TRM-1
Low-band RF Power Amplifier

Product Requirements Document

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Technical Brief

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Scope

The scope of this PRD is to describe the technical implementation of a custom modular Low-Band RF Power Amplifier Unit. The PA is part of a wide-area data network base station. It is non-linear, with redundancy built-in for extra reliability and up-time.

Functionality

The amplifier takes in a constant-envelope (CE) RF signal at a level of approximately 5dBm, and amplifies it to a level of 56dBm (400 watts). The amplifier module and the power supplies are all fully redundant. A CPU monitors the amplifier, manages alarms, and controls the switching of redundant circuits.

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The internal CPU provides a Command Line Interface (CLI) via an RS-232 serial port, for an external device to monitor and control its operation.

The Amplifier runs off of 90-130V AC input. The CPU controller will also operate off of an external DC input, if available.

Design Philosophy

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Robustness

The design will incorporate, to the extent feasible and cost effective, margin against the specified criteria. In each case the margin is determined from the expected normal variations in manufacturing parameters and device variations as they apply to the design. Additionally, the product incorporates robust circuit design to require minimal alignment or tuning during test. To the extent possible, all components will be surface mount and utilize multiple source parts.

The amplifier must self-protect against all fault conditions. In particular, care is taken to prevent damage due to:

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1. Reverse DC voltage
2. RF overdrive
3. High VSWR on output
4. Over-temperature
5. Failure of any LRU

Implementation and Construction

The amplifier is divided into these sections, each section capable of being tested by itself.

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1. Two field replaceable 500 watt RF Amplifier Modules.
2. An RF switch to select which output stage is routed to the antenna.
3. Lowpass Filter and RF wattmeter with directional coupler.
4. DC monitoring (current and voltage)
5. CPU Controller (bias voltage generation, AGC management, monitoring, CLI, alarming…)
6. Two field replaceable AC power supplies.

Operation

The amplifier should look like a gain block, with some AGC for power leveling.

It powers up in the "on" state.

Specifications

Parameter	Customer Specification	Design Goals	Notes
System			
Temperature Range	0 to +50 C ambient	-30 to +60 C	
Shock			So LRUs can be easily packed and shipped via Fedex
Size	19" open telecom rack mount TBD height	19" rack mount, 6U tall, 17" deep.	
Weight	TBD	<50 lbs	
Line Replaceable Units	PAs/Drivers, Fans, AC-DC Supplies	PAs/Drivers, Fans, AC-DC Supplies	Plug-in LRUs are hot swappable
MTBF	25,000 hours for soft failures 80,000 hours for hard failures	50,000 soft fail 100,000 hrs hard-fail	Soft failures don't degrade performance. Room temperature calculations.
Time To Repair	10 minutes max to replace LRU to fix soft failure	2 minutes to replace LRUs	
EMC, Line Faults and Lightening Protection	UL Approved AC power supply Lightening protection on RF output	UL Approved AC power supply Lightening protection on RF output 15kV ESD on all other I/Os	
Hot Standby stages	PA, Driver, Fan, AC-DC converter	PA, Driver, Fan, AC-DC converters	
Power Amp			
Power Line Input	110 VAC; 60 Hz < 10 Amps	90-130VAC, <10A at 110Vac	
AC Power Switch and Breaker	On front or rear panel	Rear Panel	Bump-proof
Frequency Range	35.15 to 35.75 MHz	32-38 MHz	No tuning
Input Signal	+5 dBm (+/-3 dB) 50 ohms single carrier constant envelope phase modulation < 40 kHz bandwidth nominally 2 Hz pulse with 99% duty <-30dBm in OFF mode, Rise/Fall time < 5 mS and >100uS	+5 dBm (+/-3 dB) 50 ohms single carrier constant envelope phase modulation < 40 kHz bandwidth nominally 2 Hz pulse with 99% duty <-30dBm in OFF mode, Rise/Fall time < 5 mS and >100uS	
Input Connector	Panel-mount N-Type female	TNC female	
Output Power	400 W (+/- 1 dB)	Programmable 250-500 watts +/- 1dB 0-50C; +/-1.5dB –30 to +60 C	
Harmonics and Spurious	Per FCC 22.359 (b)(1) with 10 dB margin for +/- 50 kHz Also, close-in spurs (+/- 15 kHz) < -45 dBc	Per FCC 22.359 (b)(1) with 10 dB margin for +/- 50 kHz Also, close-in spurs (+/- 15 kHz) < -45 dBc	Assume "authorized bandwidth" of 20 KHz Test with pure carrier Do we need additional limits such as those for Unintentional Radiators or Restricted Bands as specified in Part 15? No
Harmonic Filter		All harmonics up to 500MHz, <80dBc	Some tower contracts require the use of a "harmonic filter." While the performance of this device isn't specified, we should have something in the P.A. that we can point to and call a "harmonic filter."
Type Approvals	None	None	Trimble will take responsibility for this
Output Impedance	50 ohms	50 ohms	
Output Match	Operate into 2:1 VSWR No damage into infinite VSWR	Operate into a 3:1. No damage into infinite VSWR.	
Output Connector	7/16 DIN female	7/16 DIN female	
Duty Cycle	100 %	100% at up to 500 watts.	Will not usually be operated below 50 %
Soft-fail cut-over		< 2 Seconds	Time to switch over to redundant back-up circuitry.
Controller			
Battery Power Input	10-16 VDC	10-32V	Controller operates independent of AC

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	< TBD Amps		power to power amp. Battery MUST be present in order to ensure operation of controller when amplifier power is off.
Control Interfaces	Serial port for local console	Serial port for local console, 38400 bps, N,8,1.	
Measurements	Voltages, currents, forward and reflected RF power, temperature, fan health, alarms, PA stage in use.	Voltages, currents, forward and reflected RF power, temperature, fan health, alarms, PA stage in use.	As appropriate on all fans, power supplies, power amp stages
Alarms	Via Control Serial port.	Via Control Serial port. LED alarm status.	
Console Protocol	VT100 over serial port XModem or Ymodem for software upgrading	VT100 over serial port XModem or XModem/1k for software upgrading	
Network Protocols	none	none	
Connectors	DB9 female for console	DB9 Female	
Firmware update	Via serial port	Via serial port	
Soft-fail modes	Fan monitoring PA stage Driver Stage AC-DC converter	Fan monitoring PA stage Driver Stage AC-DC converter	Failure of any one of these components will not cause the amplifier to cease operation.
Hard reset input	Via RTS pin on Serial Port	Via RTS pin on Serial Port or via serial command. RTS reset ability may be defeated by removal of internal jumper.	Unit is operational when RTS is asserted and held in reset when not asserted.
Internal Measurement Accuracy		Power +/- 0.5dB Voltage +/- 2% Current +/- 5% Temperature +/- 3 degrees	Power valid for VSWR < 1.15:1
RF leveling time constant for changes in drive level.		<10 seconds.	
Antenna Switching		No "Hot Switching"	Power Amplifiers must be in "standby" or "off" state when changing the antenna switch setting.

Table 1: Specifications

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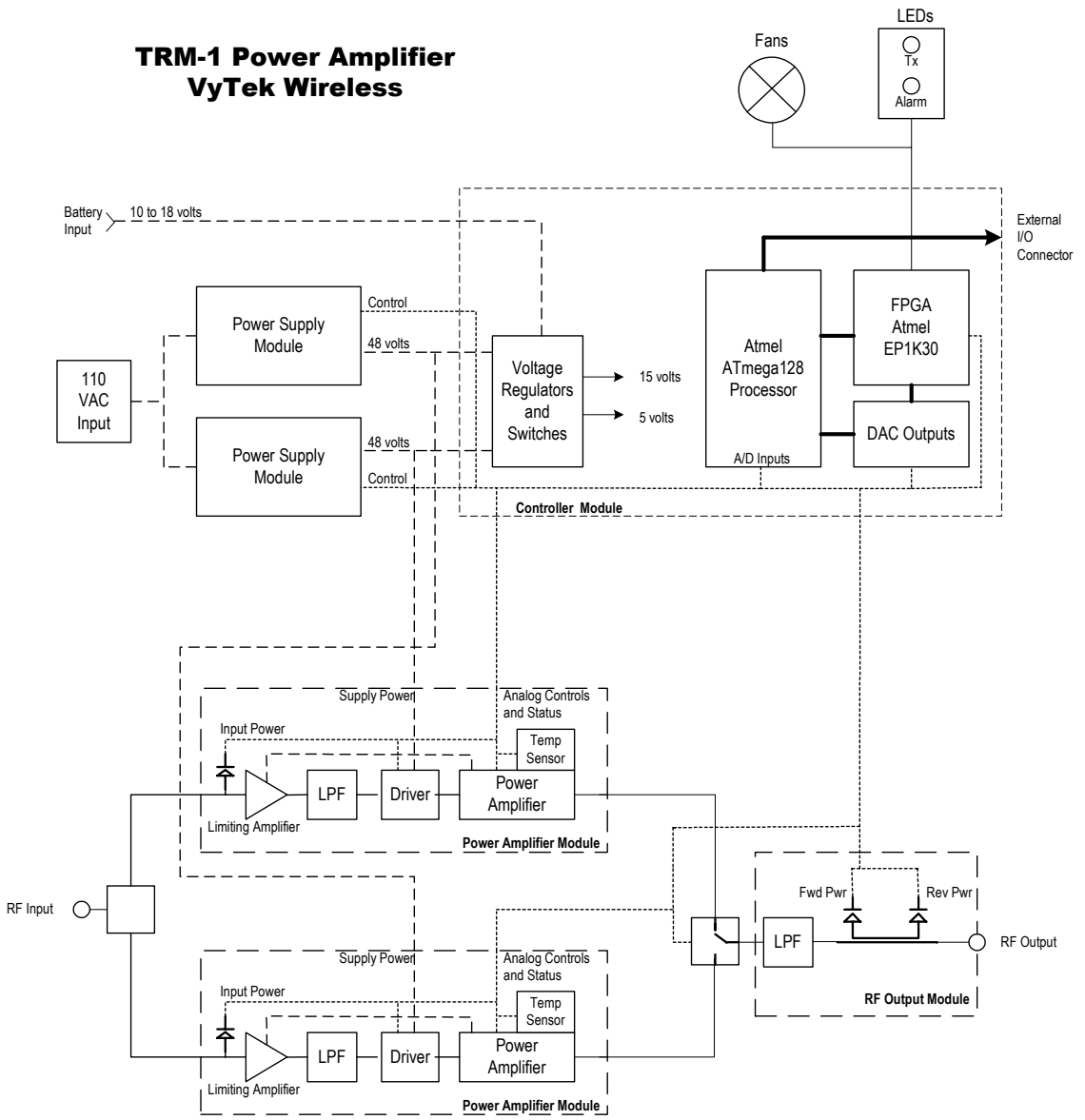
Hardware Block Diagram



Interface Definitions

Power Supply Connector

Pin	Name	Function
1	+Vout	Output Voltage
2	+Vout	Output Voltage
3	GND	Output Return
4	GND	Output Return
5	-Sense	Connect to Ground
6	Vout Adjust	Output Voltage Control. Vout = 59v – 2.42v – 1.8 x {Vout Adjust} 59v – 2.42v – 1.8 x {Vout Adjust = 5v} = 47.6 volts
7	OC Alarm	Over Current Alarm
8	Iout Monitor	Output Current Monitor. Iout monitor = Iout x 10^{-4}. Not Connected.
9	Share Bus	Connect with Share Bus of the other Power Supply. Not Connected.
10	Enable	Low = Enable Power Supply. Floating or High = Turn Power Supply Off.
11	+Vout	Output Voltage
12	+Vout	Output Voltage
13	GND	Output Return
14	GND	Output Return
15	+Sense	Connect to Output Voltage
16	NC	No Connect
17	V Shift	Voltage Shift Input. Connected to Vout.
18	OV Alarm	Over Voltage Alarm
19	GND	Output Return
20	Rect Fail	High = Power Supply is OK. Low = Power Supply Failure.
21	+Vout	Output Voltage
22	GND	Output Return
23	GND	Output Return
24	GND	Output Return
25	SD0	Serial Data Option. Not Connected.
26	SD1	Serial Data Option. Not Connected.
27	AC Sense	Low = AC is < 60 VAC. High if AC is > 60 VAC.
28	OV Adjust	Over Voltage Adjustment Pin. OV Level = 60v – 1.2 x {OV Adjust} 60v – 1.2 x {OV Adjust = 5v} = 54 volts 60v – 1.2 x {OV Adjust = 8.3v} = 50 volts
29	Lamp Test	Turn on all LEDs for Testing. Not Connected
30	On / Off	Front Panel Power Switch Status. Low = On, High = Off

Table 2: Power Supply Connector

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Power Amplifier Module Connector

Pin	Name	I/O	Function
A1	GND	Input	High Current Ground
A2	+48V	Input	High Current Power Supply (+48 volts)
1	Installed	Output	"Amplifier Installed" signal to the Controller. Connected to Ground inside of the PA. Floats high when module is not plugged-in.
2			Not Connected
3	V_out	Output	Low Current Power Supply Loopback to Controller
4	Amp_Select	Input	Amplifier Select Switching: (+15 volts = Amplifier 1, Low = Amplifier 2) Note: Internal pullup to +15 volts required.
5	+5V_Controller	Input	+5 volts from the Controller
6	RF_Detect	Output	RF Input Detector
7	Fan_On	Input	Fan Power On Signal (+28V = Fan On, 0V = Fan Off)
8	TX_LED	Input	Drive to the TX LED from Controller
9	RF_det_thresh	Input	RF Detector threshold voltage from Controller
10	Fan_2	Output	Fan #2 Current Sensor Analog Signal
11	Address	Input	Amplifier Identification: (0 = Amplifier 1, Float = Amplifier 2)
12	Amp_Bias	Input	Bias Voltage (Analog Control Signal from Controller)
13	Temp	Output	Temperature analog signal
14	Fan_1	Output	Fan #1 current sensor analog signal
15	Alarm LED	Input	Alarm LED Digital Control Signal (0 = OK, 1 = Alarm)

Table 3: Power Amplifier Connector

Filter / Coupler Module Connector

Pin	Name	I/O	Function
1	Ground		
2	+5v_Controller	Input	+5 volts from Controller
3	Fwd Offset	Input	Bias Voltage for Forward Power Detector
4	Fwd Power	Output	Forward Power Detector Analog Signal
5	Rev Offset	Input	Bias Voltage for Reverse Power Detector
6	Rev Power	Output	Reverse Power Detector Analog Signal
7	NC		
8	NC		
9	NC		

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Rear Panel DC Power Connector

Pin	Name	Function
1	Monitor	Controller Power Monitor (Don't apply an external voltage to this pin, but it may be used to monitor the actual controller voltage if desired.)
2	Gnd	Ground
3	Gnd	Ground
4	Battery	Battery Backup Power (8 to 24 volts)

Rear Panel RS232 Connector

DB9 Female Connector

Pin	Name	Function
1	DCD	No Connection
2	RXD	Receive Data from the unit
3	TXD	Transmit Data to the unit
4	DTR	No Connection
5	GND	Ground
6	DSR	No Connection
7	RTS	Active level enables the unit. Inactive level resets the unit, Jumper Selectable
8	CTS	No Connection
9	RI	No Connection

Table 4: Rear Panel RS232 Connector

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Controller Connections

Pin	Name	I/O	Logical Connection	Function
J1-1	+5v	Output	Voltage Regulator	+5 Volts from Controller
J1-2	Temp 2	Input	CPU ADC2	Temperature Sensor Signal from Amp #2
J1-3	Gnd			

Pin	Name	I/O	Logical Connection	Function
J2-1	Fan1	Input	FANA MUX to CPU ADC6	Fan #1 current sensor analog signal
J2-2	Fan2	Input	FANB MUX to CPU ADC6	Fan #2 current sensor analog signal
J2-3		Input	FANC MUX to CPU ADC6	Unused current sensor analog signal
J2-4	Fan_On	Output	FPGA Pin 130 -> Q6 FET Switch	Fan Power On Signal (+28V = Fan On, 0V = Fan Off)
J2-5	Alarm LED1	Output	CPU PB0	Amp #1 Alarm LED Control Signal (0 = OK, 1 = Alarm)
J2-6	Alarm LED2	Output	CPU PB6	Amp #2 Alarm LED Control Signal (0 = OK, 1 = Alarm)
J2-7	TX LED	Output	CPU PB2	Transmit LED (1 = On)
J2-8			Ground	
J2-9	Rev Power	Input	CPU ADC1	Reverse Power Detector Analog Signal
J2-10	Rev Offset	Output	DAC U11-B	Bias Voltage for Reverse Power Detector
J2-11		Output	Voltage Regulators	+5 Volts
J2-12			Ground	
J2-13			TP16	
J2-14	Amp Select	Output	CPU PB5 -> Q5 FET (Open Drain)	Amplifier Select Switching: (Low = Amplifier 1, Hi-Z = Amplifier 2)

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Pin	Name	I/O	Logical Connection	Function
J5-1	Power	Input	Voltage Regulators	Input Supply Voltage (+28 volts nominal)
J5-2	Gnd		Ground	
J5-3	Gnd		Ground	
J5-4	Curr Sens	Input	CPU ADC5	Current Sensor Input
J5-5	+5v	Output	Voltage Regulator	+5 Volts

Pin	Name	I/O	Logical Connection	Function
J15-1		Output	Voltage Regulator	+5 Volts (Analog)
J15-2			Ground	
J15-3	(mod1_bias)	Output	DAC U13-A	
J15-4	(mod2_bias)	Output	DAC U13-B	
J15-5	(mod3_bias)	Output	DAC U13-C	
J15-6	(mod4_bias)	Output	DAC U13-D	
J15-7	Amp 1 Inst (intspi_cs1)	Input	FPGA Pin 59	0 = Amplifier 1 Installed (Must be pulled up by FPGA.)
J15-8	RF_det_thresh (drvr_stg_bias)	Output	DAC U12-D	PA RF Detector threshold voltage

J15-9			TP15	
J15-10	Amp 2 Inst (intspi_clk)	Input	FPGA Pin 67	0 = Amplifier 2 Installed (Must be pulled up by FPGA.)
J15-11	Fwd Power (fwd_pwr)	Input	CPU ADC0	Forward Power Detector Analog Signal
J15-12	Fwd Offset (fwd_offset)	Output	DAC U11-A	Bias Voltage for Forward Power Detector
J15-13	PS1 AC (intspi_reset)	Input	FPGA Pin 70	Low = AC is < 60 VAC. High if AC is > 60 VAC.
J15-14	PS2 AC (intspi_miso)	Input	Inverter -> FPGA Pin 68	Low = AC is < 60 VAC. High if AC is > 60 VAC.
J15-15			NC	
J15-16			NC	

Pin	Name	I/O	Logical Connection	Function
J16-1		Output	Power Filter	+5 Volts (Analog)
J16-2			Ground	
J16-3	(mod1_bias)	Output	DAC U13-A	
J16-4	(rms_threshold)	Output	DAC U11-C	
J16-5	(peak_threshold)	Output	DAC U11-D	
J16-6	PS1 Disable (rms_alarm)	Output	CPU PB4	0 = Enable Power Supply #1 1 = Power Supply #1 Off
J16-7	PS2 Disable (peak_alarm)	Output	CPU PB1	0 = Enable Power Supply #2 1 = Power Supply #2 Off
J16-8	Temp 1 (pd_temp)	Input	CPU ADC3	Temperature Sensor Signal from Amp #1
J16-9	+15v	Output	Voltage Regulator	+15 volts
J16-10	(phase_adjust)	Output	DAC U12-B	
J16-11	Bias (attenuation)	Output	DAC U12-A	Bias Voltage for Power Amplifiers
J16-12		Output	Power Filter	+5 Volts (Analog)
J16-13	(fuse_rms_offset)	Output	DAC U12-C	
J16-14	(rffuse_reset)	I/O	CPU BP3	
J16-15		NC		
J16-16		NC		

Pin	Name	I/O	Logical Connection	Function
J17-1			Ground	
J17-2	PS1 Fail (extspi_a5)	Input	Inverter -> FPGA Pin 43	0 = Power Supply Failure 1 = Power Supply is OK
J17-3	PS1 Switch (extspi_a4)	Input	Inverter -> FPGA Pin 41	Front Panel Power Switch Status: (0 = On, 1 = Off)
J17-4	PS2 Fail (extspi_a3)	Input	Inverter -> FPGA Pin 39	0 = Power Supply Failure 1 = Power Supply is OK
J17-5	PS2 Switch (extspi_a2)	Input	Inverter -> FPGA Pin 38	Front Panel Power Switch Status: (0 = On, 1 = Off)
J17-6	RF Detect 1	Input	Inverter ->	RF Detected at Power Amplifier 1

	(extspi_a1)		FPGA Pin 37	(0 = No, 1 = Yes)
J17-7	RF Detect 2 (extspi_a0)	Input	Inverter -> FPGA Pin 36	RF Detected at Power Amplifier 2 (0 = No, 1 = Yes)
J17-8	PS1 OV (extspi_clk)	Input	Inverter -> FPGA Pin 46	Over Voltage Alarm
J17-9	PS1 OC (extspi_mosi)	Input	Inverter -> FPGA Pin 48	Over Current Alarm
J17-10	(extspi_miso)	Output	Inverter -> FPGA Pin 47	
J17-11	PS2 OV (extspi_backplid0)	Input	Inverter -> FPGA Pin 83	Over Voltage Alarm
J17-12	PS2 OC (extspi_backplid1)	Input	Inverter -> FPGA Pin 86	Over Current Alarm
J17-13		NC		
J17-14		NC		
J17-15			Ground	
J17-16		NC		

FPGA Register Definitions

Note that CS signal from CPU must be set high in order for the FPGA to be selected. This signal comes from the CPU's PE2 pin.

Address lines shown are used to select between the internal registers as defined below. All other address lines are "don't cares."

A11	A10	A9	A8	Bit(s)	R/W	Function
0	1	0	0	0	Read	NC – Read as 0
0	1	0	0	1	Read	PS1 Front Panel Power Switch Status: (0 = On, 1 = Off)
0	1	0	0	2	Read	PS1 AC Detected (0 = No, 1 = Yes)
0	1	0	0	3	Read	NC – Read as 0
0	1	0	0	4	Read	NC – Read as 0
0	1	0	0	5	Read	PS1 Over Voltage Alarm Input (1 = OK, 0 = Alarm)
0	1	0	0	6	Read	PS1 Over Current Alarm Input (1 = OK, 0 = Alarm)
0	1	0	0	7	Read	PS1 Status: (0 = Failure, 1 = OK)
0	1	0	1	0	Read	NC – Read as 0
0	1	0	1	1	Read	PS2 Front Panel Power Switch Status: (0 = On, 1 = Off)
0	1	0	1	2	Read	PS2 AC Detected (0 = No, 1 = Yes)
0	1	0	1	3	Read	NC – Read as 0
0	1	0	1	4	Read	NC – Read as 0
0	1	0	1	5	Read	PS2 Over Voltage Alarm Input (1 = OK, 0 = Alarm)
0	1	0	1	6	Read	PS2 Over Current Alarm Input

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						(1 = OK, 0 = Alarm)
0	1	0	1	7	Read	PS2 Status: (0 = Failure, 1 = OK)
0	1	1	0	7-0	R/W	Read / Write Scratch Register
0	1	1	1	0	Read	Amp 1 Installed (1 = No, 0 = Yes)
0	1	1	1	1	Read	RF Detect 1 (0 = No, 1 = Yes)
0	1	1	1	2	Read	NC – Read as 0
0	1	1	1	3	Read	NC – Read as 0
0	1	1	1	4	Read	Amp 2 Installed (1 = No, 0 = Yes)
0	1	1	1	5	Read	RF Detect 2 (0 = No, 1 = Yes)
0	1	1	1	6	Read	NC – Read as 0
0	1	1	1	7	Read	NC – Read as 0
1	0	0	0	0	Write	Fan Control (0 = Off, 1 = On)
1	0	0	0	1	Write	DAC_Enable (0 = Disable DACs, 1 = Enable DACs)
1	0	0	0	2	Write	Fan Select A Control
1	0	0	0	3	Write	Fan Select B Control
1	1	0	0	7-0	Write	DAC1
1	1	0	1	7-0	Write	DAC2
1	1	1	0	7-0	Write	DAC3
1	1	1	1	7-0	Write	DAC4

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Software Description

Alarms Types & Behavior

Power Amplifier Alarms

Alarm Type	*Status Byte bit*	*PA #1 Alarm Occurrence*		*PA #2 Alarm Occurrence*
Fan Failure	7	Cut to PA #2		Cut to PA #1
High Reverse	6	**Shutdown**		**Shutdown**
Low Pwr	5	Cut to PA #2		**Stay at PA #2**
Overcurrent	3	Cut to PA #2		Cut to PA #1
Thermal	2	Cut to PA #2		Cut to PA #1
High Pwr	1	Cut to PA #2		Cut to PA #1

cut back and forth to PA #1 & PA #2,"failcount" times (to find non-cut condition)

The table below lists all of the power amplifier alarm types and the cutover behavior of each alarm.

Table 5: Power Amplifier Alarms

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Status information for both PA #1 and PA #2 is read via a 3 byte (24-bit) status word called PAStatusWord24, as described below. The amplifier sets the bit when the relevant condition occurs. The bit will stay set until cleared by a write of a 0 to the corresponding bit in the status register –OR– when the alarming amplifier is removed or taken offline, then manually brought back online (the failure count will also be cleared in this case).

PAStatusWord24: There is a 3 byte (24-bit) status word:

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Byte #1: Generic Info

7, 6	*5, 4, 3*	*2,1,0*
Active PA	PA #1 failures causing cutover	PA #2 failures causing cutover
00 = none	000=0	000=0
01 = PA #1	001=1	001=1
10 = PA #2	010=2	010=2
11 = INVALID	011=3	011=3
	100=4	100=4
NOTE: these bits	101=5	101=5
are READ ONLY	110=6	110=6
	111=7+	111=7+

Byte #2: PA#1 Status Byte

7	*6*	*5*	*4*	*3*	*2*	*1*	*0*
Fan Warn	High Reverse	Low Pwr		Overcurrent	Thermal	High Pwr	NotInstalled

Byte #3: PA#2 Status Byte

7	*6*	*5*	*4*	*3*	*2*	*1*	*0*
Fan Warn	High Reverse	Low Pwr		Overcurrent	Thermal	High Pwr	NotInstalled

** All alarm bits in PA #1 and PA #2 are latched, and remain set even if the condition has gone away with or without transmission except the NotInstalled flag (bit 0)

Power Supply Alarms

In addition to the power amplifier alarms, Status information for both PS #1 and PS #2 is read via a 2 byte (16-bit) status word called PSStatusWord16, as described below. The amplifier sets the bit when the relevant condition occurs. The bit will stay set until cleared by a write of a 0 to the corresponding bit in the status register.

PSStatusWord16: There is a 2 byte (8-bit) status word:

Byte #1: PS#1 Status Byte

7	6	5	4	3	2	1	0
Fail	Overcurrent	Overvoltage			ACSense 0 = good 1 = bad	SwitchOn 0 = on 1 = off	Offline

Byte #2: PS#2 Status Byte

7	6	5	4	3	2	1	0
Fail	Overcurrent	Overvoltage			ACSense	SwitchOn	Offline

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"Push" Enabling for alarm conditions

The TRM-1 can be configured to send unsolicited alarm information (see command table below) on the occurrence of a power amplifier or power supply alarm. The unsolicited alarm information is sent as PAStatusWord24 or PSStatusWord16 through the serial port. It is sent once on the setting of any alarm bits in Byte 2 or Byte 3 of PAStatusWord24, or if a Power Supply alarm occurs, Byte 1 or Byte 2 in PSStatusWord16.

The pushed alarm status word will be sent in ASCII format (as are all commands and responses). It will have the following format. Note that numeric values are given in hex.

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PAStatusWord24=488000

or

PSStatusWord16=0400

By default, alarm "push" is enabled.

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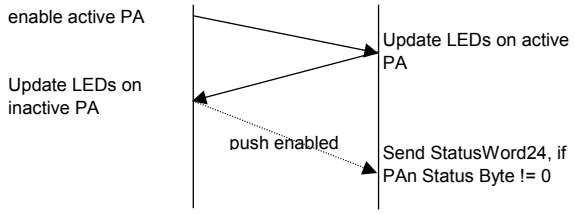
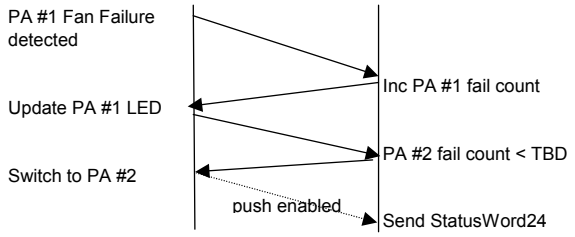
Alarm Algorithms

Several alarm scenarios are described in the flow diagrams below.

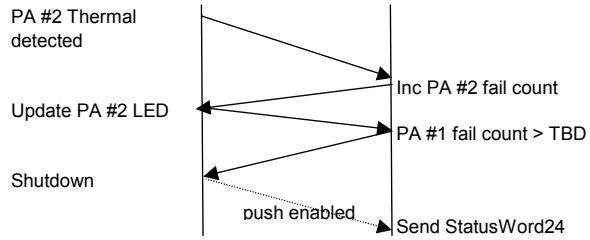
Power On:



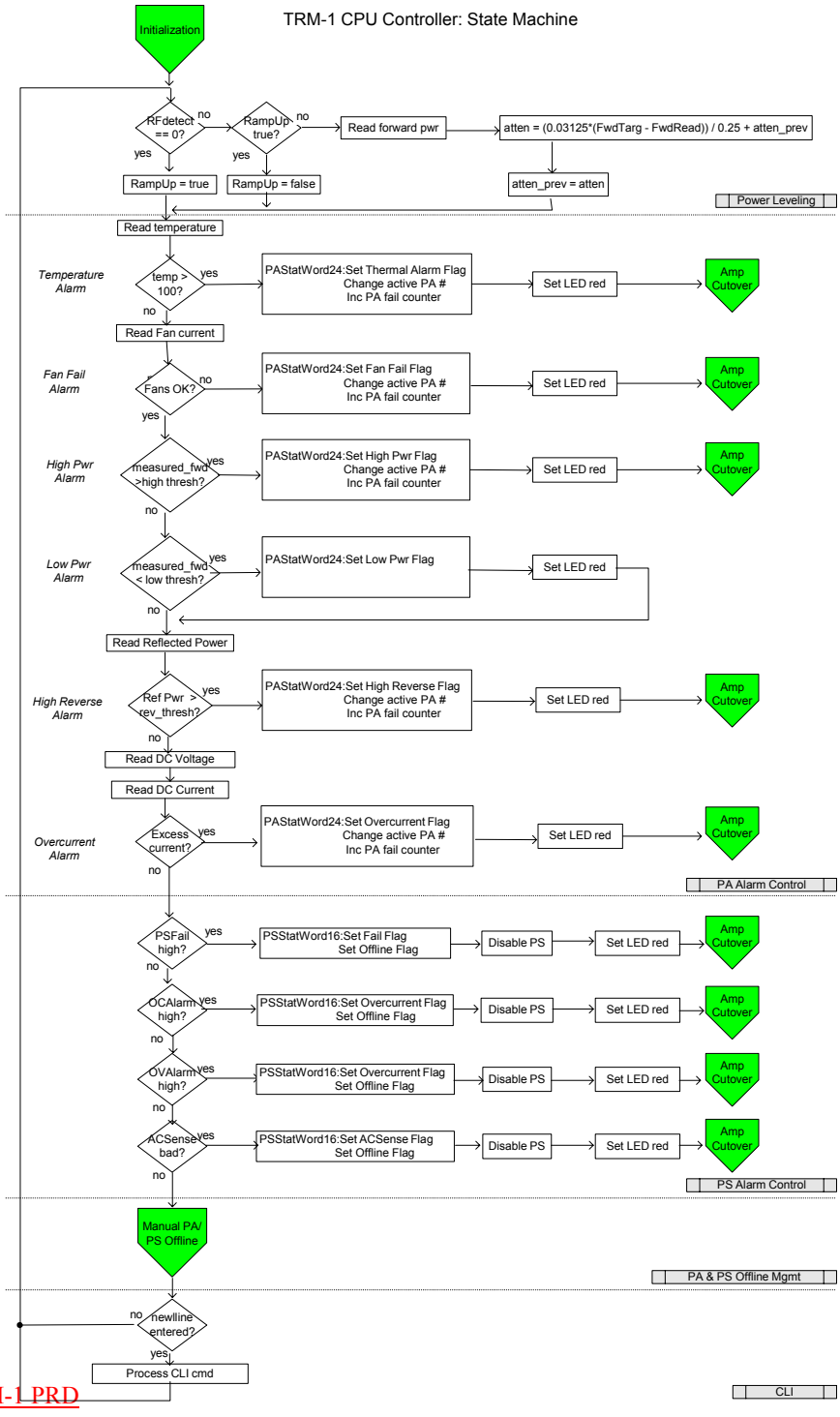
PA #1 Alarms with Fan Failure



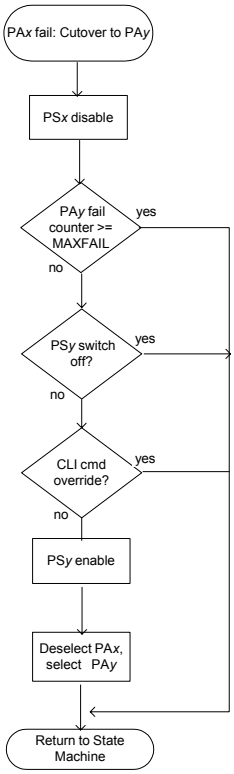
PA #1 Alarms with Fan Failure
& PA #2 Alarms with Thermal



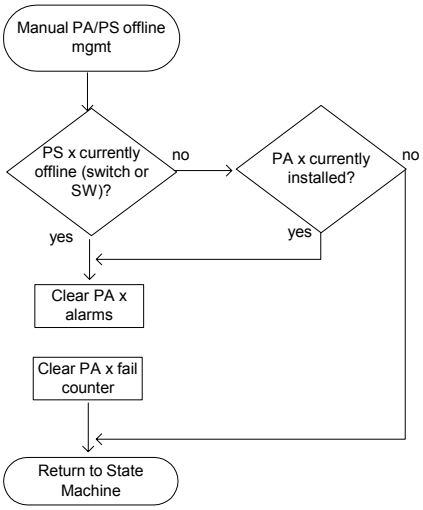
State Machine



PA Cutover



Manual PA/PS Offline



Serial Port Commands available to User

The table below lists all of the serial commands available to the user. All configuration parameters that are modified using the serial commands are stored in non-volatile memory and will be applied through subsequent power/reset cycles.

CMD	PARAMETERS	Units of Measure	Range	Resolution	Default Value	MEANING/ACTION
CUrrent		Amps	0 –- 40	0.01		Get the DC supply current
DOWNLOAD						Start xmodem1k download
Failcount	m			1-255	5	Get/Set the maximum PA fail count
FWd	m	Watts	250 - 500	0.01	400	Get/Set forward power
FWd	Thresh High m	Watts	0 – 1024	0.01	500	Get/Set the high power alarm high threshold
FWd	Thresh Low m	Watts	0 – 1024	0.01	200	Get/Set the high power alarm low threshold
PA	m				3	Gets/Sets active PA m = 0 ==> both PAs disabled m = 1 ==> PA #1 enabled m = 2 ==> PA #2 enabled m = 3 ==> firmware controlled
PA	Status m			000000-ffffff		Set/Get PAStatusWord24
PS	m ON | OFF					Set/Get Power Supply m online status
PS	Status m			0000-ffff		Set/Get PSStatusWord16
PUsh	YES | NO				YES	Set/Get alarm "push" status
RESet						Performs a hardware reset of the controller
REV		Watts	0 – 1024	0.01		Display reverse power
REV	Thresh m	Watts	0 – 1024	0.01	100	Gets/Sets the reverse power alarm threshold
SErial	xxxx					Get the serial number (max 16 chars)
TEmp	PA x	Deg C	-50 – +100	0.01		Gets linear PA x temperature
TEmp	Thresh High m	Deg C	-50 – +100	0.01	100	Gets/Sets the amplifier high temperature alarm threshold
TEmp	Thresh Low m	Deg C	-50 – +100	0.01	-30	Gets/Sets the amplifier low temperature alarm threshold
VEr						Get firmware version
VOltage		Volts	0 – 63	0.01		Get DC supply voltage

Table 6: Serial Port Commands available to User

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Status Word Definition¶
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LEDs

PA #1 and PA #2 will each have LEDs indicating their status, as well as a single Tx LED indicating the presence of RF output greater than 10 Watts.

	GREEN ●	RED ●	OFF ●
Alarm LED	OK	Alarm Condition active	PA off w/no alarms
Tx	RF Output		No RF Output

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All Warn and Shutdown flags remain

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Alarm Behaviour¶
All Warn and Shutdown flags remain ¶

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Driver Bias

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Driver Bias Signal

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DC Voltage

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Out to PA

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Low = Amplifier 1,

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High

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BiasA

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Bias Transistor A signal

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d

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I

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digital signal

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a

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Bias Transistor B signal

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s

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Serial Port Commands available to User

CMD	PARAMETERS	MEANING/ACTION	Digital Range
COntrol	m	Sets the control byte m	0-255
CUrrent		Gets the DC supply current. 0.0-19.9	0.0-19.9
FWDRead		Display forward power	0-600
FWDSet	m	Set the desired forward power for internal AGC target.	0-600
FWDAlarm	m	Display or set the FWD power alarm	0-600
Help		Display all commands with their definition	
PA	m	Display which PA is active, or set active PA to m.	1-2
RESet		Performs a hardware reset of the CONTROLLER.	
REFRead		Display the reflected power output	0-600

REFAlarm	m	Display or set the reflected power alarm	0-600
Status	m	Display the amplifier status and alarms (if no parameter), else Set the Status word to m	0-255
TEmp	A	Gets linear Amp temperature	-40 to +100
TEmp	P	Gets PreDriver temperature	-40 to +100
Voltage		Gets DC supply voltage	0.0-40.0

Design Philosophy

Robustness

The design will incorporate, to the extent feasible and cost effective, margin against the specified criteria. In each case the margin is determined from the expected normal variations in manufacturing parameters and device variations as they apply to the design. Additionally, the product incorporates robust circuit design to require minimal alignment or tuning during test. To the extent possible, all components will be surface mount and utilize multiple source parts.

The amplifier must self-protect against all fault conditions. In particular, care is taken to prevent damage due to:

Reverse DC voltage

RF overdrive

High VSWR on output

Over-temperature

Failure of any LRU

Implementation and Construction

The amplifier is divided into these sections, each section capable of being tested by itself.

500 watt RF Output Stage. A two-stage power module, field replicable, with approximately 25dB of gain. Two per unit.

RF Driver/Splitter/AGC Stage. With approximately 20dB of gain. One per unit.

RF switch to select which output stage to operate off of.

RF wattmeter with directional coupler.

DC monitoring (current and voltage)

CPU Controller (bias voltage generation, AGC management, monitoring, CLI, alarming…)

AC power supply, two per unit. Load-sharing, each with enough capacity to output 1500 watts if needed.

Operation

The amplifier should look like a gain block, with some AGC for power leveling.

It powers up in the “on” state.

Status Word Definition

Status byte For all bits except bit 6, the amplifier sets the bit when the relevant condition occurs. The bit will stay set until cleared by a write of a 1 to the corresponding bit in the control register. Bit 6 indicates whether the amplifier is active or shut down. The amplifier may only be brought back online by writing a 1 to bit 6 of the status byte, but shutdown may occur either by writing a 0 to bit 6 of the status byte, or by one of the shutdown conditions being detected.							
7	6	5	4	3	2	1	0
Fan Warn Flag	Amp Online	Amplifier Reset Flag	Active Amp	Overdrive Warn Flag	Thermal Warn Flag	Overdrive Shutdown Flag	Thermal Shutdown Flag

7	Fan Warn	1	fan current has exceeded or fallen below fixed high/low thresholds
		0	fan current is within fixed high/low thresholds
6	Amp Online	1	amp is online
		0	amp is shutdown
5	Reset	1	performs a hardware reset on controller
		0	controller is running
4	Active	1	amp #2 is currently active
		0	amp #1 is currently active
3	Overdrive Warn	1	output power exceeds fixed warn threshold
		0	output power is below fixed warn threshold
2	Thermal Warn	1	temperature exceeds fixed temperature warn threshold
		0	temperature is below fixed temperature warn threshold
1	Overdrive Shutdown	1	output power exceeds fixed overdrive shutdown threshold
		0	output power is below fixed overdrive shutdown threshold
0	Thermal Shutdown	1	temperature exceeds fixed temperature shutdown threshold
		0	temperature is below fixed temperature shutdown threshold