QM

AC/DC Modular Power Supply Series

APPLICATION NOTES

Contents

1. INPUT

AC Input Line Requirements

Please see the datasheet for the specification of input line requirements (including Input voltage range, input frequency, input harmonics, input current and leakage current).

The power supply will automatically recover from AC power loss and start-up with maximum loading at 90VAC.

Repetitive ON/OFF cycling of the AC input voltage will not damage the power supply or cause the input fuse to blow.

- Input Fuses

One ('E' input fuse option) or two ('D' input fuse option) internal fuses are fitted. The fuses are not user serviceable and are fast acting rated 25A / 250Vac HBC types.

- Input Undervoltage

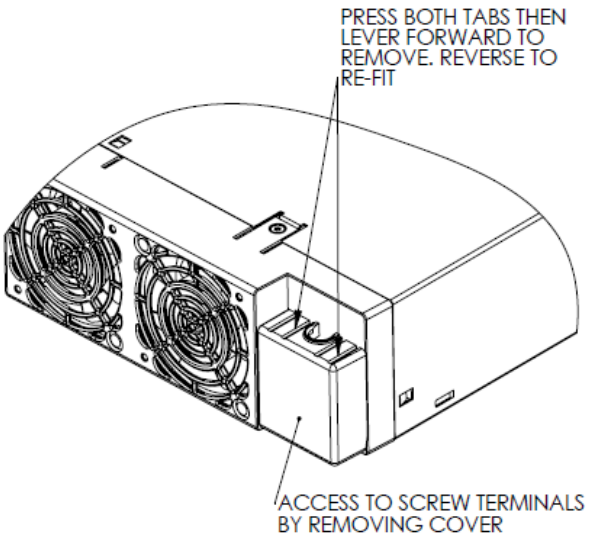
The power supply is protected against the application of an input voltage below the minimum specified so that it shall not cause damage to the power supply.

AC Input Connections

- QM with factory fitted fan – F or R type cooling

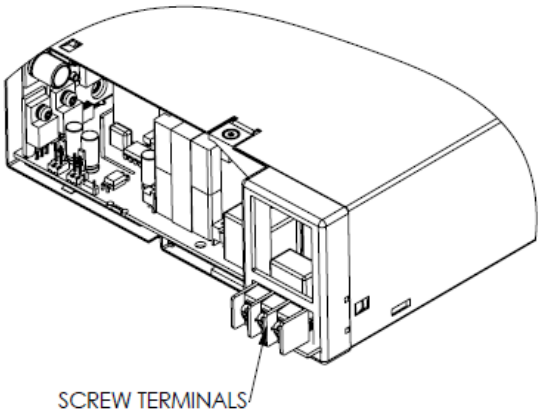
To access the AC terminal block remove terminal block cover by pressing both tabs and pulling forward.

Perform the reverse operation to re-fit.



- QM with customer supplied airflow – C type cooling

No fan or terminal block cover is fitted with the customer supplied air option



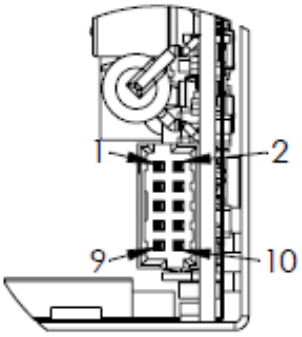
2. HIPOT TESTING

Isolation testing

During the manufacturing process, all QM units are subjected to safety Hipot testing. If conducting these tests on the end equipment, it is important to ensure that the high voltage is ramped up and down over a period of greater than 1 second to ensure that no damage occurs to the unit under test.

3. STANDBY / SIGNALS OPTION

When fitted, the standby / signals option module is situated in the far right hand position of the QM chassis (when looking at the output end of the power supply).



Option Code E5L, E5H, T5L, T5H

Standby 1

An isolated 5V 0.25A output and is always present provided AC is applied to the QM

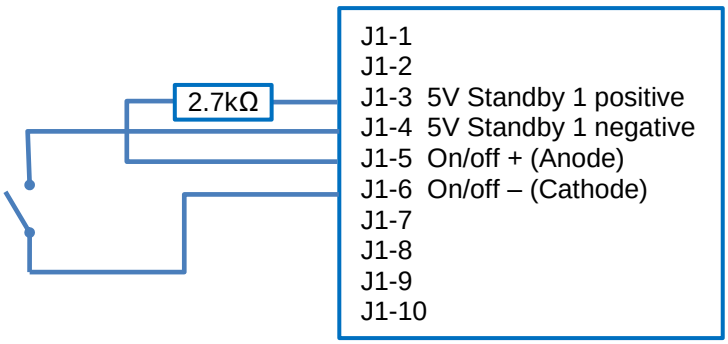
Standby 2 (ExH and TxH options only)

An isolated output, the voltage and current selectable at the time of ordering. The output is always present provided AC is applied to the QM.

PSU on/off

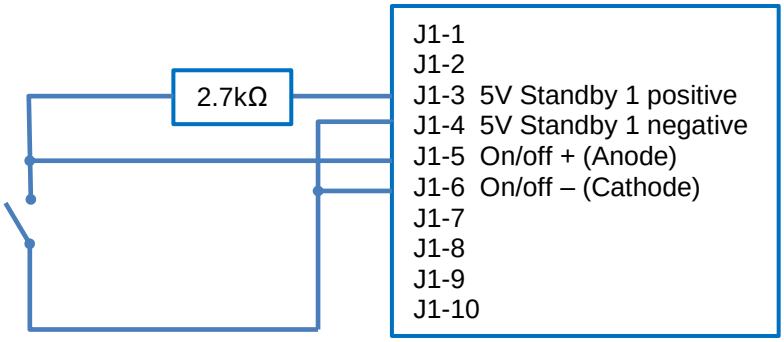
Is controlled through an isolated opto-coupler diode input. Passing a minimum of 1mA (10mA maximum) through the opto diode will either “enable” (turn on) the QM power supply (fitted with Exx option), or “inhibit” (turn off) the QM (fitted with Txx option). Note, when turned off, the internal cooling fans will not operate.

	Standby / signals type	
Switch state	**T5L, T5H, T12H**	**E5L, E5H, E12H**
Open	PSU ON	PSU OFF
Closed	PSU OFF	PSU ON



Connection method 1

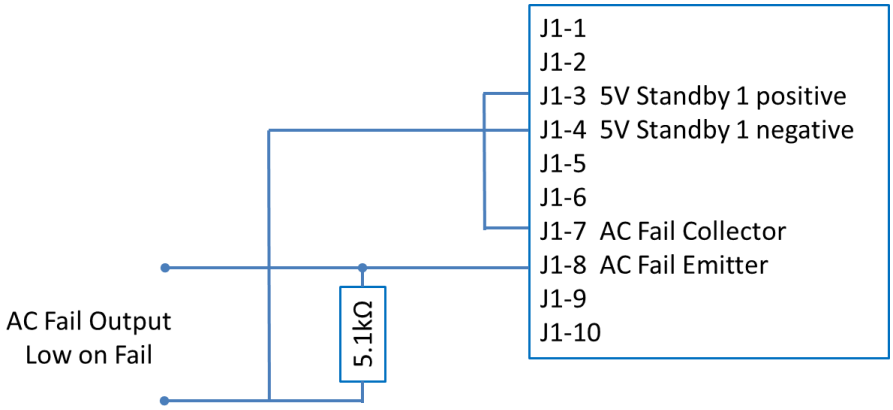
	Standby / signals type	
Switch state	**T5L, T5H, T12H**	**E5L, E5H, E12H**
Open	PSU OFF	PSU ON
Closed	PSU ON	PSU OFF



Connection method 2

AC Fail

An isolated opto-coupler transistor output. Pin 7 is the collector and pin 8 the emitter. This signal provides a warning that the AC is not present (or out of range) and the outputs will be losing regulation after 5ms. The transistor is “on” when the AC is good. It is recommended that the AC Fail is connected to the 5V standby 1 supply with a 5.1kΩ series resistor to limit the current.



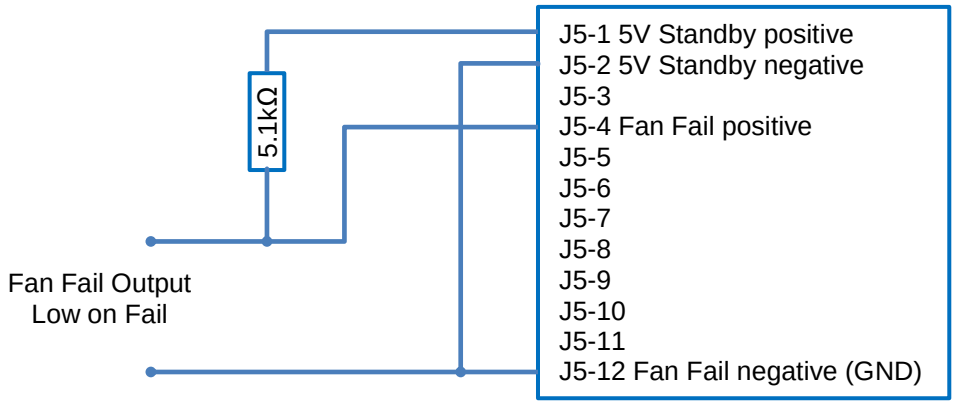
Option Code P5H

Standby

An isolated 5V 2A output and is always present provided AC is applied to the QM.

The Fan Fail signal

Provided by an internal FET which is referenced to pin 12 of the option connector. Pin 4 is the FET drain (+) and pin 12 the source (-). This signal provides a warning that the QM fan has stopped or the fan speed is slowing and should be replaced. The FET will be on when the fan is running less than 50% of the expected fan speed for the ambient temperature and “off” if the fan speed is above 50%. It is recommended that the Fan Fail is connected to the 5V standby supply with a 5.1kΩ series resistor to limit the current.



Signal ratings

AC fail signal	
Signal type (internal to PSU)	Uncommitted optocoupler transistor
Vce max	30V
Ic max	1mA

Fan fail signal	
Signal type (internal to PSU)	Open drain FET with 10R series resistor (referenced to Fan fail negative output)
Vce max	30V
Ic max	10mA

PSU on/off signal	
Signal type (internal to PSU)	Uncommitted optocoupler diode with 390R series resistor
Min LED current	1mA
Max LED current	10mA

Connector Pin-out for standby / signals options

Pin No.	**E5L or T5L**	**E5H, T5H, E12H or T12H**	**E13.5H or T13.5H**	**P5H**
1	No connection	Standby 2 +		Standby +
2		Standby 2 -		Standby -
3	Standby 1 +			No connection
4	Standby 1 -			Fan Fail
5	PSU on/off + (Anode)			Address 0*
6	PSU on/off – (Cathode)			Address 1*
7	AC Fail Collector			Address 2*
8	AC Fail Emitter			Address 3*
9	No connection		On/off logic 0	SCL – Clock*
10			On/off logic 1	SDA – Data*
11				Control line in*
12				GND

*Refer to the PMBus section for further information

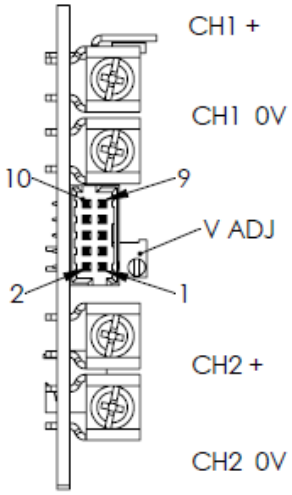
Molex mating connectors and pins

(Contact Molex for other pin alternatives)

Description	**Molex part number**	**TDK-Lambda part number**
10 way Milli-Grid with locking ramp	51110-1060	12934
12 way Milli-Grid with locking ramp	51110-1260	200401
Crimp terminal, gold flash, female, supplied on a reel	50394-8051	12935
Crimp terminal, gold flash, female, supplied in a bag	50394-8400	
Crimp terminal, tin plated, female, supplied on a reel	51087-8101	

4. DC OUTPUTS

DH Modules



The output voltages can be adjusted across the range shown in the datasheet by using the potentiometer situated to the right of the signal connector. Turning the potentiometer clockwise will increase both the output voltages.

Channel 2 tracks channel 1. The output voltage for V2 = V2max* x V1(actual set point) / V1max*

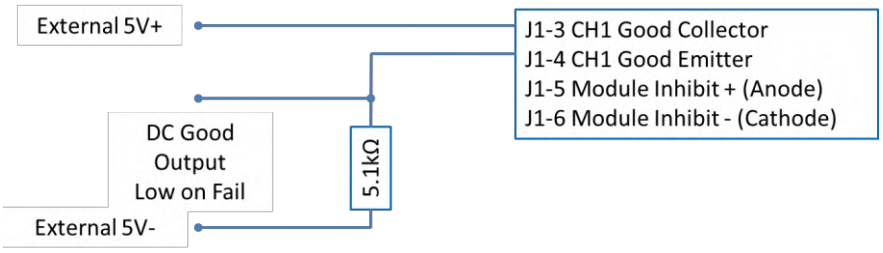
* Maximum adjustment voltage as shown in the datasheet

For example:

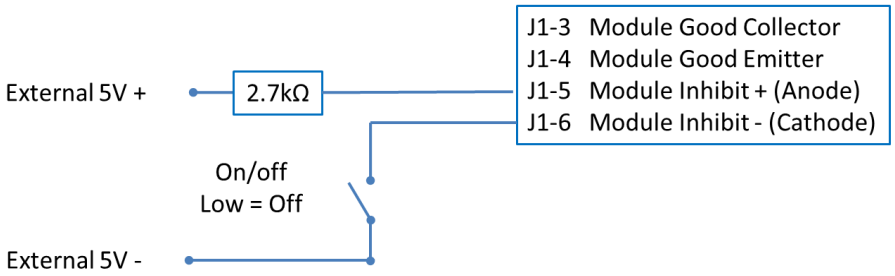
V1	V1 max	V2 max	V2
12.5V	13.8V	13.8V	**12.5V**

Signals

The Module Good signal is an isolated (200V from CH1) opto-coupler transistor output. The maximum current allowed through the transistor is 1mA. This signal provides an indication that CH1 is above 90% of the output set voltage. The transistor is on when the module is “good”.



Module inhibit is an isolated opto-coupler diode input. Passing a minimum of 1mA through the diode will inhibit (turn off) both outputs of the module.



Signal ratings

Module good signal	
Signal type (internal to PSU)	Uncommitted optocoupler transistor
Vce max	30V
Ic max	1mA

Module inhibit signal	
Signal type (internal to PSU)	Uncommitted optocoupler diode with 390R series resistor
Min LED current	1mA
Max LED current	10mA

Connector pin-out for signals

Pin	Function
1	Do not connect
2	
3	Module good collector
4	Module good emitter
5	Module inhibit anode
6	Module inhibit cathode
7	Do not connect
8	
9	
10	

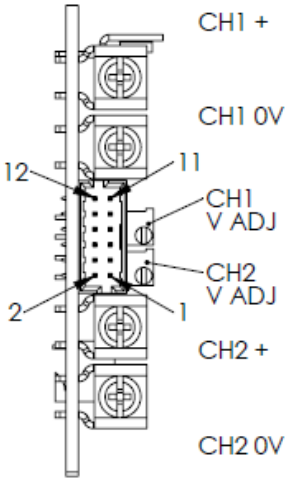
Molex mating connectors and pins

(Contact Molex for other pin alternatives)

Description	**Molex part number**	**TDK-Lambda part number**
10 way Milli-Grid with locking ramp	51110-1060	12934
Crimp terminal, gold flash, female, supplied on a reel	50394-8051	12935
Crimp terminal, gold flash, female, supplied in a bag	50394-8400	
Crimp terminal, tin plated, female, supplied on a reel	51087-8101	

DM Modules

Channel 1 and 2 output voltages can be adjusted across the range shown in the datasheet by using the potentiometer situated to the right of the signal connector. Channel 1 potentiometer is the upper one, closest to the Channel 1 output terminals. Turning the potentiometer clockwise increases the output voltage.



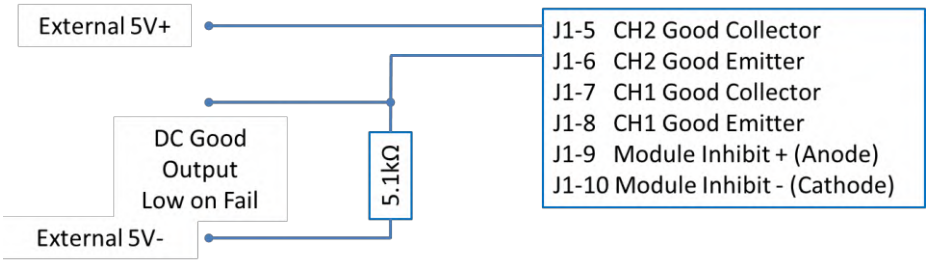
Remote sense for Channel 1 and 2 provides compensation for a maximum total load cable drop of 0.5V for each output. The voltage at the output terminals must be within the specified adjustment range. See the Remote Sense section in the POWER SUPPLY OPERATION chapter for connection advice.

To improve the transient load performance, it is recommended that a 120µF, low ESR, electrolytic capacitor is fitted across the output terminals.

To reduce susceptibility to Electrical Fast Transients, it is recommended that a 120µF, low ESR, electrolytic capacitor is fitted across the output terminals of channel 2 of the 12/12DM module.

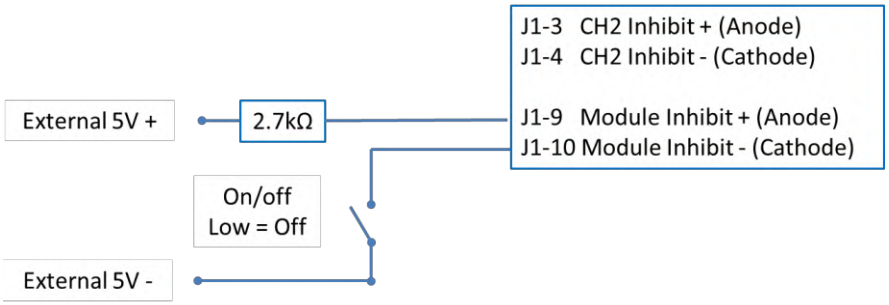
Signals

The CH1 and CH2 Good signals are isolated (200V from each output) opto-coupler transistor outputs. The maximum current allowed through the transistor is 1mA. These signals provide an indication that each output is above 90% of the output set voltage. The transistor is on when the output is “good”.

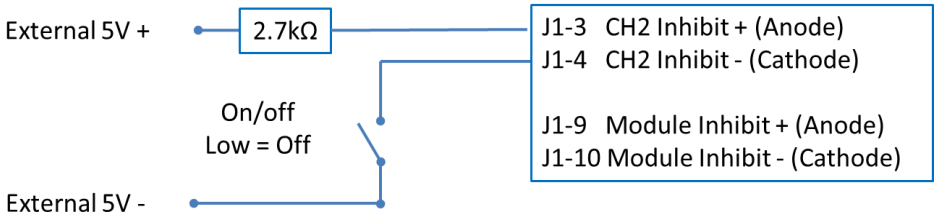


CH2 Good connection shown, use J1-7 & J1-8 for CH2 Good

Module inhibit is an isolated opto-coupler diode input. Passing a minimum of 1mA through the diode will inhibit (turn off) both outputs of the module.



CH2 inhibit is an isolated opto-coupler diode input. Passing a minimum of 1mA through the diode will inhibit (turn off) only Channel 2 of the module.



Signal ratings

Ch1 good signal	
Signal type (internal to PSU)	Uncommitted optocoupler transistor
Vce max	30V
Ic max	1mA

Ch2 good signal	
Signal type (internal to PSU)	Uncommitted optocoupler transistor
Vce max	30V
Ic max	1mA

Module inhibit signal	
Signal type (internal to PSU)	Uncommitted optocoupler diode with 390R series resistor
Min LED current	1mA
Max LED current	10mA

Ch2 inhibit signal	
Signal type (internal to PSU)	Uncommitted optocoupler diode with 390R series resistor
Min LED current	1mA
Max LED current	10mA

Connector pin-out for signals

Pin	Function
1	CH2 Sense +
2	CH2 Sense -
3	CH2 Inhibit + (Anode)
4	CH2 Inhibit + (Cathode)
5	CH2 Good Collector
6	CH2 Good Emitter
7	CH1 Good Collector
8	CH1 Good Emitter
9	Module Inhibit + (Anode)
10	Module Inhibit – (Cathode)
11	CH1 Sense +
12	CH1 Sense -

Molex mating connectors and pins

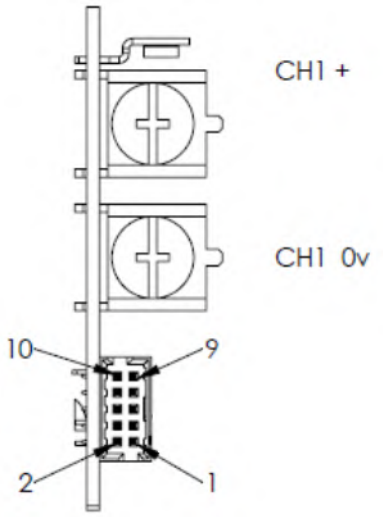
(Contact Molex for other pin alternatives)

Description	**Molex part number**	**TDK-Lambda part number**
12 way Milli-Grid with locking ramp	51110-1260	200401
Crimp terminal, gold flash, female, supplied on a reel	50394-8051	12935
Crimp terminal, gold flash, female, supplied in a bag	50394-8400	
Crimp terminal, tin plated, female, supplied on a reel	51087-8101	

SA Modules

The output voltage is fixed and cannot be adjusted.

The remote sense (on 5V modules only) provides compensation for a maximum total load cable drop of 0.5V for the output. See the Remote Sense section in the POWER SUPPLY OPERATION chapter for connection advice.



Connector pin-out for signals (on 5V modules only)

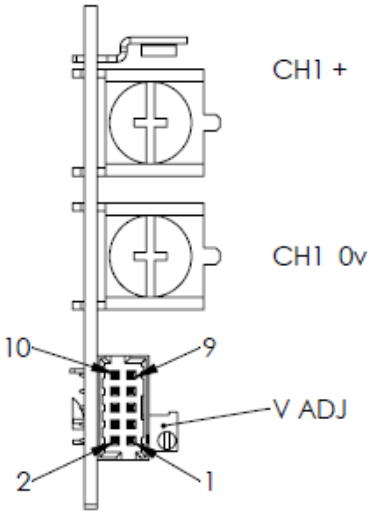
Pin	Function
1	No connection
2	
3	
4	
5	
6	
7	Remote Sense +
8	Remote Sense -
9	No connection
10	

Molex mating connectors and pins

(Contact Molex for other pin alternatives)

Description	**Molex part number**	**TDK-Lambda part number**
10 way Milli-Grid with locking ramp	51110-1060	12934
Crimp terminal, gold flash, female, supplied on a reel	50394-8051	12935
Crimp terminal, gold flash, female, supplied in a bag	50394-8400	
Crimp terminal, tin plated, female, supplied on a reel	51087-8101	

SB Modules

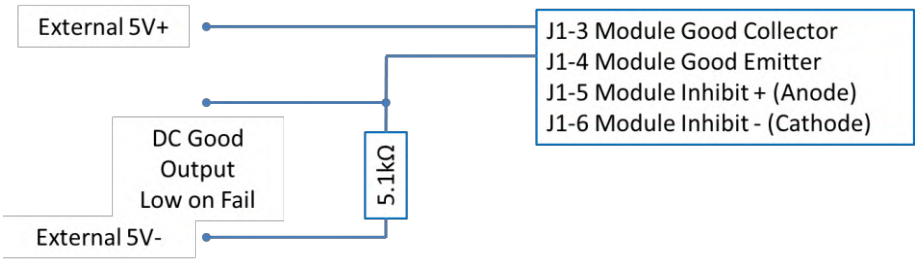


The output voltage can be adjusted across the range shown in the datasheet by using the potentiometer situated to the right of the signal connector. Turning the potentiometer clockwise increases the output voltage.

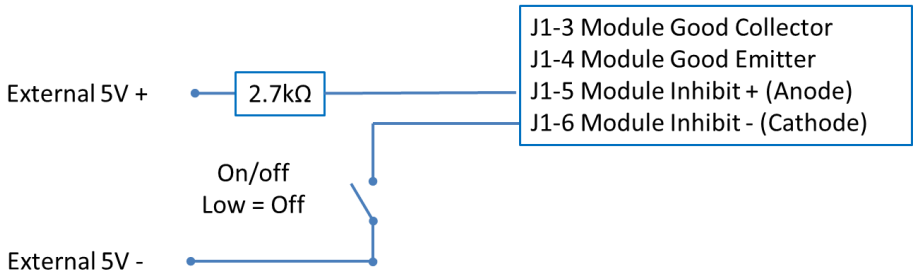
The remote sense provides compensation for a maximum total load cable drop of 0.5V for the output. The voltage at the output terminals must be within the specified adjustment range. See the Remote Sense section in the POWER SUPPLY OPERATION chapter for connection advice.

Signals

The Module Good signal is an isolated (200V from the output) opto-coupler transistor output. The maximum current allowed through the transistor is 1mA. This signal provides an indication that the output is above 90% of the output set voltage. The transistor is on when the output is “good”



Module inhibit is an isolated opto-coupler diode input. Passing a minimum of 1mA through the diode will inhibit (turn off) the output of the module.



Signal ratings

Module good signal	
Signal type (internal to PSU)	Uncommitted optocoupler transistor
Vce max	30V
Ic max	1mA

Module inhibit signal	
Signal type (internal to PSU)	Uncommitted optocoupler diode with 390R series resistor
Min LED current	1mA
Max LED current	10mA

Connector pin-out for signals

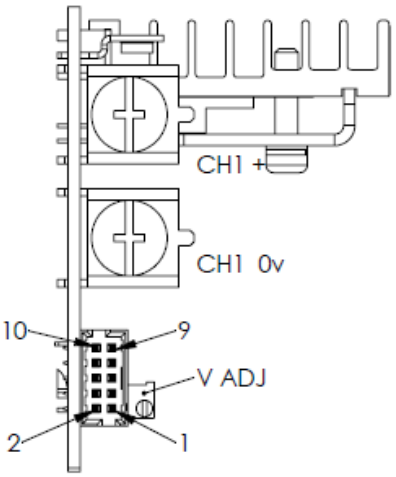
Pin	Function
1	No connection
2	
3	Module Good Collector
4	Module Good Emitter
5	Module Inhibit + (Anode)
6	Module Inhibit - (Cathode)
7	Remote Sense +
8	Remote Sense -
9	No connection
10	

Molex mating connectors and pins

(Contact Molex for other pin alternatives)

Description	**Molex part number**	**TDK-Lambda part number**
10 way Milli-Grid with locking ramp	51110-1060	12934
Crimp terminal, gold flash, female, supplied on a reel	50394-8051	12935
Crimp terminal, gold flash, female, supplied in a bag	50394-8400	
Crimp terminal, tin plated, female, supplied on a reel	51087-8101	

SC Modules

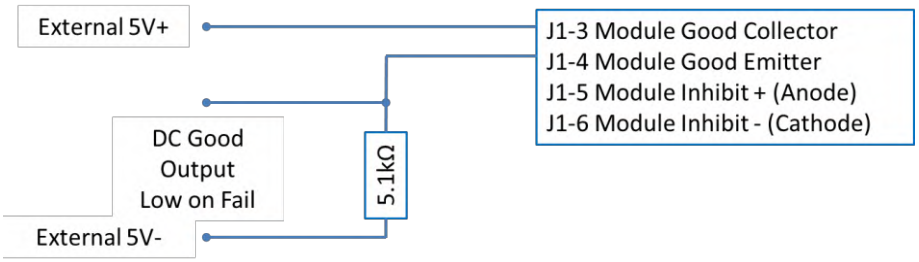


The output voltage can be adjusted across the range shown in the datasheet by using the potentiometer situated to the right of the signal connector. Turning the potentiometer clockwise increases the output voltage.

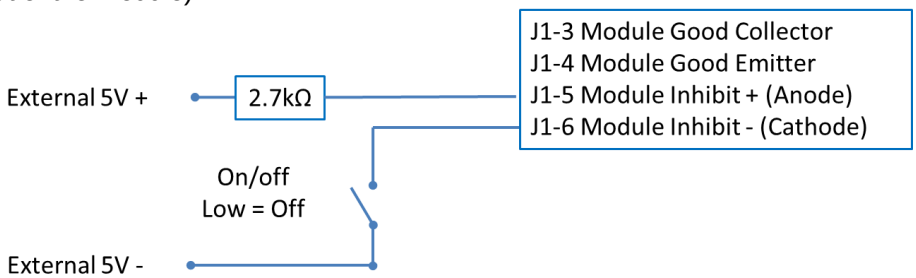
The remote sense provides compensation for a maximum total load cable drop of 0.5V for the output. The voltage at the output terminals must be within the specified adjustment range. See the Remote Sense section in the POWER SUPPLY OPERATION chapter for connection advice.

Signals

The Module Good signal is an isolated (200V from the output) opto-coupler transistor output. The maximum current allowed through the transistor is 1mA. This signal provides an indication that the output is above 90% of the output set voltage. The transistor is on when the output is “good”.



Module inhibit is an isolated opto-coupler diode input. Passing a minimum of 1mA through the diode will inhibit (turn off) the output of the module).



Signal ratings

Module good signal	
Signal type (internal to PSU)	Uncommitted optocoupler transistor
Vce max	30V
Ic max	1mA

Module inhibit signal	
Signal type (internal to PSU)	Uncommitted optocoupler diode with 390R series resistor
Min LED current	1mA
Max LED current	10mA

Connector pin-out for signals

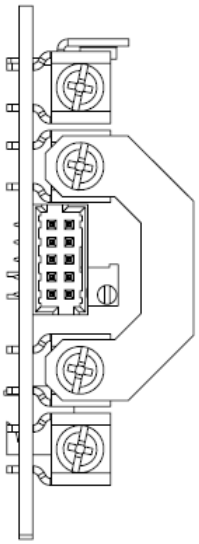
Pin	Function
1	No connection
2	
3	Module Good Collector
4	Module Good Emitter
5	Module Inhibit + (Anode)
6	Module Inhibit - (Cathode)
7	Remote Sense +
8	Remote Sense -
9	No connection
10	

Molex mating connectors and pins

(Contact Molex for other pin alternatives)

Description	**Molex part number**	**TDK-Lambda part number**
10 way Milli-Grid with locking ramp	51110-1060	12934
Crimp terminal, gold flash, female, supplied on a reel	50394-8051	12935
Crimp terminal, gold flash, female, supplied in a bag	50394-8400	
Crimp terminal, tin plated, female, supplied on a reel	51087-8101	

YB Modules

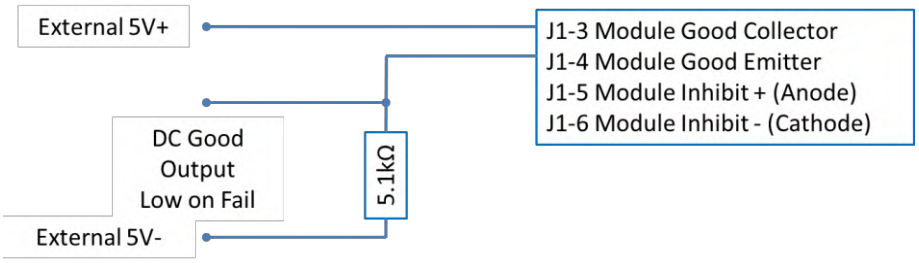


The YB module consists of a DH module preconfigured with outputs connected in series.

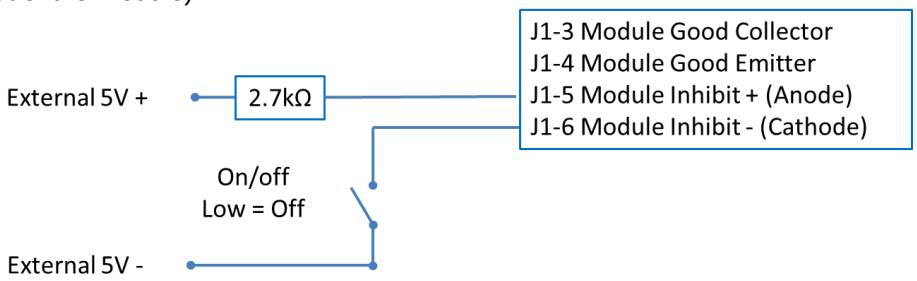
The output voltage can be adjusted across the range shown in the datasheet by using the potentiometer situated to the right of the signal connector. Turning the potentiometer clockwise increases the output voltage.

Signals

The Module Good signal is an isolated (200V from the output) opto-coupler transistor outputs. The maximum current allowed through the transistor is 1mA. This signal provides an indication that the output is above 90% of the output set voltage. The transistor is on when the output is “good”.



Module inhibit is an isolated opto-coupler diode input. Passing a minimum of 1mA through the diode will inhibit (turn off) the output of the module).



Signal ratings

Module good signal	
Signal type (internal to PSU)	Uncommitted optocoupler transistor
Vce max	30V
Ic max	1mA

Module inhibit signal	
Signal type (internal to PSU)	Uncommitted optocoupler diode with 390R series resistor
Min LED current	1mA
Max LED current	10mA

Connector pin-out for signals

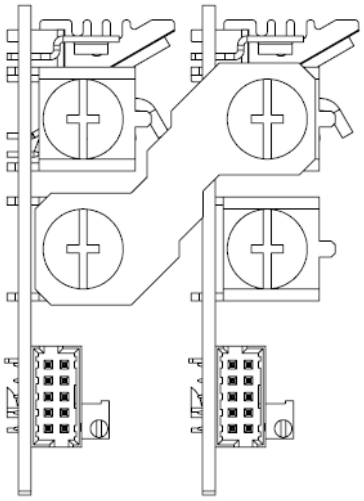
Pin	Function
1	No connection
2	
3	Module Good Collector
4	Module Good Emitter
5	Module Inhibit + (Anode)
6	Module Inhibit - (Cathode)
7	No connection
8	
9	
10	

Molex mating connectors and pins

(Contact Molex for other pin alternatives)

Description	**Molex part number**	**TDK-Lambda part number**
10 way Milli-Grid with locking ramp	51110-1060	12934
Crimp terminal, gold flash, female, supplied on a reel	50394-8051	12935
Crimp terminal, gold flash, female, supplied in a bag	50394-8400	
Crimp terminal, tin plated, female, supplied on a reel	51087-8101	

YC Modules



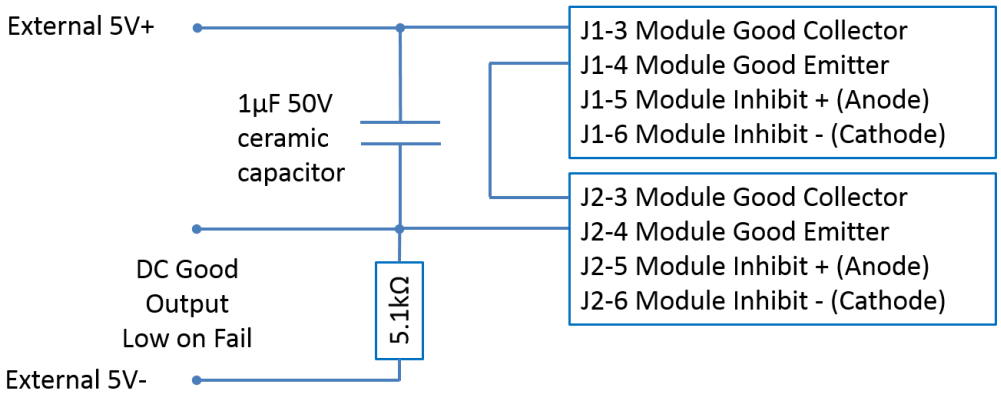
The output voltage can be adjusted from the factory set point across the range shown in the datasheet by performing the following operation:

- Apply AC power
- Individually adjust both potentiometers, situated to the right of the signal connectors, so that the output voltage of each board assembly is 50% of the desired output voltage. Turning the potentiometer clockwise increases the output voltage.
- Confirm that the module has the desired output voltage

The remote sense provides compensation for a maximum total load cable drop of 0.5V for the output. The voltage at the output terminals must be within the specified adjustment range. Connect J1 Pin 8 to J2 Pin 7. See the Remote Sense section in the POWER SUPPLY OPERATION chapter for connection advice.

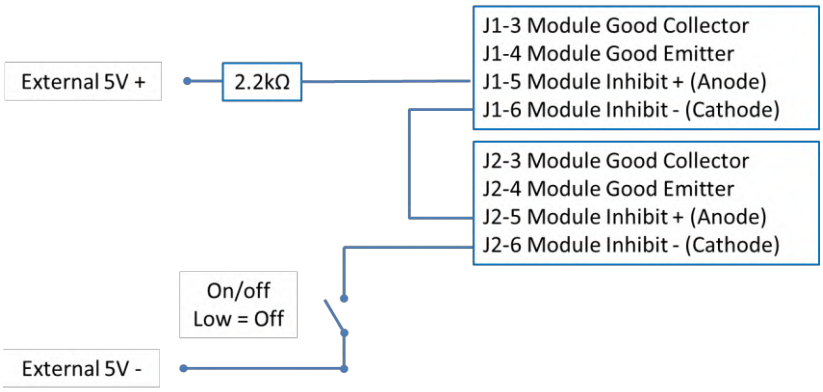
Signals

The Module Good signal is an isolated (200V from the output) opto-coupler transistor output. The maximum current allowed through the transistor is 1mA. This signal provides an indication that the output is above 90% of the output set voltage. The transistor is on when the output is “good”.



It is highly recommended to connect a 1uF 50V X7R ceramic capacitor between J1 Pin 3 and J2 Pin 4. This will avoid a voltage spike / false triggering of the Module Good signal during turn on. This is due to the series connection of the Module Good signals in the Y modules.

Module inhibit is an isolated opto-coupler diode input. Passing a minimum of 1mA through the diode will inhibit (turn off) the output of the module.



Signal ratings

Module good signal	
Signal type (internal to PSU)	Uncommitted optocoupler transistor (1 in each sub-module)
Vce max	30V
Ic max	1mA

Module inhibit signal	
Signal type (internal to PSU)	Uncommitted optocoupler diode with 390R series resistor (1 in each sub-module)
Min LED current	1mA
Max LED current	10mA

Connector pin-out for signals

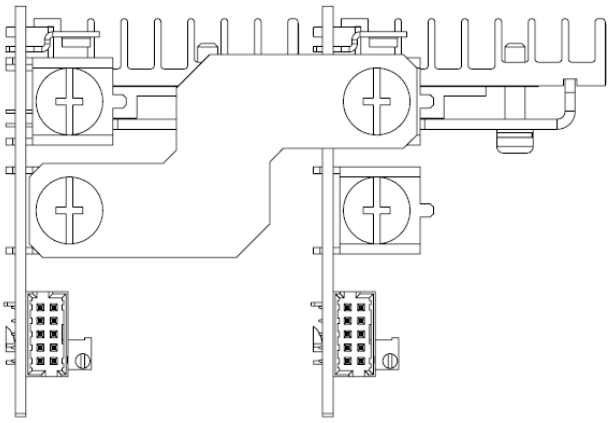
Pin	Function (J1 Left Connector)	Function (J2 Right Connector)
1	No connection	No connection
2		
3	Module Good Collector	Module Good Collector
4	Module Good Emitter	Module Good Emitter
5	Module Inhibit + (Anode)	Module Inhibit + (Anode)
6	Module Inhibit - (Cathode)	Module Inhibit - (Cathode)
7	Remote Sense +	Remote Sense +
8	Remote Sense -	Remote Sense -
9	No connection	No connection
10		

Molex mating connectors and pins

(Contact Molex for other pin alternatives)

Description	**Molex part number**	**TDK-Lambda part number**
10 way Milli-Grid with locking ramp	51110-1060	12934
Crimp terminal, gold flash, female, supplied on a reel	50394-8051	12935
Crimp terminal, gold flash, female, supplied in a bag	50394-8400	
Crimp terminal, tin plated, female, supplied on a reel	51087-8101	

YF Modules



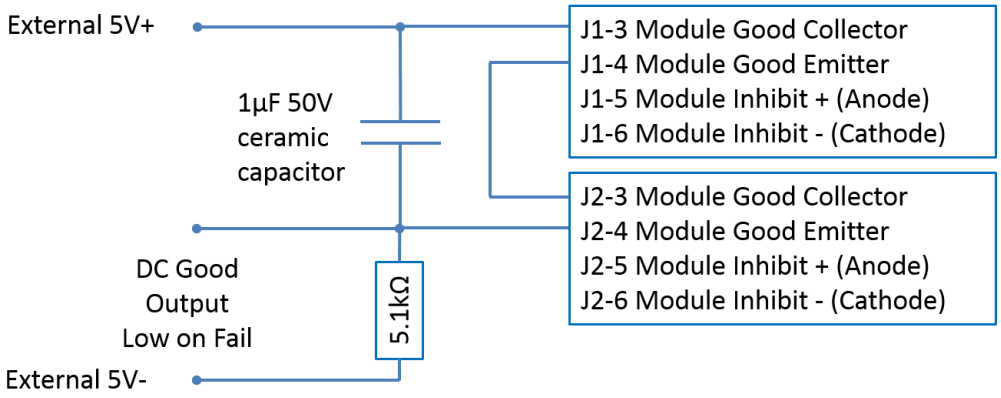
The output voltage can be adjusted from the factory set point across the range shown in the datasheet by performing the following operation:

- Apply AC power
- Individually adjust both potentiometers, situated to the right of the signal connectors, so that the output voltage of each board assembly is 50% of the desired output voltage. Turning the potentiometer clockwise increases the output voltage.
- Confirm that the module has the desired output voltage

The remote sense provides compensation for a maximum total load cable drop of 0.5V for the output. The voltage at the output terminals must be within the specified adjustment range. Connect J1 Pin 8 to J2 Pin 7. See the Remote Sense section in the POWER SUPPLY OPERATION chapter for connection advice.

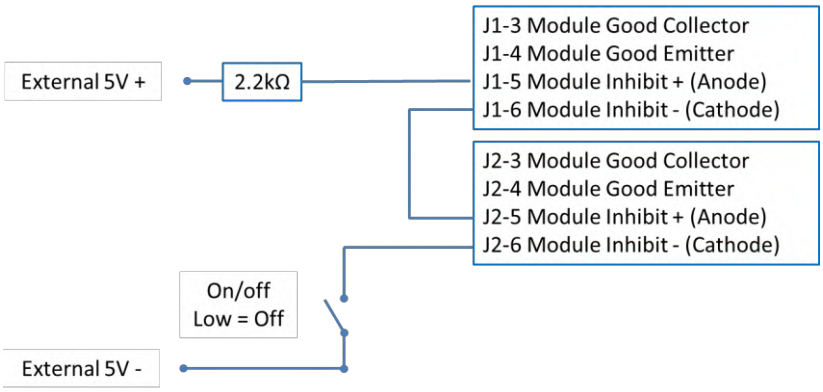
Signals

The Module Good signal is an isolated (200V from the output) opto-coupler transistor output. The maximum current allowed through the transistor is 1mA. This signal provides an indication that the output is above 90% of the output set voltage. The transistor is on when the output is “good”.



It is highly recommended to connect a 1uF 50V X7R ceramic capacitor between J1 Pin 3 and J2 Pin 4. This will avoid a voltage spike / false triggering of the Module Good signal during turn on. This is due to the series connection of the Module Good signals in the Y modules.

Module inhibit is an isolated opto-coupler diode input. Passing a minimum of 1mA through the diode will inhibit (turn off) the output of the module.



Signal ratings

Module good signal	
Signal type (internal to PSU)	Uncommitted optocoupler transistor (1 in each sub-module)
Vce max	30V
Ic max	1mA

Module inhibit signal	
Signal type (internal to PSU)	Uncommitted optocoupler diode with 390R series resistor (1 in each sub-module)
Min LED current	1mA
Max LED current	10mA

Connector pin-out for signals

Pin	Function (J1 Left Connector)	Function (J2 Right Connector)
1	No connection	No connection
2		
3	Module Good Collector	Module Good Collector
4	Module Good Emitter	Module Good Emitter
5	Module Inhibit + (Anode)	Module Inhibit + (Anode)
6	Module Inhibit - (Cathode)	Module Inhibit - (Cathode)
7	Remote Sense +	Remote Sense +
8	Remote Sense -	Remote Sense -
9	No connection	No connection
10		

Molex mating connectors and pins

(Contact Molex for other pin alternatives)

Description	**Molex part number**	**TDK-Lambda part number**
10 way Milli-Grid with locking ramp	51110-1060	12934
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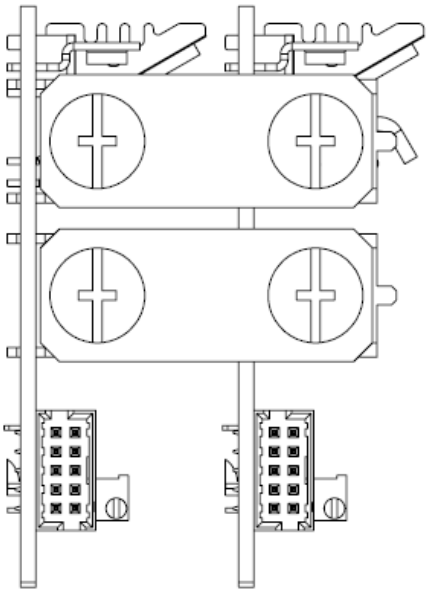
Crimp terminal, gold flash, female, supplied in a bag	50394-8400	
Crimp terminal, tin plated, female, supplied on a reel	51087-8101	

ZC Modules



The output voltage can be adjusted from the factory set point across the range shown in the datasheet by performing the following operation:

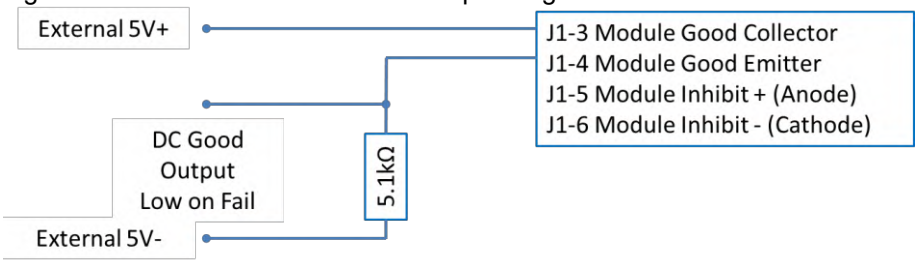
- Disconnect the AC power, then remove the two busbars connecting the Ch1 + and Ch1 0V terminals together
- Re-apply AC power
- Apply the load specified in the module table below to each of the modules which make up the Z module.
- Individually adjust both potentiometers, situated to the right of the signal connectors, so that the output voltage of each board assembly is at the desired set point. Note: Each output voltage must be within +/-0.25% of the desired point. Turning the potentiometer clockwise increases the output voltage
- Reconnect the two busbars and reapply AC power
- Confirm that the module has the desired output voltage

Output voltage range	Load to apply while adjusting output	
	Left hand module	Right hand module
15-16V	300W	300W
18-19.2V	300W	300W
28-29.9V	300W	300W

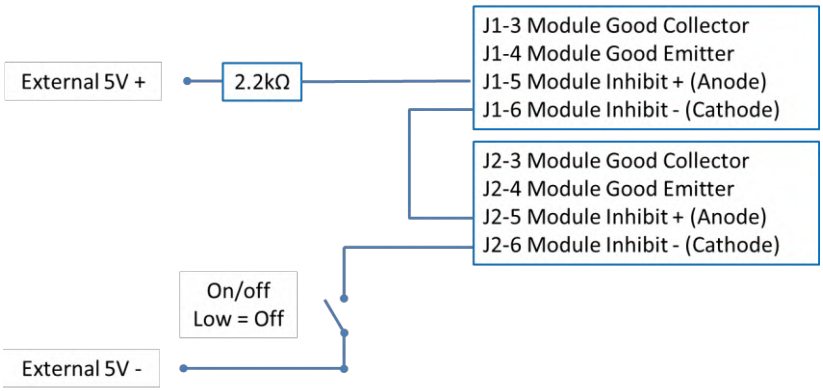
The remote sense provides compensation for a maximum total load cable drop of 0.5V for the output. The voltage at the output terminals must be within the specified adjustment range. See the Remote Sense section in the POWER SUPPLY OPERATION chapter for connection advice.

Signals

The Module Good signal is an isolated (200V from the output) opto-coupler transistor output. The maximum current allowed through the transistor is 1mA. This signal provides an indication that the output is above 90% of the output set voltage. The transistor is on when the output is “good”.



Module inhibit is an isolated opto-coupler diode input. Passing a minimum of 1mA through the diode will inhibit (turn off) the output of the module.



Signal ratings

Module good signal	
Signal type (internal to PSU)	Uncommitted optocoupler transistor (1 in each sub-module)
Vce max	30V
Ic max	1mA

Module inhibit signal	
Signal type (internal to PSU)	Uncommitted optocoupler diode with 390R series resistor (1 in each sub-module)
Min LED current	1mA
Max LED current	10mA

Connector pin-out for signals

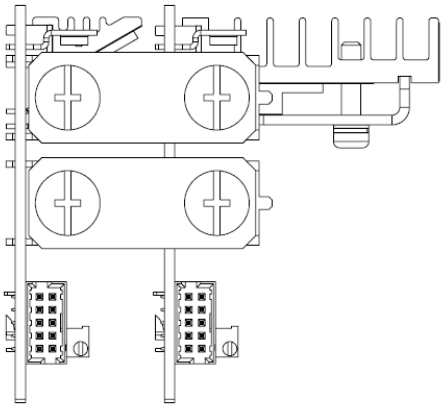
Pin	Function (J1 Left Connector)	Function (J2 Right Connector)
1	No connection	No connection
2		
3	Module Good Collector	Module Good Collector
4	Module Good Emitter	Module Good Emitter
5	Module Inhibit + (Anode)	Module Inhibit + (Anode)
6	Module Inhibit - (Cathode)	Module Inhibit - (Cathode)
7	Remote Sense +	Remote Sense +
8	Remote Sense -	Remote Sense -
9	No connection	No connection
10		

Molex mating connectors and pins

(Contact Molex for other pin alternatives)

Description	**Molex part number**	**TDK-Lambda part number**
10 way Milli-Grid with locking ramp	51110-1060	12934
Crimp terminal, gold flash, female, supplied on a reel	50394-8051	12935
Crimp terminal, gold flash, female, supplied in a bag	50394-8400	
Crimp terminal, tin plated, female, supplied on a reel	51087-8101	

ZD Modules



The output voltage can be adjusted from the factory set point across the range shown in the datasheet by performing the following operation:

- Disconnect the AC power, then remove the two busbars connecting the Ch1 + and Ch1 0V terminals together
- Re-apply AC power
- Apply the load specified in the module table below to each of the modules which make up the Z module.
- Individually adjust both potentiometers, situated to the right of the signal connectors, so that the output voltage of each board assembly is at the desired set point. Each output voltage must be within the following tolerances:

  For modules <10V: +/-0.1% of the desired voltage set point
  For modules >10V: +/-0.25% of the desired voltage set point

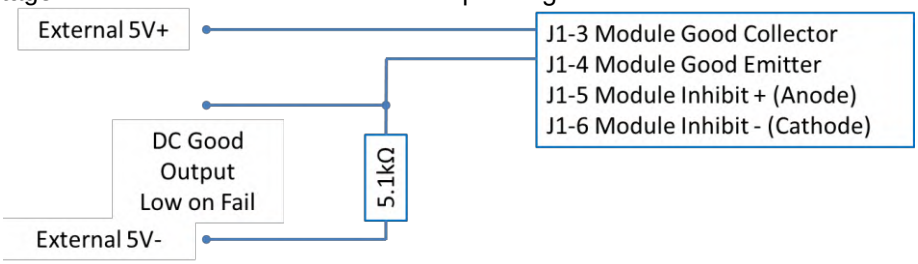
  Turning the potentiometer clockwise increases the output voltage
- Reconnect the two busbars and reapply AC power
- Confirm that the module has the desired output voltage

Output voltage range	Load to apply while adjusting output	
	Left hand module	Right hand module
5-5.3V	150W	300W
12-12.8V	300W	600W
24-25.6V	300W	600W
48-51.2V	300W	600W

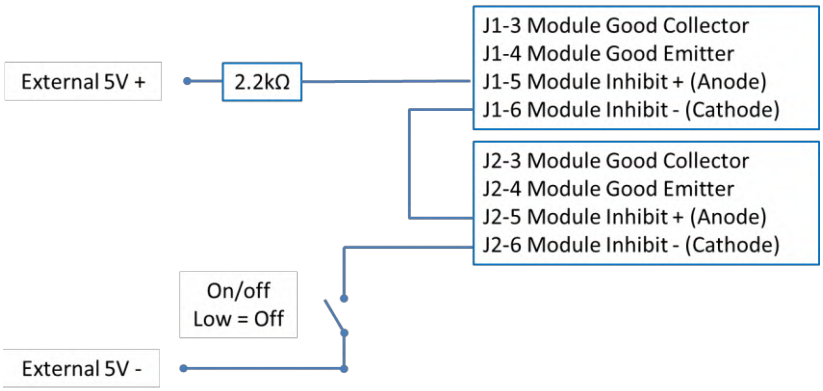
The remote sense provides compensation for a maximum total load cable drop of 0.5V for the output. The voltage at the output terminals must be within the specified adjustment range. See the Remote Sense section in the POWER SUPPLY OPERATION chapter for connection advice.

Signals

The Module Good signal is an isolated (200V from the output) opto-coupler transistor output. The maximum current allowed through the transistor is 1mA. This signal provides an indication that the output is above 90% of the output set voltage. The transistor is on when the output is “good”.



Module inhibit is an isolated opto-coupler diode input. Passing a minimum of 1mA through the diode will inhibit (turn off) the output of the module.



Signal ratings

Module good signal	
Signal type (internal to PSU)	Uncommitted optocoupler transistor (1 in each sub-module)
Vce max	30V
Ic max	1mA

Module inhibit signal	
Signal type (internal to PSU)	Uncommitted optocoupler diode with 390R series resistor (1 in each sub-module)
Min LED current	1mA
Max LED current	10mA

Connector pin-out for signals

Pin	Function (J1 Left Connector)	Function (J2 Right Connector)
1	No connection	No connection
2		
3	Module Good Collector	Module Good Collector
4	Module Good Emitter	Module Good Emitter
5	Module Inhibit + (Anode)	Module Inhibit + (Anode)
6	Module Inhibit - (Cathode)	Module Inhibit - (Cathode)
7	Remote Sense +	Remote Sense +
8	Remote Sense -	Remote Sense -
9	No connection	No connection
10		

Molex mating connectors and pins

(Contact Molex for other pin alternatives)

Description	**Molex part number**	**TDK-Lambda part number**
10 way Milli-Grid with locking ramp	51110-1060	12934
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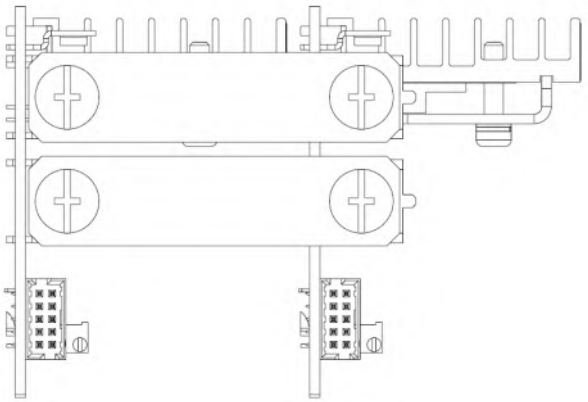
Crimp terminal, gold flash, female, supplied in a bag	50394-8400	
Crimp terminal, tin plated, female, supplied on a reel	51087-8101	

ZF Modules



The output voltage can be adjusted from the factory set point across the range shown in the datasheet by performing the following operation:

- Disconnect the AC power, then remove the two busbars connecting the Ch1 + and Ch1 0V terminals together
- Re-apply AC power
- Apply the load specified in the module table below to each of the modules which make up the Z module.
- Individually adjust both potentiometers, situated to the right of the signal connectors, so that the output voltage of each board assembly is at the desired set point Each output voltage must be within the following tolerances:

  For modules <10V: +/-0.1% of the desired voltage set point
  For modules >10V: +/-0.25% of the desired voltage set point

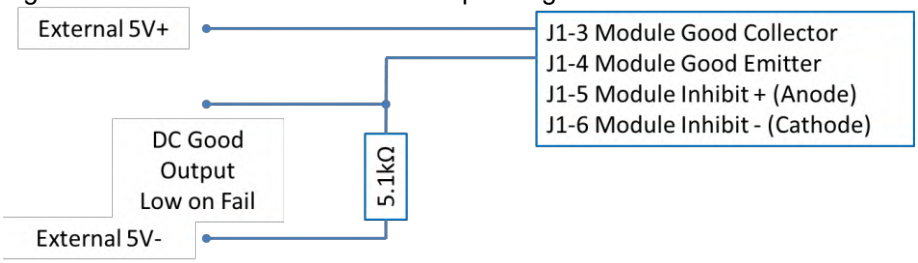
  Turning the potentiometer clockwise increases the output voltage
- Reconnect the two busbars and reapply AC power
- Confirm that the module has the desired output voltage

Output voltage range	Load to apply while adjusting output	
	Left hand module	Right hand module
5-5.3	300W	300W
12-12.8	600W	600W
36-38.4	600W	600W

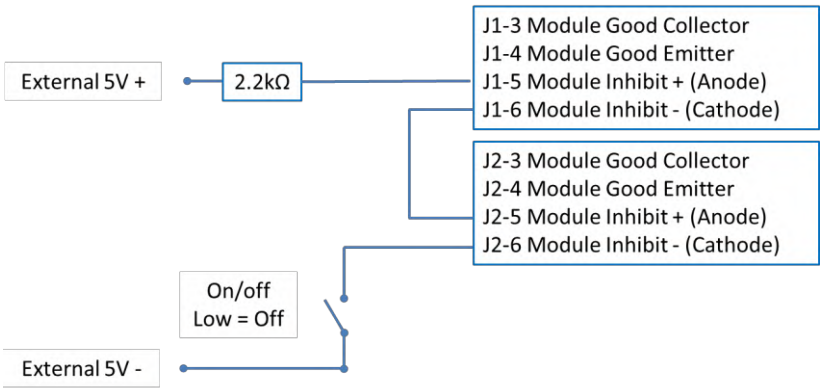
The remote sense provides compensation for a maximum total load cable drop of 0.5V for the output. The voltage at the output terminals must be within the specified adjustment range. See the Remote Sense section in the POWER SUPPLY OPERATION chapter for connection advice.

Signals

The Module Good signal is an isolated (200V from the output) opto-coupler transistor outputs. The maximum current allowed through the transistor is 1mA. This signal provides an indication that the output is above 90% of the output set voltage. The transistor is on when the output is “good”.



Module inhibit is an isolated opto-coupler diode output. Passing a minimum of 1mA through the diode will inhibit (turn off) the output of the module).



Signal ratings

Module good signal	
Signal type (internal to PSU)	Uncommitted optocoupler transistor (1 in each sub-module)
Vce max	30V
Ic max	1mA

Module inhibit signal	
Signal type (internal to PSU)	Uncommitted optocoupler diode with 390R series resistor (1 in each sub-module)
Min LED current	1mA
Max LED current	10mA

Connector pin-out for signals

Pin	Function (J1 Left Connector)	Function (J2 Right Connector)
1	No connection	No connection
2		
3	Module Good Collector	Module Good Collector
4	Module Good Emitter	Module Good Emitter
5	Module Inhibit + (Anode)	Module Inhibit + (Anode)
6	Module Inhibit - (Cathode)	Module Inhibit - (Cathode)
7	Remote Sense +	Remote Sense +
8	Remote Sense -	Remote Sense -
9	No connection	No connection
10		

Molex mating connectors and pins

(Contact Molex for other pin alternatives)

Description	**Molex part number**	**TDK-Lambda part number**
10 way Milli-Grid with locking ramp	51110-1060	12934
Crimp terminal, gold flash, female, supplied on a reel	50394-8051	12935
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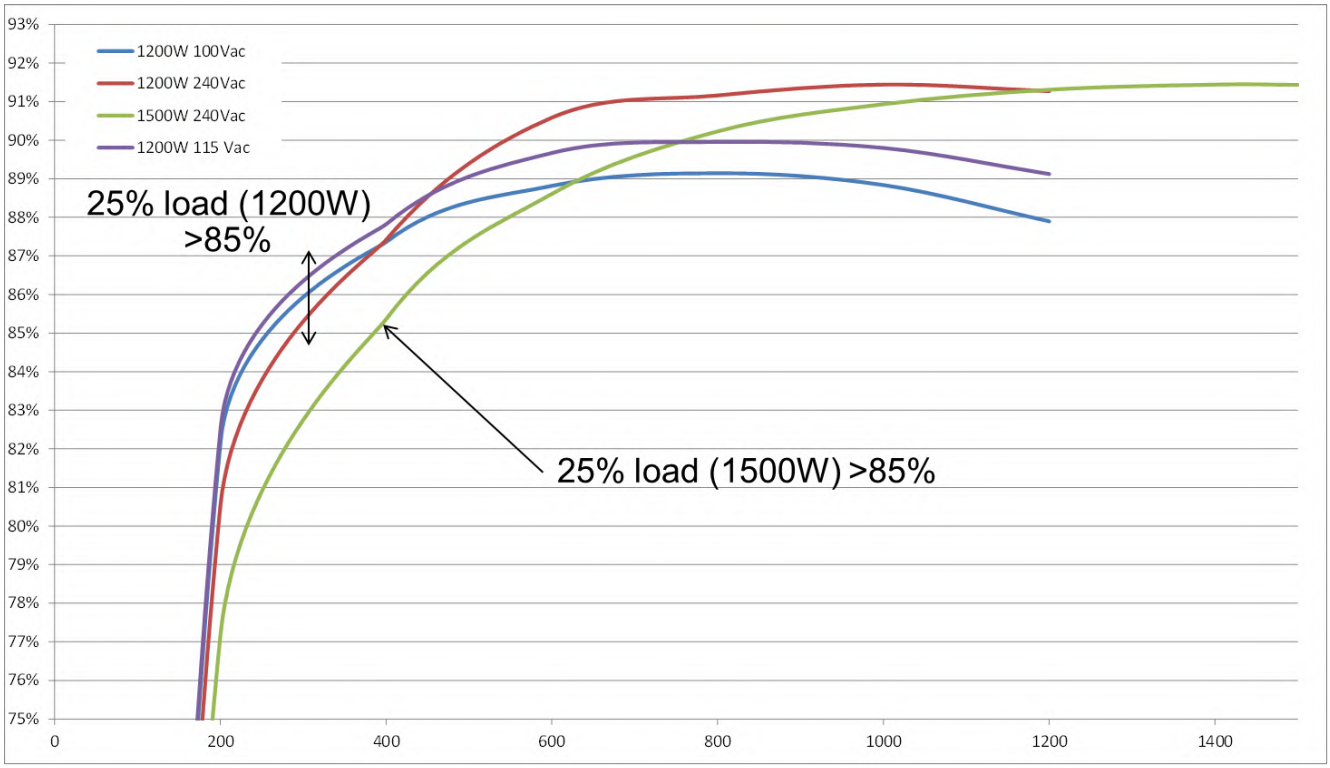
Crimp terminal, tin plated, female, supplied on a reel	51087-8101	

5. EFFICIENCY

The following chart shows the measured efficiency of a QM7FSDL 24SCS 24SCS 24SCS configuration.



6. POWER SUPPLY OPERATION

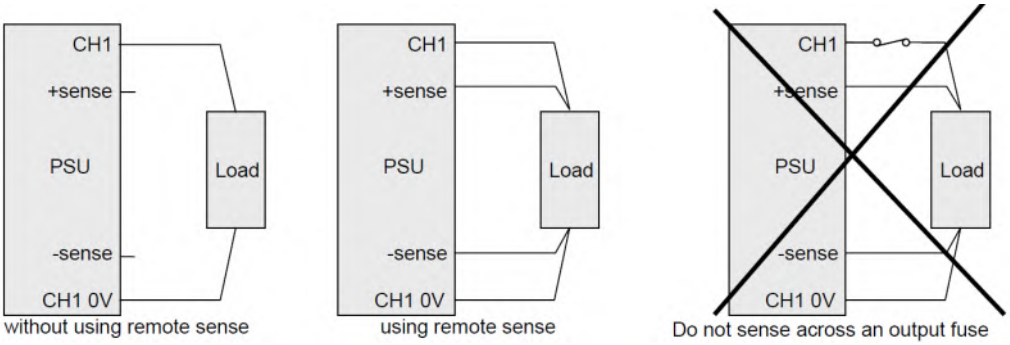
No Load Operation

No minimum load is required for the power supply to operate within specification.

Remote Sense

Remote sensing is provided on select modules to compensate for voltage drops in the power connections to the load. The remote sense lines may be connected as follows:

- If remote sense is not required, simply do not connect either '+sense' or '–sense'
- If remote sense is required, connect '-sense' and '+sense' to the corresponding point at the load (see the drawing below for details)
- Note – do not connect remote sense across an output fuse
- Care should be taken to ensure that remote sense is connected in the correct polarity and is disconnected from the load before the power connections are removed



Capacitive Load Operation

Please refer to the QM datasheets for maximum output capacitance load values.

Transient Load Operation – DM Module

Under the following conditions it is possible to get a negative transient on Ch2 that is greater than10%:

Ch1 is set to min Vo
500uF/A on both outputs

And either:

0 – 100% transient on Ch1 with Full load on Ch2

Or

No load on Ch1 With 0 – 100% transient on Ch2.

The transient deviation can be reduced to less than 10% if a minimum load is applied to Ch1 as follows:

		Load W	Min load Ch1
Module	14(12)/3v3	120W/30W	1A
	14(12)/5	120W/50W	1A
	14(12)/12	100W/100W	1A
	14(12)/24	100W/100W	1A
	24/3v3	120W/30W	0.9A
	24/5	120W/50W	0.9A
	24/24	100W/100W	0.9A

Note: The maximum frequency for the transients is 25Hz, above this frequency the deviation can be bigger than specified. Reducing the external output capacitance can be beneficial, but this would need to be evaluated in each application.

Series Connection

It is possible to connect two identical DH module outputs or two identical single output SB and SC modules in series.

The outputs connected in series are non-SELV (Safety Extra Low Voltage) if the total output voltage plus 30% of the highest maximum rated output voltage, exceeds 60V (the 30% addition allows for a single fault in any one individual channel).

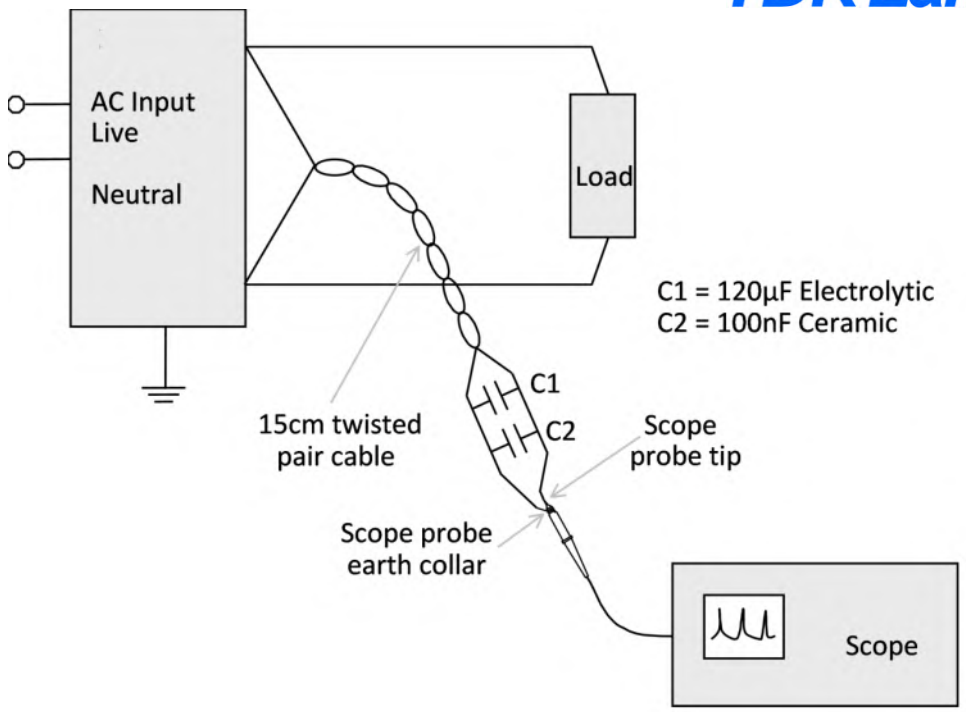
Parallel Connection

Parallel connection is possible to connect up to 2 same voltage SB and SC modules in parallel but droop mode (-D) operation must be specified on each module.

7. OUTPUT CHARACTERISTICS

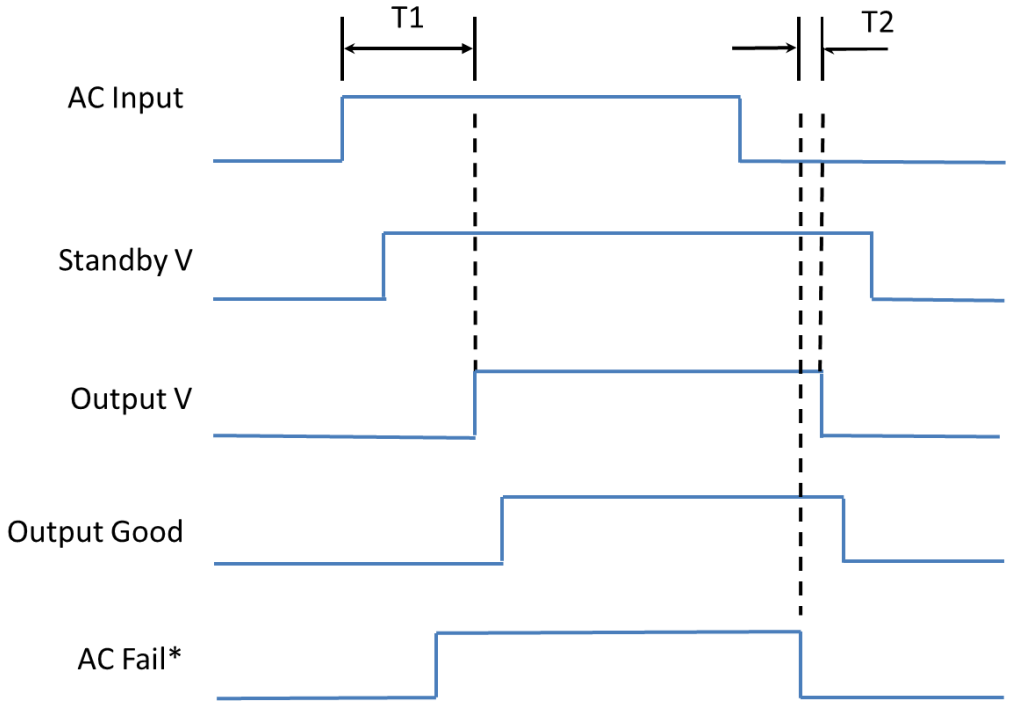
Ripple and Noise

Ripple and noise is defined as periodic or random signals over a frequency range of 10Hz to 20MHz. Measurements are to be made with a 20MHz bandwidth oscilloscope. Measurements are taken at the end of a 150mm length of a twisted pair of cables, terminated with a 100nF ceramic capacitor and a 120µF electrolytic capacitor. The earth wire of the oscilloscope probe should be as short as possible; winding a link wire around the earth collar of the probe is the preferred method.



Ripple and Noise Measurement

Power Supply Timing



* Configured as Low On Fail

	Minimum	Nominal	Maximum
T1	-	-	2s
T2	5ms	-	-

POWER SUPPLY PROTECTION

No Load Operation

The power supply will operate with no load on the output with no damage or hazardous condition.

Overload and short circuit protection

An overload or short circuit condition on the output(s) will cause no damage to the power supply. The power supply may attempt to restart until the overload or short circuit is removed. After removal of the overload or short circuit, the power supply will automatically resume normal operation.
Any output or module may latch off with a hard short applied across the output terminals, requiring an on/off ac cycle to reset.

Over temperature protection

Main converter: In the event of the temperature rising beyond specified limits, the QM power supply converter will turn off, excluding the Standby voltages. Once normal temperatures are resumed, the QM will automatically resume normal operation.

Standby supplies: If overheating occurs then this will turn off. Once normal temperatures are resumed, the QM will automatically resume normal operation.

DH module: If overheating occurs, Channels 1 and 2 will turn off and the AC will need to be recycled.

DM module: If overheating occurs, Channels 1 and 2 will turn off and the AC will need to be recycled. If overheating occurs only on the Channel 2 secondary the module will automatically restart when once normal temperatures are reached.

SB, SC, Z & Y module: If overheating occurs, The output will turn off and the AC will need to be recycled

Over voltage protection

An overvoltage on the output will cause the output module to shut-down. To restart, remove the ac supply for a minimum of 10 seconds and then reapply. Note, an overvoltage on the standby supplies will require the ac to be removed for several minutes before restarting the unit.

8. COOLING REQUIREMENTS

The QM series has internal variable speed cooling fans. A minimum clearance of 50mm should be provided at the input and output ends to allow air to enter and exit the power supply.

If other fans are used in the system, ensure that the QM airflow direction is in the same direction. Failure to do this can result in the power supply overheating due to low air pressure.

9. RELIABILITY

MTBF

Test Specifications: Telcordia SR332 Issue 4, 2016

Test Method: Method I (Parts Count), 90% upper confidence level.
Device Method I-D, Quality II, Electrical Stress 50%.

Results
The failure rates are given for the different sub-assemblies as both mean failure rate and with an upper confidence level of 90% in the table below at 70°C, 40°C and 25°C.

Assembly	Telcordia SR332 Issue 4 Mean Failure Rate (FITs[1])			Telcordia SR332 Issue 4 UCL[2] Failure Rate (FITs)		
	70°C	40°C	25°C	70°C	40°C	25°C
QM7 or QM8 EndCap & Fans	932.981	300.000	195.518	1347.091	433.157	282.301
QM7 or QM8 Converter	366.050	120.767	85.757	417.517	131.628	92.506
QM4 or QM5 EndCap & Fans	466.490	150.000	97.759	673.545	216.579	141.150
QM5 Converter	352.518	116.297	82.607	403.496	126.978	89.243
QM4 Converter	338.995	109.437	77.272	389.984	120.060	83.845
T5H or T12H Global Option	269.037	69.324	47.360	306.667	80.196	55.687
T5L Global Option	85.405	18.390	12.109	101.325	20.679	13.565
P5H Global Option	448.181	126.829	89.657	507.434	144.966	104.904
SA Module	257.791	75.691	52.270	302.278	87.476	60.927
≤8V SB or SC Module	391.874	120.833	86.075	445.098	138.202	99.972
≥8V SB or SC Module	400.853	123.523	87.809	454.374	140.961	101.738
DM Module	576.948	202.903	151.994	636.358	225.539	170.575
DH Module	373.969	132.477	98.315	419.809	150.608	113.068

Calculating for a Configuration
To calculate the mean failure rate of a given configuration you can simply sum the mean failure rates of the constituent sub-assemblies. To convert to MTBF divide one billion (1,000,000,000) by the mean failure rate. To calculate the upper confidence level failure rate however, simply summing the ULC failure rates gives a pessimistic result. To calculate it correctly will require contacting Technical Support at TDK Lambda UK, this can be done for any configuration at any ambient temperature and different confidence levels if required.

Worked Examples
To calculate the reliability at 40°C for the configuration:

QM5FSDL P5H 5SB 12/12DM 12/12DM 24/5DM 24/3V3DM
The F in QM5**F**SDL shows this is a unit with built in fan.

EndCap & Fan	150.000
QM5 Converter	116.297
P5H	126.829
5SB	120.833
DM Module ×4	202.903 × 4
Mean failure rate	1325.571
MTBF	1,000,000,000 ÷ 1325.571= 754,391 hours

With an Upper Confidence Level (UCL) of 90% this is 1408.518 or an MTBF of 774,275 hours.

[1] FIT's = Failures In Time. A failure rate of 1 per billion hours.
[2] UCL = Upper Confidence Level, for a confidence level of 90%.

To calculate the reliability at 25°C for the configuration:

QM7FSDL T5H 12ZF 24SB 12/12DM

The F in QM7**F**SDL shows this is a unit with built in fans.

EndCap & Fans	195.518
QM7 Converter	85.757
T5H	47.360
12ZF (2 × 12SC in parallel)	175.618
24SB	87.809
12/12DM	151.994
Mean failure rate	744.057
MTBF	1,000,000,000 ÷ 744.057= 1,325,572 hours

With an Upper Confidence Level (UCL) of 90% this is 833.471 or an MTBF of 1,199,801 hours.

If you require a configuration calculated correctly, rather than the slightly pessimistic approximation given here, please contact Technical Support.

Electrolytic capacitor life calculations

Conditions: 40°C ambient, 100Vac input, 75% loading. Figures in hours

Capacitor	QM4 Converter	QM5 Converter	QM7 Converter	QM8 Converter
C10	252,813	158,895	208,653	208,653
C11	251,389	251,389	475,656	475,656
C2	167,146	167,146	176,676	176,676
C7	148,060	148,060	285,227	285,227
C8	121,772	121,772	267,002	267,002
C9	N/A	N/A	399,128	399,128
C13	3,327,524	3,327,524	4,646,450	3,690,806

DH module			
Capacitor	DH12/12	DH12/24	DH24/24
C207	74,575	73,896	138,431
C204	171,638	192,534	194,432
C210	93,827	140,257	140,257

DM module		
Capacitor	DM12/12	DM4/24
C207	123,974	129,700

SA module				
Capacitor	SA5	SA12	SA15	SA24
C200	369,820	208,952	333,300	190,285
C201	369,820	231,029	341,781	190,285
C202	442,851	229,036	366,312	201,135

SB module			
Capacitor	SB4	SB12	SB24
C205	354,723	137,648	107,596
C206	306,869	110,222	88,562
C207	306,643	110,176	89,852

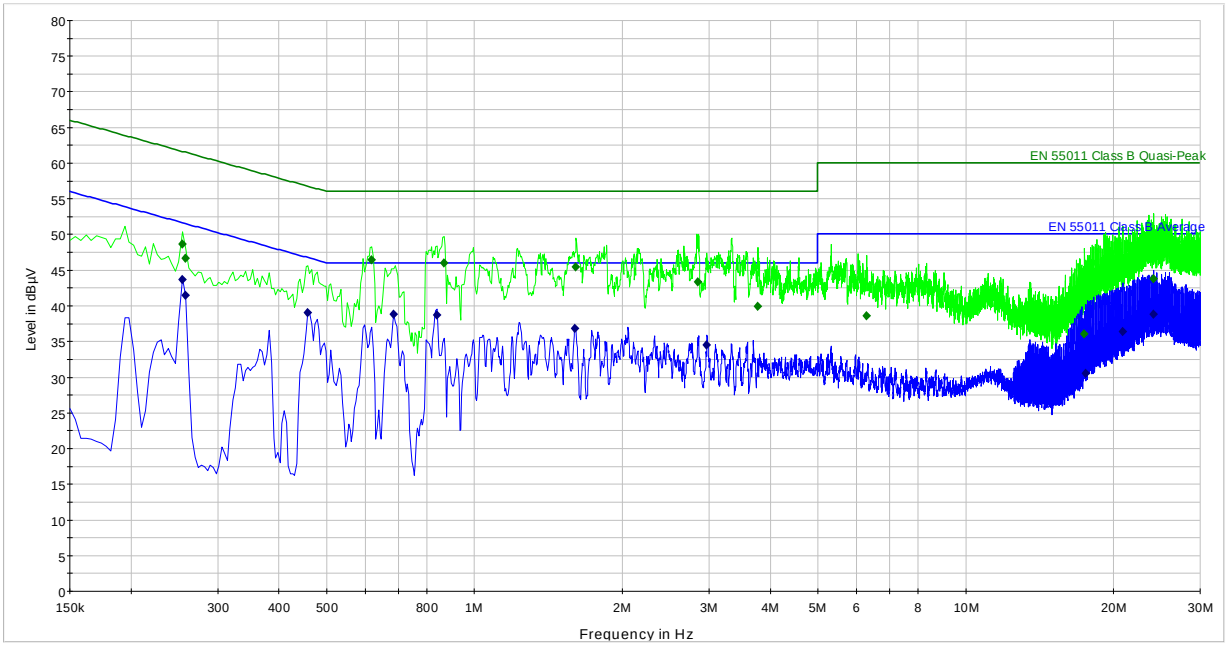
SC module			
Capacitor	SC5	SC12	SC24
C205	391,713	529,423	527,205
C206	148,613	498,584	142,108
C207	391,540	532,502	535,502

10. EMC PERFORMANCE

Conducted and Radiated Emissions Result for a QM7

Configuration with one of each type of module, at 1500W load, 7dB margin to Class B (High line)

Conducted emissions



In configurations with dual output modules (DM or DH) the margin is reduced with very low load levels. To avoid reduced margin the total load of these modules should be kept above 5W.

Radiated emissions, 6.8dB margin

Frequency (MHz)	QuasiPeak (dBµV/m)	Polarisation	Limit EN55011 Class B (dBµV/m)	Margin EN55011 Class B (dB)	Limit FCC Class B (dBµV/m)	Margin FCC Class B (dB)
47.76	32.2	V	40.0	7.8	40.0	7.8
51.60	31.1	V	40.0	6.9	40.0	6.9
56.60	32.9	V	40.0	7.1	40.0	7.1
60.80	30.5	V	40.0	9.5	40.0	9.5
66.64	30.5	V	40.0	9.5	40.0	9.5
72.80	33.2	V	40.0	6.8	40.0	6.8*
88.68	33.9	V	40.0	6.1*	43.5	9.6
92.88	33.2	V	40.0	6.8	43.5	10.3
151.04	24.6	H	40.0	15.4	43.5	18.9
160.00	28.1	V	40.0	11.9	43.5	15.4

*Minimum margin highlighted.

Installation for Optimum EMC Performance

Mounting

All equipment ideally should be mounted inside an earthed shielded metal box. Alternatively an earthed metal plate can be used to mount the power supply and load.

EMC Susceptibility

To reduce susceptibility to electrical fast transients fit a 120uF low ESR cap across the output terminals of Ch2 of the 12/12 DM module.

Cables

All cables (AC input, DC output, remote sense and signal) should be run as close as possible to the earthed metal box/plane.
AC input cable should be a twisted group laid as flat to the earthed metal box/plane as possible.

Run the remote sense and power output cables as separate pairs twisted tightly together with at least 1 twist per centimetre. Keep separate from the input cables. If the input and output cables must be run close to each other screen one (or ideally both).

All cable run loops should be kept as small as possible (this should be implemented in the system PCB design also).

The radiated emissions performance may be further improved by fitting ferrite clamps to each of the input and output cables.

Example parts which can be used are
TDK ZCAT3035-1330
TDK ZCAT2436-1330

PMBus™ Option

The PMBus™ Clock and Data rise and fall times can be as fast as 20 ns, with a clock frequency of 100 kHz. TDK-Lambda recommends that the appropriate precautions are taken to improve EMC performance. The following will help with both emissions and immunity performance when the PMBus™ feature is used:

All communications cables should be kept as short as possible.

Good practice should be used in laying out any system PCB's containing the communications bus.

For the communications cable, use screened cable with the screen connected to ground at the QM PMBus™ interface end, or at both ends.

If an unscreened communications cable is used it should not be run in parallel with other cables in the system.

If USB - PMBus™ Adaptors are used, care should be taken in their placement, as these can cause interference problems. For the purpose of EMC testing, TDK-Lambda recommends a screened box to reduce its emissions.

Any system components that are known to be sources of interference should be physically separated from the PMBus™ cabling.

Connecting between boxes

If cables must be connected between equipment boxes, then at the closest possible point to the port where the cables exit the 1st enclosure connect 100nF decoupling Y caps (between the output and earth). Note that these capacitors must be rated at the working voltage. Ideally these capacitors should be between all signal cables which have to connect between boxes although this may not be practical if fast switching [digital] signals are involved (if this is the case then smaller value Y capacitors should be used).

The Electrical Fast Transient (EFT) immunity test to EN 61000-4-4 and Conducted RF Immunity to EN 61000-4-6 have tests to be applied to DC Power Ports and Signal Ports and Control Ports where the length of the connection is greater than 3m. Due to practical limitations of voltage drops down cables this test was not applied to output voltage modules of less than 12V nominal.

Earth star point

Where the AC supply enters the equipment, this should be taken to a 'star point' chassis mounted earth point. Ensure wiring and earth grounding methods comply with the appropriate safety standards and National Electrical Codes.

ESD Protection

Where signal or control ports are connected to a user accessible panel (for example PSU inhibit to a switch, module good to an indicator circuit, etc.), these ports must be protected from electrostatic discharges. This can be done by selecting suitable panel controls or by fitting ESD suppression devices to the connections on the panel.

Switching frequencies

	Min kHz	Nom kHz	Max kHz
Converter	106	125	144
QM Auxiliary supply	82	100	119
HPGO Standby supply	90	100	110
SA Module	70		125
SB, YC Module	70	-	110
SC, YF, ZC, ZF Module	65	-	100
DM Module CH1	100	-	140
DM Module CH2 – 3.3V	456	518	580
DM Module CH2 – 5V	456	518	580
DM Module CH2 – 12V	204	227	249
DM Module CH2 – 24V	273	307	340
DH, YB Module	100	-	140
ZD Module	65	-	110

Steady state condition

11. MOUNTING

Please refer to Installation Manual for allowable orientations and any possible derating.

Mount using a minimum of four of the threaded mounting inserts.

12. WEIGHT

The QM power supply weights are variable determined by the number of modules fitted. From the configuration code select the modules, options and blanking plate(s).

Module	Weight (g)	Notes
QM4 Converter & Chassis	1020	
QM5 Converter & Chassis	1030	
QM5 Converter, Chassis & IEC320 Connector	1160	One converter and chassis
QM7 Converter & Chassis	1683	must be chosen
QM8 Converter & Chassis	1766	
Standby/Signals Option (xxL)	27	
Standby/Signals Option (xxH)	57	
1 Slot Module (DH or DM)	196	
1 Slot Module (SA)	120	
1 Slot Module (SB)	180	
2 Slot Module (SC)	256	
2 Slot Module (YC or ZC)	371	
3 Slot Module (ZD)	446	
4 Slot Module (YF, ZF)	530	
Blanking Plate	5	

13. AUDIBLE NOISE

Measured in accordance with BS EN ISO 3744:2010
(Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure)

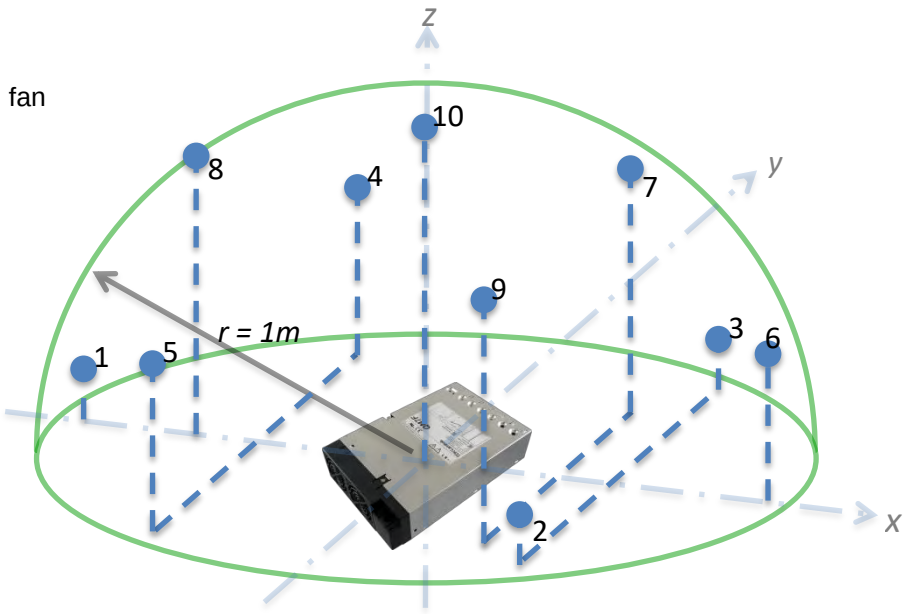
The QM7 has two variable speed fans sensing incoming ambient airflow.

QM7F at 25°C 43.6 dB(A)
QM7F at 50°C 57.3 dB(A)

The QM5 has one variable speed fan

QM5F at 25°C 40.3 dB(A)
QM5F at 50°C 54.9 dB(A)

QM5I at 25°C 36.9 dB(A)
QM5I at 50°C 51.0 dB(A)

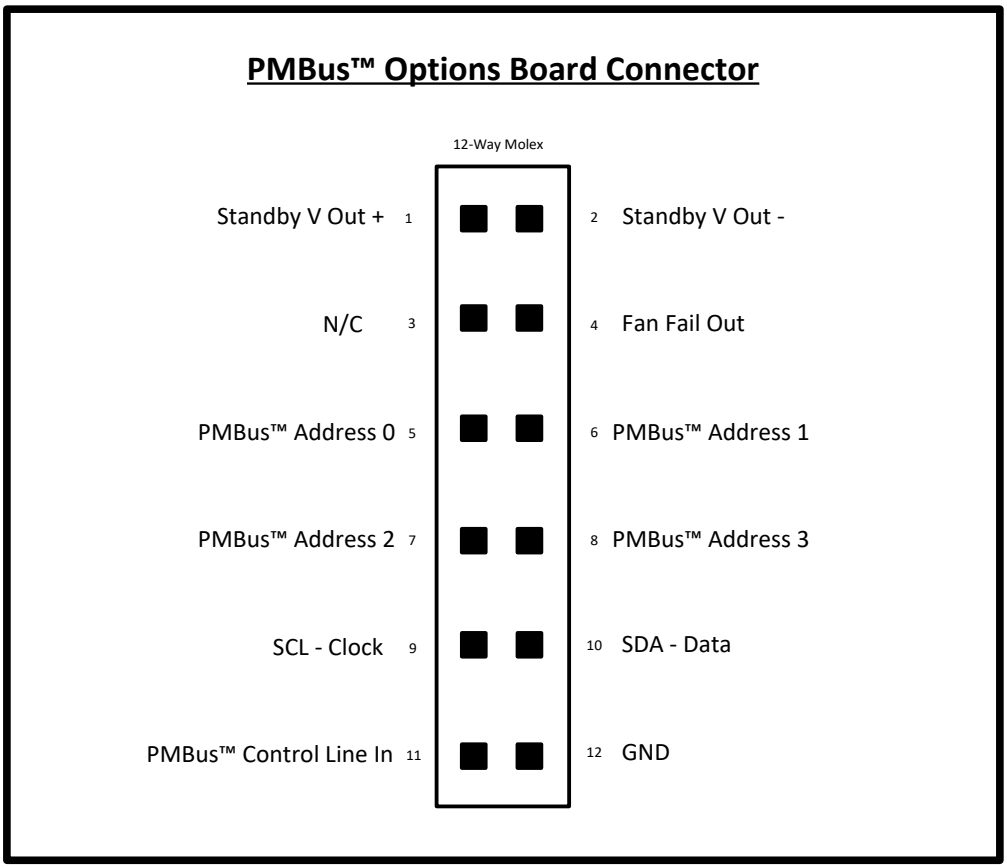


14. PMBus™

Overview of the PMBus™ Interface

Standard 100kHz operation
PEC (Packet Error Checking) supported
Monitoring of status - reading and clearing of fault and warning indications
Reading manufacturing related data – manufacturer id, model name, serial number & manufacturing date
Reading of fan speeds and inlet temperature
Reading operating time and power cycle count
On/Off control of the module outputs by PMBus™ Command, PMBus™ Control Pin, or a combination of both
Up to 8 units may be connected to a single PMBus™ controller

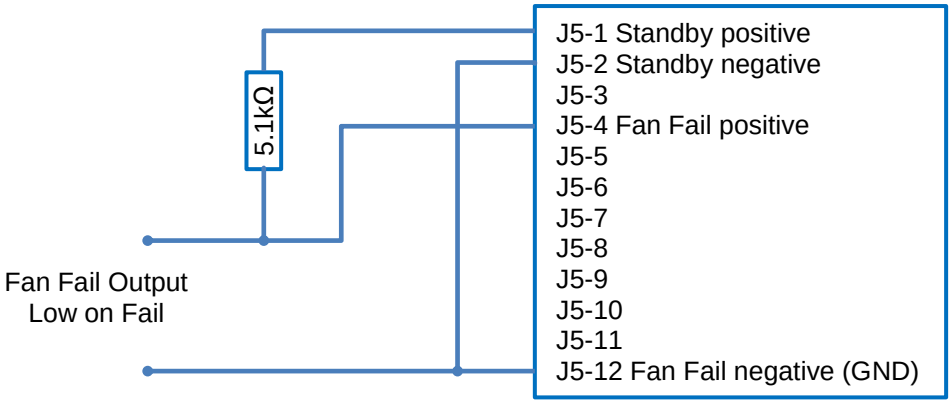
Hardware Interface



Pin #	Use	Notes
J5-1	Standby V Out +	Standby Voltage Supply Output (+ve)
J5-2	Standby V Out -	Standby Voltage Supply Output (-ve)
J5-3	N/C	Not Connected
J5-4	Fan Fail Out	Open Collector, see below
J5-5	PMBus Address 0	These lines are pulled high internally. Pull to Ground (pin 12) to select different PMBus addresses. See Section 3 below.
J5-6	PMBus Address 1	
J5-7	PMBus Address 2	
J5-8	PMBus Address 3	
J5-9	SCL – Clock	Logic 0/1 – GND/3v3
J5-10	SDA - Data	Logic 0/1 – GND/3v3
J5-11	PMBus Control Line In	Logic 0/1 – GND/3v3
J5-12	GND	Reference Ground for J5-4 to J5-11

The Fan Fail Out signal (J5-4)

Provided by an internal FET which is referenced to pin 12 of the option connector. Pin 4 is the FET drain (+) and pin 12 the source (-). This signal provides a warning that the QM fan has stopped or the fan speed is slowing and should be replaced. The FET will be on when the fan is running less than 50% of the expected fan speed for the ambient temperature and "off" if the fan speed is above 50%. It is recommended that the Fan Fail is connected to the 5V standby supply with a 5.1kΩ series resistor to limit the current.



Note that the Fan Fail Out signal may be generated by the slow running of either fan 1 or fan2 (if fitted). The Fan Fail Out indication is latching, and remains indicating until reset by PMBus™ command (81h), or cycling the power to the unit.

Setting the PMBus™ Address

Each unit in a system sharing a common Bus must use a unique PMBus™ address. The address may be set by grounding the address pins on the connector. The address of the unit is then given by the following table:

A3 Grounded	A2 Grounded	A1 Grounded	A0 Grounded	Address (decimal)
✓	✓	✓	✓	100
✓	✓	✓	×	101
✓	✓	×	✓	102
✓	✓	×	×	103
✓	×	✓	✓	104
✓	×	✓	×	105
✓	×	×	✓	106
✓	×	×	×	107
×	✓	✓	✓	108
×	✓	✓	×	109
×	✓	×	✓	110
×	✓	×	×	111
×	×	✓	✓	112
×	×	✓	×	113
×	×	×	✓	114
×	×	×	×	115

By default the address lines are pulled high internally, giving a default PMBus™ address of 115.

Supported PMBus™ Commands

See references [1], [2], and [3] for details of the PMBus™ command structure and transaction types.

Command Name	Command Code	Transaction Type(s)	Notes
OPERATION	01h	Read/Write Byte	
ON/OFF CONFIG	02h	Read/Write Byte	
CLEAR FAULTS	03h	Send Byte	
CAPABILITY	19h	Read Byte	
STATUS BYTE	78h	Read/Write Byte	General unit status
STATUS_FANS_1_2	81h	Read/Write Byte	Fan faults or warnings
READ TEMPERATURE	8Dh	Read Word	LINEAR11 format
READ FANSPEED 1	90h	Read Word	LINEAR11 format
READ FANSPEED 1	91h	Read Word	LINEAR11 format
PMBus™ REVISION	98h	Read Byte	
MANUFACTURER ID	99h	Read Block	ASCII string – “TDK_LAMBDA”
MANUFACTURER MODEL	9Ah	Read Block	ASCII String – “QM”
MANUFACTURE DATE	9Dh	Read Block	Special format
SERIAL NUMBER	9Eh	Read Block	ASCII string – 10 characters
RUNTIME	C4h	Read Block	Special format
POWER CYCLE COUNT	C5h	Read Block	Special format
SOFTWARE VERSION NUMBER	C6h	Read Word	Special format

More details for each command are given in the sections below.

Controlling the Module Outputs of the Unit

Modes of Operation

There are 6 distinct modes of operation:

1. Module outputs enabled when Input Power is present (factory default)
2. Module outputs enabled when commanded to by the PMBus™ Operation Command
3. Module outputs enabled when the PMBus™ Control Pin is HIGH
4. Module outputs enabled when the PMBus™ Control Pin is LOW
5. Module outputs enabled when commanded to by the PMBus™ Operation Command AND the PMBus™ Control Pin is HIGH
6. Module outputs enabled when commanded to by the PMBus™ Operation Command AND the PMBus™ Control Pin is LOW

The active mode of operation is selected using the On/Off Configuration Command (02h) described below. From the factory, units are programmed to default to mode (1) so that units may be used without a PMBus™ connection.
N.B. The output state of all modules fitted in a QM unit are switched together. Individual control of the separate modules within a QM unit is not possible. If multiple QM units (maximum of 8) are connected to the bus, each unit can be controlled independently.

On/Off Configuration – Command 02h

This command is used to configure the mode of operation of the unit. The read and write byte transaction types are supported. The following table shows the data bytes sent /read that indicate the available modes of operation.

Mode	Data Byte
Module outputs enabled when Input Power is present (factory default)	01h or 03h
Module outputs enabled when commanded to by the PMBus™ Operation Command	19h or 1Bh
Module outputs enabled when the PMBus™ Control Pin is HIGH	17h
Module outputs enabled when the PMBus™ Control Pin is LOW	15h
Module outputs enabled when commanded to by the PMBus™ Operation Command AND the PMBus™ Control Pin is HIGH	1Fh
Module outputs enabled when commanded to by the PMBus™ Operation Command AND the PMBus™ Control Pin is LOW	1Dh

Note that the operating mode is persistent across a power cycle of the QM unit.

Operation – Command 01h

When a unit is in an operating mode dependent upon the PMBus™ Command (modes 2, 5 and 6 above), this command is used to control the unit's module outputs (in combination with the Control Line if required). QM units only support bit 7 of this command (On/Off State). If any other bit is set in the command data byte, the command is ignored, and a communication error is generated. The only legal commands are as follows:

Commanded State	Data Byte
Module Outputs ENABLED (ON)	80h
Module Outputs DISABLED (OFF)	00h

The commanded On/Off state is not persistent across a power cycle, and will default to OFF when input power is restored to the unit.

Control Line Operation

When a unit is in an operating mode dependent upon the PMBus™ Control Line (modes 3, 4, 5 and 6 above), the Control pin should be set HIGH or LOW as required to control the module outputs (in combination with the PMBus™ Operation Command if required).

Reading Status from the Unit - Errors and Warnings

The status of a unit can be determined through a hierarchy of status bytes. Interrogation of a unit starts with reading the Status Byte. Read and Write transactions are supported to the status bytes – writes are used to clear transitory status indicators. If a condition is persistent, a cleared indicator will immediately re-indicate. Bits for unsupported features are always returned as 0.

Status Byte – Command 78h

The following bits of the Status Byte are supported:

Bit Number	Meaning when Bit Set
7	Not Supported
6	Module Outputs are OFF
5	Not Supported
4	Not Supported
3	UV Fault
2	Over Temperature Fault
1	PMBus™ Communication Fault
0	None of the above (this indicates a Fan Fault or Warning has been generated – Read the STATUS_FANS_1_2 status byte for further details)

Read and write byte transactions are supported. To clear an indicator, write a 1 to the relevant bit. Clearing bit 0 will clear all bits in the STATUS_FANS_1_2 byte.

STATUS_FANS_1_2 Status Byte – Command 81h

The following bits of the STATUS_FANS_1_2 status byte are supported:

Bit Number	Meaning when Bit Set
7	Fan1 Fault – Fan 1 running too slow or stopped
6	Fan2 Fault – Fan 2 running too slow or stopped
5	Fan1 Warning – Fan 1 running too fast – check for blockage
4	Fan2 Warning – Fan 2 running too fast - check for blockage
3	Not Supported
2	Not Supported
1	Not Supported
0	Not Supported

Read and write byte transactions are supported. To clear an indicator, write a 1 to the relevant bit. If all bits are clear, bit 0 of the main status byte (command 78h) is also cleared.

Clear Faults – Command 03h

Send byte transaction type. This command is used to clear all fault or warning indications in a single transaction. If conditions are persistent, the errors or warnings will immediately re-indicate.

Reading Data from the Unit

Read Temperature – Command 8Dh

Read word transaction type. The temperature is returned in LINEAR11 format. The temperature value is in Celsius.

Read Fan speed 1 – Command 90h

Read word transaction type. The fan speed is returned in LINEAR11 format. The value is in units of RPM. If no fan is fitted this will return 0.

Read Fan speed 2 – Command 91h

Read word transaction type. The fan speed is returned in LINEAR11 format. The value is in units of RPM. If one or no fans are fitted this will return 0.

Manufacturer ID – Command 99h

Read Block transaction type. The value is returned as an ACSII string, and is always equal to “TDK_LAMBDA”.

Model ID – Command 9Ah

Read Block transaction type. The value is returned as an ACSII string, and is always equal to “QM”.

Manufacture Date – Command 9Dh

Read Block transaction type. The value is returned in 3 bytes as follows:
Byte 1 = Day of Month (1-31)
Byte 2 = Month of Year (1-12 representing January to December)
Byte 3 = Year (16-99 representing 2016 – 2099)

Serial Number – Command 9Eh

Read Block transaction type. The value is returned as a 10 character ACSII string.

Runtime – Command C4h

Read Block transaction type. The data is returned as a 32-bit unsigned value as follows:
Byte 1 = Least Significant Byte
Byte 2 = 2nd Least Significant Byte
Byte 3 = 2nd Most Significant Byte
Byte 4 = Most Significant Byte
Note that he value represents the time the unit has been powered up, which may not equal the time that module outputs have been enabled. The value is in units of ¼ hours e.g. a value of 13 represents 3.25 hours.

Power Cycle Count – Command C5h

Read Block transaction type. The data is returned as a 32-bit unsigned value as follows:
Byte 1 = Least Significant Byte
Byte 2 = 2nd Least Significant Byte
Byte 3 = 2nd Most Significant Byte
Byte 4 = Most Significant Byte
Note that he value represents the number of times that power has been cycled to the unit.

S/W Version Number – Command C6h

Read Word transaction type. The version number is expressed as a major and minor pair as follows:
Byte 1 = Major version number (unsigned value 0-255)
Byte 2 = Minor version number (unsigned value 0-255)
The version number is usually expressed as “<major>.<minor>”.

Miscellaneous Commands

Capability – Command 19h

Read byte transaction type. The value returned represents the capability of the PMBus™ implementation. A fixed value is returned by QM units of 80h. This indicates:

- PEC Supported
- 100kHz Max Speed
- SMBAlert Not Supported
- Numeric Format LINEAR11
- AVSBus™ Not Supported

PMBus™ Revision – Command 98h

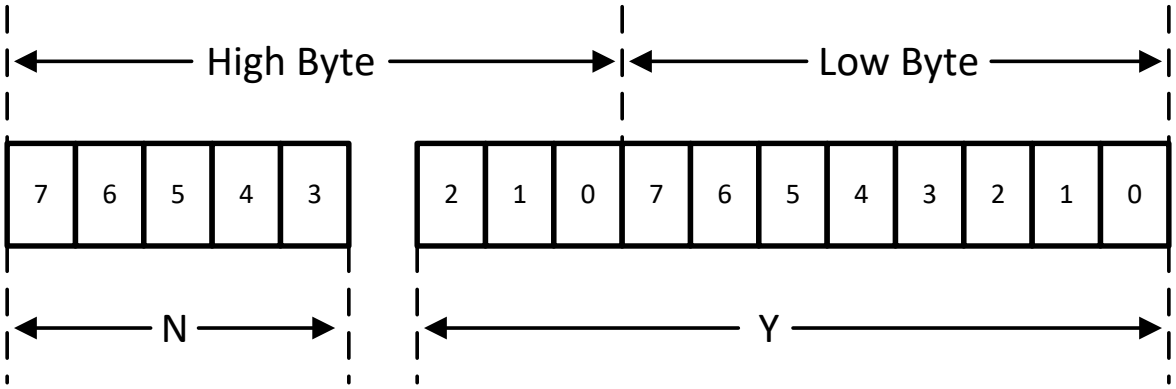
Read byte transaction type. The value returned represents the PMBus™ revision supported. A fixed value is returned by QM units of 33h. This indicates that the units support PMBus™ version 1.3.

LINEAR11 Data Format

Temperature and Fan Speed queries use the LINEAR11 format described below:
The LINEAR11 format is a two byte value with:

- An 11-bit two's complement mantissa (Y)
- A 5-bit two's complement exponent (N)

The format is as follows:



The value represented by the format is given by: Value = $Y \times 2^N$

Recommended Operation

Following a command or query to a unit, the Status Byte should be read to determine if a communication error occurred during the transaction. If a communication error occurred (as indicated by Bit 1 of the Status Byte being set) it should be assumed that the command was not actioned, or the data returned is not valid. The communication error status should then be cleared by writing a 1 to Bit 1 of the Status Byte, followed by a read of the Status Byte to check that it's clear. The command or query should then be repeated and the Status Byte rechecked until no error is reported during the transaction.

General Notes

SMBAlert is not supported.
The PMBus™ Group Command is not supported.
PEC (Packet Error Checking) is supported and should be used.
If simultaneous control of the module outputs from multiple QM units is required, this may be achieved using the PMBus™ Control Pin which may be routed to all units. It should be noted that due to differences in module output start-up times, precise synchronisation cannot be guaranteed.
QM units operate as a slave in single master systems only.
A maximum of 8-units may be connected to the bus, each unit must have a unique PMBus™ address.

Recommended PMBus™ Interface Adapter

The following USB to PMBus™ adapter is recommended:
Manufacturer: Texas Instruments
Manufacturer Part Number: USB-TO-GPIO
This is available from many suppliers, for example:
Farnell order Code: 1901883
Digi-Key Part Number: 296-23114-ND
RS Stock Number: 819-7562
Mouser Part Number: 595-USB-TO-GPIO

References

Ref[1]: System Management Bus (SMBus) Specification. Version 3.0, 20 Dec 2014.
Ref[2]: PMBus™ Power System Management Protocol Specification Part 1 – General Requirements, Transport And Electrical Interface. Revision 1.3.1, 13th March 2015.
Ref[3]: PMBus™ Power System Management Protocol Specification Part II – Command Language. Revision 1.3.1, 13th March 2015.