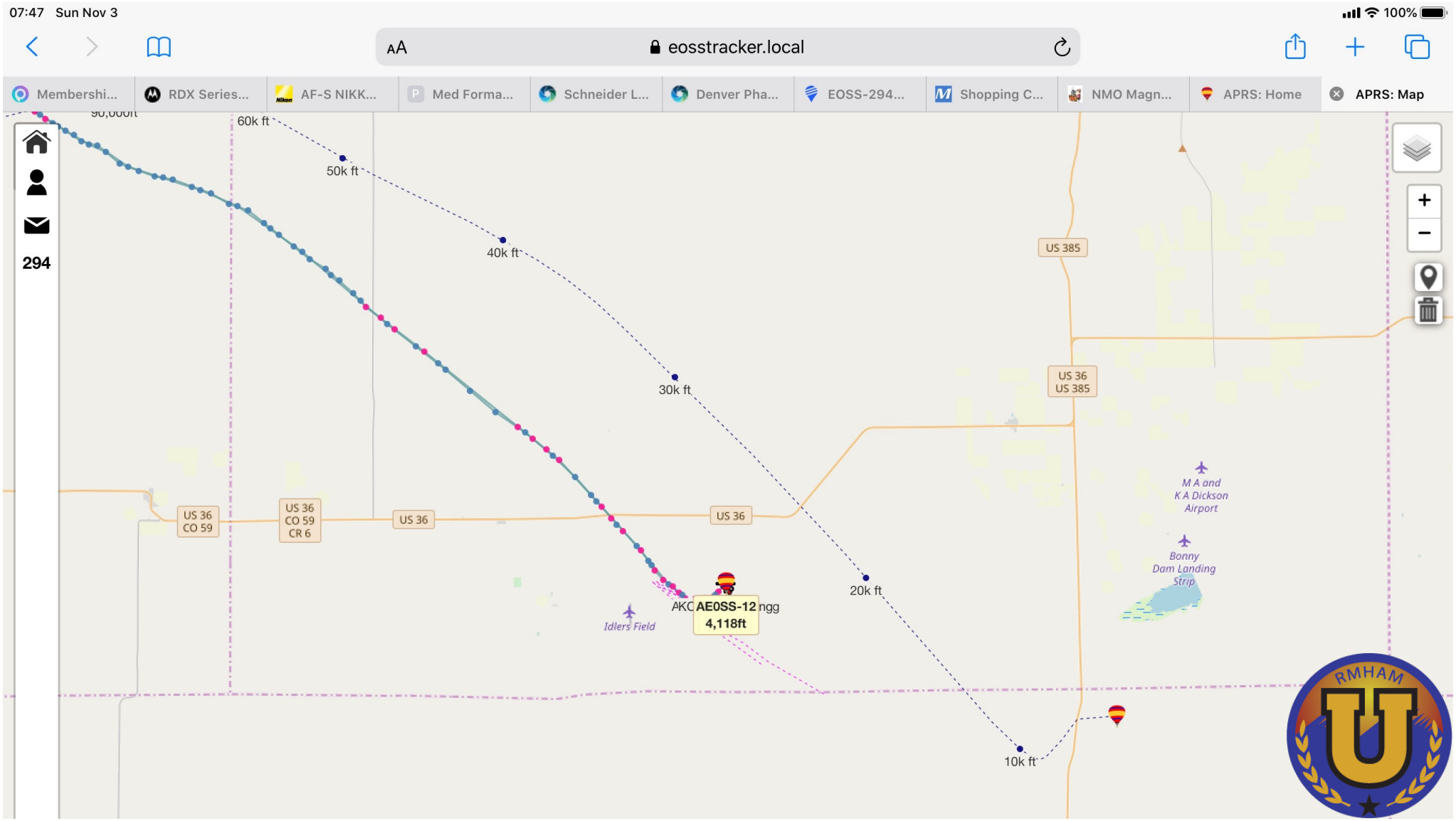
VEHICLE POWER SYSTEMS

MIKE PAPPAS, W9CN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AA
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Membershi...
RDX Series...
AF-S NIKK...
Med Forma...
Schneider L...
Denver Pha...
EOSS-294...
Shopping C...
NMO Magn...
APRS: Home
APRS: Map
294
60k ft
50k ft
40k ft
30k ft
20k ft
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CO 59
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CO 59
CR 6
US 36
US 36
M A and
K A Dickson
Airport
Bonny
Dam Landing
Strip
Idlers Field
AE0SS-12
4,118ft
RMHAM


T520
Mark2
Second Edition


MOTOROLA
XPR 5550e
Ch 5
Squaw Rk Mtn
Scan
Hi-Lo
Zn-s
Brite
OK
P1
P2
P3
P4
MOTOROLA
XPR 4550
H
BOULDER RK MT
CH+
CH-
P1
P2
P3
P4
MENU
OK
BACK


WAN
routerboard
MOTOROLA
Great Value
Glass Cleaner
RMHAM
U


RMHAM
U


GMC
CGB·K70
COLORADO

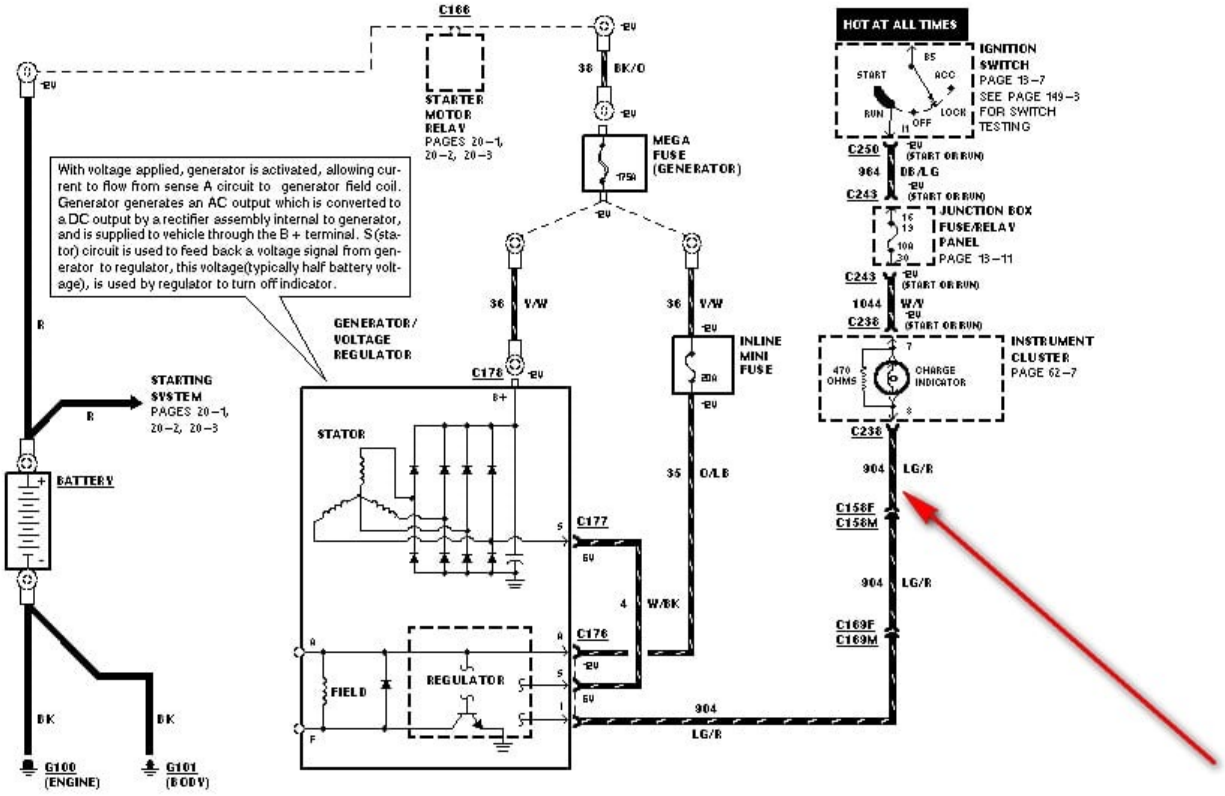
EVERYTHING YOU WANTED TO KNOW ABOUT VEHICLE POWER SYSTEMS, BUT WERE AFRAID TO ASK

- The ABC’s of Vehicle Power Systems

EVERYTHING YOU WANTED TO KNOW ABOUT VEHICLE POWER SYSTEMS, BUT WERE AFRAID TO ASK

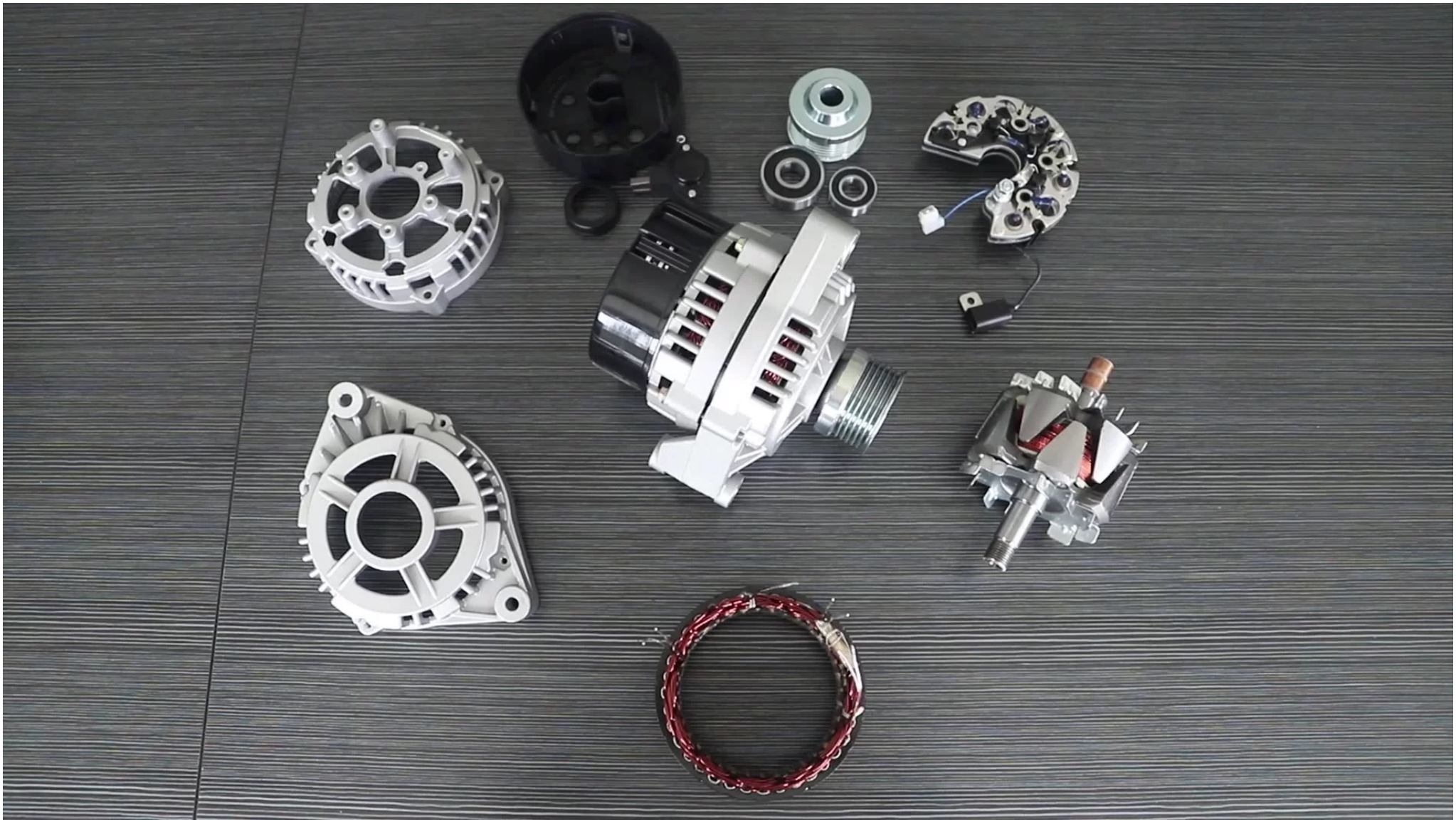
- Vehicle power systems consist of
  - **A**lternator
  - **B**attery
  - **C**ontrol system

Charging System (012-1)



ALTERNATOR 101

- 3 Phase Stator
- Rotor Field coil
- Rectifiers (8)
- Voltage regulator



ALTERNATOR 101

- Alternator Rated output (SAE Specifications)
  - Measured at 6,000 RPM alternator shaft speed
  - Which is typically between 2000 to 3000 RPM engine RPM
  - At idle (1500 RPM alternator shaft speed) its typically half of its “rated” output
    - Your 150 amp alternator at idle will have 75 amp output
  - Measured at 72 F
    - Typical engine compartment temps at over 140 degrees
    - Output will be less

ALTERNATOR 101

- Alternator vulnerabilities
  - Heat is the number one killer of alternators
  - Rectifiers do not like high temperatures and have reduced performance
    - They have gotten better in the last couple of decades
    - Higher electrical loads increase alternator temperature and stress the rectifiers even more
    - Manufacturers put the smallest alternator in most vehicles that they can get away with which increases the load on the rectifiers

ALTERNATOR 101

TADITEL

HOME ABOUT US OE AFTERMARKET APPLICATION GUIDE

Ford 6G – T68

$46.50

SPECIFICATIONS:
RATING: 200AMP
AVALANCHE DIODES

COPPER POSITIVE HEAT SINK
BATTERY POST: 8MM

− 1 + Add to cart

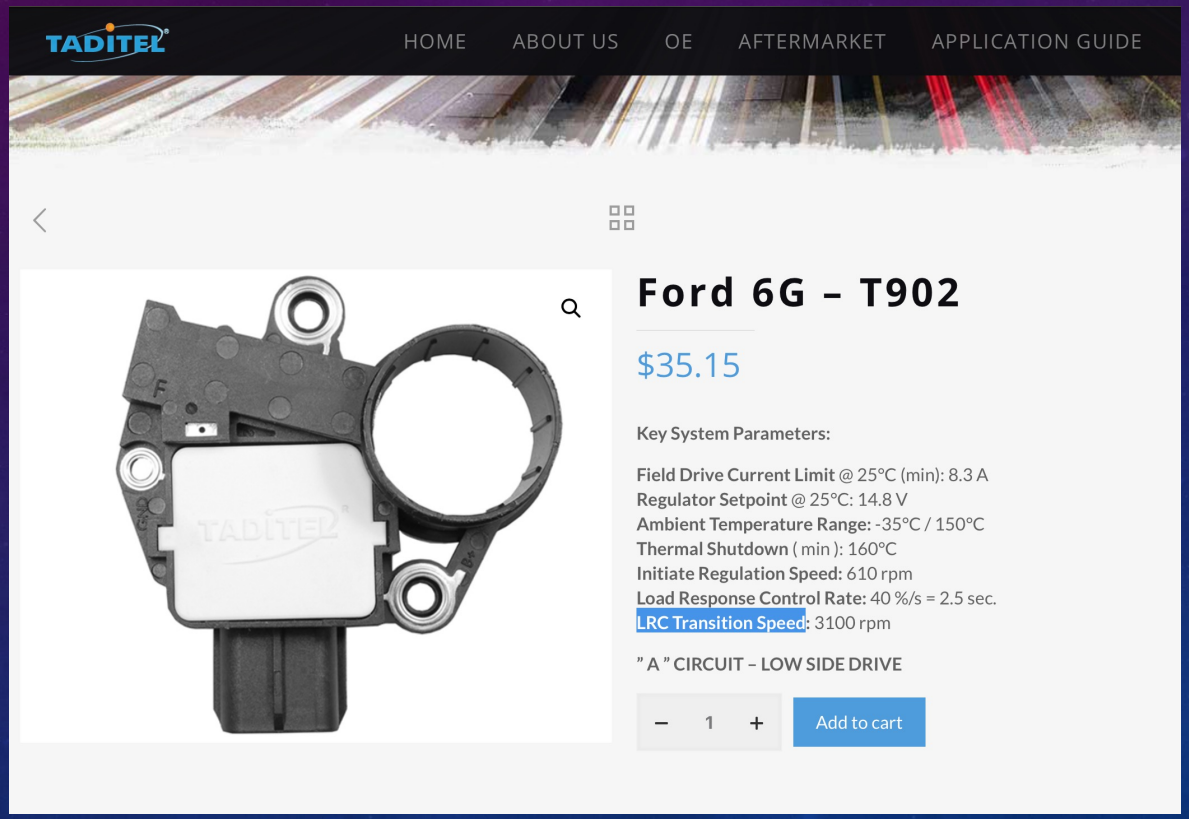
ALTERNATOR 101

- Alternator vulnerabilities
  - Stators coils
    - Vibration can cause shorts
    - Don’t like high temps

ALTERNATOR 101

- Alternator vulnerabilities
  - Regulators
    - Heat
    - Electrical System Faults
    - Wear/Dirt on brushes/slip rings

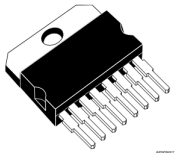
ALTERNATOR 101



Alternator voltage regulator with load response control

Features

- IC regulator for 12 V type alternator
- Fixed frequency regulation loop
- 130 mΩ high side field driver
- Fail safe device with double sensing of battery voltage (VB and VS)
- Load response control (LRC) function activates after an initial time delay
- Self start function from phase frequency
- “Z” shaped regulation curve compliant with VW specification.
- Key recognition from L input
- Field driver, lamp driver and relay driver short protection
- Complex diagnostics
- Thermal shutdown at 175 °C



Multiwatt8

Description

The L9409 is a monolithic multifunction alternator voltage regulator intended for use in automotive applications.

The device regulates the output of an automotive generator by controlling the field winding current by means of either an analog fixed frequency PWM signal or digital fixed frequency PWM signal (LRC). The Load Response Control function is activated in order to eliminate IC engine speed fluctuation and vibrations caused by the insertion of sudden electrical loads during alternator low speed operations (f < 310 Hz). Both the analog and digital duty cycle are applied to a high side driver.

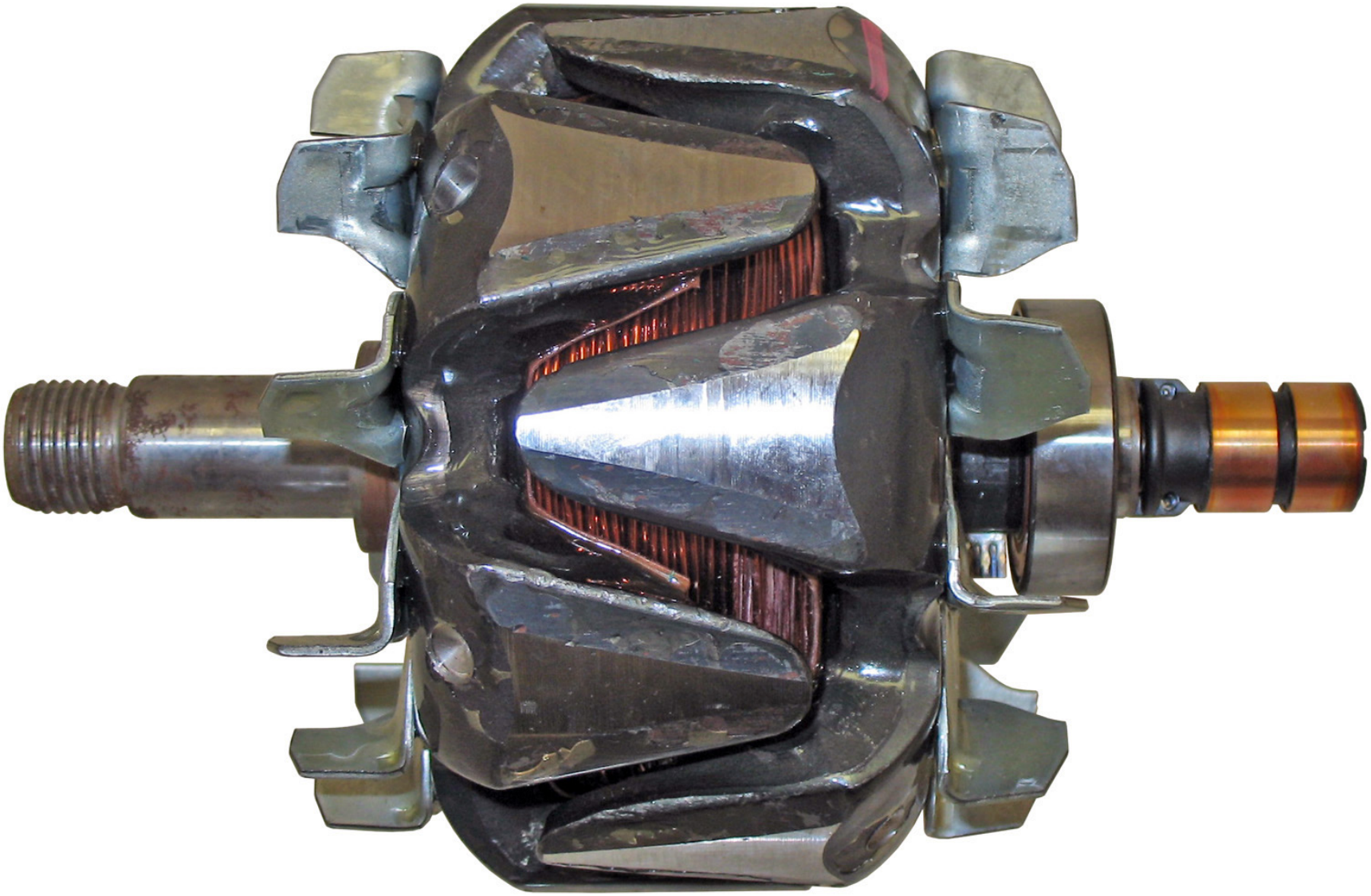
The device is able to regulate the voltage either using a feedback signal from B pin or from S pin depending on application needs. S pin is intended to have a clear direct connection with the positive terminal of the car battery. If this connection gets lost the device will regulate voltage using B pin giving a fail safe functionality.

Using L pin is possible to sense key switch and a pre-excitation duty cycle is applied on the field coil in order to start phase voltage sensing. In the case L connection gets lost, device starts to generate using residual magnetism of the generator.

Field, lamp and relay drivers are protected against short circuit.

ALTERNATOR 101

- Alternator vulnerabilities
  - Rotor
    - Wear/Dirt on slip rings
    - Bearings 6000 RPM
    - Significant Rotational mass



ALTERNATOR 101

- Alternator vulnerabilities
    - New alternators use “clutches”

ALTERNATOR 101

- Alternator vulnerabilities
    - Overrunning Alternator Pulley (OAP)
        - Designed to reduce shocks on the front drive belt system
        - Caused by the high rotational force of the alternator rotor going to war with the crankshaft
        - Can seize or decouple the alternator
        - Can require special tools to replace

ALTERNATOR 101

ALTERNATOR 101

BATTERY 101

- A battery is a chemical storage system
  - In automobiles it's referred to as an SLI battery
  - SLI: Starting Lighting Ignition
  - Note: Doesn't say anything about "radios"
  - Usually lead acid design

BATTERY 101

- Fully charged lead acid battery
  - 12.5 VDC (measured 24 hours after charging to allow “surface charge” to dissipate)
- 50% discharged lead acid battery
  - 11.5 VDC
- Fully discharged lead acid battery
  - 10.5 VDC
- Note: AGM Batteries voltages are higher

BATTERY 101

- Battery Specs
  - Cold Cranking Amps (CCA):
    - The discharge load in amperes that a new, fully charged battery can deliver at 0 degrees F for 30 seconds while maintaining a voltage of 1.20 volts/cell or higher
  - Cranking Amps (CA):
    - The discharge load in amperes that a new, fully charged battery at 32 degrees F can continuously deliver for 30 seconds while maintaining a terminal voltage equal to or higher than 1.20 volts/cell
  - Note: 0 degrees for CCA vs 32 degrees for CA

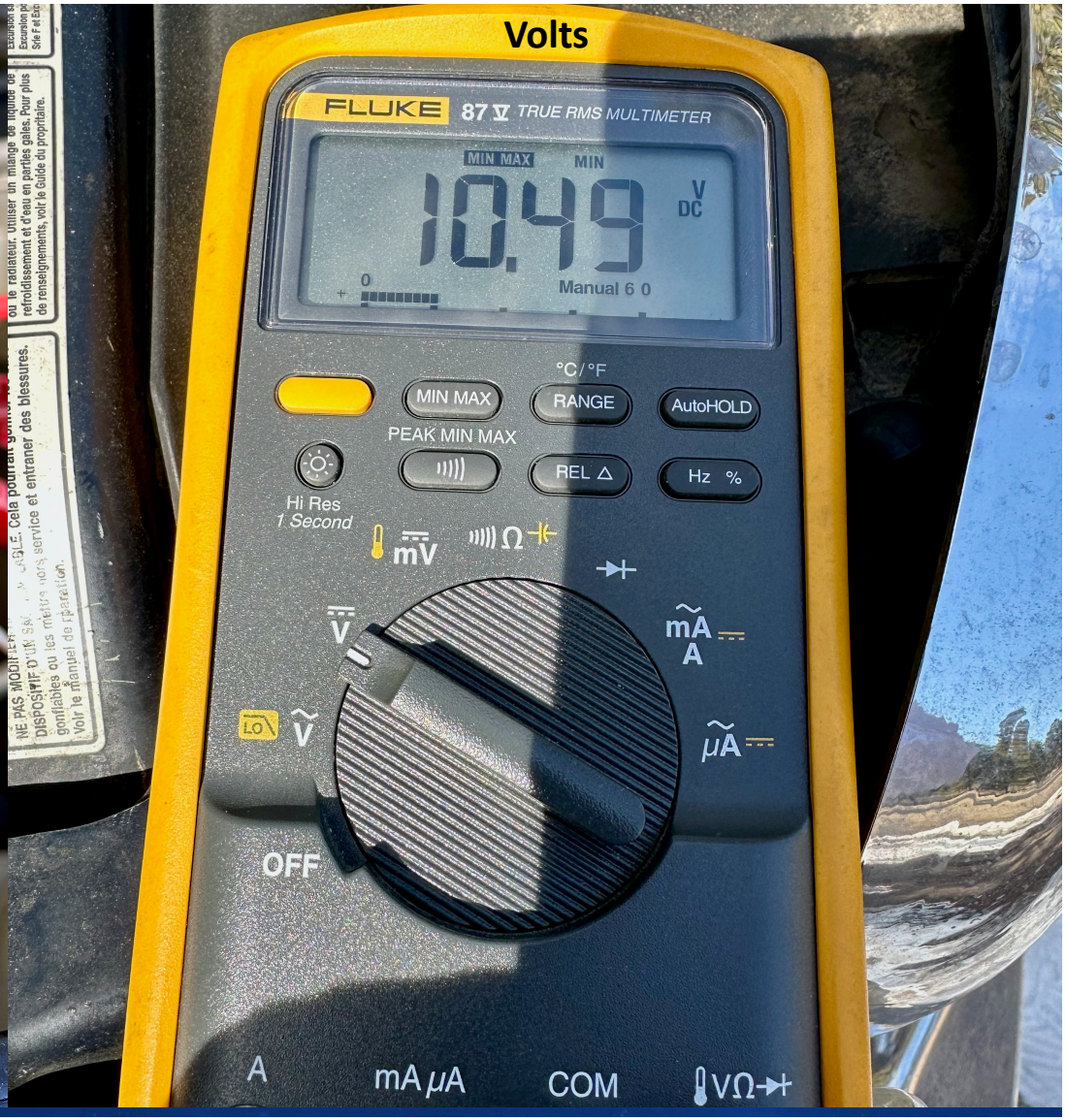
BATTERY 101

- Battery Specs
  - Reserve Capacity (RC):
    - The number of minutes a new, fully charged battery at 80 degrees F can be discharged at 25 amperes while maintaining a voltage of 1.75 volts/cell or higher.
    - For a 12-volt battery (six cells), RC is the number of minutes it can maintain a voltage of 10.5 volts with a 25-amp draw; therefore, a "75-minute" battery lasts 75 minutes under these conditions

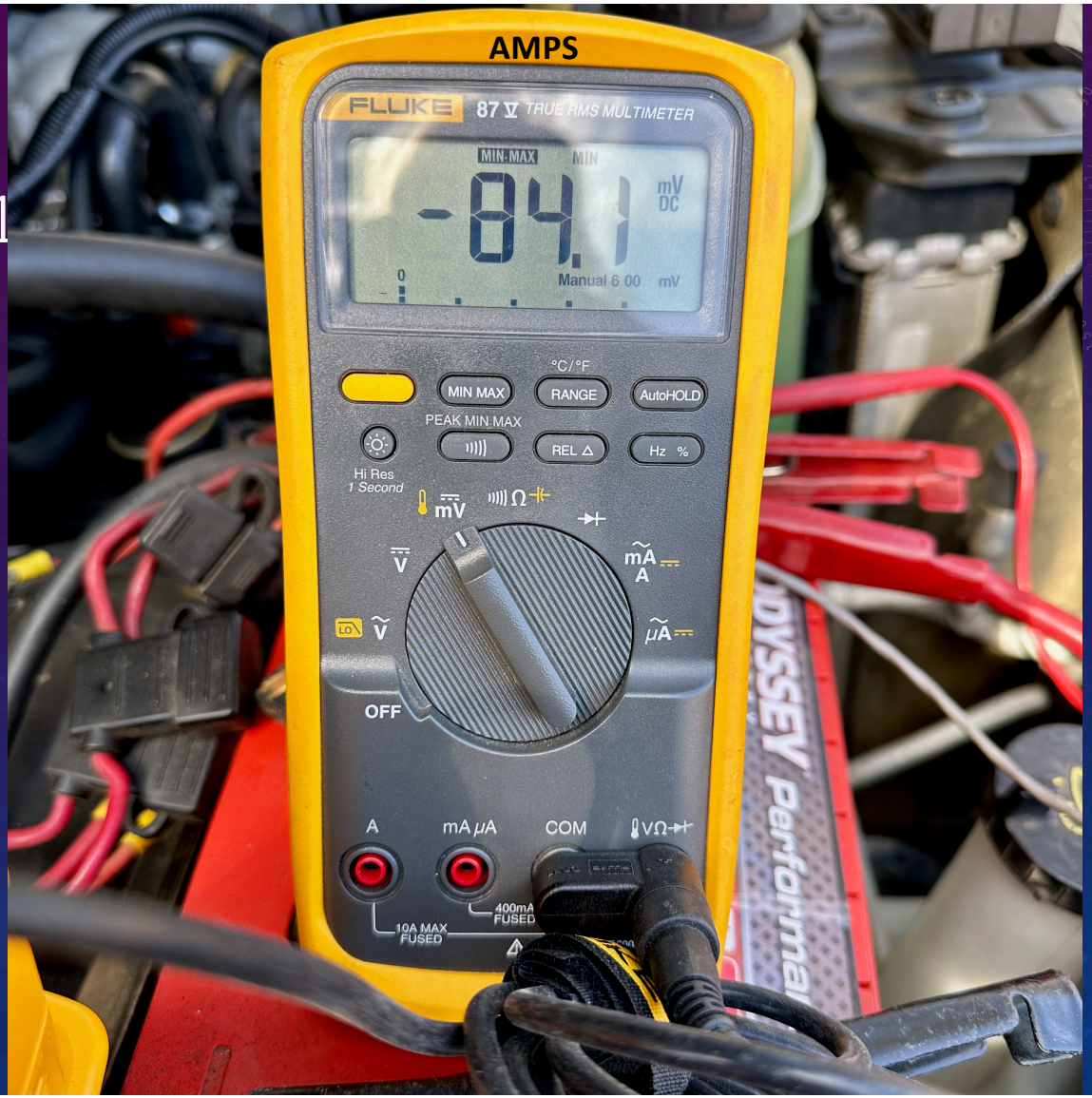
BATTERY 101

- Life Span:
  - Depends upon how much abuse it gets
  - Figure 3 to 5 years
  - Less if you beat it to death
  - High temps are not good for them
  - The engine compartment can hit 160 F in the summer-time
  - Cold temps reduce the available cranking current
    - Hundreds of amps to crank an engine


AMPS
FLUKE
87 V TRUE RMS MULTIMETER
MIN MAX MAX
486.0
mV DC
Manual 6 00 mV
°C/°F
MIN MAX
RANGE
AutoHOLD
PEAK MIN MAX
REL Δ
Hz %
Hi Res
1 Second
OFF
A
mA μA
COM
VΩ
10A MAX FUSED
400mA FUSED


Volts
FLUKE
87 V TRUE RMS MULTIMETER
MIN MAX MIN
10.49
V DC
Manual 6 0
°C/°F
MIN MAX
RANGE
AutoHOLD
PEAK MIN MAX
REL Δ
Hz %
Hi Res
1 Second
OFF
A
mA μA
COM
VΩ

BATTERY 101


AMPS
FLUKE
87 V TRUE RMS MULTIMETER
MIN MAX
MIN
-84.1
mV DC
Manual 6 00 mV
°C/°F
MIN MAX
RANGE
AutoHOLD
PEAK MIN MAX
REL Δ
Hz %
Hi Res
1 Second
mV
OFF
A
mA μA
COM
VΩ
10A MAX FUSED
400mA FUSED
ODYSSEY

VEHICLE 101

- Vehicle manufactures are under intense pressure to hit their EPA CAFÉ milage numbers
- Everything is under a microscope
- The EPA “incentivizes” manufactures to employ various “schemes” to improve gas milage
- The “Auto Start Stop” system in many vehicles gives the manufacture a 0.5 MPG CAFÉ bonus
  - Even though it doesn’t improve gas milage in the EPA MPG test cycle
  - It does in my opinion, beat starters and batteries to death

VEHICLE 101

- Many now use advanced power system management techniques
- Including
  - Cycling the Alternator on and off
    - Which is why they have to use the Overrunning Alternator Pulley (OAP)
  - Discharging the battery to 11.5 VDC (50% discharge) before turning the alternator back on
    - Which kills batteries
    - The cynic in me says that they have these systems setup to just get the battery past the warranty
  - Managing the alternator output and measuring the current output and battery state of charge to reduce engine load and “improve” gas mileage

VEHICLE 101

- The ECM looks at the bus voltage and current being delivered by the alternator and the current in/out of the battery
- It makes some decisions to turn on or off the alternator or decrease/increase its output
- Uses the only battery (until it hits 11.5 VDC)
- EPA gives them a 0.5 MPG CAFÉ credit for this
  - Even though it doesn't improve gas mileage in the EPA MPG test cycle
  - It does beat batteries to death

VEHICLE 101

VEHICLE 101

VEHICLE 101

- This makes using the vehicle electrical systems for amateur radio more “interesting”
- You may be able to defeat the alternator cycling by unplugging the battery current sensor
  - On GMC trucks it will throw a CEL which will go out eventually
  - This will return the system to a normally operating electrical system

RADIO 101

- So now that you have an overview of a vehicles electrical system how do you get clean power to your radio(s)
- Motorola recommends the radio be fed from the Positive Terminal of the battery
- And negative tied to chassis

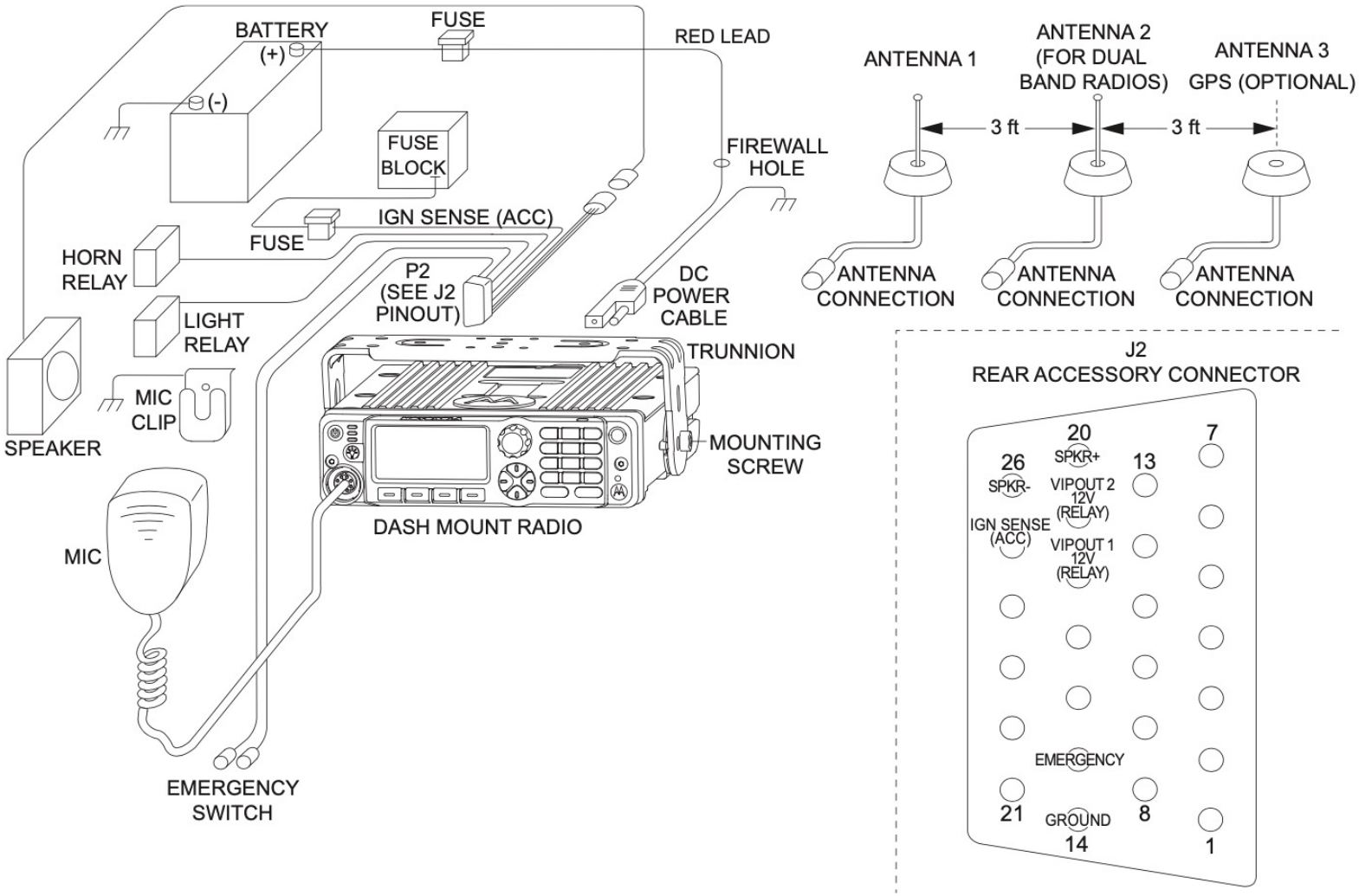


Figure 2-7. Radio Installation (O7 Mid Power Dash Mount)

RADIO 101

- Motorola recommends the radio be fed from the Positive Terminal of the battery
  - Note the fuse in the positive lead near the battery
  - All Motorola power harnesses have a fuse holder with fuse at the far end of the harness
- Negative tied to the chassis
  - I try to put the negative lead as close to the battery as possible
  - This will tend to be the lowest noise point in the system

RADIO 101

- Places not to use
  - Cigarette lighter sockets
    - Those are not designed to be low noise, high current sources
    - They are designed to be cheap
    - No good comes from using them for your radio
  - At the end of any OEM wiring harnesses
    - Those are not designed to be low noise, high current sources
    - They are designed to be cheap
    - No good comes from using them for your radio

RADIO 101

- Battery Boosters
  - I am not fan of battery boosters
  - Significant RFI issues
  - PWM and it varies with load
    - Which means you can be chasing your tail around looking for the RFI problem
  - 90% efficiency
    - Which increases your electrical system load by an additional 10%!
  - Can run your battery down to the point it won't start your car

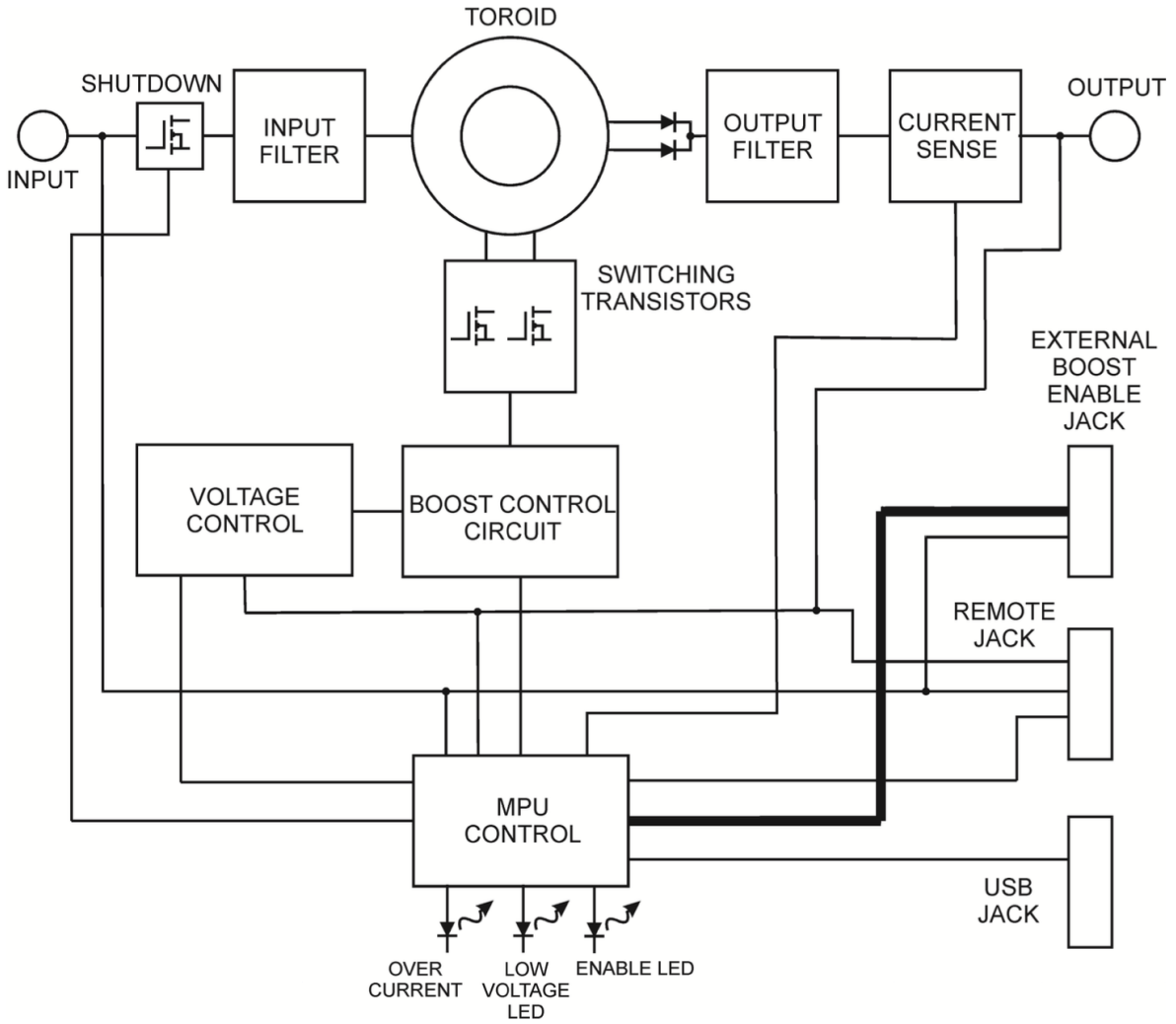


Figure 10 Block Diagram

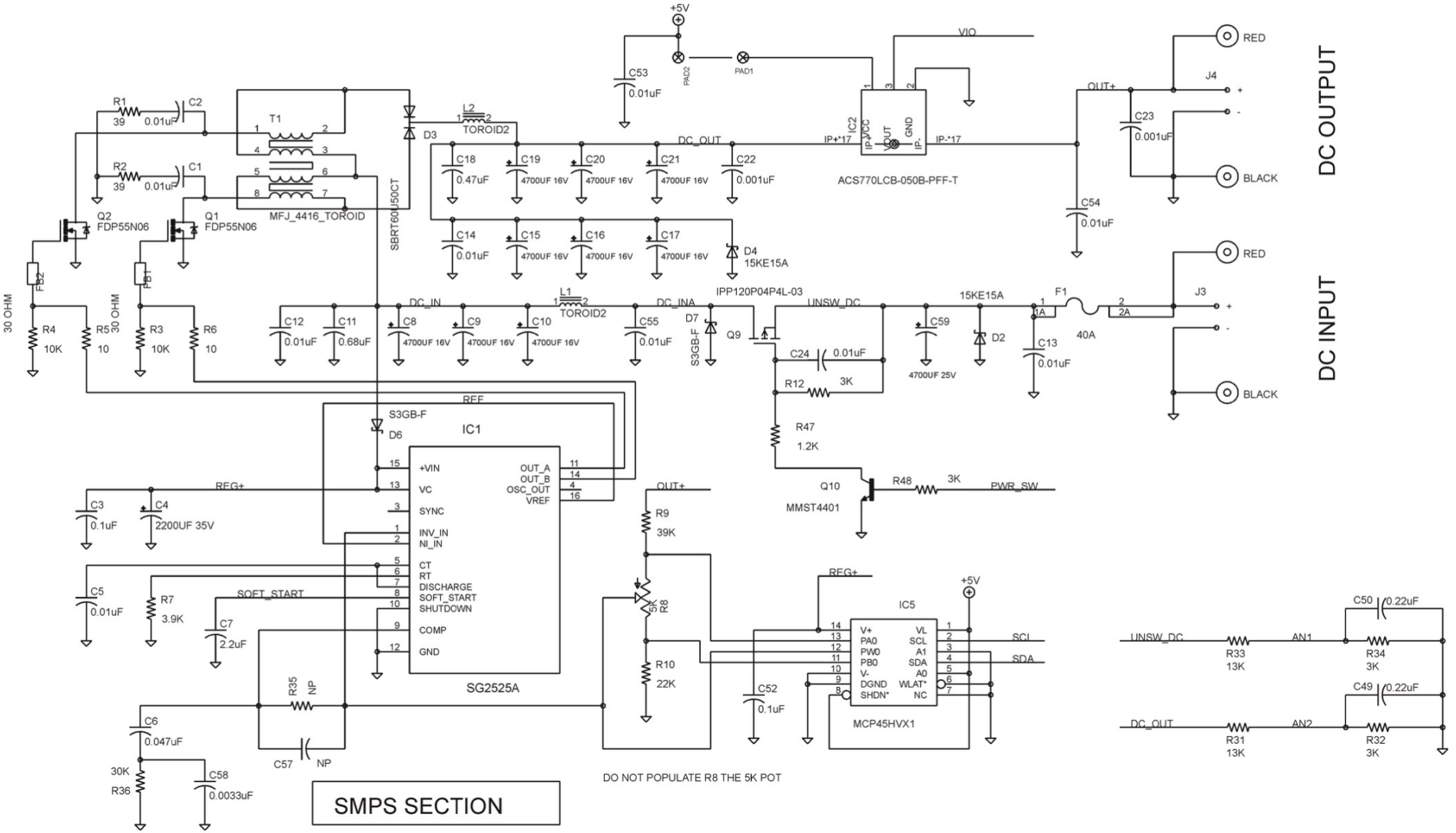
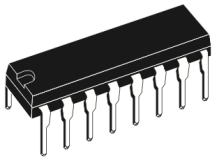


Figure 11 SMPS Section Schematic

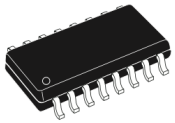
SG2525A
SG3525A

REGULATING PULSE WIDTH MODULATORS

- 8 TO 35 V OPERATION
- 5.1 V REFERENCE TRIMMED TO ± 1 %
- 100 Hz TO 500 KHz OSCILLATOR RANGE
- SEPARATE OSCILLATOR SYNC TERMINAL
- ADJUSTABLE DEADTIME CONTROL
- INTERNAL SOFT-START
- PULSE-BY-PULSE SHUTDOWN
- INPUT UNDERVOLTAGE LOCKOUT WITH HYSTERESIS
- LATCHING PWM TO PREVENT MULTIPLE PULSES
- DUAL SOURCE/SINK OUTPUT DRIVERS



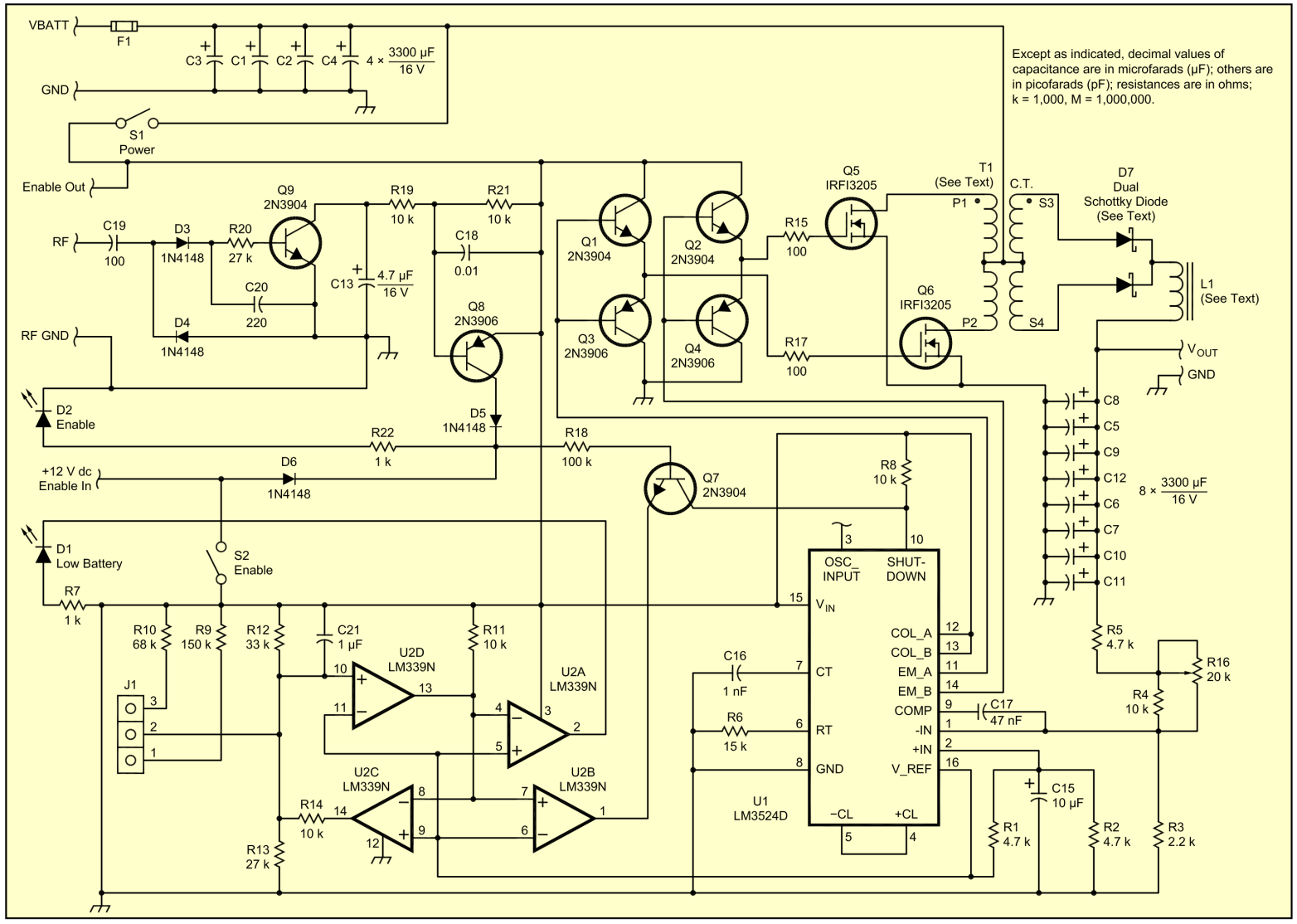
DIP16



16(Narrow)

DESCRIPTION

The SG3525A series of pulse width modulator integrated circuits are designed to offer improved performance and lowered external parts count when used in designing all types of switching power supplies. The on-chip + 5.1 V reference is trimmed to ± 1 % and the input common-mode range of the error amplifier includes the reference voltage eliminating external resistors. A sync input to the oscillator allows multiple units to be slaved or a single unit to be synchronized to an external system clock. A single resistor between the C_T and the discharge terminals provide a wide range of dead time ad- justment. These devices also feature built-in soft-start circuitry with only an external timing capacitor required. A shutdown terminal controls both the soft-start circuity and the output stages, providing instantaneous turn off through the PWM latch with pulsed shutdown, as well as soft-start recycle with longer shutdown commands. These functions are also controlled by an undervoltage lockout which keeps the outputs off and the soft-start capacitor discharged for sub-normal input voltages. This lockout circuitry includes approximately 500 mV of hysteresis for jitter-free operation. Another feature of these PWM circuits is a latch following the comparator. Once a PWM pulses has been terminated for any reason, the outputs will remain off for the duration of the period. The latch is reset with each clock pulse. The output stages are totem-pole designs capable of sourcing or sinking in excess of 200 mA. The SG3525A output stage features NOR logic, giving a LOW output for an OFF state.


VBATT
F1
C3
C1
C2
C4
4 × 3300 µF 16 V
GND
S1
Power
Enable Out
RF
C19
100
D3
1N4148
R20
27 k
Q9
2N3904
R19
10 k
R21
10 k
C18
0.01
C13
4.7 µF
16 V
C20
220
D4
1N4148
RF GND
Q8
2N3906
D5
1N4148
D2
Enable
R22
1 k
+12 V dc
Enable In
D6
1N4148
R18
100 k
Q7
2N3904
D1
Low Battery
S2
Enable
R7
1 k
R10
68 k
R9
150 k
R12
33 k
C21
1 µF
U2D
LM339N
R11
10 k
U2A
LM339N
J1
U2C
LM339N
R14
10 k
R13
27 k
U2B
LM339N
Q1
2N3904
Q2
2N3904
Q3
2N3906
Q4
2N3906
Q5
IRFI3205
Q6
IRFI3205
R15
100
R17
100
T1
(See Text)
P1
P2
C.T.
S3
S4
D7
Dual
Schottky Diode
(See Text)
L1
(See Text)
VOUT
GND
C8
C5
C9
C12
C6
C7
C10
C11
8 × 3300 µF 16 V
R8
10 k
U1
LM3524D
OSC_ INPUT
SHUT-DOWN
VIN
CT
RT
GND
COL_A
COL_B
EM_A
EM_B
COMP
-IN
+IN
V_REF
-CL
+CL
C16
1 nF
R6
15 k
C17
47 nF
C15
10 µF
R1
4.7 k
R2
4.7 k
R3
2.2 k
R5
4.7 k
R4
10 k
R16
20 k
Except as indicated, decimal values of capacitance are in microfarads (µF); others are in picofarads (pF); resistances are in ohms; k = 1,000, M = 1,000,000.

LM2524D/LM3524D Regulating Pulse Width Modulator

Check for Samples: LM2524D, LM3524D

FEATURES

- **Fully Interchangeable With Standard LM3524 Family**
- **±1% Precision 5V Reference With Thermal Shut-Down**
- **Output Current to 200 mA DC**
- **60V Output Capability**
- **Wide Common Mode Input Range for Error-Amp**
- **One Pulse per Period (Noise Suppression)**
- **Improved Max. Duty Cycle at High Frequencies**
- **Double Pulse Suppression**
- **Synchronize Through Pin 3**

DESCRIPTION

The LM3524D family is an improved version of the industry standard LM3524. It has improved specifications and additional features yet is pin for pin compatible with existing 3524 families. New features reduce the need for additional external circuitry often required in the original version.

The LM3524D has a ±1% precision 5V reference. The current carrying capability of the output drive transistors has been raised to 200 mA while reducing V_{CEsat} and increasing V_{CE} breakdown to 60V. The common mode voltage range of the error-amp has been raised to 5.5V to eliminate the need for a resistive divider from the 5V reference.

In the LM3524D the circuit bias line has been isolated from the shut-down pin. This prevents the oscillator pulse amplitude and frequency from being disturbed by shut-down. Also at high frequencies (≈300 kHz) the max. duty cycle per output has been improved to 44% compared to 35% max. duty cycle in other 3524s.

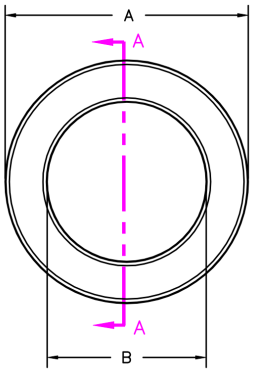
In addition, the LM3524D can now be synchronized externally, through pin 3. Also a latch has been added to insure one pulse per period even in noisy environments. The LM3524D includes double pulse suppression logic that insures when a shut-down condition is removed the state of the T-flip-flop will change only after the first clock pulse has arrived. This feature prevents the same output from being pulsed twice in a row, thus reducing the possibility of core saturation in push-pull designs.

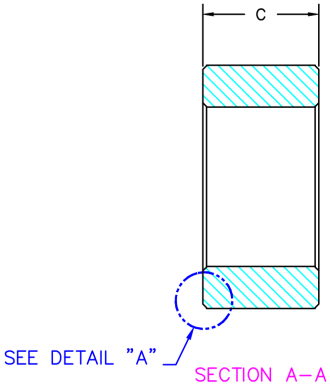
RADIO 101

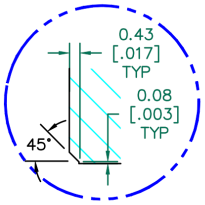
- Battery Boosters
  - There is no free lunch with using a booster
  - The lower the battery voltage the more current the booster will draw from the battery
  - Plus the additional 10% loss in the booster
  - 100 W load plus the loss of the booster is now 110 watt load
  - Ohms law always wins
  - 110 W
    - @ 12.5 VDC is 8.8 A
    - @ 11.5 VDC is 9.56 A
    - @ 10.5 VDC is 10.47 A

RADIO 101

- Battery Boosters
  - From the MFJ Manual
    - Noise Reduction
    - Although every effort was made to reduce switching noise RF noise is a possibility**. To reduce noise to a minimum ground the case of the MFJ-4418 to the automotive chassis with as short of a wire or grounding braid as possible.** Clamp on ferrite beads can be used on the input and out power leads to further reduce noise. 1 or 2 turns through the bead will help.
    - Clamp on ferrite “beads” only start working above 450 MHz
    - You need big ones to get down to below VHF



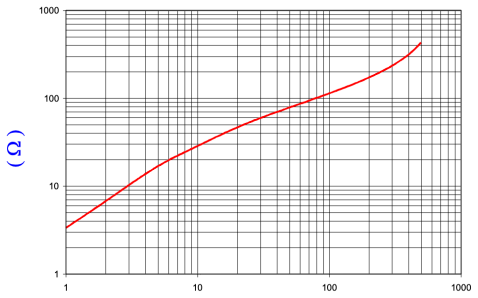




DETAIL "A"
CHAMFER
SCALE=4:1

IMPEDANCE (Z)			
Frequency	25 MHz	100 MHz	300 MHz
Nominal (REF)	54 Ω	114 Ω	235 Ω
Minimum	- Ω	91 Ω	- Ω

Z vs. FREQUENCY
(REF. ONLY)



AGILENT E4991A Impedance/Material Analyzer
HP 16092A Test Fixture

FERRITE CORE DIMENSIONS (SPEC): mm/inches

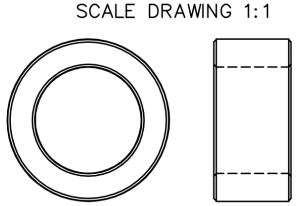
A	29.01 [1.142]	±	0.51 [.020]
B	19.00 [.748]	±	0.38 [.015]
C	13.84 [.545]	±	0.35 [.014]

WEIGHT/1000 25.67 kgs [56.59 Lbs]

NOTES: UNLESS OTHERWISE SPECIFIED

1. COSMETIC SPECIFICATION REFER TO WI–QA–038.

SCALE DRAWING 1:1



28B1142–100

RoHS

REV	DESCRIPTION	DATE	INT
	DIMENSIONS ARE IN mm [INCHES].		
F	UPDATE LOGO	05/22/15	QIU
E	UPDATE PRINT FORMAT, Z SPECS & CURVE CHANGE C TOLERANCE TO 0.35[.014]	07/22/03	JRK
D	UPDATE PRINT, REM COATING SPECS CHG P/N FROM 00* ADD Z CURVE UPDATE Z SPECS	11/07/02	JRK
C	CHG P/N ADD COATING SPECS	03/19/99	IS
B	UPDATED P/N FOR NEW CATALOG	10/31/95	JBE
A	ORIGINAL DRAFT	12/28/92	LNK

Laird

PROJECT/PART NUMBER: 28B1142–100
REV: F
DRAWN BY: Jcai
DATE: 12/28/92
SCALE: 1.5 : 1
CAD #: 28B1142–100–F
TOOL #: B1142
MATERIAL: Ferrite

DigiKey

All Products | Enter keyword or part # | Login or REGISTER | 0 item(s)

Products | Manufacturers | Resources

Product Index > Filters > Cable Ferrites > Laird-Signal Integrity Products 28B1142-100

Dark Mode | Share

Image shown is a representation only. Exact specifications should be obtained from the product data sheet.

28B1142-100

DigiKey Part Number	240-2314-ND
Manufacturer	Laird-Signal Integrity Products
Manufacturer Product Number	28B1142-100
Description	FERRITE CORE 114 OHM SOLID 19MM
Manufacturer Standard Lead Time	12 Weeks
Customer Reference	
Detailed Description	Solid Free Hanging Ferrite Core 114Ohm @ 100MHz ID 0.748" Dia (19.00mm) OD 1.142" Dia (29.01mm) Length 0.545" (13.84mm)
Datasheet	Datasheet
EDA/CAD Models	28B1142-100 Models

In-Stock: 6,168

Can ship immediately

QUANTITY

Add to List | Add to Cart

All prices are in USD

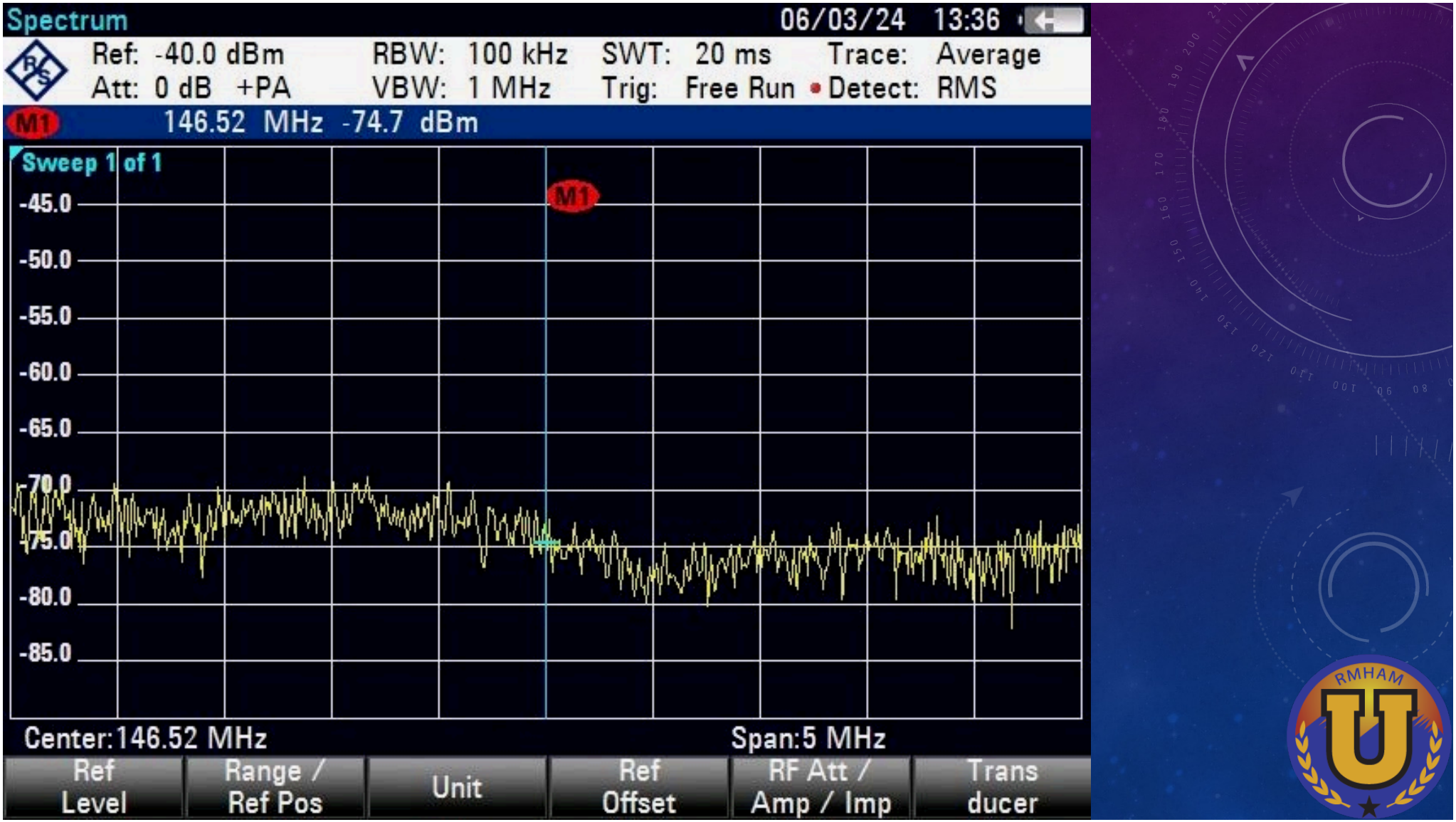
Tray

QUANTITY	UNIT PRICE	EXT PRICE
1	$1.62000	$1.62
10	$1.39500	$13.95
25	$1.06040	$26.51

RADIO 101

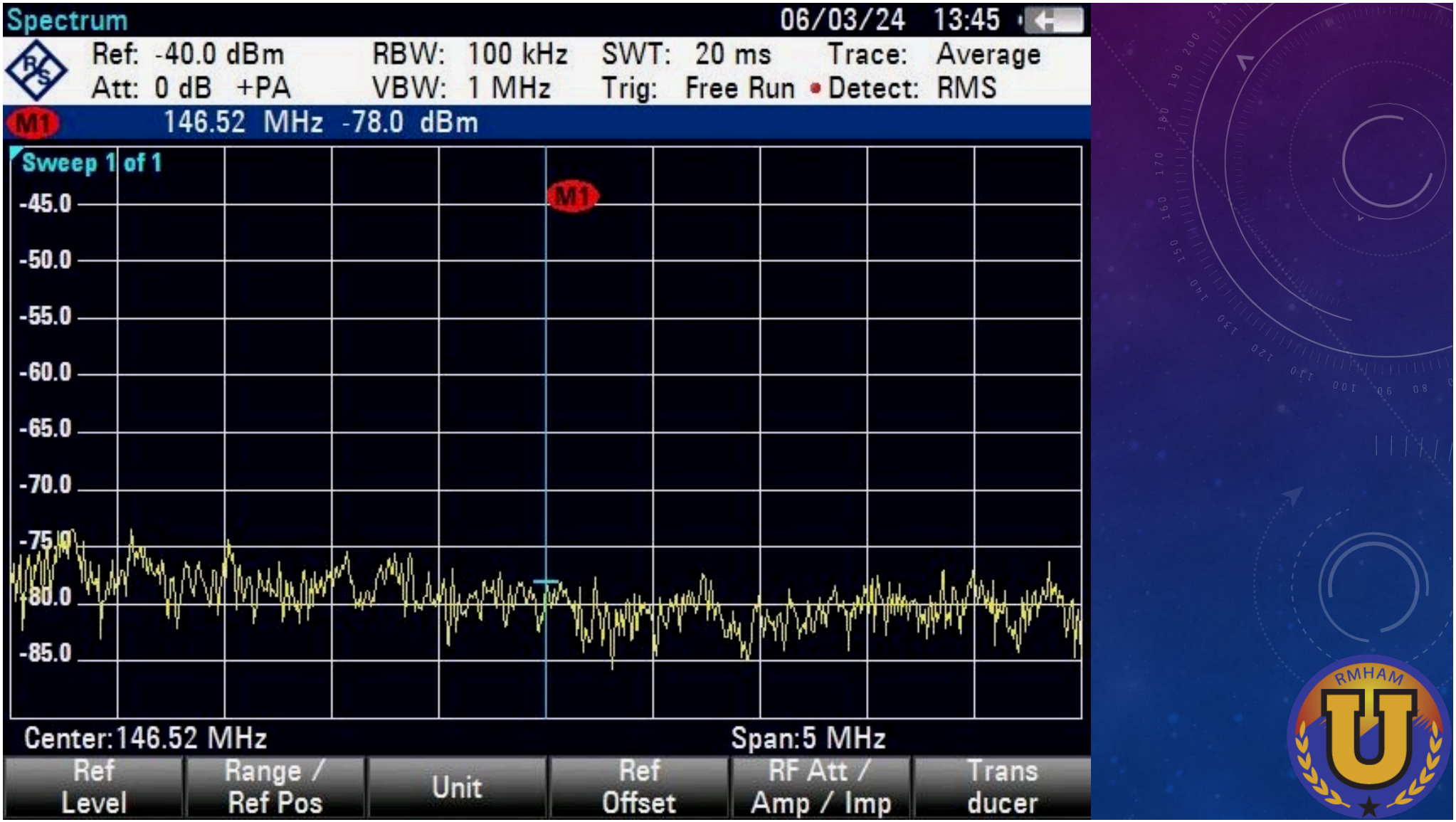
- Battery Boosters
    - RFI Testing VHF 146.520

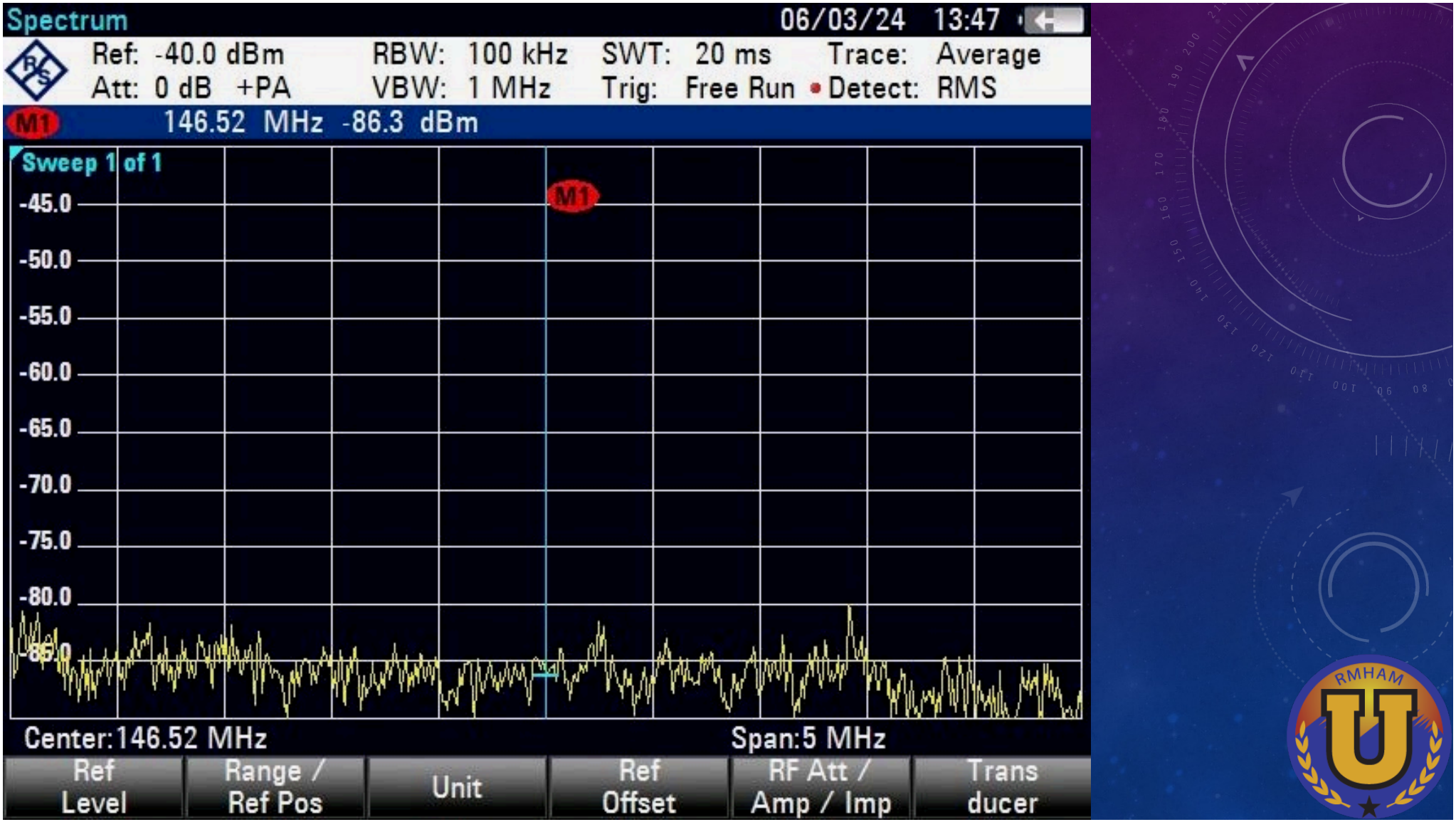

Spectrum
06/03/24 13:36
Ref: -40.0 dBm
RBW: 100 kHz
SWT: 20 ms
Trace: Average
Att: 0 dB +PA
VBW: 1 MHz
Trig: Free Run
Detect: RMS
M1
146.52 MHz -86.2 dBm
Sweep 1 of 1
-45.0
-50.0
-55.0
-60.0
-65.0
-70.0
-75.0
-80.0
Center:146.52 MHz
Span:5 MHz
Ref Level
Range / Ref Pos
Unit
Ref Offset
RF Att / Amp / Imp
Trans ducer


Spectrum
06/03/24 13:36
Ref: -40.0 dBm
RBW: 100 kHz
SWT: 20 ms
Trace: Average
Att: 0 dB +PA
VBW: 1 MHz
Trig: Free Run
Detect: RMS
M1
146.52 MHz -74.7 dBm
Sweep 1 of 1
-45.0
-50.0
-55.0
-60.0
-65.0
-70.0
-75.0
-80.0
-85.0
Center:146.52 MHz
Span:5 MHz
Ref Level
Range / Ref Pos
Unit
Ref Offset
RF Att / Amp / Imp
Trans ducer


Spectrum
06/03/24 13:37
Ref: -40.0 dBm
RBW: 100 kHz
SWT: 20 ms
Trace: Average
Att: 0 dB +PA
VBW: 1 MHz
Trig: Free Run
Detect: RMS
M1
146.52 MHz -72.3 dBm
Sweep 1 of 1
-45.0
-50.0
-55.0
-60.0
-65.0
-70.0
-75.0
-80.0
-85.0
Center:146.52 MHz
Span:5 MHz
Ref Level
Range / Ref Pos
Unit
Ref Offset
RF Att / Amp / Imp
Trans ducer

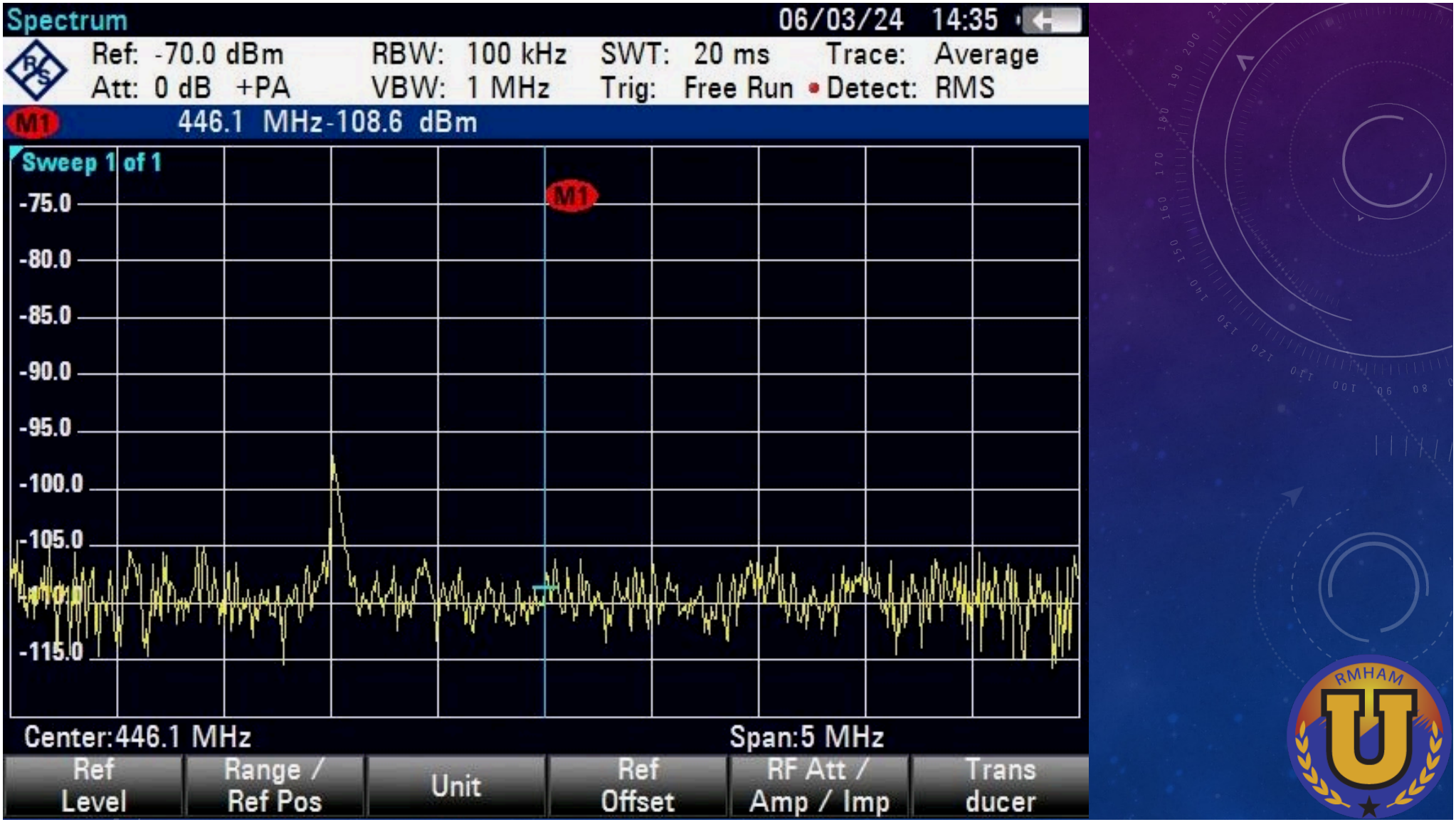

Spectrum
06/03/24 13:39
Ref: -40.0 dBm
RBW: 100 kHz
SWT: 20 ms
Trace: Average
Att: 0 dB +PA
VBW: 1 MHz
Trig: Free Run
Detect: RMS
M1
146.52 MHz -77.3 dBm
Sweep 1 of 1
-45.0
-50.0
-55.0
-60.0
-65.0
-70.0
-75.0
-80.0
-85.0
Center:146.52 MHz
Span:5 MHz
Ref Level
Range / Ref Pos
Unit
Ref Offset
RF Att / Amp / Imp
Trans ducer

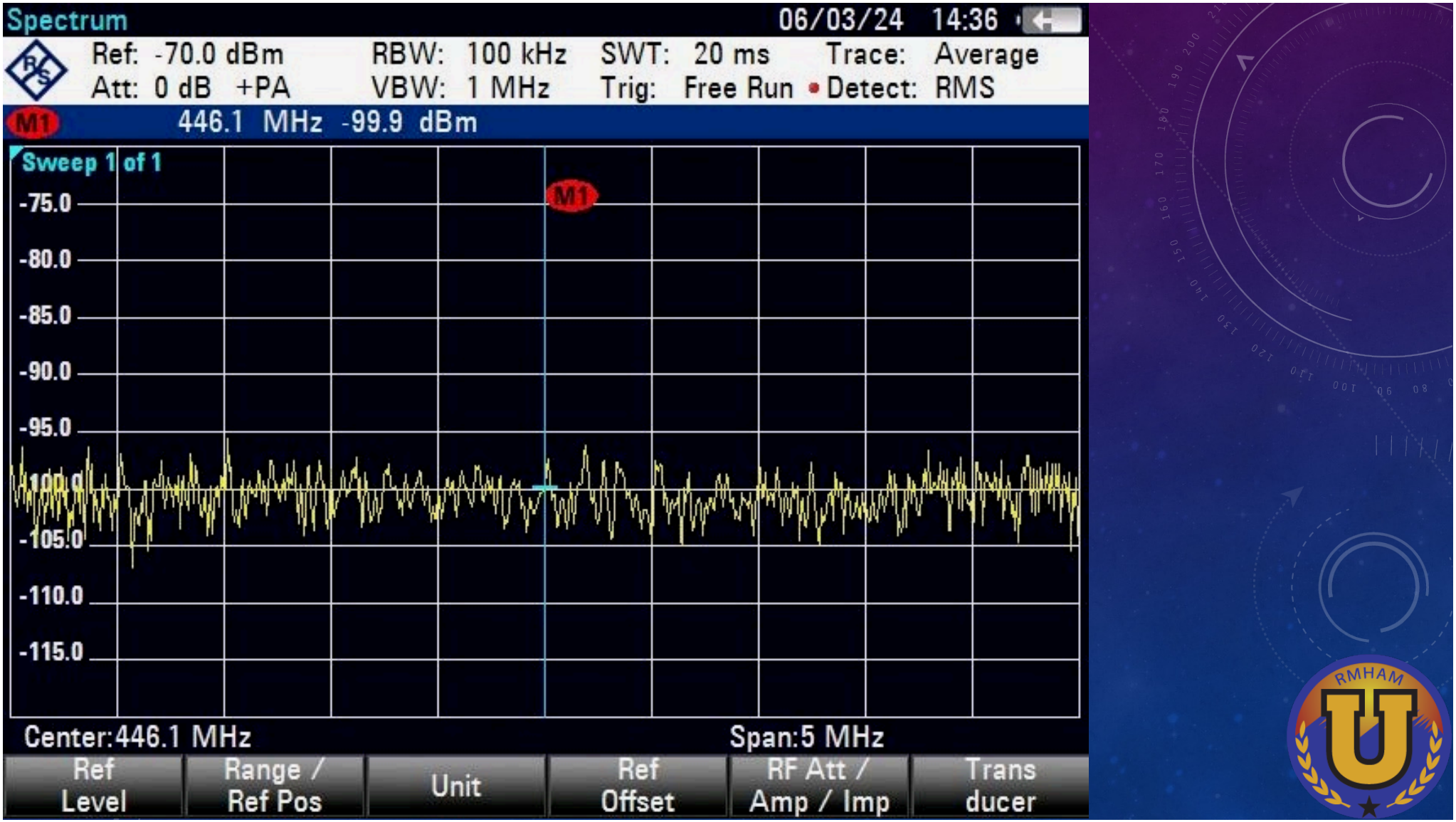

Spectrum
06/03/24 13:45
Ref: -40.0 dBm
RBW: 100 kHz
SWT: 20 ms
Trace: Average
Att: 0 dB +PA
VBW: 1 MHz
Trig: Free Run
Detect: RMS
M1
146.52 MHz -78.0 dBm
Sweep 1 of 1
-45.0
-50.0
-55.0
-60.0
-65.0
-70.0
-75.0
-80.0
-85.0
Center:146.52 MHz
Span:5 MHz
Ref Level
Range / Ref Pos
Unit
Ref Offset
RF Att / Amp / Imp
Trans ducer

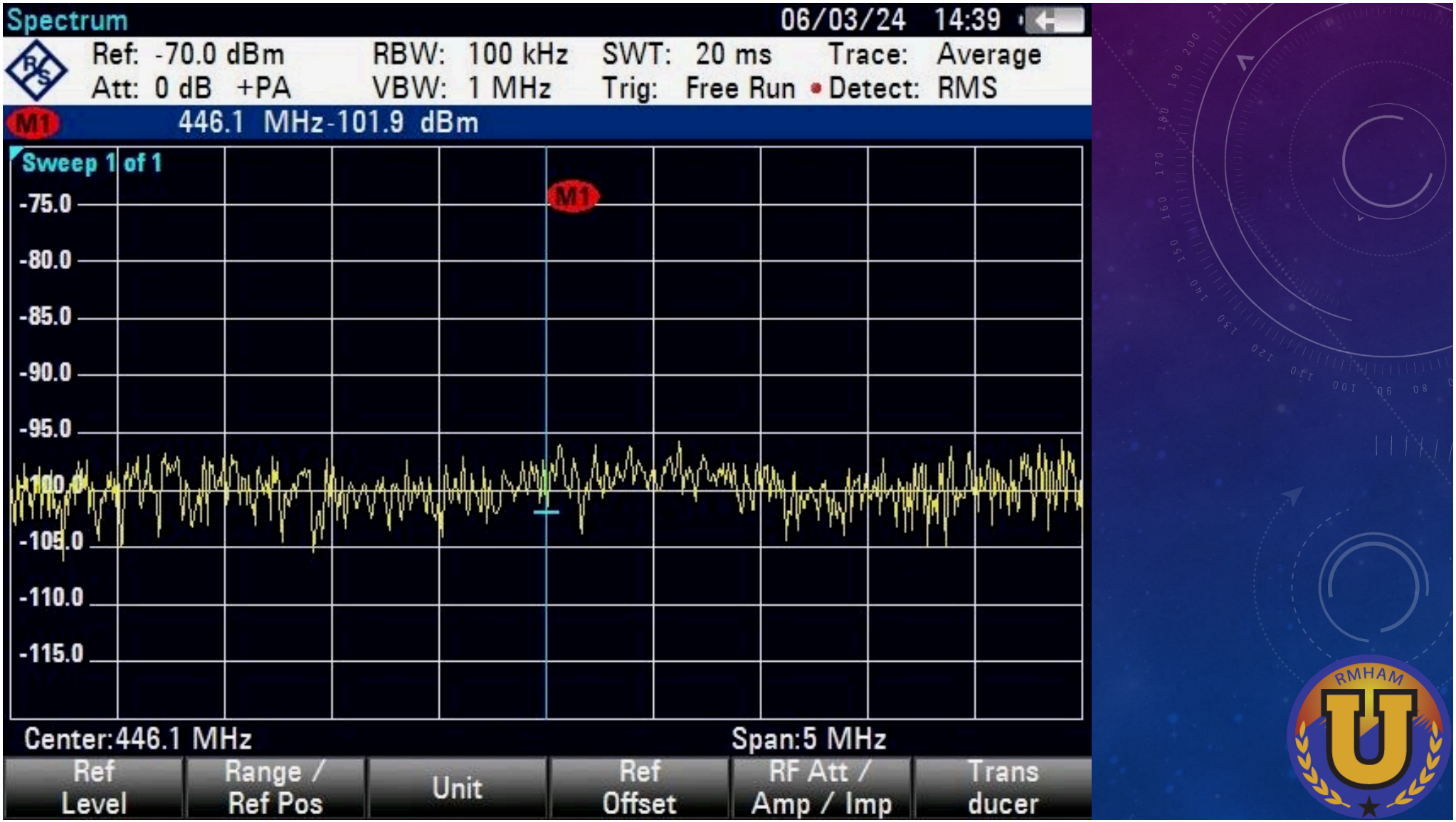

Spectrum
06/03/24 13:47
Ref: -40.0 dBm
RBW: 100 kHz
SWT: 20 ms
Trace: Average
Att: 0 dB +PA
VBW: 1 MHz
Trig: Free Run
Detect: RMS
M1
146.52 MHz -86.3 dBm
Sweep 1 of 1
-45.0
-50.0
-55.0
-60.0
-65.0
-70.0
-75.0
-80.0
Center:146.52 MHz
Span:5 MHz
Ref Level
Range / Ref Pos
Unit
Ref Offset
RF Att / Amp / Imp
Trans ducer

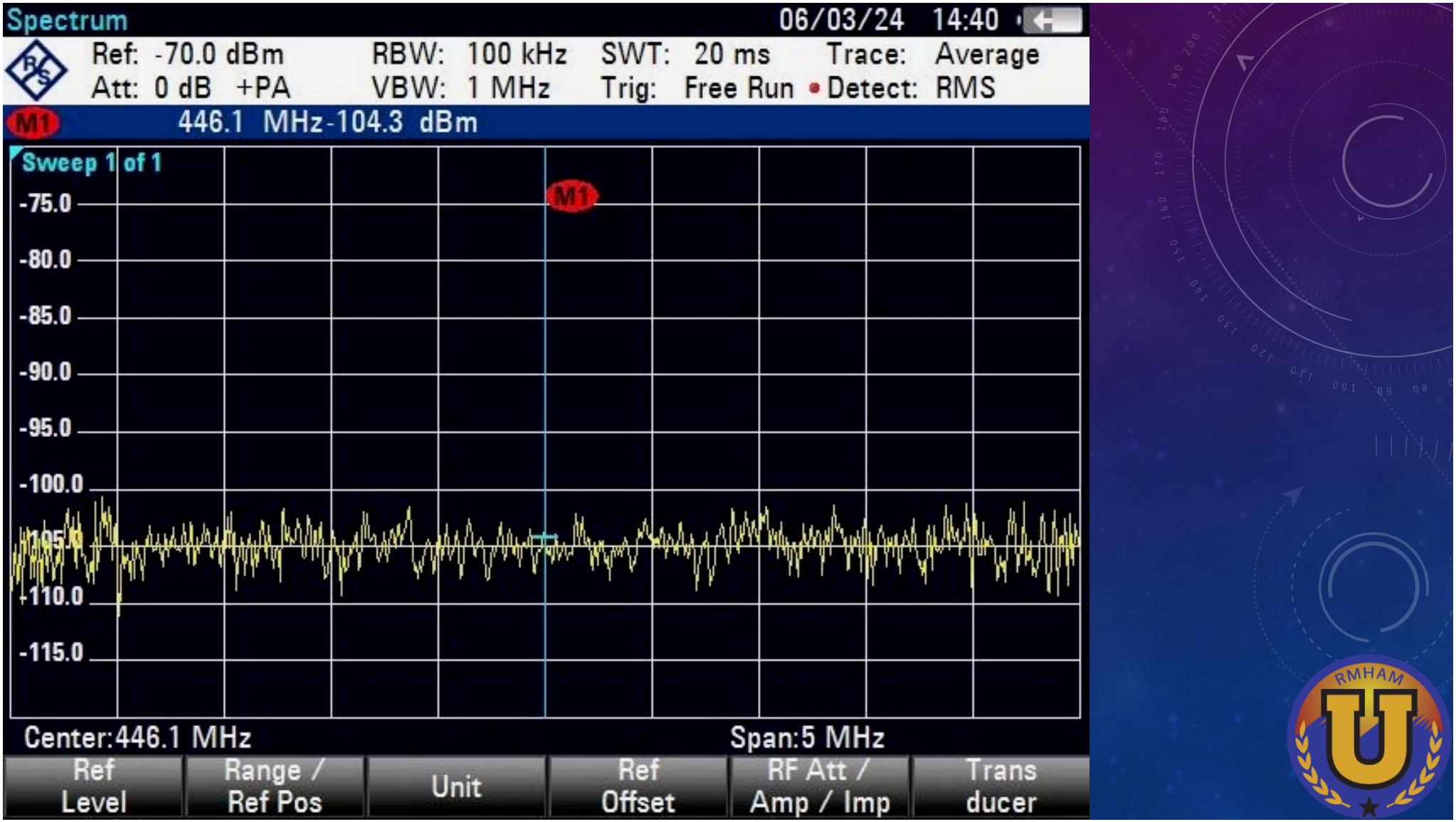
RADIO 101

- Battery Boosters
    - RFI Testing UHF 446.100


Spectrum
06/03/24 14:35
Ref: -70.0 dBm
RBW: 100 kHz
SWT: 20 ms
Trace: Average
Att: 0 dB +PA
VBW: 1 MHz
Trig: Free Run
Detect: RMS
M1
446.1 MHz -108.6 dBm
Sweep 1 of 1
-75.0
-80.0
-85.0
-90.0
-95.0
-100.0
-105.0
-115.0
Center:446.1 MHz
Span:5 MHz
Ref Level
Range / Ref Pos
Unit
Ref Offset
RF Att / Amp / Imp
Trans ducer


Spectrum
06/03/24 14:36
Ref: -70.0 dBm
RBW: 100 kHz
SWT: 20 ms
Trace: Average
Att: 0 dB +PA
VBW: 1 MHz
Trig: Free Run
Detect: RMS
M1
446.1 MHz -99.9 dBm
Sweep 1 of 1
-75.0
-80.0
-85.0
-90.0
-95.0
-100.0
-105.0
-110.0
-115.0
Center:446.1 MHz
Span:5 MHz
Ref Level
Range / Ref Pos
Unit
Ref Offset
RF Att / Amp / Imp
Trans ducer

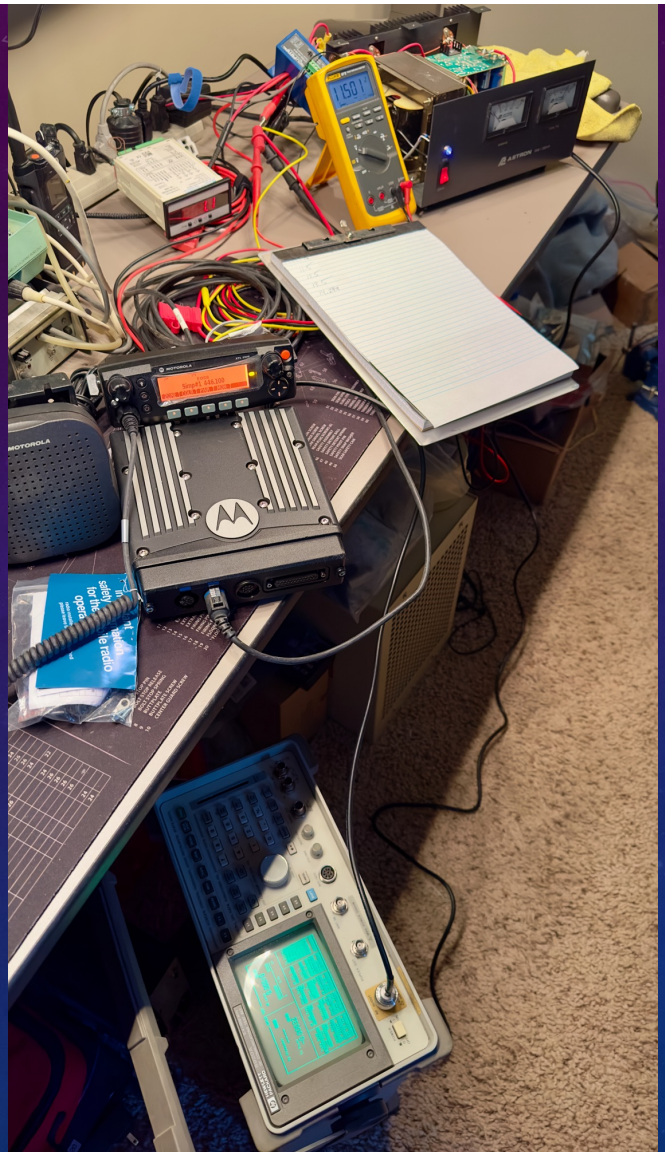

Spectrum
06/03/24 14:39
Ref: -70.0 dBm
RBW: 100 kHz
SWT: 20 ms
Trace: Average
Att: 0 dB +PA
VBW: 1 MHz
Trig: Free Run
Detect: RMS
M1
446.1 MHz -101.9 dBm
Sweep 1 of 1
-75.0
-80.0
-85.0
-90.0
-95.0
-100.0
-105.0
-110.0
-115.0
Center:446.1 MHz
Span:5 MHz
Ref Level
Range / Ref Pos
Unit
Ref Offset
RF Att / Amp / Imp
Trans ducer


Spectrum
06/03/24 14:40
Ref: -70.0 dBm
RBW: 100 kHz
SWT: 20 ms
Trace: Average
Att: 0 dB +PA
VBW: 1 MHz
Trig: Free Run
Detect: RMS
M1
446.1 MHz -104.3 dBm
Sweep 1 of 1
-75.0
-80.0
-85.0
-90.0
-95.0
-100.0
-105.0
-110.0
-115.0
Center:446.1 MHz
Span:5 MHz
Ref Level
Range / Ref Pos
Unit
Ref Offset
RF Att / Amp / Imp
Trans ducer

RADIO 101

- Battery Boosters Radio Testing
  - How much TX power do you lose from 13.5 VDC to 12.5 VDC to 11.5 VDC??
  - Let's look at a Motorola XTL 2500 P25 UHF 40 W radio
  - Test Setup
    - HP8920A Communications Test Set Calibrated by Amtronix in 2019
    - Astron RS-35M 25 A power supply

RADIO 101



RADIO 101

- Battery Boosters Radio Testing
- Motorola XTL 2500 P25 UHF Test Frequency 446.100
  - 11.500 VDC 39.9W 8.9A 102.9 W
  - 12.500 VDC 42.6W 8.3A 103.7 W
  - 13.508 VDC 44.1W 7.9A 106.7 W
  - 14.299 VDC 44.2W 7.6A 108.7 W (max voltage out of the Aston)

RADIO 101

- Battery Boosters Radio Testing Power output in dBm
  - 11.500 VDC 39.9W 46.01 dBm
  - 12.500 VDC 42.6W 46.29 dBm
  - 13.508 VDC 44.1W 46.44 dBm
  - 14.299 VDC 44.2W 46.45 dBm (max voltage out of the Aston)
  - **From 11.500 VDC to 14.299 VDC there is 0.44 dBm output power difference.**
  - That's effectively **Zero.**

RADIO 101

- Battery Boosters Radio Testing
  - How much TX power do you lose from 13.5 VDC to 12.5 VDC to 11.5 VDC??
  - Let's look at a Motorola XTL 2500 P25 VHF 50 W radio
  - Test Setup
    - HP8920A Communications Test Set Calibrated by Amtronix in 2019
    - Astron RS-35M 25 A power supply

RADIO 101

- Battery Boosters Radio Testing
- Motorola XTL 2500 P25 VHF 50W Test Frequency 146.520
  - 11.500 VDC 44.5W 8.0A 92.0 W
  - 12.500 VDC 52.1W 8.4A 105.0 W
  - 13.508 VDC 52.1W 7.8A 105.3 W
  - 14.299 VDC 52.1W 7.8A 105.3 W (max voltage out of the Aston)

RADIO 101

- Battery Boosters Radio Testing Power output in dBm
- Motorola XTL 2500 P25 VHF 50 W Test Frequency 146.520
  - 11.500 VDC 44.5W 46.48 dBm
  - 12.500 VDC 52.6W 47.17 dBm
  - 13.508 VDC 52.6W 47.17 dBm
  - 14.299 VDC 52.6W 47.17 dBm (max voltage out of the Aston)
  - **From 11.500 VDC to 14.299 VDC there is 0.69 dBm output power difference.**
  - That's effectively **Zero.**


DMR
APRS TX
FT 8900
WiFi
WiFi
ADS-B RX
DMR
DMR
SDR Antenna
DF Antennas
LTE
GPS

RADIO 101

- Understanding Vehicle Loads
  - On the 2001 Ford Excursion with 4 radios, DF System, 5G LTE modem, DMR Repeater and upwards of 5 computers the technical load is 29.8 Amps.
  - The Whelen light bar is 40 Amps with the rear “hide-a-away” strobes its 50 Amps
  - The AC running wide open with both front and rear blowers is 30 amps
  - Headlights and sundry loads (SLI) is about 40 amp.
  - Total 149.8 amps

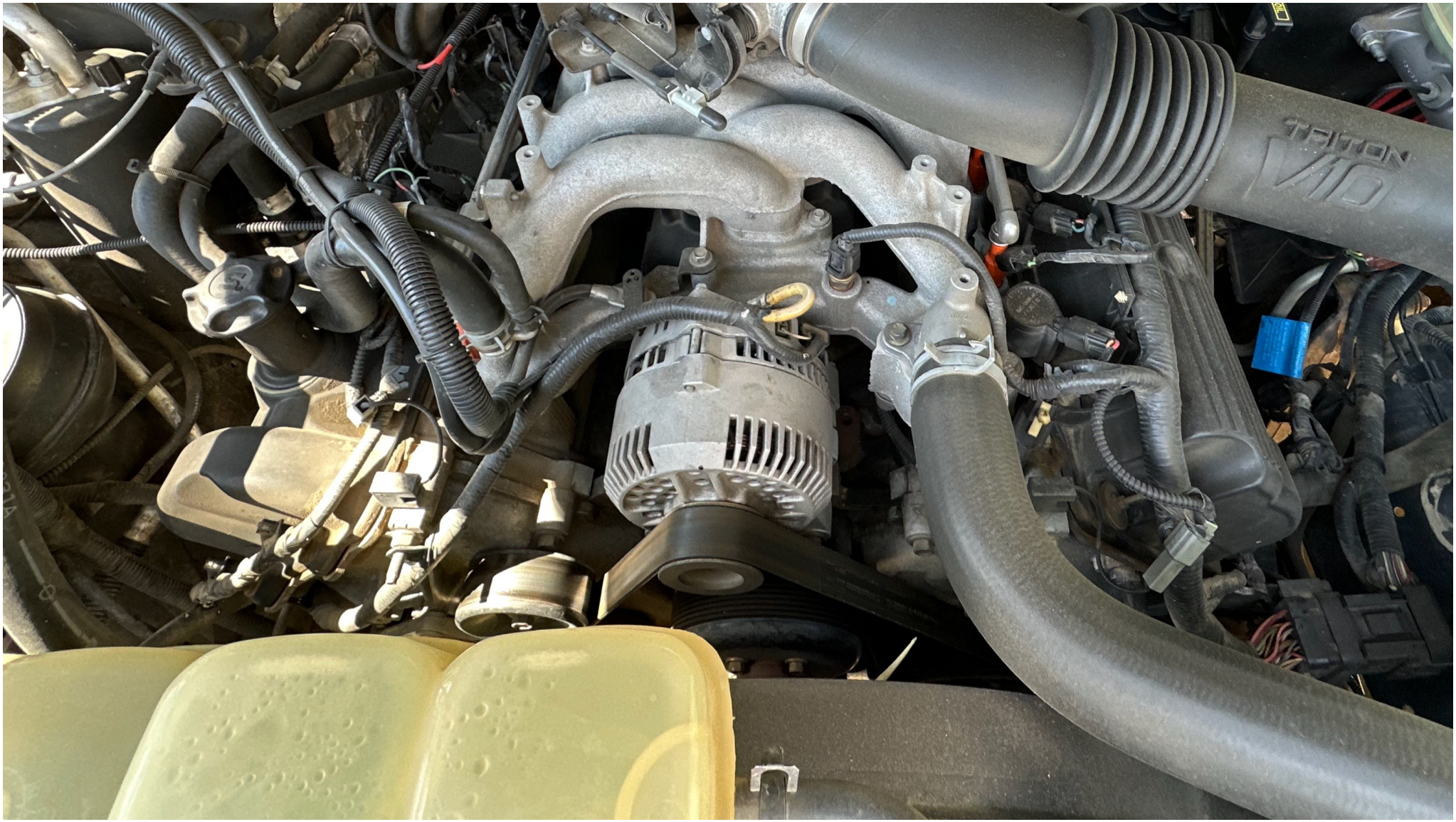

WAN
MikroTik
routerboard
MOTOROLA
TxA RxA TxB RxB
RMHAM
U

RADIO 101


FLUKE 87 V TRUE RMS MULTIMETER
MIN MAX MAX
29.8
mV DC
Manual 6 00 mV
°C/°F
MIN MAX
RANGE
AutoHOLD
PEAK MIN MAX
REL Δ
Hz %
Hi Res
1 Second
mV
Ω
V
mA A
µA
OFF
A
mA µA
COM
VΩ
10A MAX FUSED
400mA FUSED
CAT III 1000V
CAT IV 600V

RADIO 101

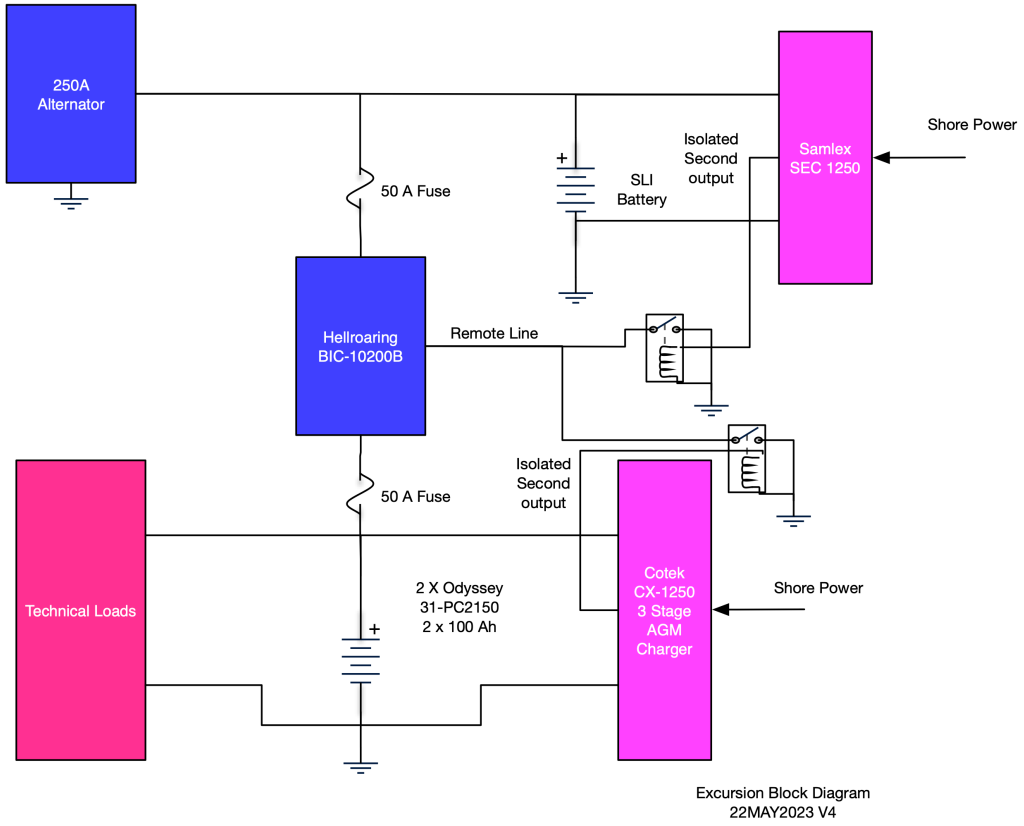
- Vehicle Loads
  - Total 149.8 amps
  - Stock alternator 130 Amp
  - At idle its 65 Amp
  - That didn’t work
  - We had National Quick Start build a 250 Amp alternator with external rectifier pack
  - We had them put a smaller pully on it to get us 150 Amp at idle
  - We are right on the ragged edge


TRITON
V10


EXCURSION
064-ZEX
RMHAM
U

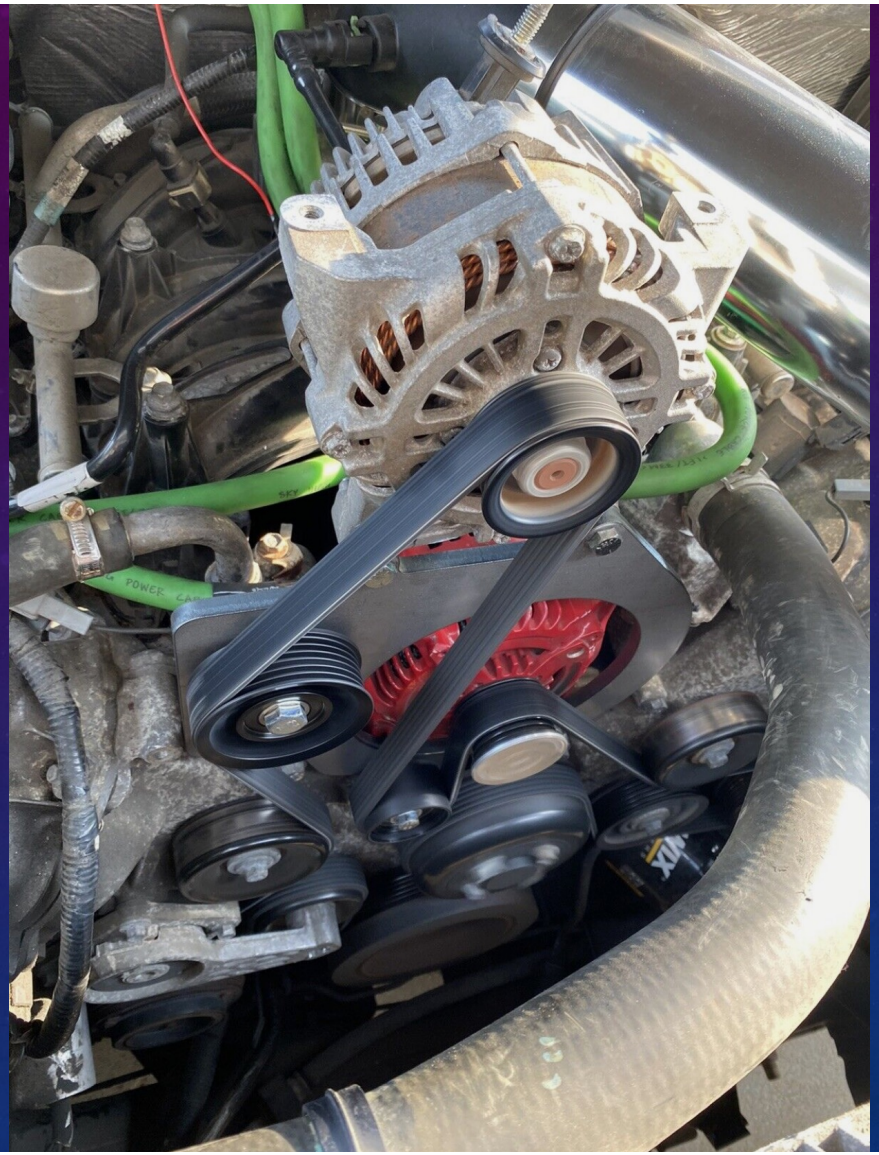
RADIO 101

- Vehicle Loads
  - If we had to do it all over again we would add a second alternator & battery for just the “technical loads”



Excursion Block Diagram
22MAY2023 V4

RADIO 101



RADIO 101

- Problem Diagnostics
  - Alternator “whine” on TX audio
    - Bad battery
    - Bad Alternator
    - Bad wiring
  - Dead Battery
    - Parasitic loads (or left the radio on)
    - Bad Battery
    - Bad or undersized alternator not capable of keeping up with all of the loads

RADIO 101

- Problem Diagnostics
  - RFI
    - Battery booster
    - Ground the booster to the frame of the vehicle with a very short strap.
    - Ferrite cores on both input and output as close to the booster as possible

RADIO 101

- Problem Diagnostics
  - RFI
    - Ground straps on hood and trunk (hinges are notoriously bad ground paths)
    - Ground Straps on exhaust system at both ends

QUESTIONS?

THANK YOU!