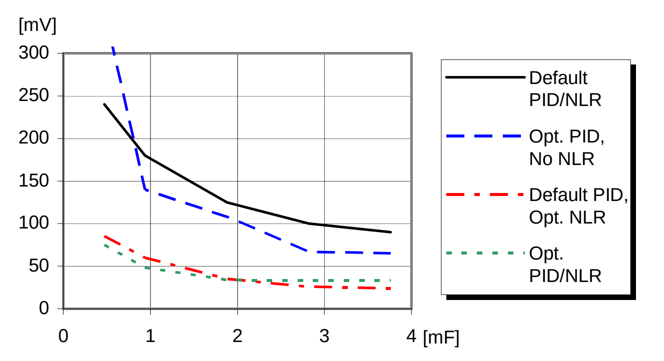
Dissipated power vs. load current and switch frequency at
T_{P1} = +25°C. V_I=12 V, V_O=1.0 V, C_O=470 µF/10 mΩ
Default configuration except changed frequency

BMR 464 series POL Regulators
Input 4.5-14 V, Output up to 40 A / 132 W

Typical Characteristics
Load Transient

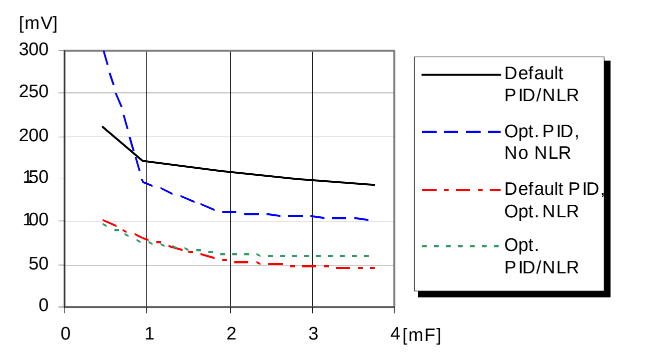
BMR 464 2002 (SIP)

Load Transient vs. External Capacitance, V_O=1.0 V



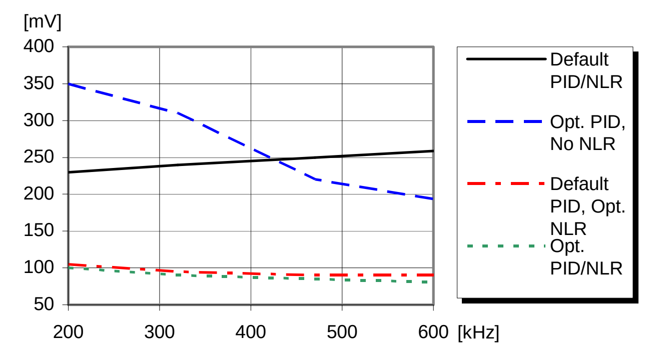
Load transient peak voltage deviation vs. external capacitance.
Step-change (10-30-10 A). Parallel coupling of capacitors with 470 µF/10 mΩ,
T_{P1} = +25°C. V_I=12 V, V_O=1.0 V, f_{sw}=320 kHz, di/dt=2 A/µs

Load Transient vs. External Capacitance, V_O=3.3 V



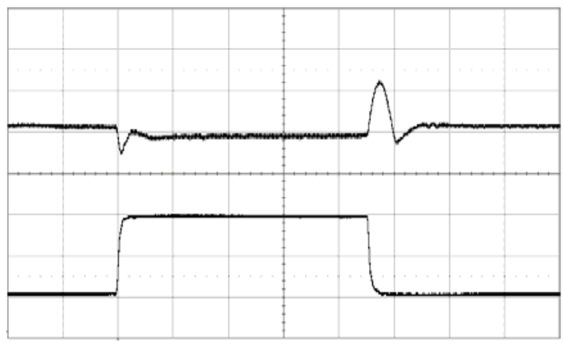
Load transient peak voltage deviation vs. external capacitance.
Step-change (10-30-10 A). Parallel coupling of capacitors with 470 µF/10 mΩ,
T_{P1} = +25°C. V_I=12 V, V_O=3.3 V, f_{sw}=320 kHz, di/dt=2 A/µs

Load transient vs. Switch Frequency



Load transient peak voltage deviation vs. frequency.
Step-change (10-30-10 A).
T_{P1} = +25°C. V_I=12 V, V_O=1.0 V, C_O=470 µF/10 mΩ

Output Load Transient Response, Default PID/NLR



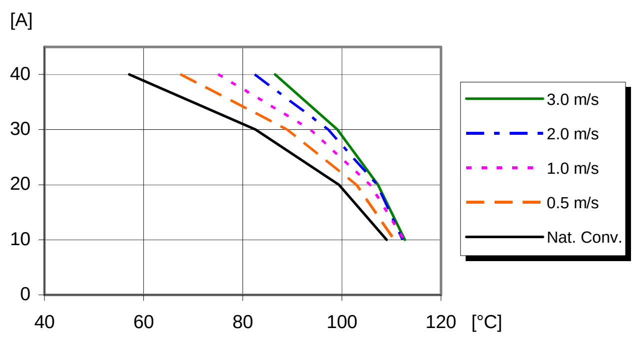
Output voltage response to load current step-change (10-30-10 A) at:
T_{P1} = +25°C, V_I = 12 V, V_O =1.0 V
di/dt=2 A/µs, f_{sw}=320 kHz, C_O=470 µF/10 mΩ

Top trace: output voltage (200 mV/div.).
Bottom trace: load current (10 A/div.).
Time scale: (0.1 ms/div.).

Typical Characteristics
Output Current Characteristic

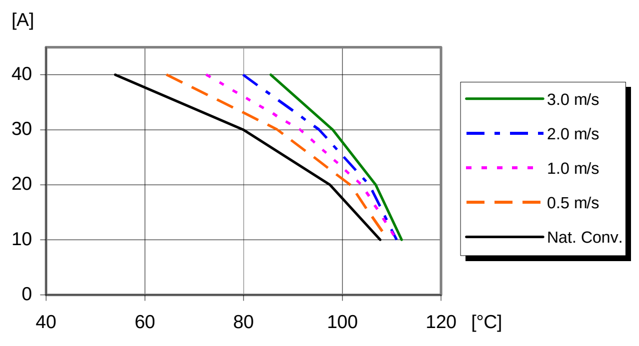
BMR 464 2002 (SIP)

Output Current Derating, V_O=0.6 V



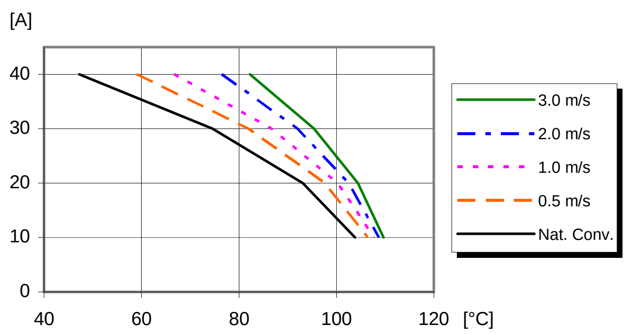
Available load current vs. ambient air temperature and airflow at V_O=0.6V, V_I = 12 V. See Thermal Consideration section.

Output Current Derating, V_O=1.0 V



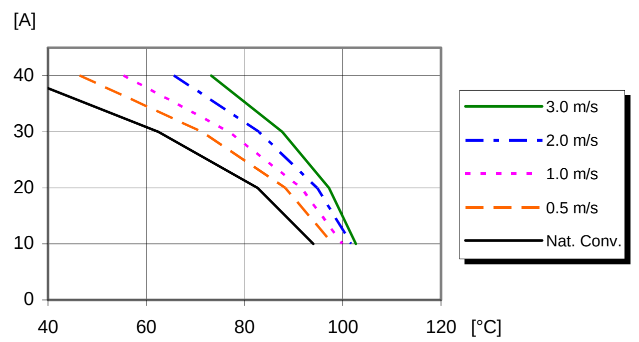
Available load current vs. ambient air temperature and airflow at V_O=1.0V, V_I = 12 V. See Thermal Consideration section.

Output Current Derating, V_O=1.8 V



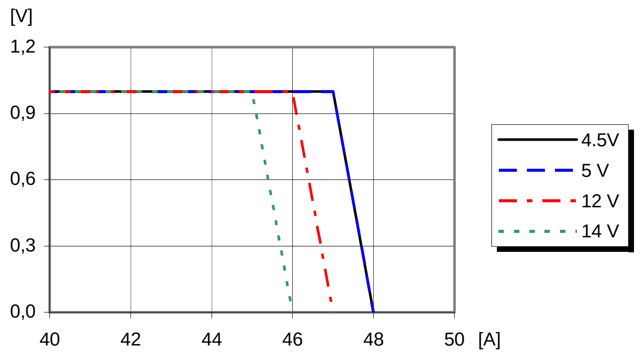
Available load current vs. ambient air temperature and airflow at V_O=1.8V, V_I = 12 V. See Thermal Consideration section.

Output Current Derating, V_O=3.3 V



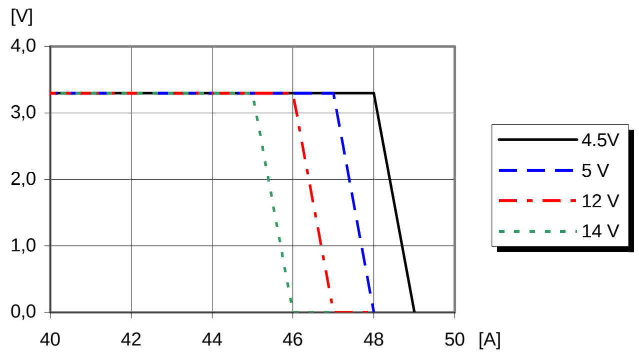
Available load current vs. ambient air temperature and airflow at V_O=3.3V, V_I = 12 V. See Thermal Consideration section.

Current Limit Characteristics, V_O=1.0 V



Output voltage vs. load current at T_{P1} = +25°C. V_O=1.0V.

Current Limit Characteristics, V_O=3.3 V



Output voltage vs. load current at T_{P1} = +25°C. V_O=3.3V.

BMR 464 series POL Regulators Input 4.5-14 V, Output up to 40 A / 132 W	EN/LZT 146 435 R2B August 2011
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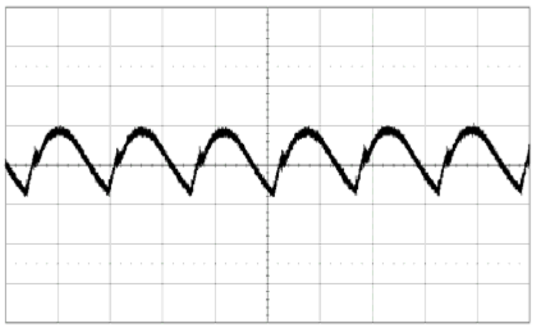
Typical Characteristics
Output Voltage

BMR 464 2002 (SIP)

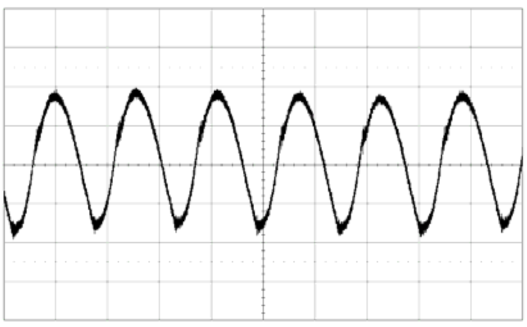
Output Ripple & Noise, V_O=1.0 V



Output voltage ripple at:
T_{P1} = +25°C, V_I = 12 V, C_O=470 µF/10 mΩ
I_O = 40 A

Trace: output voltage (10 mV/div.).
Time scale: (2 µs/div.).

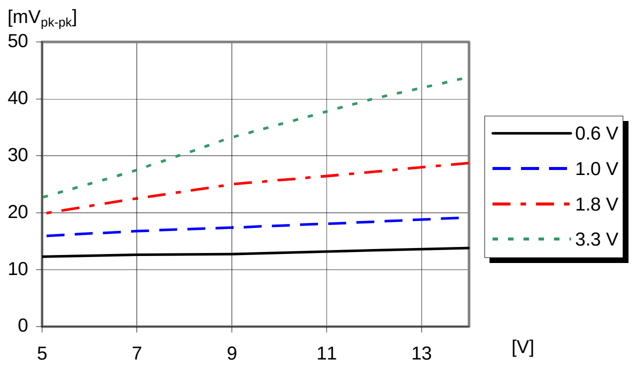
Output Ripple & Noise, V_O=3.3 V



Output voltage ripple at:
T_{P1} = +25°C, V_I = 12 V, C_O=470 µF/10 mΩ
I_O = 40 A

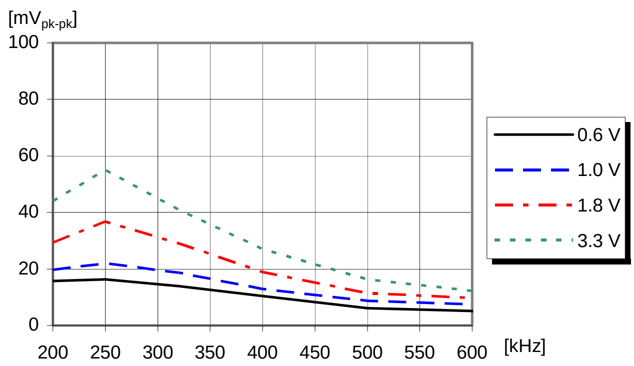
Trace: output voltage (10 mV/div.).
Time scale: (2 µs/div.).

Output Ripple vs. Input Voltage



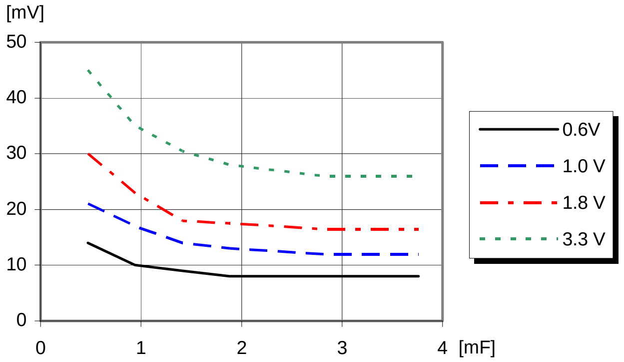
Output voltage ripple V_{pk-pk} at: T_{P1} = +25°C, C_O=470 µF/10 mΩ, I_O = 40 A.

Output Ripple vs. Frequency



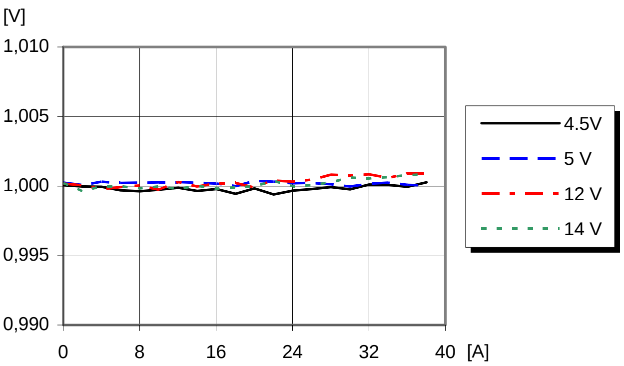
Output voltage ripple V_{pk-pk} at: T_{P1} = +25°C, V_I = 12 V, C_O=470 µF/10 mΩ, I_O = 40 A. Default configuration except changed frequency.

Output Ripple vs. External Capacitance



Output voltage ripple V_{pk-pk} at: T_{P1} = +25°C, V_I = 12 V. I_O = 40 A. Parallel coupling of capacitors with 470 µF/10 mΩ,

Load regulation, V_O=1.0V

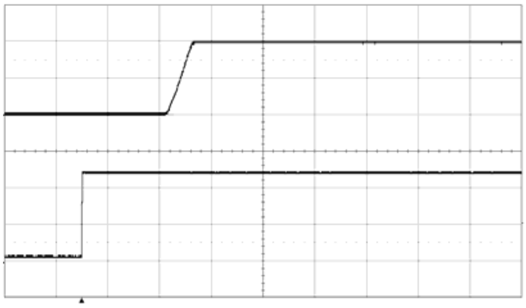


Load regulation at V_o=1.0 V at: T_{P1} = +25°C, C_O=470 µF/10 mΩ

Typical Characteristics
Start-up and shut-down

BMR 464 2002 (SIP)

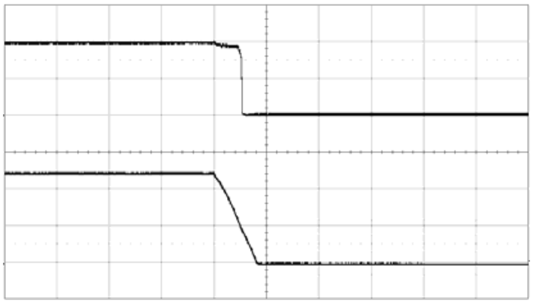
Start-up by input source



Start-up enabled by connecting V_I at:
T_{P1} = +25°C, V_I = 12 V, V_O = 1.0 V
C_O = 470 µF/10 mΩ, I_O = 40 A

Top trace: output voltage (0.5 V/div.).
Bottom trace: input voltage (5 V/div.).
Time scale: (20 ms/div.).

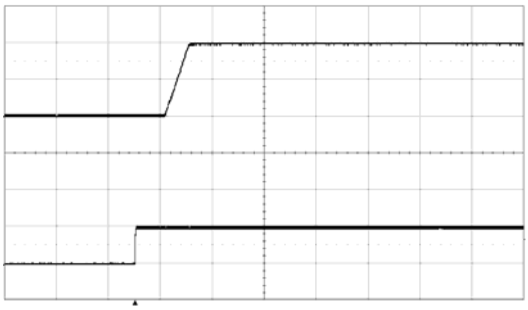
Shut-down by input source



Shut-down enabled by disconnecting V_I at:
T_{P1} = +25°C, V_I = 12 V, V_O = 1.0 V
C_O = 470 µF/10 mΩ, I_O = 40 A

Top trace: output voltage (0.5 V/div).
Bottom trace: input voltage (5 V/div.).
Time scale: (2 ms/div.).

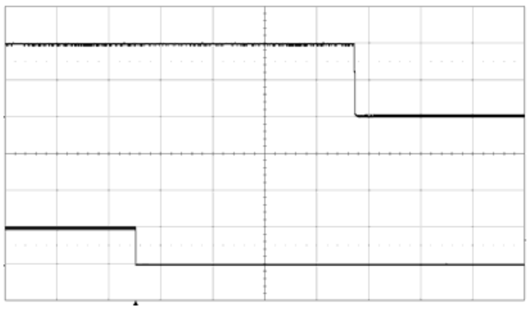
Start-up by CTRL signal



Start-up by enabling CTRL signal at:
T_{P1} = +25°C, V_I = 12 V, V_O = 1.0 V
C_O = 470 µF/10 mΩ, I_O = 40 A

Top trace: output voltage (0.5 V/div.).
Bottom trace: CTRL signal (5 V/div.).
Time scale: (20 ms/div.).

Shut-down by CTRL signal



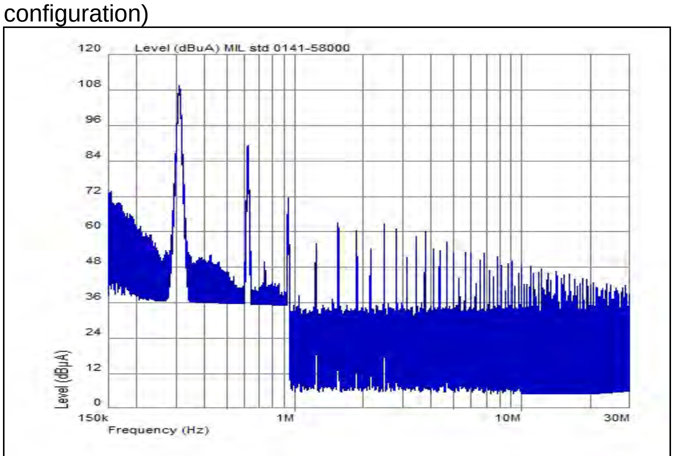
Shut-down enabled by disconnecting V_I at:
T_{P1} = +25°C, V_I = 12 V, V_O = 1.0 V
C_O = 470 µF/10 mΩ, I_O = 40 A

Top trace: output voltage (0.5 V/div).
Bottom trace: CTRL signal (5 V/div.).
Time scale: (2 ms/div.).

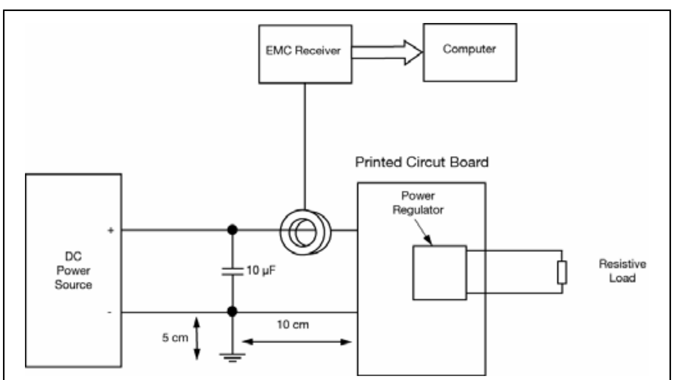
EMC Specification

Conducted EMI measured according to test set-up and standard MIL std 0141 - 58000.
The fundamental switching frequency is 320 kHz for BMR464 at V_I = 12.0 V, max I_O.

Conducted EMI Input terminal value (typical for default configuration)



EMI without filter



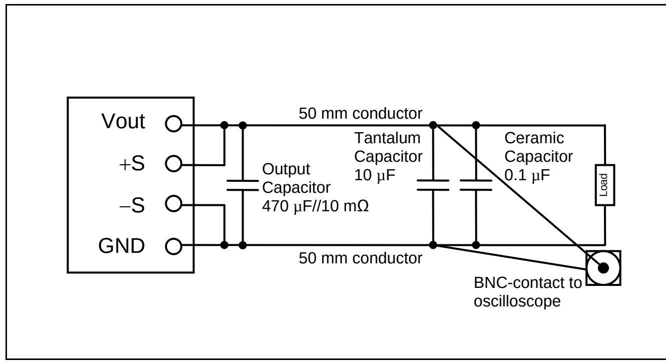
Test set-up

Layout Recommendations

The radiated EMI performance of the product will depend on the PWB 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 PWB and improve the high frequency EMC performance.

Output Ripple and Noise

Output ripple and noise is measured according to figure below. A 50 mm conductor works as a small inductor forming together with the two capacitances a damped filter.



Output ripple and noise test set-up.

Operating information

Power Management Overview

This product is equipped with a PMBus interface. The product incorporates a wide range of readable and configurable power management features that are simple to implement with a minimum of external components. Additionally, the product includes protection features that continuously safeguard the load from damage due to unexpected system faults. A fault is also shown as an alert on the SALERT pin. The following product parameters can continuously be monitored by a host: Input voltage, output voltage/current, and internal temperature. If the monitoring is not needed it can be disabled and the product enters a low power mode reducing the power consumption. The protection features are not affected.
The product is delivered with a default configuration suitable for a wide range operation in terms of input voltage, output voltage, and load. The configuration is stored in an internal Non-Volatile Memory (NVM). All power management functions can be reconfigured using the PMBus interface. Please contact your local Ericsson Power Modules representative for design support of custom configurations or appropriate SW tools for design and down-load of your own configurations.

Input Voltage

The input voltage range, 4.5 - 14 V, makes the product easy to use in intermediate bus applications when powered by a non-regulated bus converter or a regulated bus converter. See Ordering Information for input voltage range.

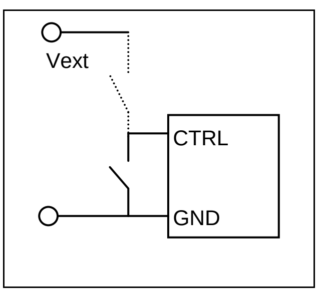
Input Under Voltage Lockout, UVLO

The product monitors the input voltage and will turn-on and turn-off at configured levels. The default turn-on input voltage level setting is 4.20 V, whereas the corresponding turn-off input voltage level is 3.85 V. Hence, the default hysteresis between turn-on and turn-off input voltage is 0.35 V. Once an input turn-off condition occurs, the device can respond in a number of ways as follows:

1. Continue operating without interruption. The unit will continue to operate as long as the input voltage can be supported. If the input voltage continues to fall, there will come a point where the unit will cease to operate.
2. Continue operating for a given delay period, followed by shutdown if the fault still exists. The device will remain in shutdown until instructed to restart.
3. Initiate an immediate shutdown until the fault has been cleared. The user can select a specific number of retry attempts.

The default response from a turn-off is an immediate shutdown of the device. The device will continuously check for the presence of the fault condition. If the fault condition is no longer present, the product will be re-enabled. The turn-on and turn-off levels and response can be reconfigured using the PMBus interface.

Remote Control



The product is equipped with a remote control function, i.e., the CTRL pin. The remote control can be connected to either the primary negative input connection (GND) or an external voltage (Vext), which is a 3 - 5 V positive supply voltage in accordance to the SMBus Specification version 2.0.

The CTRL function allows the product to be turned on/off by an external device like a semiconductor or mechanical switch. By default the product will turn on when the CTRL pin is left open and turn off when the CTRL pin is applied to GND. The CTRL pin has an internal pull-up resistor. When the CTRL pin is left open, the voltage generated on the CTRL pin is max 5.5 V.
If the device is to be synchronized to an external clock source, the clock frequency must be stable prior to asserting the CTRL pin.
The product can also be configured using the PMBus interface to be “Always on”, or turn on/off can be performed with PMBus commands.

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 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 a capacitor with low ESR at the input of the product will ensure stable operation.

External Capacitors

Input capacitors:
The input ripple RMS current in a buck converter is equal to

Eq. 1. $I_{inputRMS} = I_{load}\sqrt{D(1-D)}$,

where I_{load} is the output load current and D is the duty cycle. The maximum load ripple current becomes $I_{load}/2$. The ripple current is divided into three parts, i.e., currents in the input source, external input capacitor, and internal input capacitor. How the current is divided depends on the impedance of the input source, ESR and capacitance values in the capacitors. A minimum capacitance of 300 µF with low ESR is recommended. The ripple current rating of the capacitors must follow Eq. 1. For high-performance/transient applications or wherever the input source performance is degraded, additional low ESR ceramic type capacitors at the input is recommended. The additional input low ESR capacitance above the minimum level insures an optimized performance.

Output 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 capacitors in parallel 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. Ceramic capacitors will also reduce high frequency noise at the load.
It is equally important to use low resistance and low inductance PWB layouts and cabling.
External decoupling capacitors are a part of the control loop of the product and may affect the stability margins.
Stable operation is guaranteed for the following total capacitance C_O in the output decoupling capacitor bank where

Eq. 2. $C_O = [C_{\min}, C_{\max}] = [470, 30000]$ µF.

The decoupling capacitor bank should consist of capacitors which has a capacitance value larger than $C \geq C_{\min}$ and has an ESR range of

Eq. 3. $ESR = [ESR_{\min}, ESR_{\max}] = [5, 30]$ mΩ

The control loop stability margins are limited by the minimum time constant $\tau_{\min}$ of the capacitors. Hence, the time constant of the capacitors should follow Eq. 4.

Eq. 4. $\tau \geq \tau_{\min} = C_{\min} ESR_{\min} = 2.35\ \mu s$

This relation can be used if your preferred capacitors have parameters outside the above stated ranges in Eq. 2 and Eq.3.

- If the capacitors capacitance value is $C < C_{\min}$ one must use at least N capacitors where $N \geq \left\lceil \frac{C_{\min}}{C} \right\rceil$ and $ESR \geq ESR_{\min} \frac{C_{\min}}{C}$.
- If the ESR value is $ESR > ESR_{\max}$ one must use at least N capacitors of that type where

$$N \geq \left\lceil \frac{ESR}{ESR_{max}} \right\rceil \text{ and } C \geq \frac{C_{min}}{N}.$$

- If the ESR value is $ESR < ESR_{min}$ the capacitance value should be

$$C \geq C_{min} \frac{ESR_{min}}{ESR}.$$

For a total capacitance outside the above stated range or capacitors that do not follow the stated above requirements above a re-design of the control loop parameters will be necessary for robust dynamic operation and stability.

Control Loop Compensation

The product is configured with a robust control loop compensation which allows for a wide range operation of input and output voltages and capacitive loads as defined in the section External Decoupling Capacitors. For an application with a specific input voltage, output voltage, and capacitive load, the control loop can be optimized for a robust and stable operation and with an improved load transient response. This optimization will minimize the amount of required output decoupling capacitors for a given load transient requirement yielding an optimized cost and minimized board space. The control loop parameters can be reconfigured using the PMBus interface.

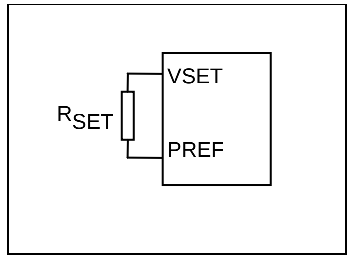
Load Transient Response Optimization

The product incorporates a Non-Linear transient Response, NLR, loop that decreases the response time and the output voltage deviation during a load transient. The NLR results in a higher equivalent loop bandwidth than is possible using a traditional linear control loop. The product is pre-configured with appropriate NLR settings for robust and stable operation for a wide range of input voltage and a capacitive load range as defined in the section External Decoupling Capacitors. For an application with a specific input voltage, output voltage, and capacitive load, the NLR configuration can be optimized for a robust and stable operation and with an improved load transient response. This will also reduce the amount of output decoupling capacitors and yield a reduced cost. However, the NLR slightly reduces the efficiency. In order to obtain maximal energy efficiency the load transient requirement has to be met by the standard control loop compensation and the decoupling capacitors. The NLR settings can be reconfigured using the PMBus interface.

Remote Sense

The product has remote sense that can be used to compensate for voltage drops between the output and the point of load. The sense traces should be located close to the PWB ground layer to reduce noise susceptibility. Due to derating of internal output capacitance the voltage drop should be kept below $V_{DROPMAX} = (5.5 - V_{OUT})/2$. A large voltage drop will impact the electrical performance of the regulator. If the remote sense is not needed +S should be connected to VOUT and −S should be connected to GND.

Output Voltage Adjust using Pin-strap Resistor



Using an external Pin-strap resistor, R_{SET}, the output voltage can be set in the range 0.6 V to 3.3 V at 28 different levels shown in the table below. The resistor should be applied between the VSET pin and the PREF pin.

R_{SET} also sets the maximum output voltage, see section "Output Voltage Range Limitation". The resistor is sensed only during product start-up. Changing the resistor value during normal operation will not change the output voltage. The input voltage must be at least 1 V larger than the output voltage in order to deliver the correct output voltage. See Ordering Information for output voltage range.

The following table shows recommended resistor values for R_{SET}. Maximum 1% tolerance resistors are required.

V_{OUT} [V]	R_{SET}[kΩ]	V_{OUT} [V]	R_{SET}[kΩ]
0.60	10	1.50	46.4
0.65	11	1.60	51.1
0.70	12.1	1.70	56.2
0.75	13.3	1.80	61.9
0.80	14.7	1.90	68.1
0.85	16.2	2.00	75
0.90	17.8	2.10	82.5
0.95	19.6	2.20	90.9
1.00	21.5	2.30	100
1.05	23.7	2.50	110
1.10	26.1	3.00	121
1.15	28.7	3.30	133
1.20	31.6		
1.25	34.8		
1.30	38.3		
1.40	42.2		

The output voltage and the maximum output voltage can be pin strapped to three fixed values by connecting the VSET pin according to the table below.

V_{OUT} [V]	VSET
0.60	Shorted to PREF
1.2	Open "high impedance"
2.5	Logic High, GND as reference

Output Voltage Adjust using PMBus

The output voltage of the product can be configured using the PMBus interface in the range 0.54 to 3.63. See Ordering Information for output voltage range.

Output Voltage Range Limitation

The output voltage range configurable by the PMBus interface is limited by the pin-strap resistor R_{SET}. R_{SET} sets the maximum output voltage to approximately 110% of the nominal output value, $V_{OUTMAX} = 1.1 \times V_{OUT} - calibration\_offset$, where calibration offset is max 70 mV. A PMBus command can not set the output voltage higher than V_{OUTMAX} . This protects the load from an over voltage due to an accidental wrong PMBus command.

Over Voltage Protection (OVP)

The product includes over voltage limiting circuitry for protection of the load. The default OVP limit is 15% above the nominal output voltage. If the output voltage exceeds the OVP limit, the product can respond in different ways:

1. Initiate an immediate shutdown until the fault has been cleared. The user can select a specific number of retry attempts.
2. Turn off the high-side MOSFET and turn on the low-side MOSFET. The low-side MOSFET remains ON until the device attempts a restart, i.e. the output voltage is pulled to ground level (crowbar function).

The default response from an overvoltage fault is to immediately shut down as in 2. The device will continuously check for the presence of the fault condition, and when the fault condition no longer exists the device will be re-enabled. For continuous OVP when operating from an external clock for synchronization, the only allowed response is an immediate shutdown. The OVP limit and fault response can be reconfigured using the PMBus interface.

Under Voltage Protection (UVP)

The product includes output under voltage limiting circuitry for protection of the load. The default UVP limit is 15% below the nominal output voltage. The UVP limit can be reconfigured using the PMBus interface.

Power Good

The product provides a Power Good (PG) flag in the Status Word register that indicates the output voltage is within a specified tolerance of its target level and no fault condition exists. If specified in section Connections, the product also provides a PG signal output. The PG pin is active high and by default open-drain but may also be configured as push-pull via the PMBus interface.
By default, the PG signal will be asserted if the output is within -10%/+15% of the target voltage. These limits may be changed via the PMBus interface. A PG delay period is defined as the time from when all conditions within the product for asserting PG are met to when the PG signal is actually asserted. By default, the PG delay is set equal to the soft-start ramp time setting. Therefore, if the soft-start ramp time is set to 10 ms, the PG delay will be set to 10 ms. The PG delay may be set independently of the soft-start ramp using the PMBus interface.

Switching Frequency

The fundamental switching frequency is 320 kHz, which yields optimal power efficiency. The switching frequency can be set to any value between 200 kHz and 640 kHz using the PMBus interface. The switching frequency will change the efficiency/power dissipation, load transient response and output ripple. For optimal control loop performance the control loop must be re-designed when changing the switching frequency.

Synchronization

Synchronization is a feature that allows multiple products to be synchronized to a common frequency. Synchronized products powered from the same bus eliminate beat frequencies reflected back to the input supply, and also reduces EMI filtering requirements. Eliminating the slow beat frequencies (usually <10 kHz) allows the EMI filter to be designed to attenuate only the synchronization frequency. Synchronization can also be utilized for phase spreading, described in section Phase Spreading.
The products can be synchronized with an external oscillator or one product can be configured with the SYNC pin as a SYNC Output working as a master driving the synchronization. All others on the same synchronization bus should be configured with SYNC Input or SYNC Auto Detect (Default configuration) for correct operation. When the SYNC pin is configured in auto detect mode the product will automatically check for a clock signal on the SYNC pin.

Phase Spreading

When multiple products share a common DC input supply, spreading of the switching clock phase between the products can be utilized. This dramatically reduces input capacitance requirements and efficiency losses, since the peak current drawn from the input supply is effectively spread out over the whole switch period. This requires that the products are synchronized. Up to 16 different phases can be used.
The phase spreading of the product can be configured using the PMBus interface.

Parallel Operation (Current Sharing)

Paralleling multiple products can be used to increase the output current capability of a single power rail. By connecting the GCB pins of each device and configuring the devices as a current sharing rail, the units will share the current equally, enabling up to 100% utilization of the current capability for each device in the current sharing rail. The product uses a low-bandwidth, first-order digital current sharing by aligning the output voltage of the slave devices to deliver the same current as the master device. Artificial droop resistance is added to the output voltage path to control the slope of the load line curve, calibrating out the physical parasitic mismatches due to power train components and PWB layout. Up to 7 devices can be configured in a given current sharing group.

Phase Adding and Shedding for Parallel Operation

During periods of light loading, it may be beneficial to disable one or more phases (modules) in order to eliminate the current drain and switching losses associated with those phases, resulting in higher efficiency. The product offers the ability to add and drop phases (modules) using a PMBus command in response to an observed load current change. All phases (modules) in a current share rail are considered active prior to the current sharing rail ramp to power-good. Phases can be dropped after power-good is reached. Any member of the current sharing rail can be dropped. If the reference module is dropped, the remaining active module with the lowest member position will become the new reference. Additionally, any change to the number of members of a current sharing rail will precipitate autonomous phase distribution within the rail where all active phases realign their phase position based on their order within the number of active members. If the members of a current sharing rail are forced to shut down due to an observed fault, all members of the rail will attempt to re-start simultaneously after the fault has cleared.

Adaptive Diode Emulation

Most power converters use synchronous rectification to optimize efficiency over a wide range of input and output conditions. However, at light loads the synchronous MOSFET will typically sink current and introduce additional energy losses associated with higher peak inductor currents, resulting in reduced efficiency. Adaptive diode emulation mode turns off the low-side FET gate drive at low load currents to prevent the inductor current from going negative, reducing the energy losses and increasing overall efficiency. Diode emulation is not available for current sharing groups. Note: the overall bandwidth of the product may be reduced when in diode emulation mode. It is recommended that diode emulation is disabled prior to applying significant load steps. The diode emulation mode can be configured using the PMBus interface.

Adaptive Frequency and Pulse Skip Control

Since switching losses contribute to the efficiency of the power converter, reducing the switching frequency will reduce the switching losses and increase efficiency. The product includes an Adaptive Frequency Control mode, which effectively reduces the observed switching frequency as the load decreases. Adaptive frequency mode is only available while the device is operating within Adaptive Diode Emulation Mode. As the load current is decreased, diode emulation mode decreases the Synch-FET on-time to prevent negative inductor current from flowing. As the load is decreased further, the Switch-FET pulse width will begin to decrease while maintaining the programmed frequency, f_{PROG} (set by the FREQ_SWITCH command). Once the Switch-FET pulse width (D) reaches 50% of the nominal duty cycle, D_{NOM} (determined by V_I and V_O), the switching frequency will start to decrease according to the following equation:

Eq. 5. $$f_{sw} = D\left(\frac{2(f_{PROG} - f_{MIN})}{D_{NOM}}\right) + f_{MIN}\ .$$

Disabling a minimum Synch-FET makes the product also pulse skip which reduces the power loss further.
It should be noted that adaptive frequency mode is not available for current sharing groups and is not allowed when the device is placed in auto-detect mode and a clock source is present on the SYNC pin, or if the device is outputting a clock signal on its SYNC pin. The adaptive frequency and pulse skip modes can be configured using the PMBus interface.

Efficiency Optimized Dead Time Control

The product utilizes a closed loop algorithm to optimize the dead-time applied between the gate drive signals for the switch and synch FETs. The algorithm constantly adjusts the deadtime non-overlap to minimize the duty cycle, thus maximizing efficiency. This algorithm will null out deadtime differences due to component variation, temperature and loading effects. The algorithm can be configured via the PMBus interface.

Over Current Protection (OCP)

The product includes current limiting circuitry for protection at continuous overload. The following OCP response options are available:

1. Initiate a shutdown and attempt to restart an infinite number of times with a preset delay period between attempts.
2. Initiate a shutdown and attempt to restart a preset number of times with a preset delay period
3. Continue operating for a given delay period, followed by shutdown if the fault still exists.
4. Continue operating through the fault (this could result in permanent damage to the product).
5. Initiate an immediate shutdown.

The default response from an over current fault is an immediate shutdown of the device. The device will continuously check for the presence of the fault condition, and if the fault condition no longer exists the device will be re-enabled.The load distribution should be designed for the maximum output short circuit current specified. The OCP limit and response of the product can be reconfigured using the PMBus interface.

Note for BMR464.
When the ratio V_O/V_I is below 0.07 (e.g. V_I = 12 V and V_O = 0.6 V), and the default configuration file is used, the OCP limit threshold may be below specified minimum value. If the specified maximum output current is reached under such operating conditions, it is recommended to increase the OCP limit.

Start-up Procedure

The product follows a specific internal start-up procedure after power is applied to the VIN pin:

1. Status of the address and output voltage pin-strap pins are checked and values associated with the pin settings are loaded.

2. Values stored in the Ericsson default non-volatile memory are loaded. This overwrites any previously loaded values.
3. Values stored in the user non-volatile memory are loaded. This overwrites any previously loaded values.

Once this process is completed and the start-up time has passed (see Electrical Specification), the product is ready to be enabled using the CTRL pin. The product is also ready to accept commands via the PMBus interface, which will overwrite any values loaded during the start-up procedure.

Soft-start Power Up

The soft-start control introduces a time-delay before allowing the output voltage to rise. Once the start-up time has passed and the output has been enabled, the device requires approximately 2 ms before its output voltage may be allowed to start its ramp-up process. If a soft-start delay period less than 2 ms has been configured the device will default to a 2 ms delay period. If a delay period greater than 2 ms is configured, the device will wait for the configured delay period prior to starting to ramp its output. After the delay period has expired, the output will begin to ramp towards its target voltage according to the configured soft-start ramp time.
The default settings for the soft-start delay period and the soft-start ramp time is 10 ms. Hence, power-up is completed within 20 ms in default configuration using remote control. Precise timing reduces the delay time variations and is by default activated. The soft-start power up of the product can be reconfigured using the PMBus interface.

Output Voltage Sequencing

A group of products may be configured to power up in a predetermined sequence. This feature is especially useful when powering advanced processors, FPGAs, and ASICs that require one supply to reach its operating voltage prior to another. Multi-product sequencing can be achieved by configuring the start delay and rise time of each device through the PMBus interface and by using the CTRL start signal.

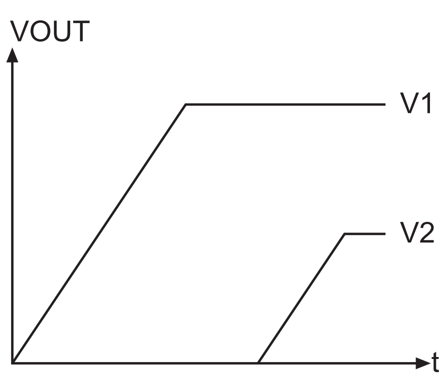


Illustration of Output Voltage Sequencing.

Voltage Tracking

The product integrates a lossless tracking scheme that allows its output to track a voltage that is applied to the VTRK pin with no external components required. During ramp-up, the output voltage follows the VTRK voltage until the preset output voltage level is met. The product offers two modes of tracking as follows:

1. Coincident. This mode configures the product to ramp its output voltage at the same rate as the voltage applied to the VTRK pin.

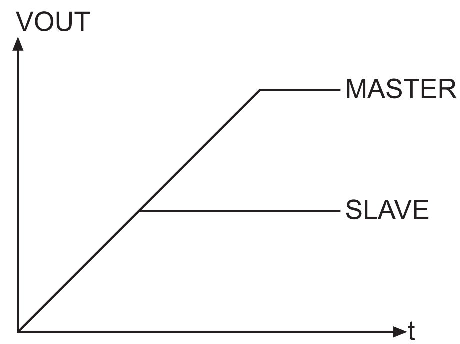


Illustration of Coincident Voltage Tracking.

2. Ratiometric. This mode configures the product to ramp its output voltage at a rate that is a percentage of the voltage applied to the VTRK pin. The default setting is 50%, but a different tracking ratio may be set by an external resistive voltage divider or through the PMBus interface.

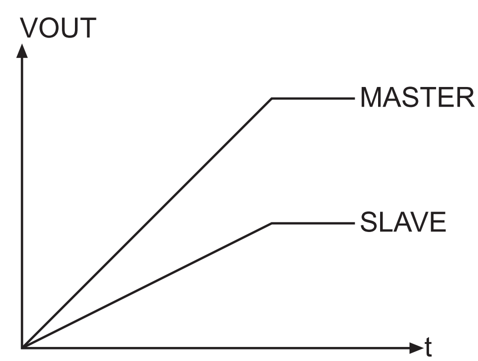


Illustration of Ratiometric Voltage Tracking

The master device in a tracking group is defined as the device that has the highest target output voltage within the group. This master device will control the ramp rate of all tracking devices and is not configured for tracking mode. All of the CTRL pins in the tracking group must be connected and driven by a single logic source. It should be noted that current sharing groups that are also configured to track another voltage do not offer pre-bias protection; a minimum load should therefore be enforced to avoid the output voltage from being held up by an outside force.

Voltage Margining Up/Down

The product can adjust its output higher or lower than its nominal voltage setting in order to determine whether the load device is capable of operating over its specified supply voltage range. This provides a convenient method for dynamically testing the operation of the load circuit over its supply margin or range. It can also be used to verify the function of supply voltage supervisors. Margin limits of the nominal output voltage ±5% are default, but the margin limits can be reconfigured using the PMBus interface.

Pre-Bias Startup Capability

Pre-bias startup often occurs in complex digital systems when current from another power source is fed back through a dual-supply logic component, such as FPGAs or ASICs. The BMR464 product family incorporates synchronous rectifiers, but will not sink current during startup, or turn off, or whenever a fault shuts down the product in a pre-bias condition. Pre-bias protection is not offered for current sharing groups that also have voltage tracking enabled.

Group Communication Bus

The Group Communication Bus, GCB, is used to communicate between products. This dedicated bus provides the communication channel between devices for features such as sequencing, fault spreading, and current sharing. The GCB solves the PMBus data rate limitation. The GCB pin on all devices in an application should be connected together. For robust communication it is recommended that 27 ohm series resistors are placed, close to the GCB pin, between each device and the common GCB connection. A pull-up resistor is required on the common GCB in order to guarantee the rise time as follows:

Eq. 6 $\tau = R_{GCB} C_{GCB} \leq 1\mu s$,

where R_{GCB} is the pull up resistor value and C_{GCB} is the bus loading. The pull-up resistor should be tied to to an external 3.3 V or 5 V supply voltage, which should be present prior to or during power-up.

Fault spreading

The product can be configured to broadcast a fault event over the GCB to the other devices in the group. When a non-destructive fault occurs and the device is configured to shut down on a fault, the device will shut down and broadcast the fault event over the GCB. The other devices on the GCB will shut down together if configured to do so, and will attempt to re-start in their prescribed order if configured to do so.

Over Temperature Protection (OTP)

The products are protected from thermal overload by an internal over temperature shutdown circuit. When T_{P1} as defined in thermal consideration section exceeds 120°C the product will shut down. The product will make continuous attempts to start up and resume normal operation automatically when the temperature has dropped >15°C below the over temperature threshold. The specified OTP level and hysteresis are valid for worst case operation regarding cooling conditions, input voltage and output voltage. This means the OTP level and hysteresis in many cases will be lower. The OTP level, hysteresis, and fault response of the product can be reconfigured using the PMBus interface. The fault response can be configured as follows:

1. Initiate a shutdown and attempt to restart an infinite number of times with a preset delay period between attempts (default configuration).
2. Initiate a shutdown and attempt to restart a preset number of times with a preset delay period between attempts.
3. Continue operating for a given delay period, followed by shutdown if the fault still exists.
4. Continue operating through the fault (this could result in permanent damage to the power supply).
5. Initiate an immediate shutdown.

Optimization examples

This product is designed with a digital control circuit. The control circuit uses a configuration file which determines the functionality and performance of the product. It is possible to change the configuration file to optimize certain performance characteristics. In the table below is a schematic view on how to change different configuration parameters in order to achieve an optimization towards a wanted performance.

↑	Increase
→	No change
↓	Decrease

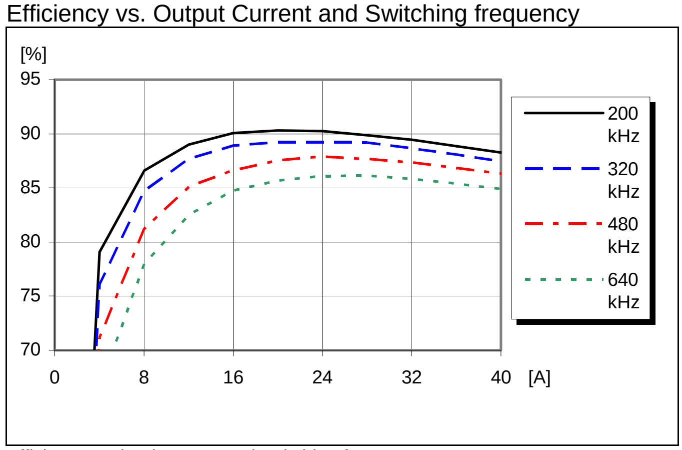
Config. parameters	Switching frequency	Control loop bandwidth	NLR threshold	Diode emulation (DCM)	Min. pulse
Optimized performence					
Maximize efficiency	↓	→	↑	Enable	Disable
Minimize ripple ampl.	↑	→	↑	Enable or disable	Enable or disable
Improve load transient response	↑	↑	↓	Disable	Disable
Minimize idle power loss	↓	↑	→	Enable	Enable

P_{li}	Input idling power (no load)	Default configuration: Continues Conduction Mode, CCM	V_O = 0.6 V	1.1	W
			V_O = 1.0 V	1.1	
			V_O = 1.8 V	1.4	
			V_O = 3.3 V	2.2	
		DCM, Discontinues Conduction Mode (diode emulation)	V_O = 0.6 V	0.21	W
			V_O = 1.0 V	0.21	
			V_O = 1.8 V	0.21	
			V_O = 3.3 V	0.21	

BMR 464 series POL Regulators Input 4.5-14 V, Output up to 40 A / 132 W	EN/LZT 146 435 R2B August 2011

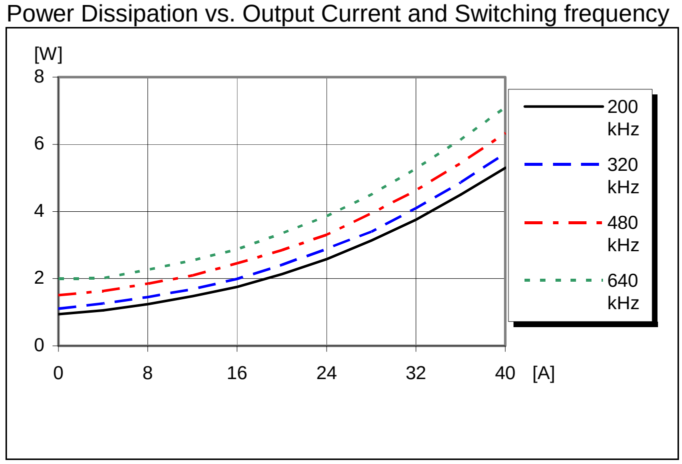
P_{li}	Input idling power (no load)	DCM with Adaptive Frequency and Minimum Pulse Enabled	V_O = 0.6 V	0.42	W
			V_O = 1.0 V	0.42	
			V_O = 1.8 V	0.55	
			V_O = 3.3 V	0.81	
		DCM with Adaptive Frequency and Minimum Pulse Disabled	V_O = 0.6 V	0.19	W
			V_O = 1.0 V	0.19	
			V_O = 1.8 V	0.20	
			V_O = 3.3 V	0.20	
P_{CTRL}	Input standby power	Turned off with CTRL-pin	Default configuration: Monitoring enabled, Precise timing enabled	180	mW
			Monitoring enabled, Precise timing disabled	120	mW
			Low power mode: Monitoring disabled, Precise timing disabled	85	mW
V_{tr1}	Load transient peak voltage deviation Load step 25-75-25% of max I_O	Default configuration di/dt = 2 A/μs C_O=470 μF	V_O = 0.6 V	250	mW
			V_O = 1.0 V	250	
			V_O = 1.8 V	240	
			V_O = 3.3 V	220	
		Optimized PID and NLR configuration di/dt = 2 A/μs C_O=470 μF	V_O = 0.6 V	120	mW
			V_O = 1.0 V	120	
			V_O = 1.8 V	120	
			V_O = 3.3 V	110	
t_{tr1}	Load transient recovery time Load step 25-75-25% of max I_O	Default configuration di/dt = 2 A/μs C_O=470 μF	V_O = 0.6 V	150	mW
			V_O = 1.0 V	100	
			V_O = 1.8 V	100	
			V_O = 3.3 V	50	
		Optimized PID and NLR configuration di/dt = 2 A/μs C_O=470 μF	V_O = 0.6 V	75	
			V_O = 1.0 V	50	
			V_O = 1.8 V	50	
			V_O = 3.3 V	25	

Efficiency vs. Output Current and Switching frequency



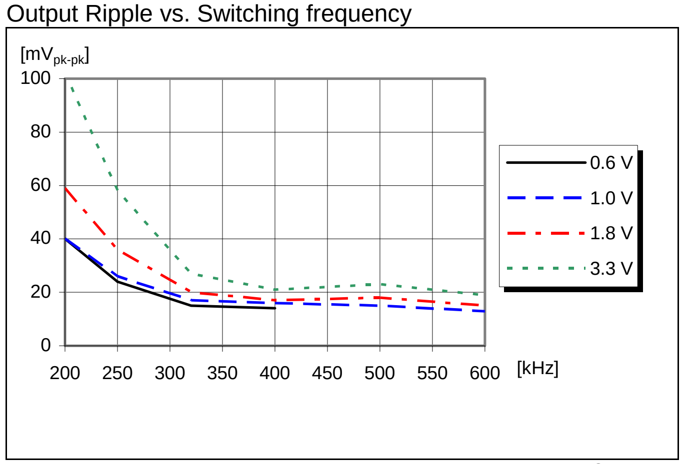
Efficiency vs. load current and switching frequency at T_{P1} = +25°C. V_I=12 V, V_O=1.0 V, C_O=470 μF/10 mΩ
Default configuration except changed frequency

Power Dissipation vs. Output Current and Switching frequency



Dissipated power vs. load current and switching frequency at T_{P1} = +25°C. V_I=12 V, V_O=1.0 V, C_O=470 μF/10 mΩ
Default configuration except changed frequency

Output Ripple vs. Switching frequency



Output voltage ripple V_{pk-pk} at: T_{P1} = +25°C, V_I = 12 V, C_O=470 μF/10 mΩ,
I_O = 40 A resistive load. Default configuration except changed frequency.

BMR 464 series POL Regulators Input 4.5-14 V, Output up to 40 A / 132 W	EN/LZT 146 435 R2B August 2011
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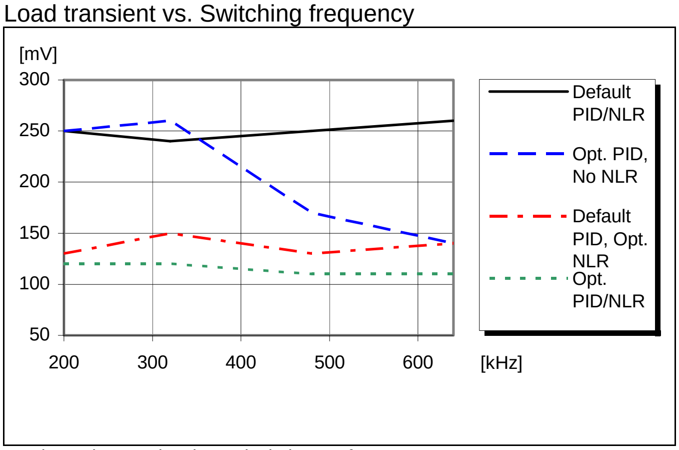
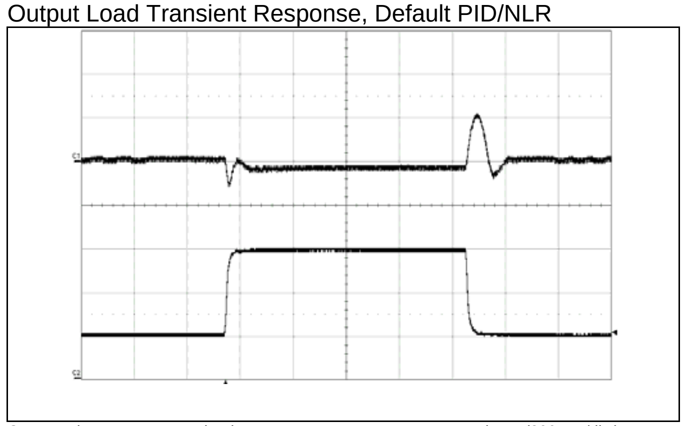
Load transient vs. Switching frequency



Load transient peak voltage deviation vs. frequency.
Step-change (10-30-10 A).
T_{P1} = +25°C. V_I=12 V, V_O=1.0 V, C_O=470 µF/10 mΩ

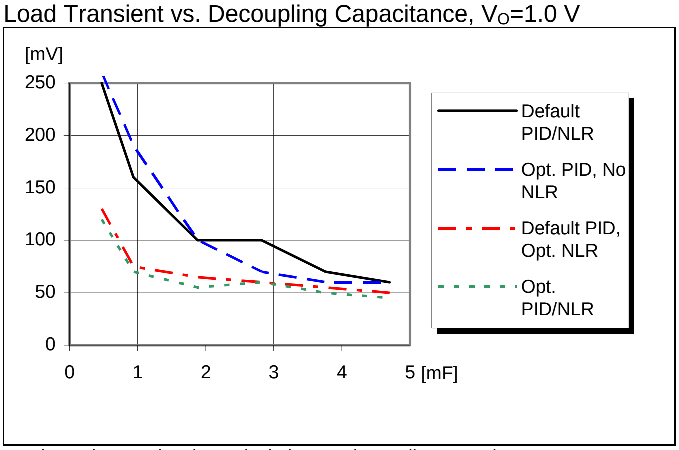
Output Load Transient Response, Default PID/NLR



Output voltage response to load current step-change (10-30-10 A) at:
T_{P1} = +25°C, V_I = 12 V, V_O =1.0 V
di/dt=2 A/µs, f_{sw}=320 kHz, C_O=470 µF/10 mΩ
Default PID Control Loop and NLR

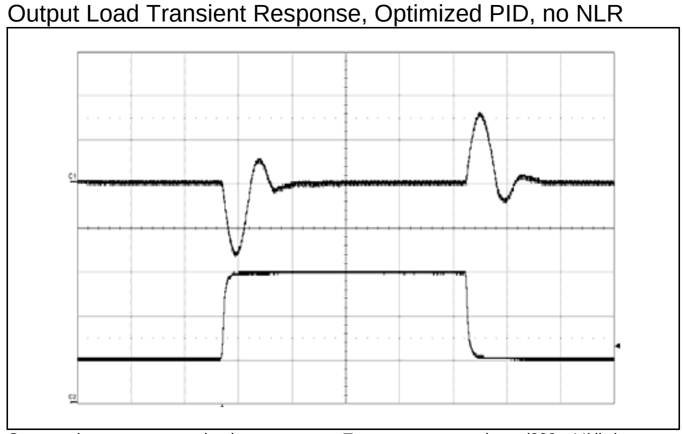
Top trace: output voltage (200 mV/div.).
Bottom trace: load current (10 A/div.).
Time scale: (0.1 ms/div.).

Load Transient vs. Decoupling Capacitance, V_O=1.0 V



Load transient peak voltage deviation vs. decoupling capacitance.
Step-change (10-30-10 A). Parallel coupling of capacitors with 470 µF/10 mΩ,
T_{P1} = +25°C. V_I=12 V, V_O=1.0 V, f_{sw}=320 kHz, di/dt=2 A/µs

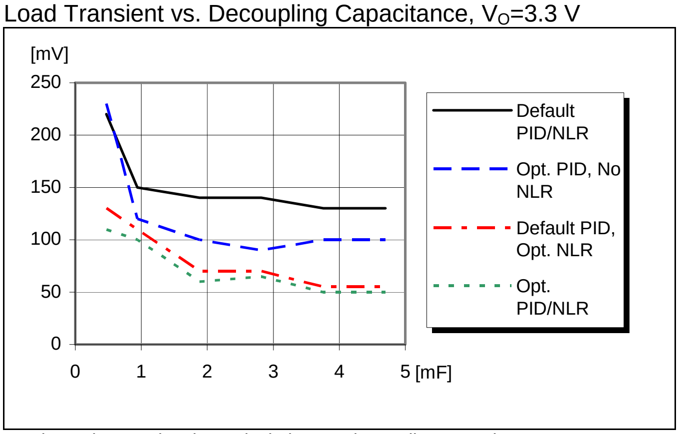
Output Load Transient Response, Optimized PID, no NLR



Output voltage response to load current step-change (10-30-10 A) at:
T_{P1} = +25°C, V_I = 12 V, V_O =1.0 V
di/dt=2 A/µs, f_{sw}=320 kHz, C_O=470 µF/10 mΩ
Optimized PID Control Loop and no NLR

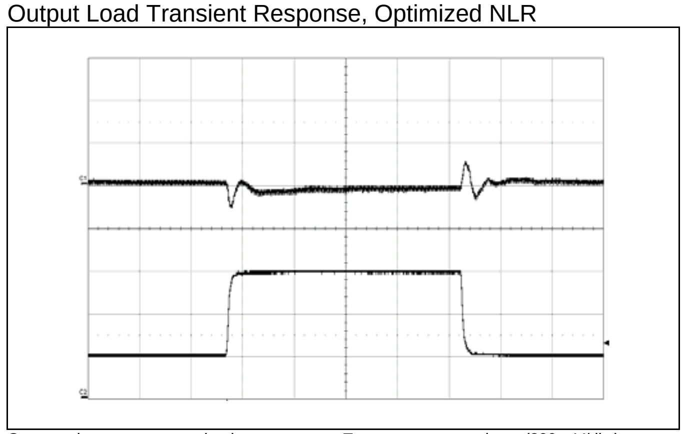
Top trace: output voltage (200 mV/div.).
Bottom trace: load current (10 A/div.).
Time scale: (0.1 ms/div.).

Load Transient vs. Decoupling Capacitance, V_O=3.3 V



Load transient peak voltage deviation vs. decoupling capacitance.
Step-change (10-30-10 A). Parallel coupling of capacitors with 470 µF/10 mΩ,
T_{P1} = +25°C. V_I=12 V, V_O=3.3 V, f_{sw}=320 kHz, di/dt=2 A/µs

Output Load Transient Response, Optimized NLR



Output voltage response to load current step-change (10-30-10 A) at:
T_{P1} = +25°C, V_I = 12 V, V_O =1.0 V
di/dt=2 A/µs, f_{sw}=320 kHz, C_O=470 µF/10 mΩ
Default PID Control Loop and optimized NLR

Top trace: output voltage (200 mV/div.).
Bottom trace: load current (10 A/div.).
Time scale: (0.1 ms/div.).

Thermal Consideration

General

The product is designed to operate in different thermal environments and sufficient cooling must be provided to ensure reliable operation.
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 for each model provides the available output current vs. ambient air temperature and air velocity at specified V_I.

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

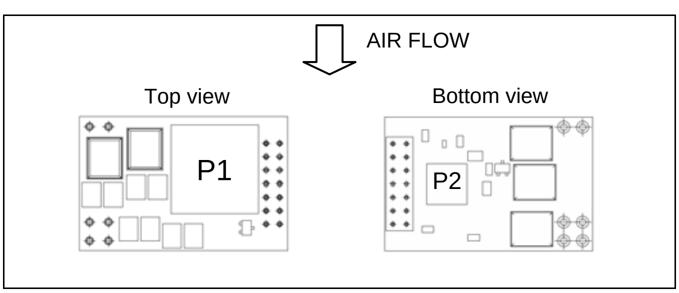
Proper cooling of the product can be verified by measuring the temperature at positions P1 and P2. The temperature at these positions should not exceed the max values provided in the table below.
Note that the max value is the absolute maximum rating (non destruction) and that the electrical Output data is guaranteed up to T_{P1} +85°C.

See Design Note 019 for further information.

Definition of product operating temperature

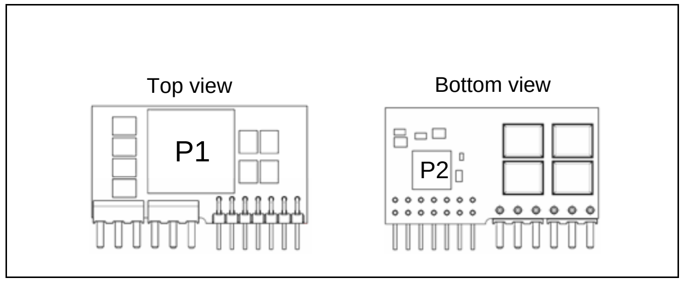
The product operating temperatures are used to monitor the temperature of the product, and proper thermal conditions can be verified by measuring the temperature at positions P1 and P2. The temperature at these positions (T_{P1}, T_{P2}) should not exceed the maximum temperatures in the table below.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

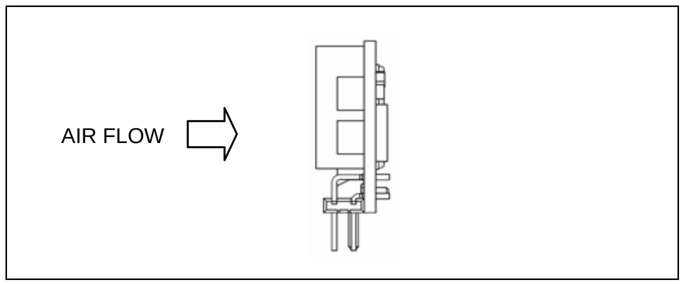
Position	Description	Max Temp.
P1	Reference point, L1, inductor	120º C
P2	N1, control circuit	120º C



Temperature positions and air flow direction.

SIP version



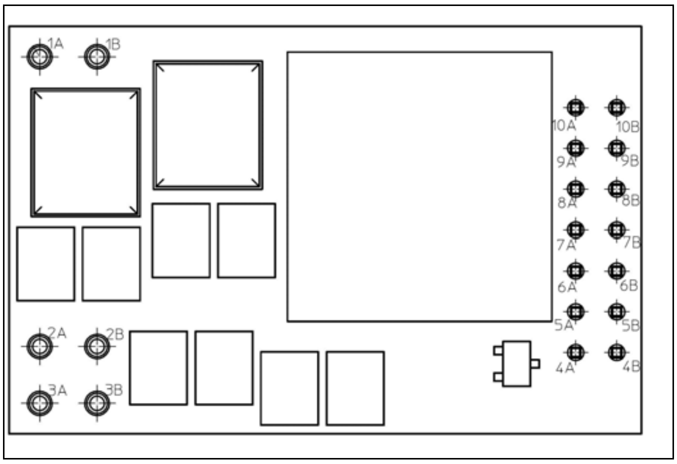


Temperature positions and air flow direction.

Definition of reference temperature T_{P1}

The reference temperature is used to monitor the temperature limits of the product. Temperature above maximum T_{P1}, measured at the reference point P1 is not allowed and may cause degradation or permanent damage to the product. T_{P1} is also used to define the temperature range for normal operating conditions. T_{P1} is defined by the design and used to guarantee safety margins, proper operation and high reliability ot the product.

Connections



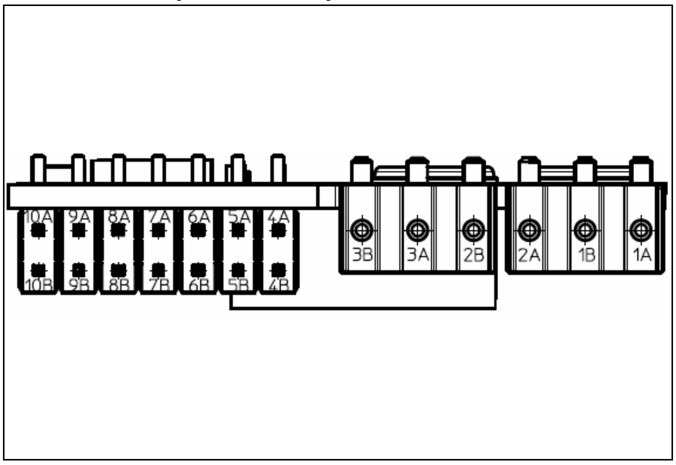
Pin layout, top view (component placement for illustration only).

Pin	Designation	Function
1A, 1B	VIN	Input Voltage
2A, 2B	GND	Power Ground
3A, 3B	VOUT	Output Voltage
4A	VTRK	Voltage Tracking input
4B	PREF	Pin-strap reference
5A	+S	Positive sense
5B	−S	Negative sense
6A	SA0	PMBus address pinstrap 0
6B	GCB	Group Communication Bus
7A	SCL	PMBus Clock
7B	SDA	PMBus Data
8A	VSET	Output voltage pinstrap
8B	SYNC	Synchronization I/O
9A	SALERT	PMBus Alert
9B	CTRL	Remote Control
10A	PG	Power Good
10B	SA1	PMBus address pinstrap 1

PWB layout considerations

The pinstrap resistors, Rset, and R_{SA0}/R_{SA1} should be placed as close to the product as possible to minimize loops that may pick up noise.
Avoid current carrying planes under the pinstrap resistors and the PMBus signals.
The capacitor C_I (or capacitors implementing it) should be placed as close to the input pins as possible.
Capacitor C_O (or capacitors implementing it) should be placed close to the load.

Connections (SIP version)



Pin layout, side view (component placement for illustration only).

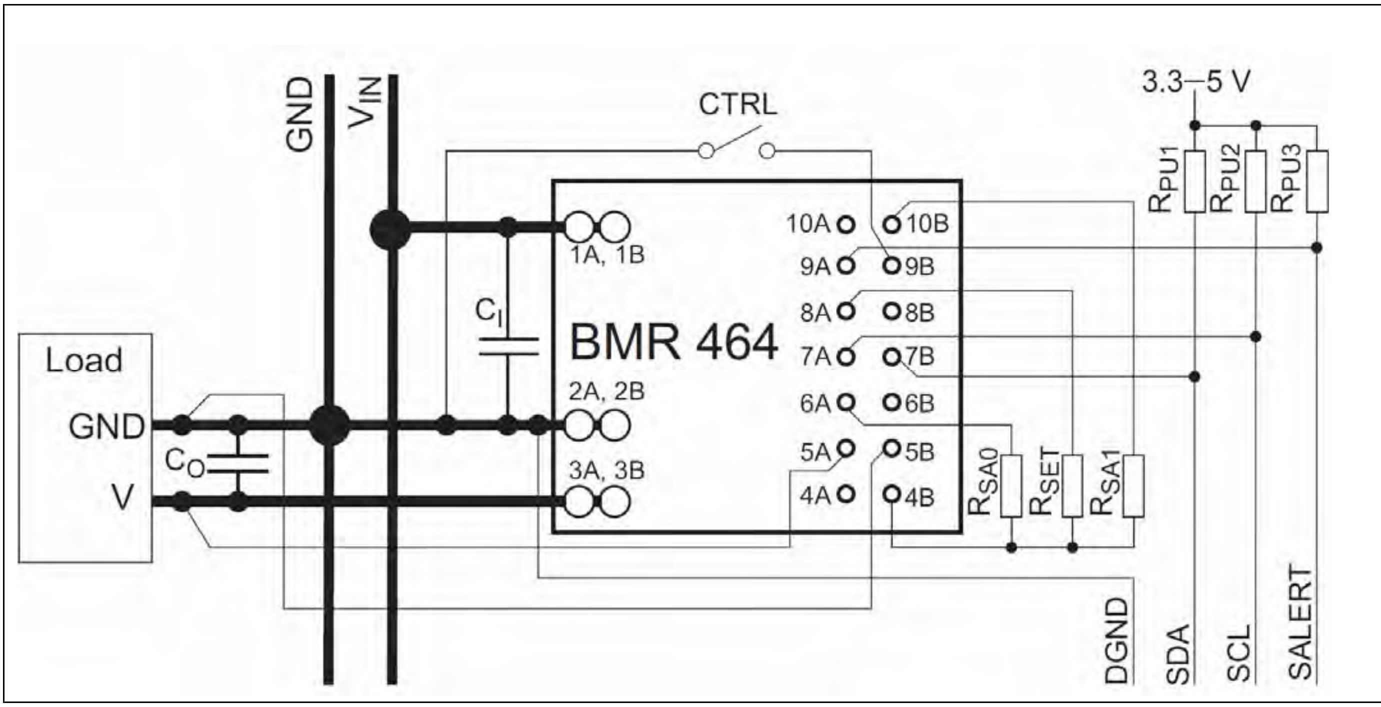
Pin	Designation	Function
1A, 1B	VIN	Input Voltage
2A, 2B	GND	Power Ground
3A, 3B	VOUT	Output Voltage
4A	+S	Positive sense
4B	−S	Negative sense
5A	VSET	Output voltage pinstrap
5B	VTRK	Voltage Tracking input
6A	SALERT	PMBus Alert
6B	SDA	PMBus Data
7A	SCL	PMBus Clock
7B	SA1	PMBus address pinstrap 1
8A	SA0	PMBus address pinstrap 0
8B	SYNC	Synchronization I/O
9A	PG	Power Good
9B	CTRL	Remote Control
10A	GCB	Group Communication Bus
10B	PREF	Pin-strap reference

Unused input pins

Unused SDA, SCL and GCB pins should still have pull-up resistors as specified. Unused VTRK or SYNC pins should be left unconnected or connected to the PREF pin. Unused CTRL pin can be left open due to internal pull-up.
VSET and SA0/SA1 pins must have pinstrap resistors as specified.

BMR 464 series POL Regulators Input 4.5-14 V, Output up to 40 A / 132 W	EN/LZT 146 435 R2B August 2011 © Ericsson AB

Typical Application Circuit



Standalone with PMBus communication

BMR 464 series POL Regulators Input 4.5-14 V, Output up to 40 A / 132 W	EN/LZT 146 435 R2B August 2011
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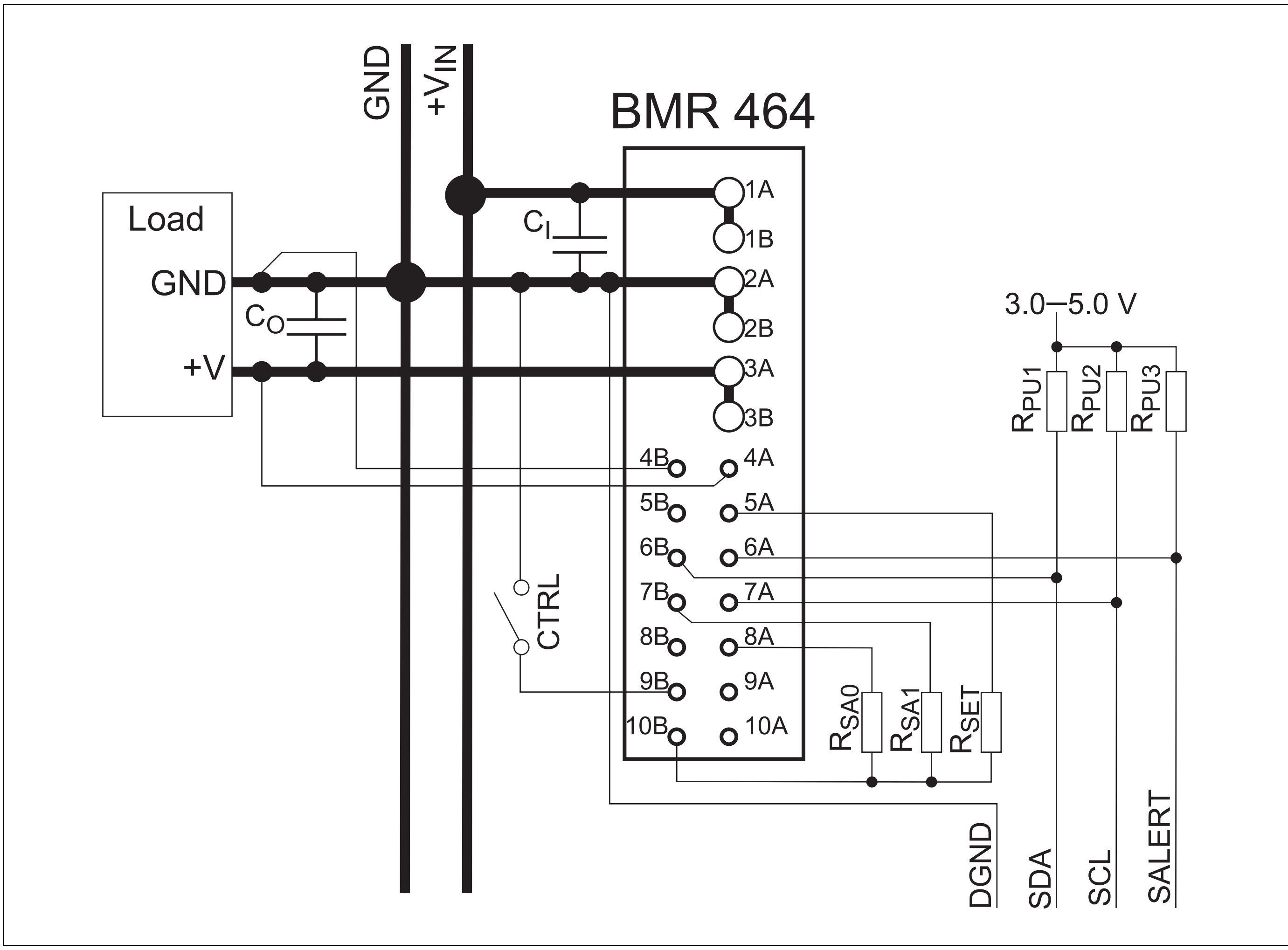
Typical Application Circuit (SIP version)



Standalone with PMBus communication. Top side view of product footprint.

PMBus Interface

This product provides a PMBus digital interface that enables the user to configure many aspects of the device operation as well as to monitor the input and output voltages, output current and device temperature. The product can be used with any standard two-wire I^2C or SMBus host device. In addition, the module is compatible with PMBus version 1.1 and includes an SALERT line to help mitigate bandwidth limitations related to continuous fault monitoring. The product supports 100 kHz bus clock frequency only. The PMBus signals, SCL, SDA and SALERT require passive pull-up resistors as stated in the SMBus Specification. Pull-up resistors are required to guarantee the rise time as follows:

Eq. 7 $$\tau = R_P C_p \le 1\mu s$$

where R_p is the pull-up resistor value and C_p is the bus loading, the maximum allowed bus load is 400 pF. The pull-up resistor should be tied to an external supply voltage in range from 2.7 to 5.5V, which should be present prior to or during power-up. If the proper power supply is not available, voltage dividers may be applied. Note that in this case, the resistance in the equation above corresponds to parallel connection of the resistors forming the voltage divider.

Monitoring via PMBus

It is possible to monitor a wide variety of different parameters through the PMBus interface. Fault conditions can be monitored using the SALERT pin, which will be asserted when any number of pre-configured fault or warning conditions occur. It is also possible to continuously monitor one or more of the power conversion parameters including but not limited to the following:

- Input voltage
- Output voltage
- Output current
- Internal junction temperature
- Switching frequency
- Duty cycle

Snap Shot Parameter Capture

This product offers a special feature that enables the user to capture parametric data during normal operation or following a fault. The following parameters are stored:

- Input voltage
- Output voltage
- Output current
- Internal junction temperature
- Switching frequency
- Duty cycle
- Status registers

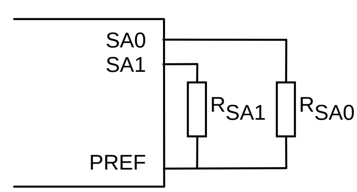
The Snapshot feature enables the user to read the parameters via the PMBus interface during normal operation, although it should be noted that reading the 22 bytes will occupy the bus for some time. The Snapshot enables the user to store the snapshot parameters to Flash memory in response to a pending fault as well as to read the stored data from Flash memory after a fault has occurred. Automatic store to Flash memory following a fault is triggered when any fault threshold level is exceeded, provided that the specific fault response is to shut down. Writing to Flash memory is not allowed if the device is configured to restart following the specific fault condition. It should also be noted that the device supply voltage must be maintained during the time the device is writing data to Flash memory; a process that requires between 700-1400 µs depending on whether the data is set up for a block write. Undesirable results may be observed if the input voltage of the modules drops below 3.0 V during this process

Software Tools for Design and Production

Ericsson provides software for configuration and monitoring of this product via the PMBus interface.
For more information please contact your local Ericsson sales representative.

PMBus Addressing

The PMBus address should be configured with resistors connected between the SA0/SA1 pins and the PREF pin, as shown in the figure below. Recommended resistor values for hard-wiring PMBus addresses are shown in the table. 1% tolerance resistors are required.



Schematic of connection of address resistor.

Index	R_{SA} [kΩ]	Index	R_{SA} [kΩ]
0	10	13	34.8
1	11	14	38.3
2	12.1	15	42.2
3	13.3	16	46.4
4	14.7	17	51.1
5	16.2	18	56.2
6	17.8	19	61.9
7	19.6	20	68.1
8	21.5	21	75
9	23.7	22	82.5
10	26.1	23	90.9
11	28.7	24	100
12	31.6		

The PMBus address follows the equation below:

Eq. 8 PMBus Address (decimal) = 25 x (SA1 index) + (SA0 index)

The user can theoretically configure up to 625 unique PMBus addresses, however the PMBus address range is inherently limited to 128. Therefore, the user should use index values 0 - 4 on the SA1 pin and the full range of index values on the SA0 pin, which will provide 125 device address combinations. The user shall also be aware of further limitations of the address space as stated in the SMBus Specification.
Note that address 0x4B is allocated for production needs and can not be used.

Optional PMBus Addressing

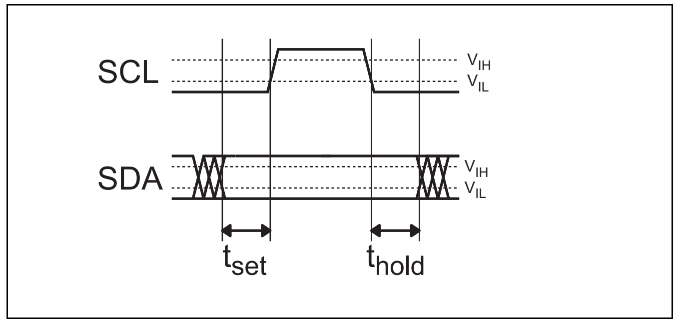
Alternatively the PMBus address can be defined by connecting the SA0/SA1 pins according to the following table. SA1 = open for products with no SA1 pin.

		SA0		
		low	open	high
SA1	low	0x20	0x21	0x22
	open	0x23	0x24	0x25
	high	0x26	0x27	Reserved

Low = Shorted to PREF
Open = High impedance
High = Logic high, GND as reference

Logic High definitions see Electrical Specification

I^2C/SMBus – Timing



Setup and hold times timing diagram

The setup time, t_{set}, is the time data, SDA, must be stable before the rising edge of the clock signal, SCL. The hold time t_{hold}, is the time data, SDA, must be stable after the rising edge of the clock signal, SCL. If these times are violated incorrect data may be captured or meta-stability may occur and the bus communication may fail. When configuring the product, all standard SMBus protocols must be followed, including clock stretching. Additionally, a bus-free time delay between every SMBus transmission (between every stop & start condition) must occur. Refer to the SMBus specification, for SMBus electrical and timing requirements. Note that an additional delay of 20 ms has to be inserted in case of storing the RAM content into the internal non-volatile memory.

PMBus Commands

The product is PMBus compliant. The following table lists the implemented PMBus commands. For more detailed information see PMBus Power System Management Protocol Specification; Part I – General Requirements, Transport and Electrical Interface and PMBus Power System Management Protocol; Part II – Command Language.

Designation	Cmd	Impl
Standard PMBus Commands		
Control Commands		
PAGE	00h	No
OPERATION	01h	Yes
ON_OFF_CONFIG	02h	Yes
WRITE_PROTECT	10h	No
Output Commands		
VOUT_MODE (Read Only)	20h	Yes
VOUT_COMMAND	21h	Yes
VOUT_TRIM	22h	Yes
VOUT_CAL_OFFSET	23h	Yes
VOUT_MAX	24h	Yes
VOUT_MARGIN_HIGH	25h	Yes
VOUT_MARGIN_LOW	26h	Yes
VOUT_TRANSITION_RATE	27h	Yes
VOUT_DROOP	28h	Yes
MAX_DUTY	32h	Yes
FREQUENCY_SWITCH	33h	Yes
IOUT_CAL_GAIN	38h	Yes
IOUT_CAL_OFFSET	39h	Yes
VOUT_SCALE_LOOP	29h	No
VOUT_SCALE_MONITOR	2Ah	No
COEFFICIENTS	30h	No
Fault Limit Commands		
POWER_GOOD_ON	5Eh	Yes
VOUT_OV_FAULT_LIMIT	40h	Yes
VOUT_UV_FAULT_LIMIT	44h	Yes
IOUT_OC_FAULT_LIMIT	46h	Yes
IOUT_UC_FAULT_LIMIT	4Bh	Yes
OT_FAULT_LIMIT	4Fh	Yes
OT_WARN_LIMIT	51h	Yes
UT_WARN_LIMIT	52h	Yes
UT_FAULT_LIMIT	53h	Yes
VIN_OV_FAULT_LIMIT	55h	Yes
VIN_OV_WARN_LIMIT	57h	Yes

Designation	Cmd	Impl
VIN_UV_WARN_LIMIT	58h	Yes
VIN_UV_FAULT_LIMIT	59h	Yes
VOUT_OV_WARN_LIMIT	42h	No
VOUT_UV_WARN_LIMIT	43h	No
IOUT_OC_WARN_LIMIT	4Ah	No
Fault Response Commands		
VOUT_OV_FAULT_RESPONSE	41h	Yes
VOUT_UV_FAULT_RESPONSE	45h	Yes
OT_FAULT_RESPONSE	50h	Yes
UT_FAULT_RESPONSE	54h	Yes
VIN_OV_FAULT_RESPONSE	56h	Yes
VIN_UV_FAULT_RESPONSE	5Ah	Yes
IOUT_OC_FAULT_RESPONSE	47h	No
IOUT_UC_FAULT_RESPONSE	4Ch	No
Time setting Commands		
TON_DELAY	60h	Yes
TON_RISE	61h	Yes
TOFF_DELAY	64h	Yes
TOFF_FALL	65h	Yes
TON_MAX_FAULT_LIMIT	62h	No
Status Commands (Read Only)		
CLEAR_FAULTS	03h	Yes
STATUS_BYTE	78h	Yes
STATUS_WORD	79h	Yes
STATUS_VOUT	7Ah	Yes
STATUS_IOUT	7Bh	Yes
STATUS_INPUT	7Ch	Yes
STATUS_TEMPERATURE	7Dh	Yes
STATUS_CML	7Eh	Yes
STATUS_MFR_SPECIFIC	80h	Yes
Monitor Commands (Read Only)		
READ_VIN	88h	Yes
READ_VOUT	8Bh	Yes
READ_IOUT	8Ch	Yes
READ_TEMPERATURE_1	8Dh	Yes
READ_TEMPERATURE_2	8Eh	No
READ_FAN_SPEED_1	90h	No
READ_DUTY_CYCLE	94h	Yes
READ_FREQUENCY	95h	Yes

Designation	Cmd	Impl
Identification Commands (Read Only)		
PMBUS_REVISION	98h	Yes
MFR_ID	99h	Yes
MFR_MODEL	9Ah	Yes
MFR_REVISION	9Bh	Yes
MFR_LOCATION	9Ch	Yes
MFR_DATE	9Dh	Yes
MFR_SERIAL	9Eh	Yes
Group Commands		
INTERLEAVE	37h	Yes
Supervisory Commands		
STORE_DEFAULT_ALL	11h	Yes
RESTORE_DEFAULT_ALL	12h	Yes
STORE_USER_ALL	15h	Yes
RESTORE_USER_ALL	16h	Yes
Product Specific Commands		
Time Setting Commands		
POWER_GOOD_DELAY	D4h	Yes
Fault limit Commands		
IOUT_AVG_OC_FAULT_LIMIT	E7h	Yes
IOUT_AVG_UC_FAULT_LIMIT	E8h	Yes
Fault Response Commands		
MFR_IOUT_OC_FAULT_RESPONSE	E5h	Yes
MFR_IOUT_UC_FAULT_RESPONSE	E6h	Yes
OVUV_CONFIG	D8h	Yes
Configuration and Control Commands		
MFR_CONFIG	D0h	Yes
USER_CONFIG	D1h	Yes
MISC_CONFIG	E9h	Yes
PID_TAPS	D5h	Yes
INDUCTOR	D6h	Yes
NLR_CONFIG	D7h	Yes
TEMPCO_CONFIG	DCh	Yes
DEADTIME	DDh	Yes
DEADTIME_CONFIG	DEh	Yes
DEADTIME_MAX	BFh	Yes
SNAPSHOT	EAh	Yes
SNAPSHOT_CONTROL	F3h	Yes
DEVICE_ID	E4h	Yes
USER_DATA_00	B0h	Yes

Designation	Cmd	Impl
Group Commands		
SEQUENCE	E0h	Yes
GCB_GROUP	E2h	Yes
ISHARE_CONFIG	D2h	Yes
PHASE_CONTROL	F0h	Yes
Supervisory Commands		
PRIVATE_PASSWORD	FBh	Yes
PUBLIC_PASSWORD	FCh	Yes
UNPROTECT	FDh	Yes
SECURITY_LEVEL	FAh	Yes

Notes:
Cmd is short for Command.
Impl is short for Implemented.

BMR 464 series POL Regulators
Input 4.5-14 V, Output up to 40 A / 132 W

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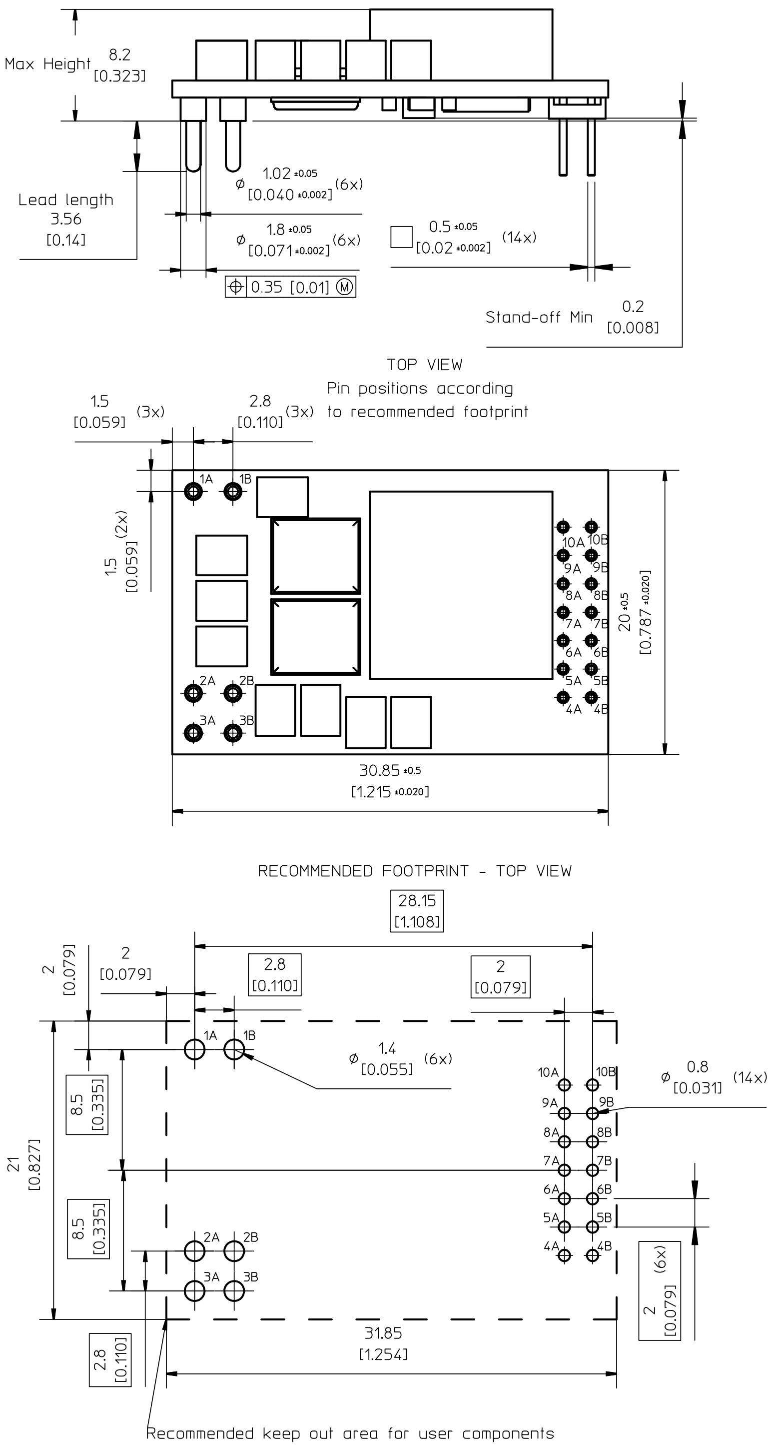
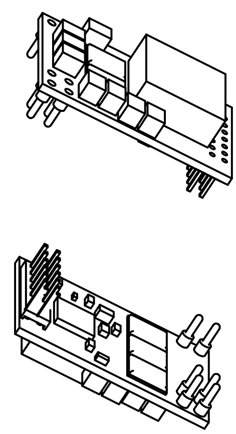
Mechanical Information - Hole Mount, Open Frame Version

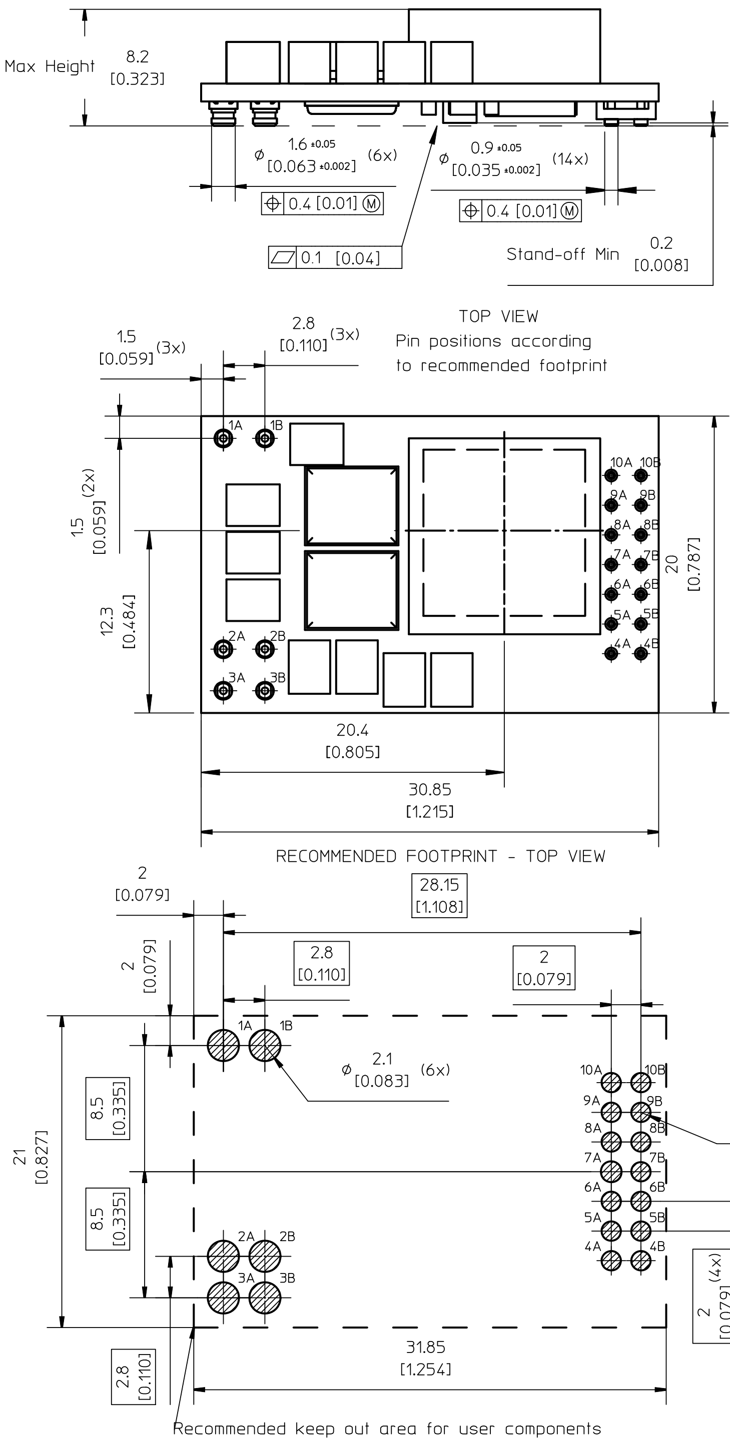


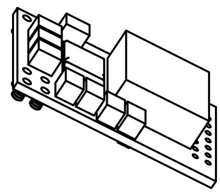


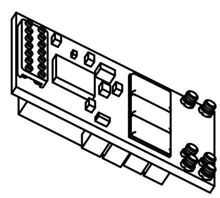
PIN SPECIFICATIONS
PIN 1A-3B Material: Copper alloy
Plating: Min Matte tin 8-13 µm over 2.5-5 µm Ni.
PIN 4A-9B Material: Brass
Plating: Min Au 0.2 µm over 1.27 µm Ni.

Weight: Typical 10 g
All dimensions in mm [inch]
Tolerances unless specified
x.x ±0.50 [0.02]
x.xx ±0.25 [0.01]
(not applied on footprint or typical values)

Mechanical Information - Surface Mount Version





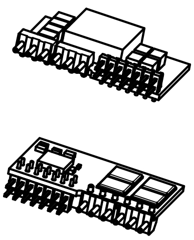


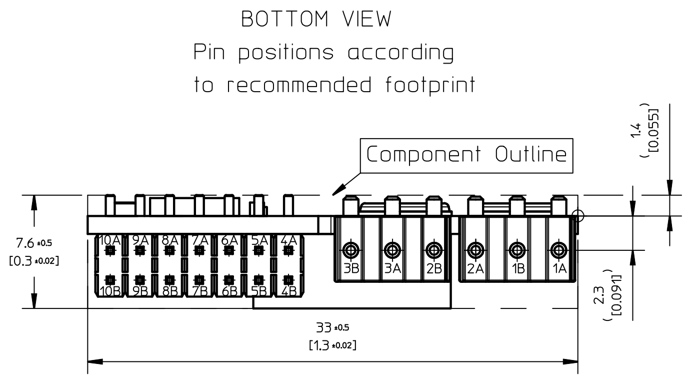
PIN SPECIFICATIONS
PIN 1A-3B Material: Copper alloy
Plating: Min Au 0.1 µm over 1-3 µm Ni.
PIN 4A-9B Material: Brass
Plating: Min Au 0.1 µm over 2 µm Ni.

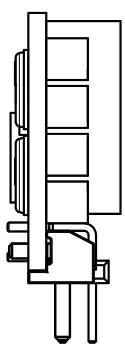
PICK-UP SURFACE
Recommended pick-up nozzle size for assigned pick-up area is maximum Ø8 [0.315].

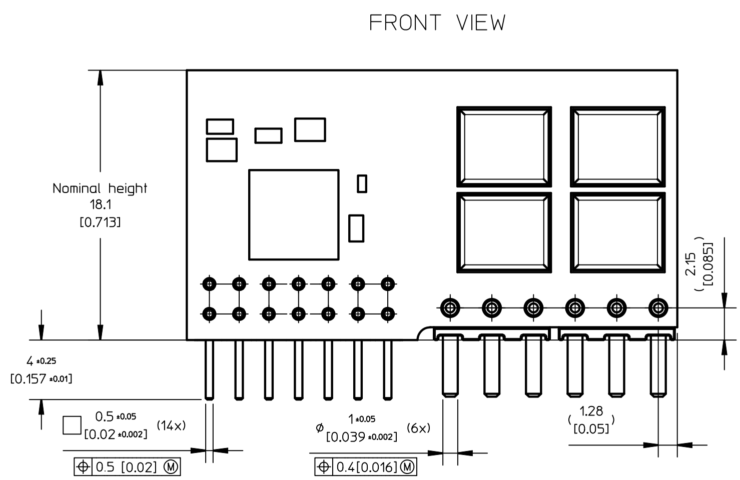
Weight: Typical 9.5 g
All dimensions in mm [inch]
Tolerances unless specified:
x.x ±0.50 [0.02]
x.xx ±0.25 [0.01]
(not applied on footprint or typical values)

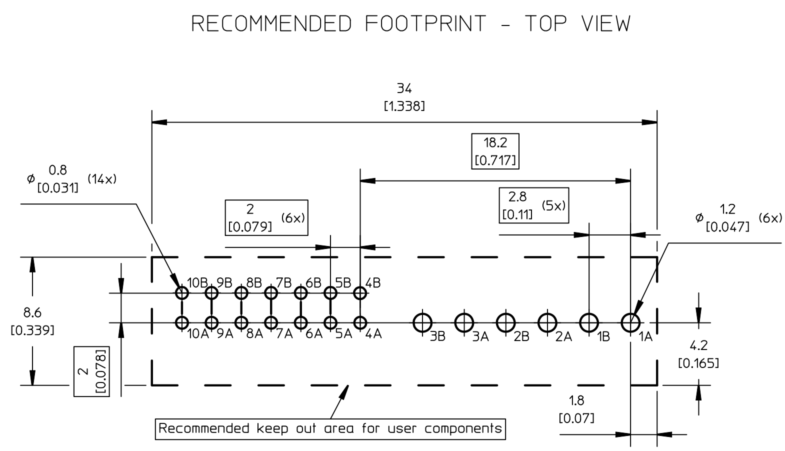
Mechanical Information











PIN SPECIFICATIONS
Pin 1A-3B Material: Copper alloy (C11000)
Plating: Min Au 0.1 µm over 1-3 µm Ni.
Pin 4A-10B Material: Copper alloy
Plating: Min Au 0.1 µm over 1 µm Ni.

Weight: Typical 10.3 g
All dimensions in mm [inch]
Tolerances unless specified:
x.x ±0.50 [0.02]
x.xx±0.25 [0.01]
(not applied on footprint or typical values)

Soldering Information - Surface Mounting

The surface mount product is intended for forced convection or vapor phase reflow soldering in SnPb or Pb-free 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 it is also recommended 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.

Minimum Pin Temperature Recommendations

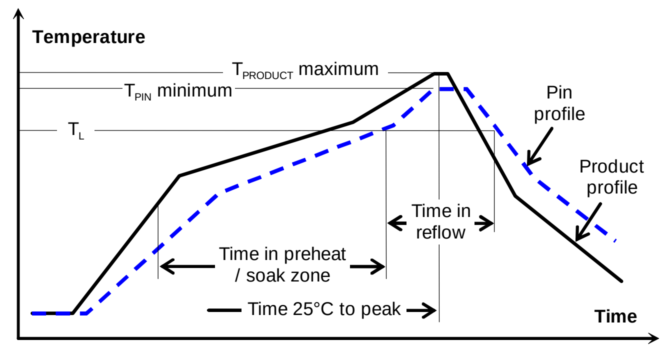
Pin number 2B chosen as reference location for the minimum pin temperature recommendation since this will likely be the coolest solder joint during the reflow process.

SnPb solder processes

For SnPb solder processes, a pin temperature (T_{PIN}) in excess of the solder melting temperature, (T_L, 183°C for Sn63Pb37) for more than 30 seconds and a peak temperature of 210°C is recommended to ensure a reliable solder joint.

For dry packed products only: depending on the type of solder paste and flux system used on the host board, up to a recommended maximum temperature of 245°C could be used, if the products are kept in a controlled environment (dry pack handling and storage) prior to assembly.

General reflow process specifications		SnPb eutectic	Pb-free
Average ramp-up ($T_{PRODUCT}$)		3°C/s max	3°C/s max
Typical solder melting (liquidus) temperature	T_L	183°C	221°C
Minimum reflow time above T_L		30 s	30 s
Minimum pin temperature	T_{PIN}	210°C	235°C
Peak product temperature	$T_{PRODUCT}$	225°C	260°C
Average ramp-down ($T_{PRODUCT}$)		6°C/s max	6°C/s max
Maximum time 25°C to peak		6 minutes	8 minutes



Lead-free (Pb-free) solder processes

For Pb-free solder processes, a pin temperature (T_{PIN}) in excess of the solder melting temperature (T_L, 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 10B 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.

SnPb solder processes

For SnPb solder processes, the product is qualified for MSL 1 according to IPC/JEDEC standard J-STD-020C.

During reflow $T_{PRODUCT}$ must not exceed 225 °C at any time.

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.

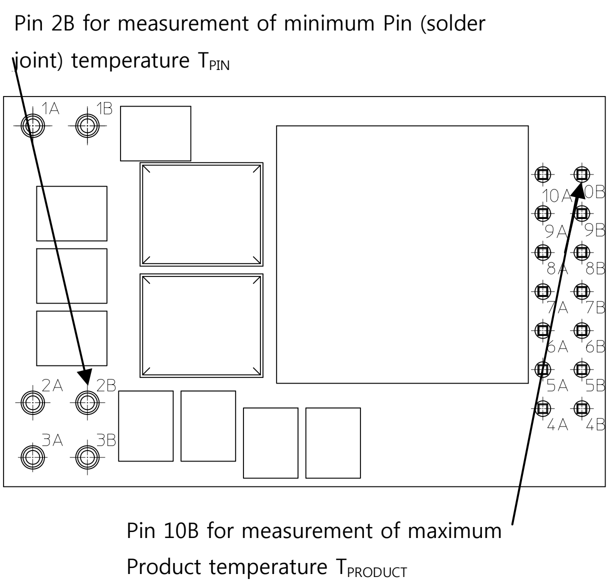
Dry Pack Information

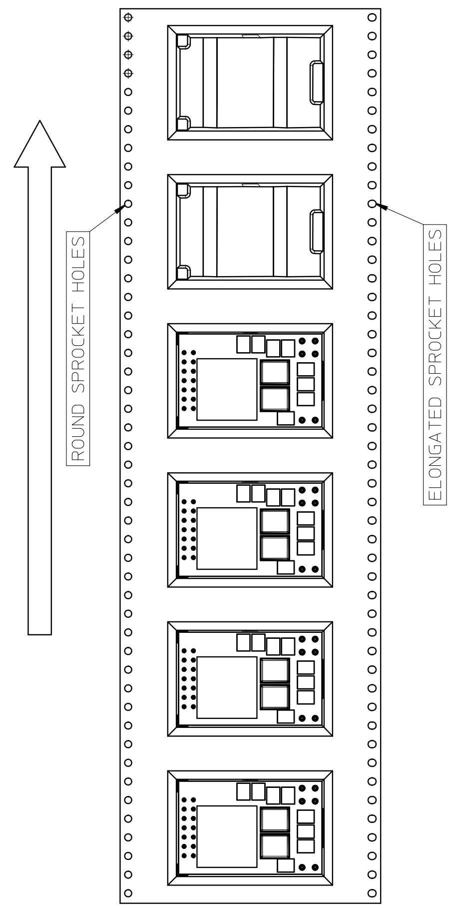
Surface mounted versions of the products are delivered in standard moisture barrier bags according to IPC/JEDEC standard J-STD-033 (Handling, packing, shipping and use of moisture/reflow sensitivity surface mount devices).

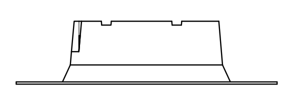
Using products in high temperature Pb-free soldering processes requires dry pack storage and handling. In case the products have been stored in an uncontrolled environment and no longer can be considered dry, the modules must be baked according to J-STD-033.

BMR 464 series POL Regulators Input 4.5-14 V, Output up to 40 A / 132 W	EN/LZT 146 435 R2B August 2011 © Ericsson AB

Thermocoupler Attachment







Soldering Information - Hole Mounting

The hole mounted product is intended for plated through hole mounting by wave or manual soldering. The pin temperature is specified to maximum to 270°C for maximum 10 seconds.

A maximum preheat rate of 4°C/s and maximum preheat temperature of 150°C is suggested. When soldering by hand, care should be taken to avoid direct contact between the hot soldering iron tip and the pins for more than a few seconds in order to prevent overheating.

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. The cleaning residues may affect long time reliability and isolation voltage.

Delivery Package Information

The products are delivered in antistatic carrier tape (EIA 481 standard).

Carrier Tape Specifications	
Material	PS, antistatic
Surface resistance	< 10^7 Ohm/square
Bakeability	The tape is not bakable
Tape width, W	56 mm [2.20 inch]
Pocket pitch, P_1	32 mm [1.26 inch]
Pocket depth, K_0	13 mm [0.51 inch]
Reel diameter	381 mm [15 inch]
Reel capacity	130 products /reel
Reel weight	1783 g/full reel

BMR 464 series POL Regulators Input 4.5-14 V, Output up to 40 A / 132 W	EN/LZT 146 435 R2B August 2011 © Ericsson AB

Soldering Information - Hole Mounting (SIP version)

The product is intended for plated through hole mounting by wave or manual soldering. The pin temperature is specified to maximum to 270°C for maximum 10 seconds.

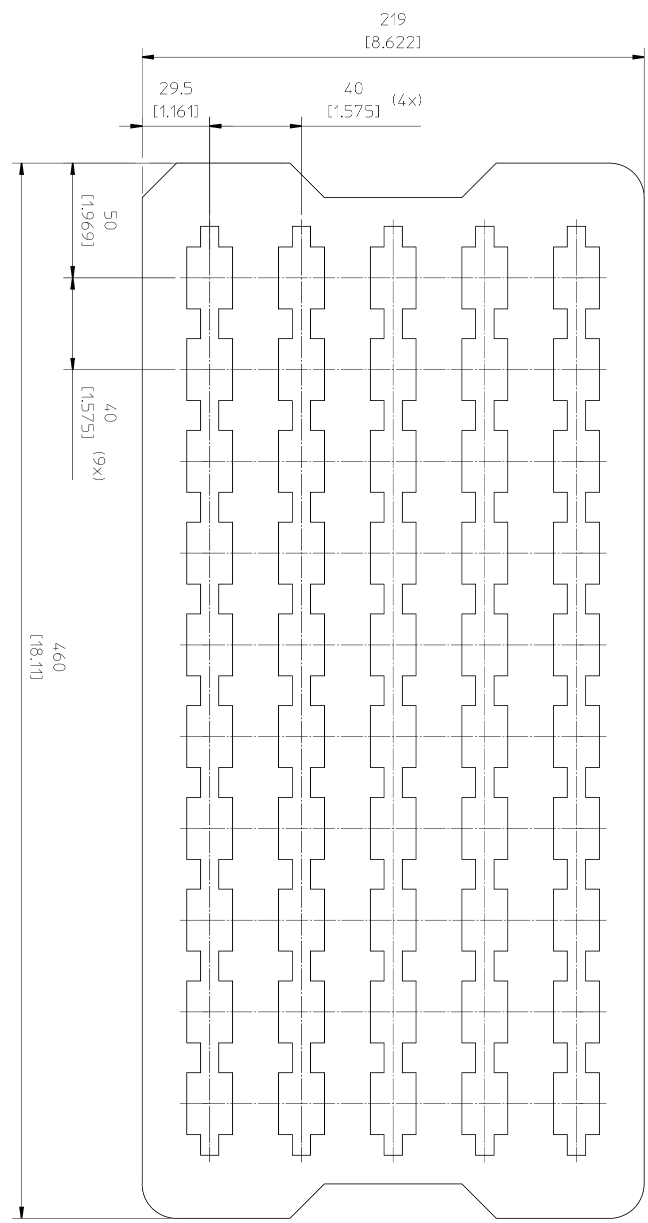
A maximum preheat rate of 4°C/s and maximum preheat temperature of 150°C is suggested. When soldering by hand, care should be taken to avoid direct contact between the hot soldering iron tip and the pins for more than a few seconds in order to prevent overheating.

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. The cleaning residues may affect long time reliability and isolation voltage.

Delivery Package Information (SIP version)

The products are delivered in antistatic trays

Tray Specifications	
Material	Antistatic Polyethylene foam
Surface resistance	10^5< Ohms/square <10^{12}
Bakability	The trays are not bakeable
Tray thickness	15 mm [0.709 inch]
Box capacity	100 products, 2 full trays/box)
Tray weight	35 g empty tray, 549 g full tray



Product Qualification Specification

Characteristics			
External visual inspection	IPC-A-610		
Change of temperature (Temperature cycling)	IEC 60068-2-14 Na	Temperature range Number of cycles Dwell/transfer time	-40 to 100°C 1000 15 min/0-1 min
Cold (in operation)	IEC 60068-2-1 Ad	Temperature T_A Duration	-45°C 72 h
Damp heat	IEC 60068-2-67 Cy	Temperature Humidity Duration	85°C 85 % RH 1000 hours
Dry heat	IEC 60068-2-2 Bd	Temperature Duration	125°C 1000 h
Electrostatic discharge susceptibility	IEC 61340-3-1, JESD 22-A114 IEC 61340-3-2, JESD 22-A115	Human body model (HBM) Machine Model (MM)	Class 2, 2000 V Class 3, 200 V
Immersion in cleaning solvents	IEC 60068-2-45 XA, method 2	Water Glycol ether	55°C 35°C
Mechanical shock	IEC 60068-2-27 Ea	Peak acceleration Duration	100 g 6 ms
Moisture reflow sensitivity [1]	J-STD-020C	Level 1 (SnPb-eutectic) Level 3 (Pb Free)	225°C 260°C
Operational life test	MIL-STD-202G, method 108A	Duration	1000 h
Resistance to soldering heat [2]	IEC 60068-2-20 Tb, method 1A	Solder temperature Duration	270°C 10-13 s
Robustness of terminations	IEC 60068-2-21 Test Ua1 IEC 60068-2-21 Test Ue1	Through hole mount products Surface mount products	All leads All leads
Solderability	IEC 60068-2-58 test Td [1] IEC 60068-2-20 test Ta [2]	Preconditioning Temperature, SnPb Eutectic Temperature, Pb-free Preconditioning Temperature, SnPb Eutectic Temperature, Pb-free	150°C dry bake 16 h 215°C 235°C Steam ageing 235°C 245°C
Vibration, broad band random	IEC 60068-2-64 Fh, method 1	Frequency Spectral density Duration	10 to 500 Hz 0.07 g^2/Hz 10 min in each direction

Notes
[1] Only for products intended for reflow soldering (surface mount products)
[2] Only for products intended for wave soldering (plated through hole products)

ericsson.com

3E GUI

Gold Edition

User Guide

ERICSSON

1553-CXC 173 1142/2 Rev B

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1 Introduction

This User Guide describes the 3E GUI (graphical user interface) Gold Edition software that demonstrates Ericsson's solution for its family of 3E PMBus-enabled devices. The document describes all the GUI objects (menus, fields, and buttons) in detail, including all activities. Reference 1 provides information about installing the 3E GUI Gold Edition software.

1.1 How to contact Ericsson

For general questions or interest in our products, please contact your local sales representative. Contact details are available from our website:
www.ericsson.com/powermodules

The 3E Design Kit is supported by our Application Engineers. You may contact your local support agent or use our dedicated 3E support mailbox.
Send e-mail to: 3e-support@ericsson.com

1.2 Prerequisites

The 3E GUI Gold Edition software package and a compatible Windows PC (see reference 1 for details). Users must be familiar with the **Windows®** operating system.

1.3 Graphical User Interface: Conventions

The Mouse Buttons

This document uses the following terminology to describe mouse actions:

- Click - Click once on the left mouse button.
- Double-click - Click twice rapidly on the left mouse button.
- Right-click - Click once on the right mouse button.

Check boxes

Check boxes indicate if a specific setting is to be used. A check box displaying a tick means ON (checked). In Figure 1, "Acts on Control Pin" has been selected.

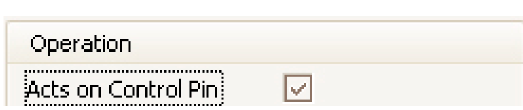


Figure 1. Example of check boxes – Acts on Control Pin selected.

Radio Buttons

These select one option from multiple alternatives. Figure 2 shows the selection of High Margin using a radio button.

Figure 2. Example of radio buttons – Margin High selected.

Spin box

The spin box sets makes it possible to set values using the up or down arrows to the right of the field, or by entering a value manually. The value that is entered must be within the allowable limits for the Spin box.

Figure 3. Example of Spin Box - 3.30V selected.

Drop Down Box

Clicking on a selection within a drop-down box selects optional values or actions. These boxes are mainly used to choose between various states that define how a device operates under certain conditions.

Figure 4. Example of drop down box – Restart selected.

1.3.1 Resizing Windows and Columns

Resize a window by dragging any side of the window to increase or decrease it. It is possible to resize columns in the panes to customize their individual views. To resize a column:

1. At header level, move the pointer to one of the grid lines dividing the columns.
2. Click and hold the left mouse button.
3. Move the mouse either left or right to customize the column size.

Note: Full stops in a column signify that there is more text that is not currently possible to display because the column is too narrow to show all the information.

1.3.2 Error Messages

An attempt to perform an incorrect action such as entering values that are out of range results in an error indication.

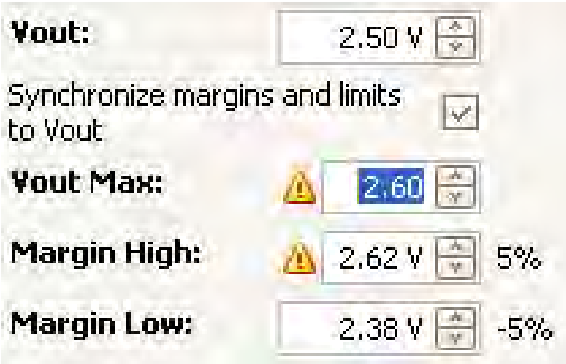


Figure 5. Example of an error indication.

The warning triangle indicates the location of the error (in Figure 5, the Margin High value cannot be higher than Vout Max).

1.4 GUI Components

Figure 6 shows an example of the screen that appears when IBC and POL evaluation boards are connected to the PC via the USB-to-PMBus adapter and the user starts 3E GUI Gold Edition.

The GUI consists of:

1. The Window title.

2. Top menu bar – *File*, *View*, *Device*, and *Help* drop-down boxes, and the PMBus *Refresh Rate* control and spin box – see Section 2.

3. The *Shortcuts* panel – provides controls to scan and refresh PMBus devices, and save and load device configuration data - see Section 3.

4. The *System Overview* window displays key information about the devices on an evaluation board while they are running and allows you to select them - see Section 4.

5. The Detail window provides four tabs that access these panes:
   Device Monitor view - see Section 5.1
   System Monitor view - see Section 5.2
   Basic and Protection Configuration controls - see Section 5.3
   Advanced Configuration controls - see Section 5.4

Figure 6. 3E GUI Gold Edition components - System Overview.

1.5 Software Version Information

You can check the version of the 3E GUI Gold Edition software by selecting the “About Ericsson 3E GUI” menu option from the “Help” drop-down menu in the top menu bar.

A screen appears that reports the version and revision numbers:

Figure 7. The About 3E GUI window displays the software version - the revision information appears after the version number.

2 Top Menu Bar

The top menu bar accesses the following facilities:

Figure 8. The top menu bar.

2.1 File

Rescan for device causes the program to scan the PMBus for connected devices and refresh its System Overview information.

Exit closes the program.

2.2 View

System Device Overview opens the System Overview window.

PMBus Transaction Log makes available the realtime record of PMBus transactions by clicking on the tab that appears at the bottom left-hand corner of the screen.

PMBus Command Line opens a dialog that allows you to directly enter PMBus commands and send them to connected devices using Ericsson's PMBus CLI (command line interface).

2.3 Device

Save/Reload Memory Operations allows you to Save, Store, and Reload configuration data by communicating with the selected device's memory.

The *Reset* option is reserved for future enhancements.

Load/Save Configuration allows you to Save the selected device's configuration data to a disk file, and to Load configuration data from a disk file into the selected device's memory.

2.4 Help

User Guide opens this document.

Command Line Syntax Description opens a document that describes how to use Ericsson's PMBus CLI (command line interface).

Report Bug launches the PC's email client and addresses a new message to Ericsson's 3E support team. A header that reports version and environmental information for 3E GUI Gold Edition is automatically generated. You can then enter a description of the problem and send it for analysis.

Feature Suggestion acts similarly to Report Bug above, but is intended to make it easy for users to provide suggestions and feedback to Ericsson's 3E support team.

Contact displays the email address of Ericsson's 3E support team and the Web address for Ericsson Power Modules. Clicking on these links launches the PC's email client and creates a message to Ericsson's 3E support team that you can use to request information, or directs a Web browser to Ericsson Power Modules' homepage.

About Ericsson 3E GUI reports the software's version and revision information.

2.5 Refresh Rate Control

Appearing by default below the normal Windows top menu bar, the Refresh Rate control's spin box allows you to set the intervals at which the software refreshes the information displays of connected PMBus devices. Clicking on the button to the right of the spin box starts and stops the automatic refresh sequence.

Figure 9. The Refresh Rate control.

You can move the Refresh Rate control within the display area by moving the cursor over the vertical-bar symbol at its left-hand edge, holding down the left-hand mouse button, and dragging the control to the desired location.

3 Shortcuts

The Shortcuts panel appears to the left-hand side of the 3E GUI Gold Edition display area and divides its buttons between Project and Device bars, making it possible to collapse or expand the command buttons that appear in each area by clicking on the up/down arrow to the right side of each bar:

Figure 10. The 3E GUI Gold Edition Shortcuts panel.

3.1 Rescan for…

A PMBus scan runs automatically when the software starts up, and the System Overview window displays devices that have been discovered during this process. Clicking the *Rescan for…* button at any later time re-scans the evaluation boards for PMBus-enabled devices and refreshes the System Overview display.

3.2 Save

Clicking this button saves parameters that you may have changed using the software's device configuration tools to the selected device's RAM, causing the device to update its internal state and reflect the new configuration. Any updates using *Save* are temporary and persist only until power is removed. Upon subsequent power-up, the device loads its configuration data from Flash. This facility suits testing new configurations before committing them to non-volatile storage within a device's Flash memory.

3.3 Store

This button acts similarly to *Save* but instead of writing configuration parameters to the selected device's RAM, *Store* writes to its Flash memory. As a result, any changes made using *Store* are non-volatile and remain available until overwritten by another *Store* command. This is particularly useful for programming devices for production purposes.

3.4 Reload

Clicking the *Reload* button causes the selected device to overwrite the contents of its RAM with configuration data from its Flash memory. This makes it easy to re-instate a previous configuration.

3.5 Save config

Clicking this button launches a Save As file box, allowing you to specify a name and location for the configuration file that you wish to save to the PC's hard disk. You can use this facility to save a device's set-up information for re-use - such as backing up the factory default configuration before experimenting with new parameters, or for programming another device of the same type using *Load config*.

3.6 Load config

Clicking this button launches an Open file box, allowing you to select a previously-stored device configuration file. Opening the file reads the configuration data into 3E GUI Gold Edition, after which you can temporarily *Save* it to the selected device's RAM or *Store* it to non-volatile Flash memory, as described above.

See Section 5.5 for more details of how to save, store, and restore device configuration data.

4 System Overview Window

4.1 Picture View

When the software start-up process completes, the System Overview window defaults to Picture View and displays devices that were discovered when scanning the PMBus.

Figure 11. System Overview Window – Picture View.

Figure 11 shows a Picture View representation of each 3E family device discovered during a scan together with its PMBus address. The Device, Chart, and Monitor panels offer these features:

Device reports the status of the PMBus link for each device. The Linkstatus symbol is green for good and red for bad communications. The On/Off check box toggles a single-click on/off command button for each device.

Chart lets you assign a color to represent each device for graphing in the System Monitor window.

Monitor continually reports the key operating parameters for each device at update intervals that you can adjust using the Refresh Rate control that Section 2.5 describes. In addition, the green Power Good indicator signifies that the output voltage is within tolerance, while a red indicator flags an out-of-tolerance condition.
Section 4.2 provides more details of each of these facilities.

4.2 Table View

Like Picture View, Table View provides a summary of each device under the Device, Chart, and Monitor headings. Dots that appear in columns indicate that more text is available than can currently be displayed, such as Ch… for Chart in Figure 12. To see more text, re-size the column by dragging its right-hand edge.

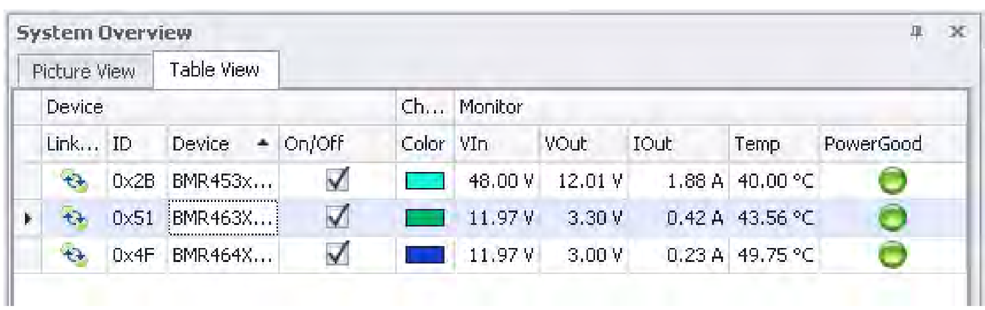


Figure 12. System Overview Window – Table View.

You can select the order in which to display rows by clicking on the up/down arrow or dialog box that appears when you right-click in a column heading. The list order in Figure 12 is by Device and ascending. The contents and/or functions of the fields within Table View comprise:

Selected Device

The marker in the left-hand column in Figure 12 identifies the currently-selected device. To select another device, click anywhere in its row. At the same time, the Device Monitor, Basic & Protection Configuration, and Advanced Configuration tabs within the Detail window change to reflect the currently selected device. Section 5 describes the facilities that these tabs make available.

Figure 13 shows the result of selecting the BMR463 above, with each tab identifying the device by its PMBus address between square brackets:

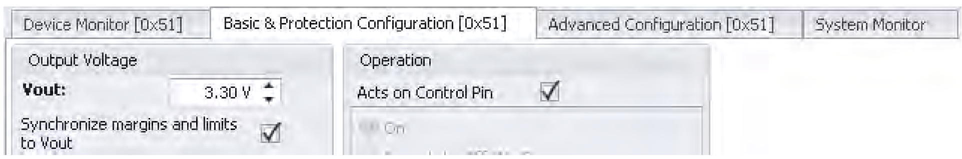


Figure 13. Detail Window – tabs focus on currently selected device.

Link status

The green symbol shows that PMBus communications are good for the device in this row, turning red if data exchanges are lost or not possible.

ID

The default ID (identification) value in this field is the unique PMBus address for each device that is installed on an evaluation board. On-board resistors set these addresses.

Device

The Device field displays the Ericsson type designator and revision level information that describes the device's hardware and firmware combination.

On/Off

Clicking on the check box toggles each device on and off. A tick shows that the device is enabled while a blank signifies that it is off.

Color

This control assigns a color for each device that makes it easy to identify in the System Monitor view. Clicking on the color block or drop-down symbol in this field displays a Custom palette together with Web and System color options that you can select. Dragging the column sufficiently wide reveals the RGB values of the currently selected color.

VIn

The VIn field displays the input voltage that each device reports.

VOut

The VOut field displays the output voltage setting for each device.

IOut

The IOut field displays the output current that each device reports that it is delivering.

Temp

The Temp field displays the onboard temperature of each device.

Power Good

The green indicator signifies that the device's output voltage is within tolerance, while red signals out-of-tolerance conditions.

4.3 Controlling the System Overview Window display

Sometimes it is useful to be able to maximize the display area to allow other windows more space. 3E GUI Gold Edition allows this possibility for several windows, where the selection options follow the model of the System Overview display below.

Clicking on the pin symbol on the right-hand side of the System Overview bar in Figure 14 allows you to shrink this window and retain it in dockable format (the x closes the window):

Figure 14. System Overview window display controls.

In this mode, the pin symbol turns to the horizontal and a System Overview tab appears to the left-hand side of the display area. The System Overview window shrinks away and the full window area becomes available to display other views as figure 15 shows:

Figure 15. System Overview window docked to a tab.

Moving the mouse cursor over the System Overview tab causes the window to re-appear while the cursor remains over the tab. If you click on the horizontal pin symbol at this time, the pin returns to its vertical position and both the System Overview window and the right-hand pane return to occupy their previous areas.

5 Monitoring and Configuring Devices

The Detail window on the right-hand side of 3E GUI Gold Edition's display area offers four tabs that allow you to select between Device Monitor, Basic & Protection Configuration, Advanced Configuration, and System Monitor windows.

Figure 16 shows these selection options, together with the PMBus address of the currently selected device within the square brackets:

Figure 16. Device Monitor, Basic & Protection Configuration, Advanced Configuration, and System Monitor tabs.

5.1 Device Monitor

The Device Monitor window graphs input voltage, output voltage, output current, and temperature for the selected device whose PMBus address appears within the tab - see Section 4.2. You can adjust the screen update rate using the Refresh Rate control – see Section 2.5.

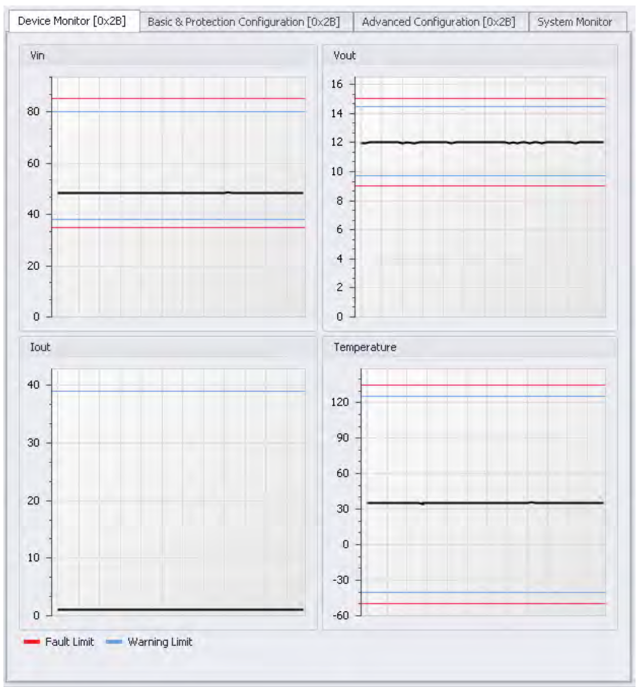


Figure 17. An example Device Monitor screen.

The example screen in Figure 17 displays the measured parameters as the black line that appears between blue warning limit and red fault limit thresholds.

5.2 System Monitor

The System Monitor window graphs the input voltage, output voltage, output current, and temperature for each of the connected devices on the evaluation boards. Using the Chart facility in the System Overview window to select individual colors for each device makes it easy to identify them in the composite display – see Section 4.2.

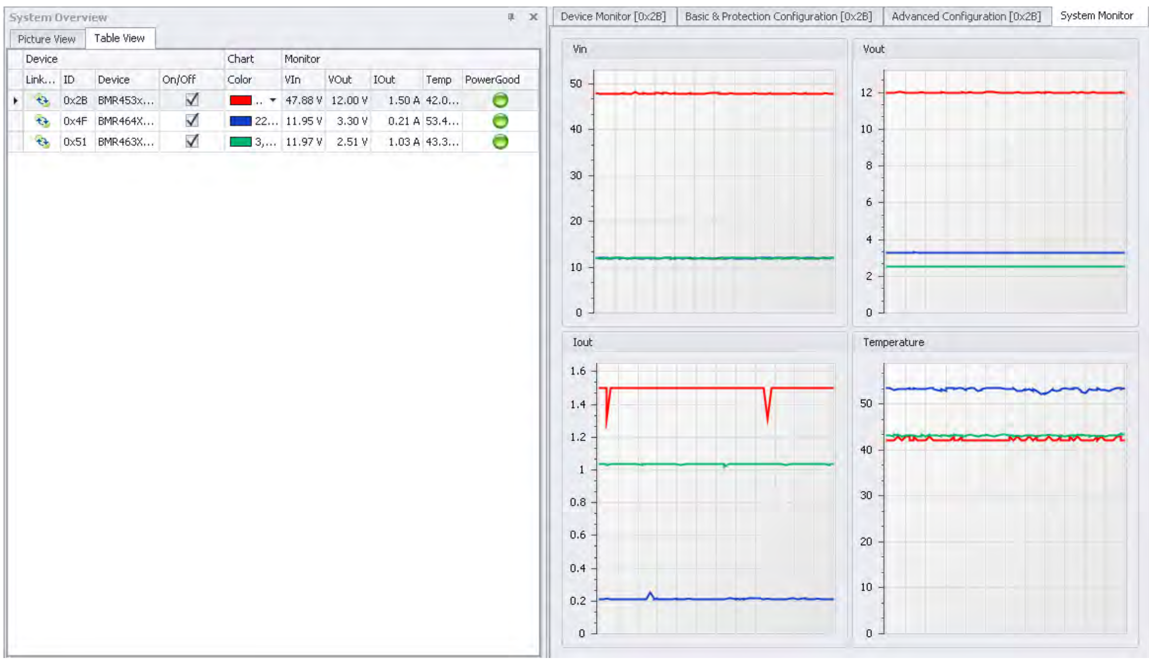


Figure 18. The System Monitor screen.

5.3 Basic & Protection Configuration

The Basic & Protection Configuration window makes it possible to program new values for each device's output voltage, voltage margins, control pin operating mode, and soft-start delay times. This window also allows you to set protection limits for input and output voltage, output current, and the device's internal temperature. To select the device that you wish to program, click on the row that identifies it within the Table View display of the System Overview window to the left of the main screen area – see Section 4.2.

Figure 19. Parameters, values, and options that are available for programming the selected device – for instance, a BMR463 POL.

5.3.1 Output Voltage panel

You can enter output voltages within the range that the device supports into the Vout box, either by using the increment/decrement arrows within the spin box or by typing a new value into the text area.

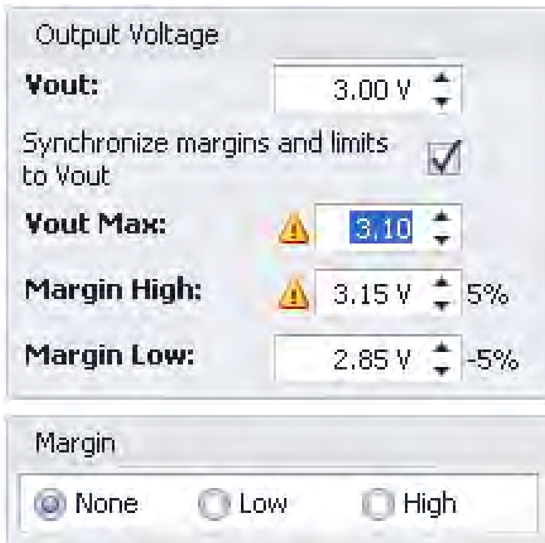


Figure 20. The Output Voltage panel.

In the same way, you can enter values for the device's maximum output voltage (Vout Max), and set high and low margins (Margin High and Margin Low) to evaluate the load's voltage dependency. The software warns of out-of-bounds conditions with a warning triangle symbol beside the conflicting item – as figure 20 shows - allowing you to re-enter suitable values.

Ticking the Synchronize margins and limits to Vout check-box causes the software to display the applicable percentages of margins and limits relative to the value of Vout.

Selecting the None radio button under the Margin heading causes the device to output the voltage that appears in the Vout box. Similarly, selecting the Low or High margin radio buttons outputs the values that appear in the Margin Low or Margin High boxes.

To temporarily apply changes for testing, select Device then Save/Load Memory Operations from the top menu bar and click the Save button, or simply click on Save in the Shortcuts panel. The device updates its RAM memory area to reflect the new conditions and will now output the values set prior to clicking the Save button.

To make changes permanent, select Save then Store. The Store command writes to the device's non-volatile Flash memory and will automatically load the new configuration into RAM at every subsequent power up event.

See Section 5.5 before committing to new values if you wish to save the device's original configuration.

5.3.2 Operation panel

The operation panel determines how the device responds when it turns its output on and off. You can also set turn-on and turn-off delays to suit power-rail sequencing applications, and specify the output voltage's slew rates when turning on and off to limit inrush currents or to protect sensitive circuits.

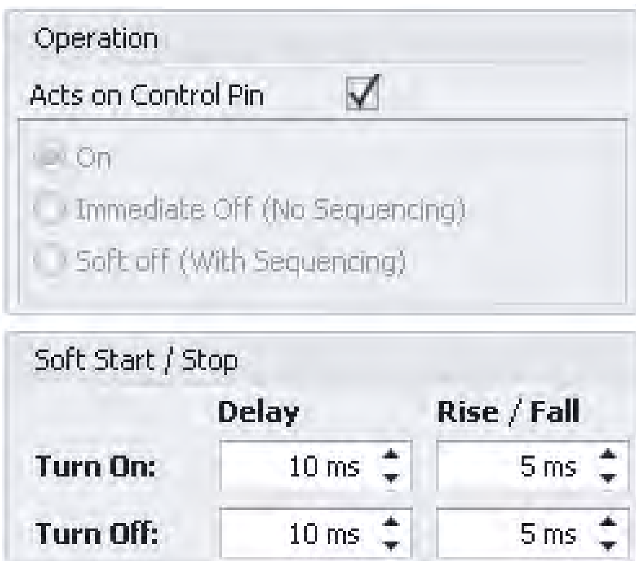


Figure 21. The Operation panel.

Setting the Acts on Control Pin check box causes the device to respond directly to its hardware control pin rather than to PMBus commands, and grays out the On/Immediate Off/Soft off radio buttons.

Clearing the Acts on Control Pin check box permits the On/Immediate Off/Soft off radio buttons to choose between the device turning on in response to PMBus commands using any programmed Turn On parameters; turning off immediately; or turning off using the Turn Off parameters. The Immediate Off and Soft off radio buttons disable any margining values that are set.

The Soft Start/Stop control specifies the delay between the device turning its output on and off in response to a PMBus command.

The Rise/Fall box specifies the slew rate of the voltage that the device outputs during turn on and turn off events.

To temporarily apply changes for testing, select Device then Save/Load Memory Operations from the top menu bar and click the Save button, or click on Save in the Shortcuts panel. To make changes permanent, select Save then Store.

See Section 5.5 before committing to new values if you wish to save the device's original configuration.

5.3.3 Protection Limits panel

The protection limits panel allows you to set threshold values for the device to flag warning and fault conditions, and specify how the device responds when normal conditions resume.

Figure 22. The Protection Limits panel.

The Output Voltage control offers Fault and Response settings, where Fault specifies upper and lower threshold values for the output voltage that the device sources. The software displays the percentage above and below the device's nominal output voltage beside the settings boxes.

The Response drop-down box determines how the device behaves following a temporary fault condition that has cleared. In Latched mode, the device's output remains off until it receives an external on command. In Restart mode, the device automatically restarts without any external intervention.

The Input Voltage control operates similarly but adds separate warning thresholds that allow the device to flag circumstances that are approaching fault conditions.

The Output Current control sets the maximum allowable output current level.

The Temperature control provides warning and fault thresholds for the device's internal temperature.

To temporarily apply changes for testing, select Device then Save/Load Memory Operations from the top menu bar and click the Save button, or click Save in the Shortcuts panel. To make changes permanent, select Save then Store.

See Section 5.5 before committing to new values if you wish to save the device's original configuration.

5.4 Advanced Configuration

The Advanced Configuration window divides into Standard Configuration and Device Specific Configuration views. The contents of these windows comprise the PMBus-standard commands and the manufacturer-specific commands that the selected device supports.

While requiring users to understand the native command sets that a device implements, the Advanced Configuration facilities offer maximum access to a device's capabilities. To acquire the command set and protocol information that is necessary to use these tools, please see the References section at the end of this User Guide.

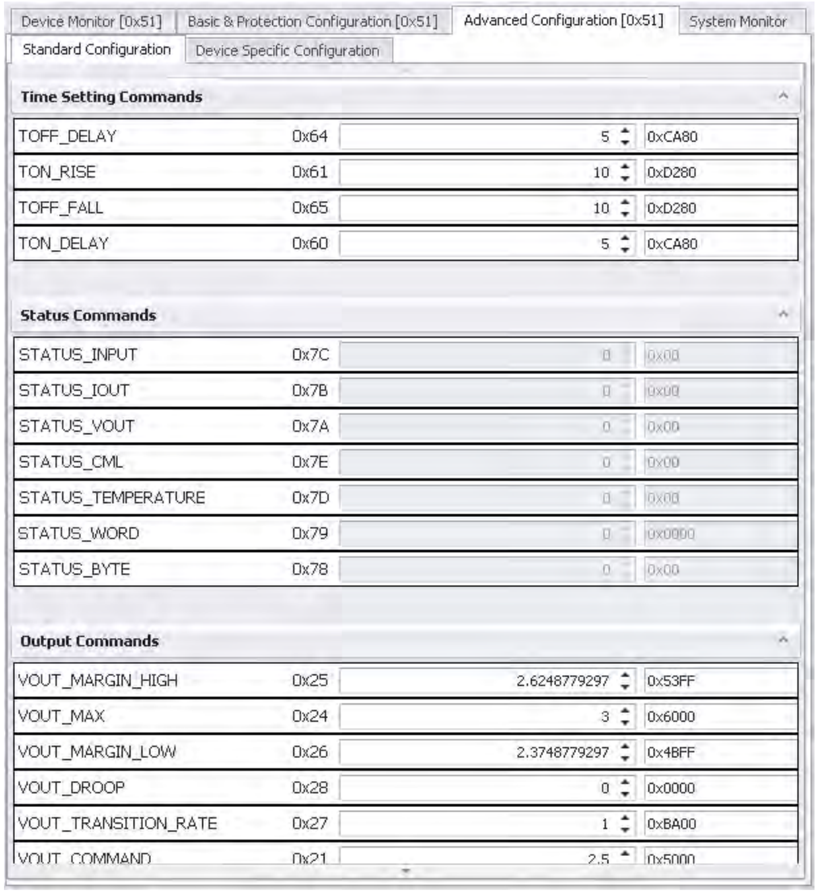


Figure 23. The Advanced Configuration window - Standard Configuration.

As Figure 23 shows, many items within this view - such as the Time Setting Commands – have equivalent graphical panels within the Basic Protection & Configuration window. Yet this detailed view can be more useful to a systems programmer as it displays the PMBus commands in the left-hand column alongside the hexadecimal values that pass across the bus in the right-hand column. Fields that appear in gray are read-only.

Figure 24 shows an example Device Specific Configuration screen. As many of the parameters that this view displays are critical to device operation, it is essential that users properly understand the effects of applying changes. **Ericsson strongly recommends** that you save the default factory settings before making any configuration changes. This step will allow you to return to a known-good condition if problems arise – see Section 5.5.

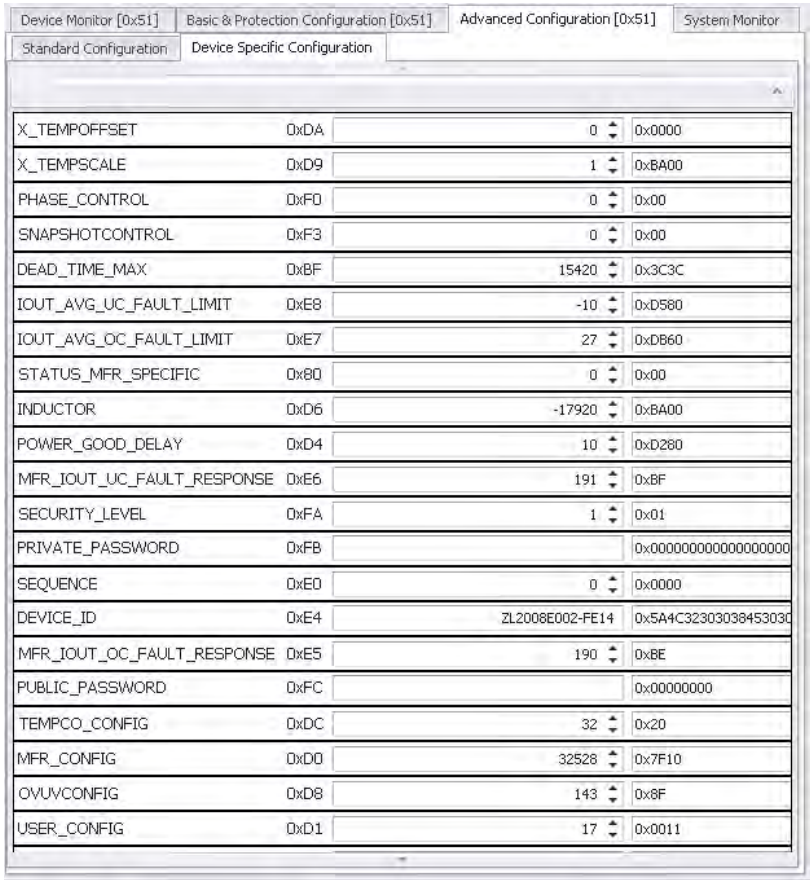


Figure 24. The Advanced Configuration window - Device Specific Configuration – use with care!

The values in the parameter fields are those that 3E GUI Gold Edition reads back from the selected device during a PMBus scan. To adjust or enter a parameter, you can type decimal values into the appropriate field of the center column, or use the spin box increment/decrement arrows. Alternatively, you can enter hexadecimal values into the right-hand column. The software automatically converts between decimal and hexadecimal values and updates the partner field to the one used for parameter entry.

To temporarily apply changes, select Device then Save/Load Memory Operations from the top menu bar and click the Save button, or click Save in the Shortcuts panel. To make changes permanent, select Save then Store –**see Section 5.5 to save the device's factory default configuration**.

5.5 Saving, Storing, and Reloading Configuration data

It is often essential to record a device’s settings for future uses such as programming production devices. For development purposes in particular, **Ericsson strongly recommends** that you save the default factory settings before making any configuration changes. This step will allow you to return to a known-good condition if necessary.

Save config—to save a device’s configuration data to a disk file, select Device and Load/Save Configuration from the top menu bar and then click the Save button, or click Save config in the Shortcuts panel. A Save As dialog box opens, allowing you to specify the file name and its location. The disk format for configuration files is .xml (Extended Mark-up Language), and the default directory is ConfigFiles in the installation path.

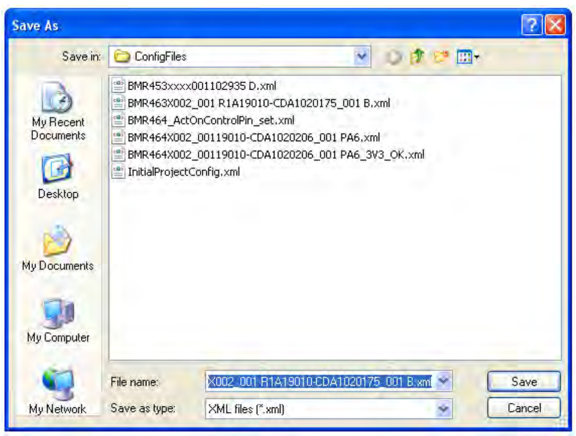


Figure 25. The Save As dialog for saving configuration files to disk.

Load config—to restore a previous configuration from disk, select Device and Load/Save Configuration from the top menu bar and then click the Load button, or click Load config in the Shortcuts panel. This displays an Open file window from which you can select the configuration file of interest.

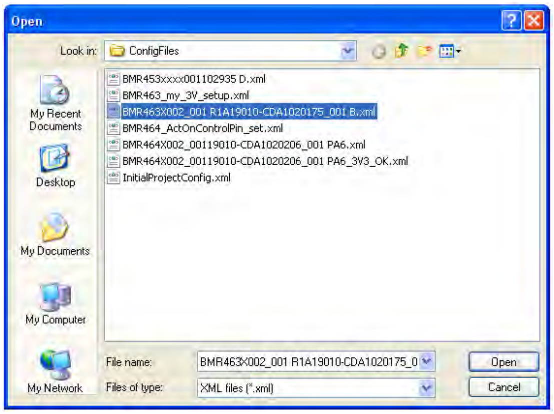


Figure 26. The Open file selection window.

Clicking Open with a configuration file highlighted reads the data into the Basic & Protection Configuration or Advanced Configuration screens. You can then save or store this data in the same way as for the configuration screens:

Save - to apply the configuration until the device next powers on, select Device then Save/Load Memory Operations from the top menu bar and click the Save button, or click Save in the Shortcuts panel. A Save Succeeded message box confirms that the configuration data has been written to the device's RAM, and its state now reflects the latest configuration.

Figure 27. The Save Succeeded message.

Store - to make the configuration permanent or until another Store overwrites it, perform a Save and then select the Store button under Device and Save/Load Memory Operations in the top menu bar. Or, click Save then Store in the Shortcuts panel. A Store Succeeded message confirms that the configuration has been written to Flash.

Figure 28. The Store Succeeded message.

Reload - to manually overwrite the RAM area that determines a device's current operating state with configuration information from its Flash memory that the device automatically loads into RAM at power on, select Reload from Device and Save/Load Memory Operations from the top menu bar, or click Reload in the Shortcuts panel. A Restore Succeeded message confirms the action.

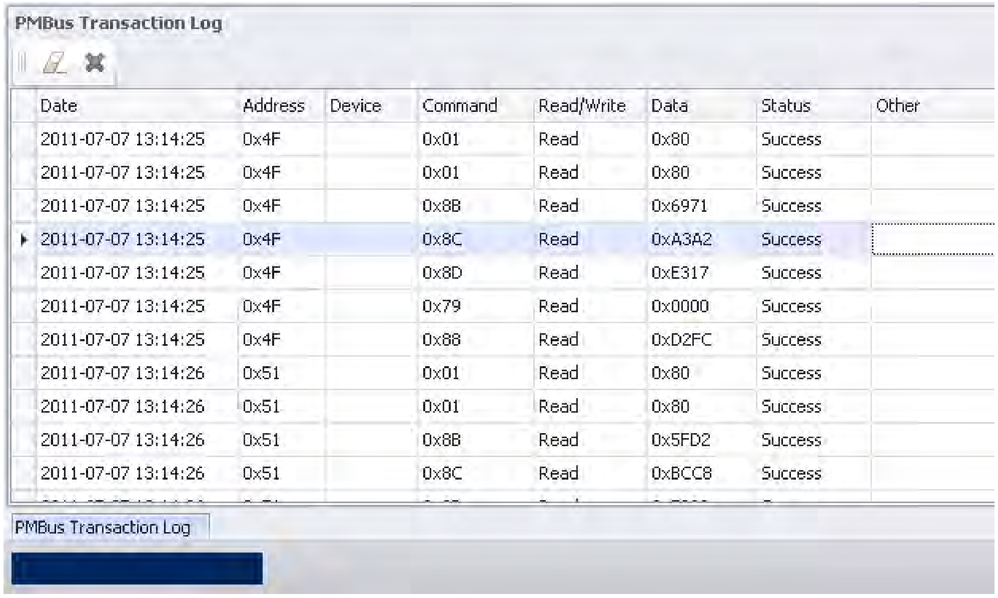
Figure 29. The Restore Succeeded message.

6 PMBus-Specific Facilities

3E GUI Gold Edition includes tools that can help users to develop and debug PMBus systems including those that contain PMBus-compliant devices from manufacturers other than Ericsson.

6.1 PMBus Transaction Log

Accessible from the View drop-down box on the top menu bar, selecting PMBus Transaction Log adds this tab to the bottom left-hand corner of the screen. Holding the mouse cursor over the tab causes the transaction log's window to pop up temporarily, while clicking on the tab opens the window. The pin symbol in the right-hand side of the window's header toggles between keeping the window open and docking it to a tab when the user selects another screen area. The x button closes the display.



Date	Address	Device	Command	Read/Write	Data	Status	Other
2011-07-07 13:14:25	0x4F		0x01	Read	0x80	Success	
2011-07-07 13:14:25	0x4F		0x01	Read	0x80	Success	
2011-07-07 13:14:25	0x4F		0x8B	Read	0x6971	Success	
2011-07-07 13:14:25	0x4F		0x8C	Read	0xA3A2	Success	
2011-07-07 13:14:25	0x4F		0x8D	Read	0xE317	Success	
2011-07-07 13:14:25	0x4F		0x79	Read	0x0000	Success	
2011-07-07 13:14:25	0x4F		0x88	Read	0xD2FC	Success	
2011-07-07 13:14:26	0x51		0x01	Read	0x80	Success	
2011-07-07 13:14:26	0x51		0x01	Read	0x80	Success	
2011-07-07 13:14:26	0x51		0x8B	Read	0x5FD2	Success	
2011-07-07 13:14:26	0x51		0x8C	Read	0xBCC8	Success	

Figure 30. The PMBus Transaction Log.

The transaction log display updates in real time while 3E GUI Gold Edition is running PMBus refresh cycles (you can start and stop refresh cycles using the Refresh Rate control button – see Section 2.5).

For each transaction, columns are available to record a timestamp; the PMBus address that was accessed; the device that was accessed; the PMBus command that was executed; whether the device was read from or written to; the data that was exchanged; and the success or failure of the transaction.

The icon box that appears by default under the window's title includes the center Eraser icon that clears the log's record, and the x icon that deletes a selected row of data. The vertical bar icon allows you to position these controls at a location of your choice within the window's title header area.

6.2 PMBus Command Line Interface

Selecting PMBus Command Line from View in the top menu bar opens Ericsson's PMBusCLI (command line interface). This utility allows you to enter PMBus command text strings and send them to a selected device, or broadcast to the PMBus to – for instance – scan it for connected devices. The utility also checks for responses and displays them within the upper portion of the display area below.

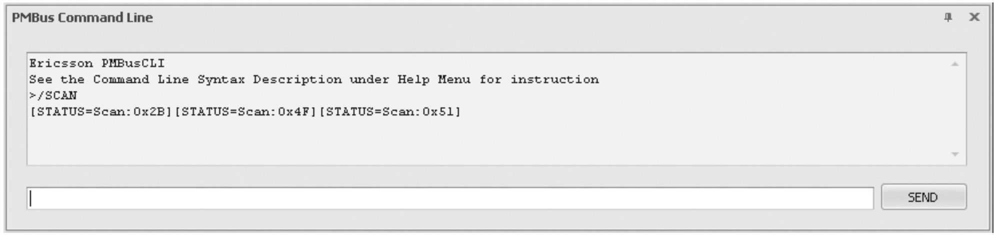


Figure 31. The PMBus Command Line Interface.

Figure 31 shows the result of sending the /SCAN command to interrogate the evaluation board configuration that has been used as an example earlier within this User Guide. As the figure demonstrates, the software discovered devices at addresses 0x2B, 0x4F, and 0x51.

Clicking on Command Line Syntax Description from Help in the top menu bar opens a document that describes the commands that PMBusCLI supports together with examples of their use. Rather than being specific to Ericsson's 3E series devices, the command set that PMBusCLI implements is generic and can be used with many PMBus-compliant devices.

The pin symbol on the right-hand side of the window's header area toggles between keeping the window open and docking it to a tab when the user selects another screen area. The x button closes the display.

6.3 Working with Third-Party PMBus Devices

3E GUI Gold Edition can interface with PMBus-compliant devices that are not members of Ericsson's 3E family. The software will automatically scan a connected device for the same parameters that System Overview reports for 3E series devices, but the PMBus Command Line Interface that Section 6.2 describes is likely to be more useful as it allows you to send PMBus commands that are relevant to the device of interest and read its responses.

To connect a device, 3E GUI Gold Edition needs to create an entry that makes the device accessible to the facilities that the software offers. To discover devices during a PMBus scan, the software interrogates each device using standard PMBus identification commands, such as MFR_MODEL that appears under the Standard Configuration screen within the Advanced Configuration facilities.

Figure 32 shows the Identification Commands fields in the left-hand column together with the responses that the software reads from an example BMR463 in the gray read-only fields in the remainder of the display.

Identification Commands			
MFR_MODEL	0x9A	BMR463X002/001 R1A	0x424D523436335830303...
MFR_ID	0x99	Ericsson Power Modules	0x4572696373736F6E205...
MFR_DATE	0x9D	2011-02-23	0x323031312D30322D3233
MFR_LOCATION	0x9C	EAB/SEC	0x4541422F534543
MFR_REVISION	0x9B	19010-CDA1020175/001 B	0x31393031302D434413...
MFR_SERIAL	0x9E	7038884829423	0x37303338383834383323...

Figure 32. PMBus Identification commands in the Standard Configuration screen.

When 3E GUI Gold Edition does not recognize a device, it displays an Unknown device box that reports the PMBus address to resolve, and asks you to select the type of device from a list.

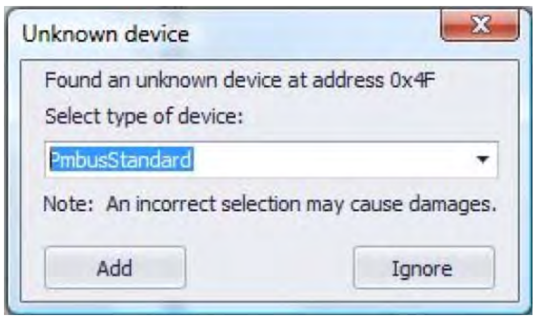


Figure 33. Unknown device dialog box.

Selecting PmbusStandard and clicking Add then OK generates an entry for the part within 3E GUI Gold Edition. The lower graphic in Figure 34 shows how this entry might look from the Picture View within System Overview:

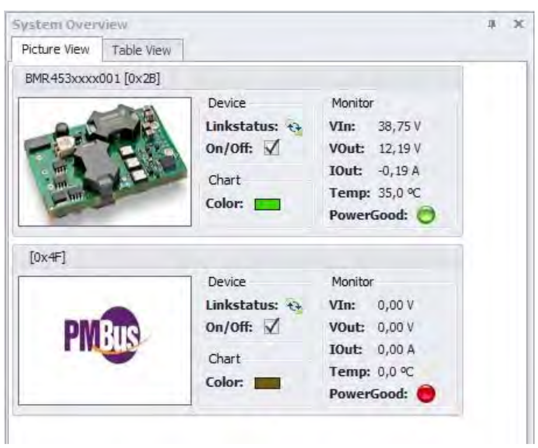


Figure 34. Unknown PMBus device added to 3E GUI Gold Edition.

7 References

[1] Installation Instructions – 3E GUI Gold Edition.

[2] www.PMBus.org – PMBus protocols and commands.

[3] www.smbus.org – hardware implementation of PMBus.

[4] 3E Design Kit.

8 Glossary

3E	Energy management, Enhanced performance, End-user value
GUI	Graphical User Interface
ID	Identification (PMBus address)
Iout	Output current
ms	millisecond
mV	milliVolt
PMBus™	Power Management Bus (see reference 2)
RAM	Random Access Memory
Temp	Temperature (in °Celsius)
VDD	Power Supply Voltage
Vin	Input Voltage
Vout	Output Voltage

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