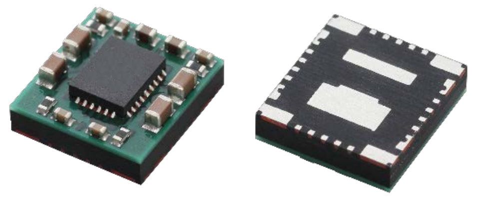


Typical unit

PRODUCT OVERVIEW

The MYWGC3R53FFW92RAE is Multi output DC-DC power converters for embedded applications. The small form factor measures only 9.0 x 8.3 x 2.9 mm. Applications include powering FPGA/CPU's, datacom/telecom systems, Distributed Bus Architectures (DBA), programmable logic and mixed voltage systems.

The converter has input voltage ranges of 4.3 to 5.5V and a multiple output voltage. Based on a fixed frequency synchronous buck converter switching topology, this high power conversion efficient PoL module features On/Off control and Power Good signal output.

This product also includes under voltage lock out (UVLO), output short circuit protection, over-current protection (OCP), over-voltage protection (OVP) and over-temperature protection (OTP).

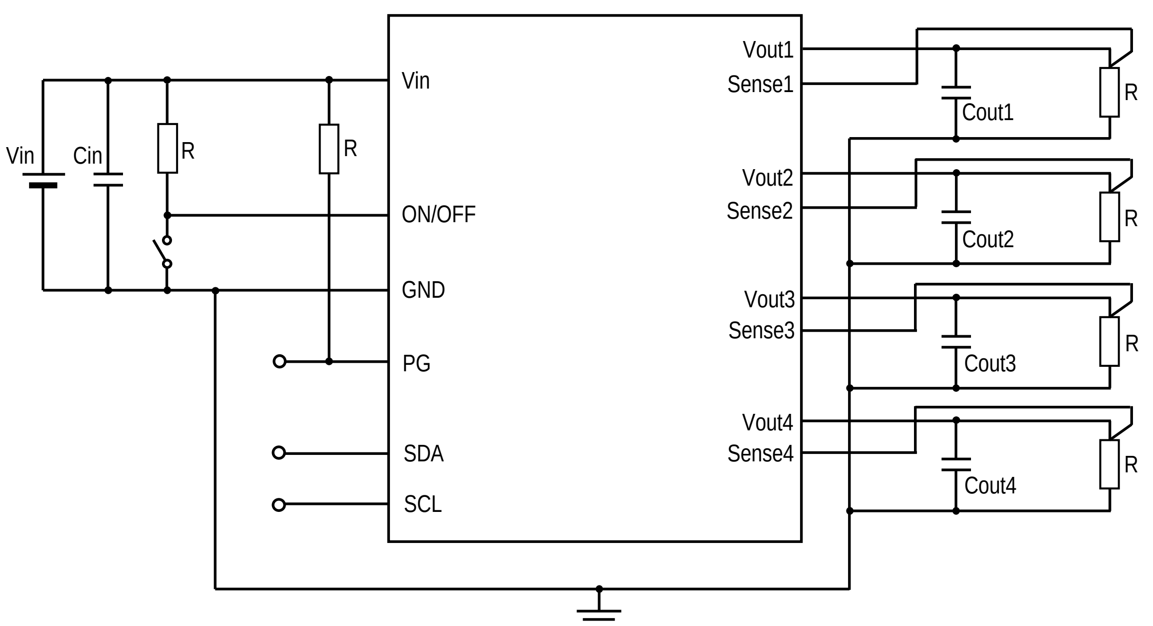
FEATURES

- Quick response to load change
- Ultra small surface mount package 9.0 x 8.3 x 2.9 mm
- Peak efficiency of 91.0% (max.)
- Outstanding thermal derating performance
- Over Current (OCP) /Voltage (OVP) ,Under Voltage (UVP) protection and Over Temperature protection (OTP).
- On/Off control (Positive logic)
- Auto-PFM/PWM Control
- I2C communication function
- Power Good (PG) signal

TYPICAL APPLICATIONS

- PCIe / server applications
- FPGA and DSP
- Datacom / telecom systems
- Distributed bus architectures (DBA)
- Programmable logic and mixed voltage systems

SIMPLIFIED APPLICATION



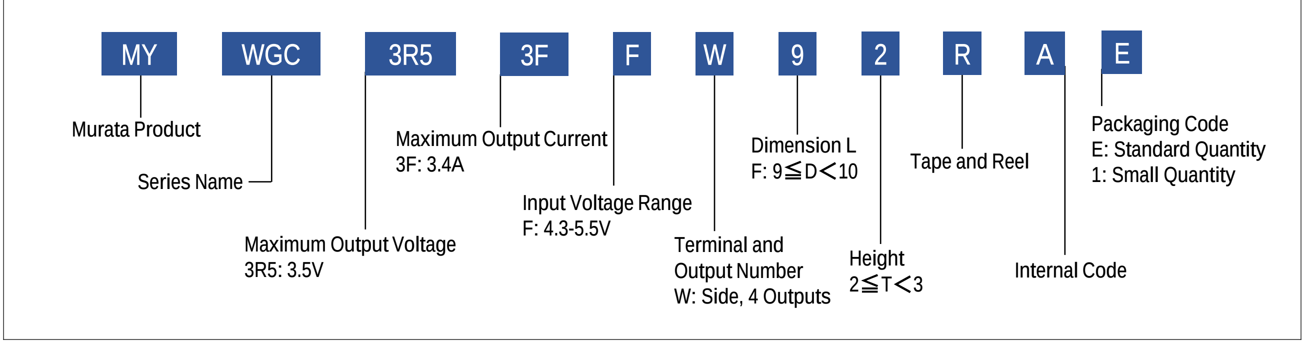
(Typical topology is shown. Murata recommends an external input fuse.)

PERFORMANCE SPECIFICATIONS SUMMARY AND ORDERING GUIDE

PART NUMBER	OUTPUT							INPUT				Efficiency [%]	ON/OFF	Package [mm]
		Vout [V]	Iout (max.) [A]	Power [W]	R/N (typ.) [% of Vout]	Regulation (typ.) Line [%]	Regulation (typ.) Load [%]	Vin (typ.) [V]	Range [V]	Iin no load [mA]	Iin full load [A]			
MYWGC3R53FFW92RAE	Vout1	1.2	2.5	3.0	1	±0.5	±0.5	5	4.3 - 5.5	60	3.45	88.2	Yes (Positive)	9.0 x 8.3 x 2.9
	Vout2	1.8	1.0	1.8	1	±0.5	±0.5							
	Vout3	3.3	2.0	6.6	1	±0.5	±0.5							
	Vout4	2.5	1.5	3.75	1	±0.5	±0.5							
MYWGC3R53FFW92RA1	Vout1	1.2	2.5	3.0	1	±0.5	±0.5	5	4.3 - 5.5	60	3.45	88.2	Yes (Positive)	9.0 x 8.3 x 2.9
	Vout2	1.8	1.0	1.8	1	±0.5	±0.5							
	Vout3	3.3	2.0	6.6	1	±0.5	±0.5							
	Vout4	2.5	1.5	3.75	1	±0.5	±0.5							

1. Please refer to the Part Number Structure for additional ordering information and options.
2. All specifications are at nominal line voltage, each Vout=typical and full load, +25degC unless otherwise noted. Output capacitor conditions are mentioned in the test circuit. Input capacitors are 22 uF*2 ceramic and plenty electrolytic capacitors. See detailed specifications. Input and output capacitors are necessary for our test equipment.
3. Use adequate ground plane and copper thickness adjacent to the converter.

PART NUMBER STRUCTURE

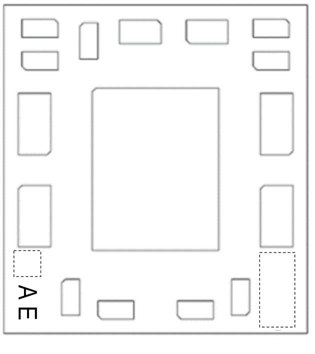


Product Marking

Because of the small size of the product, the product marking contains a character-reduced code to indicate the model number and manufacturing date code. Not all items on the marking are always used. Please note that the marking differs from the product photograph. Here is the layout of the marking.

Part Number	Product Code
MYWGC3R53FFW92RAE	AE
MYWGC3R53FFW92RA1	AE

Layout



Codes (reference)

[dotted box] Internal Manufacturing code
AE Product code
(Please see product code table beside.)

FUNCTIONAL SPECIFICATIONS OF MYWGC3R53FFW92RAE (Note 1)

ABSOLUTE MAXIMUM RATINGS	Conditions	Minimum	Typical	Maximum	Units
Vin, SCL, SDA		-0.3	-	6.0	V
ON/OFF, PG		-0.3	-	Vin	V
Vout1 to 4, Sense1 to 4		-0.3	-	3.55	V
Iout1	(Note 2)	-	-	2.5	A
Iout2	(Note 2)	-	-	1.0	A
Iout3	(Note 2)	-	-	2.0	A
Iout4	(Note 2)	-	-	1.5	A
Storage Temperature Range	Vin = Zero (no power)	-40	-	125	degC
Soldering / Reflow Peak Temperature	(Note 22)	-	-	260	degC
Maximum Number of Reflows Allowed	(Note 22)			2	
Absolute maximums are stress ratings. Exposure of devices to greater than any of these conditions may adversely affect long-term reliability. Proper operation under conditions other than those listed in the Performance/Functional Specifications Table is not implied or recommended.					
INPUT	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Units**
Operating Voltage Range		4.3	5	5.5	V
Start-up Threshold	Rising input voltage	-	2.5	-	V
Under Voltage Shutdown	(Note 12)	-	2.2	-	V
Internal Filter Type			Capacitive		
Input Current					
Full Load Condition	Vin=typ.	-	3.45	-	A
Low Line Condition	Vin=min.	-	3.98	-	A
No Load Current Condition	Iout1 to 4=0A, unit=ON	-	0.7	-	mA
GENERAL and SAFETY	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Units**
Efficiency	Vin=5.0V, Iout1 to 4=max.	-	88.2	-	%
Control Mode		Auto-PFM/PWM			
Calculated MTBF (Note 3)	Ta=40degC, Vin=typ., Vout1 to 4=typ., Iout1 to 4=50%	-	5.5×10^6	-	hours
DYNAMIC CHARACTERISTICS	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Units**
Fixed Switching Frequency	Under PWM control	-	1650	-	kHz
Startup Time (Vin ON)	Vout1 to 4=typ. (Vin=ON to 90% of Vout), (Note 21)	Same as Remote ON for reference			ms
Startup Time (Enable ON)	Vout1 to 4=typ. (Remote=ON to 90% of Vout)	See the waveform for reference			ms
Dynamic Load Peak Deviation	Same as above (Note 15), Slew Rate=1.0A/us	-	±3	-	% of Vout
FUNCTIONS	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Units**
Remote On/Off Control (Note 4)					
Logic					
ON State Range		1.2	-	Vin	V
OFF Stage Range		-0.3	-	0.6	V
Power-Good Output					
Power-Good Rising Threshold	No protect	-	90	-	% of Vout
Power-Good Falling Threshold	No protect	-	80	-	% of Vout
MECHANICAL(Common)	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Units**
Mechanical Dimension	L x W x H (Note 19)	9.0(typ.) x 8.3(typ.) x 3.0(max.)			mm
Weight		-	0.65	-	grams
ENVIRONMENTAL(Common)	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Units**
Operating Ambient Temperature Range	With Derating (Notes 2,7)	-40	-	105	degC
Operating Case Temperature Range of Top Mounted IC	Primary condition, With Derating (Note 2)	-	-	110	degC
Operating Junction Temperature Range of Top Mounted IC	With Derating (Note 2)	-40	-	120	degC
Thermal Characterization Parameter of Top Mounted IC	Case to junction of mounted IC on surface (Note 16)	-	5	-	degC/W
Storage Temperature Range	Vin=Zero (no power)	-40	-	125	degC
Thermal Protection/Shutdown	Measured in module (Note 9)	-	150	-	degC
Thermal Protection/Shutdown (Recovery)	Measured in module (Notes 9,14)	-	130	-	degC
Moisture Sensitivity Level		3			

ENVIRONMENTAL VALIDATION TESTING (For Reference)	
Test	**Conditions**
Temperature Cycling	Ta=-40degC/30min <=> +125degC/30min, 300cycles

FUNCTIONAL SPECIFICATIONS OF MYWGC3R53FFW92RAE (Note 1)

OUTPUT	Conditions	Minimum	Typical	Maximum	Units
Total Output Power	See Derating	0	-	15.2	W
Voltage					
Output Voltage Vout1	(Note 10)	-	1.2	-	V
Output Voltage Vout2	(Note 10)	-	1.8	-	V
Output Voltage Vout3	(Note 10)	-	3.3	-	V
Output Voltage Vout4	(Note 10)	-	2.5	-	V
Over Voltage Protection Threshold	(Note 13)	-	120	-	% of Vout
Over Voltage Protection Recovery Threshold		-	110	-	% of Vout
Current					
Output Current Range at Vout1	(Note 2)	0	-	2.5	A
Current Limit Inception at Vout1	After warm-up	-	5.5	-	A
Output Current Range at Vout2	(Note 2)	0	-	1.0	A
Current Limit Inception at Vout2	After warm-up	-	3.0	-	A
Output Current Range at Vout3	(Note 2)	0	-	2.0	A
Current Limit Inception at Vout3	After warm-up	-	5.5	-	A
Output Current Range at Vout4	(Note 2)	0		1.5	A
Current Limit Inception at Vout4	After warm-up	-	3.0	-	A
Short Circuit					
Short Circuit Duration (remove short for recovery)	Output shorted to ground, no damage		Continuous		
Short Circuit Protection Method	(Note 5)		Hiccup		
Pre-bias Start-up		The converter will start up if the external output voltage is less than set Vout.			
Regulation (Notes 8,18)					
Line Regulation	Vin=min. to max., Iout1 to 4=20% load current to max.	-	±0.5	-	% of Vout
Load Regulation	Iout1 to 4=20% load current to max.	-	±0.5	-	% of Vout
Total Output Voltage Variation	Fixed Vin, Iout1 to 4=20% load current to max. Tj of top IC=-40 to 120degC (Note 17)	-	-	±3	% of Vout
Ripple and Noise (20MHz bandwidth)	Iout1 to 4=20% load current to max. (Note 6)	-	1	-	% of Vout
External Output Capacitance Range Vout1	(Note 11)	44	-	400	uF
External Output Capacitance Range Vout2	(Note 11)	22	-	400	uF
External Output Capacitance Range Vout3	(Note 11) with a polymer aluminum electrolytic capacitor 47uF	69	-	400	uF
External Output Capacitance Range Vout4	(Note 11)	22	-	400	uF
I2C INTERFACE SPECIFICATIONS (Note 20)	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Units**
Input Logic High		1.4	-	-	V
Input Logic Low		-	-	0.4	V
Output Voltage Logic Low		-	-	0.4	V
SCL Clock Frequency		-	-	3.4	MHz
SCL High Time		60	-	-	ns
SCL Low Time		160	-	-	ns
Data Set-up Time		10	-	-	ns
Data Hold Time		-	70	-	ns
Set-up Time for Repeated Start		160	-	-	ns
Hold Time for Repeated Start		160	-	-	ns
Bus Free Time between Start and Stop Condition		160	-	-	ns
Set-up Time for Stop Condition		160	-	-	ns
SCL and SDA Rise Time		10	-	300	ns
SCL and SDA Fall Time		10	-	300	ns
Pulse Width of Suppressed Spike		0	-	50	ns
Capacitance Bus for Each Bus Line		-	-	400	pF

Specification Notes

(1)Specifications are typical at Ta=+25degC, Vin=typical (+5.0V), Vout1 to 4=typical (+1.2V, +1.8V,+3.3V,+2.5V), full load, external capacitors and natural convection unless otherwise indicated. Extended tests at full power must supply substantial natural airflow. This model is tested and specified with external capacitors shown in the test circuit below. Most capacitors are low ESR types. These capacitors are necessary to accommodate our test equipment and may not be required to achieve specified performance in your applications. However, Murata recommends installation of these capacitors.
(2)Note that Maximum Power Derating curves indicates an average current at typical input voltage. At higher temperatures and/or lower airflow, the DC/DC converter will tolerate brief full current outputs if the total RMS current over time does not exceed the Derating curve.
(3)Mean Time Between Failure is calculated by using the Telecordia SR-332 method, Ta=40degC, half output load, natural air convection.
(4)The On/Off Control Input should use either a switch or an open collector/open drain transistor to connect to GND. A logic gate may also be used by applying appropriate external voltages which do not exceed +Vin
(5)"Hiccup" overcurrent operation repeatedly attempts to restart the converter with a brief, full-current output. If the overcurrent condition still exists, the restart current will be removed and then tried again. This short current pulse prevents the converter from overheating and damaging the converter. Once the fault is removed, the converter immediately recovers normal operation.
(6)Output noise may be further reduced by adding an external filter. At zero output current or light load, the output may contain low frequency components which exceed the ripple specification. The output may be operated indefinitely with no load or light load.
(7)This model is able to start at Ta=-40degC.
(8)Regulation specifications describe the deviation as the line input voltage or output load current is varied from a nominal midpoint value to either extreme without no load and light load.
(9)Thermal Protection/Shutdown temperature is measured with the sensor in the converter.
(10)Murata can review output specifications and output sequence under customer's request. Please contact to Murata for details.
(11)The maximum output capacitive loads depend on the Equivalent Series Resistance (ESR) of the external output capacitors and, to a lesser extent, the distance and series impedance to the load in addition to ambient temperature. Larger capacitance will reduce output noise but may change the transient response. Newer ceramic capacitors with very low ESR may require lower capacitor values to avoid instability. Thoroughly test your capacitors in your applications. For reference, please refer to the "Output Capacitor Design Application Notes".
(12)Do not allow the input voltage to degrade lower than the input under voltage shutdown voltage at all times. Otherwise, you risk having the converter turn off. The under-voltage shutdown is not latching and will attempt to recover when the input is brought back into normal operating range.
(13)The outputs are not intended to sink appreciable reverse current.
(14)When the temperature decreases below the recovery threshold, the converter will automatically restart.
(15)About di/dt condition, please refer to the table described later.
(16)The thermal resistance is reference data, and they are measured with our evaluation board as below.
50.0mm x 101.6mm x 1.6mm (4 Layers, 1oz copper each) FR-4
(17)Ensured by design. Not production tested.
(18)This product may not meet the specifications due to Auto PFM/PWM control at light output load.
(19)Some of product terminal shapes are different from the dimensional drawing because our dicing process might make the product terminal deformed. The deformation length is up to 150um.
(20)It is recommended to start to operate the I2C functions after the power-on sequence is complete.
(21)When Vin is ramped up slowly, the sequence may lag 3ms (max.) behind the setting.
(22)Recommended reflow profile is described in "Soldering Guidelines".

Internal Circuit Diagrams

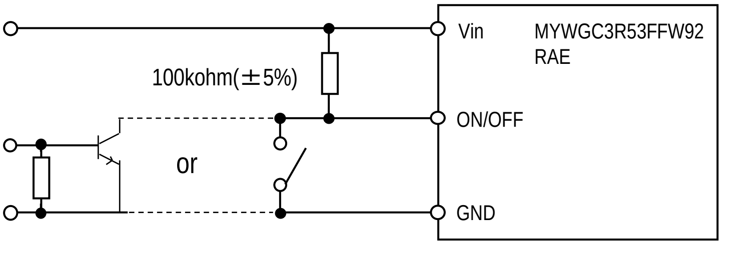
ON/OFF Using Guide

By using ON/OFF function, the operation of this product can be disabled with supplying input voltage.
Power-saving control with the sequence can be easy by using this function.

ON/OFF control logic

- ON/OFF pin(1pin) is pull-up : Output Voltage = ON
- ON/OFF pin(1pin) is connected to GND : Output Voltage = OFF

Example Circuit



It is strongly recommended that the ON/OFF terminal should be used when turning on/off this product.
The characteristics of the ON/OFF function may be affected by turning on/off input voltage.
Please check product operation on your application with turning on/off input voltage.

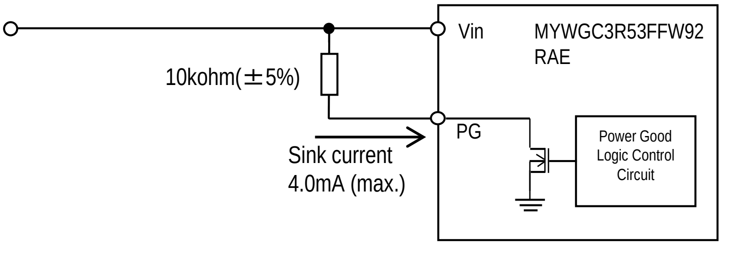
Power Good Signal Using Guide

The power good signal terminal should be pulled up to Vin.
The resistance value for pulling up is recommended at 10kohm in case that the PG terminal is pulled up to Vin.
This product has an open-drain circuit internally.

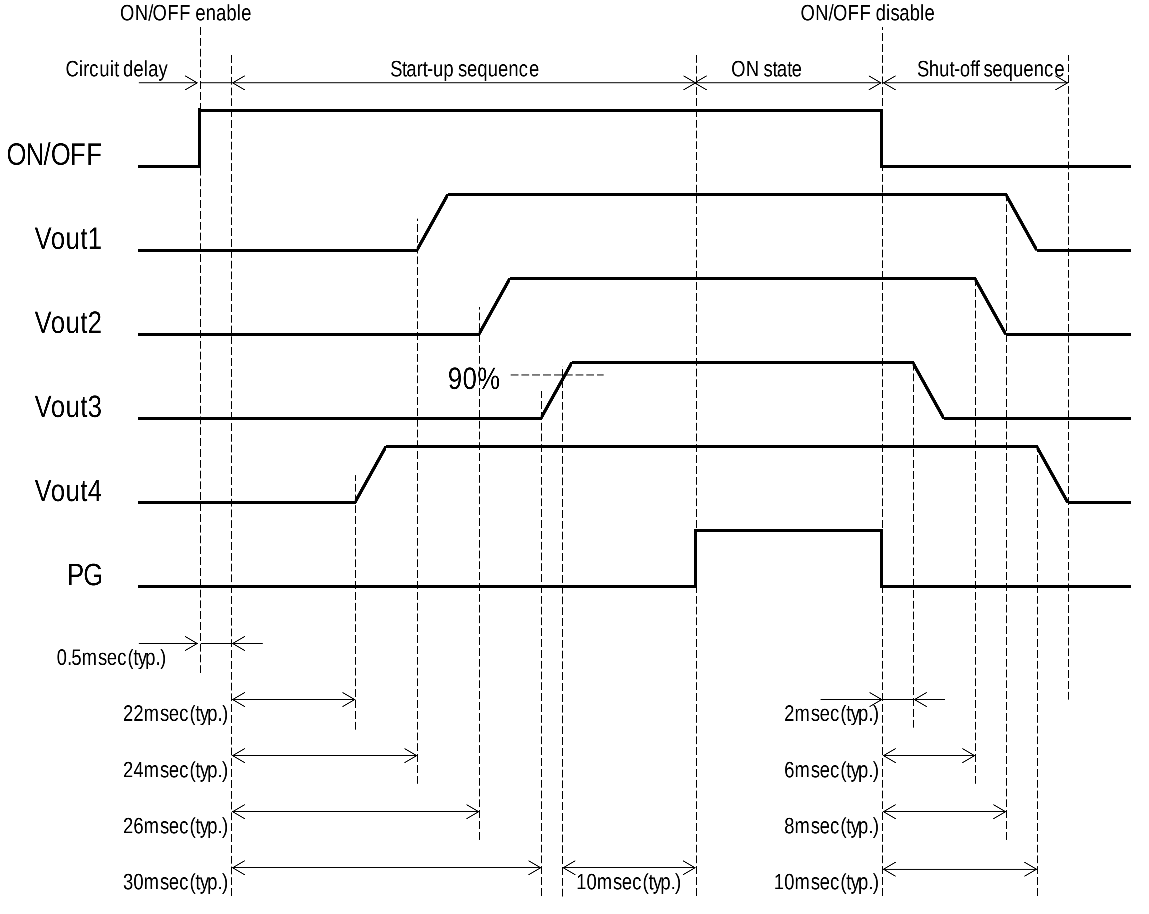
■PG = High situations
・Input voltage is 4.3 to 5.5V and ON/OFF terminal is high.
・Each output voltage is within its voltage detection threshold (over 90% (typ.)) etc…

■PG=Low situations
・ON/OFF pin is low and either output voltage is out of its voltage detection threshold(lower than 80% (typ.)).
・During the PG rising delay time after all output are risen.
・UVLO is activated.
・Over current protection is activated.
・Over temperature protection is activated. etc…

Example Circuit

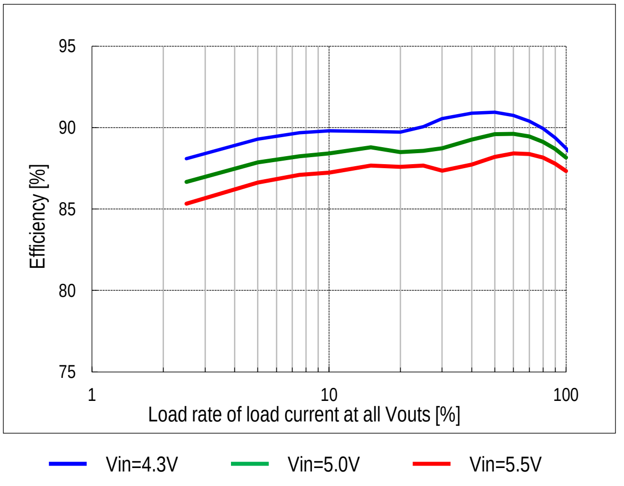


ON/OFF Sequence



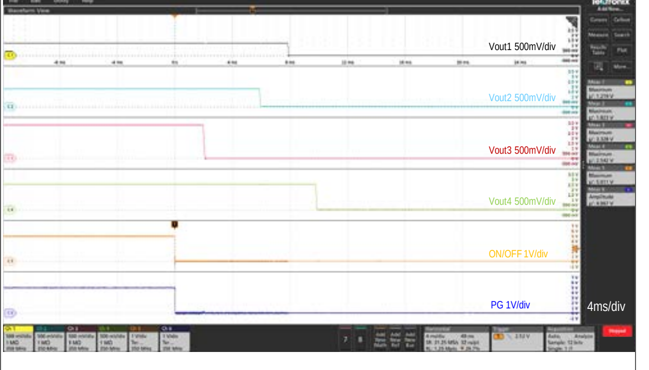
PERFORMANCE DATA AND OSCILLOGRAMS OF MYWGC3R53FFW92RAE

Efficiency vs. Line Voltage and Load Current at Ta=25degC.

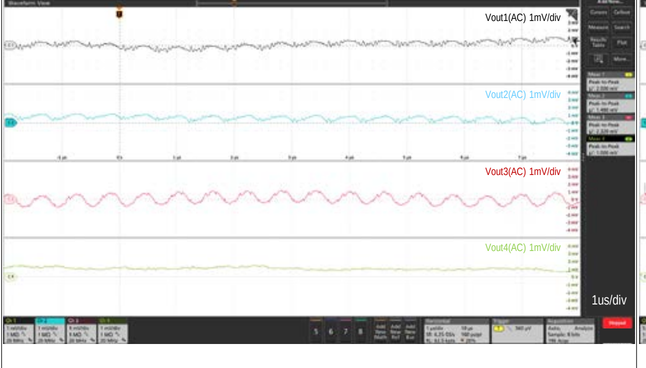


ON/OFF Enable Delay (Vin=5.0V, All Iout=max.)
Trace1=Vout1 500mV/div, Trace2=Vout2 500mV/div, Trace3=Vout3 500mV/div
Trace4=Vout4 500mV/div, Trace5=ON/OFF 1V/div, Trace6=PG 1V/div, 10ms/div

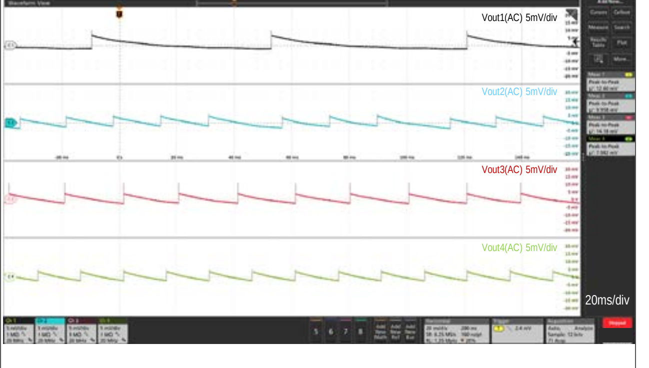
ON/OFF Enable Delay (Vin=5.0V, All Iout=max.)
Trace1=Vout1 500mV/div, Trace2=Vout2 500mV/div, Trace3=Vout3 500mV/div
Trace4=Vout4 500mV/div, Trace5=ON/OFF 1V/div, Trace6=PG 1V/div, 4ms/div



Output Ripple and Noise (Vin=5.0V, All Iout=max.)
Trace1=Vout1(AC) 1mV/div, Trace2=Vout2(AC) 1mV/div, Trace3=Vout3(AC) 1mV/div,
Trace4=Vout4(AC) 1mV/div, 1us/div

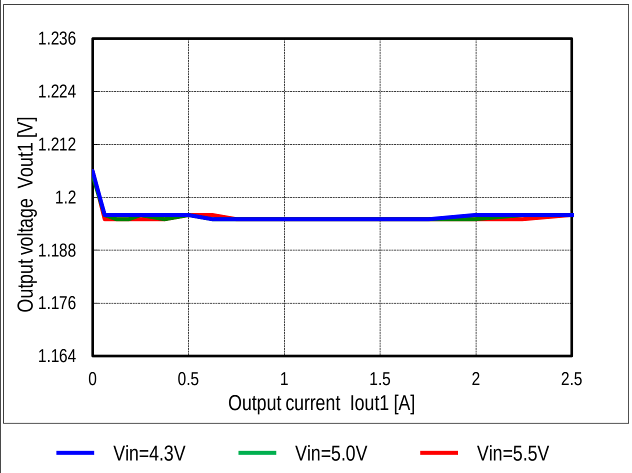


Output Ripple and Noise (Vin=5.0V, All Iout=no load)
Trace1=Vout1(AC) 5mV/div, Trace2=Vout2(AC) 5mV/div, Trace3=Vout3(AC) 5mV/div,
Trace4=Vout4(AC) 5mV/div, 20ms/div

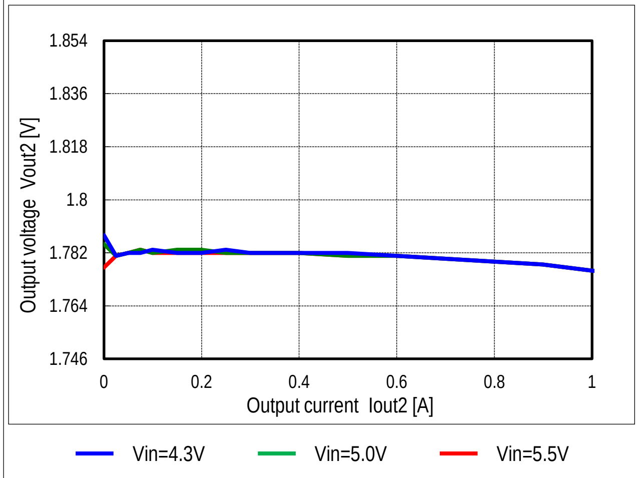


PERFORMANCE DATA AND OSCILLOGRAMS OF MYWGC3R53FFW92RAE

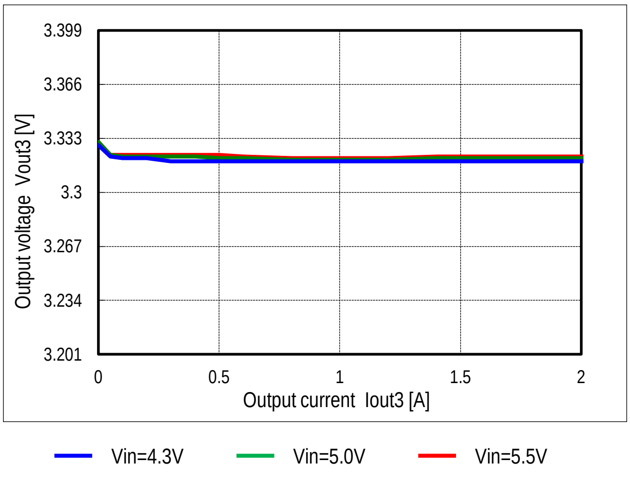
Vout1 vs. Line Voltage and Load Current at Ta=25degC.



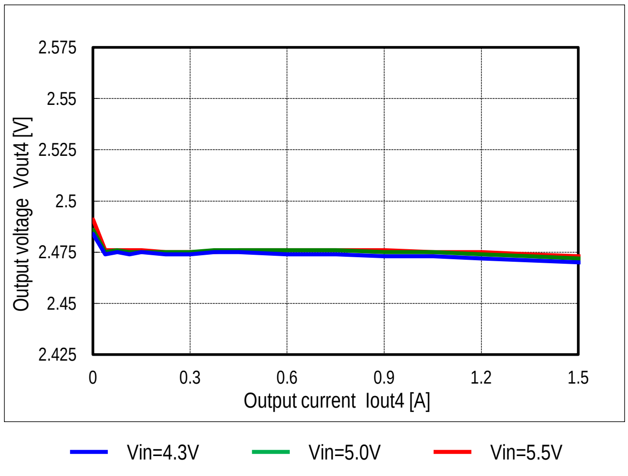
Vout2 vs. Line Voltage and Load Current at Ta=25degC.



Vout3 vs. Line Voltage and Load Current at Ta=25degC.



Vout4 vs. Line Voltage and Load Current at Ta=25degC.

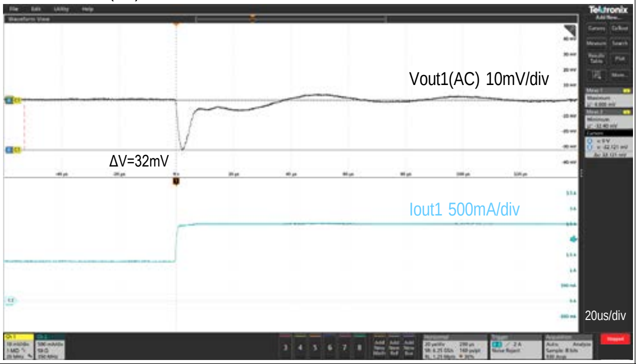


Note

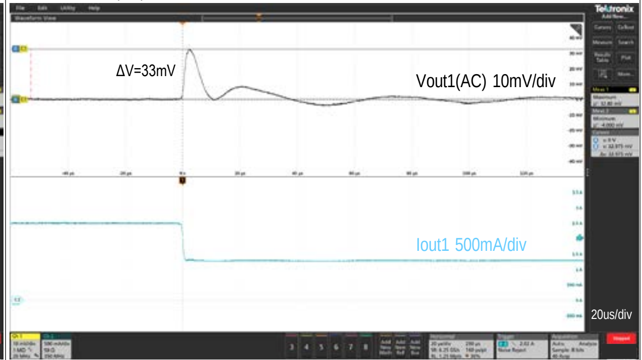
(1)The load regulation data above is measured under conditions of varying output currents at other Vouts at same load rate.

PERFORMANCE DATA AND OSCILLOGRAMS OF MYWGC3R53FFW92RAE

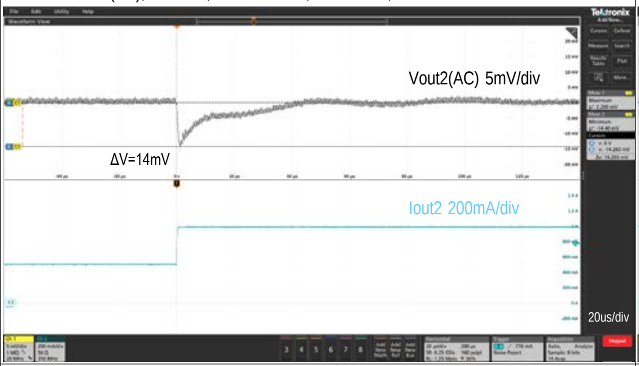
Step Load Transient Response (Vin=5.0V, Vout1=1.2V, Iout1=1.25 to 2.5A)
Trace1=Vout1(AC) 10mV/div, Trace2=Iout1, 500mA/div, 20us/div



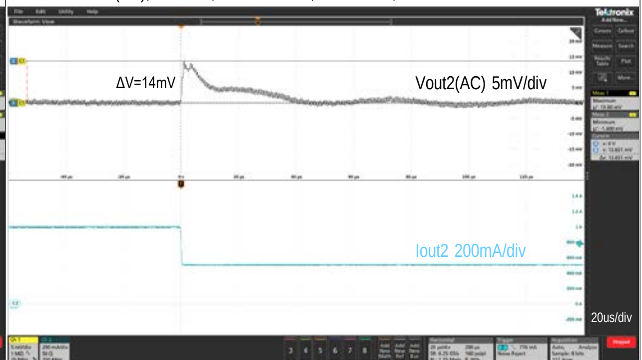
Step Load Transient Response (Vin=5.0V, Vout1=1.2V, Iout1=2.5 to 1.25A)
Trace1=Vout1(AC), 10mV/div, Trace2=Iout1, 500mA/div, 20us/div



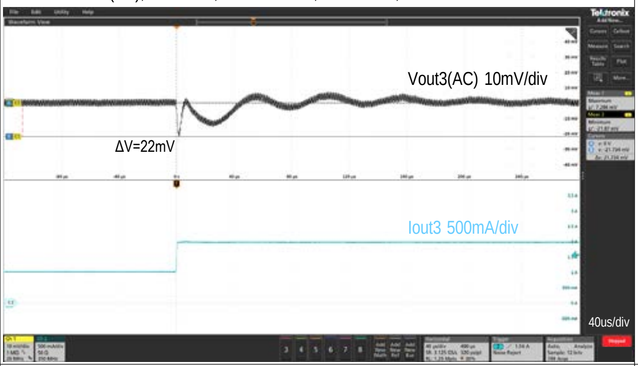
Step Load Transient Response (Vin=5.0V, Vout2=1.8V, Iout2=0.5 to 1.0A)
Trace1=Vout2(AC), 5mV/div, Trace2=Iout2, 200mA/div, 20us/div



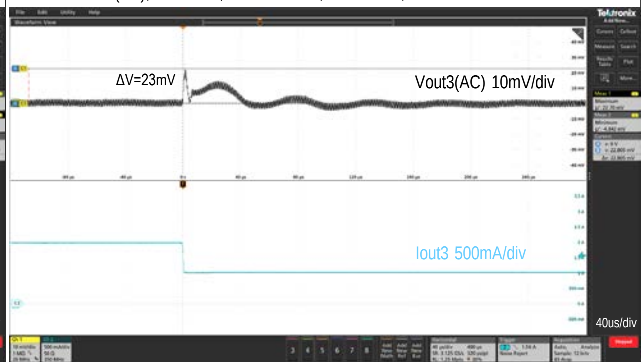
Step Load Transient Response (Vin=5.0V, Vout2=1.8V, Iout2=1.0 to 0.5A)
Trace1=Vout2(AC), 5mV/div, Trace2=Iout2, 200mA/div, 20us/div



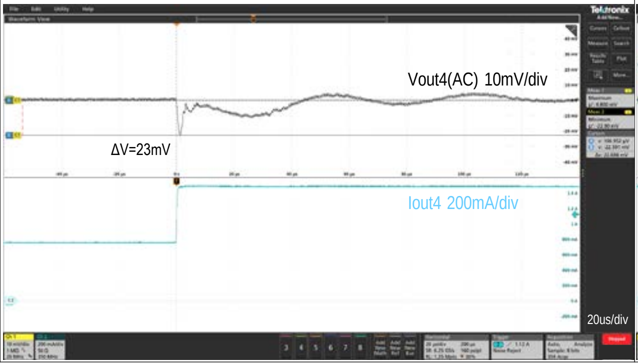
Step Load Transient Response (Vin=5.0V, Vout3=3.3V, Iout3=1.0 to 2.0A)
Trace1=Vout3(AC), 10mV/div, Trace2=Iout3, 500mA/div, 40us/div



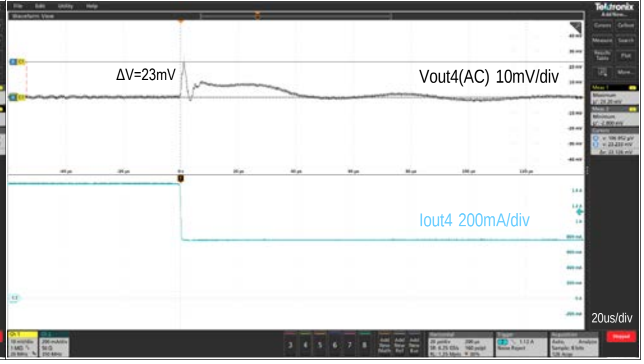
Step Load Transient Response (Vin=5.0V, Vout3=3.3V, Iout3=2.0 to 1.0A)
Trace1=Vout3(AC), 10mV/div, Trace2=Iout3, 500mA/div, 40us/div



Step Load Transient Response (Vin=5.0V, Vout4=2.5V, Iout4=0.75 to 1.5A)
Trace1=Vout4(AC), 10mV/div, Trace2=Iout4, 200mA/div, 20us/div

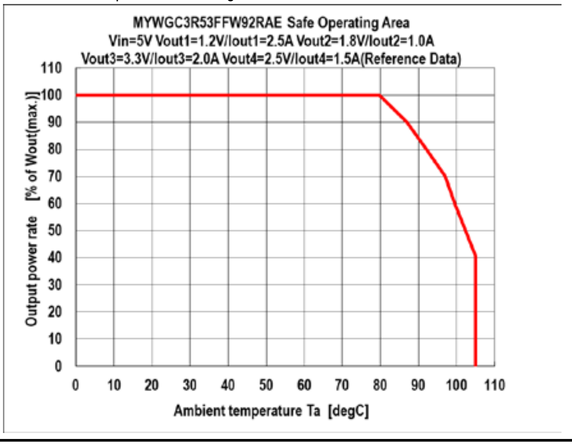


Step Load Transient Response (Vin=5.0V, Vout4=2.5V, Iout4=1.5 to 0.75A)
Trace1=Vout4(AC), 10mV/div, Trace2=Iout4, 200mA/div, 20us/div

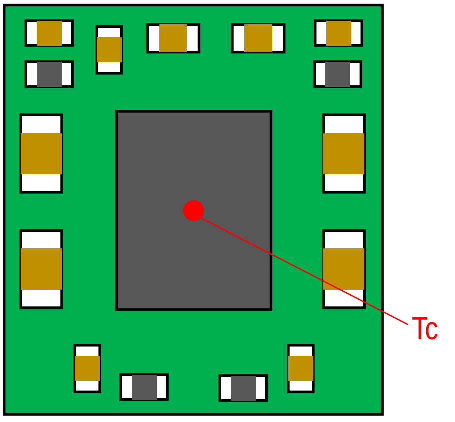


THERMAL DERATINGS OF MYWGC3R53FFW92RAE

Maximum Current Temperature Derating at Sea Level



Position of the IC top temperature



Thermal deratings are evaluated in following conditions.

- The product is mounted on 114.5 x 101.5 x 1.6mm (Layer1, 4: 2oz copper / Layer2, 3: 1oz copper) FR-4 board.
- No forced air flow.

Top temperature of the IC mounted on the product Tc : 110degC (max.)

TRANSIENT RESPONSE DATAS OF MYWGC3R53FFW92RAE

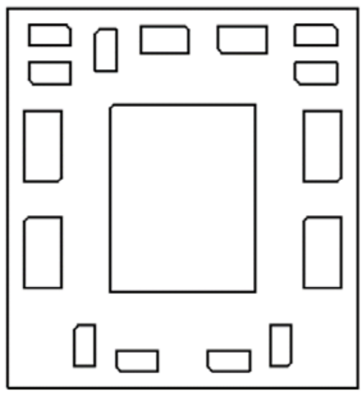
Transient response data at various conditions are showed in following table.
Test circuit condition can serve less than 3% of Vout deviation for 50% to 100% load change(1.0A/us) at room temperature.

	Vin [V]	Cout [uF]	Voltage Deviation [mV]
			50-100% Load Step (1.0A/us)
Vout1=1.2V	4.3	22 x 2	32
	5.5		33
Vout2=1.8V	4.3	22 x 1	15
	5.5		14
Vout3=3.3V	4.3	22 + 47	23
	5.5		23
Vout4=2.5V	4.3	22 x 1	24
	5.5		23

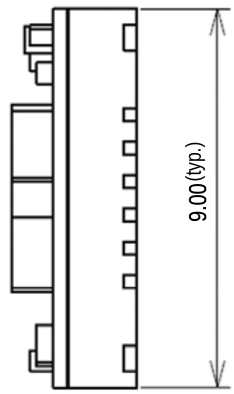
MECHANICAL SPECIFICATIONS

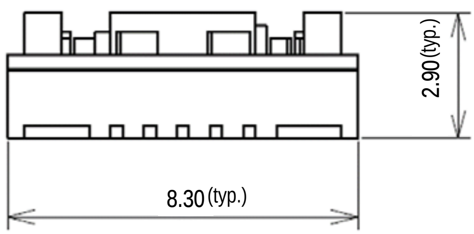
Dimension and Pin Assignment

<Top View>



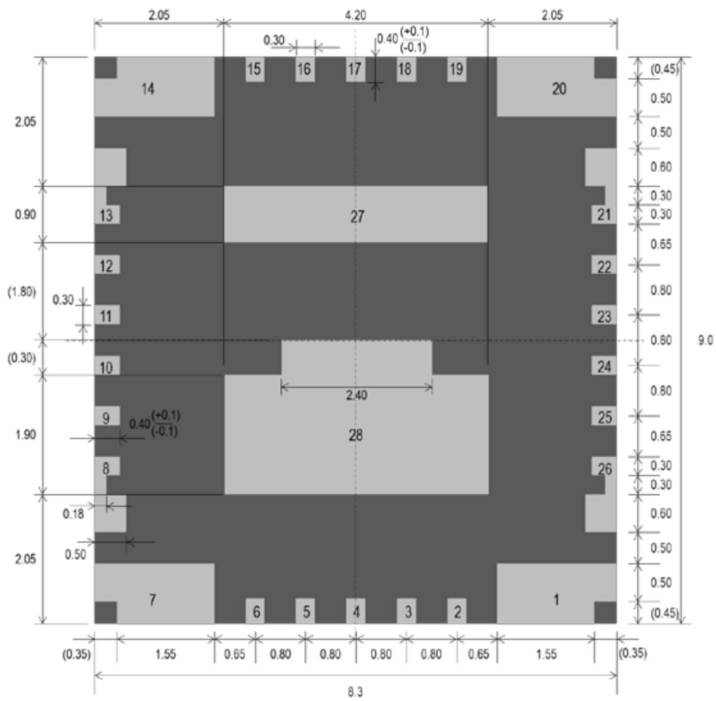
<Side View>





<Side View>

<Bottom View>

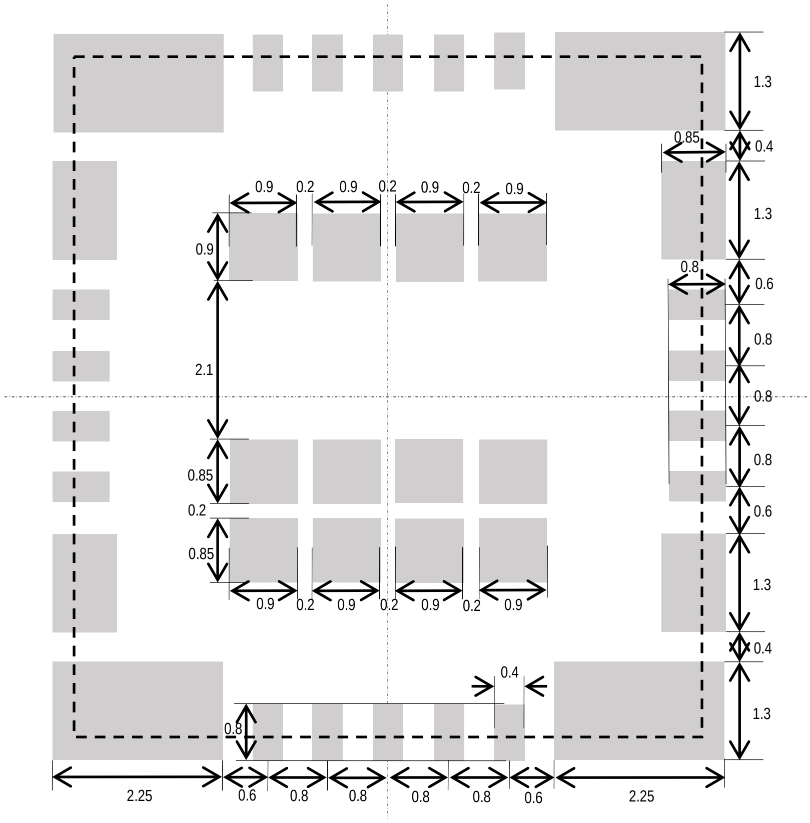


Tolerance : ±0.15
Coplanarity : less than 0.12
[Unit : mm]
(without burr)

Pin Function & Descriptions

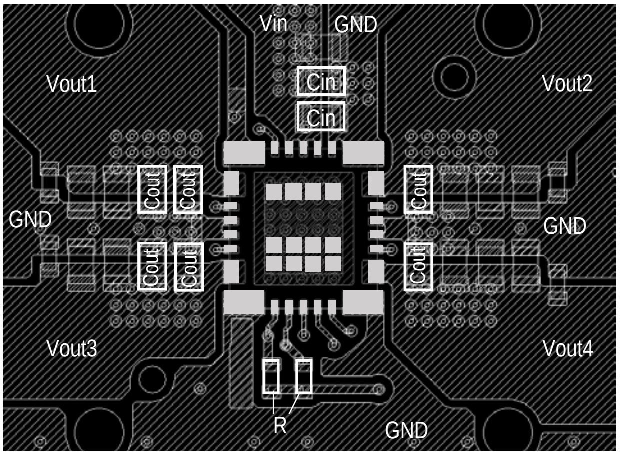
INPUT/OUTPUT Pins Functions & Descriptions		
Pin No.	Name	Function & Description
1, 4, 7, 10, 11, 14, 15, 20, 23, 24, 27, 28	GND	Power GND
2	ON/OFF	Power-on/off input. Logic input pin to start up or shut down the device. This pin should be pulled high by an external voltage.
3	PG	Power good open-drain output. This pin requires an external pull-up resistor.
5	SCL	I2C clock signal input.
6	SDA	I2C data pin.
8	Vout4	Vout4 output.
9	Sense4	Vout4 sense pin. Connect Vout4 output line directly to this pin.
12	Sense2	Vout2 sense pin. Connect Vout2 output line directly to this pin.
13	Vout2	Vout2 output.
16-19	Vin	Supply voltage input.
21	Vout1	Vout1 output.
22	Sense1	Vout1 sense pin. Connect Vout1 output line directly to this pin.
25	Vout3	Vout3 output.
26	Sense3	Vout3 sense pin. Connect Vout3 output line directly to this pin.

Recommended Board Land Pattern (Top View)

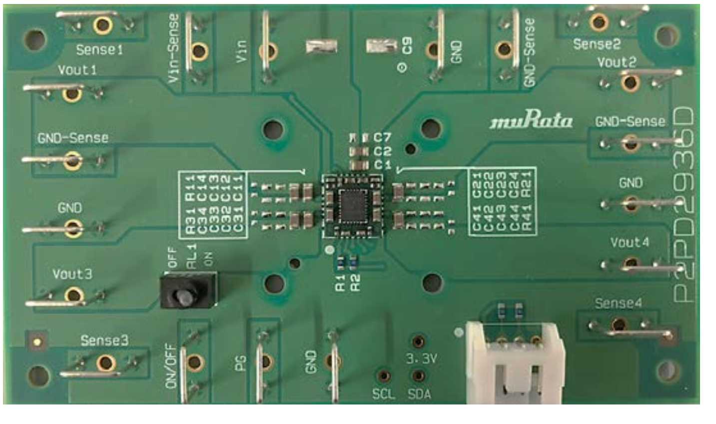


Unit: mm

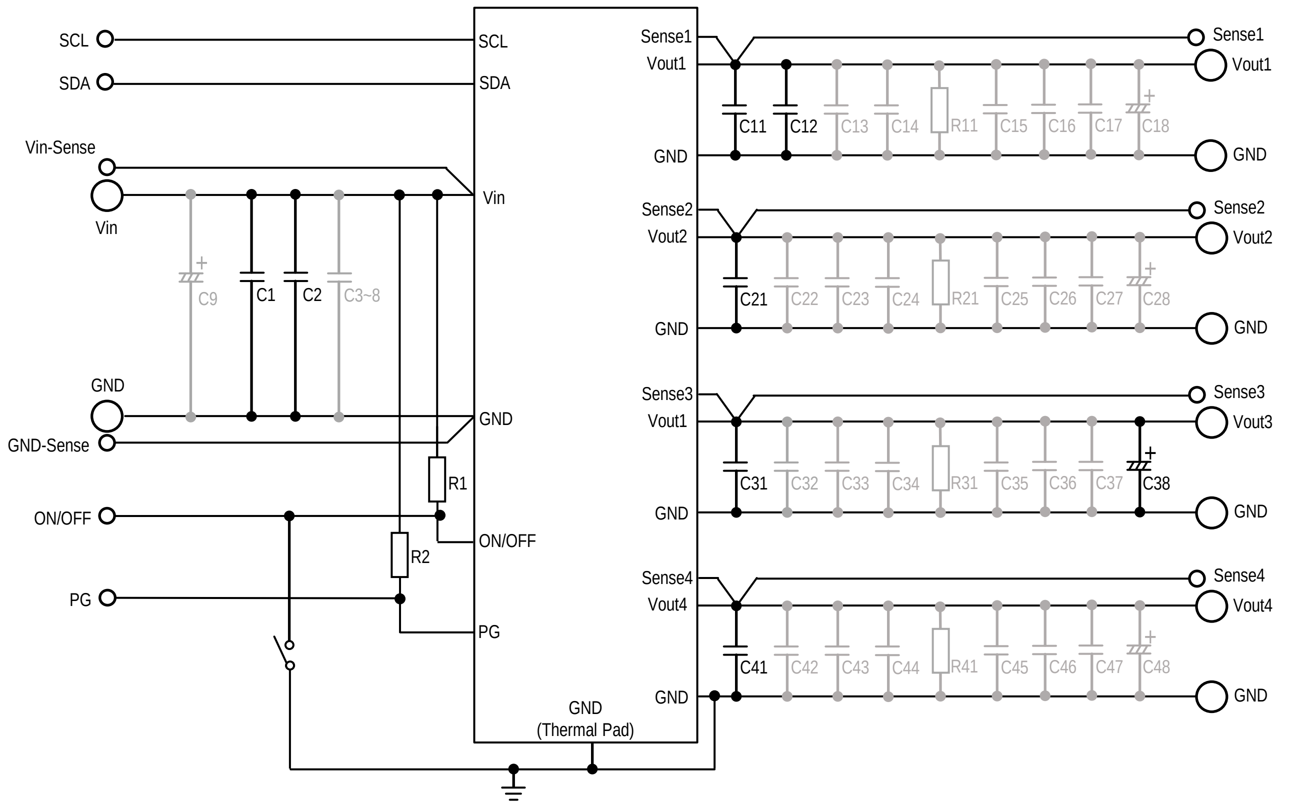
Example of Pattern Layout (Top View)



Picture



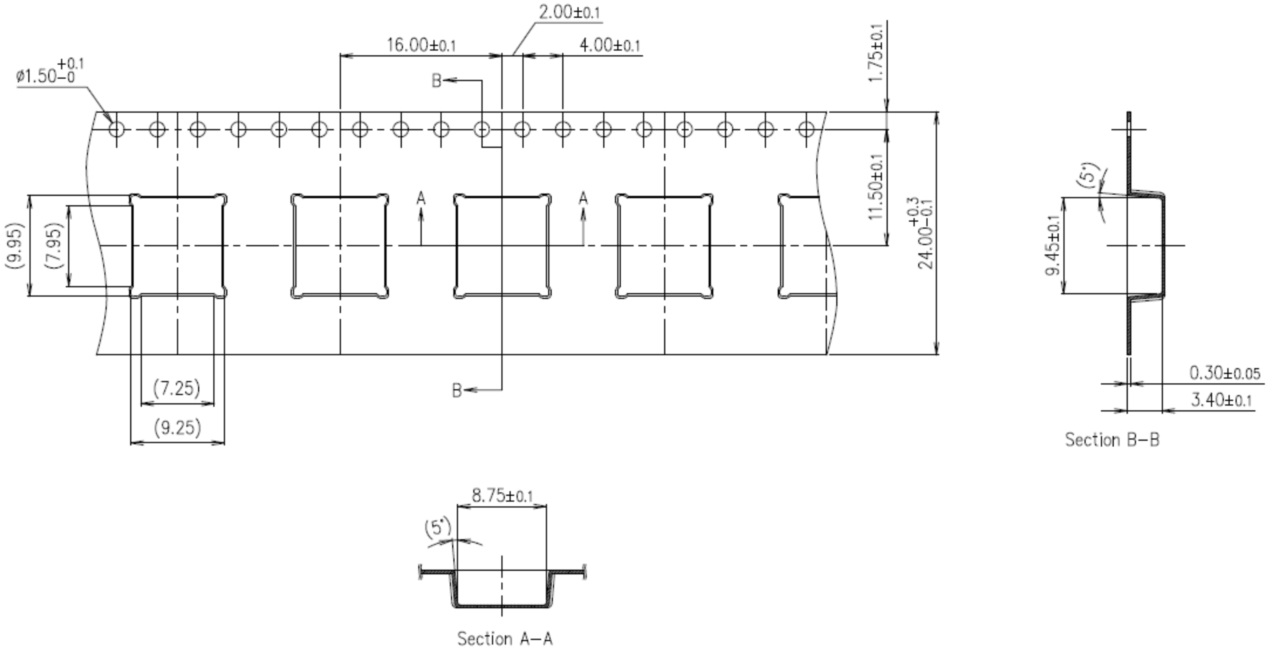
Application Circuit & BOM list (Evaluation Board)



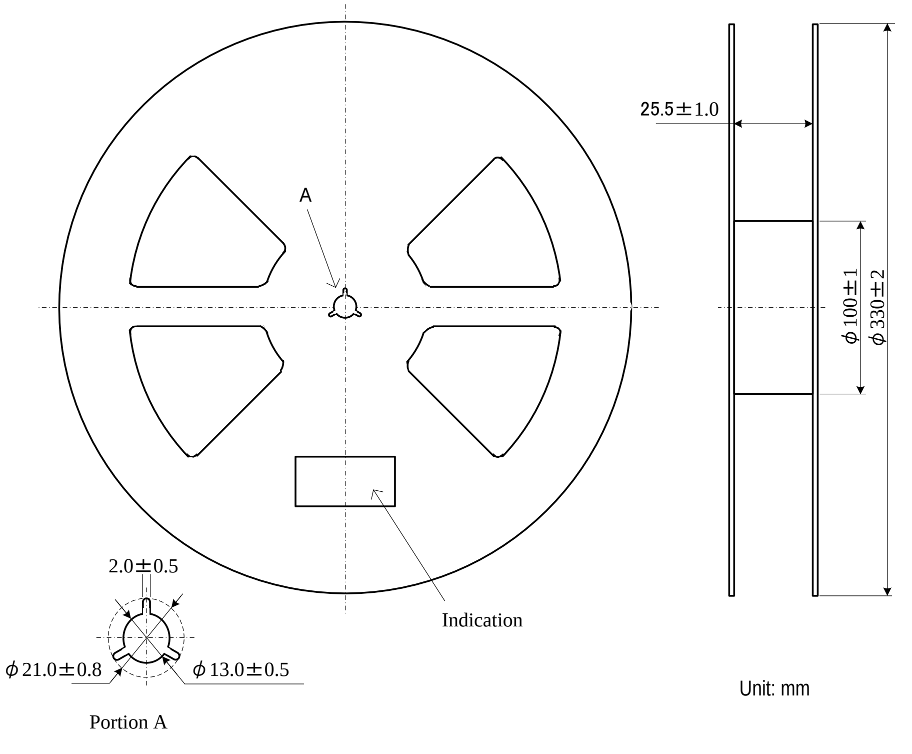
	MYWGC3R53FFW92RAE
C1, C2	22uF/10V GRM21BD71A226ME44L (Murata)
C11, C12, C21, C31, C41	22uF/6.3V GRM21BD70J226ME44L (Murata)
C38	47uF/6.3V ECASD40J476M025K00 (Murata)
R1	1608M, Chip resistor, 100kohm
R2	1608M, Chip resistor, 10kohm
C3-9, C13-18, C22-28 C32-C37, C42-C48 R11, R21, R31, R41	No mount

TAPE AND REEL INFORMATION

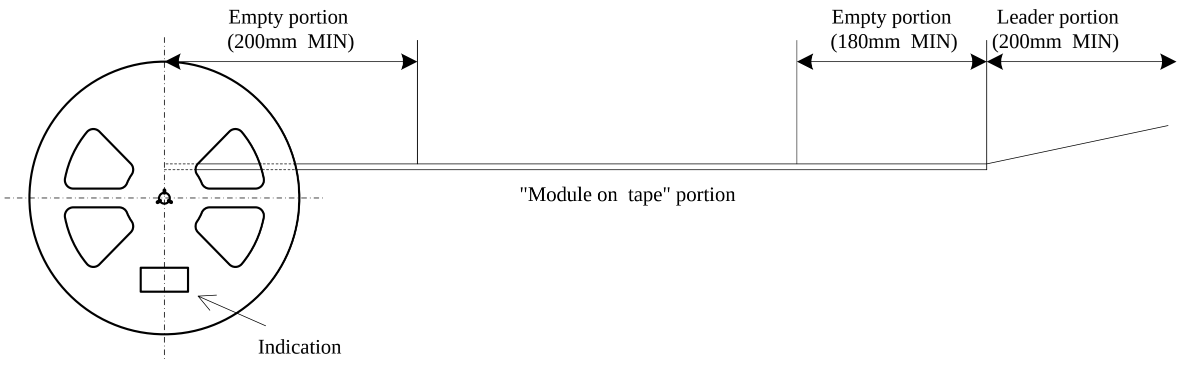
Tape Dimension

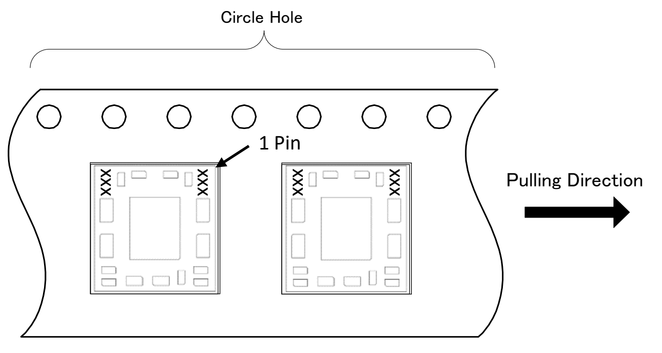


Reel Dimension



TAPE SPECIFICATIONS





Notes

1. The adhesive strength of the protective tape must be within 0.3-1.0N.
2. Each reel contains the quantities such as the table below.
3. Each reel set in moisture-proof packaging because of MSL 3.
4. No vacant pocket in “Module on tape” section.
5. The reel is labeled with Murata part number and quantity.
6. The color of reel is not specified.

Part Number	Quantity
MYWGC3R53FFW92RAE	400
MYWGC3R53FFW92RA1	100

TECHNICAL NOTES

Input Fuse
Certain applications and/or safety agencies may require fuses at the inputs of power conversion components. Fuses should be also used when there is the possibility of sustained input voltage reversal which is not current limited. For greatest safety, we recommend a fast blow fuse installed in the ungrounded input supply line. The installer must observe all relevant safety standards and regulations. For safety agency approvals, install the converter in compliance with the end-user safety standard.

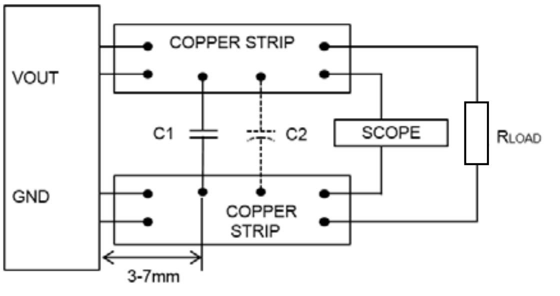
Input Under-Voltage Shutdown and Start-Up Threshold
Under normal start-up conditions, the converter will not begin to regulate properly until the ramping-up input voltage exceeds and remains within the Inout Voltage Range (see Specifications). Once operating, the converter will not turn off until the input voltage drops below the Under-Voltage Shutdown Limit. Subsequent restart will not occur until the input voltage rises again above the Start-Up Threshold. This built-in hysteresis prevents any unstable on/off operation at a single input voltage.
Users should be aware however of input sources near the Under-Voltage Shutdown whose voltage decays as input current is consumed (such as capacitor inputs), the converter shuts down and then restarts as the external capacitor recharges. Such situations could oscillate. To prevent this, make sure the operating input voltage is well above the UV Shutdown voltage at all times.

Start-Up Time
The Startup Time (see Specifications) will vary with input source impedance, external input capacitance, input voltage slew rate and final value of the input voltage as it appears at the converter.
The converter includes a soft start circuit to moderate the duty cycle of its PFM/PWM controller at power up, thereby limiting the input inrush current.
The On/Off Remote Control interval from On command to Vout regulated assumes that the converter already has its input voltage stabilized above the Start-Up Threshold before the On command. The interval is measured from the On command until the output enters and remains within its specified accuracy band. The specification assumes that the output is fully loaded at maximum rated current. Similar conditions apply to the On to Vout regulated specification such as external load capacitance and soft start circuitry.

Recommended Input Filtering
Users must assure that the input source has low AC impedance to provide dynamic stability and that the input supply has little or no inductive content, including long distributed wiring to a remote power supply. For best performance, we recommend installing a low-ESR capacitor immediately adjacent to the converter's input terminals.
The capacitor should be a ceramic type such as the Murata GRM21 series and an electrolytic type such as Panasonic OS-CON series. Initial suggested capacitor values are 22 uF x 2 ceramic type, rated at twice the expected maximum input voltage. Make sure that the input terminals do not go below the under-voltage shutdown voltage at all times. More input bulk capacitance may be added in parallel (either electrolytic or tantalum) if needed.

Recommended Output Filtering
The converter will achieve its rated output ripple and noise with additional external capacitors. Users may install more external output capacitance to reduce the ripple even further, to improve dynamic response and to ensure the operation stability. Initially we recommend to use low-ESR ceramic (Murata GRM21 series) as described in our circuits. Mount these close to the converter. Check the operation stability with margin and measure the output ripple in your application. If necessary to meet your requested specification, please add the capacitors in parallel up to achieving your requested specification according to Output Capacitor Design Notes.
Excessive capacitance can make step load recovery sluggish or possibly introduce instability. Do not exceed the maximum rated output capacitance listed in the specifications.

Output Noise
The converter is tested and specified for output noise using designated external output components, circuits and layout as shown in the figures below. In the figure below, the two copper strips simulate real-world printed circuit impedances between the power supply and its load. In order to minimize circuit errors and standardize tests between units, scope measurements should be made using BNC connectors or the probe ground should not exceed one half inch and soldered directly to the test circuit.



C1= Cout conditions (described in the test circuit for each Vout)
C2=OPEN
Figure : Measuring Output Ripple and Noise

Minimum Output Loading Requirements
This model regulates within specifications and is stable with the specified load conditions. Operation at no load might however increase output ripple and noise due to PFM control.

Thermal Shutdown
To prevent many over temperature problems and damage, the converter includes thermal shutdown circuitry. If environmental conditions cause the temperature rise of the converter above the Operating Temperature Range up to the shutdown temperature, an on-board electronic temperature sensor will power down the unit. When the temperature decreases below the turn-on threshold, the converter will automatically restart.
CAUTION: If you operate too close to the thermal limits, the converter may shut down suddenly without warning. Be sure thoroughly to avoid unplanned thermal shutdown in your application.

Temperature Derating Curves

The graph in this data sheet illustrates typical operation under a variety of conditions. The derating curve shows the maximum continuous ambient air temperature. Note that these are AVERAGE measurements.
Note that the temperatures are of the ambient airflow, not the converter itself which is obviously running at higher temperature than the outside air. Also note that very low flow rates (below about 25 LFM) are similar to "natural convection," that is, not using fan-forced airflow. We use both thermocouples and an infrared camera system to observe thermal performance.
CAUTION: The graph is collected at slightly above Sea Level altitude. Be sure to reduce the derating for higher density altitude.

Output Current Limiting

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

Output Short Circuit Condition

When the converter is in current-limit mode, the output voltage will drop as the output current demand increases. Following a time-out period, the converter will restart, causing the output voltage to begin ramping up to its appropriate value. If the short-circuit condition persists, another shutdown cycle will initiate. This rapid on/off cycling is called "hiccup mode". The hiccup cycling reduces the average output current, thereby preventing excessive internal temperatures and/or component damage. A short circuit can be tolerated indefinitely.
The "hiccup" system differs from older latching short circuit systems because you do not have to power down the converter to make it restart. The system will automatically restore operation as soon as the short circuit condition is removed.

Output Voltage Remote Sense

This function is capable to compensate up the voltage drop between the output and input of load. The voltage of the Vout pin must NOT be over their allowed maximum voltage if using the remote sense. The sense trace should be connected to Vout line as shortly as possible. The sense trace should be shielded by GND line or something else to reduce noise pick-up. The power-line length from the product to a sensing point should be within 10cm for output voltage stability. If the remote sense is not needed, the Sense pin should be connected to the Vout pin directly.

OVP Function

This product monitors a feedback voltage to detect over voltage. When the feedback voltage becomes higher than 120% of the target voltage, the circuit operates sink-mode to decrease output voltage. If the output voltage decrease 110% of target voltage, the circuit returns normal operation.

Remote On/Off Control

Please refer to the Connection Diagram on page 6 for On/Off connections. The model is enabled when the On/Off pin is pulled high with respect to GND. Positive-polarity devices are disabled when the On/Off is grounded or brought to within a low voltage (see Specifications) with respect to GND.
Dynamic control of the On/Off function should be able to sink appropriate signal current when brought low and withstand appropriate voltage when brought high. Be aware too that there is a finite time in milliseconds (see Specifications) between the time of On/Off Control activation and stable, regulated output. This time will vary slightly with output load type and current and input conditions.

Output Capacitive Load

Users should consider adding capacitance to reduce switching noise and/or to handle spike current load steps. Install enough capacitance to achieve noise objectives. However excess external capacitance may cause regulation problems, degraded transient response and possible oscillation or instability.

Soldering Guidelines

Murata recommends the specifications below when installing the converter. These specifications vary depending on the solder type. Exceeding these specifications may cause damage to the product. Your production environment may differ. Therefore, please thoroughly review these guidelines with your process engineers. This product can be reflowed twice.

Reflow Solder Operations for surface-mount products	
For Sn/Ag/Cu based solders:	
Preheat Temperature	Less than 1degC per second
Time over Liquidus	45 to 75 seconds
Maximum Peak Temperature	260degC
Cooling Rate	Less than 3degC per second
For Sn/Pb based solders:	
Preheat Temperature	Less than 1degC per second
Time over Liquidus	60 to 75 seconds
Maximum Peak Temperature	235degC
Cooling Rate	Less than 3degC per second

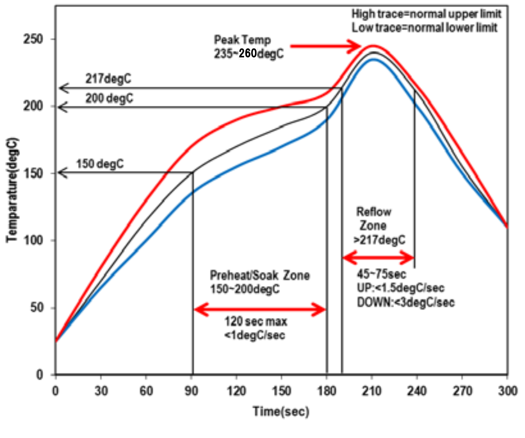
Pb-free Solder Processes

For Pb-free solder processes, the product is qualified for MSL 3 according to IPC/JEDEC standard J-STD-020D. During reflow the product temperature must not exceed 260degC at any time.

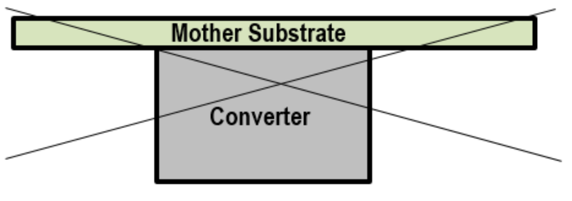
Dry Pack Information

Products intended for Pb-free reflow soldering processes are delivered in standard moisture barrier bags according to IPC/JEDEC standard J-STD-033. (Handling, packing, shipping and use of moisture/reflow sensitivity surface mount devices.) Using products in high temperature Pb-free soldering processes requires dry pack storage and handling. In case the product has been stored in an uncontrolled environment and no longer can be considered dry, the modules must be baked according to J-STD-033.

Recommended Lead-free Solder Reflow Profile



CAUTION: Do not reflow the converter as follows, because the converter may fall from the substrate during reflowing.



I2C INTERFACE

I2C Serial Interface Description

The I2C is a two-wire, bidirectional serial interface consisting of a clock line (SCL) and a data line (SDA). The lines are externally pulled to a bus voltage when they are idle. A master device is connected to the lines. Then it generates the SCL signal and device address, and arranges the communication sequence.
The interface of the product is an I2C slave that can support fast mode (400kHz). The I2C interface makes it possible to monitor the product status. If the master sends the address as an 8-bit value, the 7-bit address should be followed by 0 or 1 to indicate a read operation. When the I2C is not used, SCL and SDA should be pulled high (5V) by a resistor (4.7kohm).

CAUTION: When the I2C is not used, SCL and SDA should be pulled high (5V) by a resistor (4.7kohm).

Start and Stop Conditions

The start and stop conditions are signaled by the master device, and signify the beginning and the end of the I2C transmission. The start condition is defined as the SDA signal transition from high to low while the SCL is high. The stop condition is defined as the SDA signal transition from low to high while the SCL is high. The master then generates the SCL clocks, and transmits the device address and the Read bit on the SDA line.

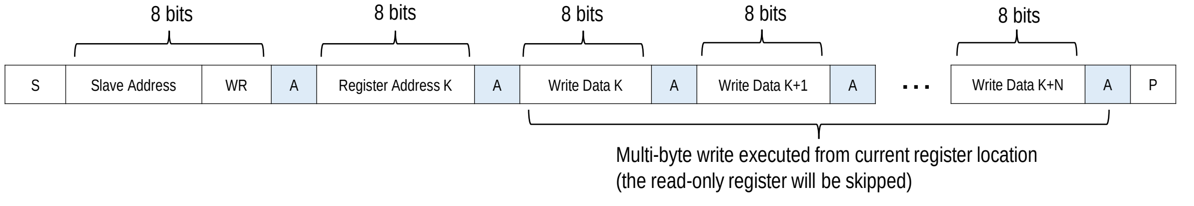
Transfer Data

Data is transmitted in 8-bit bytes through SDA line. Each byte of data should be followed by an acknowledge (ACK) bit.

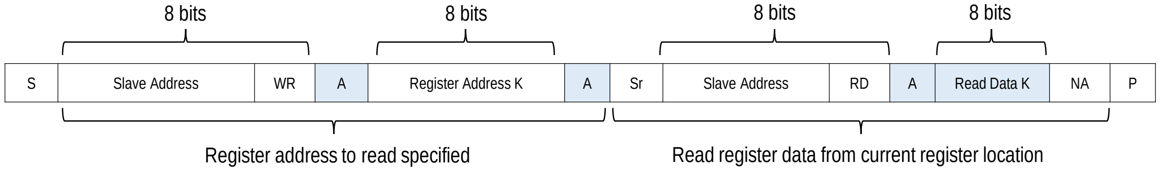
I2C Update Sequence

The product requires a start condition, a valid I2C address, a register address byte and a data byte for a single data update. After receiving each byte, the product acknowledges the byte by pulling the SDA line low during the high period of a SCL pulse. A valid I2C address selects the product. The product performs an update on the falling edge of the LSB byte. Example of I2C read sequence is described below.

I2C Write Example



I2C Read Example



☐ Master to Slave	A = Acknowledge (SDA = Low)	S = Start Condition	Sr = Repeat Start Condition	
■ Slave to Master	NA = NOT Acknowledge (SDA = High)	P = Stop Condition	WR (Write) = 0	RD (Read) = 1

I2C Register Map

ADD (HEX)	NAME	R/W	D7	D6	D5	D4	D3	D2	D1	D0
15	ADDRESS	R				I2C_SLAVE_ADDRESS				
22	EN	R/W	EN_BUCK1	EN_BUCK2	EN_BUCK3	EN_BUCK4	RESERVED			
27	Status1	R	RESERVED				PGBUCK4	PGBUCK3	PGBUCK2	PGBUCK1
28	Status2	R	OTWARNING	OTEMPP	RESERVED					

I2C Register Description

・ADDRESS(15h)

NAME	BITS	DEFAULT	DESCRIPTION
I2C_SLAVE_ADDRESS	[4:0]	01001	Murata can set the A5 to A1 bit of the slave I2C address according to your request. (see the I2C Bus Slave Address section on the next page for more details)

・EN (22h)

NAME	BITS	DEFAULT	DESCRIPTION
EN_BUCK1 EN_BUCK2 EN_BUCK3 EN_BUCK4	[7:4]	1111	Enable control bit for each power rail. 0 : Disable 1 : Enable If changing the data from the default value, the functional specifications are not guaranteed.

・Status1 (27h)

NAME	BITS	DEFAULT	DESCRIPTION
PGBUCK4	[3]	0	Power good indicator for Buck4. PG=1 when output voltage is higher than 90% of reference voltage; PG=0 when output voltage is lower than 80% of reference voltage. During I2C controlled dynamic voltage scaling, PG deglitch timer will blank the possible PG glitch.
PGBUCK3	[2]	0	Power good indicator for Buck3. PG=1 when output voltage is higher than 90% of reference voltage; PG=0 when output voltage is lower than 80% of reference voltage. During I2C controlled dynamic voltage scaling, PG deglitch timer will blank the possible PG glitch.
PGBUCK2	[1]	0	Power good indicator for Buck2. PG=1 when output voltage is higher than 90% of reference voltage; PG=0 when output voltage is lower than 80% of reference voltage. During I2C controlled dynamic voltage scaling, PG deglitch timer will blank the possible PG glitch.
PGBUCK1	[0]	0	Power good indicator for Buck1. PG=1 when output voltage is higher than 90% of reference voltage; PG=0 when output voltage is lower than 80% of reference voltage. During I2C controlled dynamic voltage scaling, PG deglitch timer will blank the possible PG glitch.

・Status2 (28h)

NAME	BITS	DEFAULT	DESCRIPTION
OTWARNING	[7]	0	Die temperature early warning bit. When the bit is high, the die temperature is higher than 120degC. This bit is latched once it's a triggered. Cleared by write "0xFF" to the status2 register.
OTEMPP	[6]	0	Over temperature indication. When bit is high, the IC is the thermal shutdown. This bit is latched once it's triggered. Cleared by write "0xFF" to the status2 register.

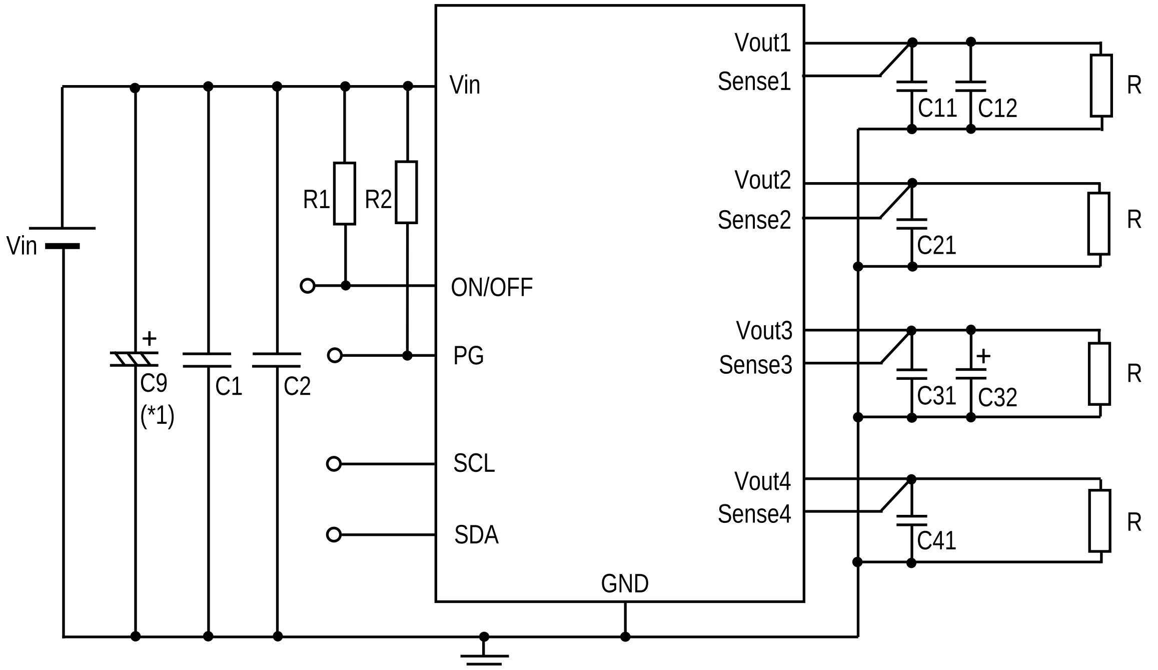
I2C Bus Slave Address

The slave address is a 7-bit address followed by an 8th read data direction bit. The A5 to A1 bits can be configured by Murata according to your request. By default, the slave address is 0x69, A[7:1] = 1101001

	A7	A6	A5	A4	A3	A2	A1
Setting Value	1	1	0*	1*	0*	0*	1*

APPENDIX

Test Circuit



*1: If there is a non-negligible parasitic impedance between the power supply and the converter, such as during evaluation, the optional input capacitor "C9" may be required to reduce the impedance. The recommended optional capacitor is an example. Please consider the optimum value for the case. This capacitor is usually an aluminum electrolytic type. It is not necessary to place the capacitor near the input terminal of the converter. This would be typically aluminum electrolytic type and does not need to be close to the input terminals of the converter.

	MYWGC3R53FFW92RAE
C1, C2	22uF/10V GRM21BD71A226ME44L (Murata)
C11, C12, C21, C31, C32, C41	22uF/6.3V GRM21BD70J226ME44L (Murata)
C32	47uF/6.3V ECASD40J476M025K00 (Murata)
R1	1608M, Chip resistor, 100kohm
R2	1608M, Chip resistor, 10kohm

Notices

Scope
This datasheet is applied to MYWGC3R53FFW92RAE and MYWGC3R53FFW92RA1.
- Specific applications: Consumer Electronics, Industrial Equipment

⚠ CAUTION

Limitation of Applications
The products listed in the datasheet (hereinafter the product(s) is called the "Product(s)") are designed and manufactured for applications specified in the specification or the datasheet. (hereinafter called the "Specific Application"). We shall not warrant anything in connection with the Products including fitness, performance, adequateness, safety, or quality, in the case of applications listed in from (1) to (11) written at the end of this precautions, which may generally require high performance, function, quality, management of production or safety. Therefore, the Product shall be applied in compliance with the specific application.

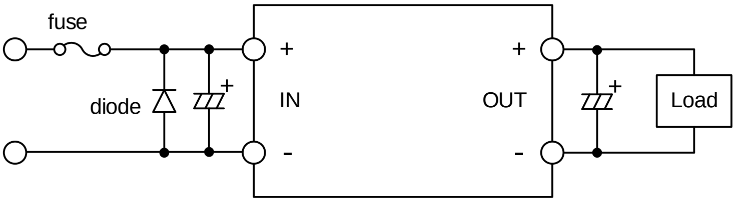
We disclaim any loss and damages arising from or in connection with the products including but not limited to the case such loss and damages caused by the unexpected accident, in event that (i) the product is applied for the purpose which is not specified as the specific application for the product, and/or (ii) the product is applied for any following application purposes from (1) to (11) (except that such application purpose is unambiguously specified as specific application for the product in our catalog specification forms, datasheets, or other documents officially issued by us*).

(1) Aircraft equipment
(2) Aerospace equipment
(3) Undersea equipment
(4) Power plant control equipment
(5) Medical equipment
(6) Transportation equipment (such as vehicles, trains, ships)
(7) Traffic control equipment
(8) Disaster prevention / crime prevention equipment
(9) Industrial data-processing equipment
(10) Combustion/explosion control equipment
(11) Application of similar complexity and/or reliability requirements to the applications listed in the above

For exploring information of the Products which will be compatible with the particular purpose other than those specified in the datasheet, please contact our sales offices, distribution agents, or trading companies with which you make a deal, or via our web contact form.
Contact form: https://www.murata.com/contactform
*We may design and manufacture particular Products for applications listed in (1) to (11). Provided that, in such case we shall unambiguously specify such Specific Application in specification or datasheet without any exception. Therefore, any other documents and/or performances, whether exist or non-exist, shall not be deemed as the evidence to imply that we accept the applications listed in (1) to (11).

Fail-safe function
Be sure to add an appropriate fail-safe function to your finished product to prevent secondary damage in the unlikely event of an abnormality function or malfunction in our product.

Please connect the input terminal by right polarity. If you mistake the connection, it may break the DC-DC converter. In the case of destruction of the DC-DC converter inside, over input current may flow. Please add a diode and fuse as following to protect them.



Please select diode and fuse after confirming the operation.

⚠ Note

1. Please make sure that your product has been evaluated in view of your specifications with our product being mounted to your product.
2. You are requested not to use our product deviating from the reference specifications.
3. If you have any concerns about materials other than those listed in the RoHS directive, please contact us.
4. Please don't wash this product under any conditions.

Product Specification
Product Specification in this datasheet are as of Jun 2023. Specifications and features may change in any manner without notice. Please check with our sales representatives.

Contact form
https://www.murata.com/contactform?Product=Power%20Device

Disclaimers

The information described in this data sheet was carefully crafted for accuracy. However this product is based on the assumption that it will be used after thoroughly verifying and confirming the characteristics and system compatibility. Therefore, Murata is not responsible for any damages caused by errors in the description of the datasheet.

Murata constantly strives improve the quality and reliability of our products, but it is inevitable that semiconductor products will fail with a certain probability. Therefore regardless of whether the use conditions are within the range of this data sheet, Murata is not responsible for any damage caused by the failure of this product., (for example, secondary damage, compensation for accidents, punitive damage, loss of opportunity, and etc.) Also, regardless of whether Murata can foresee the events caused by the failure of our product, Murata has no obligations or responsibilities.

The buyer of this product and developer of systems incorporating this product must analyze, evaluate, and make judgements at their own risk in designing applications using this product. The buyer and the developer are responsible for verifying the safety of this product and the applications, and complying with all applicable laws, regulations, and other requirements.

Furthermore, the buyer and developer are responsible for predicting hazards and taking adequate safeguards against potential events at your own risk in order to prevent personal accidents, fire accidents, or other social damage. When using this product, perform thorough evaluation and verification of the safety design designed at your own risk for this product and the application.

Murata assumes that the buyer and developer have the expertise to verify all necessary issues for proper use of the product as described above and to take corrective action. Therefore, Murata has no liability arising out of the use of the product. The buyer and developer should take all necessary evaluations, verifications, corrective actions and etc., in your own responsibility and judgment.

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