SRK Electronics

MFTX100 MFTX200
MFTX400 MFTX600

100W/200W/400W/600W MF AM
BROADCAST TRANSMITTER

Operation and service manual

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1. MFTX Quick Start Guide

We strongly urge our customers to read this manual before attempting to use the transmitter. The MFTX range of MF transmitters incorporate functionality and features not normally found in equipment of this type and a thorough understanding if these will lead to easier commissioning and use.

However, we understand that our customers are busy people with a high level of technical competence. So with this in mind the following is a quick procedure to get your transmitter up and running:

1. Unpack the transmitter. Please retain the packing.

2. The MFTX600 consists of the transmitter proper and an external power supply. Both units are rack mountable. The power supply is designed to sit on top of the transmitter (for standalone configurations) or immediately above the transmitter (if rack mounted). All other models use an internal power supply.

3. Please allow adequate front-to-back air flow. No additional ventilation space is needed.

4. Depending on the power supply configuration, 0ne, two or three supplies may be included in the power supply (MFTX600 only). There are three separate mains feeds to the power supply from the transmitter. The DC output of the power supply is fed back to the transmitter on the blue Anderson connector. This must be fully engaged into the mating connector on the rear of the transmitter. This may require some force (which is normal)

5. Antenna connection is made via the N connector on the rear of the transmitter.

6. Audio connection is made by the three pin XLR connector on the rear of the transmitter. This is electronically balanced so unbalanced audio feeds should connect pins 1 and 3 as return.

7. Earth connection can be made to the M6 stud on the rear of the transmitter.

8. Mains is supplied to the transmitter via the IEC cable (supplied).

9. All manual controls are accessible via the single front panel knob. This is rotated to select the menu or parameter to be read or modified. A flashing arrow on the LCD points to the current parameter. Pressing the knob will cause that parameter to flash and rotating the knob will allow that parameter to be modified. Once set to the desired value, pressing the knob again will cause the value to be stored in NV RAM and will allow another parameter to be selected.

10. This transmitter has been shipped with the following settings:
    a. RF = off
    b. Set power = maximum
    c. Audio gain = 20%
    d. LPF = in
    e. LPF type = Bessel
    f. LPF cutoff = 8.8KHz
    g. Compressor = off
    h. Limiter = on
    i. Positive limit/negative limit = gives -95/+125% limit

       Note that the positive and negative limit values are arbitrary units, not percent.
    j. Night time power = Disabled, 96W
    k. Reference = internal
    l. Location = Melbourne
    m. Front panel = enabled

11. These represent a typical setup.

12. Turn on the transmitter by the circuit breaker on the rear panel (MFTX600 and 400) or by plugging in the mains cord (MFTX200 and 100).

13. All fans should start and the LCD should light, showing the summary screen.

14. You can now change any settings as desired using the front panel control.

15. Apply program audio and set the audio gain that gives the desired modulation depth.

16. Adjust set power to give the desired carrier rest power.

17. Turn on the RF.

18. The forward power meter should indicate the presence of RF output. Note that the forward and reflected power measurements are true average power reading. Also that there is no forward power control loop. Therefore discrepancies between the set power and indicated forward power will almost certainly occur, especially if running into a reflective load. In practice, set power should be adjusted to give the desired forward power.

2. Overview

The MFTX100, MFTX200, MFTX400 and MFTX600 are 100W, 200W, 400W and 600W carrier rest AM transmitters designed for continuous unattended service in MF broadcast applications.

Amongst others, the MFTX transmitters have the following features:

- 10-100W, 20-200W, 40-400W and 60-600W carrier rest power
- Power efficient design
- Pseudo frequency agile
- Electronically balanced professional audio inputs
- In-built audio processor
- Over SWR and over temperature protection
- Loss of audio alarm
- Automatic recovery from alarm conditions – no user intervention required
- Night-time power reduction
- Alarm tally – records nature and time of up to 4000 alarms
- Safety interlock input
- Transmitter OK and audio OK relay outputs
- Serial remote control port
- Elapsed operational days counter
- Unity power factor mains load
- RF sample port

3. Specifications

MFTX100

RF output power (0% mod)	10-100W, settable in 1W steps
RF output power (peak)	500W
RF output connector	N female
Harmonics and spurious	>-65dBc
Factory set frequency range	531-1701KHz
User set frequency range	within ±3% of factory setting
Carrier stability	+/-2Hz
Audio input level	0.24-2.4V RMS
Audio frequency response	10Hz-13KHz
Audio distortion	<0.5% THD
Audio signal-to-noise ratio	>60dB
Squarewave tilt @40Hz	5%
Squarewave overshoot	2%
Carrier shift	<5%
Modulation capability	125% positive peak modulation
Audio input impedance	>10,000 ohms
Audio input connectors	XLR 3 pin female
SWR alarm threshold	10W
Over temperature trip	85°C
Audio alarm period	30 seconds
Alarm tally capacity	4000 alarm events
Power input (100W, 0% mod)	170W
Supply voltage	105-264VAC
Supply connector	IEC 3 pin male
Earth stud	M6
Cooling	Convection/Forced air
Size	2U rack case, 300mm deep
Weight	<10Kg
Ambient temperature	-5°C to +50°C
Humidity	0 to 95% RH, non-condensing
Altitude	0 to 4000m above sea level

MFTX200

RF output power (0% mod)	20-200W, settable in 2W steps
RF output power (peak)	1000W
RF output connector	N female
Harmonics and spurious	>-65dBc
Factory set frequency range	531-1701KHz
User set frequency range	within ±3% of factory setting
Carrier stability	+/-2Hz
Audio input level	0.24-2.4V RMS
Audio frequency response	10Hz-13KHz
Audio distortion	<0.5% THD
Audio signal-to-noise ratio	>60dB
Squarewave tilt @40Hz	5%
Squarewave overshoot	2%
Carrier shift	<5%
Modulation capability	125% positive peak modulation
Audio input impedance	>10,000 ohms
Audio input connectors	XLR 3 pin female
SWR alarm threshold	20W
Over temperature trip	85°C
Audio alarm period	30 seconds
Alarm tally capacity	4000 alarm events
Power input (200W, 0% mod)	400W
Supply voltage	105-264VAC
Supply connector	IEC 3 pin male
Earth stud	M6
Cooling	Convection/Forced air
Size	3U rack case, 300mm deep
Weight	<10Kg
Ambient temperature	-5°C to +50°C
Humidity	0 to 95% RH, non-condensing
Altitude	0 to 4000m above sea level

MFTX400

RF output power (0% mod)	40-400W, settable in 4W steps
RF output power (peak)	2000W
RF output connector	N female
Harmonics and spurious	>-65dBc
Factory set frequency range	531-1701KHz
User set frequency range	within ±3% of factory setting
Carrier stability	+/-2Hz
Audio input level	0.24-2.4V RMS
Audio frequency response	10Hz-13KHz
Audio distortion	<0.5% THD
Audio signal-to-noise ratio	>60dB
Squarewave tilt @40Hz	5%
Squarewave overshoot	2%
Carrier shift	<5%
Modulation capability	125% positive peak modulation
Audio input impedance	>10,000 ohms
Audio input connectors	XLR 3 pin female
SWR alarm threshold	40W
Over temperature trip	85°C
Audio alarm period	30 seconds
Alarm tally capacity	4000 alarm events
Power input (400W, 0% mod)	800W
Supply voltage	105-264VAC
Supply connector	IEC 3 pin male
Earth stud	M6
Cooling	Forced air
Size	5U rack case, 450mm deep
Weight	<15Kg
Ambient temperature	-5°C to +50°C
Humidity	0 to 95% RH, non-condensing
Altitude	0 to 4000m above sea level

MFTX600

RF output power (0% mod)	60-600W, settable in 6W steps
RF output power (peak)	3000W
RF output connector	N female
Harmonics and spurious	>-65dBc
Factory set frequency range	531-1701KHz
User set frequency range	within ±3% of factory setting
Carrier stability	+/-2Hz
Audio input level	0.24-2.4V RMS
Audio frequency response	10Hz-13KHz
Audio distortion	<0.5% THD
Audio signal-to-noise ratio	>60dB
Squarewave tilt @40Hz	5%
Squarewave overshoot	2%
Carrier shift	<5%
Modulation capability	125% positive peak modulation
Audio input impedance	>10,000 ohms
Audio input connectors	XLR 3 pin female
SWR alarm threshold	60W
Over temperature trip	85°C
Audio alarm period	30 seconds
Alarm tally capacity	4000 alarm events
Power input (600W, 0% mod)	1200W
Supply voltage	105-264VAC
Supply connector	IEC 3 pin male
Earth stud	M6
Cooling	Forced air
Size	7U rack case, 450mm deep
Weight	<25Kg
Ambient temperature	-5°C to +50°C
Humidity	0 to 95% RH, non-condensing
Altitude	0 to 4000m above sea level

4. Warranty

SRK warrants that the equipment is newly manufactured and is free of any defects in materials and workmanship.

SRK shall rectify any defect in the equipment which is notified in writing to SRK by the Customer within the period of 3 years after the date of acceptance where such defect renders the equipment unable to conform to the specifications and configuration prescribed in this manual.

SRK shall be responsible for all costs of rectification of such defects save for freight and travel costs.

SRK warrants that any replacement parts provided to the Customer are newly manufactured and are free from defects in materials and workmanship. If the replacement parts are found to be defective during a period of 90 days after installation of those parts, they shall be rectified or replaced at SRK's expense.

SRK shall not be liable for defects resulting from improper use of the equipment, whether by the Customer or by a third party or from damage caused to the equipment by external influences, including, but not limited to lightning strike, power surges or irregularity, ingress of water or other moisture, impact or temperature fluctuations in excess of the tolerances set out in the specifications.

5. Unpacking

This section details the way in which the transmitter should be unpacked upon receipt by the customer.

Upon receipt the transmitter should be visually inspected to ensure that no damage has occurred in transit.

The packing should be stored and used should it be necessary to return the transmitter to the manufacturer.

The customer should ensure that all items are present and then store them in a safe place.

6. Installation

6.1 General

This section describes the installation and infrastructure requirements for the transmitter. Departure from the instructions contained herein may void any warranty provided by SRK.

The MFTX100 has been designed to be mounted in a standard 19” rack frame, where it will occupy 2 rack units.

The MFTX200 has been designed to be mounted in a standard 19” rack frame, where it will occupy 3 rack units.

The MFTX400 has been designed to be mounted in a standard 19” rack frame, where it will occupy 5 rack units.

The MFTX600 has been designed to be mounted in a standard 19” rack frame, where it will occupy 6 to 8 rack units, depending upon power supply options supplied.

However, the transmitter may also be used in a free standing situation, so long as all other requirements are met as below.

6.2 Environmental

The transmitter is intended for indoor use.

The transmitter should be protected from rainfall and direct sunlight, extremes of temperature and humidity and from conditions of high dust levels.

The transmitter shall not be operated at altitudes in excess of 4000m above sea level.

The transmitter must be installed on a flat, stable surface.

The transmitter must be installed in the upright position.

The transmitter must be installed in a location free from vermin and the ingress of other animals.

The transmitter shall not be installed in locations prone to flooding.
All ventilation orifices must be clear to allow adequate air flow.

If installed in a rack, the equipment immediately above or below the transmitter should not overhang the fins of the heatsink on the rear of the transmitter (MFTX100 and 200 only).

6.3 Electrical supply

The electrical supply to the transmitter must be of the voltage, form and frequency described in the specifications.

All electrical wiring must be carried out in accordance with local laws, standards and regulations.

If power supply voltages regularly fall outside specifications then a voltage regulator must be installed between the supply inlet and the transmitter.

Whilst the transmitter does include live-neutral mains supply MOV protection, external three way protection is also recommended for long term reliability.

6.4 Earthing

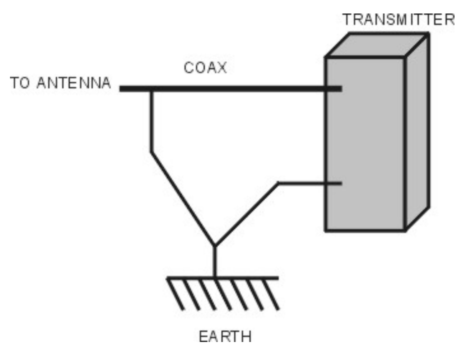
Adequate earthing of the transmitter is vital to ensure long term reliability and user safety.

The electrical supply must be earthed, via the earthing pin of the IEC connector. In countries where power outlet earthing is only optional, an earthed outlet **must** be used.

A separate, independent, earth is required for the transmitter/antenna system and must be connected to the earthing point indicated on the rear of the transmitter.

The cable used to connect this earth should be as thick as possible, with 8 AWG being the smallest size acceptable. Where possible, broad earthing band should be used.

In addition to the earth connection to the transmitter, the outer conductor of the coax feed to the antenna should be connected to the earth, as indicated below.



The earth itself must be of high quality buried copper, at least 1.5m deep and preferably in ground that is habitually humid (eg, the base of a gutter down pipe).

6.5 Antenna

The antenna load connected to the transmitter must be tuned to minimise reflections. Whilst the transmitter is designed to withstand high levels of reflection for short periods, continually high levels of reflected power will degrade the long term reliability of the transmitter. Operating SWR should be kept to below 1.9:1.

6.6 Audio feed

In situations where the audio feed to the transmitter is over any form of land line, suitable protection must be included external to the transmitter to ensure voltage transients do not enter the transmitter. These may be in the form of high power zener diodes and/or gas discharge tubes.

6.7 External Power Supply (MFTX600 only)

The MFTX600 uses an external power supply. This is designed to sit immediately above the transmitter.

There are various power supply options including multiple redundant switch mode supplies or a linear supply.

The MFTX600 has capacity for up to three supplies and there is a switched mains supply for each (controlled by the main breaker).

The nominal 50VDC from the supply is fed back into the transmitter via the blue Anderson connector. Note that this connector must be fully engaged and this may require some force. This is normal.

7. External views

7.1 Front panel

7.1.1 (1) Display

This is a backlit 2 line x 40 character display where all parameters are shown. Used in conjunction with the control knob, parameters can be read and changed by the user.

7.1.2 (2) Control knob

This knob allows the user to scroll through, select, modify and store parameters. This is a compound control. By rotating clockwise or anticlockwise screens and parameters can be scrolled through. Pressing the knob allows the selected parameter to be modified.

7.1.3 (3) RF sample connector

This is a BNC 50Ω female connector that allows the output RF voltage to be sampled. The output level of this connector is about 5V RMS when driving a 50Ω load and at full power.

7.1.4 (4) Air vents

These vents allow convection or forced air cooling of the transmitter and must not be obstructed.

7.2 Rear panel

7.2.1 (1) Right/mono audio input connector

Balanced audio input. XLR (Cannon) 3 pin socket. Pin 1 is ground, pin 2 is +ve and pin 3 is –ve. For unbalanced audio short pins 1 and 3. Input impedance is >10,000Ω.

If the stereo option is installed, and stereo tuned on, this input becomes the right channel input.

7.2.2 (2) Left audio input

If the stereo option is installed, and stereo tuned on, this input becomes the left channel input. Otherwise, this input is not used.

7.2.3 (3) RF output connector

RF is output on this connector, normally connected to the antenna via an ATU or combiner network. This is an N type 50Ω socket.

7.2.4 (4) Mains input connector

Mains input.

7.2.5 (5) Earth stud

M6 earth stud for connection to the antenna system earth. This must be connected to a reliable earth for the best possible lightning protection.

7.2.6 (6) Air vent

Allows free air convection cooling of the transmitter (MFTX100 and MFTX200) or forced air (MFTX400 and MFTX600), along with the vents on the front panel. These should not be obstructed.

7.2.7 (7) Analogue remote control barrier strip

The analogue remote control functions allow very basic control and monitoring of the transmitter using relay closures. Full details can be found in section 10.1

7.2.8 (8) Serial remote control connector

This is an RS232 port which enables full control and monitoring of the transmitter. See section for full details see section 10.2.

7.2.9 (9) Heatsink

The heatsink is the main form of cooling for the transmitter and should have free space both above and below the fins to allow proper operation. MFTX100 and MFTX200 only

8. Transmitter operation

This section describes the various functions of the transmitter.

All of these functions can be accessed by using either the front panel control or via the serial remote control. For details on how to do this please consult the relevant section of this manual.

The functions described in this section are:

- RF functions
    - Set RF power
    - Forward and reflected power metering
    - Carrier frequency
    - Carrier reference
- Audio functions
    - Gain control
    - Modulation metering
    - Compressor
    - Limiter
    - Low pass filter
    - Stereo
- Time functions
    - Clock
    - Night-time power

8.1 RF Functions

8.1.1 Set RF power

The RF output of the transmitter is controllable in the range 10 to 100% of maximum rated power. This is achieved by having a SET POWER, calibrated in watts.

SET POWER is the nominal carrier rest power that the transmitter will generate into a non-reflective load. Loads that are not exactly $50\pm j0\Omega$ may result in slightly different output powers.

SET POWER and FORWARD POWER are related in the following way; forward power is the actual average forward power at any given moment. The nature of AM means that the average output power increases with greater modulation depth and is also highly dependent on the crest factor of the audio modulating the transmitter. The set power parameter allows the user to set the output RF power generated by the transmitter at 0% modulation (sometimes referred to as "carrier rest"). Thus under program audio conditions the forward power will be fluctuating but always equal to, or greater than, the set power.

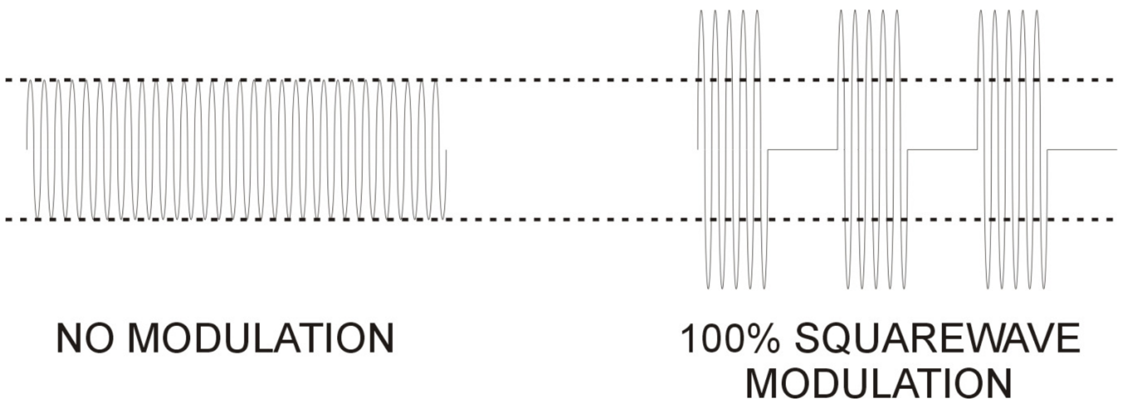
Similarly, reflected power is dependent upon forward power and the characteristics of the antenna system. Ideally, reflected power should read zero watts.

8.1.2 Forward and reflected power metering

The forward and reflected power meters of the MFTX series are true average reading. This is unlike normal transmitter power meters which are actually average *voltage* reading.

Average power measurement gives a far more accurate indication of actual power delivered to the antenna system. The following example shows why this is the case.

Consider the two RF waveforms shown below. The one on the left is a carrier with no modulation. The one on the right is the same carrier with 100% sqaurewave modulation (time scales are exaggerated for the sake of clarity).



The average RMS voltage for both waveforms is the same, as the modulated carrier spends half its time at twice the unmodulated voltage and the rest of the time is at zero volts.

However, power is proportional to the the *square* of voltage. This means, for the examplke above, the modulated waveform alternates between zero watts and ***four*** times the unmodulated power. Thus its average power is twice that of the unmodulated carrier.

What this means is that the forward and reflected power measurement can be substantially higher than the set power under modulation conditions. In fact, under extreme conditions they can read up to 2.5 times the carrier rest value.

8.1.3 Carrier frequency

The transmitter is partially frequency agile. This means that the user can set the carrier frequency within a small range centered on the factory set frequency. This range is in the order of ±3.0%. Retuning to a new frequency outside of this range can only be done by the manufacturer.

Note that changing the carrier frequency can only be performed via the front panel.

8.1.4 Carrier reference

The carrier can be phase locked to an external reference frequency. This allows multiple transmitters to be phase and frequency locked to minimize interference.

The external reference is applied to the EXT REF BNC on the rear of the transmitter and must have the following characteristics:

- Nominal frequency 10MHz

- Nominal level 3Vp-p

The EXT REF input impedance is nominally 50Ω.

The carrier frequency adjustment range is approximately ±10 PPM.

For standalone operation, an internal reference is available.

The internal or external reference can be selected either by the using the front panel settings, or via the serial port.

Should the external reference be selected, but none connected to the EXT REF BNC, the carrier frequency will drift down to approximately -13 PPM of its nominal value. No damage will occur to the transmitter.

8.2 Audio Functions

8.2.1 Gain control

The transmitter is designed to accept peak audio input levels from +10 to -10dBm. The gain control allows the user to set full modulation at any audio level in this range.

The gain control is adjustable from 0 to 100% in 1% increments.

The optimum gain setting will depend on the audio input level. Lower levels will require more gain than higher levels.

Note that due to the advanced design of the MFTX, it is not necessary to change audio gain when changing set power. The ratio of carrier power to audio level is entirely determined by the gain setting.

8.2.2 Modulation metering

The transmitter includes metering of peak positive and negative modulation.

The peak hold function lasts for one second and is then updated.

8.2.3 Compressor

The audio compressor function is not currently implemented.

8.2.4 Limiter

The transmitter incorporates a peak limiter that allows independent setting of positive and negative limits.

The limits are calibrated in arbitrary units from 0 to 255. They are factory set to limit at -95% and +125%, but can be changed by the user, or the limiter can be turned off completely.

Note that setting the negative limit excessively low, or the positive limit excessively high, will affect the other limit level.

As this is a hard limiter it should only be used when the audio low pass filter is also turned on. Otherwise, excessive spectrum "splatter" will be generated.

8.2.5 Low Pass Filter

The transmitter includes an audio low pass filter that can be turned on if needed.

The filter is an eighth order Butterworth or Bessel type with a number of possible cutoff frequencies. Both the type and cutoff frequency can be selected by the user.

The available cutoff frequencies are:

Butterworth	Bessel
3.3KHz	2.6KHz
3.7KHz	2.9KHz
4.1KHz	3.3KHz
4.6KHz	3.8KHz
5.3KHz	4.4KHz
6.2KHz	5.3KHz
7.4KHz	6.6KHz
9.2KHz	8.8KHz

It is strongly recommended that this filter be used, even if external audio processing is available.

The Bessel topology will give a response with no overshoot but poor roll-off.

The Butterworth topology will give a response with about 5% overshoot but a more rapid roll-off.

8.2.6 Stereo

If the optional stereo board is fitted, the transmitter is capable of producing C-QUAM stereo.

All other audio processing settings are applied to both left and right audio channels.

The stereo function can only be turned on if the optional board is fitted. This board can be retrofitted in the field with no additional modifications.

8.3 Time functions

8.3.1 Clock

The transmitter incorporates a real time clock to allow automatic switching between night and day power and also to keep track of total days of operation.

The clock is backed up by a super capacitor that will keep time without mains power for up to three weeks. Any longer without power will require the time and date to be set when next powered up.

The clock does not automatically compensate for daylight saving.

8.3.2 Night-time power

If enabled, the transmitter can be programmed to automatically switch to a different set power during the hours of darkness.

In this way it is possible to limit co-channel interference at night due to sky wave propagation.

9. Front panel operation

All parameters and functions of the transmitter may be accessed via the front panel using the display and control knob.

The knob is a multipurpose control that can be rotated clockwise or anticlockwise or pushed like a button, depending on the desired action. Generally, the control knob is rotated to show the appropriate screen or menu, then further rotated to select the desired function or parameter. Pressing the knob then allows that parameter to be modified (if possible). Pressing again causes the modified parameter to be stored in memory, and another parameter to be selected if desired.

Note that the serial remote control function "FD" allows the control knob to be disabled for non-secure applications. See section 10.2 for further details.

The transmitter is a complex piece of equipment with dozens of parameters. These are grouped logically according to function, screen by screen. The following screens are available:

- Summary
- RF Menu
- Audio menu
- Limiter menu
- LPF menu
- RF PA1
- RF PA2 (MFTX200, 400 and 600 only)
- RF PA3 (MFTX400 and 600 only)
- RF PA4 (MFTX400 and 600 only)
- RF PA5 (MFTX600 only)
- RF PA6 (MFTX600 only)
- Alarms
- Date/time menu
- Night power menu
- Carrier reference
- Unit data

The following sections detail the meaning and use of each screen or menu and are listed in the order they are displayed when rotating the control knob in the clockwise direction. Rotating the knob in the anticlockwise direction causes the screens to appear in the reverse order.

9.1 Summary screen

The summary screen appears as follows:

As the name suggests, it shows all the main transmitter parameters to allow a quick overview of the current operating state of the transmitter.

Fwd Pwr shows the current forward RF power in watts.

Ref Pwr shows the current reflected RF power in watts.

Mod shows the current modulation depth in percent.

Freq shows the transmitter’s operating frequency in kilohertz.

TX status shows the overall alarm status. If none of the alarms is active then OK is shown. If any single alarm is active, then SWR, GEN, TEMP, INT’LK or AUDIO is shown (depending on which alarm is active). If more than one alarm is active then FAIL is shown. See section 11 for more details about individual alarms.

The summary screen is shown when the transmitter is first switched on.

No parameters can be changed whilst displaying the summary screen.

9.2 RF menu

The RF menu shows all RF related parameters and appears as follows:

Parameters on this menu can be modified by rotating the knob to put the flashing arrow next to the parameter of interest, then momentarily pressing the knob. This will cause the selected parameter to flash. Rotating the knob will increase or decrease the parameter. Whilst changing any parameter has an immediate effect, the knob must be pressed again to ensure the new value is stored in memory. The parameter will then stop flashing, and the arrow will start flashing as before.

9.2.1 Setting carrier power

To set the carrier power, rotate the control knob until the flashing arrow is adjacent to and pointing towards “Set Pwr=”. Momentarily pressing the knob will cause the set power to flash. Whilst flashing, rotating the knob in the clockwise direction will increase the power, up to maximum. Rotating the knob in the anti-clockwise direction decreases the power.

Once the desired power has been set, the control knob should be momentarily pressed once more to ensure the new value is stored in memory. This will ensure that this value is set when the unit is next switched on.

9.2.2 Setting carrier frequency

The carrier frequency can be set by rotating the control knob until the flashing arrow is adjacent to and pointing towards “Freq=”. Momentarily pressing the knob will cause the frequency to flash. Whilst flashing, rotating the knob in the clockwise direction will increase the frequency. Rotating the knob in the anti-clockwise direction decreases the frequency. The range of frequencies that can be selected is dependent upon factory settings and would have been specified when the transmitter was first purchased. However, all frequencies are in multiples of 9KHz or 10KHz, depending on factory settings.

Once the desired frequency has been set, the control knob should be momentarily pressed once more to ensure the new value is stored in memory. This will ensure that this value is set when the unit is next switched on.

9.2.3 Turning RF on and off

The output RF may be turned off or on by rotating the control knob until the flashing arrow is adjacent to and pointing towards “RF=”. Momentarily pressing the knob will cause the RF status to flash. Whilst flashing, rotating the knob in the clockwise direction will turn the RF on. Rotating the knob in the anti-clockwise direction will turn the RF off.

Once the RF status has been set, the control knob should be momentarily pressed once more to ensure the new value is stored in memory. This will ensure that this value is set when the unit is next switched on.

9.2.4 Reading forward and reflected power

The forward and reflected power are available at “Fwd Pwr=” and “Ref Pwr=” respectively

9.3 Audio Menu

The audio menu shows all audio related parameters and appears as follows:

9.3.1 Setting audio gain

Under normal program audio conditions, audio gain should be set to give the highest value of modulation depth consistent with acceptable levels of distortion. Thus, the correct value for audio gain will depend entirely on the audio input level. Higher gain will be needed for lower levels of audio drive and vice-versa.

The audio gain can be set by rotating the control knob until the flashing arrow is adjacent to and pointing towards “Gain=”. Momentarily pressing the knob will cause the gain to flash. Whilst flashing, rotating the knob in the clockwise direction will increase the gain, up to 100%. Rotating the knob in the anti-clockwise direction decreases the gain. The gain can be set to any value in the range zero to 100% in 1% increments.

Once the desired gain has been set, the control knob should be momentarily pressed once more to ensure the new value is stored in memory. This will ensure that this value is set when the unit is next switched on.

Note that due to the advanced design of these transmitters, it is not necessary to change audio gain when changing set power. The ratio of carrier power to audio level is entirely determined by the gain setting.

9.3.2 Reading modulation depth

The positive modulation depth is displayed next to “mod depth =”.

9.3.3 Enabling and disabling the audio low pass filter (LPF)

The status of the audio low pass filter is shown next to “LPF=”.

The LPF may be turned off or on by rotating the control knob until the flashing arrow is adjacent to and pointing towards “LPF=”. Momentarily pressing the knob will cause the LPF status to flash. Whilst flashing, rotating the knob in the clockwise direction will turn the LPF on. Rotating the knob in the anti-clockwise direction will turn the LPF off.

Once the LPF status has been set, the control knob should be momentarily pressed once more to ensure the new value is stored in memory. This will ensure that this value is set when the unit is next switched on.

9.3.4 Enabling and disabling audio compressor

The status of the audio compressor is shown next to “Compressor =”. This is permanently off.

9.3.5 Enabling and disabling stereo

The status of the stereo generator is shown next to “Stereo=”.

Stereo may be turned off or on by rotating the control knob until the flashing arrow is adjacent to and pointing towards “Stereo=”. Momentarily pressing the knob will cause the stereo status to flash. Whilst flashing, rotating the knob in the clockwise direction will turn stereo on. Rotating the knob in the anti-clockwise direction will turn stereo off.

Once stereo status has been set, the control knob should be momentarily pressed once more to ensure the new value is stored in memory. This will ensure that this value is set when the unit is next switched on.

Note that stereo can only be turned on if the optional stereo card is fitted to the control unit. If the stereo card is not fitted then pressing the knob whilst the arrow is next to “Stereo=” will have no effect.

9.4 Limiter menu

The audio limiter menu appears as follows:

The limiter menu allows the settings for the audio peak limiter to be changed.

9.4.1 Enabling and disabling the limiter

The status of the limiter is shown next to “Limiter=”.

The limiter may be turned off or on by rotating the control knob until the flashing arrow is adjacent to and pointing towards “Limiter=”. Momentarily pressing the knob will cause the limiter status to flash. Whilst flashing, rotating the knob in the clockwise direction will turn the limiter on. Rotating the knob in the anti-clockwise direction will turn the limiter off.

Once the limiter status has been set, the control knob should be momentarily pressed once more to ensure the new value is stored in memory. This will ensure that this value is set when the unit is next switched on.

9.4.2 Setting the positive limit level

The positive limit level can be set by rotating the control knob until the flashing arrow is adjacent to and pointing towards “Positive limit=”. Momentarily pressing the knob will cause the positive limit to flash. Whilst flashing, rotating the knob in the clockwise direction will increase the limit, up to 255. Rotating the knob in the anti-clockwise direction decreases the limit. The positive limit can be set to any value in the range zero to 255 in increments of 1.

Once the desired limit has been set, the control knob should be momentarily pressed once more to ensure the new value is stored in memory. This will ensure that this value is set when the unit is next switched on.

The positive limit is calibrated in arbitrary units in the range 0 to 255. Care should exercised when setting the positive limit as an excessively high value can effect negative peaks.

9.4.3 Setting the negative limit level

The negative limit level can be set by rotating the control knob until the flashing arrow is adjacent to and pointing towards “Negative limit=”. Momentarily pressing the knob will cause the negative limit to flash. Whilst flashing, rotating the knob in the clockwise direction will increase the limit, up to 255. Rotating the knob in the anti-clockwise direction decreases the limit. The negative limit can be set to any value in the range zero to 255 in increments of 1.

Once the desired limit has been set, the control knob should be momentarily pressed once more to ensure the new value is stored in memory. This will ensure that this value is set when the unit is next switched on.

The negative limit is calibrated in arbitrary units in the range 0 to 255. Care should exercised when setting the negative limit as an excessively low value can effect positive peaks.

9.5 LPF menu

The audio LPF menu appears as follows:

The LPF (if turned on) is placed in the audio path after the limiter.

9.5.1 Setting filter type

The type of low pass filter is shown next to “Filter type =”.

The filter response can be set to Butterworth or Bessel.

The filter response may be set by rotating the control knob until the flashing arrow is adjacent to and pointing towards “Filter type =”. Momentarily pressing the knob will cause the filter type to flash. Whilst flashing, rotating the knob in the clockwise direction will set the filter type to Bessel. Rotating the knob in the anti-clockwise direction will set the filter type to Butterworth.

Once the filter type has been set, the control knob should be momentarily pressed once more to ensure the new value is stored in memory. This will ensure that this value is set when the unit is next switched on.

9.5.2 Setting cutoff frequency

The filter cutoff frequency is shown next to “Cutoff frequency =”.

The filter cutoff frequency may be set by rotating the control knob until the flashing arrow is adjacent to and pointing towards “Cutoff frequency =”. Momentarily pressing the knob will cause the cutoff frequency to flash. Whilst flashing, rotating the knob in the clockwise direction will increase the frequency. Rotating the knob in the anti-clockwise direction will decrease the frequency.

Once the cutoff frequency has been set, the control knob should be momentarily pressed once more to ensure the new value is stored in memory. This will ensure that this value is set when the unit is next switched on.

9.6 RF PA1 – RF PA6

These screens allow a number of the RF PA parameters to be monitored and appears as follows:

Only the relevant screens are available, depending on the transmitter model.

“Temp=” shows the internal temperature of the PA.

“Driver volts=” shows the driver supply voltage.

“PA voltage=” shows the DC supply voltage for the PA.

“PA Current=” shows the DC current drawn from the main power supply by the PA.

9.7 Alarms

The alarms screen shows the status of all six alarms as either “OK” or “FAIL”.

“TALLY=” shows the total number of alarms that have occurred since last reset. This value rolls over to zero when it reaches 65535.

“SWR=” shows the status of the SWR alarm. If the reflected power is greater than the reflected power threshold then the SWR alarm will be activated and “FAIL” will appear in this field.

“INT’LK=” shows the status of the interlock signal of the analogue remote control port. If the interlock circuit is open then this field will be shown as “FAIL” and RF power will be turned off.

“GEN=” shows the status of the RF generator module. If there is an error with communication with the RF generator then “FAIL” will appear in this field.

“TEMP=” shows the status of the high temperature alarm. If the internal temperature of the transmitter exceeds 85°C this field will show “FAIL” and RF power will be turned off.

“AUDIO=” shows the status of the audio alarm. If more than 30 seconds have elapsed with a modulation depth of 2% or less then this field will show “FAIL” and the “AUDIO OK” relay contact of the analogue remote control interface will go open. This can be used to reset the program source or select an alternative.

“F’OVR=” show the status of the internal flashover detector. If an internal flashover occurs then “FAIL” will show in this field.

9.8 Date/Time menu

The date/time menu allows the current date and time to be set.

9.8.1 Reading elapsed days

“ELAPSED DAYS” shows the number of days the transmitter has been running since it was manufactured. If RF is turned on then this value is incremented at midday of every day. This parameter can be used to determine the total operating time that the transmitter has achieved.

9.8.2 Setting date and time

The time and date are shown in the format hour:minute:second day/month/year. The time is always in 24 hour format.

Pressing the control knob momentarily will allow the time and date to be set. The hour value will flash, indicating that rotating the knob will increment or decrement the hour. Once the correct hour has been set, another press of the knob will cause the hour to stop flashing and the minute to start flashing. The minute may now be set. The second, day, month and year are set in the same way and in that order. A final press of the knob once the year has been set causes the clock to be programmed with the set time and date.

9.9 Night power menu

The output power of the transmitter may be automatically reduced during the hours of darkness to allow for the disappearance of the D layer. This can be done by enabling the night-time power between a given start and stop time.

The night power menu allows the night-time power to be enabled, as well as the start and stop times and power level to be set.

9.9.1 Enabling and disabling night-time power switching

When the night power menu is displayed, pressing the control knob will cause the DISABLED or ENABLED field to flash. Rotating the knob clockwise will enable night-time power switching. Rotating the knob anticlockwise will disable night-time power switching.

9.9.2 Setting night-time power start and stop times

Pressing the knob will cause the “From” hour to start flashing. The start and stop times can be set just as the current time is set on the date/time menu.

9.9.3 Setting night-time power

Once the knob is pressed to set the “to” seconds the night power will flash. This can be set by rotating the knob to show the desired carrier rest power, analogous to the set power during normal operation. If the knob is pressed one last time all values will be stored in memory and if the current time falls between the “from” and “to” times, the output power will immediately be set to the night-time power.

Note that it is not necessary for the night-time power to be lower than the set power, or for the “from” and “to” times to be in the evening and morning respectively.

9.10 Carrier reference

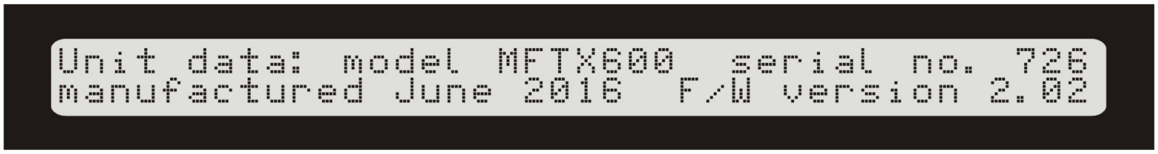
The carrier reference frequency can be set to internal or external using the carrier reference screen.

When the carrier reference screen is displayed, pressing the control knob will cause the “Internal” or “External” field to flash. Rotating the knob clockwise will set the carrier reference to internal. Rotating the knob anticlockwise will set the carrier reference to external.

Once the reference has been set, the control knob should be momentarily pressed once more to ensure the new value is stored in memory. This will ensure that this value is set when the unit is next switched on.

9.11 Unit data

The unit data screen gives various unit specific parameters.



10. Remote control

The transmitter has two means of remote control and monitoring. The analogue remote control is a very basic analogue interface which allows the transmitter to be turned on/off and audio and other alarms to be monitored. The serial remote control is a sophisticated RS232 based interface that allows all parameters and controls to be accessed.

10.1 Analogue remote control

The analogue remote control interface consists of an 8 way barrier strip that allows four signals to be accessed.

10.1.1 Interlock

The interlock input turns on the RF output of the transmitter when both terminals are shorted together. One of the terminals is internally connected to 0V, so control can also be implemented by using a low impedance voltage source to feed the interlock input. In this case the transmitter will be turned on when the input voltage is below 0.4V and turned off when the input voltage is above 2.4V. The input resistance is greater than 10KΩ for voltages below 5V. The maximum safe input voltage is 15V.

When the interlock input is open circuit (or at a voltage of >2.4V) the transmitter output is turned off, though all other functions are still active. The interlock alarm is also active and is indicated as such on the display.

10.1.2 TX OK relay

When all alarms are OK (except the audio alarm) the TX OK terminals are shorted together (by a relay contact internal to the transmitter). If any alarm becomes active (except the audio alarm) the relay contact will open for the duration of the alarm. As soon as the alarm condition clears the relay contact will close again.

The differential voltage on this contact should be limited to 120VAC or 24VDC and the current should be less than 0.5A AC or DC. Both terminals are galvanically isolated from all other circuitry within the transmitter, but the common mode voltage should be limited to no more than 100V AC or DC with respect to ground.

10.1.3 Audio OK relay

If the modulation depth falls to 2% or below continuously for more than 30 seconds the AUDIO OK relay contact will open and stay open until the modulation depth rises above 2%, even instantaneously.

The differential voltage on this contact should be limited to 120VAC or 24VDC and the current should be less than 0.5A AC or DC. Both terminals are galvanically isolated from all other circuitry within the transmitter, but the common mode voltage should be limited to no more than 100V AC or DC with respect to ground.

10.1.4 Alarm tally output

The alarm tally output is a voltage source that generates an output of between 0V and 7V, in 1V increments. Each time the alarm tally is incremented, this output voltage is incremented. At 7V, the output returns to 0V upon the next alarm.

The output resistance of this voltage is 100Ω. No external voltage should be injected in to this output.

10.2 Serial remote control

The transmitter may be monitored and controlled remotely via the "TELEMETRY" connector on the rear of the unit. This is an RS232 standard connection with the following characteristics:

Baud rate: 9600
Data bits: 8
Parity: NONE
Stop bits: 1
Flow control: NONE

The pinout for the DB9 connector is as follows: pin 2, transmit data, pin 3, receive data, pin 5, common (0V). All other pins are not connected.

The transmitter responds to the following commands. <CR> indicates the ASCII character 0D hex. All letters are upper case, spaces (20 hex) are indicated by "_". All commands must be terminated by <CR>. Note that a line feed (0A hex) must not be sent before or after <CR>. After a response is sent, a carriage return, line feed and ">" are sent back by the transmitter. For M2M functionality, this can be used to ensure a command is not sent before a previous command has

Whilst this interface is designed specifically for human interaction, machine-to-machine control can be implemented by using the syntax for each command as described in the relevant section. The only additional consideration is time between transmissions of characters to the transmitter. All characters received by the transmitter over the serial remote control are read immediately and the relatively slow baud rate of this link means that characters can be sent to the transmitter with no wait period inserted between them. The only exception to this is the <CR> (0Dh) byte which indicates to the transmitter the end of a command. Upon receipt of a <CR> character the transmitter disables the serial link receiver whilst the command is processed, a response generated and sent, then <CR>,<LF> and > sent by the transmitter. Any automated communication should wait for the receipt of the ">" character before starting to send a new command to avoid losing command characters.

10.2.1 Serial command list (alphabetical)

Below is a list of all serial commands in alphabetical order. For more information regarding any particular command please consult the relevant section that follows.

Command	Description

AC?	Returns compressor status
AC=	Turns compressor on or off
AF?	Returns LPF status
AF=	Turns LPF on or off
AG?	Returns the audio gain
AG=	Sets audio gain
AI1?	Returns PA1 current
AL?	Returns limiter status
AL=	Turns limiter on or off
AT1?	Returns PA1 temperature
AV?	Returns PA voltage
BS?	Returns BITE status
CF?	Returns the carrier frequency
DN?	Returns status of night time power switching
ET?	Returns elapsed days
FD	Disable front panel
FE	Enable front panel
FF?	Returns LPF cutoff frequency
FP?	Returns the forward output power
FR?	Returns LPF response (Butterworth or Bessel)
FT?	Returns night power finish time
HP?	Returns a summary of all commands
LO?	Returns location
LO=	Sets location
MD?	Returns the modulation depth
ND	Disables night power
NE	Enables night power
NF=	Sets night power finish time
NL?	Returns negative limit value
NL=	Sets negative limit value
NP?	Returns night time power level
NP=	Sets night power level
NS=	Sets night power start time
OFF	Turns RF off
ON	Turns RF on
PL?	Returns positive limit value
PL=	Sets positive limit value
PS?	Returns front panel status
RF?	Returns the RF on/off status
RP?	Returns the reflected output power
RS	Resets over SWR alarm
RT	Resets alarm tally to zero
SD=	Sets date
SG?	Returns stereo generator status
SG=	Turns stereo generator on or off

SN?	Returns serial number
SP?	Returns the set output power
SP=	Sets set power
ST?	Returns night power start time
ST=	Sets time
TD?	Returns current time and date
TR	Toggles LPF response between Butterworth and Bessel
TY?	Returns alarm tally

10.2.2 Serial command list (by function)

RF related commands

CF?	Returns the carrier frequency
FP?	Returns the forward output power
OFF	Turns RF off
ON	Turns RF on
RF?	Returns the RF on/off status
RP?	Returns the reflected output power
SP?	Returns the set output power
SP=	Sets set power

Audio related commands

AC?	Returns compressor status
AC=	Turns compressor on or off
AF?	Returns LPF status
AF=	Turns LPF on or off
AG?	Returns the audio gain
AG=	Sets audio gain
AL?	Returns limiter status
AL=	Turns limiter on or off
FF?	Returns LPF cutoff frequency
FR?	Returns LPF response (Butterworth or Bessel)
MD?	Returns the modulation depth
NL?	Returns negative limit value
NL=	Sets negative limit value
PL?	Returns positive limit value
PL=	Sets positive limit value
SG?	Returns stereo generator status
SG=	Turns stereo generator on or off
TR	Toggles LPF response between Butterworth and Bessel

Time and night power related commands

DN?	Returns status of night time power switching
FT?	Returns night power finish time
ND	Disables night power
NE	Enables night power
NF=	Sets night power finish time
NP?	Returns night time power level
NP=	Sets night power level
NS=	Sets night power start time
SD=	Sets date
ST?	Returns night power start time
ST=	Sets time
TD?	Returns current time and date

Alarm related commands

BS?	Returns BITE status
RS	Resets over SWR alarm
RT	Resets alarm tally to zero
TY?	Returns alarm tally

PA1 - PA6 commands

AI1?	Returns PA1 current
AT1?	Returns PA1 temperature
AV?	Returns PA voltage

Unit related commands

ET?	Returns elapsed days
FD	Disable front panel
FE	Enable front panel
LO?	Returns location
LO=	Sets location
PS?	Returns front panel status
SN?	Returns serial number

Miscellaneous commands

HP?	Returns a summary of all commands

11. Alarms

The transmitter incorporates an exceptional array of alarms that ensure reliable operation with no user intervention. All alarms will recover automatically upon the removal of the cause of the alarm. Whilst some alarms will result in the output of the transmitter being turned off or reduced, the output will return to normal once the alarm in question becomes inactive. The individual alarms are as follows:

11.1 SWR alarm and flashover alarm

The MFTX range of transmitters incorporates a unique and sophisticated form of high SWR protection designed specifically for unattended operation and automatic recovery. This feature is particularly useful for those sites that use a short antenna as the high Q of these installations can often generate short term situations of high reflected power.

The level of reflected power needed to trigger a high SWR alarm is factory set to 10W, 20W, 40W and 60W for the MFTX100, 200, 400 and 600 respectively. This is an absolute value and is independent of actual output power set. This allows larger transmitters to have a greater tolerance to reflected power, even if run at a much lower power.

The flashover alarm operates if any parts of the output filter experience excessive voltage which could lead to a flashover.

Upon detection of a high SWR or flashover the transmitter will immediately reduce RF power to zero for one second, then return to the same set power. This allows any ionization to be dissipated.

If another two failures occur within a minute of the first, the output power is halved and the process repeats, ad infinitum. In this way the transmitter will continue to function at a lower power, even under conditions of high reflection.

As can be seen, this is similar to the traditional “three strikes” type of behavior, but without the total shutdown.

If the time from last failure is more than one minute then the failure count is reset to zero. However, if the output power has already been reduced due to a previous occurrence of three alarms in under a minute, the power will stay at the reduced level.

If no SWR alarms occur for more than an hour, the output power will be automatically returned to its original setting.

If an SWR alarm has caused a partial power shutdown then the transmitter can be returned to full power before the one hour timeout by:

- Turning off then on at mains.
- Sending serial command RS
- Opening, then closing the interlock.

The TX OK relay will stay open and the alarms screen will show SWR (or flashover) fail until reset by the above methods or the one hour timeout expires.

11.2 Interlock alarm

As described in the section dealing with the analogue remote control interface, if the interlock circuit is open the transmitter will reduce its output power to zero. As soon as the interlock circuit is closed the transmitter will restore full output.

This alarm may be used for an external emergency shutdown, or for hot standby applications.

11.3 GEN alarm

If the RF generator module fails to communicate properly with the main microprocessor the GEN alarm will be triggered.

11.4 Temperature alarm

The temperature alarm becomes active if the internal temperature of the transmitter exceeds 85°C. Once active, the output of the transmitter is turned off until the internal temperature falls to below 70°C, whereupon the alarm becomes inactive and full output is restored.

As no user intervention is needed to clear this alarm, if the cause of the over temperature is still present then the transmitter will cycle in and out of this alarm condition indefinitely.

Operation of this alarm generally indicates inadequate ventilation or inappropriate installation.

11.5 Audio alarm

The audio alarm becomes active if the modulation depth falls below 3% continuously for more than 30 seconds. This alarm is used to detect a loss of external audio and may be used to reset the audio source or select an alternative source.

The audio alarm is deactivated immediately the modulation depth exceeds 2%.

12. Maintenance

The MFTX range of transmitters requires little routine maintenance.

The heatsink and ventilation grills should be regularly inspected and cleaned if necessary.

Any air filters should be removed and cleaned as needed.

It is also good practice to log all parameters on a monthly basis to allow changes in operating conditions to be identified.

12.1 Example log sheet

TBA

13. Adjustments

The MFTX range are of advanced design with very few adjustments. Below is a summary of these adjustments. These are factory set and will not normally need to be adjusted in the field.

However, this information is included here to aid servicing.

13.1 POT1, Forward power calibration

This pot is adjusted so that the measured forward output RF power reads correctly.

13.2 POT2, Reflected power threshold

This pot is used to set the reflected power level at which the transmitter's high SWR protection is tripped. Normally set to 10% of the transmitter's rated output.

13.3 POT3, Reflected power calibration

This pot is adjusted so that the measured forward output RF power reads correctly.

13.4 POT4, carrier frequency fine adjustment

Allows the free running carrier frequency to fine tuned over a range of a few PPM. This pot has no effect when the external 10MHz reference is selected.

13.5 POT5, LCD contrast

Allows the contrast of the LCD on the front panel to be adjusted.

13.6 POT6, alarm tally analogue voltage trim

This pot allows the analogue voltage of the alarm tally on the analogue remote control interface to be adjusted to exactly 1.00V per alarm.

13.7 DC supply adjustment

The output of the DC supply is nominally 50V. Hover, it can be adjusted up or down to make the carrier rest power of the transmitter correct.

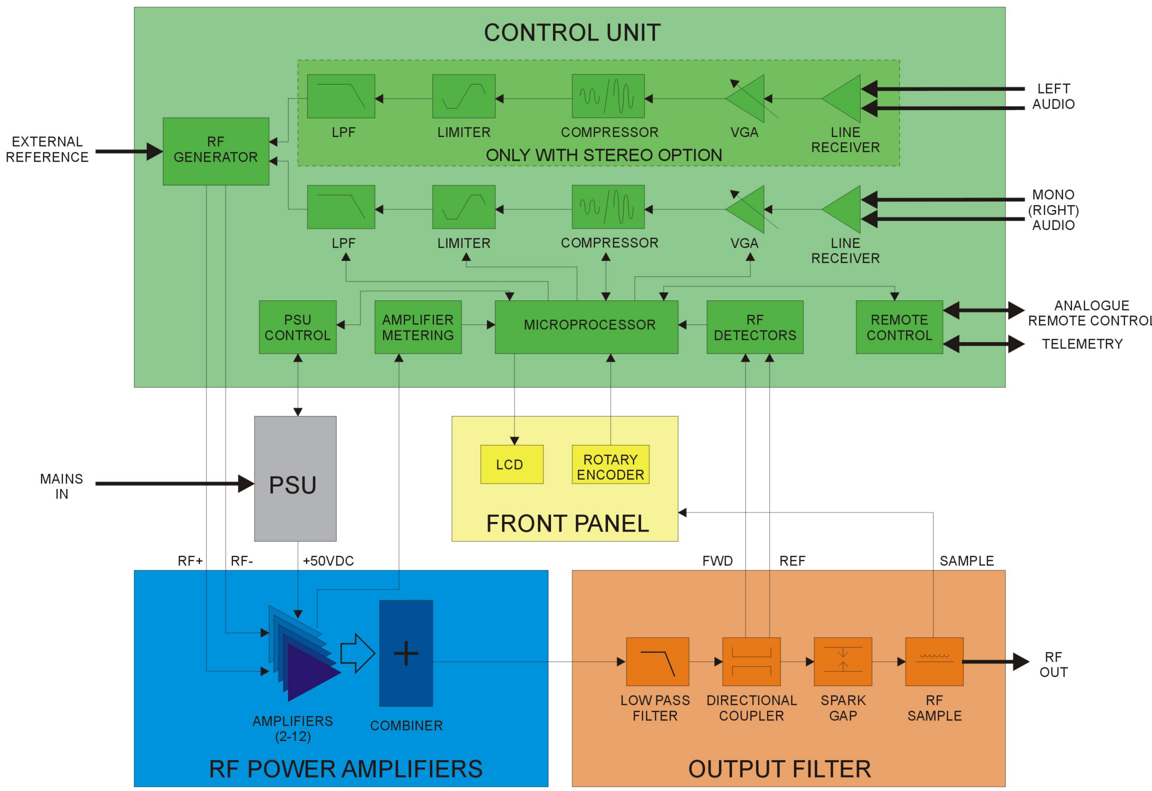
13.8 Directional coupler null

This adjustment allows the reflected power to be set to zero when driving a non-reflective load.

14. Circuit description

14.1 Theory of operation

The MFTX range of transmitters uses a unique phase-to-amplitude modulation technique to implement AM. All models follow the general scheme described below.



As can be seen from the diagram above, there is no modulation stage. Instead the RF amplifiers are fed with two signals (RF+ and RF-) whose relative phase is adjusted to produce amplitude modulation.

RF+ and RF- are used to drive a number of RF amplifiers. Each amplifier produces 100W at 0% modulation. Thus there are 1, 2, 4 and 6 amplifiers in the MFTX100, MFTX200, MFTX400 and MFTX600 respectively. The DC supply to the RF amplifiers is derived from a self contained switch mode power supply that generates a nominal voltage of 50V. Appropriate capacitive storage is included on the DC supply to allow extended periods of +125% positive modulation.

The outputs of the RF amplifiers are summed in a transformer based combiner.

The output from the combiner is passed to the output filter assembly. This consists of a lumped constant low pass filter, followed by a directional coupler. The directional coupler generates a sample of the forward and reflected RF voltages which are used by the control unit to monitor forward and reflected output powers.

A spark gap and RF sample port are also included in the output filter assembly.

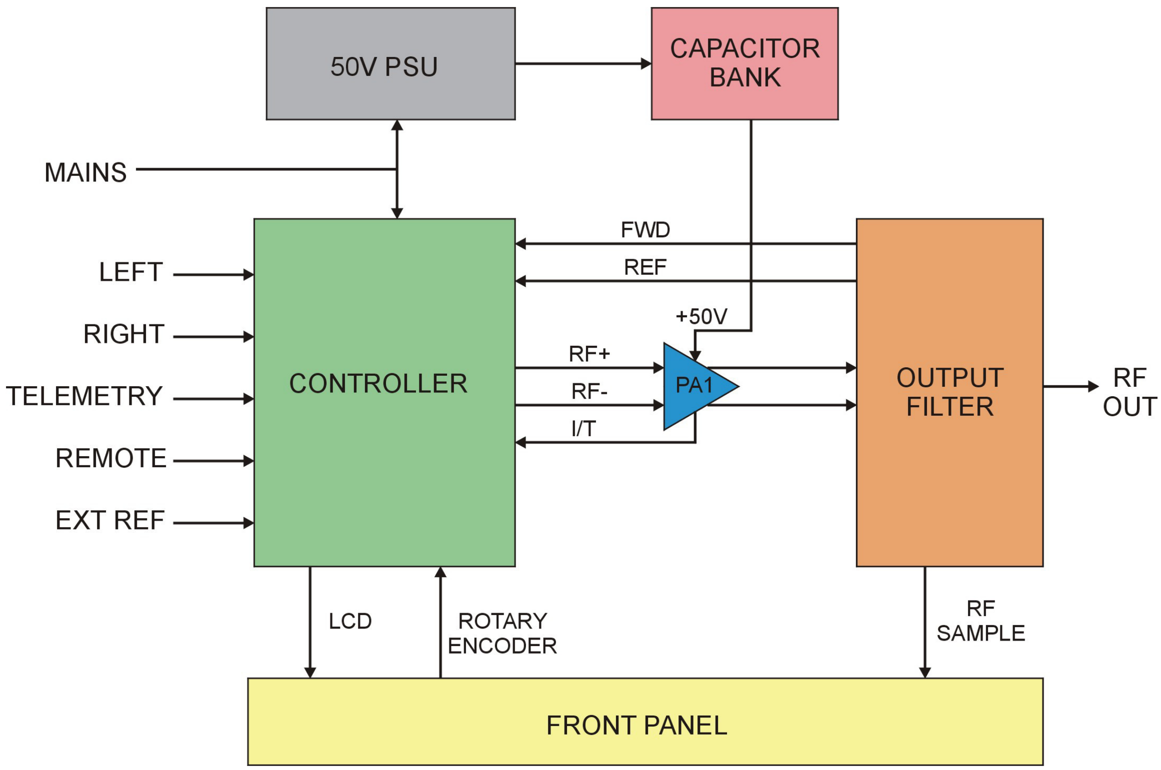
Audio processing, RF generation, remote control, metering, protection and front panel interface is provided by the controller unit.

Audio is processed in the analogue domain, with gain control, compression, limiting and filtering performed by circuitry within the control unit. Processed audio is then passed the RF generator module.

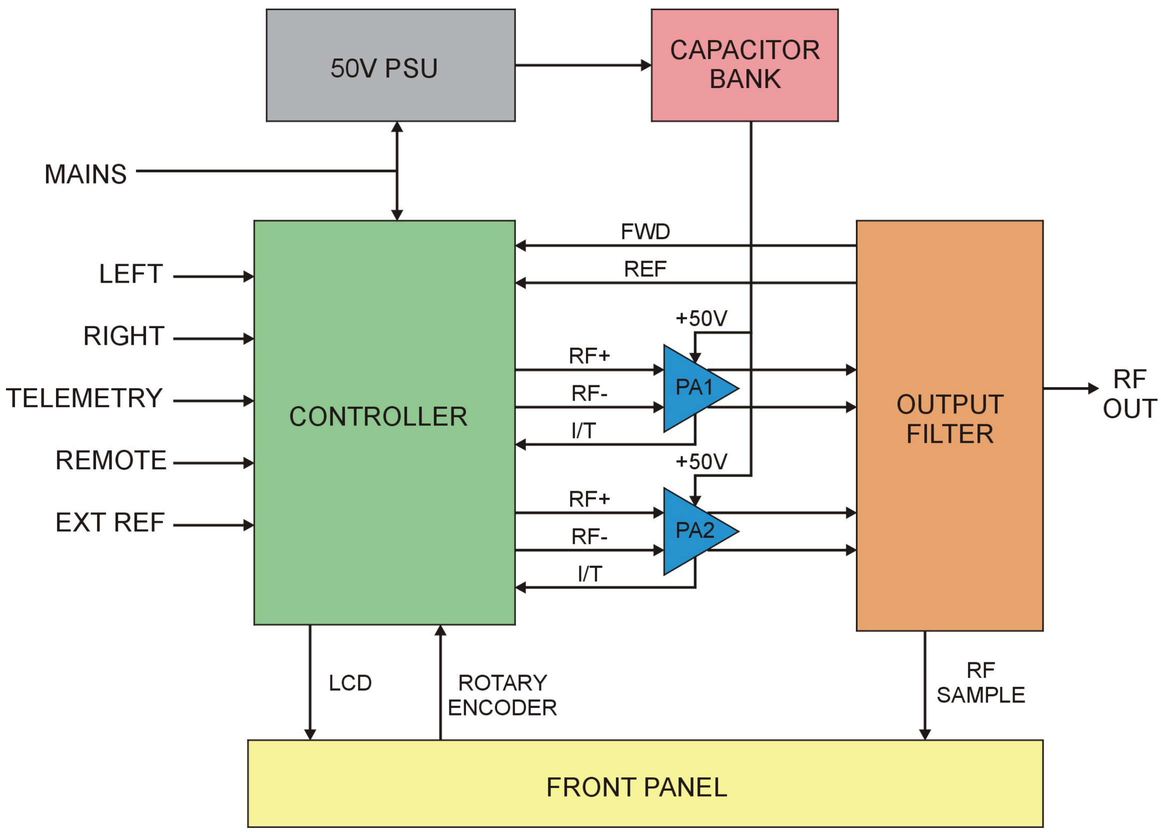
The RF generator module is a proprietary unit that performs advanced amplitude-to-phase conversion in the digital domain. The output of the RF generator consists of two squarewaves at the carrier frequency (RF+ and RF-). The relative phase of these squarewaves sets the instantaneous RF voltage at the output of the transmitter.

14.2 Block diagrams

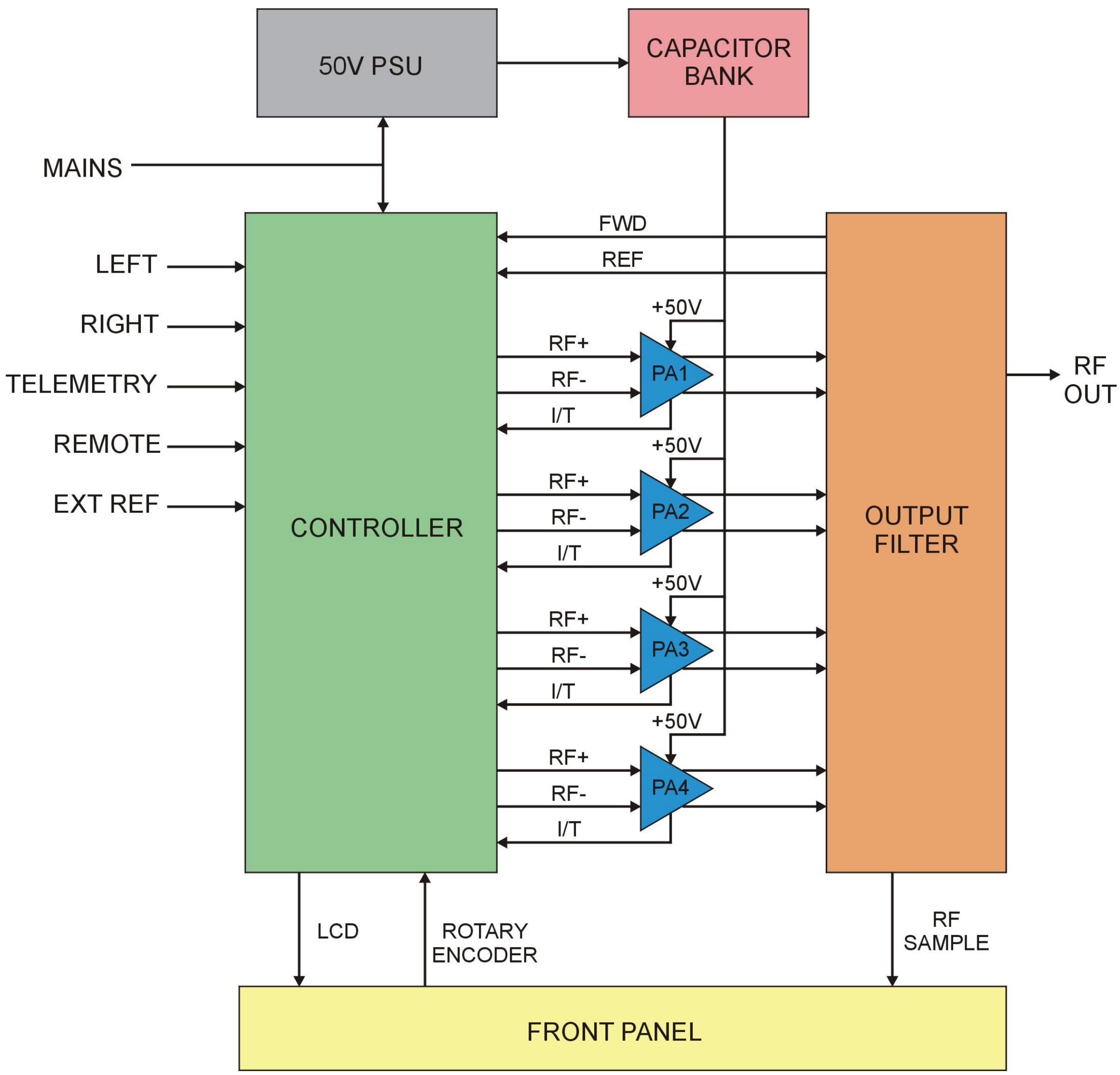
14.2.1 MFTX100 block diagram



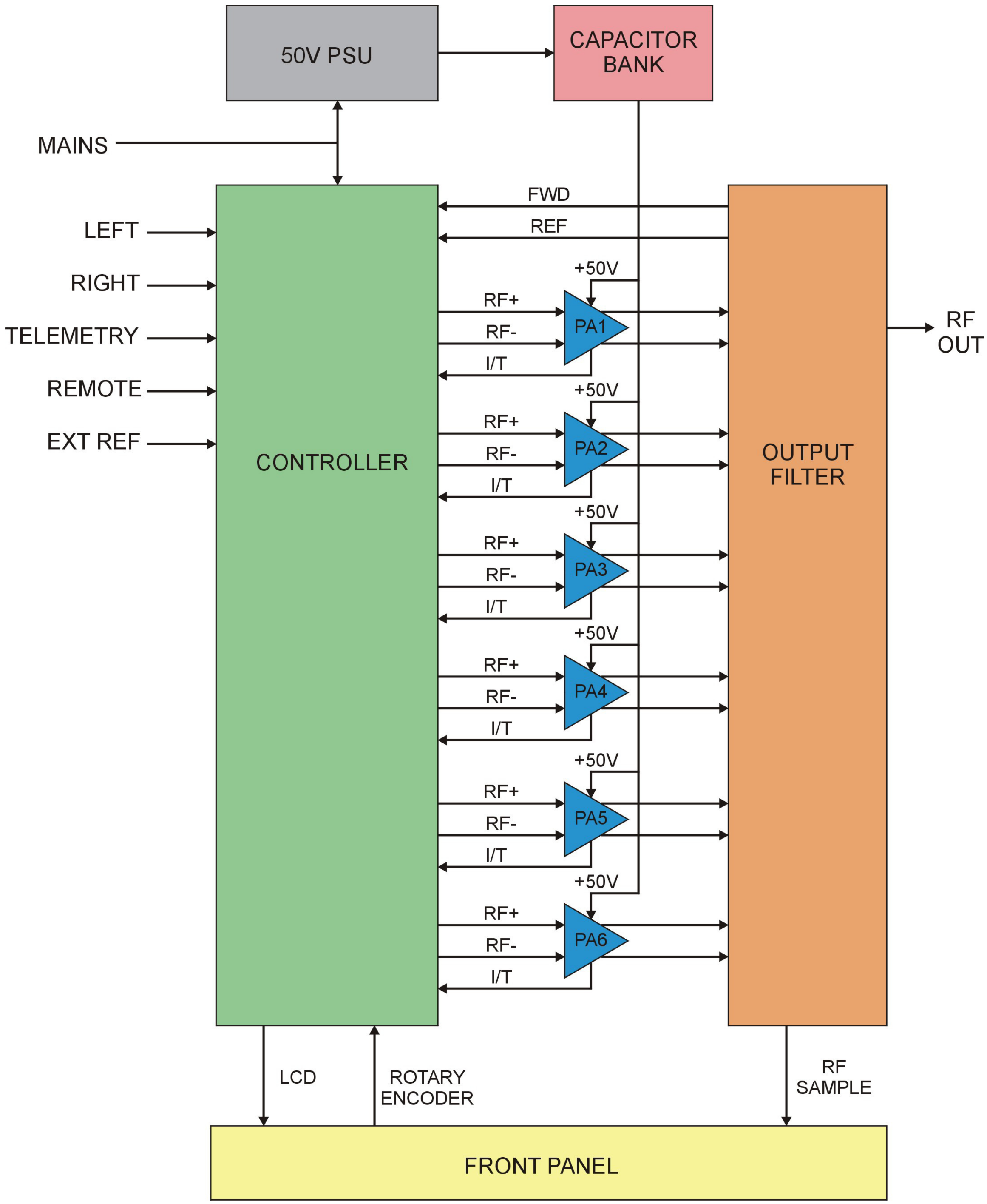
14.2.2 MFTX200 block diagram



14.2.3 MFTX400 block diagram



14.2.4 MFTX600 block diagram



14.3 Control unit

Audio enters on J9. This is a balanced high impedance input. D3 and D4 provide overvoltage transient protection. The following LC network has high attenuation in the 500KHz to 1.7MHz range to ensure that even when the audio feed is run over considerable distances, no adverse affects will be seen.

The filtered audio is passed to a line receiver (U1) with unity gain. This amplifier has an extremely high CMRR and good immunity to over voltage transients.

The single ended output is passed to a digitally controlled variable gain amplifier formed by U2 (a four quadrant multiplying DAC) and associated amplifier. The gain of this stage is determined by the eight bit value latched into the DAC. This value is set by the microprocessor with U4 forming a level shifter.

The gain adjusted audio is then passed to the compressor. This is a hybrid system where the audio is reduced by a digitally controlled pot (U10). The peak analogue audio voltage is fed in to a dedicated audio microprocessor (U7). Algorithms within this microprocessor allow adjustable attack and release times, as well as threshold and compression ratio. This microprocessor communicates with the main microprocessor over a two wire I^2C bus.

Compressed audio is passed to a peak limiter formed by U8 and U15. The positive and negative limit thresholds are independently settable by the digital pots U6 and 11. These pots are controlled by the audio microprocessor, which in turn is given the pot values by the main microprocessor.

The peak limited audio is passed to an audio low pass filter (LPF) formed by U12. This is an eight order filter with cutoff frequency determined by the frequency of the clock signal on pin 12. This clock signal is generated by the audio microprocessor (U7) which is, in turn, programmed by the main microprocessor. U12 can be configured as either a Bessel or Butterworth response. This is selected by the state of the signal on pin 11 and is set from the main microprocessor via the audio microprocessor.

Any clock breakthrough is removed from the audio by the active filter formed by U14.

The processed audio is then passed to the RF generator module.

The RF generator module is a sealed unit that contains advanced digital processing that directly converts the processed audio into two carrier waves (RF+ and RF-) of variable phase difference.

RF drive to the RF amplifiers is taken directly from the RF generator module.

The RF generator module can be locked to an external 10MHz reference or be free running with fine frequency control provided by variable resistor, POT4.

The RF generator module communicates with the main microprocessor over a simple serial link. This allows the microprocessor the set frequency, power and reference source and to read positive and negative peak modulation depth. All these functions are performed entirely in the digital domain.

Each of the six possible RF amplifiers is monitored by the main microprocessor. The DC current drawn is converted to a ground referenced voltage by U43-48. The voltage generated by the temperature sensor on the amplifiers is also monitored. These signals are passed to the main microprocessor via the analogue multiplexor formed by U25 and 27.

This multiplexor also allows the microprocessor to measure the forward and reflected power, 50VDC and 20V auxiliary supply voltages.

The forward and reflected voltage samples from the directional coupler within the output filter are precision rectified by U16 and 20 respectively. These devices are far more linear than conventional diode rectifiers and ensure accurate power metering even at the lowest power setting.

These voltages are then scaled by POT1 and POT3. These allow correct reading of forward and reflected power.

U17 and U21 are RMS-to-DC converters which allow true average power measurement, even under high levels of modulation.

The reflected power sample is compared with a fixed voltage (set by POT2). U19 is a comparator whose output can disable the RF drive to the RF amplifiers during periods of high reflected power.

Analogue remote control as well as PSU control (where implemented) is performed the main microprocessor via the IO expander, U40.

The main microprocessor (U24) controls all functions of the transmitter, either directly or indirectly. Serial communications via the telemetry port is level shifted by U21.

14.4 RF power amplifier

Each RF power amplifier generates 100W of RF power at 0% modulation.

The unique phase modulation system used by the MFTX range means that there are actually two identical amplifiers per RF PA. These are driven by the RF+ and RF- signals and their outputs summed in the transformer(s) of the output filter assembly.

The RF+ and RF- signals are logic level squarewaves at the carrier frequency with a phase difference that varies in proportion to the required instantaneous RF output power.

These signals are amplified by U1 and 2 to approximately 20V p-p and coupled into the gates of the output transistors by transformers T1 and 2.

Gate protection is provided by D1 to 8.

The output transistors (Q1-4) are configured as a full bridge with the two output nodes connected to the primary of the relevant output transformer in the output filter assembly.

The drain supply of the output transistors is a nominal 50V DC from the main power supply. The current drawn from this supply is sampled by R5. This sample is passed to the control unit to allow monitoring of PA current.

The DC supply is also fused to prevent serious damage if one or more of the output transistors fails. This fuse is shunted by a resistor/LED combination to indicate fuse failure.

Temperature measurement is provided by U3. This signal is passed to the control unit for monitoring and protection.

14.5 Output filter

The output filter incorporates the power combiner, harmonic filter, directional coupler, sample port and spark gap.

The combiner consists of 1 to six transformers, one for each RF amplifier. Where more than one transformer is present, the secondaries are connected in series.

The harmonic filter is a lumped constant circuit of sufficient order to ensure the harmonic content of the output RF is negligible. The actual configuration and component values for the harmonic filter are frequency and power dependent. Refer to the relevant schematic for details. The harmonic filter also incorporates impedance matching the convert the 50+/-j0 ohm load impedance to a value suitable to load the RF amplifiers.

The directional coupler is a modified Bruene directional wattmeter. High frequency amplifiers are used to provide high impedance loads to the sampling networks and low impedance sources to the summing transformers. This ensures high directivity and a flat frequency response.

The spark gap for the MFTX100 is a gas discharge tube of suitable voltage rating. For all other models it is an adjustable stainless steel ball gap.

The RF sample port is inductively coupled to the main line and resistively terminated. Nominal output voltage into an open circuit at full power and zero modulation is 7V RMS.

15. Abbreviations

A	Amp(s)
AC	Alternating Current
ADC	Analogue to Digital Converter
AM	Amplitude Modulation
ATU	Antenna Tuning Unit
BITE	Built In Test Equipment
BOM	Bill Of Materials (parts list)
C	Centigrade
CMRR	Common mode rejection ratio
DAC	Digital to Analogue Converter
dB	Decibels
dBc	Decibels relative to carrier level
dBm	Decibels relative to 1mW (into 50Ω for RF or 600Ω for audio)
Hz	Hertz
IDC	DC current
K	Kilo, kilo-ohm
Kg	Kilogram
KHz	Kilohertz
LPF	Low Pass Filter
nF	nanofarads
m	metre, milli
M	Mega, mega-ohms
MF	Medium Frequency (300KHz to 3MHz)
MHz	Megahertz
PCB	Printed Circuit Board
PDM	Pulse Duration Modulation (aka PWM)
pF	picofarads
PPM	Parts Per Million
PWM	Pulse Width Modulation (aka PDM)
R	Ohms
RF	Radio Frequency
RH	Relative Humidity
RMS	Root-Mean-Square
RTC	Real Time Clock
SWR	Standing Wave Ratio
THD	Total Harmonic Distortion
TX	Transmitter
U	Rack unit, 1.75”
uF	Microfarad
uS	Microsecond
V	Volt(s) or voltage
VAC	AC voltage
VDC	DC voltage

VGA	Variable Gain Amplifier
VSWR	Voltage Standing Wave Ratio
W	Watt(s)

16. Bill of materials

16.1 MFTX100 Top level

TBA

16.2 MFTX200 Top level

TBA

16.3 MFTX400 Top level

TBA

16.4 MFTX600 Top level

TBA

16.5 Control unit

16.6 RF power amplifier

TBA

16.7 MFTX100 output filter

TBA

16.8 MFTX200 Output filter

TBA

16.9 MFTX400 Output filter

TBA

16.10 MFTX600 Output filter

TBA

17. Schematics

17.1 MFTX100 Overall Schematic

TBA

17.2 MFTX200 Overall Schematic

TBA

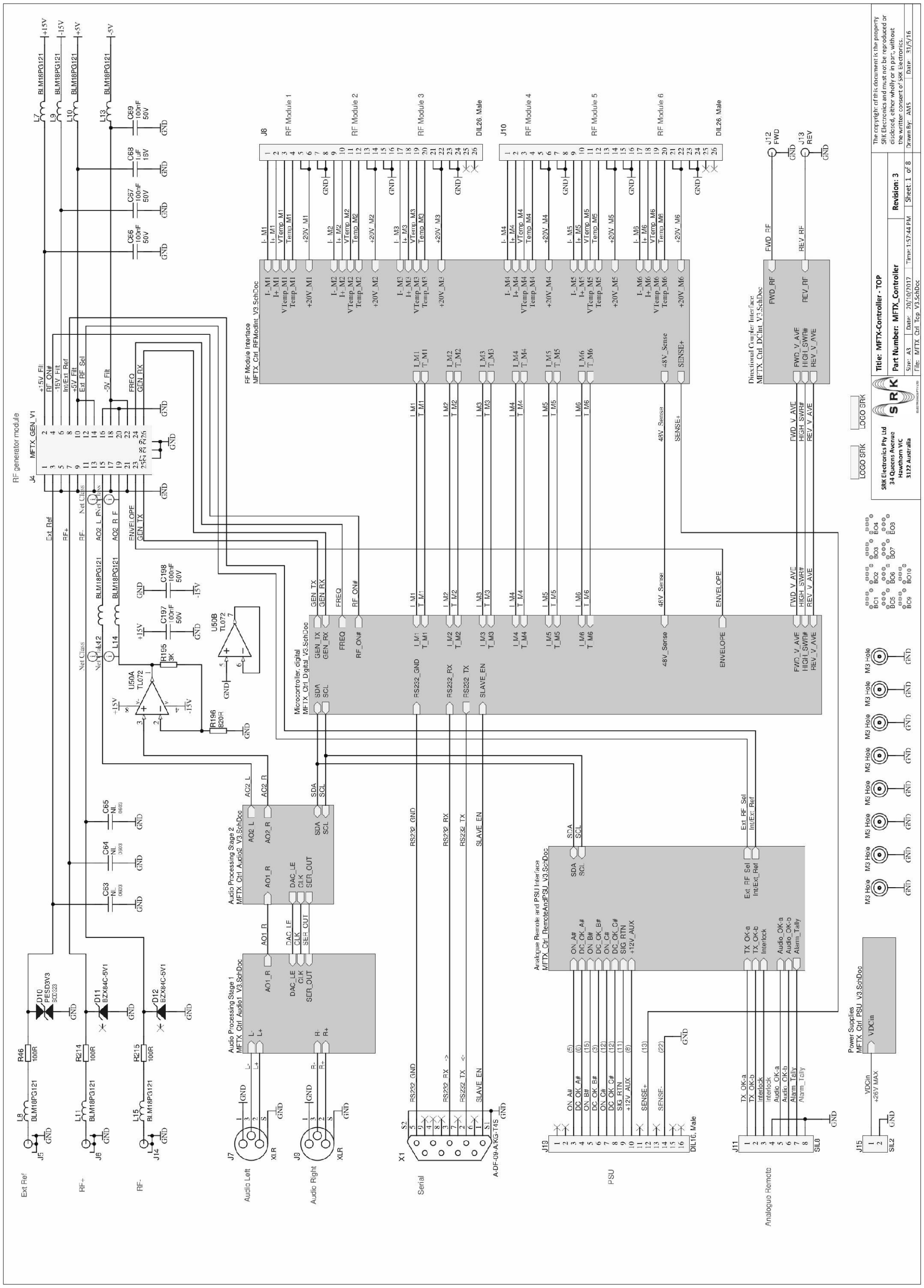
17.3 MFTX400 Overall Schematic

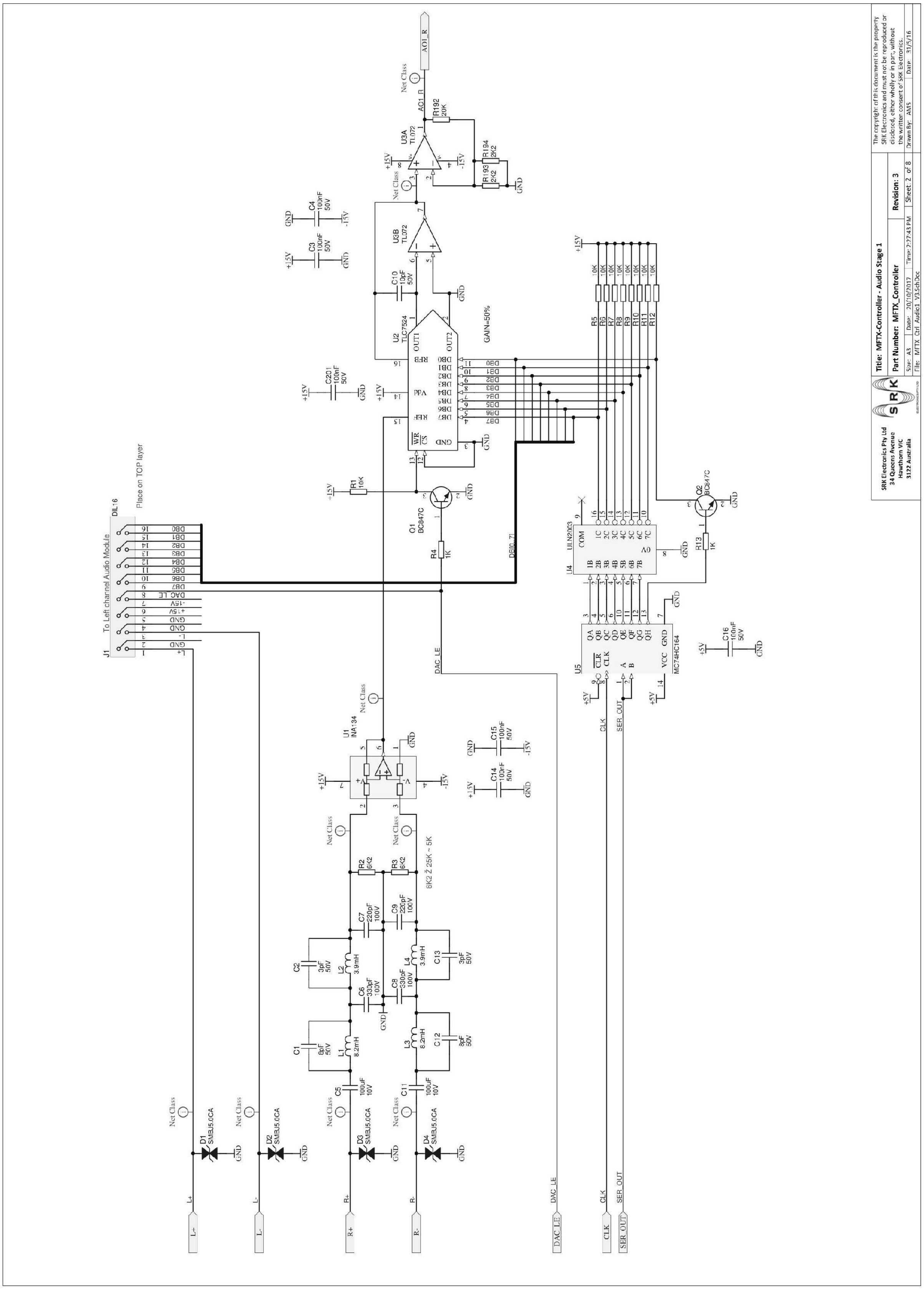
TBA

17.4 MFTX600 Overall Schematic

TBA

17.5 Control Unit Schematic





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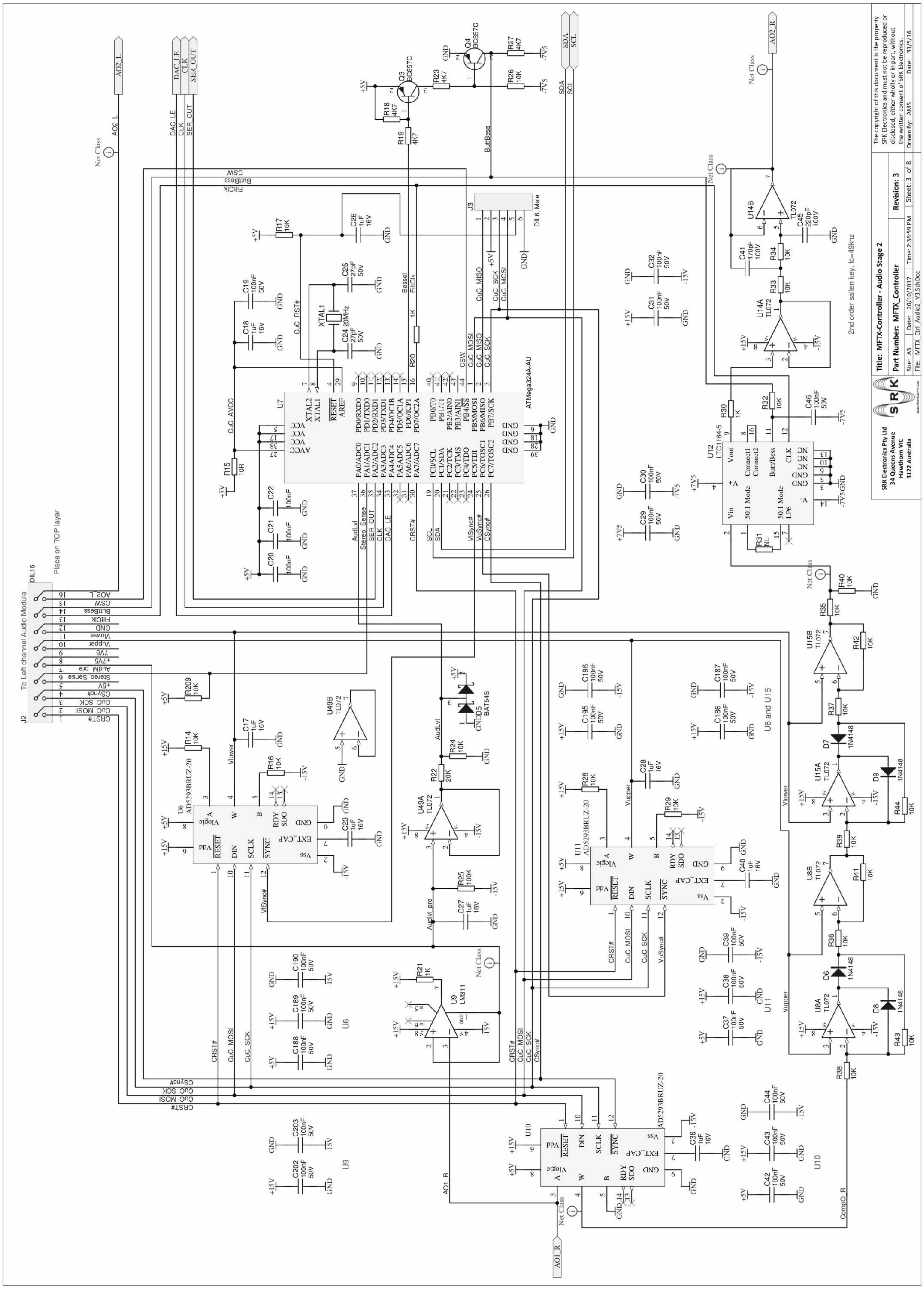
Part Number: MFTX_Controller
Revision: 3
SRK Electronics Pty Ltd
34 Queens Avenue
Hawthorn VIC
3122 Australia
AO1_R
U3A
TL072
U3B
TL072
U2
TLC7524
GAIN=50%
U1
INA134
U4
ULN2003
U5
MC74HC164
Q1
BC847C
Q2
BC847C
J1
To Left channel Audio Module
Place on TOP layer
DIL16
L+
L-
R+
R-
DAC LE
CLK
SER OUT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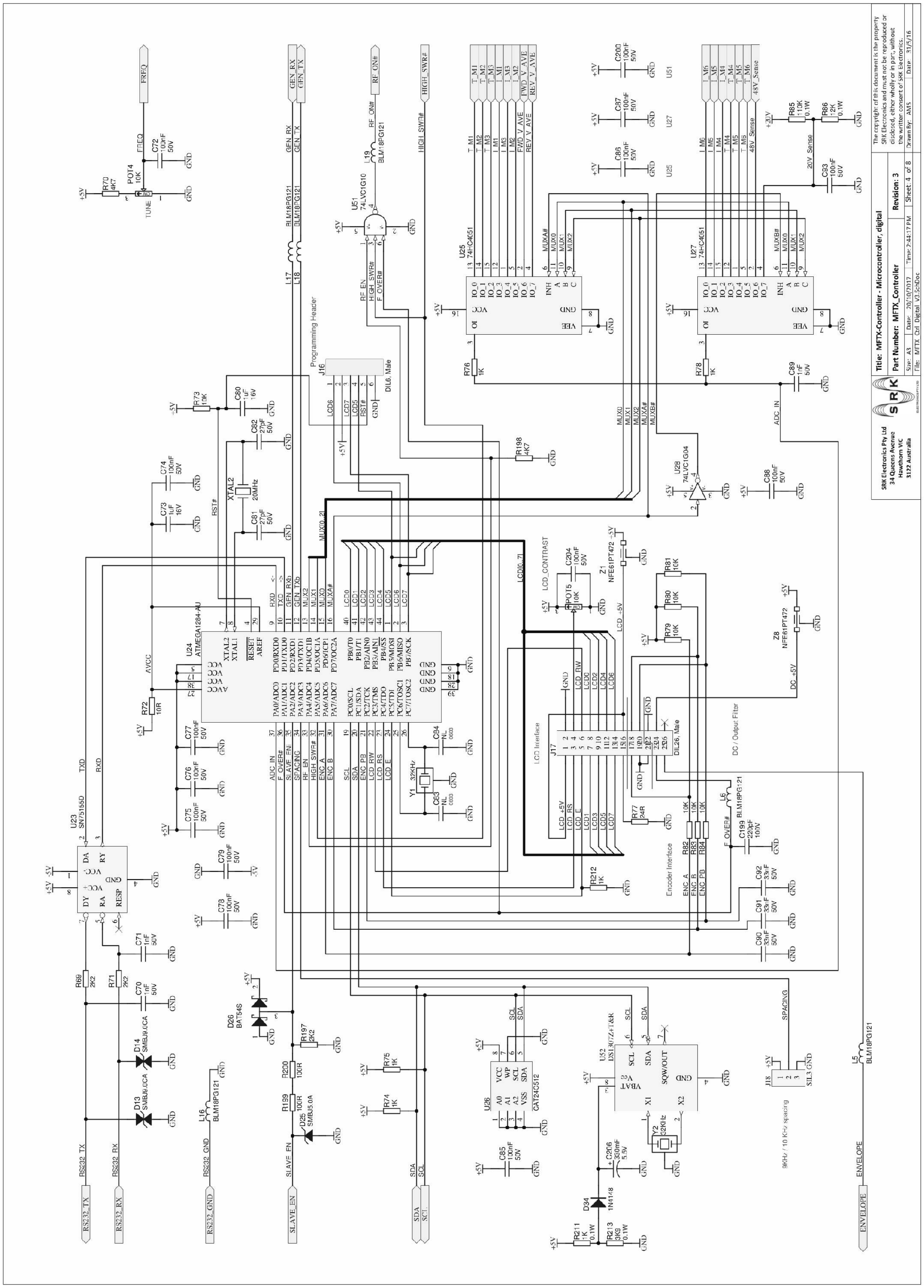
Part Number: MFTX_Controller
Revision: 3
Sheet: 3 of 8
SRK Electronics Pty Ltd
34 Queens Avenue
Hawthorn VIC
3122 Australia
2nd order sallen key, fc=49khz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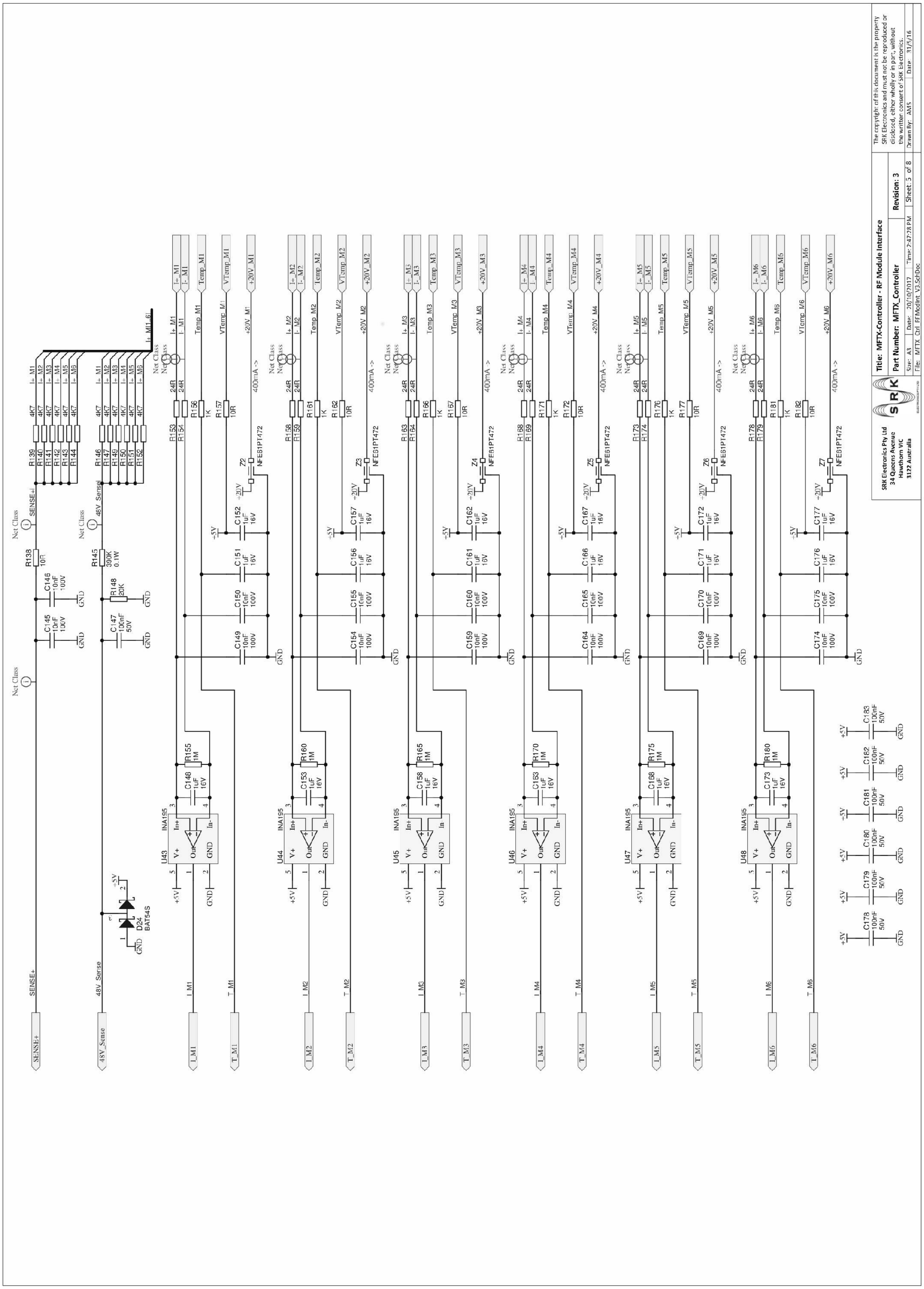
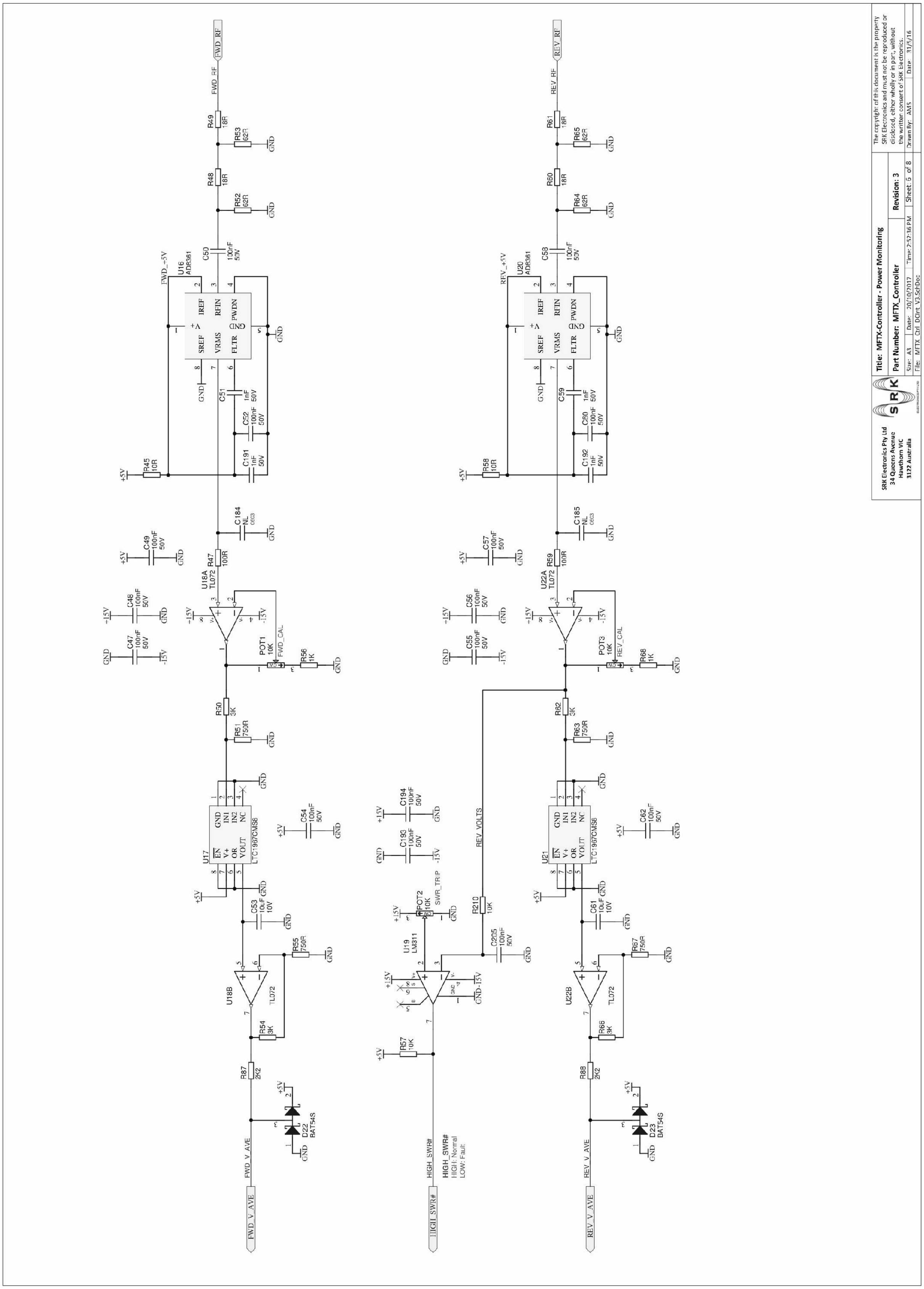
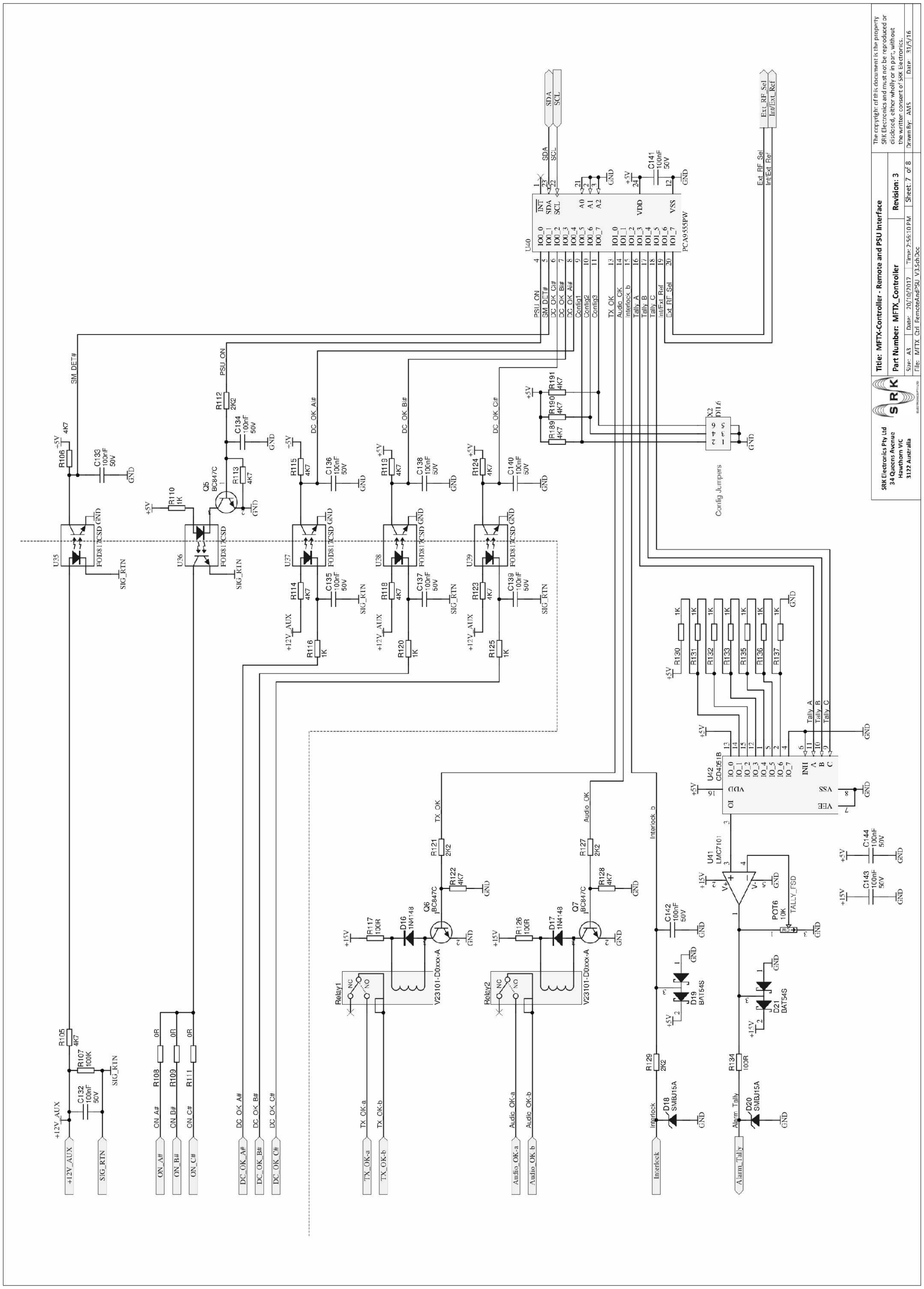
Part Number: MFTX_Controller
Revision: 3
Sheet 4 of 8
SRK Electronics Pty Ltd
34 Queens Avenue
Hawthorn VIC
3122 Australia



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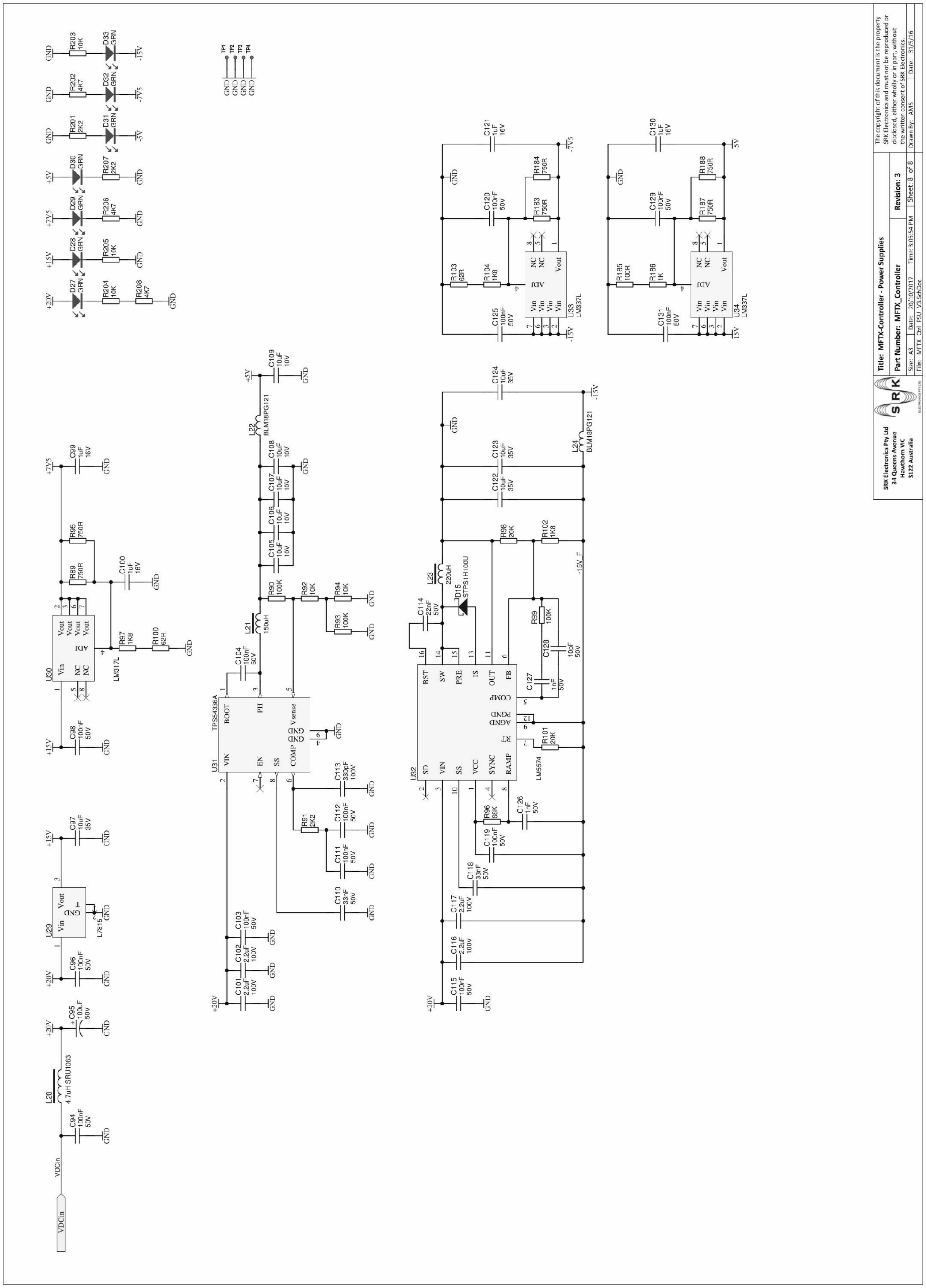
Part Number: MFTX_Controller
Revision: 3
SRK Electronics Pty Ltd
34 Queens Avenue
Hawthorn VIC
3122 Australia
Config Jumpers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Part Number: MFTX_Controller
Revision: 3
SRK Electronics Pty Ltd
34 Queens Avenue
Hawthorn VIC
3122 Australia

17.6 RF Power Amplifier Schematic

18. PCB Layouts

TBA

19. Change History

Version No.	Release Date	Description of change(s)
1.00	28/8/16	First issue
1.01	5/5/17	Various additions
1.02	8/5/17	Added theory of operation. Fixed typos
1.03	19/10/17	Added block diagrams, schematics and adjustments
1.04	6/11/17	Updated specifications section