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**SPS-2500WG / SPS-2500BWG / SPS-2500AWG**

**(RoHS Compliant)**

**25GE / 300 m / 1310 nm Digital Diagnostic SFP28 LC SINGLE-MODE TRANSCEIVER**  
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**FEATURES**

- Up to 25.78 Gbps Bi-directional Data Links
- Complaint with SFF-8402 SFP28 MSA
- Support 25GBASE
- Support CPRI Option 10 @ 24.33Gbps
- Built-in dual CDR
- Distance up to 300 m
- 1310nm FP Transmitter
- SFF-8472 Digital Diagnostic Function
- AC/AC Coupling according to MSA
- Single +3.3 V Power Supply
- RoHS Compliant
- 0 to 70°C Operation: SPS-2500WG
- -10 to 85°C Operation: SPS-2500BWG
- -40 to 85°C Operation: SPS-2500AWG
- Class 1 Laser International Safety Standard IEC-60825 Compliant
- Enhanced EWRAP and OWRAP operational features
- CDR auto sensing

**APPLICATIONS**

- 25G Ethernet
- CPRI Option 10

**DESCRIPTION**

The SPS-2500WG series single mode transceiver is a small form factor pluggable module for bi-directional serial optical data communications such as 25G Ethernet and CPRI Option 10. It is with the SFP+ 20-pin connector to allow hot plug capability. Digital diagnostic functions are available via an I<sup>2</sup>C. This module is designed for single mode fiber and operates at a nominal wavelength of 1310 nm. The transmitter section uses a 1310 nm multiple quantum well laser and is a class 1 laser compliant according to International Safety Standard IEC-60825. The receiver section uses an integrated InGaAs detector preamplifier (IDP) mounted in an optical header and a rate selection clock data recovery (CDR) IC.

**LASER SAFETY**

This single mode transceiver is a Class 1 laser product. It complies with IEC-60825 and FDA 21 CFR 1040.10 and 1040.11. The transceiver must be operated within the specified temperature and voltage limits. The optical ports of the module shall be terminated with an optical connector or with a dust plug.

**ORDER INFORMATION**

| P/No.       | Bit Rate (Gb/s) | 25GBASE | CPRI      | Distance (m) | Wavelength (nm) | Package        | Case Temp (°C) | RoHS Compliant |
|-------------|-----------------|---------|-----------|--------------|-----------------|----------------|----------------|----------------|
| SPS-2500WG  | Up to 25.78     | -       | Option 10 | 300          | 1310            | SFP28 with DMI | 0 to 70        | Yes            |
| SPS-2500BWG | Up to 25.78     | -       | Option 10 | 300          | 1310            | SFP28 with DMI | -10 to 85      | Yes            |
| SPS-2500AWG | Up to 25.78     | -       | Option 10 | 300          | 1310            | SFP28 with DMI | -40 to 85      | Yes            |

| Absolute Maximum Ratings     |        |                 |                |       |  |
|------------------------------|--------|-----------------|----------------|-------|--|
| Parameter                    | Symbol | Min             | Max            | Units | Notes                                    |
| Storage Temperature          | Tstg   | -40             | 85             | °C    |  |
| Relative Humidity            | RH     | 5               | 85             | %     | Non-condensing                           |
| Operating Case Temperature   | Topr   | 0<br>-10<br>-40 | 70<br>85<br>85 | °C    | SPS-2500WG<br>SPS-2500BWG<br>SPS-2500AWG |
| Power Supply Voltage         | Vcc    | -0.5            | 3.6            | V     |  |
| Receiver Input Optical Power | Mip    |                 | 3              | dBm   | Average power                            |

| Recommended Operating Conditions |                        |                 |               |                |   |
|----------------------------------|------------------------|-----------------|---------------|----------------|---|
| Parameter                        | Symbol                 | Min             | Typ           | Max            | Units / Notes   |
| Power Supply Voltage             | Vcc                    | 3.135           | 3.3           | 3.465          | V   |
| Operating Case Temperature       | Topr                   | 0<br>-10<br>-40 |               | 70<br>85<br>85 | °C / SPS-2500WG<br>°C / SPS-2500BWG<br>°C / SPS-2500AWG |
| Relative Humidity                | RH                     | 5               |               | 85             | % / Non-condensing                                      |
| Power Supply Current             | I <sub>CC(TX+RX)</sub> |                 | 270           | 340            | Ma  |
| Data Rate                        |                        |                 | 24.33 / 25.78 |                | Gb/s  |

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| Transmitter Optical Specifications (0°C < T <sub>opr</sub> < 70°C, 3.13V < V <sub>cc</sub> < 3.47V) |                     |      |      |      |       |         |
|---|---------------------|------|------|------|-------|---------|
| Parameter   | Symbol              | Min  | Typ  | Max  | Units | Notes   |
| Average Launch Power  | P <sub>O, AVG</sub> | -4   |      | 2    | dBm   | 1       |
| Optical Modulation Amplitude  | P <sub>O, OMA</sub> | -4   |      | 2.2  | dBm   |         |
| Output Center Wavelength  | λ <sub>c</sub>      | 1260 | 1310 | 1360 | nm    |         |
| Output Spectrum Width   | Δλ                  | ---  |      | 4    | nm    | RMS (σ) |
| Extinction Ratio  | ER                  | 3.5  |      |      | dB    |         |
| Transmitter and Dispersion Penalty  | TDP                 |      |      | 1    | dB    |         |
| Relative Intensity Noise  | RIN                 |      |      | -130 | dB/Hz |         |
| Average Launch Power of OFF Transmitter   |                     |      |      | -30  | dBm   |         |

1. Output power is power coupled into a 9/125 μm single-mode fiber.

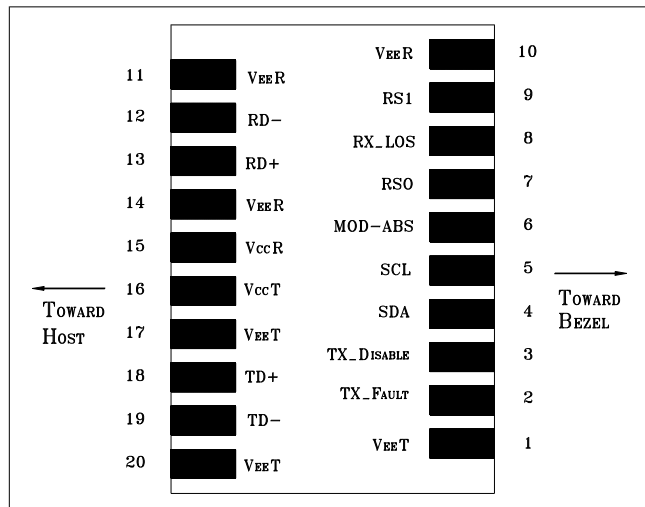
| Receiver Optical Specifications (0°C < T <sub>opr</sub> < 70°C, 3.13V < V <sub>cc</sub> < 3.47V) |                     |       |     |      |       |                         |
|--|---------------------|-------|-----|------|-------|-------------------------|
| Parameter  | Symbol              | Min   | Typ | Max  | Units | Notes                   |
| Average Receive Power  | P <sub>i, AVG</sub> | -10.3 |     | 2    | dBm   | 2                       |
| LOS – Deasserted   | LOS <sub>D</sub>    | ---   | --- | -14  | dBm   | Transition: low to high |
| LOS – Asserted   | LOS <sub>A</sub>    | -24   | --- | ---  | dBm   | Transition: high to low |
| Wavelength of Operation  | λ <sub>c</sub>      | 1260  |     | 1355 | nm    |                         |
| Optical Return Loss  | ORL                 |       |     | -27  | dB    |                         |

2. Measured with worst ER; BER < 5E-5 and PRBS 2<sup>31</sup>-1.

| Electrical Characteristics                              |                  |      |             |                      |                  |                       |
|---|------------------|------|-------------|----------------------|------------------|-----------------------|
| Parameter   | Symbol           | Min  | Typ         | Max                  | Units            | Notes                 |
| <b>High-Speed Signal (CML) Interface Specification</b>  |                  |      |             |                      |                  |                       |
| Input Data Rate   |                  |      | 24.33/25.78 |                      | Gb/s             |                       |
| TX Clock Tolerance                                      |                  | -100 |             | +100                 | ppm              | 3                     |
| Differential Input Impedance                            | R <sub>in</sub>  |      | 100         |                      | Ω                |                       |
| Differential Data Input Amplitude                       |                  | 150  |             | 1000                 | mV <sub>pp</sub> | Internally AC coupled |
| Output Data Rate  |                  | 8.5  | 25.78       |                      | Gb/s             |                       |
| RX Clock Tolerance                                      |                  | -100 |             | +100                 | ppm              | 3                     |
| Differential Output Impedance                           | R <sub>out</sub> |      | 100         |                      | Ω                |                       |
| Differential Data Output Amplitude                      |                  | 350  | 600         | 700                  | mV <sub>pp</sub> | Internally AC coupled |
| <b>Low-Speed Signal (LVTTL) Interface Specification</b> |                  |      |             |                      |                  |                       |
| Input High Voltage                                      |                  | 2.0  |             | V <sub>cc</sub> +0.3 | V                |                       |
| Input Low Voltage                                       |                  | GND  |             | 0.8                  | V                |                       |
| Output High Voltage                                     |                  | 2.4  |             | V <sub>cc</sub>      | V                |                       |
| Output Low Voltage                                      |                  | GND  |             | 0.5                  | V                |                       |

3. Clock tolerance for 24.33Gb/s and 25.78Gb/s.

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**CONNECTION DIAGRAM**



| PIN | Signal Name       | Description  | PIN | Signal Name       | Description                 |
|-----|-------------------|--|-----|-------------------|-----------------------------|
| 1   | V <sub>EE</sub> T | Transmitter Signal Ground  | 11  | V <sub>EE</sub> R | Receiver Signal Ground      |
| 2   | TX_Fault          | Transmitter Fault Indication. Logic “1” Output = Laser Fault. Logic “0” Output = Normal Operation                            | 12  | RD-               | Inverse Receiver Data Out   |
| 3   | TX_Disable        | Logic “1” Input (or no connection) = Laser off, Logic “0” = Laser on.  | 13  | RD+               | Receiver Data Out           |
| 4   | SDA               | Modulation Definition 2 – Two wires serial ID Interface  | 14  | V <sub>EE</sub> R | Receiver Signal Ground      |
| 5   | SCL               | Modulation Definition 1 – Two wires serial ID Interface  | 15  | V <sub>CC</sub> R | Receiver Power – 3.3V±5%    |
| 6   | MOD-ABS           | Modulation Definition 0 – Ground in Module   | 16  | V <sub>CC</sub> T | Transmitter Power – 3.3V±5% |
| 7   | RS0               | RX Rate Select:<br>This pin has an internal 30k pulldown to ground. A signal on this pin will not affect module performance. | 17  | V <sub>EE</sub> T | Transmitter Signal Ground   |
| 8   | RX_LOS            | Loss of Signal Out (OC).   | 18  | TD+               | Transmitter Data In         |
| 9   | RS1               | TX Rate Select:<br>This pin has an internal 30k pulldown to ground. A signal on this pin will not affect module performance. | 19  | TD-               | Inverse Transmitter Data In |
| 10  | V <sub>EE</sub> R | Receiver Signal Ground   | 20  | V <sub>EE</sub> T | Transmitter Signal Ground   |

**MODULE DEFINITION**

| Module Definition | PIN 4 | PIN 5 | PIN 6   | Interpretation by Host            |
|-------------------|-------|-------|---------|-----------------------------------|
| 4                 | SDA   | SCL   | MOD-ABS | Serial module definition protocol |

Module Definition 4 specifies a serial definition protocol. For this definition, upon power up, SDA and SCL appear as no connector (NC) and MOD-ABS is TTL LOW. When the host system detects this condition, it activates the serial protocol. The protocol uses the 2-wire serial CMOS E<sup>2</sup>PROM protocol of the ATMEL AT24C01A/02/04 family of components.

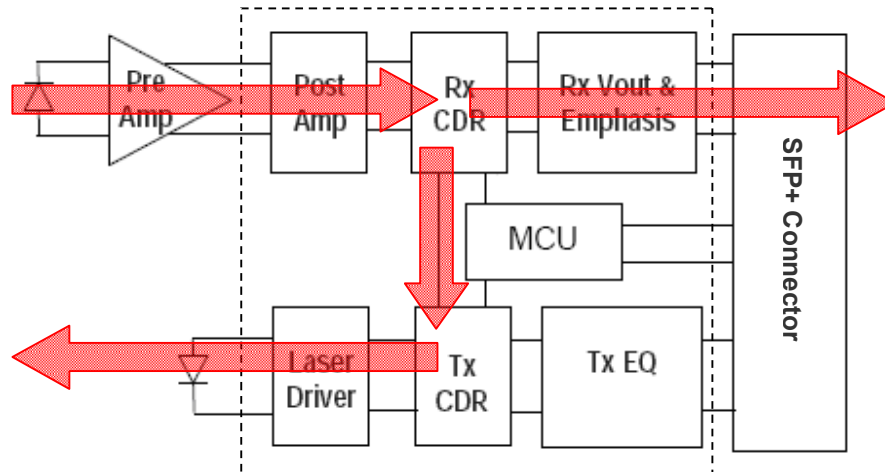


## WRAP AND BYPASS CDR OPERATION FUNCTIONS - SOFT CONTROL (Address A2h, Byte 111).

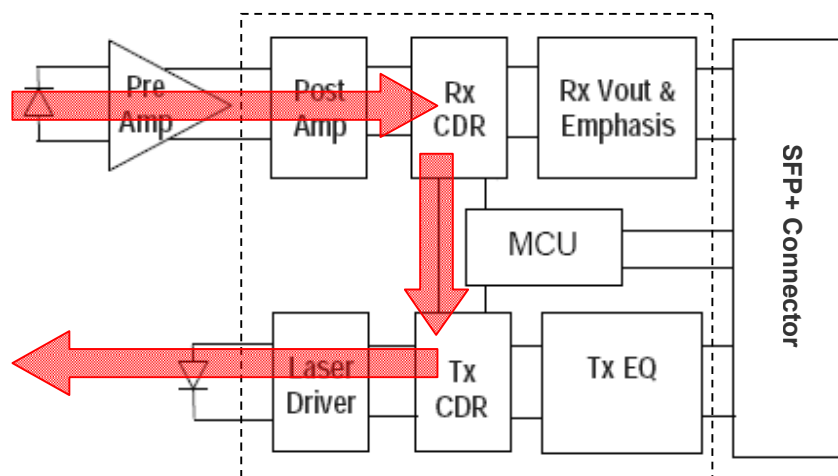
To assist with local host or remote diagnostic and optimization sequences, electrical and optical wrap functions can be enabled. Optical wrap (OWRAP) takes the received optical signal through CDRs and retransmits it optically out. Electrical wrap (EWRAP) takes the received electrical signal through CDRs and retransmits it electrically out. Optional forward functions can be transmitted outbound the wrapped information via i2c control.

| Byte | Bit | Name                     | Description  |
|------|-----|--------------------------|--|
|      | 4-7 | Reserved                 | Reserved.  |
|      | 3   | OWRAP Forward Enable Bit | When set in combination with OWRAP Enable, OWRAP Forward routes incoming SFP+ Rx optical data to both the Tx optical output and the Rx electrical output. Enabling sets bit 2 and clears all other bits in byte 111. |
|      | 2   | OWRAP Enable Bit         | When set, OWRAP routes incoming SFP+ Rx optical data to the Tx optical output. Enabling clears all other bits in byte 111.   |
|      | 1   | EWRAP Forward Enable Bit | When set in combination with EWRAP Enable, EWRAP Forward routes incoming SFP+ Tx electrical data to both Rx electrical output and Tx optical output. Enabling sets bit 0 and clears all other bits in byte 111.      |
|      | 0   | EWRAP Enable Bit         | When set, EWRAP Enable routes incoming SFP+ Tx electrical data to the Rx electrical output. Enabling clears all other bits in byte 111.  |

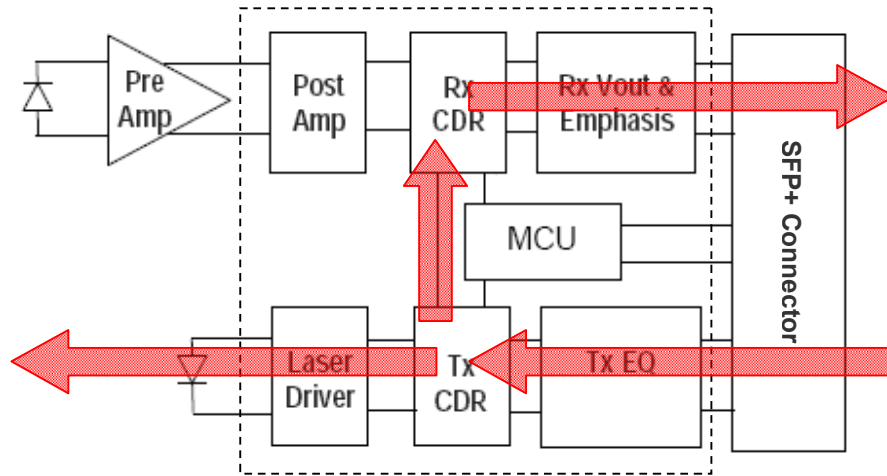
### OWRAP FORWARD ENABLE MODE (I2C CONTROLLED)



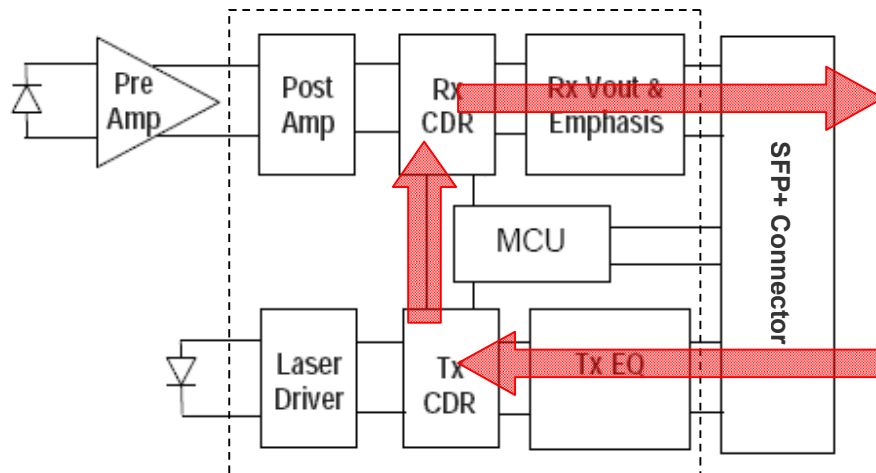
### OWRAP ENABLE MODE (I2C CONTROLLED)



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EWRAP FORWARD ENABLE MODE (I2C CONTROLLED)  
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EWRAP ENABLE MODE (I2C CONTROLLED)



EEPROM Series ID Memory Contents (Address A0h)

| Addr. | Hex | ASCII | Note        | Addr. | Hex | ASCII           | Note                          | Addr. | Hex | ASCII          | Note  | Addr.     | Hex | ASCII | Note                   |  |
|-------|-----|-------|-------------|-------|-----|-----------------|-------------------------------|-------|-----|----------------|---|-----------|-----|-------|------------------------|--|
| 0     | 03  |       | SFP28       | 32    | 20  |                 | Part Number                   | 64    | 18  |                | Power Level 1, w/ CDR, Uncooled Tx, Txdis, Txfault, LOS | 96        | 00  |       | Vendor specific EEPROM |  |
| 1     | 04  |       |             | 33    | 20  |                 |                               | 65    | 1A  |                |   | 97        | 00  |       |                        |  |
| 2     | 07  |       | LC          | 34    | 20  |                 |                               | 66    | 67  |                |   | 25.78Gbps | 98  | 00    |                        |  |
| 3     | 00  |       |             | 35    | 20  |                 |                               | 67    | 00  |                |   |           | 99  | 00    |                        |  |
| 4     | 00  |       |             | 36    | 00  |                 |                               | 68    |     |                | Serial number: each piece with different serial number  | 100       | 00  |       |                        |  |
| 5     | 00  |       |             | 37    | 00  | NA              |                               | 69    |     |                |   | 101       | 00  |       |                        |  |
| 6     | 00  |       |             | 38    | 0E  | Vendor IEEE OUI |                               | 70    |     |                |   | 102       | 00  |       |                        |  |
| 7     | 00  |       |             | 39    | FA  |                 |                               | 71    |     |                |   | 103       | 00  |       |                        |  |
| 8     | 00  |       |             | 40    | 53  | S               |                               | 72    |     |                |   | 104       | 00  |       |                        |  |
| 9     | 00  |       |             | 41    | 50  | P               |                               | 73    |     |                |   | 105       | 00  |       |                        |  |
| 10    | 00  |       |             | 42    | 53  | S               |                               | 74    |     |                |   | 106       | 00  |       |                        |  |
| 11    | 06  |       | 64B/66B     | 43    | 2D  | -               |                               | 75    |     |                |   | 107       | 00  |       |                        |  |
| 12    | FF  |       | > 25.4 Gbps | 44    | 32  | 2               |                               | 76    |     |                |   | 108       | 00  |       |                        |  |
| 13    | 00  |       |             | 45    | 35  | 5               |                               | 77    |     |                |   | 109       | 00  |       |                        |  |
| 14    | 00  |       |             | 46    | 30  | 0               |                               | 78    |     |                | 110   | 00        |     |       |                        |  |
| 15    | 03  |       | 300 m       | 47    | 30  | 0               |                               | 79    |     |                | 111   | 00        |     |       |                        |  |
| 16    | 00  |       |             | 48    | 57  | W               |                               | 80    |     |                | 112   | 00        |     |       |                        |  |
| 17    | 00  |       |             | 49    | 47  | G               |                               | 81    |     |                | 113   | 00        |     |       |                        |  |
| 18    | 00  |       |             | 50    | 20  |                 |                               | 82    |     |                | 114   | 00        |     |       |                        |  |
| 19    | 00  |       |             | 51    | 20  |                 | 83                            |       |     | 115            | 00  |           |     |       |                        |  |
| 20    | 4F  | O     | Vendor name | 52    | 20  |                 | 84                            |       | Y   | Date Code      | 116   | 00        |     |       |                        |  |
| 21    | 50  | P     |             | 53    | 20  |                 | 85                            |       | Y   |                | 117   | 00        |     |       |                        |  |
| 22    | 54  | T     |             | 54    | 20  |                 | 86                            |       | M   |                | 118   | 00        |     |       |                        |  |
| 23    | 4F  | O     |             | 55    | 20  |                 | 87                            |       | M   |                | 119   | 00        |     |       |                        |  |
| 24    | 57  | W     |             | 56    | 30  | 0               | Revision, depended on version | 88    |     |                | D   | 120       | 00  |       |                        |  |
| 25    | 41  | A     |             | 57    | 30  | 0               |                               | 89    |     |                | D   | 121       | 00  |       |                        |  |
| 26    | 59  | Y     |             | 58    | 30  | 0               |                               | 90    | 20  |                | 122   | 00        |     |       |                        |  |
| 27    | 20  |       |             | 59    | 31  | 1               | 91                            | 20    |     | 123            | 00  |           |     |       |                        |  |
| 28    | 20  |       |             | 60    | 05  |                 | 1310 nm                       | 92    | 68  |                | Monitoring  | 124       | 00  |       |                        |  |
| 29    | 20  |       |             | 61    | 1E  |                 |                               | 93    | F0  |                | Soft Control and Monitoring                             | 125       | 00  |       |                        |  |
| 30    | 20  |       | 62          | 00    |     | Reserved        | 94                            | 08    |     | SFF-8472 V12.3 | 126   | 00        |     |       |                        |  |
| 31    | 20  |       | 63          |       |     | Checksum 0-62   | 95                            |       |     | Checksum 64-94 | 127   | 00        |     |       |                        |  |

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**EEPROM Series ID Memory Contents (Address A2h)**  
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| Addr. | Hex | Note                         | Addr. | Hex | Note                           | Addr. | Hex | Note              | Addr. | Hex | Note                     |
|-------|-----|------------------------------|-------|-----|--------------------------------|-------|-----|-------------------|-------|-----|--------------------------|
| 0     | 4B  | Temp. High Alarm (75°C)      | 32    | 4D  | Rx Power High Alarm (3dBm)     | 64    | 00  | For External Cal. | 96    |     | Real Time Temp. MSB      |
| 1     | 00  |                              | 33    | F1  |                                | 65    | 00  | For External Cal. | 97    |     | Real Time Temp. LSB      |
| 2     | FB  | Temp. Low Alarm(-5°C)        | 34    | 02  | Rx Power Low Alarm (-12.3dBm)  | 66    | 00  | For External Cal. | 98    |     | Real Time Vcc MSB        |
| 3     | 00  |                              | 35    | 4D  |                                | 67    | 00  | For External Cal. | 99    |     | Real Time Vcc LSB        |
| 4     | 49  | Temp. High Warming(73°C)     | 36    | 3D  | Rx Power High Warming (2dBm)   | 68    | 3F  | For External Cal. | 100   |     | Real Time Tx Bias MSB    |
| 5     | 00  |                              | 37    | E9  |                                | 69    | 80  | For External Cal. | 101   |     | Real Time Tx Bias LSB    |
| 6     | 00  | Temp. Low Warming (0°C)      | 38    | 03  | Rx Power Low Warming(-10.3dBm) | 70    | 00  | For External Cal. | 102   |     | Real Time Tx Pwr MSB     |
| 7     | 00  |                              | 39    | A5  |                                | 71    | 00  | For External Cal. | 103   |     | Real Time Tx Pwr LSB     |
| 8     | 8C  | Voltage High Alarm (3.6V)    | 40    | 00  | Reserved                       | 72    | 00  | For External Cal. | 104   |     | Real Time Rx Pwr MSB     |
| 9     | A0  |                              | 41    | 00  | Reserved                       | 73    | 00  | For External Cal. | 105   |     | Real Time Rx Pwr LSB     |
| 10    | 75  | Voltage Low Alarm(3.0V)      | 42    | 00  | Reserved                       | 74    | 00  | For External Cal. | 106   |     | Reserved                 |
| 11    | 30  |                              | 43    | 00  | Reserved                       | 75    | 00  | For External Cal. | 107   |     | Reserved                 |
| 12    | 88  | Voltage High Warming(3.5V)   | 44    | 00  | Reserved                       | 76    | 01  | For External Cal. | 108   |     | Reserved                 |
| 13    | B8  |                              | 45    | 00  | Reserved                       | 77    | 00  | For External Cal. | 109   |     | Reserved                 |
| 14    | 79  | Voltage Low Warming (3.1V)   | 46    | 00  | Reserved                       | 78    | 00  | For External Cal. | 110   |     | Tx Dis, Tx Fault, Rx Los |
| 15    | 18  |                              | 47    | 00  | Reserved                       | 79    | 00  | For External Cal. | 111   |     | OWRAP, EWRAP             |
| 16    | AF  | Tx Bias High Alarm(90mA)     | 48    | 00  | Reserved                       | 80    | 01  | For External Cal. | 112   |     | Alarm Flag               |
| 17    | C8  |                              | 49    | 00  | Reserved                       | 81    | 00  | For External Cal. | 113   |     | Alarm Flag/Reserved      |
| 18    | 03  | Tx Bias Low Alarm(2mA)       | 50    | 00  | Reserved                       | 82    | 00  | For External Cal. | 114   |     | Reserved                 |
| 19    | E8  |                              | 51    | 00  | Reserved                       | 83    | 00  | For External Cal. | 115   |     | Reserved                 |
| 20    | 88  | Tx Bias High Warming(70mA)   | 52    | 00  | Reserved                       | 84    | 01  | For External Cal. | 116   |     | Warming Flag             |
| 21    | B8  |                              | 53    | 00  | Reserved                       | 85    | 00  | For External Cal. | 117   |     | Warming Flag/Reserved    |
| 22    | 07  | Tx Bias Low Warming(4mA)     | 54    | 00  | Reserved                       | 86    | 00  | For External Cal. | 118   |     | RS1 Select               |
| 23    | D0  |                              | 55    | 00  | Reserved                       | 87    | 00  | For External Cal. | 119   |     | Reserved                 |
| 24    | 4D  | Tx Power High Alarm (3dBm)   | 56    | 00  | For External Cal.              | 88    | 01  | For External Cal. | 120   |     | Vendor Specific          |
| 25    | F1  |                              | 57    | 00  | For External Cal.              | 89    | 00  | For External Cal. | 121   |     |                          |
| 26    | 0C  | Tx Power Low Alarm(-5dBm)    | 58    | 00  | For External Cal.              | 90    | 00  | For External Cal. | 122   |     |                          |
| 27    | 5A  |                              | 59    | 00  | For External Cal.              | 91    | 00  | For External Cal. | 123   |     |                          |
| 28    | 3D  | Tx Power High Warming(2dBm)  | 60    | 00  | For External Cal.              | 92    | 00  | For External Cal. | 124   |     |                          |
| 29    | E9  |                              | 61    | 00  | For External Cal.              | 93    | 00  | For External Cal. | 125   |     |                          |
| 30    | 0F  | Tx Power Low Warming (-4dBm) | 62    | 00  | For External Cal.              | 94    | 00  | For External Cal. | 126   |     |                          |
| 31    | 8D  |                              | 63    | 00  | For External Cal.              | 95    |     | Check Sum         | 127   |     |                          |

Note: Address 128 – 247: customer R/W eeprom. Address 248 – 255: Vendor Specific.



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**REVISION HISTORY**

| Version | Subject           | Release Date |
|---------|-------------------|--------------|
| 1.0     | Initial datasheet | 2019/2/25    |
|         |                   |              |
|         |                   |              |