Technical Service Bulletin 030624

DCX AGC Setup Procedure for MODAP Exciters

This service bulletin provides the procedure to properly install and align the total system automatic gain control (AGC) upgrade (P/N 47267125) in Comark DCX ATSC Transmitters equipped with MODAP Exciter. This upgrade permits AGC control of total system forward power at the output of the transmitter RF system, while preventing overdrive of individual HPAs during non-standard operating conditions. This upgrade also provides an automatic VSWR fold back function.

CAUTION: The procedure contained below is for advanced users only and should not be attempted without a full understanding of the theory of operation of the transmitter gain control system. Incorrect set-up of the gain control system could create the potential for serious damage to the transmitter amplifiers resulting from RF overdrive conditions.

GC/AGC Simplified Theory of Operation

The transmitter gain control system uses the principal of negative feedback to maintain a steady operating power despite changes in amplifier gain due to temperature shifts or other component drift. *(see Figure 1 and schematic 47267125.030)*

The transmitter remote control interface provides DC metering voltages proportional the levels of the system forward output power, system reverse power, and each individual PA cabinet output power. These voltages are typically between zero and five volts.

The DCX / ADAPT AGC Interface PCB (AGC card) takes an amplified sample of each of these metering voltages and compares them according to a diode-OR selection rule. The diode-OR circuit allows only the highest metering value to pass on to the next stage: the exciter AGC feedback input. All other diodes are reversed bias by the highest metering value passing through to the next stage.

The diode-OR selection is such that the transmitter gain control system will only track the highest metering voltage coming into the AGC card. Under normal operation, the variable gain controls on the AGC card are adjusted such that system forward power metering voltage is slightly higher that the metering voltages from the individual HPA cabinets. This ensures that the exciter AGC tracks the system forward power. Should the system forward power drop the exciter AGC will attempt to compensate by raising its output power. This will raise the output power levels of the individual HPA cabinets. When an individual HPA power level rises to 110% of nominal, its metering voltage takes control of the diode-OR circuit, thereby preventing further power increases. The level of the system reverse power metering voltage is adjusted such that a reflected power level of 2.5% allows it to seize control of the diode-OR circuit and force the AGC to reduce forward power while keeping the reflected power level constant (VSWR fold back).

The diodes forming the diode-OR circuit are LEDs, thereby allowing easy determination of which metering voltage is current controlling the AGC system.

The AGC voltage from the AGC card passes through backplane connector J17 to the CUDC module in the ADAPT exciter. This voltage is scaled by the front panel AGC potentiometer and then inverted, such that an increase in AGC voltage input causes a decrease in the RF level command to a variable attenuator in the RF signal chain. The exciter control system has the ability to modify this RF level command voltage according to actions taken through either ADAPT Control (*AGC Level* parameter) or the exciter user interface module. When the exciter is in AGC mode, the RF level command voltage is passed directly on to the variable attenuator. When the manual gain control (MGC) gain mode is selected, an alternative RF level command voltage is obtained from exciter control system (*MGC Level* parameter). The front panel MGC level control is disconnected in this application.

While in MGC gain mode, the exciter still maintains an overdrive protection via a clamping diode connected to the AGC system. If the RF level command coming from the MGC system becomes too high relative to the AGC voltage (approx 2.5dB greater), the clamping diode conducts, thereby restraining the MGC voltage. ***For this reason, the AGC potentiometer will still act to limit the maximum power when the exciter is in the MAN gain mode.***

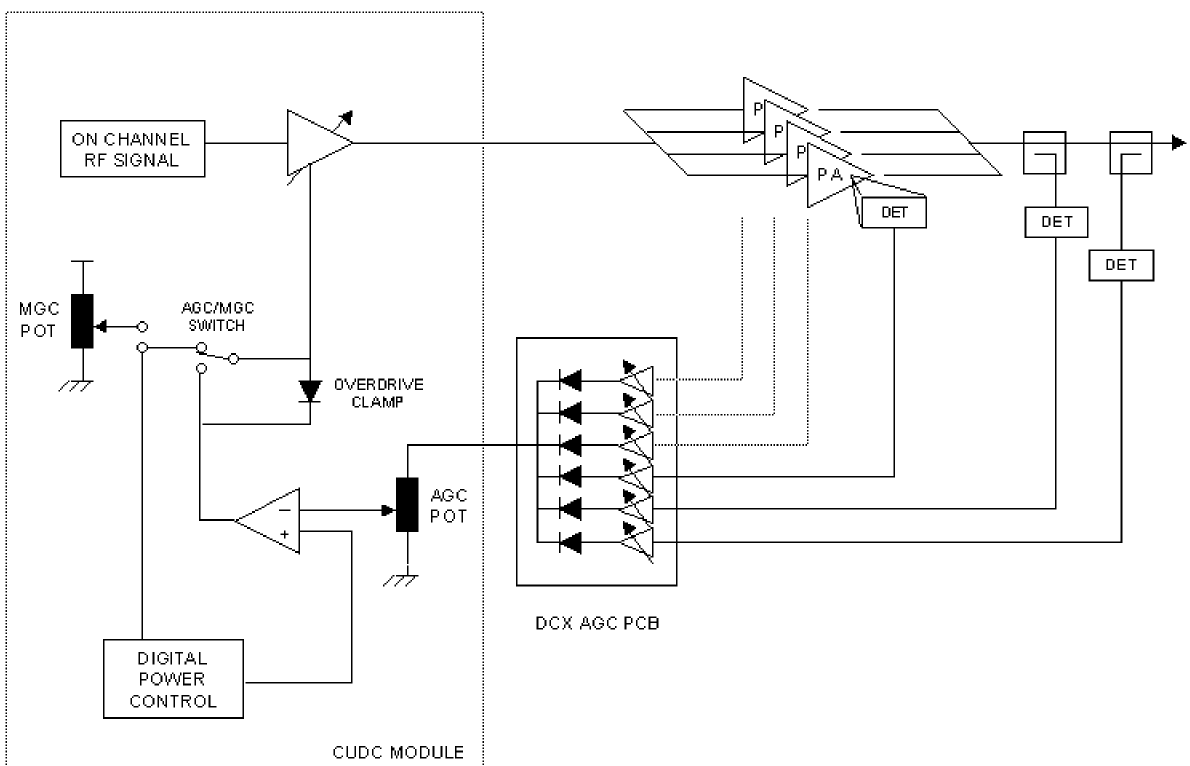

Figure 1. Simplified block diagram of transmitter gain control system.

Procedure 030624: AGC Setup Procedure DCX	
Applicability	DCX IOT Transmitters
Prerequisites	Transmitter operating at 100% with acceptable non-linear (LUT) performance. ADAPT Control software installed and connected to exciter. ADAPT has correct hardware for AGC (pre-1999). See procedure 46744257 521 S1
Equipment Required	P/N 47267125 DCX / ADAPT AGC Interface PCB with supplied hardware kit. Spectrum analyzer 50 ohm RF cable PC with ADAPT Control software RS-232 null modem cable Selection of BNC RF attenuators
Comments	Instructions for optional DCX AGC card made by Dave Sparano.

1. Ensure that transmitter is operating normally at 100% system forward power with 100% HPA forward power on each individual cabinet. Adjust power level and system phasing to achieve this necessary condition before attempting to install AGC PCB.
2. Ensure that transmitter has been satisfactorily corrected for non-linear distortions. That is, ensure that LUT corrector is engaged and adjacent channel sidebands have been reduced to an acceptable level.
3. Mechanically install AGC PCB by performing following steps.
   a. Select suitable unused portion of wall in rear section of DCX exciter cabinet.
   b. Using card as template, trace four mounting holes on wall of DCX exciter cabinet.
   c. Center punch holes, and drill with 1/16" pilot bit.
   d. Drill holes with 7/64" bit.
   e. Tap holes with 6-32 tap.
   f. Mount card to wall with supplied 6-32 hardware and standoffs.
4. Electrically install AGC PCB by performing following interconnects:
   a. Wire from P1-1 (GND) of AGC card mating connector to TB1-87 (GND) for DCX1 or TB1-94(Gnd) for Millennium exciter cabinet.
   b. Wire from P1-2 (+24V) of AGC card mating connector to TB1-48 (unused) of DCX exciter cabinet.
   c. Analog system forward power metering voltage from remote control rack to P1-4 (+) and P1-10 (-/GND) of AGC card mating connector.
   d. Analog system reverse power metering voltage from remote control rack to P1-5 (+) and P1-11 (-/GND) of AGC card mating connector.

NOTE: DCX Millennium transmitter users may skip this step, as reverse power AGC (VSWR foldback) is already provided by the Total Power Control Unit (TCPU) and should disregard all future instructions concerning the reverse channel in this AGC setup procedure.

e. Analog HPA forward power metering voltages from remote control rack to P1-6, 7, 8, 9 (+ for HPAs 1-4) and P1-12, 13, 14 (-/GND for HPAs 1-4) of AGC card mating connector. It will be necessary to double-up some -/GND connections.

f. Place a jumper from the (+) input to ground for any unused HPAs (e.g. jumper P1-8, 9 to P1-10…14 on AGC card mating connector for HPAs 3 & 4 in two cabinet system).

g. Connect P1 to J1 on AGC card.

h. Use multimeter to verify that suitable analog voltages (approx 0.5 - 5V) are being applied between + and GND connections for each input channel.

i. Insert WAGO jumper plug (supplied) between TB1-48 (unused) and TB1-49 (+24V) of DCX exciter cabinet. This should apply +24V to the AGC card. One or more input channel LEDs should light.

NOTE: A silkscreen error on REV A boards mistakenly indicates that a +12V connection is required and that connections J1-10…13 are unused.

5. Ensure that outputs from J1 and J2 are disconnected.
6. Turn all potentiometers on AGC card fully counterclockwise.
7. Adjust SYS FWD potentiometer to obtain a reading of +15.74 volts on test point TP3.
8. Adjust GAIN potentiometer until a reading of +3.2V is obtained on TP1.
9. Adjust PA1 potentiometer until reading of +15.60 volts is obtained on test point TP5.
10. Adjust PA2 potentiometer until reading of +15.60 volts is obtained on test point TP6 (where applicable).
11. Adjust PA3 potentiometer until reading of +15.60 volts is obtained on test point TP7 (where applicable).
12. Adjust PA4 potentiometer until reading of +15.60 volts is obtained on test point TP8 (where applicable).

NOTE: A voltage set point of 15.60 volts will allow a 5% increase of HPA power before taking over AGC control. 15.60 is the nominal set point which is 5% lower than that of the System Fwd meter at nominal power. The amount of change can be adjusted by the user to a greater difference in the set points (to allow a higher change of power) if the system has the adequate headroom. The maximum power an HPA should be allowed to reach is 120%. An increase over 120% will cause the HPA to fault on Forward Power High.

13. Locate system forward power sample coax entering the universal meter driver (UMD) or total power control unit (TCPU) in DCX exciter cabinet.
14. Simulate a system reflected power of 2.5% by connecting forward power sample cable + 6dB attenuator to BNC input of the reverse power metering channel on UMD. Verify that a reading of 2.5% power is registered on system reflected power meter.
15. Adjust SYS REV potentiometer to obtain a reading of +15 volts on test point TP4.
16. Do not connect output from J1 or J2 to exciters until max exciter output level (headroom) has been properly restrained by the following procedure:
    a. Adjust exciter power to obtain 100% forward power.
    b. While transmitter is operating at 100%, connect BNC RF cable from RF sample port on front of the ADAPT preamplifier to spectrum analyzer.
    c. Establish measurement reference on spectrum analyzer screen of nominal RF sample level with transmitter operating at 100% power.
    d. Switch other exciter to the on-air position to maintain broadcast (where applicable).
    e. Switch REM/LCL switch at top of user interface module in exciter to LCL position (as necessary) to force exciter on while in the non-selected (off-air) position.
    f. Disconnect J23 (RF output) at rear of exciter, as a precaution.
    g. Place exciter in AGC mode via ADAPT Control software or user interface module AGC OFF switch. Status light on CUDC should turn green.
    h. Disconnect J17 (AGC input) at rear of exciter. With AGC feedback sample disconnected, exciter output power should rise to its maximum possible level. A jump in power of anywhere from +3 to +20 dB should be observed on spectrum analyzer.
    i. Add BNC attenuators to J15 (CUDC output) at rear of exciter until max exciter power is only 1 to 1.5 dB above nominal 100% level recorded earlier.
    j. Switch REM/LCL switch at top of user interface module in exciter to REM position to allow exciter to turn off while in the non-selected (off-air) position.
    k. Reconnect J23 (RF output) at rear of exciter.
17. Turn AGC potentiometer on front of CUDC module fully counter clockwise.
18. Connect J1 or J2 of AGC PCB to J17 (AGC input) of exciter in question.
19. Switch exciter back to the on-air position.
20. Turn AGC potentiometer on CUDC module clockwise until transmitter power output climbs to 100%.
21. Verify AGC is working by performing following tests:
    a. Lightly disturb system phasing by adjusting a phasing trombone (multitube systems). System forward power level should spring back to 100% for small changes. AGC should hold power at 100% until any HPA exceeds its set point of 110% HPA power.

b. While in HPA internal control, de-select RF mode for one HPA (i.e. turn RF off at HPA control panel). Power on remaining HPAs should be held to 110%. Jump in power on remaining HPAs should not cause overpower alarm due to overshoot. (See note at end of procedure).

c. Run new non-linear LUT correction. Power should always spring back to 100% after each iteration.

d. Simulate a system reflected power of 5% by connecting the forward sample + 3dB attenuator to system reverse metering channel on UMD. Power on each HPA meter should be reduced from 100%, and system reverse power should be held to 2.5%, thus indicating that VSWR fold back is working.

22. Verify that AGC power level can still be adjusted by issuing power raise and lower commands via ADAPT Control software.

23. Using ADAPT Control software, also check and re-adjust MGC levels as necessary.

24. Repeat procedure for second exciter in two exciter systems.

25. Procedure complete.

NOTE: In two exciter systems, it is very important that both exciters be kept in the REM mode at all times (switch on user interface module). This ensures that the exciters will always shut down when de-selected and ramp start when re-selected. The AGC power level in an exciter that is left on while in the non-selected position will float to either zero power or maximum power, depending on the AGC set point. An exciter that has floated to maximum power level will cause overdrive alarms when it is re-selected for on-air operation.

This effect occurs because the de-selected exciter (in LCL mode) is still on and receiving feedback from the transmitter AGC card. However, none of the internal AGC power adjustments it makes will affect the level of incoming AGC feedback because the transmitter output power is being controlled by the other exciter. The negative feedback loop is effectively broken and the power level will float to the upper or lower rail*…just as an op amp becomes a comparator when the negative feedback loop is removed.* Because it is impossible to set both exciter AGCs to the exact same power level, the exciter with the lower set point will always float to the lower rail (no power) while de-selected. The exciter with the higher set point will always float to the upper rail (max power) while de-selected.

Leaving both exciters in REM mode will prevent this effect. If local control of the exciter is desired, the REM/LCL switch should be switched to the LCL mode for the time necessary to perform the desired adjustments, then placed back in the REM mode.

NOTE: The AGC system has a relatively slow loop response speed. This creates the risk of power level overshoot in response to sudden changes in system power level (e.g. one HPA shutting off). When the exciter headroom has been properly limited to 1dB ~1.5dB (see procedure above), this overshoot should be minimal. However, the higher system gain typical of the first hour of transmitter warm-up will cause the exciter to operate at a lower nominal output level, thereby increasing the exciter headroom available. If AGC overshoot is excessive during this warm-up period, HPA overpower faults on the remaining HPAs may occur when one HPA is switched off, thereby leaving the AGC stranded at the upper rail (max power)…because the exciter is on, but no AGC feedback is returning from the system (all HPAs have faulted). This, in turn, will make it impossible to turn the HPAs back on, due to instant overdrive conditions. If such cases, correct AGC operation may be re-established by commanding the RF OFF then back ON at the system controller. This will force a ramp start of the exciter and allow the exciter AGC circuits to sync back up with the transmitter output power level.

Clearing the LUT corrector will also temporarily create more exciter headroom and create the potential for this overshoot effect. As the LUT correction is re-run, the system will naturally return to the previous exciter headroom range.

If this is a persistent problem, the exciter headroom should be reduced to a lower value (more attenuators on J15).

In summary, the user should always remember this golden rule while using the DCX AGC:

Never leave the exciter ON while the RF feedback is either interrupted (HPAs are off) or being controlled by the other exciter. Failure to observe this rule may cause the exciter AGC to float to the maximum value and cause cyclical overdrive trips. To break this cycle, the exciter must be shut off and ramp started again. This may be done via the RF ON button on the system controller (exciter in REM mode) or the DRIVE switch on the user interface card (exciter in LCL mode).

Schematic 47267125.030 attached.

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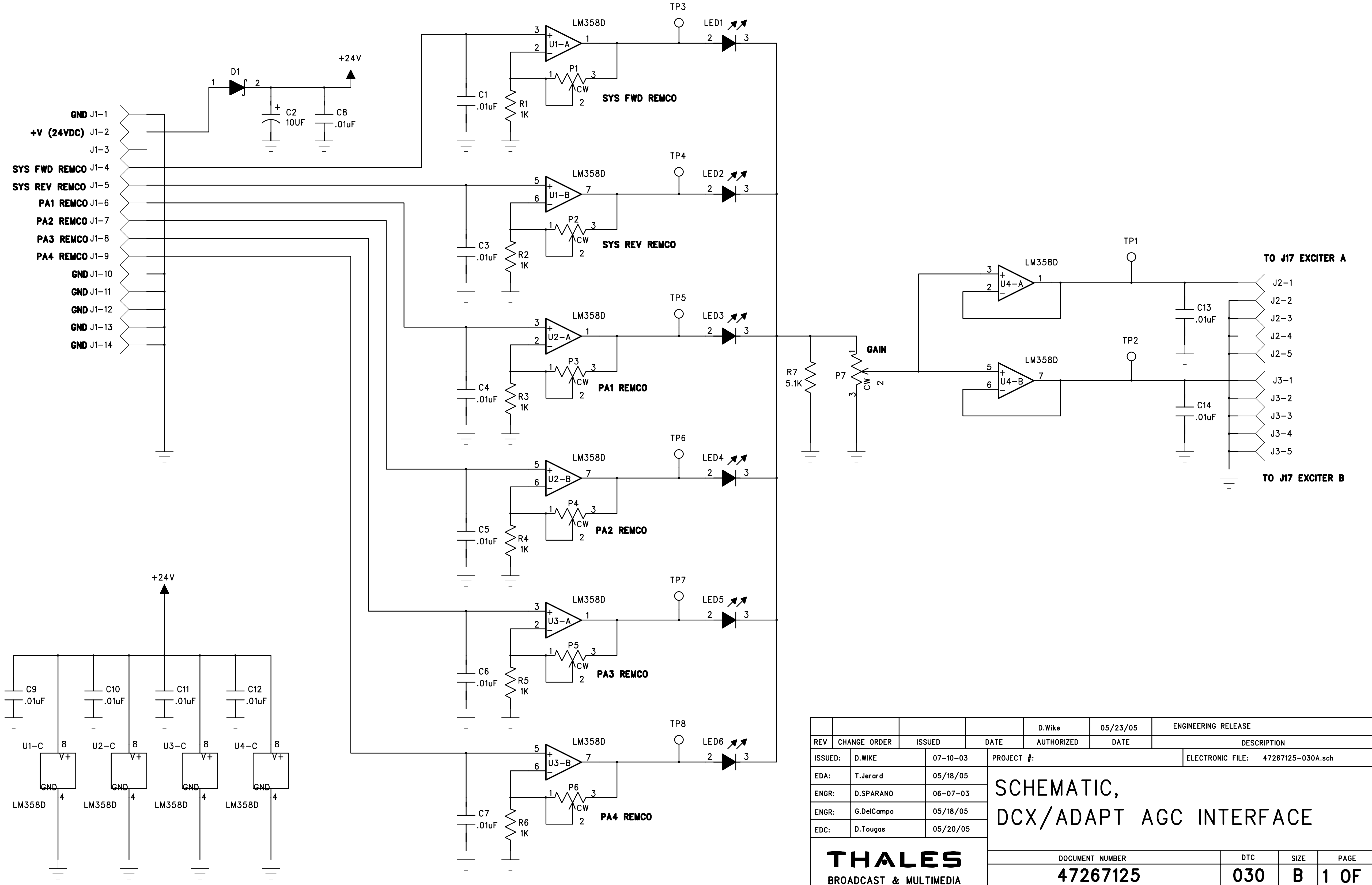

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SCHEMATIC, DCX/ADAPT AGC INTERFACE

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